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Notes on *Elephas shigensis* (MATSUMOTO and OZAKI) from the Ōsaka Group and the Paleo-Biwa Group

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Abstract

In the present paper the description is given of five specimens of elephant remains referable to *Elephas shigensis* (MATSUMOTO and OZAKI). They were all discovered formerly or newly from the Ōsaka group and the Paleo-Biwa group, Plio-Pleistocene deposits in the Kinki district, Central Japan. The species described here is quite different from *E. naumanni* (MAKIYAMA), while it has close relation to *E. proximus* (MATSUMOTO) of the earliest Pleistocene in Japan and *Elephas* of *E. meridionalis—E. trogontherii* line of that age in China.

Introduction and Acknowledgement

Recently the author has had opportunities to observe fossil elephants which were found in the past and recently from the Ōsaka group and the Paleo-Biwa group, Plio-Pleistocene deposits in the Kinki district, Central Japan. Since the olden times it has been known that those deposits had yielded many mammalian remains in fossil state, and some of them have been described time after time by various workers. As for the fossil elephants, some species from those deposits belonging to *Stegodon* have been well described and are familiar to the Japanese geologists. Among them, *Stegodon orientalis* OWEN from the classical locality of Ikadachi, on the west coast of Lake Biwa, is known to be of the Paleo-Biwa group, and on the other hand, *Stegodon akashiensis* (TAKAI) was yielded from the Ōsaka group.

However, some specimens which belong to *Elephas* remained to be univestigated for a long time. Only MAKIYAMA (1924b) studied a fragmental molar from Kyutoku on the east coast of Lake Biwa and referred it to *Elephas trogontherii* POHLING, but later it was removed to *E. namadicus naumanni* (MAKIYAMA) (=*E. naumanni* (MAKIYAMA) of this paper) (MAKIYAMA, 1938). In this paper, this molar is excluded

because of the uncertainty of the stratigraphical horizon which yielded it. Except for this case, for the first time MATSUMOTO and OZAKI (1959) described a new material of *Elephas* from the Paleo-Biwa group as *Archidiskodon paramammonteus shigensis.* On the other hand, IKEBE, ISHIDA and CHIJI (1965) published their opinion on the biostratigraphical divisions of the Pliocene and the Pleistocene deposits in the Kinki district, based upon fossil elephants, and recognized in them a zone of *Stegodon orientalis—Elephas shigensis* association as J_2 of IKEBE's letter nomination (IKEBE, 1954). In this case, "*Elephas shigensis*" is used as the synonym of *Archidiskodon paramammonteus shigensis* of MATSUMOTO and OZAKI.

In Japan numerous materials of fossil elephants belonging to genus *Elephas* were found in the Pleistocene deposits here and there and many species of this genus were discriminated. Among these, materials referred to *Elephas naumanni* (MAKIYAMA) are the most abundant, but it is questionable whether some of them are referable to that species or not. Therefore, it is necessary to examine other species of *Elephas* from Japan, and to make comparison between those and *E. naumanni.* Then, the present paper deals with the description and discussion of five specimens assignable to *E. shigensis* cited above, found from the Ōsaka group and the Paleo-Biwa group.

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Note on Specimens

The specimens treated here are two from the Paleo-Biwa group and three from the Ōsaka group. The first of the former (Specimen 1) is a fragmental left lower jaw bone with molar which was found by Ichimatsu FUJITA in 1875 at Ushiroyama, Sakawa, Katata Town, Shiga Pref., on the west coast of Lake Biwa. It was named "Mano elephant". The second (Specimen 2) is also a fragmental and detached upper molar from Miyagidani, Ōki, Katata Town which is very near to the former locality. It was discovered by Hanshiro TAMURA in 1919 and was named "Ōki elephant".

The first from the Ōsaka group (Specimen 3) is the posterior half of a lower right molar which was discovered on the grounds of Nomura Security Co.,

Kamimura, Fukui, Ibaraki City, Ōsaka Pref., in December 1963. The second (Specimen 4) is a severely broken right lower jaw bone which bears a fragmental molar. It was discovered by S. ISHIDA and T. YOKOYAMA on the south-east bank of a pond named "Kōmyō-Ike", Wada Town, Izumi City, Ōsaka Pref., when they were surveying the geology of that area in March 1965. The last (Specimen 5) was presented by M. ITIHARA who had found it at about 200 m north-east of Imakuma, Sayama Town, Kawachi District, Ōsaka Pref. in 18th May 1965. It is the posterior portion of a left upper molar.

Specimen 1 is in possession of Mano Primary School, Katata Town and Specimen 2 belongs to Mr. S. YŪKI of the same town, Specimens 3, 4, and 5 are all in charge of the Geological and Mineralogical Institute of the University of Kyoto.

Stratigraphical Note

It is known that both the Ōsaka group and the Paleo-Biwa group participated mainly in the formation of the higher terraces in the surrounding areas of Ōsaka City on one hand and in those of Lake Biwa on the other hand. Furthermore, they are distributed separately from each other, but having the same composition such as thick alternation of clay, sand and gravels. In addition, it is known that although they are mainly composed of fresh-water deposits, several marine clay beds are recognized in the Ōsaka group.

Stratigraphical investigations were carried out on them by various researchers many times. Recently, an excellent study was carried out tephrochronologically by ITIHARA (1960) on the Ōsaka group in that classical type area, the Ōsaka and Akashi district. According to him, these marine clay beds are recognized as eight beds stratigraphically and are named ascendingly from the first marine clay bed (Ma 1) to the eighth marine clay bed (Ma 8). These marine clay beds and some tuff layers intercalated in that group are very characteristic and make good indications for the identification of each stratigraphical horizon. Therefore, in this paper the stratigraphical succession is represented by them conveniently, from lower to upper, Yellow tuff, Ma 1, Pink tuff, Ma 2 and Yamada tuff, Ma 3 and Azuki tuff, Ma 4, Ma 5 and Hattyoike tuff, Ma 6, Ma 7, Ma 8 and so on.

On the other hand TAKAYA (1963) attempted to correlate the Paleo-Biwa group with the Ōsaka group by means of the same method as used by ITIHARA, and suggested that synchronous deposition occured in the two groups. Namely, it was found that some common tuff layers are intercalated in both the Paleo-Biwa group and the Ōsaka group.

In order to show the stratigraphical relations of the specimens dealt with here, it is effective to use such horizons represented by marine clay beds and tuff layers. Namely, Specimens 1 and 2 are yielded from about 10 m below Pink tuff and above Yellow tuff, according to TAKAYA. In the same manner the horizon of Specimen 3 is at 25-30 m below Ma 1 and 2.5 m above Yellow tuff, according to ISHIDA and others. Specimen 4 is derived from Ma 2, which is between Azuki tuff and Pink tuff, according to ISHIDA and YOKOYAMA. Specimen 5 is from Ma 5, according to ITIHARA. As a result, these specimens can be arranged ascendingly in stratigraphical succession as follows: Specimen 3, Specimen 1 and Specimen 2, Specimen 4, and Specimen 5.

Description of Species

Elephas shigensis (MATSUMOTO and OZAKI)

Pl. 12, figs. 1, 2; Pl. 13, Figs. 1-10; Pl. 14, figs. 1,2.

1959. *Archidiskodon paramammonteus shigensis*, MATSUMOTO and OZAKI, pp. 355—357, pls. 55—57.

The type specimen is a detached left lower molar which MATSUMOTO and OZAKI identified as $M_{\bar{2}}$ *sin.* It was found by Hidenosuke YAMADA in 1950 at Nishino, Ono, Wani, Shiga Town, on the west coast of Lake Biwa, which was called "Wani elephant No. 1". MATSUMOTO and OZAKI referred this specimen to the mutation of *Archidiskodon paramammonteus* which was described by MATSUMOTO (1939) with a fragmental tooth, "upper left the second molar", from Nagahama, Minato Town, Chiba Pref., South Kanto. However, the holotype referred to this species is fragmental and ill-preserved, and the tooth position of these two specimens is different. Moreoevr, it is very difficult to know the detailed specific characters from that single and fragmental specimen, so it does not seem safe to give the same specific name to two specimens which occured from different and distantly searate localities. In order to avoid confusion in future, it may be adequate to refer the specific *Elephas shigensis* (MATSUMOTO and OZAKI) to the specimen from Lake Biwa region. In this paper, the genus *Elephas* comprises *Archidiskodon*, *Parelephas*, *Mammuthus* and *Palaeoloxodon*.

The holotype specimen of *E. shigensis* was yielded from the Ryūge gravel bed which was interbedded within the Nanshō clay member of the Paleo-Biwa group, according to S. Yūki. In TAKAYA's new divisions of 1963 this horizon is set in B 9 bed of the Katata formation of the Paleo-Biwa group, of which the upper limit is represented by Ōno tuff. Also he pointed out that the Ōno tuff is same to Pink tuff of the Ōsaka group. Accordingly, it is possible to compare the stratigraphical

horizon of the holotype with those of other specimens of the Osaka group. Among the present specimens, Specimen 1 and Specimen 2, both from the Paleo-Biwa group, were also from the same horizon as that of the hlotype.

MATSUMOTO and OZAKI stated the characteristic features of the type specimen as follows: "....the valleys both inner and outer views very acutely thin out basally. .... The disks of well-worn ridges consist of each of one anterio-posteriorly widened mesial part and two not especially widened lateral wings, the figure of enamel being mesially annular and laterally laminar. The anterior border of the widened mesial part corresponds to the anterior loxodont sinus, while the posterior border does to the posterior one. Either the loxodont sinus is broad, obtuse and even plicated, as a distinctive characteristic of *Archidiskodon*. The anterior loxodont sinus is weaker than the posterior...." Also they distinguished this specimen from "*A. paramammonteus*" of MATSUMOTO in "the apparently broader crown, in the slightly more advanced hypsodonty, in the less prominent and better divided bases of ridges and in the thinner layer of enamel."

The measurements of the holotype and the present specimens are given in the table below for reference.

Table 1

	Position of tooth	Number(1) of lamellae	Maximal mesio-distal length (mm)	Maximal bucco-lingual breadth (mm)	Maximal height of crown (mm)	Lamellae frequency in 100 mm	Length-lamellar ratio	Height-breadth index
Holotype	$M_{\bar{2}}$ sin.	×11×	195 (ca. 153(2))	72	128	5-6.5	(ca. 14.8)	178
Specimen 1	$M_{\bar{3}}$ sin.	×11×	164.1(2)	87.1	—(4)	5.5-6	13.7	—
Specimen 2	M^{3} dext.	+11+	161.0(3)	78.0	151.0	5-6	14.6	195
Specimen 3	$M_{\bar{2}}$ dext.	+8	113.5(2)	75.0	116.0	5-6	14.1	155
Specimen 4	$M_{\bar{1}}$ dext.	12	149.0(2)	59.0	110.0	7	12.4	186
Specimen 5	M^{2} or M^{3} sin.	+4	49.0(3)	59.0	104.5	8	12.3	176

(1) Number of lamellae as preserved, and + means the position of lost or incomplete lamellae.
(2) Maximal distance measured in parallel with the occlusal surface between the mesial and the distal and the distal extremities of the tooth on that surface.
(3) Distance between the two plans tangential to the mesial and distal ends of the tooth which are parallel with the central lamella.
(4) Unmesurable because the root is embedded in the jaw bone.

Specimen 1 (Pl. 1, figs. 1, 2): This specimen is found from the same horizon as that of the holotype specimen, and the locality which yielded it is also very near. The horizontal ramus is broken off in front of its mesial portion, so that nearly nothing of the mandibular symphysis has been preserved. However, from the re-

maining feature it appears to have very short-spouted symphysis and larger mandibular angle than that of *Elephas naumanni* (MAKIYAMA). The whole of the ascending ramus is lost. The lower border of the horizontal ramus is slightly but clearly convex and protrudes outwardly in the frontal plane. The ramus as preserved measures 4045 mm in length, 115 mm in height at the inner lateral side at the middle of the molar, and 142 mm in transverse width at the same point. The color of the ramus is dark brown by limonite staining.

The ramus bears rather broad molar, probably $M_{\bar{3}}$ sin. because of the absence of the succeeding molar. It has also broader crown and larger number of dental lamellae than the holotype of $M_{\bar{2}}$ sin.. It measures 164.1 mm in length from the mesial end and to the distal end, on and in parallel with the occlusal surface. Its maximal breadth is 87.1 mm at the fifth lamella from the mesial end, but its maximal height is not determined as the root is throughly enbedded in the ramus. The lamellae ground down are nine in number and three unworn lamellae of the distal side are observed. Thus, the lamellae formula is represented approximately as $\times 12\times$. The worn surface of the molar shows roughly an oval, and its mesio-distal length is measured as 122 mm. The lamellae frequency in 100 mm is 5.5 on the lingual side, 6 on the buccal side. The length-lamella ratio obtained from the occlusal surface is 13.6 and is very near to that of the holotype.

The distal portion of this molar curves conspicuously toward the buccal side in the same manner as ordinarily in the last lower molar of *Elephas*. On the occlusal surface, the dental lamellae are arranged subparallel with each other and make some convergence toward the buccal portion as in the holotype specimen. The lamellae are slghtly convex toward the mesial end. The surface is slightly concave and slopes slightly from the buccal side to the lingual side. There is very much cementum on this specimen, concealing the slopes of the lamellae and filling up the valleys. Cementum is brown in color all over. The mesio-distal distance of the valley is generally larger than that of the adjacent lamella on the less worn surface, while the former is nearly equal to or somewhat shorter than the latter on well worn surface. From the fact mentioned above, it can be assumed that the mesio-distal thickness of a lamella thickens basally in the same manner as shown in the description of the holotype.

The enamel loops are very distinctly marked by their lustrous black color forming a contrast with the brown cementum and dention. Four smaller transverse enamel loops, all annular, are observed at the slightly worn lamella of the distal portion and three rather large ones are seen at adjacent lamella of the mesial side. They increase in size with progressing wear mesially. The well worn lamella con-

sists of three regions, central annular region and two lateral laminar regions. Loxodont sinus is represented by obtuse and broad median expansion which protrudes mesially or distally, but that of the opposite lamellae are never in contact with each other. The enamel is thick, 3.1 mm on an average and is rather smooth but coarsely plicated.

The present specimen is almost similar to a left horizontal ramus with $M_{\bar{3}}$ *in situ* from the lower Pleistocene deposits of Koito, Mishima Village, Kimitsu District, Chiba Pref. This specimen was referred to *Parelephas protomammonteus matsumotoi* SAHEKI, but now is included in *Elephas proximus* (MATSUMOTO) (=*Parelephas proximus* or *P. protomammonteus proximus*) (SAHEKI, 1931; TAKAI, 1938, 1939). Both the present specimen and that specimen have commen characteristics and are distinguished from *Elephas naumanni* (MAKIYAMA) in broader breadth of crown, in less advanced hypsodonty, in larger values of length-lamellae ratio and in rather small size. On the other hand, the present specimen differs clearly from the specimen of *E. proximus* (MATSUMOTO) in smaller number of lamellae, viz. 12 in the former and 19 in the latter, in smaller number of digitelli (or conelets) shown as transverse small annular enamel loops, viz. 3 or 4 in the former and 7 in the latter, in thicker enamel layer and the presence of obtuse and broad median expansion or loxodont sinus. A few years ago, the author carried out an examination on some fossil elephants from the lower Pleistocene deposits Kuchinotsu formation of the Shimabara Peninsula, North Kyushū (KAMEI 1964). Among these specimens, $M_{\bar{3}}$ dext. of *Elephas* sp. has some similarities with the present specimen. However, the former differs from the latter in narrower crown, in more advanced hypsodonty, in more crenulated but coarsely plicated thick enamel layer, in larger values of the length-lamellae ratio and in greater lamellae frequency.

Although the present molar is designated as broad crown group, it is evident, when compared with typical broad crown group of "*Archidiskodon*" of Europe, *e.g. E. planifrons* FALCONER and CAUTLEY from Dobermansdorf, Austria (SCHLESINGER, 1912) and *E. meridionalis* NESTI from Upper Val d'Arno, Italy (WEITHOFFER, 1890), that the present specimen belongs to the narrow crowned and more advanced hypsodont group.

Specimen 2 (Pl. 2, figs. 1-3): The stratigraphical horizon of this specimen is the same as the former. The central portion of a right upper molar which comprises eleven dental lamellae is preserved, and its mesial and distal portion are lost. It is difficult to know its tooth position correctly from such isolated and fragmental materials, but it is deduced from its broadness and from the large number of lamellae that this molar may belong to $M^{\bar{3}}$ dext.. It measures 161 mm in length as pre-

served, 78 mm in maximal breadth at the first lamella from the mesial end and 151 mm in maximal height of the crown at about the tenth lamella from the mesial end. As some lamellae of the mesial part of this molar are lost, it may be assumed that the true maximal breadth of the crown exceeds the measured values. The molar is gray to white in color covered with excess cementum. The length-lamellae ratio is 14.6 and the thickness of the lamella varies from 7.9 mm to 9.0 mm. Thus, the thickening of the lamella toward the basal part is not so conspicuous.

The specimen is composed of five worn lamellae of the mesial side and six unworn lamellae of the distal side, which are all in flat plane-like form. They form an angle of about 65° with the occlusal surface. In the frontal aspect of a lamella, it is characteristic that the cervical portion has nearly the same breadth as the basal portion, but in the case of *Elephas naumanni* (MAKIYAMA) the cervical portion of a lamella of M^3 clearly shows abrupt narrowing comparing with the basal portion. Four smaller and annular enamel loops are observed transversely at the crest of the sixth lamella just starting to wear. The figure of the enamel loop on worn surface is quite similar to that of Specimen 1 and the holotype, viz. consisting of annular figure of the central portion and two laminar figures of the lateral portion. Median expansion of obtuse and broad loxodont sinus is developed in both the mesial and the distal sides of a lamella. The enamel is rather smooth and about 2.2 mm in thickness and is coarsely and irregularly plicated.

Specimen 3 (Pl. 2, figs. 4-6): Among the present specimens, this is the one derived from the lowest horizon in stratigraphical succession. A detached and weathered specimen is taken to be a lower right molar, probably M_2 dext.. Some lamellae of the mesial portion are lost, but a distal talon and eight lamellae, of which three of the mesial portion are already in wear, are preserved. The cementum of yellowish white color remains only in the fillings of valleys, and therefore rugose enamel is exposed on both lateral surfaces and on the occulsal surface. The distal portion of the molar curves strongly toward the buccal side and the lamellae are arranged subparallel with the others and are converged toward the buccal side, as seen in Specimen 1 and the holotype. Each lamella is slightly concave toward the distal end. In lateral views, the lamellae, especially toward the distal portion, form long S-shape; namely each crest portion slants slightly to the distal portion, the middle portion is nearly vertical or inclines to the distal portion, and the basal portion bends abruptly to the distal portion again.

It measures 169 mm in length as preserved, 75 mm in maximal breadth at the first lamella from the mesial end, 116 mm in maximal height of the crown at the fourth lamella from the mesial end. Mesio-distal length along the occlusal surface

Table 2. Mesio-distal distance of the lamellae and the valleys (in mm)

No. of lamella and valley	L. 1	V. 1-2	L. 2	V. 2-3	L. 3	V. 3-4	L. 4	V. 4-5
Cervical portion 1.	11.0	13.0	10.0	9.5	8.0	11.0	8.0	9.0
b.	11.5	6.0	8.5	7.0	10.0	4.5	8.5	4.0
Middle portion 1.	11.0	13.0	9.0	11.0	9.5	13.0	7.0	12.0
b.	8.5	7.0	10.5	7.0	10.0	6.0	8.5	6.0
Basal portion 1.	12.5	15.0	10.0	14.5	15.0	14.0	12.0	11.5
b.	12.0	7.0	12.0	8.5	14.0	7.5	10.0	6.0

No. of lamella and valley	L. 5	V. 5-6	L. 6	V. 6-7	L. 7	V. 7-8	L. 8
Cervical portion 1.	8.0	6.5	8.0	5.0	9.0	4.5	9.8
b.	11.0	4.8	10.0	4.3	8.5	2.5	8.2
Middle portion 1.	8.0	9.0	10.0	8.3	9.5	6.0	9.0
b.	8.0	6.5	8.5	8.5	8.8	5.0	8.5
Basal portion 1.	9.5	11.5	10.0	10.0	10.0	7.5	10.0
b.	10.7	8.0	10.0	7.5	7.5	5.0	8.0

L: lamella V: valley 1: lingual side b: buccal side

Table 3. Bucco-lingual breadth and height of each lamella (in mm)

No. of lamella		1	2	3	4	5	6	7	8	talon
Breadth	crest	48.8	47.1	40.0	35.1	29.2	28.8	ca. 28	15.1	10.8
	middle	74.2	76.1	75.0	69.5	67.0	59.2	47.2	36.8	
	base			70.9	60.5	62.0	57.0	47.0	29.0	
Height				112.0	116.5	113.2	108.0	94.1	84.0	

is 113.5 mm, and the length-lamellae ratio is about 14.1. The lamellae frequency in 100 mm is 5 on the lingual side, 6 on the buccal side. Therefore, these measurements suggest that the present specimen is very near to the holotype, M_2 sin.. Each lamella thickens slightly from the crest to base, while each valley becomes narrow basally. These measurements are shown in tables above.

The enamel is gray to black in color and shows some finely arranged parallel wrinkles of perikymata which are rugose on weathered surface. It is about 2 mm thick on the occlusal surface, but it thickens up to 4 mm near the base of crown. The crest of unworn lamella consists of four digitelli (or conelets), of which two central ones are more developed than the others. These two central digitelli are

further divided into three to five smaller ones at some of the more mesial lamellae. Such a large number of digitelli of a lamella is not observed among the others of the present specimens. The enamel loops of well-worn lamella appear to be suppressed ovoid in form, and one of them is composed of central dentine of white color and surrounding black, rather smooth and coarsely plicated enamel layer. Median expansion of loxodont sinus is indistinct. At the base of molar, all of the lamellae are joined by enamel layer to the most distal portion, and the dentine fills up every pulp cavity to built the root. Such extension of dentine filling and root formation to the distal extremity of the tooth as seen in the present specimens are not yet observed in most of the molars of *Elephas naumanni* (MAKIYAMA), as far as the author has investigated.

Cosequently, the molar $M_{\bar{2}}$ dext. of the present specimen is quite similar to $M_{\bar{2}}$ sin. of the holotype specimen in feature and characters. Namely, broader breadth of crown and less advanced hypsodonty of both specimens are very characteristic. As for $M_{\bar{2}}$ of *E. naumanni* (MAKIYAMA) dredged from the sea bottom of the Seto Inland Sea, those having a breadth which exceeds 70 mm and crown height of less than 130 mm are very rare. On the other hand, the present specimen is also nearer to *E. proximus* (MATSUMOTO) in less prominent median expansion of loxodont sinus and in greater number of digitelli than the others of the present specimens. $M_{\bar{2}}$ sin. of *Elephas* sp. of the Kuchinotsu formation (KAMEI, 1964) has narrower and higher crown than the present specimen.

Specimen 4 (Pl. 3, figs. 1-3): Owing to severe weathering, this specimen is brittle and earthy in preservation. As a whole, it is white to brownish in color. The specimen preserved is a right horizontal ramus with a molar *in situ*. As it is broken off at the front of and just behind the molar, it is unknown wheather the preceding and the succeeding molars are present or not. The horizontal ramus is 215 mm in length as preserved, 112 mm in height at the middle of the molar on the buccal side, and 96.5 mm in width at the same point. Accordingly, as it is smaller than Specimen 1, a ramus with $M_{\bar{2}}$, and Specimen 3, $M_{\bar{3}}$ dext., it may be assumed that the present molar is $M_{\bar{1}}$ dext.. Neverthless, the features of this ramus is very similar to that of Specimen 1, and the basal margin in frontal view curves strongly toward the outer lateral side.

The molar is ill-preserved, but it consists of twelve lamellae and the mesial and the distal talons. Thus, the lamellae formula can be represented as $\times 12\times$. The length of the molar is 149 mm as preserved, 59 mm in maximal breadth at the third lamella from the mesial end, and 110 mm in height at the eighth lamella from the mesial end. Each lamella is about 9 mm thick an average on the occlusal sur-

face, and no marked increment of the thickness toward the base is observed. On the occlusal surface each lamella is separated without any contact with each other. On the lateral sides no conspicuous bending of lamellae as seen in the holotype specimen and Specimen 3 is observed. The lamellae frequency in 100 mm is about 7.

The number of digitelli is actually three in one lamella, but they are divided by fission into smaller ones, especially at the central portion of crest of a lamella. The enamel is white in color and varies in thickness from 2.5 mm on the occlusal surface to 3.5 mm at the basal part of the crown. The enamel plication is generaly coarse and irregular.

Specimen 5 (Pl. 2, figs. 7-10): The specimen represented by a fragment of a molar is composed of only four of the most distal lamellae and a distal talon of a upper molar. From the breadth and the height of crown and a plane-like lamella form, it is tentatibely assigned to the distal portion of a upper left molar, probably $M^{\frac{2}{}}$ or $M^{\frac{3}{}}$ sin.. The length of this preserved portion is 49 mm. Height, breadth and thickness of each lamella are as follows (in mm)

Table 4

No. of lamella	Height	Breadth	Thickness	
			crest	base
1st.	101.5	59.0	not measurable	
2nd.	104.5	56.9	9.2	11.0
3 rd.	103.0	54.9	9.1	9.0
4 th.	98.0	47.5	8.0	9.5
talon	77.1	34.1	—	9.5

The molar is dark brown in color as a whole and covered by thick excess cementum. The basal uniting by enamel layer is perfectly formed. As the pulp-cavity of each lamella is filled with dentine thoroughly, the root formation has already proceeded to the most distal lamella. In Fig. 1 the artificial horizontal cut, 35 mm and 68 mm from the coronal surface is shown. From these it can be seen that lamellae are strongly convex toward the mesial portion in horizontal plane. Obtuse and slightly broad median expansion of loxodont sinus to the mesial portion is also shown. There are actually three digitelli which are represented by transversely arranged annular enamel loops on one lamella. Among them, the central annular one is expanded mesio-distally, while the other two of the lateral side become linear bucco-lingually. The plication of the enamel is coarsely and irregu-

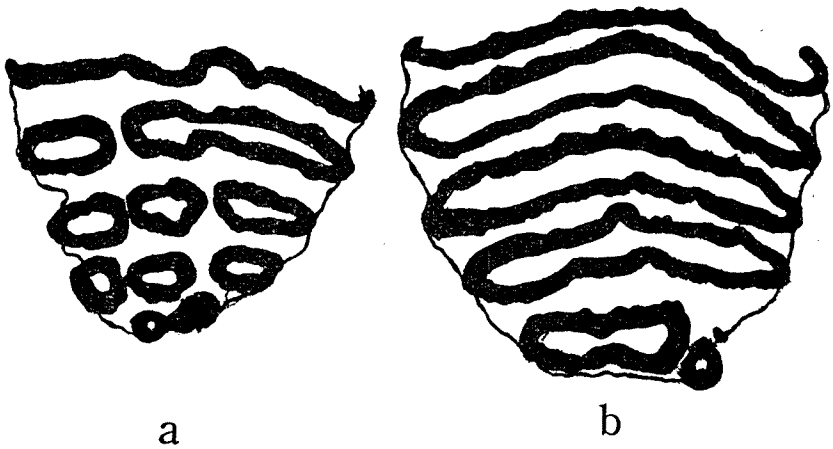

Fig. 1. Enamel loops of specimen 5. a.: 35mm below the cornal surface, b.: 68 mm below ditto. ×1

larly arranged. The thickness of enamel varies from 2.5 mm at the crest to 3.5 mm at the base. It is black by staining at lateral margins, but white to translucent in the central portion of a lamella. The dentine is delicate and brown in color, and the cementum is yellowish brown to dark brown, somewhat rough in touch. The frontal view of a lamella is different in form from that of *E. naumanni* (MAKIYAMA), in having rather broad cervical part and less prominent median longitudianl fold of loxodonta sinus.

As each of the present specimens has been brought from different stratigraphical horizons, it is probable that some variant forms are embraced together under the name of *Elephas shigensis* (MATSUMOTO and OZAKI). Neverthless, it is also true that they have some common characteristics which separate the species from other species. Namely, this species differs from the commonly known *E. naumanni* (MAKIYAMA) from the younger Pleistocene deposits in Japan and China, in broader and less advanced hypsodonty, in obtuse and broad median expansion of loxodont sinus, in coarsely and irregularly plicated enamel layer and in more advanced root formation. Furtheremore, it is noticeable that the dental lamella of the present specimens has three digitelli usually and does not bear any remarkable finely arranged longitudinal ridges of frontal mesial and distal sides of a lamella which are frequently seen by fission on the enamel surface of *E. naumanni* and *E. maximus*.

As for the other species of Elephas from the lower Pleistocene of Japan, *E. proximus* (MATSUMOTO) is very near the present species. But the former has larger

number of lamellae in M_3, less prominent median expansion of loxodont sinus and larger number of digitelli of one lamella. Moreover, the definition of the former is somewhat confused, because the species embraces too much different forms in which some are evidently assignable to other species of Elephas (DIETRICH, 1927; TAKAI, 1936, 1939; SHIKAMA, 1937). However, some of the present specimens of *E. shigensis* (MATSUMOTO and OZAKI), e.g. Specimen 3, have some resemblances to a certain specimen belonging to *E. proxmius* (MATSUMOTO). On the other hand, *Elephas* sp. of the Kuchinotsu formation of North Kyushû (KAMEI, 1964) is similar in some points to *E. shigensis* and *E. proximus*, but the former is referrable to still narrower and more a dvanced hypsodonty group than the latter two.

From the lower Pleistocene of China, some remains of *Elephas* were known, which were referred to "*Archidiskodon*" group. Among them, *E. tokunagai* (MATSUMOTO) from Lower Zone III of Yushê (TEILHARD DE CHARDIN & TRASSAERT 1937) and *Elephas* (*Archidiskodon*) sp. of Loyang (CHOW, 1957) are close to *E. shigensis*. All of them mentioned above are quite different from typical "*Archidiskodon*" like *E. planifrons* and *E. meridionalis* in having narrower and higher crown, but they have some characters in common with those observed in *E. meridoinalis—E. trogontherii* lines of Europe as stated by CHOW. The detail study of those *Elephas* in Japan and China is remained in future, but it can be said, therefore, that the present specimens referred to *E. shigensis* (MATSUMOTO and QZAKI) have close relations to *Elephas* of the earliest Pleistocene in Japan and China.

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Explanation of Plate 12

Fig. 1. *Elephas shigensis* (MATSUMOTO and OZAKI); fragment of left mandibular ramus bearing $M_{\bar{3}}$ (Specimen 1); outer lateral view $\times\frac{1}{2}$.

Fig. 2. Ditto; ditto; dorso-ventral view, $\times\frac{1}{2}$

1

2

Explanation of Plate 13

Figs. 1-3. *Elephas shigensis* (MATSUMOTO and OZAKI); fragment of right upper molar $M^{\frac{3}{}}$ (specimen 2)

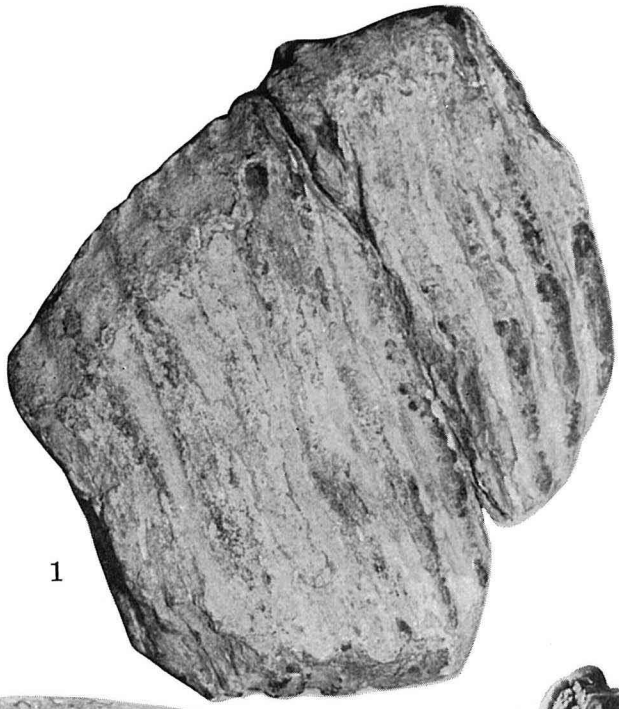
1. lingual view, $\times\frac{1}{2}$
2. distal view $\times\frac{1}{2}$
3. occlusal view $\times\frac{1}{2}$

Figs. 4-6. Ditto; fragment of right lower molar $M_{\overline{2}}$ (specimen 3)

4. occlusal view, $\times\frac{1}{2}$
5. buccal view $\times\frac{1}{2}$
6. lingual view $\times\frac{1}{2}$

Figs. 7-10. Ditto; fragment of left upper molar $M^{\frac{2}{}}$ or $M^{\frac{3}{}}$ (specimen 5)

7. lingual view, $\times\frac{1}{2}$
8. mesial view, $\times\frac{1}{2}$
9. buccal view, $\times\frac{1}{2}$
10. distal view. $\times\frac{1}{2}$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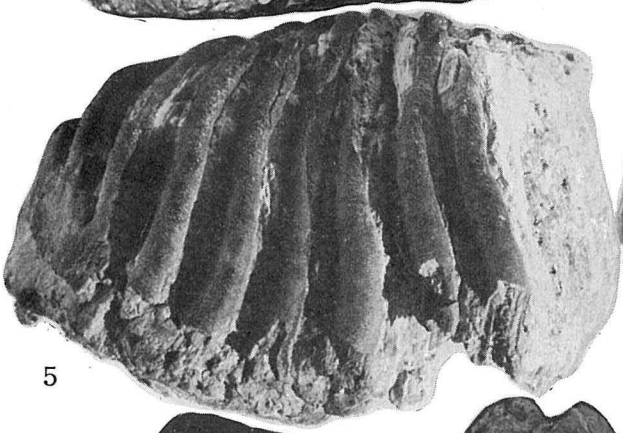
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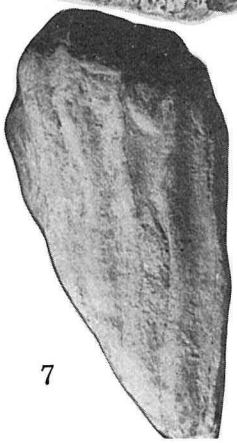
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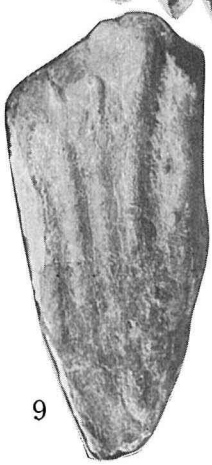
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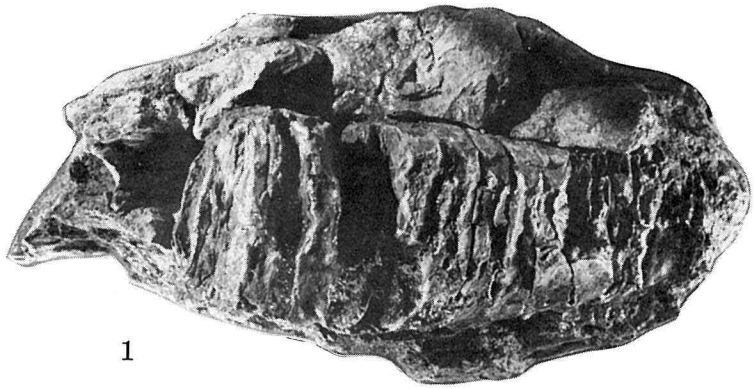
Explanation of Plate 14

Figs. 1-3. *Elephas shigensis* (MATSUMOTO and OZAKI); fragment of right mandibular ramus bearing $M_{\bar{1}}$ (specimen 4)

1. dorso-ventral view $\times\frac{1}{2}$
2. inner lateral view $\times\frac{1}{2}$
3. outer lateral view $\times\frac{1}{2}$



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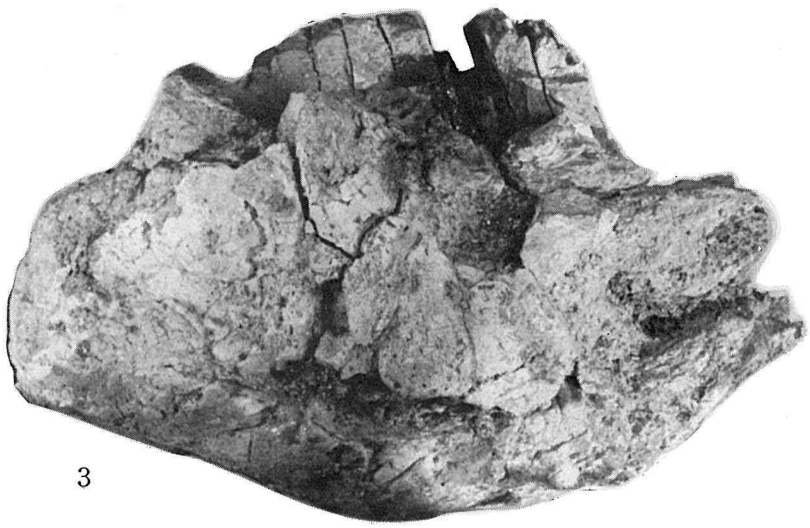

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