FOSSIL PROBOSCIDEA FROM THE MALAY ARCHIPELAGO AND THE PUNJAB

by

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with pls. I—XVII

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INTRODUCTION

The fossil Proboscidea from Java that form the main subject of the present paper were brought together during the closing decade of the last century by Eug. Dubois and his assistants in search of *Pithecanthropus*. Fossil proboscideans had long been known to occur in the island; as a matter of fact it is just about one hundred years ago that the first note on fossil Java proboscideans was published (Junghuhn, 1857).

Prior to Dubois's researches, Martin (1883-1890) had already devoted a series of papers to the fossil proboscideans of Java. To this Dubois (1908) added only a few pages, containing brief diagnoses of new species of *Stegodon* and of *Elephas*. There are various subsequent papers dealing with fossil proboscideans from Java, describing material of the species already made known by Martin and by Dubois, such as Janensch (1911), Pohlig (1911), Soergel (1913), Janensch and Dietrich (1916), Stehlin (1925), Dietrich (1926), Van der Maarel (1932), Von Koenigswald (1933, 1934, 1935b), and Osborn (1942, pp. 1302-1303). Several papers published during the last few decades contain descriptions of, or comments upon, fossil Java proboscidean species proposed as new, viz., Van der Maarel (1932), Von Koenigswald (1933, 1951), Dietrich (1934), Kretzoi (1950), and myself (Hooijer, 1953c, pp. 225 and 227; 1954a).

As the result of all this work much information concerning the fossil Proboscidea of Java is already available. The Dubois collection, however, remained virtually undescribed. For various reasons it appears desirable that an account of it should be written. The collection contains a wealth of material, cranial, dental, and skeletal, of the most common stegodont of Java, *Stegodon trigonocephalus* Martin, that rounds off all previous work on this form. Secondly, it clarifies the specific position of the fossil Java elephant, *Elephas hysudrindicus* Dubois, the cranial characters of which show that it has quite unjustifiably been sunk in the synonymy of *Palaeoloxodon namadicus* (Falconer et Cautley). Further, it contains material of several of the rarer Java proboscideans, viz., *Stegodon hypsilophus* Hooijer, and *Archidiskodon planifrons* (Falconer et Cautley).

There is proboscidean material in the Dubois collection from localities outside Java, too. From 1888 to 1890 Eug. Dubois worked in Central Sumatra, and collected subfossil mammals from limestone caves in the Padang Highlands, including molars of *Elephas maximus* L.

In 1895 Eug. Dubois visited a number of Upper Siwalik localities in the Punjab. Here, again, he proved to be a lucky collector, for during his brief stay he found a molar, the second to become known, of the rarest Upper Siwalik proboscidean, *Stegolophodon stegodontoides* (Pilgrim), a duplicate specimen of the one and only known skull of *Archidiskodon planifrons* (Falconer et Cautley), as well as good material of *Stegodon insignis* (Falconer et Cautley) and of *Elephas hysudricus* Falconer et Cautley. These specimens will be described for the first time in the present paper.

In the years 1948-1950 I had the good fortune to receive a collection of Pleistocene vertebrates from Celebes, containing a rare *Stegodon* and a pygmy *Archidiskodon* (Hooijer, 1949, 1953a-c, 1954b). Additional material from this source is included in the present work.

In 1954 Dr. Joseph T. Gregory sent me for study the *Archidiskodon* material found by Dr. G. E. Lewis during the Yale North India Expedition of 1932. One molar, the first *Archidiskodon* to be described from the Tatrot zone, basal Upper Siwaliks, has already been published upon (Hooijer, 1955), and the Pinjor zone specimens will be dealt with below.

Beside the recent material of *Elephas maximus* L. in the Leiden Museum, including the cotype skeletons of *Elephas sumatranus* Temminck, I also studied that in the Laboratoire d'Anatomie Comparée at Paris, by kind permission of Dr. J. Anthony. In the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle at Paris I have examined a collection of *Elephas maximus* molars originating from the Thung Lang basin, Tonkin, Indo-China, brought together by Dr. J. Fromaget, who most kindly offered this material to me for study.

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FOSSIL PROBOSCIDEA AND THE STRATIGRAPHY OF THE PLEISTOCENE IN SOUTHEASTERN ASIA

The proboscideans have had a considerable bearing on the problem of the age of *Pithecanthropus*. The advanced *Stegodon* of the Trinil beds originally led Dietrich (1926, p. 139) to accept a Late Pleistocene age, but Osborn (1929a, p. 216) considered *Pithecanthropus* to be almost certainly Middle Pleistocene in age. After having examined the photographs of the molars of *Elephas hysudrindicus* sent to him by Dubois (Osborn and Colbert, 1931, p. 187) Osborn gave his final dictum thus:

"Osborn, 1930: This progressive stage of *Palaeoloxodon,* like that of *Stegodon airâwana,* is of great anthropological interest as establishing the Middle Pleistocene age of *Pithecanthropus erectus*, first pointed out by Dietrich" (Osborn, 1942, p. 1303).

The Trinil beds have been assigned to the Middle Pleistocene also by Von Koenigswald (1934, p. 200; 1935a). The various successive mammal horizons first distinguished in Java by Von Koenigswald (l.c.) have been correlated with those of India as follows:

India	Java
Narbada Beds	Trinil
Boulder Conglomerate	
	Djetis
Pinjor zone	Kali Glagah
Tatrot zone	Tjidjoelang

Incidentally, Von Koenigswald originally envisaged the Tatrot and Pinjor zone faunas, and the Tjidjoelang plus Kali Glagah faunas as Pliocene, but these faunas have a Villafranchian aspect, and, therefore, have been placed in the Early Pleistocene by Colbert (1942, p. 1454; 1943, p. 427), Movius (1944, p. 84; 1949, p. 346), and myself (Hooijer, 1950, p. 37; 1951, p. 274; 1952b, p. 442) [1]. The characteristic Villafranchian fossil is *Archidiskodon planifrons,* which makes its first appearance in the Tatrot zone, basal Upper Siwaliks (Hooijer, 1955), and which persists into the Pinjor zone. It is also found in Java and in China. Von Koenigswald (1940, p. 70) has designated this faunal stage as the "Siva-Malayan" fauna, having its origin in Northern India, and spreading from there to Java, where *Archidiskodon planifrons* occurs both in the Tjidjoelang and in the Kali Glagah beds (Von Koenigswald, 1940, p. 74; 1950, p. 92).

Subsequent to this Early Pleistocene, Villafranchian development in the Orient, as first clearly expressed by Pei (1935, p. 424), there is the *Stegodon-Ailuropoda* faunal complex, the "Sino-Malayan" fauna of Von Koenigswald (1939, p. 49; 1940, p. 72), a Middle Pleistocene mammal assemblage that includes the cave faunas of Southern China such as those described by Young and Liu (1951) and by Colbert and Hooijer (1953), as well as the Trinil fauna of Java with *Pithecanthropus* (Colbert, 1942, pp. 1452 and 1454; 1943, p. 426; Hooijer, 1951, p. 276; 1952b, p. 437). In Burma, its equivalent is found in the fauna of the Mogok caves (Colbert, 1943, p. 425). The proboscidean characteristic of the post-Villafranchian development on the continent is *Palaeoloxodon namadicus,* originally described from the Narbada beds, Central India.

Thus, two Pleistocene faunas have come to be recognized in Southeastern Asia, an Early Pleistocene, Villafranchian stage, the Siva-Malayan fauna, followed by a Middle Pleistocene stage, the *Stegodon-Ailuropoda* or Sino-Malayan fauna. These two faunas are present in Burma as invading assemblages, the Early Pleistocene or Upper Irrawaddy fauna coming in from the West, and the Middle Pleistocene or Mogok fauna coming in from the East (Colbert, 1942, p. 1451; 1943, p. 427). In Java, of course, the two faunas also represent invading assemblages, both coming in from the North.

In his earlier correlation tables Von Koenigswald (1934, p. 200; 1939, p. 50) placed the Djetis fauna somewhat later than the Pinjor, but in later tables (Von Koenigswald, 1940, p. 74; 1950, p. 93) the Djetis fauna is

1) Even Pilgrim (1938, p. 479), who was in favour of a Pliocene age of the Tatrot, as is Von Koenigswald (1940, p. 75), later agreed as to the Pleistocene age of the Tatrot zone (Pilgrim, 1952, p. 418).

placed fully as early as the Pinjor. It is against this conclusion that I objected several years ago (Hooijer, 1952b), pointing out the close relationships of the Djetis fauna to those of the Southern China caves (Szechwan, Yunnan, Kwangsi) from which it received a number of elements such as *Hylobates, Pongo, Hystrix, Viverra, Felis, Tapirus, Muntiacus, Rusa,* and *Bubalus*. The presence of these invading elements from Southern China (Von Koenigswald, 1939, p. 49; 1940, p. 72; 1950, p. 92) are proof that the Djetis fauna should be classed with the Middle Pleistocene *Stegodon-Ailuropoda* fauna, linking it up with the Trinil fauna, and not with the Villafranchian stage of the Tatrot and Pinjor, represented in Java by the Tjidjoelang and Kali Glagah faunas. The correlations adopted in the present work are presented in table 1.

TABLE 1

Correlation of Villafranchian and of Middle Pleistocene faunas

	India	Burma	Java	South China
Middle Pleistocene	Narbadas Boulder Conglomerate	Mogok Caves	Trinil Djetis	Szechwan Yunnan Kwangsi
Lower Pleistocene	Pinjor Tatrot	Upper Irrawaddies	Kali Glagah Tjidjoelang	Ma Kai Valley

Some of these faunas, notably those of the Pinjor zone, of the Djetis and Trinil beds, and of the Southern China caves are very extensive; others are less well known. Let us consider only the proboscideans.

The Villafranchian faunas of the Tatrot and the Pinjor zones, Upper Siwaliks, are the most varied as far as the proboscideans are concerned, each containing a mastodont (a species of *Pentalophodon*), various stegodonts (*Stegolophodon stegodontoides* (Pinjor zone), *Stegodon bombifrons* (Tatrot zone), and *Stegodon insignis* (Pinjor zone), the early archidiskodont *Archidiskodon planifrons* (both zones), *Elephas hysudricus* (Pinjor zone), and *Elephas platycephalus* (Pinjor zone). *Equus* and *Leptobos*, characteristically Villafranchian types, appear only in the Pinjor zone (Hooijer and Colbert, 1951a, p. 534).

The Upper Irrawaddy fauna of Burma (Colbert, 1938, 1943) contains *Stegolophodon latidens, Stegodon elephantoides* (of which Osborn's *Stegodon insignis birmanicus* is clearly a synonym; cf. Chakravarti, 1937a, p. 35; Colbert, 1938, p. 414), and an elephant that is identified by Colbert (1938, p. 415; 1943, pp. 405 and 421) as *Elephas hysudricus* but that seems to me too high-crowned to belong to that species; it might represent a more advanced species like *Palaeoloxodon namadicus* (this paper, p. 108). Thus, no *Archidiskodon* is present in this Villafranchian fauna, although the presence of *Equus*, *Merycopotamus*, and *Hippopotamus* make it strictly correlative with the Pinjor fauna to the West.

The Tjidjoelang fauna of Java contains a *Stegodon* (identified from tusk fragments by Von Koenigswald, 1935a, p. 195) and *Archidiskodon planifrons*; the Kali Glagah fauna has in addition a mastodont, described by Van der Maarel (1932) as *Tetralophodon bumiajuensis* (but which according to Von Koenigswald, 1933, p. 103, is trilophodont). The presence of *Merycopotamus* and *Hippopotamus* beside *Archidiskodon planifrons* mark the Indian origin of these Java faunas, which are clearly derived from the Villafranchian Tatrot-Pinjor complex. *Equus* somehow never reached Java, but it did reach China, where, on the other hand, *Hippopotamus* is absent. The Ma Kai Valley fauna of Yunnan described by Colbert (1940), with *Equus*, represents the Villafranchian stage in Southern China, and contains as the only proboscidean *Stegodon* spec.. *Stegodon* and *Equus* have also been recorded from Yunnan (Yuanmo Basin) by Young and Mi (1941).

It should be noted that, in North China, the Villafranchian deposits of Nihowan (Teilhard de Chardin and Piveteau, 1930) do not contain *Archidiskodon* but a more advanced elephant, identified as *Palaeoloxodon namadicus*. Hence, this is the same situation that I found to prevail in the Upper Irrawaddy beds of Burma. To explain this apparent anomaly, Teilhard de Chardin and Trassaert (1937, p. 53) suppose that the Nihowan beds represent only the top of the Villafranchian ("*namadicus*"-subzone?). In the Yushê basin, Shansi, North China, three zones have been distinguished by Teilhard de Chardin and Trassaert (1937), but unfortunately there is no stratigraphic control on the specimens. To quote the authors (l.c., p. 53): "For none of the specimens collected in the Yushê of course do we have so far the positive record of a definite layer nor of a definite faunal association". Zone II distinguished in the Yushê basin by Teilhard de Chardin and Trassaert, stated to be of Middle Pliocene age, does contain *Zygolophodon borsoni*, a Villafranchian type, as is *Archidiskodon planifrons*, found at the top of zone II. However, *Chilotherium*, still present in this zone, is generally regarded as of Pliocene affinities, and, therefore, zone II probably should be subdivided (Hooijer and Colbert, 1951b, p. 134). Young and Liu (1948, p. 287) record *Archidiskodon planifrons* from the Yushê series, but there is no information concerning the original locality of the collection (l.c., p. 273).

The Middle Pleistocene fauna of the Narbada beds, Central India, contains *Stegodon insignis* as well as *Palaeoloxodon namadicus,* while that of the Boulder Conglomerate zone has *Stegodon pinjorensis* (Osborn, 1929b, p. 18) as well as *Stegodon insignis.* The fauna of the Mogok caves in Burma contains only *Stegodon orientalis* and *Palaeoloxodon namadicus,* which also are the leading proboscidean types of the Southern China cave faunas of Szechwan, Yunnan, and Kwangsi.

In the Middle Pleistocene of Java we find a similar association of a stegodont and an elephant, but the species are different: *Stegodon trigonocephalus,* and *Elephas hysudrindicus.* While the former is present both in the Djetis and in the Trinil beds, the latter seems to be absent from the Djetis beds. Von Koenigswald (1934, p. 192, pl. IV figs. 8-9) has recorded a low-crowned molar fragment from the Djetis beds as "*Elephas* sp.", but I found this to belong to a high-crowned pygmy stegodont, *Stegodon hypsilophus* Hooijer (1954a), as will be set forth in the present paper. The absence of elephants in the Djetis fauna is undoubtedly accidental, as in the next older Kali Glagah fauna *Archidiskodon planifrons* is already present, and in the Limbangan fauna described by Stehlin (1925) this archidiskodont occurs together with *Elephas hysudrindicus.* The *Elephas* spec. III of Stehlin (l.c., p. 8, pl. II fig. 2) cannot be distinguished from *Archidiskodon planifrons* (this paper, p. 19), while *Elephas* spec. I and II of Stehlin (l.c., pp. 6-7, pl. I figs. 3-4, pl. II fig. 1) belong to *Elephas hysudrindicus.* The Limbangan fauna has been provisionally correlated with the Trinil fauna by Von Koenigswald (1935a, p. 191, cf. Von Koenigswald, 1933, p. 102), but in my opinion the Djetis fauna would have been a better choice, as in the Limbangan fauna a pre-Djetis form (*A. planifrons*) is associated with a post-Djetis form (*E. hysudrindicus*). Further, in the Dubois collection there is material referable to *Archidiskodon planifrons* from Tritik, a locality that has also provided *Hippopotamus sivalensis koenigswaldi* (Hooijer, 1950, p. 73), suggestive of the Djetis fauna.

Several finds in the Oriental region between China and Java hint at the continuity of the Middle Pleistocene development known as *Stegodon-Ailuropoda* fauna over the whole area. Already in 1916 a collection of fossil mammals from Lang-Son, Tonkin, Indo-China, was described and figured by Mansuy. The proboscideans contained in the collection were figured as *Stegodon insignis, Stegodon cliftii,* and *Elephas namadicus,* but the stegodont has been reidentified as *Stegodon orientalis* by Patte (1928, p. 59) and by Colbert (1942, p. 1453). Further localities containing a Middle Pleistocene fauna closely comparable to that of the South China caves have been recorded by Fromaget (1940). From Borneo, still almost a complete blank as far as Pleistocene vertebrates are concerned, a molar of *Palaeolox-*

odon cf. *namadicus* was recorded several years ago (Hooijer, 1952a). This find tends to show that Borneo did play a role in the radiation of the Middle Pleistocene mammals from the Asiatic continent to Java.

Quite different from either the Villafranchian or the Middle Pleistocene faunal stages now generally recognized in Southeastern Asia is the Pleistocene vertebrate fauna of the island of Celebes, the *Archidiskodon-Celebochoerus* fauna. It contains two proboscideans, viz., *Stegodon* spec. (Hooijer, 1953b), and *Archidiskodon celebensis* Hooijer (1949, 1953a and c, 1954b). The latter is a pygmy species, only about one-half as large in linear dimensions as *Archidiskodon planifrons*. While, as judged by the molars and the presence of premolars, *Archidiskodon celebensis* would seem to represent the same evolutionary stage as *A. planifrons*, the occasional retention of lower incisive tusks indicates that *A. celebensis* is more primitive than any archidiskodont described thus far. Consequently it cannot well be an offshoot of *Archidiskodon planifrons*, but rather might represent a dwarfed descendant of still earlier elephantines, evolving parallel to the known archidiskodonts from the mastodont stock. As long as its ancestry is so obscure, *Archidiskodon celebensis* is of no value for purposes of correlation with other Asiatic Pleistocene faunas. The Celebes *Stegodon* is too fragmentarily known to be of use as a time marker. It seems clear, however, that Celebes was quite effectively isolated from Southeastern Asia (including Java and Borneo) during the time the *Stegodon-Ailuropoda* fauna developed.

In concluding these remarks we might say that the Villafranchian (Lower Pleistocene) faunas of Southeastern Asia are characterized by *Archidiskodon planifrons* and more advanced elephants, *Elephas hysudricus* and cf. *Palaeoloxodon namadicus*. The last mentioned species is the elephant prevailing in the Middle Pleistocene faunas. In Java *Palaeoloxodon namadicus* is replaced by *Elephas hysudrindicus* (whose molars are similar to those of the Narbada species). Mastodonts linger on in the Villafranchian, but do not persist into the Middle Pleistocene. The stegodonts appear to be less reliable as diagnostic time markers, several species occurring in the Villafranchian and the Middle Pleistocene throughout.

Perhaps I should mention at the very outset of the present paper that I shall not deal with the "*Mastodon* spec. indet." of Martin (1888, p. 90, pl. XI figs.1-2), a name given to an incomplete molar and a tusk fragment from Pati Ajam. Dubois (1891, p. 95) remarked that the molar fragment might represent the posterior portion of a *Stegodon* molar, and the tusk is not necessarily mastodontine either. A similar incomplete molar, from Sangiran, figured by Van Es (1931, p. 66, figs. 3-4) has been reconstructed by Von Koenigswald (1933, p. 114, fig. 8) who considered it to represent a new family of proboscideans, the Cryptomastodontidae. *Cryptomastodon martini* Von Koenigswald (l.c., p. 112) has not been accepted by Dietrich (1934), who suggests that the molars in question are abnormal *Stegodon* molars, while Osborn (1936, p. 783) only wrote: "*Cryptomastodon* is a(?) Sirenian (cf. *Desmostylus*.)", a relationship discussed but rejected by Von Koenigswald (1933, p. 115). In my opinion there is a definite possibility that "*Cryptomastodon*" belongs to the recently erected Order Desmostylia (Reinhart, 1953). We still have much to learn about the dental morphology of the representatives of this Order, but the arrangement of the molar cones in transverse rows, yet closely grouped, separate down to their bases, occasionally subdivided at the top, and with thick and externally rugose enamel, are strongly suggestive of the desmostylid relationships of "*Cryptomastodon*". Since it is not a proboscidean as we know them, a further discussion of "*Cryptomastodon*" would be out of place in the present work.

Order PROBOSCIDEA Illiger
Suborder ELEPHANTOIDEA Osborn
Family ELEPHANTIDAE Gray
Subfamily STEGODONTINAE Osborn
Genus STEGOLOPHODON Schlesinger

Stegolophodon stegodontoides (Pilgrim)

Mastodon latidens (pro parte) Lydekker, Mem. Geol. Surv. Ind., ser. 10, vol. 1, 1880, p. 235, pl. XXXIX.

Mastodon stegodontoides Pilgrim, Rec. Geol. Surv. Ind., vol. 43, 1913, p. 294.

Stegolophodon stegodontoides, Colbert, Trans. Amer. Phil. Soc. Philad., n.s., vol. 26, 1935, p. 33; Osborn, Proboscidea, vol. 2, New York, 1942, p. 846.

The stegolophodonts represent the most primitive stegodonts. Although originally Osborn (1936, p. 32) included them in the Stegodontinae, he later erected a new subfamily, the Stegolophodontinae, for the inclusion of these forms (Osborn, 1936, p. 700; 1942, pp. 839, 1531, 1578). Simpson (1945, p. 133) placed them again in the Stegodontinae.

In the Dubois collection from the vicinity of Haripoor, on the Somb Nuddy, Sirmur State, Punjab, there is a molar that definitely belongs to the genus *Stegolophodon*. The specimen is broken through the fourth ridge from behind, but the two fragments (Coll. Dub. nos. 3133 and 3140) fit nicely (pl. I figs. 2-3).

The base of the crown is slightly convex anteroposteriorly toward the roots, showing the molar to be of the lower jaw. While one of the side surfaces of the crown is straight anteroposteriorly when seen from above, the other side is convex. The convex side surface is the lingual surface; the molar is of the left side. The number of ridges preserved is six; at least one ridge is missing in front while the crown terminates behind with a small talonid; it is the lower left last molar, M_3 sin.

The talonid consists of two cones of which the lingual is the larger, and damaged at the apex. The two cones are closely approximated, and are only one-half as wide at the base as the hindmost full ridge. Cement remains indicate that the talonid was entirely covered with cement.

The crown edge of ridge 1 from behind bears four cones, of which the second from the lingual side is very small. The apical width of this ridge is only 34 mm, less than one-half the basal width. The slopes of the inner and outer edges of the ridge are unequal, that on the buccal being less steep than that on the lingual side. In side view the ridge tapers markedly to the apex, too; the basal anteroposterior diameter is 30 mm; that at the top, barely 10 mm. The height of the ridge is two-thirds its basal width (see measurements in table 2). The valley in front of it is very narrow basally, and is almost entirely filled with cement that leaves only the apices of the cones exposed; it is chipped off on the sides.

Ridge 2 from behind has four cones, of which the second from the buccal side is the largest, the second from the lingual side the smallest. This ridge is larger than that behind it; its apical width (46 mm) is exactly one-half the basal width. The height is hardly greater than that of ridge 1, only three-fifths the basal width. The cones on the coronal edge are separated by narrow clefts, and the buccal edge is, again, less steep than that on the lingual side. The basal anteroposterior diameter is, again, 30 mm; that at the top, 13 mm. The cement surface in the valley in front of this ridge reaches to a level 9 mm below the free crown edge, and extends down on the sides almost to the base of the crown. There is a slight tendency toward the formation of basal accessory cusps especially at the buccal entrances to the valleys.

Ridge 3 from behind has the apex of the buccal cone broken off. The remaining three cones, separated by narrow clefts, show that this ridge had just been taken into use; their apices are flattened by wear but do not yet show the dentine cores. The thickness of the enamel, as seen in the broken buccal cone, is 7-8 mm. The second cone from the buccal side is the largest, its lingual neighbour the smallest of the series. The present ridge is slightly convex anteriorly, and slightly wider than ridge 2, but tapers as markedly to its apex. Cement in the valley in front extends to 12 mm below the worn edge.

Ridge 4 from behind is almost entirely gone, the molar having been broken through this ridge. The basal parts of the anterior and posterior portions, however, can be matched precisely, showing that the basal anteroposterior diameter of ridge 4 is the same as that of the others, viz., 30 mm. What remains of this ridge in front shows that it possessed four cones; the three grooves between these cones extend down into the valley for at least one-half of the height of the crown. The basal part of the valley is closed in, reduced to a mere line between the surfaces of the adjoining ridges. The enamel thickness is 7-8 mm. The valley between ridges 4 and 5 from behind is almost free of cement, which remains in a few patches at the buccal entrance and more inside.

Ridge 5 from behind is completely preserved. It is slightly convex transversely to the front. All of the four cones are worn, with their dentine cores exposed except for the extreme lingual, which rises 45 mm above the crown base. The occlusal surface falls off slightly toward the buccal side. On the lingual edge of this ridge, which is steeper than the buccal, there are traces of a cingulum. The two central cones are almost equal in width; the grooves between them and their neighbours can be traced down to 20 mm on the posterior and on the anterior surfaces as the valleys behind and in front are without cement or nearly so. The two central cones occupy a width only about one-third the basal width of the ridge (100 mm); their combined width is 33 mm behind, and 37 mm in front.

The sixth ridge from behind is incomplete both buccally and lingually. The two central cones are narrower than those in ridge 5, measuring only 28 mm transversely behind, and 33 mm in front. They also are more buccally placed, leaving more space for the extreme lingual cone that appears to have been double. This would make for a total of five cones in the present ridge. The valley between ridges 5 and 6 is closed in at the bottom, and so is that in front of ridge 6, where at least one ridge is broken off. The anteroposterior width of the front ridge is 30 mm; its transverse extent cannot be determined exactly.

The crown is well marked off from the roots, which are confluent all along the borders of the molars as far as preserved. The length of the crown is 200 mm from the front of the sixth ridge to the heel; the laminar frequency is $3^1/_3$.

TABLE 2

Measurements of M_3 of *Stegolophodon stegodontoides*

No. of ridge from behind	5	4	3	2	1	talonid
Width	100	—	95	92	82	41
Height	—	—	53+	56	54	ca. 45

Although the crown has a mastodont appearance because of its low and thick cones, a median cleft is not apparent; the grooves between the central cones are not more distinct than those on either side of the central cones. There are no median accessory conules, and the valleys are closed in at the bottom, as in *Stegodon,* but the cones are not quite united into ridges to the degree seen in a true stegodont, and the enamel is thick and not crenulated.

The present specimen is a representative of the stegolophodonts, and it belongs to the rarest of Upper Siwalik Proboscidea, viz., *Stegolophodon stegodontoides* (Pilgrim, 1913, p. 294). Pilgrim's type is the right M^3 from Lehri, Punjab, described and figured by Lydekker (1880, p. 235, pl. XXXIX). The presumed stratigraphic position of this specimen is in the Pinjor zone of the Upper Siwaliks, Lower Pleistocene (Colbert, 1935, p. 33; 1942, p. 1448). In this unworn molar, which carries from four to five cones on each of its six ridges, the median cleft is placed closer to the buccal side in the first two ridges than in those following behind, the buccal edges of the ridges are less steep than those on the lingual side, and on the lingual edges of the ridges we observe traces of a cingulum, just as in the Dubois collection specimen. The greatest width of the molar figured by Lydekker is 106 mm, only 6 mm more than that of our specimen. The anteroposterior diameter of the ridges in Lydekker's Punjab specimen is about 30 mm, and the ridges are convex anteriorly with the exception of the first. The resemblance between the type of *S. stegodontoides* and the specimen just put on record is as close as one could only wish it to be.

The last molar is the widest molar of the dentition, and in its width the M^3 of *S. stegodontoides* exceeds that in all other species of its genus (see Osborn, 1942, pp. 839-851) with the exception of *Stegolophodon cautleyi* Lydekker from Perim island. *S. cautleyi,* however, is distinguished from *S. stegodontoides* by having fewer ridges (only five in M^3) which are wider anteroposteriorly, viz., about 40 mm, against only 30 mm in the type of *S. stegodontoides* and in our specimen.

Thus, the present specimen agrees well and only with the type and thus far only known molar of *Stegolophodon stegodontoides.* There can be no doubt as to their specific identity. The present molar, an M_3 sin., is a few mm narrower than the type (an M^3 dext.), and has at least one ridge more than the latter; these are the sort of differences one could only expect between an M_3 and an M^3 of one and the same species.

Genus STEGODON Falconer

Stegodon insignis (Falconer et Cautley)

Elephas insignis Falconer and Cautley, Fauna Antiqua Sivalensis, London, 1845, pl. 2 fig. 6; 1846, pls. 15-17, 18 figs. 1-6, 18A figs. 3-5, 19, 19A, 20 figs. 1-8, 20A figs. 3-5, 7, 24 fig. 6, 24A figs. 2-3; 1847, pls. 25 fig. 4, 29B figs. 1 and 8, 56 figs. 10-14; Falconer, Pal. Mem., vol. 1, London, 1868, pp. 20, 73, 109, 117, 423, 448-453, 455-457, 460, 461, 496, and 497; Lydekker, Cat. Siw. Vert. Indian Mus., part 1, Calcutta, 1885, p. 81, Cat. Foss. Mamm. Br. Mus., part 4, London, 1886, p. 89 fig. 22.

Stegodon insignis, Lydekker, Mem. Geol. Surv. Ind., ser. 10, vol. 1, 1880, p. 268, pls. XLV fig. 4, XLVI figs. 2 and 4; Pilgrim, Rec. Geol. Surv. Ind., vol. 40, 1910, p. 200; Colbert, Trans. Amer. Phil. Soc. Philad., n.s., vol. 26, 1935, p. 33; Osborn, Proboscidea, vol. 2, New York, 1942, p. 866, figs. 748-753; Chakravarti, Quart. Journ. Geol. Min. Met. Soc. India, vol. 3, 1931, p. 124, pl. VIII.

Stegodon insignis-ganesa, Osborn, Proboscidea, vol. 2, New York, 1942, p. 874.

Elephas ganesa Falconer and Cautley, Fauna Antiqua Sivalensis, London, 1845, pl. 3 fig. 7; 1846, pl. 20A figs. 1-2, pls. 21-23, 24 figs. 1-5, 24A fig. 1; 1847, pls. 25 fig. 1, 25A, 29B figs. 2-4; Falconer, Pal. Mem., vol. 1, London. 1868, pp. 20, 80, 424, 452-458, 460; Lydekker, Cat. Siw. Vert. Indian Mus., part 1, Calcutta, 1885, p. 85, Cat. Foss. Mamm. Br. Mus., part 4, London, 1886, p. 88, fig. 21.

Elephas (Stegodon) ganesa, Woodward, Geol. Mag., n.s., dec. 4, vol. 6, 1899, p. 337, pl. XIV.

Stegodon ganesa, Lydekker, Rec. Geol. Surv. Ind., vol. 9, 1876, p. 42, Mem. Geol. Surv. Ind., ser. 10, vol. 1, 1880, p. 273; Pilgrim, Rec. Geol. Surv. Ind., vol. 40, 1910, p. 200; Colbert, Trans. Amer. Phil. Soc. Philad., n.s., vol. 26, 1935, p. 33; Osborn, Proboscidea, vol. 2, New York, 1942, p. 869, fig. 766.

Stegodon ganesa and *insignis,* Pilgrim, Rec. Geol. Surv. Ind., vol. 43, 1913, p. 324.

The molars of *Stegodon insignis* appear to be indistinguishable from those Falconer and Cautley subsequently named *Stegodon ganesa* (Falconer, 1868 II, p. 84; Lydekker, 1880, p. 273, 1886, p. 88/89; Osborn, 1942, p. 874). Therefore, notwithstanding the profound cranial differences (which do not show young skulls, however), *Stegodon ganesa* is now generally considered identical with *Stegodon insignis,* the former representing the male, and the latter the female of one and the same species, which should be named *Stegodon insignis.* The species occurs in the Pinjor zone and in the Boulder Conglomerate of the Upper Siwaliks, Lower and Middle Pleistocene, respectively.

During his stay in the Punjab in 1895, Eug. Dubois collected various specimens of *Stegodon,* which all belong to the present species.

Coll. Dub. no. 3041 is a palate from Naliwala on the Somb Nuddy opposite Haripoor, Sirmur State, the locality that also provided the beautiful skull of *Archidiskodon planifrons* to be described further on. Both the right and the left M^3 (the latter is Coll. Dub. no. 3099) are preserved.

The posterior ridges of the M^3 dext. are broken off above their bases, and the M^3 sin. is damaged antero-buccally. The anterior margins of the crowns are broken, and the number of ridges preserved is nine; probably there were ten or eleven ridges in all. All but the last ridges are worn. The width of the palate between the anterior parts of the molars is 5 cm; the same width is found in the skull of *Stegodon insignis* figured by Falconer and Cautley (1846, pl. 16 fig. 4; cf. Falconer, 1868 I, p. 449). The width over the buccal margins of the molars is 24 cm.

As the number of ridges in the M^3 exceeds nine, *Stegodon bombifrons* (Falconer et Cautley) can be excluded; in *Stegodon insignis* (including *S. ganesa*) the number of ridges in M^3 varies from ten to eleven (Lydekker, 1880, p. 272). Various good specimens of M^3 of *Stegodon insignis* have been figured by Falconer and Cautley (1845-1846); their measurements will be found in table 3 together with those of the Dubois collection specimen.

TABLE 3

Measurements of M^3 of *Stegodon insignis*

Falconer and Cautley, 1845-1846	length	width
pl. 2 fig. 6a	ca. 240	—
pl. 3 fig. 7a	235+	—
pl. 19 fig. 6	280	97
pl. 19A fig. 2	287	86
pl. 22 fig. 2	302	103
Coll. Dub. no. 3041	254+	97

Another palate, somewhat distorted (Coll. Dub. no. 3105) carries five much worn ridges of a molar on either side. The width of these molars is 98 mm, and their laminar frequency is 4, slightly higher than that of the M^3s mentioned above ($3\frac{1}{2}$).

Coll. Dub. no. 3062, labelled Jamni (pl. II figs. 1-2) comprises the posterior five ridges and talon of an M^3 dext. All the preserved ridges are unworn, and bathed in cement. The number of conelets seen varies from seven to eight per ridge. The hind ridges become progressively inclined forward, and smaller; the measurements given in table 4 show that in relative height the ridges are exceeded by those in all but one or two of the series of M^3 of the Java *Stegodon trigonocephalus* (table 17), while the ridges remain much lower than those in an M^3 of *Archidiskodon planifrons*, which has the unworn ridges about as high as wide (table 53).

TABLE 4

Unworn ridges of M^3 of *Stegodon insignis*

No. of ridge from behind	5	4	3	2	1	talon
Width	96	93	87	76	66	65
Height	57	54	51	47	44	41
Height-width index	59	58	59	62	67	63

Coll. Dub. no. 3074 from Haripoor, Punjab, is a left ramus of the mandible with M_3 complete. A fragment of a right ramus with the posterior portion of the last molar (Coll. Dub. no. 3112) belongs to the same individual. The M_3 sin. has twelve ridges, and talonids. The first three ridges are worn to a continuous dentine surface; the fourth presents a single figure, but in the fifth ridge the conelets are not yet worn out, and are five in number. The sixth ridge is damaged; the seventh carries ten conelets. From this ridge on backward the ridges are unworn, and coated with cement that covers even the conelets. The resemblance between the present specimen and that figured by Falconer and Cautley (1846, pl. 20 fig. 7), with twelve or thirteen ridges, is very close indeed. Of the latter specimen no measurements are available, but those of other specimens of M_3 recorded in the literature are given in table 5 with those of the specimen collected by Dubois.

TABLE 5

Measurements of M_3 of *Stegodon insignis*

Falconer and Cautley, 1846	length	width
pl. 18A fig. 3	310	89
pl. 18A fig. 5	287	101
pl. 24A fig. 3	292	101
Osborn, 1942, p. 871	291	93
Coll. Dub. no. 3074	277	93

Coll. Dub. no. 3068 is a left mandibular ramus with M_2, worn down to the last ridge. Six ridges are preserved only, all presenting single enamel figures except the last, which has five conelets. The talonid consists of a large cone, placed lingually of the median line, with two small cones buccally. The enamel figures of the worn ridges approach each other closely already across the valley between the third and fourth ridges from behind, a typical stegodont character. A small accessory cone is observed at the lingual entrance to the fifth valley from behind. This is a rather narrow specimen (cf. the measurements given in table 6).

Portions of a right ramus of the mandible (Coll. Dub. nos. 3097 and 3072), and of a left ramus (Coll. Dub. no. 3113) belong to the same individual; the specimens originate from Haripoor. Each ramus holds the posterior four ridges of M_2 (width 84 mm) and the anterior two or three ridges of M_3 (width 96 mm at base behind ridge 3 from the front). The M_3 is unworn and cement-covered.

A similar portion of the ramus, of the left side (Coll. Dub. nos. 3042 and 3052) has the anterior ridges of M_3 worn; the first ridge shows a median cleft. Other ramus fragments (Coll. Dub. nos. 3111 and 3139) have portions of molars incomplete on the sides, which makes their serial position uncertain.

TABLE 6

Measurements of M_2 of *Stegodon insignis*

Falconer and Cautley, 1846	length	width
pl. 20A fig. 1	236	81
pl. 20A fig. 2	234	76
pl. 24A fig. 3	—	89
Osborn, 1942, p. 870	—	ca. 88
Coll. Dub. no. 3068	210+	75

Of uncertain specific position is the distal end of a left radius (Coll. Dub. no. 3064), which originates from Haripoor. It has a greatest diameter of 14 cm, which is just within the variation limits of *Stegodon trigonocephalus* from Java (below, p. 74, table 30).

The caput of a left femur (Coll. Dub. no. 3082) is 12½ cm in diameter. Two distal fragments of right femora, Coll. Dub. no. 3092, from Haripoor, with the lateral trochlea ridge damaged, and Coll. Dub. no. 3095 from Jamni, without the medial condyle, present the following measurements (table 7).

TABLE 7

Measurements of proboscidean femora from the Punjab (in cm)

Coll. Dub. nos.	3092	3095
Greatest distal width	21	—
Distal condyle width	18	—
Distal anteroposterior diameter, medial side	22	—
Idem, lateral side	—	16

The Siwalik femora are within the limits of *Stegodon trigonocephalus*.

The Siwalik collection contains further the distal portion of a right tibia (Coll. Dub. no. 3056, probably from Haripoor) that has a greatest width of 19 cm, and that measures 14½ cm anteroposteriorly. These measurements are within the variation limits of those of *Stegodon trigonocephalus* (tables 39 and 41), although they are to the higher side of the range of variation. Needless to say that the specific identity of the limb bones (radius, femur, and tibia) of proboscideans in the Punjab collection is uncertain in view of the fact that many proboscidean types have been described from the Upper Siwaliks whose limb skeleton is virtually unknown.

Stegodon trigonocephalus Martin

Mastodon elephantoides Junghuhn, Natuurk. Tijdschr. Ned. Indië, vol. 14, 1857, p. 216.

Stegodon spec. indet., Martin, Samml. Geol. Reichsmus. Leiden, vol. 4, 1884, p. 3, pl. I figs. 1-2.

Stegodon trigonocephalus Martin, Samml. Geol. Reichsmus. Leiden, vol. 4, 1887, p. 36, pls. II, III fig. 1, IV, V fig. 1, VI fig. 1, Ibid., vol. 4, 1888, p. 92, pl. XI figs. 3-4, Natuurk. Verh. Kon. Akad. Wet. Amsterdam, vol. 28, 1890, p. 10, pl. III figs. 5-6; Van der Maarel, Wet. Med. Dienst Mijnb. Ned. Indië, no. 15, 1932, p. 151, pls. XI, XII figs. 2-3; Von Koenigswald, Ibid., no. 23, 1933, pp. 88, 103, 110, Ibid., no. 28, 1940, pl. III fig. 14; Osborn, Proboscidea, vol. 2, New York, 1942, p. 890, fig. 775; Hooijer, Zool. Med. Museum Leiden, vol. 33, no. 14, 1954, p. 99, table 2.

Stegodon cf. *trigonocephalus*, Janensch, in Selenka and Blanckenhorn, Die Pithecanthropus-Schichten auf Java, Leipzig, 1911, p. 192, pl. XXV fig. 4; Soergel, Palaeontographica, suppl. 4, part 3, 1913, pp. 16, 17, pl. I fig. 3, pl. II fig. 2.

Stegodon trigonocephalus trigonocephalus, Von Koenigswald, Wet. Med. Dienst Mijnb. Ned. Indië, no. 23, 1933, pl. XXVII fig. 1, De Ing. in Ned. Indië, vol. 2, sect. IV 1935, pl. fig. 2.

Stegodon bombifrons Martin, Samml. Geol. Reichsmus. Leiden, vol. 4, 1887, p. 50, pl. V fig. 2, Ibid., vol. 4, 1888, p. 103, pl. XII fig. 1, Natuurk. Verh. Kon. Akad. Wet. Amsterdam, vol. 28, 1890, p. 12, pl. III fig. 7.

Stegodon cliftii Martin, Samml. Geol. Reichsmus. Leiden, vol. 4, 1887, p. 51, pl. III fig. 2.

Stegodon airawana Martin, Natuurk. Verh. Kon. Akad. Wet. Amsterdam, vol. 28, 1890, p. 4, pls. I-II; Janensch, in Selenka and Blanckenhorn, Die Pithecanthropus-Schichten auf Java, Leipzig, 1911, p. 162, pls. XXI, XXII, XXIII figs. 1-4, XXIV, XXV figs. 1-3; Pohlig, Ibid., p. 197; Soergel, Palaeontographica, suppl. 4, part 3, 1913, pp. 5, 6, 8, pl. I figs. 2 and 4; Janensch and Dietrich, Sitz. ber. Ges. naturf. Fr. Berlin, 1916, p. 126, pl. III; Stehlin, Wet. Med. Dienst Mijnb. Ned. Indië, no. 3, 1925, pl. I fig. 1; Van der Maarel, Ibid., no. 15, 1932, p. 132, pls. XII fig. 1, XIII figs. 1-2, XIV figs. 2-3, XV figs. 1-4, XX fig. 1; Osborn, Proboscidea, vol. 2, New York, 1942, p. 881 fig. 764C, p. 885.

Stegodon cf. *airawana*, Soergel, Palaeontographica, suppl. 4, part 3, 1913, pp. 4, 8, 10, 11, pl. I fig. 1, pl. II figs. 1 and 3.

Stegodon airawana (+ *trigonocephalus*), Dietrich, Sitz. ber. Ges. naturf. Fr. Berlin for 1924, 1926, p. 136.

Stegodon javanoganesa Dubois, Tijdschr. Kon. Ned. Aardr. Gen., ser. 2, vol. 25, 1908, p. 1245.

Stegodon ganesa var. *javanicus* Dubois, Tijdschr. Kon. Ned. Aardr. Gen., ser. 2, vol. 25, 1908, p. 1257; Osborn, Proboscidea, vol. 2, New York, 1942, p. 889.

Stegodon bondolensis Van der Maarel, Wet. Med. Dienst Mijnb. Ned. Indië, no. 15, 1932, p. 158, pl. XIV figs. 1, 4 and 5; Von Koenigswald, Ibid., no. 23, 1933, p. 106; Osborn, Proboscidea, vol. 2, New York, 1942, p. 894, fig. 782.

Stegodon trigonocephalus praecursor Von Koenigswald, Wet. Med. Dienst Mijnb. Ned. Indië, no. 23, 1933, p. 104, pl. XXVII fig. 2, De Ing. in Ned. Indië, vol. 2, sect. IV, 1935, p. 86, pl. fig. 1; Osborn, Proboscidea, vol. 2, New York, 1942, p. 896.

Stegodon sp., Soergel, Palaeontographica, suppl. 4, part 3, 1913, pp. 15, 16, pl. I fig. 5; Van der Maarel, Wet. Med. Dienst Mijnb. Ned. Indië, no. 15, 1932, p. 164, pl. XIII figs. 3-5.

Stegodon, Pohlig, in Selenka and Blanckenhorn, Die Pithecanthropus-Schichten auf Java, Leipzig, 1911, pls. XXVI-XXVII; Stehlin, Wet. Med. Dienst Mijnb. Ned. Indië, no. 3, 1925, p. 5, pl. I fig. 2.

As shown by the above synonymy the Java *Stegodon* was first recorded almost a century ago, and has been given various names. However, as already realized by Dubois (1908, p. 1256), Dietrich (1926, p. 135), and Von Koenigswald (1933, p. 88), there is only one species involved. It occurs from the Kali Glagah (Boemiajoe) up to the Ngandong beds, Lower to Upper Pleistocene. The mention of *Stegodon* from the lowermost Pleistocene Tjidjoelang fauna of Java (Von Koenigswald, 1935a, p. 195) is based on tusk fragments.

The type mandible of *Stegodon bondolensis* Van der Maarel (1932, p. 158) would carry only eight ridges in M3, and thereby be of the primitive stage of *Stegodon bombifrons* (Falconer et Cautley) or *Stegodon elephantoides* (Clift) (*S. clifti* auct.), but Von Koenigswald (1933, pp. 89, 106) has shown that the Bondol mandible belonged to a very old individual, with some of the anterior ridges of M3 gone. Hence, its formula must have been higher than 8x, and in the absence of other distinguishing characters *S. bondolensis* can be merged with *S. trigonocephalus*.

The Kali Glagah *Stegodon* is regarded by Von Koenigswald (1933, p. 104) as more primitive than the Trinil *Stegodon*, and is distinguished as *S. t. praecursor*, having only eleven ridges in M3 as opposed to thirteen in the typical subspecies (Von Koenigswald, 1933, pl. XXVII). It is noted, however, that a mandible from Lepen Aiit near Tinggang referred to *S. t. trigonocephalus* has an eleven-ridged M3 too (cf. Van der Maarel, 1932, pl. XII fig. 1). In a subsequent paper (Von Koenigswald, 1952, p. 304) we find the number of ridges to M3 in the typical Trinil *Stegodon trigonocephalus* given as "13+".

A mandibular ramus from Tjipanaroeban near Soebang in Western Java, supposedly Djetis fauna, is referred to *S. t. praecursor* too. It holds a much worn molar (Von Koenigswald, 1935b, p. 86, fig. 1), which differs from a specimen from Watoealang (Ngandong fauna) figured on the same plate (l.c., fig. 2) in its more widely spaced ridges and in its thicker and less wrinkled enamel. However, the two figures which are intended to show the disparity between the primitive Djetis specimen and the progressive Ngandong specimen (identified as *S. t. trigonocephalus*) represent molars of different serial position. The first (Von Koenigswald, 1935b, fig. 1) has a laminar frequency of 6+, and is wider than the second (l.c., fig. 2), which has a laminar frequency of 8—. We find exactly the same differences to exist between the M_1 and the DM_4 both in situ in the same left mandibular ramus from Trinil (Coll. Dub. no. 144, pl. III fig. 3), a ramus that would belong to the typical Trinil *S. t. trigonocephalus*. Hence, the examples presented by Von Koenigswald to illustrate the supposed progressive evolution within *Stegodon trigonocephalus* in the course of the Pleistocene do not appear to be well taken. It remains open to doubt whether the Djetis *Stegodon* really is more primitive than that of Trinil and Ngandong, and statements such as "Das *Stegodon* zeigt deutlich primitive Eigenschaften" (Von Koenigswald, 1935b, p. 87), or "Auch das *Stegodon* ist primitiver..." (Von Koenigswald, 1940, p. 67) referring to the Djetis form of *Stegodon* have to be backed up by better evidence before they can be accepted.

Under the head *Stegodon trigonocephalus*, Von Koenigswald (1933, p. 110) records a molar fragment from Limbangan previously identified by Stehlin (1925, p. 8, pl. II fig. 2) as *Elephas* spec. III. The fragment comprises the inner or outer third of two unworn ridge-plates, with a cement-filled valley in between. The height is given by Stehlin (l.c.) as 8-8½ cm, and the anteroposterior diameter of the two ridge-plates plus the intermediate valley as 38 mm. The broken vertical surface of the ridge-plates shows a median dilatation of the plates which blocks up the valley.

It is evident, as already correctly observed by Stehlin (l.c.), that the ridge-plates are too high for this fragment to belong to *Stegodon*; Von Koenigswald (l.c.) writes that the fragment certainly belongs to the anterior half of an M^3 of *Stegodon trigonocephalus*, but the ridges even of the M^3 of that species do not exceed 59 mm (Janensch, 1911, p. 176) or 62 mm (Hooijer, 1954a, p. 99) in height. The Limbangan fragment could not possibly belong to *Stegodon trigonocephalus*; this is furthermore indicated by the median expansions of the plates (Stehlin, 1925, pl. II fig. 2c) which make it highly improbable that the fragment belongs to a stegodont at all. As far as can be judged from Stehlin's figures and description the Limbangan fragment would seem to be very close to *Archidiskodon planifrons* (which species is known from the Pleistocene of Java: below p. 94); in suggesting this identification I find myself in agreement with Van der Maarel (1932, p. 178). The fragment is too incomplete for serial determination, however; its laminar frequency (about 5) agrees with that of a last molar of a progressive *Archidiskodon planifrons*, or with that of an

M1 or M2 of a more primitive stage of *A. planifrons*; in either case the height of the plates (8-8½ cm) is well within the known limits of variation (see Osborn, 1942, pp. 949 and 954).

At any rate, the presence of median expansions to the ridge-plates of the Limbangan fragment is practically diagnostic of its being an *Archidiskodon* molar; it is interesting to note that this find is cited once again by Von Koenigswald (1934, p. 192) under the head "*Elephas* sp.". According to Von Koenigswald (1933, p. 102) the Limbangan fauna described by Stehlin (1925) originates from the "oberer Wirbeltierhorizont" of Boemiajoe, and is provisionally correlated with the Middle Pleistocene Trinil fauna (Von Koenigswald, 1935a, p. 191).

MILK DENTITION

The anterior upper milk molar (DM^2) of the Java *Stegodon* has been figured only once, viz., by Janensch and Dietrich (1916, pl. III). On account of the unworn state of this small tooth (the DM^3 behind it being already worn), and its being provided with a single root, Janensch and Dietrich concluded that the tooth in question represented a premolar (P^2). However, as pointed out by Schlesinger (1922, p. 48 note 1), neither the lack of wear nor the reduced size are against the determination of this tooth as DM^2; this has afterwards been agreed to by Dietrich (N. Jahrb. f. Min., 1923, part 2, p. 275), who further observed that the DM^2 was originally two-rooted, but that the hind root became resorbed in the process of eruption of the DM^3. This is not invariably the case, however, for in the Dubois collection there is a palate with milk teeth (Coll. Dub. no. 1780, from Kedoeng Panas, pl. III fig. 4) in which both DM^2s are worn and two-rooted, the anterior root extending obliquely forward and inward, and the posterior root being vertical and free from the slightly worn DM^3s behind.

Both the right and the left DM^2 in Coll. Dub. no. 1780 are worn flat; the remnants of the valleys in the enamel of the crown show the teeth to have been three-ridged. The crown is subtriangular with rounded angles, as is the DM^2 figured and discussed by Janensch and Dietrich (1916, p. 127, pl. III). The worn specimens in the palate from Kedoeng Panas (pl. III fig. 4) measure about 15 mm anteroposteriorly, and about 16 mm transversely. The DM^2 recorded by Janensch and Dietrich (l.c.) measures 18 by 15 mm, and thus is slightly longer and narrower.

There is one more specimen of DM^2 in our collection; it is from Trinil and isolated and unworn (Coll. Dub. no. 1581, pl. III fig. 5). The crown is, again, subtriangular with rounded angles, and measures 16 mm both ways.

On the bud-like crown the three ridges are only indistinctly shown; it is presumably of the left side.

The anterior lower milk molar, DM_2, is not represented in the Dubois collection, but its alveolus is shown in various young rami of the mandible (Coll. Dub. nos. 122, 123, 127). It is a single, rounded hole, about 9 mm in diameter. Doubtlessly the DM_2 is even smaller than its counterpart in the upper jaw.

It is interesting to compare the various elements of the dentition of *Stegodon trigonocephalus* with those of *Stegodon orientalis* Owen from the Middle Pleistocene of Yenchingkou, Szechwan, Southern China (Colbert and Hooijer, 1953, pp. 71-81, pls. 16-17). As originally observed by Dietrich (1926, p. 138), the Java *Stegodon* is more progressive than that from China, a view first opposed to by Osborn who declared the Szechwan *Stegodon* to be the more progressive of the two (Dietrich, l.c.). Afterwards, Osborn accepted Dietrich's view on the Java *Stegodon* as he writes: "This is the most progressive Stegodont known, surpassing *Stegodon orientalis*..." (Osborn, 1942, p. 885). Incidentally, Osborn (1942, p. 885 and p. 890) still treats *Stegodon airawana* as distinct from *Stegodon trigonocephalus*, as he does *Stegodon bondolensis* (l.c., p. 894). Further Osborn (1929b, p. 16/17) regarded the Yenchingkou *Stegodon* as a distinct subspecies, *S. orientalis grangeri*, more primitive than the type of *Stegodon orientalis*, which is also from a cave in Szechwan; the same views are presented in the final monograph (Osborn, 1942, pp. 875 and 884). As is evident from the synonymy presented on p. 17 I regard *Stegodon airawana* as well as *Stegodon bondolensis* as synonymous with *Stegodon trigonocephalus*, and, as far as the China *Stegodon* is concerned, there appears to be no reason to differentiate *S. orientalis grangeri* from *Stegodon orientalis* proper (Colbert and Hooijer, 1953, p. 72).

The anterior milk molars of *Stegodon orientalis* are definitely larger than those of *Stegodon trigonocephalus*: seven specimens of DM^2 of *Stegodon orientalis* (Colbert and Hooijer, 1953, p. 73) average 23 mm anteroposteriorly and 22 mm transversely, as opposed to 15-18 mm anteroposteriorly and 15-16 mm transversely in *Stegodon trigonocephalus*. Four specimens of DM_2 of *Stegodon orientalis* (Colbert and Hooijer, l.c.) average 16 by 13 mm. Consequently, one is justified in stating that *Stegodon trigonocephalus* is more reduced, and thereby more progressive than *Stegodon orientalis* in its DM^2.

There are various specimens of the second upper milk molar, DM^3, in the Dubois collection from Java. Several Java specimens have already been described, and these will be considered first.

In 1887 Martin described a young skull from Java as *Stegodon trigonocephalus*. It has two molars in use which were taken by Martin to represent the second and third premolars (milk molars), hence DM^3 and DM^4 (Martin, 1887, pp. 36-41, pl. II). Their serial determination does not seem to have been questioned, not even by Janensch (1911, p. 155) or Van der Maarel (1932, p. 156) who both have seen the skull, which is in the Geological Museum at Leiden. The type skull of *Stegodon trigonocephalus* Martin is figured by Osborn (1942, p. 891, fig. 777E), and the two molars in situ are marked dp^3 and dp^4 respectively. The anterior molar is stated by Martin (1887, p. 39) to be oval in outline, and to possess four well-developed ridges plus a front and a back talon. It is 66 mm long, and its greatest width, at the penultimate ridge, is 51 mm.

Two specimens of DM^3 from Java have subsequently been described by Janensch (1911, pp. 163-165, pl. XXII figs. 1-2). One of these is much worn down but the other is entire and only slightly worn. The latter (refigured in Janensch and Dietrich, 1916, pl. III) shows well the characteristic shape of this element, with its crown not very much longer than wide, and constricted transversely in its anterior third. The anterior ridge is convex to the front, and asymmetrically built: much produced outward buccally but very weak lingually. The constriction of the crown is immediately behind it; ridge 2 is the narrowest ridge, convex to the front. The buccal part of the second ridge is about twice as large as the lingual, and separated from it by a cleft. From ridge 2 on backward the crown widens again; ridges 3, 4, and 5 gradually increase in transverse diameters. They are concave to the front, and have a median cleft. The widest part of the crown is at ridge 5 from the front; the crown is rounded off from side to side behind, forming another transverse ridge that is almost as large as ridge 5, and which could be regarded as ridge 6 rather than the posterior talon, the more so since on its hinder surface there are slight enamel elevations which can be taken for an incipient posterior talon (Janensch (1911, p. 165) takes the terminal ridge behind ridge 5 to represent the talon, and, therefore, writes the formula as 5x).

It could not escape Janensch's notice that the molar in the type skull of *Stegodon trigonocephalus* described by Martin as DM^3 is very different from those he had described, being regularly elliptic in outline, and lacking the characteristic constriction. Further, the molar described by Martin is much larger than those described by Janensch, the complete DM^3 measuring only 54 by 41 mm (Janensch, l.c., p. 164). In observing these differences, Janensch (l.c., p. 190) considered them specific; he referred his material to *Stegodon airawana*. In a later paper it is again stated that the DM^3 of

Stegodon trigonocephalus lacks the outer concavity that is typical of *Stegodon airawana* (Janensch and Dietrich, 1916, p. 131). As Martin (1887, p. 46) wrote, the oval shape of the second milk molar (DM³) is diagnostic of *Stegodon trigonocephalus,* no such shape being found in other species of *Stegodon.*

All the specimens of DM³ of the Java *Stegodon* found subsequently to Martin's description of the skull of *Stegodon trigonocephalus* are of the type described by Janensch as belonging to *Stegodon airawana,* with a large anterior ridge projecting forward and outward buccally, constricted at the second ridge, and then gradually widening backward. The Dubois collection specimens to be described below, as well as all the material I have seen of *Stegodon orientalis,* from the Yenchingkou collection in the American Museum of Natural History in New York, display the "*airawana*" type of DM³. Further, none of these specimens is as large as Martin's DM³, or, like the latter, has only four ridges, the number of ridges varying from 5+ to 6. Such differences, both in structure and in size, would be of sufficient importance to justify a specific distinction between *Stegodon trigonocephalus* and *Stegodon airawana,* as advocated by Janensch (1911, p. 192), Soergel (1913, p. 22), Van der Maarel (1932, p. 157), and Osborn (1942, pp. 885 and 890), in opposition to Dubois (1908, p. 1256), Dietrich (1926, p. 135), and Von Koenigswald (1933, p. 88), who consider these two species identical.

This being the state of affairs, I have taken the opportunity to study the type skull of *Stegodon trigonocephalus* myself. The anterior molar in situ in the skull proved to be incomplete; it forms only part of a longer molar, which happens to have broken off in front of the fourth ridge from behind. It is very much worn down, and damaged along its borders, especially so at the anterior end, which gives the impression of being rounded off from side to side. However, the presumed anterior talon is merely a remnant of the fifth ridge from behind; the remainder of the crown is just lost. The length of the crown, as far as preserved, is 66 mm, and the four full ridges in front of the back talon occupy an anteroposterior length of 50 mm. Hence, the molar has a laminar frequency of 8. This is a figure much too high for DM³, but that corresponds well and only with DM⁴, the third and last milk molar. The width of the anterior molar in the type skull, 51 mm at the penultimate ridge, corresponds, again, with that of a DM⁴.

The molar in situ behind that just described, and, like the former, preserved at the right side of the skull only, is likewise incomplete. Only the anterior talon and five ridges are present; the last of these only is unworn. As shown in Martin's excellent figure (Martin, 1887, pl. II fig. 1a, reproduced in Osborn, 1942, p. 890 fig. 776), the anterior full ridge has a median cleft, and the molar gradually widens backward. The width of ridge 1 is 59 mm, that of ridge 2 is 62 mm, that of ridge 3 is 64 mm, that of ridge 4, 66 mm, all measured at the base. The fifth ridge is incomplete lingually; the height of this (unworn) ridge is 39 mm. In the bone of the maxillary is seen the basal contour of the crown; there appear to have been two more ridges, making a total of seven ridges, plus the talons. The total length of the molar at the base is 118 mm, and the laminar frequency is 6, as three ridges are contained in 50 mm of anteroposterior length. In all its characters the posterior molar in the type skull of *Stegodon trigonocephalus* agrees well and only with the anterior molar, M^1, as we shall see further on.

Therefore, it is now clear that the two molars in situ in the type skull of *Stegodon trigonocephalus* preserved in the Geological Museum at Leiden are the last milk molar and the first molar, DM^4 and M^1. In 1911 Janensch described a skull from Trinil with DM^3 and DM^4 in use (Janensch, 1911, p. 152, pl. XXI), and considered himself fortunate in having in the type skull of *Stegodon trigonocephalus* a specimen splendidly suited for comparison, being a skull in the same growth stage as that of *Stegodon "airawana"* described by himself. Small wonder that he found the dimensions of the skull as well as of the teeth of *Stegodon trigonocephalus* as described by Martin to be larger than those of the Trinil skull (Janensch, l.c., p. 155), supposedly *Stegodon airawana*. For a figure of the two skulls side by side, to the same scale, see Osborn (1942, p. 891 fig. 777 E and F). It will be observed that the skull described by Martin (E, with DM^4 and M^1) is intermediate in size between the small skull described by Janensch (F, with DM^3 and DM^4), and a skull of *Stegodon orientalis* which has M^1 and M^2 in use (same figure, C).

Having established the oval shape of the DM^3 of *Stegodon trigonocephalus* as illusory, I shall now deal with the material of DM^3 in the Dubois collection from Java. Seven specimens are available, five of which complete or very nearly so. Of the two DM^3s in situ in the palate from Kedoeng Panas that also holds the worn right and left DM^2 (Coll. Dub. no. 1780, pl. III fig. 4) the posterior half of the left is broken away; the right is very slightly damaged postero-buccally only. It conforms well with Janensch's figure (Janensch, 1911, pl. XXII fig. 2; a better still in Janensch and Dietrich, 1916, pl. III) in having six ridges, and an incipient back talon; it is only smaller, both ways (see table 8). A larger specimen is in situ in a palate from Trinil (Coll. Dub. no. 1655), much worn. The largest specimen from Java (Coll. Dub. no. 11649), damaged antero-buccally, is a slightly worn left DM^3, which, again, agrees perfectly with that of Janensch's figures cited above even in such details as the subdivision of the second ridge in two parts, of which the buccal is twice as wide as that on the lingual side. Apart from an incomplete left DM^3 (Coll. Dub. no. 2190 c, an anterior fragment) there remain two splendidly preserved and unworn specimens, a DM^3 sin. (Coll. Dub. no. 1647a, pl. III fig. 1), and a DM^3 dext. (Coll. Dub. no. 1647b, pl. II fig. 4), both originating from Trinil. It will be observed that the left specimen is longer than the right, by the same width, a difference that is mainly on the part of the anterior ridge, which projects more forward and outward buccally in the former than in the latter specimen. In front of the first ridge in the DM^3 sin. there is a weak anterior talon, consisting of a row of five enamel tubercles, and placed to the buccal side of the median axis of the crown. There is only a negligible posterior talon in this specimen, however, while the DM^3 dext. presents a row of low tubercles from side to side posteriorly, behind the sixth ridge. Thus, the formula of the DM^3 sin. would be x6, and that of the DM^3 dext., 6x.

How does the DM^3 of *Stegodon trigonocephalus* compare with that of *Stegodon orientalis*? As already stated by Dietrich (1926, p. 138), the DM^3 of the Chinese *Stegodon* is less progressive than that of *Stegodon trigonocephalus*, for the ridge behind ridge 5 from the front in *Stegodon orientalis* (as clearly shown in a young skull from Yenchingkou, Szechwan, figured by Matthew and Granger, 1923, p. 571 fig. 6) is only very low and weakly developed, while in the Java specimen (Janensch, 1911, pl. XXII fig. 2) the sixth ridge is of the same value as a true ridge. As might be expected, there is some individual variation in the development of these terminal ridges or talons. While the DM^3 of *Stegodon orientalis* figured by Young (1939, p. 324 fig. 3) resembles that first figured by Matthew and Granger (1923, fig. 6) in having five ridges and a small hind talon, among the richer material from Yenchingkou there are some specimens of DM^3 in which the hind talon can be evaluated as a full sixth ridge (e.g., A.M.N.H. no. 18705: Osborn, 1942, p. 878 fig. 761, lower pair; Colbert and Hooijer, 1953, p. 73). Even in these specimens, however, the sixth ridge is not bordered behind by a row of small enamel tubercles as is usual in *Stegodon trigonocephalus*, and, therefore, the latter species is somewhat more progressive than its Chinese cousin in its DM^3, as first observed by Dietrich.

TABLE 8

Measurements of DM^3 of *Stegodon trigonocephalus*

	greatest length	posterior width
Janensch, 1911, p. 164	54	41
Coll. Dub. no. 1780	51	34
Coll. Dub. no. 1655	58	44
Coll. Dub. no. 1647a	57	39
Coll. Dub. no. 1647b	53	39
Coll. Dub. no. 11649	ca. 60	45

The specimens of *Stegodon trigonocephalus* recorded in table 8 average 55½ mm in length, and 40½ mm in width. The eleven specimens of DM^3 of *Stegodon orientalis* the measurements of which are presented in Colbert and Hooijer (1953, p. 73) average 58 mm in length, and only 38½ mm in width. Thus, the DM^3 of *Stegodon orientalis* averages longer, but narrower than that of *Stegodon trigonocephalus*; the difference is small.

Of the lower second milk molar, DM_3, of *Stegodon trigonocephalus* no specimen has ever been described; there is a good series of this element in the Dubois collection, six of the right, and five of the left side, plus a few specimens too incomplete for measurement.

The crown of DM_3 is widest behind, and narrows to the front, but the anterior ridge is slightly produced outward buccally in most cases, giving a slight twist to the anterior end of the crown, which facilitates the determination of the side to which the molar belongs. The anterior ridge is convex to the front from side to side, may show a median cleft when slightly worn, and have a row of small tubercles in front which represents the anterior talonid. The ridges following behind become ever wider transversely, and may or may not present median clefts. Behind the sixth ridge from the front, where the crown is widest, there follows the terminal ridge, which is either large (as in Coll. Dub. no. 1647d, from Kedoeng Broeboes, pl. IX fig. 6) or small (as in Coll. Dub. no. 1647h, from Pengilan, pl. II fig. 3). The seventh ridge appears to be best developed in large molars. Three specimens, one of large size, one intermediate, and one of small size, all of the right side, are presented in pl. IX figs. 6, 5 and pl. II fig. 3. In table 9, the first six specimens are of the right side, and the remaining five of the left side.

In *Stegodon orientalis,* the sixth ridge of DM_3 is occasionally small, as a posterior talonid; at any rate the number of ridges is never more than six (Colbert and Hooijer, 1953, p. 73). In *Stegodon trigonocephalus* the sixth ridge is always a full ridge, and there even may be seven full ridges.

TABLE 9

Measurements of DM_3 of *Stegodon trigonocephalus*

Coll. Dub. nos.	greatest length	posterior width
123 (? Trinil)	66	—
134 (Trinil)	62	39
1647d (Kedoeng Broeboes)	68	42
1647e (Bangle)	—	42
1647f (Mantingan)	60	37
1647h (Pengilan)	56	36
122 (Trinil)	65	41
127 (Trinil)	—	35
1647c (Kedoeng Broeboes)	66	42½
1647g (Tegoean)	64	38
11650 (loc. ?)	—	41

Thus, like the DM^3, the DM_3 of *Stegodon trigonocephalus* is somewhat more progressive than its homologue in *Stegodon orientalis*, the ridge formula varying from 6x to 7 in the former, against from 5x to 6 in the latter species. The specimens of *Stegodon trigonocephalus* DM_3 average 63½ mm in length, and 39 mm in width. The DM_3 in *Stegodon orientalis* (thirteen specimens: Colbert and Hooijer, 1953, p. 73), on an average, is slightly smaller both ways: length, 62 mm, and width, 38 mm.

The upper third milk molar, DM^4, is in situ in a fragment of a left maxillary from Kedoeng Broeboes (Coll. Dub. no. 4821, pl. II fig. 6), with, behind it, the complete and unworn M^1; the bases of the crowns of these two molars meet at an angle of ca. 125° (pl. II fig. 5). Further good specimens of DM^4 are the pair in a palate from Trinil (Coll. Dub. no. 417), two right DM^4s from Trinil (Coll. Dub. nos. 120 and 2127), and four left DM^4s, likewise from Trinil (Coll. Dub. nos. 2211, 2291, 3253, and 3387).

Two fine specimens of DM^4 from Trinil have already been described and figured by Janensch (1911, pp. 165-168, pl. XXII fig. 1, and pl. XXIII figs. 1-3). The worn and incomplete anterior molar in the type skull of *Stegodon trigonocephalus* figured by Martin (1887, pl. II fig. 1a) proved to represent a DM^4 also (above, p. 24). Both in width (51 mm) and in laminar frequency (8) the last mentioned specimen is intermediate between the two DM^4s recorded by Janensch (l.c.), the widths of which are 53, and 48 mm respectively, and their laminar frequencies (as measured from the figures) 7⅔, and 8½. The series of Dubois collection specimens varies between wider limits (table 10); the laminar frequency runs from 7 to 9, with an average of 8.

TABLE 10

Measurements of DM4 of *Stegodon trigonocephalus*

	length	width	height	laminar frequency
Martin, 1887	—	51	—	8
Janensch, 1911	101	53	29	$7\,^2/_3$
Janensch, 1911	90	48	28	$8\frac{1}{2}$
Coll. Dub. nos. 4821	108	56	—	7
417	96	54	29	8
120	99	54	25	8
2127	105	55	—	$7\,^2/_3$
2211	104	54	—	$7\,^2/_3$
2291	(88+)	52	—	9
3253	(96+)	$57\frac{1}{2}$	—	$7\,^1/_3$
3387	98	57	—	9

The anterior talon is most produced anteriorly at the buccal side (as is the rule in upper molars in general), and there is a basal tubercle at the lingual entrance to the valley between ridges 1 and 2 from the front. This tubercle shows up in all of the Dubois collection specimens. The second ridge from the front is slightly convex anteriorly; the remaining ridges are approximately straight. The crown widens gradually from front to back, and is rounded off from side to side behind the seventh ridge, forming a low but distinct back talon. The formula of DM4 of *Stegodon trigonocephalus*, therefore, is x7x. Ridges 1-4, if not too much worn down, exhibit median clefts; these clefts become less distinct in the more posteriorly placed ridges. Seen from the side, the base of the crown is slightly concave toward the root anteroposteriorly, and the ridges diverge crownward: the hindmost are less inclined forward than those following to the front. The ridges have finely wrinkled enamel, up to about fifteen conelets per ridge, and their height (measured at the penultimate ridge, if unworn) is about one-half the basal width. Cement is present in varying quantities, as usual: in unerupted crowns it may be completely absent, but in molars in early stages of wear the development may be such that it practically fills up the valleys.

The DM4 of *Stegodon orientalis* (Young 1939, p. 324 fig. 3) differs from that of the Java *Stegodon* in having only six ridges, plus the talons, although the hind talon may assume the shape of a seventh ridge, and the number of true ridges may be said to vary from 6 to 7 (Colbert and Hooijer, 1953, p. 75). *Stegodon orientalis*, therefore, again proves to be less progressive than *Stegodon trigonocephalus*. The difference in size between the DM4s of both species is more pronounced than that between the DM3s. On the average, the DM4 of *Stegodon trigonocephalus* (table 10) has the following dimensions: length, 100 mm; width, 54 mm; height, 28 mm. On the other hand, the average of DM^4 in *Stegodon orientalis* (Colbert and Hooijer, 1953, p. 73) measures: length, 112½ mm; width, 60½ mm; height, 29½ mm. Thus, the Chinese *Stegodon* is the larger.

The lower third milk molar, DM_4, is in situ in various young rami of the mandible from Java. One Java specimen only has been figured before, viz., the anterior part of a DM_4 sin. from Watoealang (Von Koenigswald, 1935b, fig. 2). There is a nice young mandible from Trinil with both DM_4s in use (Coll. Dub. no. 2892; pl. III fig. 6), and there are two more mandibles from Trinil (Coll. Dub. nos. 2897 and 2899) which have slightly worn M_1s in addition to worn DM_4s. The front part of a mandible with only DM_4 dext. preserved is from Djambe Pati Ajam (Coll. Dub. no. 4286). DM_4 is further present in four right rami (Coll. Dub. nos. 370, 2032, 2898, and 4268) and two left rami (Coll. Dub. nos. 144 and 11650), all originating from Trinil except no. 370 (Grobogan, Solo Valley) and no. 11650 (loc.?). The ridge formula in all of the six specimens that are complete and not too much worn (Coll. Dub. nos. 144, 370, 2032, 2892, and 2898) is remarkably constant, x8x, eight full ridges with front and back talonids. The largest specimen (Coll. Dub. no. 144, pl. III fig. 3) is about ten per cent longer and wider than the smallest (Coll. Dub. no. 2892, pl. III fig. 6); the laminar frequency varies from 7½ to 8½, and averages 8.

TABLE 11

Measurements of DM_4 of *Stegodon trigonocephalus*

Coll. Dub. nos.	length	width	height	laminar frequency
144	121	53	—	7⅔
370	122	—	—	7½
2032	115	53	—	8½
2892	109	47	26	8½
2897	(105+)	52	—	8
2898	121	52	—	8
2899	—	53	—	8
4268	111	46	—	8⅓
4286	—	52	—	8
11650	—	—	—	7⅔

DM_4 is, again, slightly wider behind than in front; the lingual surface of the crown is somewhat convex, the buccal concave anteroposteriorly. The anterior talonid is most prominent buccally, and the ridges show median clefts, especially those in the anterior half of the crown, which are, however, soon worn out. The number of conelets per ridge varies between 10 and 15. The posterior talonid is most produced lingually.

In *Stegodon orientalis* (Hopwood, 1935b, p. 78; Colbert and Hooijer, 1953, p. 73) the number of ridges to DM_4 is only 7 instead of 8 as in *Stegodon trigonocephalus*, and the size of the Chinese tooth is larger, on an average. The DM_4s of *Stegodon trigonocephalus* recorded in table 11 average 116½ mm in length, and 51 mm in width; in *Stegodon orientalis* the average figures are 129 mm for the length, and 56 mm for the width. In one (small) DM_4 from Java the height of the penultimate unworn ridge is 26 mm; in *Stegodon orientalis* the height is 31-33 mm (Colbert and Hooijer, l.c.).

MOLARS

The anterior upper molar of *Stegodon trigonocephalus* was represented in Janensch's collection by two unworn and two worn specimens (Janensch, 1911, pp. 168-170), and an anterior fragment. The ridge formula of these molars is x7x. In the Dubois collection there are several complete specimens of M^1 which prove that the number of ridges may also be 8.

The M^1 in situ in a fragment of a left maxillary from Kedoeng Broeboes (Coll. Dub. no. 4821, pl. II figs. 5-6), also holding DM^4, is of the seven-ridged type. The ridges, all unworn, increase slightly in width from front to back, and carry only some 6 or 7 conelets each. The median cleft is visible in all but the last two ridges. The front talon is most developed buccally; the hind talon is arched from side to side. Cement has developed on the anterior ridges only.

Another complete specimen of M^1 with the same ridge formula is also from Kedoeng Broeboes (Coll. Dub. no. 2144). It is a magnificent specimen, of the left side, in a maxillary fragment holding part of the alveolus of DM^4. It is only shorter than Coll. Dub. no. 4821, approaching in this respect the posterior molar in the type skull of *Stegodon trigonocephalus* already dealt with above (p. 24). The number of conelets per ridge varies from 6 to 10.

Coll. Dub. nos. 3818 and 3822, Grobogan, Solo valley. Skull of young individual with parts of DM^4 and both M^1s in situ. Unfortunately the upper part of the skull is gone and so are the frontals, nasals, premaxillaries, and both zygomatic arches. Few skull measurements only can be given: the width of the occiput is ca. 44 cm (48 cm in the equally old type skull of *Stegodon trigonocephalus*: Martin, 1887, p. 38), and the width over the occipital condyles amounts to 17 cm.

Only five ridges of DM^4, all worn out, are preserved; the posterior width is 57 mm. M^1 is worn only at the anterior two ridges, and consists of eight ridges, plus anterior and posterior talons. Its width increases from 61 mm at the first ridge to ca. 72 mm behind; the right M^1 is damaged posteriorly, and the left partially covered inside by the palatine. The width of the palate between the lingual surfaces of DM^4 is 55 mm, between those of M^1, 60 mm in front, and ca. 65 mm behind. Thus, the molar series converge slightly to the front. Measurements of M^1 are contained in table 12.

A second specimen of M^1 with eight ridges (Coll. Dub. no. 11651), of the left side, lacks the antero-buccal angle, and the lingual extremities of the posterior three ridges. Further specimens from Java are unfortunately broken, and their ridge formulas cannot be established. The measurements are given in table 12.

TABLE 12

Measurements of M^1 of *Stegodon trigonocephalus*

	length	width	height	laminar frequency
Martin, 1887	118	66	39	6
Janensch, 1911	127	59	—	—
Janensch, 1911	125	66	—	ca. 6
Coll. Dub. nos. 4821	136	65	38	6¼
2144	123	65	36	6
3818-3822	157	ca. 72	—	6
11651	ca. 138	67	37	6⅓

The complete M^1 of *Stegodon orientalis* from China described by Hopwood (1935b, pp. 77, 80-81, pl. VII fig. 6) has only six ridges, and a talon at either end. In size (length, 146 mm; width, 68.5 mm; height, 39 mm) it is exceeded only by one out of the seven Java specimens listed above. This result confirms the conclusions already drawn from the study of the milk molars, viz., that *Stegodon trigonocephalus* is more progressive, and smaller, on an average, than is *Stegodon orientalis*.

The only anterior lower molar (M_1) of *Stegodon trigonocephalus* that has ever been described is found in Van der Maarel (1932, pp. 138-141, pl. XV figs. 3-4). Afterwards, Von Koenigswald (1935b, fig. 1) presented a figure of the posterior portion of an M_1 dext. from Tjipanaroeban near Soebang in Western Java. Van der Maarel's specimen was broken off at the seventh ridge from behind, that of Von Koenigswald's shows only five ridges and a well-developed posterior talonid.

Coll. Dub. no. 2893, Trinil. Mandible with both M_1s. The coronoid and condyloid processes, as well as the pockets which would have held the germs of the M_2s, are missing. The first molars are worn to the penultimate ridges and are curved in a horizontal plane, with the convex surfaces facing each other. Each consists of nine ridges, and talonids; the talonid of the right M_1 is lost. The first five ridges are worn to single enamel figures, but the conelets still show on the remaining ridges, and are from 7 to 10 in number per ridge. The width of the crown increases backward; it is 55 mm at the third ridge from the front, 60 mm at the sixth, and 59 mm at the last ridge, behind which the crown is rounded off with a sizable talonid. The height of the ramus at the anterior end of the molar is ca. 145 mm.

The M_1 in the left ramus of the mandible with DM_4 and M_1 from Trinil (Coll. Dub. no. 144, pl. II fig. 3), however, has only eight ridges between the talonids at either end. The conelets per ridge vary from 5 to 8 in number, and the median cleft is discernible in the first two ridges only. The width of the crown increases from 50 mm at the first ridge to 64 at the penultimate ridge. The anterior talonid is most produced buccally, the posterior talonid lingually, and the crown is, again, curved in a horizontal plane with the outer surface concave from before backward.

In a mandible from Trinil with worn DM_4s (Coll. Dub. no. 2899) both M_1s are present, and the left has eight ridges, as in the preceding specimen; the right is broken off behind the seventh ridge from the front. In the remaining mandibular rami with worn DM_4s the M_1s are either incomplete or not fully shown (Coll. Dub. nos. 2897, 2898).

An isolated left M_1 from Trinil (Coll. Dub. no. 1789), broken off at the seventh ridge from the front, shows six conelets on each of the first three ridges, five conelets on the fourth and on the fifth ridge, and even only four conelets on the sixth ridge. The width at the base increases from 50 mm at the first to 61 mm at the sixth ridge, and the height increases accordingly from 37 mm at the first ridge to 46 mm at the sixth. There is hardly any sign of median clefts.

TABLE 13

Measurements of M_1 of *Stegodon trigonocephalus*

	length	width	height	laminar frequency
Van der Maarel, 1932	—	65	42	6
Coll. Dub. nos. 2893	164	60	ca. 38	6½
144	143	64	44	6¼
2899	—	60	38	7¼
1789	—	61	46	6½

The number of ridges in M_1 of *Stegodon orientalis* varies from 7 to 8, that of *Stegodon trigonocephalus* varies from 8 to 9. Added to that, the Chinese M_1s are larger; five specimens are from 171 mm to ca. 215 mm in length, and from 65 mm to 84 mm in width (Colbert and Hooijer, 1953, p. 73).

The second upper molar, M^2, is in situ in three subadult skulls of *Stegodon trigonocephalus* (Coll. Dub. nos. 4975, 4981 (Trinil), and 4982) in which M^3 is not or slightly worn. None of these M^2s is complete, however. A good pair of M^2, with nine ridges, is preserved in a maxillary found at the bridge near Tinggang (Coll. Dub. nos. 2411-2412). There is a palate from Kedoeng Broeboes (Coll. Dub. no. 143) with the anterior five or six ridges of both M^2s behind some worn and damaged ridges of M^1. A right M^2 in a palate from Tandjoeng near Solo (Coll. Dub. no. 146) consists of the posterior five ridges, all much worn down. A fragment of a left maxillary from Kedoeng Broeboes (Coll. Dub. no. 4821) presents five worn ridges of M^2 in front of the unworn anterior half of M^3. Finally, another fragment of a left maxillary (Coll. Dub. no. 2431) bears the posterior six ridges and talon of M^2.

Further specimens of M^2 in the Dubois collection are isolated, but among these are the best specimens, viz., a complete, nine-ridged, right M^2 from Trinil (Coll. Dub. no. 2364, pl. V figs. 1-2), and another M^2 dext., broken into two parts that fortunately fit together (Coll. Dub. nos. 3462-3463, pl. VII fig. 4), and that originates from Kebon Doeren. There remain a number of anterior and posterior molar fragments presumably representing M^2 but too incomplete to be of any use.

In Janensch's account of the proboscideans of the Selenka expedition two specimens of M^2, both from Trinil, are described and figured (Janensch, 1911, pp. 171-174, textfig. 12 and pl. XXV fig. 1). The unworn specimen has nine ridges, plus the talons; the worn molar exhibits eight ridges, and part of one more, which may be either the ninth ridge or a large anterior talon.

Our best specimen, the M^2 dext. from Trinil (pl. V fig. 1), has a large anterior talon that is most developed buccally, as usual. It has a contact facet, concave from side to side. The first seven ridges are worn; median clefts do show in ridges 1-3 only. The buccal ends of the ridges are recurved backward. The amount of cement increases markedly behind, exposing only the conelets of the posterior three ridges, which are seven in number. The posterior talon is most prominent lingually, and has four conelets, flanked by two small enamel points buccally and one low point lingually. As a whole the crown is well set off from the root part, and is concave toward the root anteroposteriorly. The roots form a solid mass, with vertical grooves on the sides dividing the buccal and lingual surfaces into ridges, one for each of the crown ridges. The root ridges converge toward their free apices. The crown width increases from 80 mm at the first ridge to 89 mm at the seventh; the eighth ridge is 85 mm wide, the ninth is, again, 80 mm wide basally.

The M^2 dext. originating from Kebon Doeren (Coll. Dub. nos. 3462-63, pl. VII fig. 4) is worn at the anterior talon and the first ridge only; the talon being most developed buccally, and the first ridge showing a median cleft, as is commonly the case. A remarkable thing about the molar is the curvature of the ridges: from the second ridge on backward to the fifth ridge the buccal halves of the ridges are displaced forward relative to their lingual halves. The sixth ridge is only a half-ridge, limited to the buccal half. The molar was broken through this ridge, but the anterior and posterior molar fragments fit well together. Behind the sixth ridge, the seventh ridge is again S-shaped, but with the buccal half placed more backward than its lingual half, which must have been in contact with the lingual half of the fifth ridge basally. In the eighth ridge the curvature is much less distinct, and the ninth and last ridge is straight transversely. Thus, the present molar has eight ridges lingually and nine buccally. Similar extra half-ridges do occur in stegodonts (as well as in other proboscideans); Lydekker (1880, p. 265, pl. XLVI fig. 1) figures an M^1 sin. of *Stegodon bombifrons* with a half-ridge lingually behind the fifth ridge; Martin (1888, p. 103, pl. XII fig. 1) discusses part of an upper (third) molar of *Stegodon trigonocephalus* in which a half-ridge does also occur. These are individual variations without specific significance, as already realized by Lydekker (1880, p. 265). Cement is abundant in the Kebon Doeren M^2, covering all the ridges except for the conelets; on the posterior ridges and the hind talon (of which only the lingual part is preserved) it has weathered off. The basal width of the first ridge is only 64 mm, that of ridge five is, however, 76 mm, and that of ridge eight, 74 mm. There is a fragment in the collection that is a perfect mirror-image of the third and fourth ridges of the present molar, with the same curvature of the ridges, and which seems to have belonged to the left M^2 of the same individual as that of Coll. Dub. no. 3462-63.

Of the M^2 dext. of Coll. Dub. no. 4975 only seven ridges are preserved; it widens decidedly behind. The posterior width is 94 mm, that at the third ridge from behind, 86 mm, and that at the sixth ridge from behind, 75 mm. All the ridges are worn. This is the largest specimen of M^2 in the Java collection. The M^2s in skulls nos. 4981 and 4982, only the posterior five or six ridges of which are preserved, are less wide behind, and have higher laminar frequencies (table 14).

TABLE 14

Measurements of M^2 of *Stegodon trigonocephalus*

	length	width	height	laminar frequency
Janensch, 1911	191	78	48	—
Janensch, 1911	196	92	—	—
Coll. Dub. nos. 2364	221	89	52	4½
3462-63	196	76	48	4⅓
4975	193+	94	—	4
4981	—	84	—	5
4982	—	85	—	4½
2411-12	208	84	—	4⅓
143	—	—	—	4½
146	—	84	—	4⅓
4821	—	82	—	4½
2431	—	89	—	4

The M^2 in Coll. Dub. nos. 2411-12 are complete except for the anterior talons. There are nine ridges, all much worn down. The conelets can be seen in the posterior three ridges only, and vary from 8 to 11 in number per ridge. The median clefts show up in the slightly worn anterior ridges of M^2 in the palate from Kedoeng Broeboes (Coll. Dub. no. 143); the width of these M^2s increases from 70 mm at the first ridge to 79 mm at the fifth; the greatest width of these molars cannot be given as the posterior halves are missing. In the much worn M^2 of Coll. Dub. no. 146, comprising the posterior five ridges, the width is uniform throughout, 84 mm. The M^2 of Coll. Dub. no. 4821 has a half-ridge lingually, in front of the second ridge from behind. A fragmentary M^2 with the posterior six ridges and talon (Coll. Dub. no. 2431) has the greatest width at the fourth ridge from behind (89 mm); the second and sixth ridges from behind are only 82 mm wide.

With a ridge formula of x9x (occasionally x8/9x) the M^2 of *Stegodon trigonocephalus* proves, again, to be more progressive than its homologue in *Stegodon orientalis*, the ridge formula of which is x8x (Colbert and Hooijer, 1953, p. 75). In shape the single M^2 of the Chinese *Stegodon* is rather unlike that of *Stegodon trigonocephalus*, being shorter (185 mm) by a width (88 mm) just over the average width of the Java M^2s (85 mm).

The second lower molar, M_2, was represented in the Java collection studied by Janensch (1911, pp. 179-181, pl. XXII fig. 4) by two incomplete specimens, worn and broken off at the front, with only seven, and three ridges, respectively. In the Dubois collection from Java we have a complete isolated specimen of M_2 sin. from Tegoean (Coll. Dub. no. 2231, pl. III fig. 2) a right and a left mandibular ramus with complete M_2 from Trinil (Coll. Dub. nos. 2432-2433), a complete M_2 in a left mandibular ramus from Kedoeng Broeboes (Coll. Dub. no. 145), and a right mandibular ramus with M_2 complete (Coll. Dub. no. 3502). Incomplete specimens of M_2 are present in one right and two left rami of the mandible (Coll. Dub. nos. 3501, 134 (Kedoeng Broeboes), and 2452 (Djambe Pati Ajam)). Various mandibles with M_3 in situ also hold the posterior parts of M_2: Coll. Dub. nos. 3442-3444, Kedoeng Broeboes; Coll. Dub. no. 2896, Trinil, and Coll. Dub. no. 2894, Trinil, and so do a right ramus (Coll. Dub. no. 3499, Trinil), and a left ramus (Coll. Dub. no. 2428, Kedoeng Broeboes). Two of the isolated and incomplete specimens of M_2 are worth recording: Coll. Dub. no. 402 (Nantja), with eight ridges, and Coll. Dub. no. 2244 (Kedoeng Broeboes), which has six.

Our best specimen, an M_2 sin. from Tegoean (Coll. Dub. no. 2231, pl. III fig. 2) has only the anterior three ridges worn. There are ten ridges, a small posterior talonid developed lingually only and a sizable anterior talonid that is most prominent buccally. The crown widens from 59 mm at the first ridge to 68 mm behind; there are from 6 to 8 conelets on each ridge. The crown is curved in a horizontal plane (with the buccal surface concave anteroposteriorly) as well as in a vertical plane: the base of the crown is convex anteroposteriorly toward the roots. The ridges tend to converge toward their summits, the hind ridges are more inclined forward than those in front.

The right and left M_2 of Coll. Dub. nos. 2432-33 agree with the preceding specimen in having ten ridges between the talonids. Wear has proceeded to the eighth ridges, and there are from 7 to 9 conelets per ridge. The dimensions only are larger; the crown widens from 69 mm in front to 80 mm behind. Thus, its least (anterior) width even exceeds the greatest (posterior) width of Coll. Dub. no. 2231.

Coll. Dub. no. 145, although it is longer than the specimens of M_2 dealt with above, has only nine ridges, plus a large anterior and a small posterior talonid. The anterior width is only 67 mm. The penultimate ridge (unworn) is lower than that in Coll. Dub. nos. 2432-33, but the number of conelets is the same.

Coll. Dub. no. 3502 has, again, ten ridges, and even a good-sized lingual posterior talonid. Yet it is shorter than any of the other complete M_2s, a difference that also shows up in the high laminar frequency (table 15). The height cannot be given as even the last ridge is touched by wear.

The remaining specimens of M_2, all incomplete, show a variation in width and laminar frequency greater than that in the complete M_2s. The M_2 in Coll. Dub. no. 3442-44 is very large compared to that of Coll. Dub. no. 2896; yet there can be no doubt as to their serial position as both are in situ in mandibles, with the last molar, M_3, behind them.

The measurements of M_2 are presented in table 15. The number of true ridges, as we have seen above, varies from 9 to 10. In *Stegodon orientalis* (Colbert and Hooijer 1953, p. 73) it varies from 8+ to 9. Of the three specimens of M_2 of *Stegodon orientalis* on record, one (A.M.N.H. no. 18633, measuring 220 by 95 mm) is above the range of variation of its homologue in *Stegodon trigonocephalus*; the others are within these limits.

TABLE 15

Measurements of M_2 of *Stegodon trigonocephalus*

Coll. Dub. nos.	length	width	height	laminar frequency
2231	188	68	44	6
2432-33	210	80	50	5½
145	213	76	43	5
3502	185	69	—	6½
3501	—	—	—	4⅔
134	—	—	—	5½
2452	—	75	44	5
3442-44	—	85	—	3¾
2896	—	69	—	5⅔
2894	—	81	—	4⅔
3499	—	78	—	4
2428	—	73	—	5
402	—	—	41	5½
2244	—	76	42	5

Complete last upper molars of *Stegodon trigonocephalus* have already been described by Janensch (1911, pp. 174-177, pl. XXV fig. 2), Soergel (1913, pp. 6-7, pl. I fig. 2), and Van der Maarel (1932, pp. 136-138, pl. XIII figs. 1-2). One of Janensch's specimens has twelve ridges between the talons; the other, as well as the specimen described by Soergel and that described by Van der Maarel, eleven only. In the Dubois collection the entire M^3 is preserved in four skulls, Coll. Dub. nos. 4975, 4976 (Trinil), 4981 (Trinil), and 4982, as well as in a palate from Kedoeng Broeboes (Coll. Dub. no. 3433). There are further two isolated complete M^3s, viz., Coll. Dub. no. 3473 (?Pati Ajam), and Coll. Dub. no. 2235. In these specimens, as we shall see below, the number of ridges (beside the talons) varies from ten to twelve. As three out of the four specimens of M^3 of *Stegodon trigonocephalus* already described, and five out of the seven here described, carry eleven ridges, the typical number of ridges to M^3 of the Java *Stegodon* is eleven.

The right M^3 of Coll. Dub. no. 4975 (the left is only partially preserved) is in a splendid state of preservation, and unworn (pl. VII fig. 2). The crown base is concave toward the roots anteroposteriorly, forming a curve that is most marked in the anterior part of the crown, from the fourth ridge on forward. The anterior talon forms a large cone buccally, and is only weakly developed lingually. The first ridge is somewhat produced forward in the middle, and has two central conelets, with a cleft in between, flanked by large buccal and lingual conelets. The outer slope of the buccal conelet is steeper than the inner slope of the lingual. On the posterior slope of the first ridge there are two enamel cusps, one on either side of the median cleft, partially hidden below the coat of cement that extends over the first five ridges of the crown.

Both at the buccal and at the lingual entrances to all the valleys of the crown there are basal enamel cusps; those on the lingual side are larger than the buccal except in the first valley in which the buccal cusp is the larger. The crown widens basally from 86 mm at the first ridge to 107 mm at the fifth, the widest part of the crown. Ridges 2 and 3 are slightly convex to the front, with eight conelets each and no median clefts. Ridges 4-6 have a weak S-shaped curvature, being convex to the front lingually and slightly concave so buccally, and they bear 8-9 conelets each, as do ridges 7-9, which are approximately straight transversely. From ridge 7 on backward the crown decreases gradually in width to 71 mm at ridge 10, which is convex behind and has 7 conelets. It is followed by the small talon that rounds off the crown behind.

Thus, the ridge formula of the present M^3 is x10x. The height of the ridges varies more or less with their width; the height is greatest at the widest ridge, the fifth (49 mm). The first ridge is only 40 mm high, the third and the seventh, 45 mm, and the ninth, again, 40 mm.

The M^3s of the next specimen (Coll. Dub. no. 4976, from Trinil) have the first seven ridges worn; the remaining four ridges and the hind talon are covered with cement so that even their conelets can hardly be seen. Thus, although it is slightly shorter than Coll. Dub. no. 4975 (table 16), it has one ridge more than the latter. The basal buccal and lingual cusps at the entrances to the valleys are weakly developed. The first five ridges are worn to single enamel figures, and their basal widths increase from ca. 78 mm at the first to 101 mm at the fifth ridge. Behind ridge 5 the width decreases gradually to 90 mm at the ninth ridge; the base of the remaining ridges is not exposed lingually, being covered by the palatines. The height of the (unworn) eighth ridge is 45 mm, but that of the fifth ridge probably was higher still. The laminar frequency, of course, varies a little according to the place where it is taken; the worn enamel figures of ridges 1-4, inclusive, measure exactly 10 cm anteroposteriorly, but it is also 10 cm from the middle of the valley between ridges 6 and 7 to the top of ridge 10, covering 3½ ridges. Anyway, the laminar frequency is higher than that of the preceding specimen, as was to be expected.

Our next specimen, in skull Coll. Dub. no. 4981, has only three ridges worn. The anterior talon and first ridge are as in Coll. Dub. no. 4975, but the width at the first ridge is 81 mm only. The greatest width is at the fifth ridge, 91 mm. All the unworn ridges are bathed in cement. Height measurements cannot be given; the median posterior border of the palate is at the level of the seventh ridge. There are twelve ridges; the hind talon is small, limited to two low lingual cusps on the right M^3, but practically undeveloped in the left. The ridges of the posterior halves of the molars show an S-shaped curvature, and they carry some 6 to 8 conelets. The present molars are again shorter than those just described, although their number of ridges is higher, which shows in their higher laminar frequency (4-4½).

The M^3s in skull Coll. Dub. no. 4982 are composed of eleven ridges, of which the ninth actually are half-ridges, limited to the buccal half of the crown. Only the anterior two ridges are worn, and both show median clefts; the others are covered with cement. The width of the first ridge is 87 mm, that of the fourth, 92 mm; the width of the fifth is a little, if at all, greater. The perpendicular portions of the palatines cover the inner surfaces of the ridges from ridge 5 on backward. While ridge 8 is of normal shape, ridge 9 is limited only to the buccal half, with two or three conelets. It is, however, of the same anteroposterior extent as the ridges in front of it. Ridge 10, then, swings forward and inward from the buccal side behind ridge 9, filling up, as it were, the space left by the incomplete ninth ridge, and as the eleventh (and last) ridge follows ridge 10 in its course, the molars terminate rather obliquely behind, projecting much more backward on the buccal than on the lingual side. Both ridges 10 and 11 have only five conelets each. There does not appear to be a posterior talon; it must have been, at any rate, small.

Coll. Dub. no. 3433 is a palate from Kedoeng Broeboes with the first ridge of the right M^3 missing. It is, however, preserved on the left M^3, of which ridges 3-6 are incomplete. There are some large conules at the lingual entrance to the valley between ridges 1 and 2. Wear has advanced to the seventh ridge, which has eight conelets. Ridges 8-11 and the hind talon have a thick cover of cement. The width, ca. 80 mm at the first ridge, is greatest (104 mm) at the fifth ridge. The ninth ridge is still 92 mm wide basally. The posterior talon is limited to the central half of the crown, and consists of a cluster of seven small cones.

Coll. Dub. no. 3473 is a right M^3 that has, again, eleven ridges. The front part of the crown is damaged on the sides; wear has progressed to the sixth ridge. Most of the ridges show a curvature, with the centre produced backward, and a convexity to the front on either side. The height of the sixth ridge is ca. 60 mm; this ridge also has the greatest width (107 mm). The posterior talon is small, and placed lingually.

Rather similar is Coll. Dub. no. 2235, another right M^3, which is only longer and narrower, maximally 98 mm, at the fifth ridge, which is 56 mm high. Ridges 1 and 2 only are worn, and both exhibit median clefts. The cement coating is heavy.

In a partial skull from Kedoeng Panas (Coll. Dub. no. 4967) the left M^3 is entire but for the anterior talon, which is largely cut out by the molar in front of it. The posterior part of the right M^3 is broken off. There are ten ridges, plus the talons; six ridges are worn. This molar is remarkable for its comparatively small size; its length as preserved is only 201 mm, but the missing part of the anterior talon would not have made a difference of more than 5 mm or so. The greatest width is at the fifth ridge from the front, as usual in M^3s, and is only 76 mm. The measurements and indices of the unworn posterior ridges will be given below in table 17.

Although none of the remaining specimens of M^3 of *Stegodon trigonocephalus* in the Dubois collection from Java is anything like complete, several are worth recording as they increase our knowledge of the individual variation. The anterior part of a left M^3 (Coll. Dub. no. 380) has a small buccal anterior talon and nine ridges preserved. It probably carried three more ridges. The first two ridges are worn; each has six conelets, and a median cleft. All the ridges are covered with cement; it can, however, be seen that the eighth ridge is a lingual half-ridge. The width increases from 70 mm in front to 85 mm at the fifth ridge. The hindmost preserved ridge (no. 9) is still 78 mm wide and 54 mm high. Its laminar frequency is rather high (table 16).

The right M^3 of Coll. Dub. no. 4821, from Kedoeng Broeboes, only six ridges of which are preserved, measures 88 mm transversely at the first ridge, and attains a width of 105 mm at the fifth. Rather smaller is an M^3 sin. from Djambe Pati Ajam (Coll. Dub. no. 3446), of which the first seven ridges are present: the width is 78 mm at the first, and 93 mm at the fifth ridge.

In the Cosijn collection from the Poetjangan layers North of Djetis and Perning, Eastern Java, preserved in the Geological Museum at Leiden, there is the anterior portion of an M^3 dext. with three ridges (Geol. Mus. Leiden no. 27813) measuring 98 mm transversely at the first, and 104 mm at the second ridge. On the posterior slope of the first ridge there are two median cones, as in Coll. Dub. no. 4975, but larger.

Various good posterior portions of the last molar are in situ in skulls, such as Coll. Dub. nos. 5005 (Kedoeng Panas), 4978 (Trinil), and 4964 (Trinil). The M^3s in Coll. Dub. no. 5005 (the posterior part of the left is Coll. Dub. no. 3451) are worn to the penultimate ridge (with seven conelets), and have only the posterior seven ridges and talon preserved; the ridges in front are worn to a continuous dentine surface. The greatest width is 99 mm, at the seventh ridge from behind, which presumably is the fifth ridge from the front, in which case there have been eleven ridges in all. Both M^3s in Coll. Dub. no. 4978 (Trinil) are complete behind, but in front of the fourth ridge from behind the crown surface is a continuous dentine surface, hollowed transversely. There would seem to have been six more ridges, as indicated on the sides of the molars. The preserved ridges show the same kind of curvature observed in Coll. Dub. no. 3473. The width of the fourth ridge from behind is 91 mm, which is not the greatest width of the molar, however. The laminar frequency is rather high (4½). In Coll. Dub. no. 4964, from Trinil too, the M^3s are rather small. Ridges 3-5 from behind in the left M^3 are damaged, but the right is entire. The hollowed dentine surface begins in front of the sixth ridge from behind, but the buccal parts of at least two more ridges are shown. Only the last ridge is unworn; apart from this ridge all the preserved ridges are convex transversely to the front. The greatest observable width (at ridge 7 from behind) is 79 mm. The laminar frequency is 5, higher even than that in the small M^3 of Coll. Dub. no. 4967.

Some isolated posterior portions of M^3 worthy of note are Coll. Dub. no. 2490 (? Trinil), broken off through the eighth ridge from behind just as Coll. Dub. no. 3408 (Kebon Doeren), and Coll. Dub. no. 3412 (Kedoeng Broeboes), with four ridges and the talon behind. Coll. Dub. no. 3474 (? Pati Ajam) is an M^3 sin., most probably of the same individual as Coll. Dub. no. 3473, the eleven-ridged M^3 dext. already dealt with above. Only five ridges and the talon of the left M^3 are preserved. While the number of conelets in Coll. Dub. nos. 2490 and 3408 varies from 9 to 11 per ridge, in Coll. Dub. no. 3412 there are only from 5 to 7 conelets per ridge.

TABLE 16

Measurements of M^3 of *Stegodon trigonocephalus*

	length	width	height	laminar frequency
Janensch, 1911	—	97	59	—
Janensch, 1911	256	86	56	—
Soergel, 1913	287	105	54	—
Van der Maarel, 1932	250	89	55	—
Coll. Dub. nos.				
4975	294	107	49	3¼
4976	281	101	45+	3½—4
4981	273	91	—	4—4¼
4982	240	92	—	4
3433	310	104	—	3¼
3473	270	107	ca. 60	3½
2235	280	98	56	3½
4967	201+	76	—	4½
380	—	85	58	4—4½
4821	—	105	ca. 60	3½—4
3446	—	93	58	4
5005	—	99	—	3½
4964	—	79+	—	5
2490	—	86	56	3½—4
3408	—	—	—	3½—4
3412	—	—	—	4
3474	—	106	59	3½

It will be observed from table 16 that the greatest width observed thus far in M^3 is 107 mm (Coll. Dub. nos. 4975 and 3473). Even larger molars do occur in the Java *Stegodon,* as shown by a fragment from Trinil (Coll. Dub. no. 3478), with three ridges, the largest of which measures 113 mm transversely at the base. As these three ridges occupy a length of 7½ cm, the laminar frequency of this record specimen of M^3 is just 4.

The relation between greatest height and greatest width of M^3, as expressed in the height-width index $(\frac{\text{height} \times 100}{\text{width}})$ varies from 46 (in Coll. Dub. no. 4975) to 68 (in Coll. Dub. no. 380). Thus, the greatest height of M^3 of *Stegodon trigonocephalus* is from one-half to two-thirds the greatest width. Both higher and lower indices may be obtained when measuring the posterior ridges of the specimens that are unworn behind. In table 17 the width, height, and height-width index of the posterior four ridges are given for the following specimens: a, Soergel, 1913, p. 7; b, Coll. Dub. no. 2490; c, Coll. Dub. no. 3474; d, Coll. Dub. no. 3412; e, Coll. Dub. no. 3408; f, Coll. Dub. no. 4967; g, Janensch, 1911, table 5, and h, Van der Maarel, 1932, table T, G.

TABLE 17

Unworn ridges of M^3 of *Stegodon trigonocephalus*

No. of ridge from behind		4	3	2	1
Width of specimen	a	102	97	91	84
	b	90	84	78	67
	c	98	85	78	56
	d	83	78	72	65
	e	86	76	69	60
	f	72	68	64	59
	g	77	69	60	44
	h	71	68	63	55
Height of specimen	a	47	43	41	39
	b	54	52	49	46
	c	62	59	54	47
	d	57	55	52	48
	e	56	52	49	47
	f	42	40	37	32
	g	47	45	44	39
	h	46	46	44	36
Height-width index of specimen	a	46	44	45	46
	b	60	62	63	69
	c	63	69	69	84
	d	69	71	72	86
	e	65	68	71	78
	f	58	59	58	54
	g	61	65	73	89
	h	65	68	70	65

In the hindmost ridge of M^3 we find indices up to 89 (Janensch, 1911, table 5, b), but in the ridges from ridge 2 on forward the index varies from 44 to 73. These figures should be compared with those of the small hypsodont *Stegodon hypsilophus* Hooijer (1954a) recently described from Java, and further discussed in the present paper (pp. 86—89).

The M^3 of *Stegodon orientalis* (Colbert and Hooijer, 1953, p. 75) has twelve ridges, or rather eleven ridges and a small posterior talon (Osborn, 1942, p. 877, gave the formula as 1/8-11-1/8). Both in length (286 mm) and in width (105-108 mm) the M^3 of the Chinese *Stegodon* is to the higher side of the range of variation of these measurements in *Stegodon trigonocephalus*.

As already remarked at the beginning of the present chapter, the last lower molar, M_3, of *Stegodon trigonocephalus* is known to vary in number of ridges from 11 to 13, a variability of two ridges, exactly as in the last upper molar just described. The lower last molars from Trinil described by Janensch (1911, pp. 182-185, figs. 15 and 4, pl. XXV fig. 3) have thirteen ridges, that from Lepen Alit near Tinggang described by Van der Maarel (1932, p. 143, pl. XII fig. 1) has eleven ridges. Although the eleven-ridged M_3 figured by Van der Maarel is regarded by Von Koenigswald (1933, p. 104) as belonging to the typical Trinil subspecies *Stegodon trigonocephalus trigonocephalus*, an eleven-ridged M_3 from Boemiajoe (Kali Glagah fauna) is regarded by Von Koenigswald (l.c.) to be subspecifically distinct: *Stegodon trigonocephalus praecursor*. The Boemiajoe M_3 is further stated to be shorter than those from the Trinil layers, having a length of ca. 240 mm as opposed to at least ca. 270 mm in the typical subspecies, a difference in length that Von Koenigswald (l.c.) thinks is due to the smaller number of ridges in the Boemiajoe form. This distinction, however, does not hold either, for in the Dubois collection there is a mandible from Trinil with M_3 only 240 mm long, and yet having thirteen ridges (Coll. Dub. no. 2896, pl. IV fig. 2). Consequently, neither in ridge formula nor in size the *Stegodon* from the Kali Glagah fauna can be differentiated from that of the Trinil fauna proper.

The best specimen of lower last molar in the Dubois collection is an M_3 dext. (Coll. Dub. no. 2326) with twelve ridges; the posterior talonid is broken off. Only the anterior talonid and five ridges are worn (pl. X fig. 1). The crown is curved horizontally, with the buccal surface concave anteroposteriorly as well as vertically: the hinder part of the crown is curved upward, causing the ridges to converge crownward. The anterior talonid is confluent with the first ridge; it is most prominent buccally. Median clefts cannot be distinguished in the first ridges, due to their advanced stage of wear. There is a tubercle at the lingual entrance to the valley between the first and second ridges. The ridges have steep buccal and lingual edges; nos. 4 and 5 carry eight conelets. From ridge 6 backward to and including ridge 10 the unworn ridges display a median cleft, flanked by two large conelets. On either side of this central portion of the ridges there are two smaller conelets, making a total of only six conelets per ridge. Ridges 11 and 12 do not show such a high incised central portion; their crown edge is more even and the conelets are not distinctly formed. The hind talonid must have been a small affair, as the crown narrows abruptly behind ridge 12. The anterior width of the crown is 72 mm; the crown widens gradually to 90 mm at the seventh ridge, and then narrows again gradually to 63 mm at the twelfth ridge. The greatest height of the crown is again at the seventh ridge (57 mm); that of the twelfth ridge is only 46 mm. There is not much cement on the crown.

The anterior part of the root system supports only the anterior two crown ridges; it is constricted in the centre. The remaining roots, one pair (buccal and lingual) for each of the ridges, have joined basally so as to form a wall on either side; the base of the crown bulges out above the roots.

In a mandible from Trinil (Coll. Dub. no. 2896) both M_3s are present behind the M_2s, but only their anterior ridges are touched by wear, and from the sixth ridge on backward they are concealed below the bone of the mandible. I have exposed the lingual surface of the left M_3 (pl. IV fig. 2) as well as its hinder surface. The crown appeared to be fully calcified, although the roots do not show yet, and there are thirteen ridges in all, plus a buccal anterior talonid and an incipient back talonid. The molar is small, only 240 mm in a straight line from the middle of the anterior surface to that of the posterior surface, and it curves outward as well as upward behind. The anterior ridge has a median cleft and is 61 mm wide at the base. The greatest width of the crown cannot be taken, but the greatest height is at the seventh ridge, 55 mm. The exposed anterior few ridges carry from 7 to 9 conelets each. An interesting detail about the present specimen is the formation of lingual basal cusps at the entrances to the valleys in the back third of the crown. Since cement formation evidently had not yet begun at this early stage of wear of the crown, the cusps are fully shown (pl. IV fig. 2). In the valley entrance between ridges 9 and 10 an accessory cusp rises to 20 mm above the crown base, with a diameter of 9 mm. In the next valley entrance, behind ridge 10, a similar cusp appears, with a height of 26 mm, and 12 mm in diameter. At the entrance to the valley between ridges 11 and 12 the cusp is again larger: 30 mm high, and 13 mm wide. At none of the other lingual entrances to the valleys such cusps are developed. The largest cusp is over one-half the height of the ridges adjoining it (ca. 50 mm). The last and thirteenth ridge is 45 mm wide by a height of ca. 40 mm; on its posterior surface we observe a row of small tubercles at about one-half of the height: the posterior talonid. The laminar frequency is 6 at the upper surface of the crown, but only 5 at the base, as the ridges converge crownward.

Lower last molars as small as the specimen just described have been made known both by Soergel (1913, p. 17, pl. II fig. 2) and by Stehlin (1925, p. 6, pl. I fig. 2). Soergel's specimen is the posterior part of an M_3 dext. with eight ridges and the talonid; that of Stehlin the posterior part of an M_3 sin. with only five ridges and the talonid. The laminar frequency of the former specimen is a little less than 6, that of the latter just over 5; both, therefore, concur with the Dubois collection M_3.

There is another mandible with small M_3s, Coll. Dub. no. 2187 (the left ramus) and no. 2296 (the right ramus). Parts of the worn M_2s are still in situ; the M3s are worn to the fifth ridges and are incomplete behind. M3 sin. has nine ridges, M3 dext., ten. The width increases from 63 mm in front to only 68 mm at the fourth ridge, and from this ridge on the width decreases gradually to 62 mm at the ninth ridge. The tenth ridge, preserved at the right side only, is 54 mm wide. The length of the M3 dext., as far as preserved, is 200 mm. If two more ridges, or one ridge and a good-sized talonid, had been present, the total length would have been about the same as that of Coll. Dub. no. 2896. A detailed comparison with Soergel's and Stehlin's specimens (table 18) tends to show that probably one ridge only is missing in the right M3, making a total of eleven

TABLE 18

Ridges of small M3 of *Stegodon trigonocephalus*

No. of ridge from behind	8	7	6	5	4	3	2	1
Width (Soergel, 1913)	—	67	67	66.5	63	58	53	45
Id., Coll. Dub. no. 2187	68	67	67	67	66	62	54	—
Id. (Stehlin, 1925)	—	—	—	—	69	65	55	49
Id., Coll. Dub. no. 3500	—	76	77	75	70	65	57	45

ridges, the minimum number of ridges also found in an M3 figured by Van der Maarel (1932, pl. XII fig. 1). It will be seen from table 19 that, as an eleven-ridged M3, Coll. Dub. no. 2187 is intermediate between the specimens described by Soergel and Stehlin, respectively, in the width of its ridges. The height at the sixth ridge from the front is 41 mm.

In table 19 I have added the measurements of an M3 dext. from Soedo (Coll. Dub. no. 3500, pl. V fig. 4), which is complete behind and is broken off in front at the eleventh ridge from behind. Its posterior four ridges are about as wide as those of Coll. Dub. no. 2187, but it becomes distinctly wider than the latter molar in front, up to 77 mm at the sixth ridge from behind. This is its widest ridge, and also the highest (49 mm); the width at the tenth ridge from behind is ca. 72 mm. The length (from the back to the front of the tenth ridge from behind) is 210 mm.

Larger specimens of M3 are decidedly more common. In the mandible from Kedoeng Broeboes (Coll. Dub. nos. 3442-44) only the anterior portions of M3 can be studied; the width is 77 mm in front, and 90 mm at the fifth ridge. In the right ramus from Tritik (Coll. Dub. no. 3499) only the anterior seven ridges of M3 are preserved, 78 mm wide in front, and 86 mm at most (at the sixth ridge). In a mandible from Trinil (Coll. Dub. no. 2894), again, only the anterior six or seven ridges are shown, with a cement cover obliterating even the conelets. The first and second ridges of M3 dext.

are 74 mm and 76 mm wide, respectively; those of the left, 67 mm and 72 mm. While the left M_3 of this mandible is only just touched by wear at its anterior ridge, the right M_3 is worn to the third ridge. It is also in recent elephants (Rühl, 1939, p. 64), and in *Stegodon hypsilophus* Hooijer (1954a, p. 98) that we find the right molars to be slightly more advanced in wear than those of the left side.

Another Trinil mandible (Coll. Dub. no. 2895) has the M_3s broken off in front of the ninth ridges from behind (part of the tenth ridge is preserved at the right side). Worn to the last ridge, these molars have the greatest width at the seventh ridge from behind (85 mm). The number of conelets is approximately eight except in the last two ridges, in which it is five.

A right and a left mandibular ramus from Grobogan-Bodjonegoro (Coll. Dub. nos. 480A and 468), undoubtedly of the same individual, have the M_3s worn to the penultimate ridges, and heavily encrusted with cement. The right M_3 still has ten ridges; the left, eight only. In the region of the 6th to 8th ridges the greatest width is attained (90 mm).

A right ramus of the mandible (Coll. Dub. no. 3423) has eight ridges and the hind talonid of M_3 preserved; only the talonid is unworn. It consists of a single central cone, 35 mm high and 24 mm across at the base, while the last ridge is 42 mm high (very slightly worn) and 57 mm wide. The molar has a strong postero-internal root that does not, however, support anything in particular. There are five conelets in the last two ridges against eight in the third ridge from behind. The widest ridge is the sixth from behind (87 mm).

Rather similar is a left ramus of the mandible from Tinggang (Coll. Dub. no. 135) with nine ridges and the hind talonid of M_3, all worn but the last. The width is rather uniform in the region from the eighth to and including the fourth ridge from behind (83-84 mm). The crown tapers backward only behind the third ridge from behind (80 mm) to 71 mm at the second, 54 mm at the first, and 35 mm at the talonid behind.

A right ramus of the mandible from Nongko near Padas Malang (Coll. Dub. no. 4991) has an M_3 of which only parts of the fifth to eleventh ridges remained on the crown. The full contour of the crown base can very clearly be seen in the bone of the mandible, and it shows this to have been a thirteen-ridged specimen. Its total length (270 mm) shows this M_3 to be a medium-sized specimen; its greatest width (87 mm) is at the seventh ridge from the front.

A right ramus (Coll. Dub. no. 489, Grobogan-Bodjonegoro), and a left (Coll. Dub. no. 3479, Kali Gedeh) both have an M_3 of which the front and back parts are missing. Only eight ridges remain, most of them worn. Some left rami with M3 (Coll. Dub. nos. 4622 and 4989, Padas Malang) are too much corroded for accurate measurement.

Of the isolated fragmentary M3s several show variations of interest. Coll. Dub. no. 2422, the hinder part of a left M3 from Kedoeng Broeboes, shows an unusually large enamel cone at the buccal entrance to the valley between the third and fourth ridges from behind; in the valley behind it there is a similar cone blocking up the entrance, but it is smaller and merged with the ridge behind (pl. V fig. 3).

TABLE 19

Measurements of M3 of *Stegodon trigonocephalus*

	length	width	height	laminar frequency
Janensch, 1911	ca. 295	92	61	—
Janensch, 1911	304	82	—	—
Van der Maarel, 1932	270	89	—	—
Coll. Dub. nos.				
2326	285+	90	57	4 1/3
2896	240	—	55	5—6
2187	200+	68	41+	5—5½
3500	210+	76	49	5
3442—44	—	90	50	4
3499	—	86	48	4½
2894	—	—	—	4½
2895	—	85	—	5
480A—468	—	90	—	4½
3423	—	87	—	4½
135	—	84	—	4½
4991	270	87	—	4½
489	—	87	—	5
3479	—	85	—	4½
3476	—	98	—	4
3368	—	97	—	4 1/3

The crown may be blunt behind, as in Coll. Dub. nos. 364 (the posterior six ridges of an M3 sin.) and 2229 (Kedoeng Broeboes, idem with four ridges), or the crown is pointed, with the ridges narrowing regularly behind and ending in a narrow talonid (Coll. Dub. nos. 3511, Djambe, and 2370, both posterior ends of left M3s with five ridges).

Two fragments, one of a right M3 with four ridges (Coll. Dub. no. 3476, ? Trinil), and one of a left M3 with six ridges (Coll. Dub. no. 3368) have greatest widths of 98 mm and 97 mm, respectively, and thereby are the widest specimens of M3 in the Dubois collection from Java.

In comparison with the M3 of *Stegodon trigonocephalus* (table 19) the lower last molar of *Stegodon orientalis* is definitely longer, one complete M_3 sin. of the Chinese *Stegodon* having a length of 360 mm (Colbert and Hooijer, 1953, p. 73). This molar has thirteen ridges but no hind talonid, and, therefore, since the terminal ridge is rather small (cf. side view of the specimen (A.M.N.H. no. 18714) in Osborn, 1942, p. 877), the latter may be taken to represent the posterior talonid, making the ridge formula x12x.

In concluding the descriptions of the molar series of the Java *Stegodon*, the full ridge formula of *Stegodon trigonocephalus* may now be presented thus:

$$\mathrm{DM2}\ \frac{3}{-}\ \mathrm{DM3}\ \frac{6}{6\text{-}7}\ \mathrm{DM4}\ \frac{7}{8}\ \mathrm{M1}\ \frac{7\text{-}8}{8\text{-}9}\ \mathrm{M2}\ \frac{8\text{-}9}{9\text{-}10}\ \mathrm{M3}\ \frac{10\text{-}12}{11\text{-}13}$$

On the other hand, the ridge formula of *Stegodon orientalis* shows the Chinese species to be just one step less advanced:

$$\mathrm{DM2}\ \frac{3}{2}\ \mathrm{DM3}\ \frac{5\text{-}6}{5\text{-}6}\ \mathrm{DM4}\ \frac{6\text{-}7}{7}\ \mathrm{M1}\ \frac{6}{7\text{-}8}\ \mathrm{M2}\ \frac{8}{8\text{-}9}\ \mathrm{M3}\ \frac{11}{12}.$$

These figures show further that the number of full ridges in the lower molars (DM2 excepted) is equal to or higher than that in the upper molars of the same serial position, and that each molar, as a rule, has more ridges than that preceding it in the dental series.

SKULL

The skull of *Stegodon trigonocephalus* first described by Martin (1887, pp. 36-41) is of a young specimen, although not quite as young as Martin considered it to be; the two molars in situ are DM^4 and M^1, and not DM^3 and DM^4 (above, p. 24). Younger still is the skull described by Janensch (1911, pp. 152-153), for it has DM^3 and DM^4 in use. This explains why Janensch's skull has smaller dimensions than that described by Martin; the length from the middle of the supraoccipital crest to the posterior border of the anterior nares, and the temporal contraction (least width of parieto-frontal region between temporal fossae) are both 20 cm in the younger skull, against 24½ cm, and 33½ cm, respectively, in the older. Both Janensch and Martin also described adult skulls, but these were rather defective and of no use for comparison with the well-known Siwalik *Stegodon* skull types such as *Stegodon bombifrons*, *Stegodon ganesa*, or *Stegodon insignis*. It was noted, however (Martin, 1887, p. 44; Janensch, 1911, p. 156), that the Java *Stegodon* neither had the very convex fronto-parietal region, and the marked temporal contraction of *Stegodon bombifrons*, nor the rounded parieto-occipital region of *Stegodon ganesa*, the Java skulls having a distinct supraoccipital crest marking the parietal region off from the occipital. In his brief notes on the *Stegodon* skulls collected by him in Java, Dubois (1908, p. 1256) agrees that the Java *Stegodon* differs from *Stegodon ganesa* in the more distinct separation between the parietal and the occipital regions, but states that the resemblances between the two skull types are very close indeed. The Java *Stegodon* differs from *Stegodon ganesa* mainly in its smaller size.

The largest skull from Java in the Dubois collection is no. 4979, from Grobogan, Solo valley, with the premaxillaries (Coll. Dub. no. 3819) preserved down to their median anterior eminences (pl. VII figs. 1, 3). The state of preservation is not bad, although the zygomatic arches are missing completely, these having broken off anteriorly at the infraorbital foramina, while behind even the lateral anterior processes of the squamosals are missing. The remainder of the squamosals, with their postglenoid ledges, are preserved. The occipital condyles have broken off, and the basi- and exoccipitals as well as the tympanic bullae are superficially damaged. The pterygoids are for the greater part preserved; on the palate the crowns of the molars are lost. The basal outline of the molars can be seen, however, and from their great width (ca. 95 mm) and length (over 220 mm), as well as from the absence of any sign of molars to follow up behind, it is clear that these were the last molars, fully erupted, and consequently that the individual was quite adult at the time of its death.

The parts of the maxillaries laterally of the infraorbital foramina are missing, but their lower surface is intact, showing the two ridges in front of the molars that first converge, and then diverge anteriorly below the tusk alveoli with the anterior palatine canal in between. In front of the right infraorbital foramen large portions of the right tusk and of the premaxillary around it have broken away, showing the tusk in cross section. The section of the tusk is almost round, with a vertical diameter of 14½ cm, and a horizontal diameter of 13½ cm. The pulp cavity has a diameter of 10 cm. Some 45 cm in front of the infraorbital foramen, at the anterior end of the premaxillaries, the tusks are of the same dimensions in cross section (14½ by 13½ cm), but the pulp cavity is only 6 cm across.

The premaxillaries are slightly concave anteroposteriorly above, following the upward curvature of the huge tusks, and have eminences anteriorly as well as posteriorly in the median line. The anterior eminences are arched anteroposteriorly above, about 17 cm long, and rise ca. 4 cm above the upper surface of the premaxillaries. There is a deep median antero-posterior groove between them, but each sends out an anterior downward process which meet in the median line between the tusks. The tusks are only 10 cm apart at the anterior border of the premaxillaries. Posteriorly the premaxillaries rise into another median eminence, which is, however, much damaged. Bounded by these eminences, and by the tusk-bearing portions of the premaxillaries on either side, is the interalveolar fossa, a very deep trough, some 45 cm long, which widens gradually from 5 cm behind to 9 cm in front, and which has a greatest depth of 15 cm in its middle part. As its lateral walls follow the curve of the tusks on either side, the fossa also widens inside: in the middle of its length the curved median surfaces of the right and left premaxillaries approach each other to a distance of 6½ cm, but toward the bottom on the same level the fossa widens to 8 cm transversely. There is a narrow median anteroposterior bony crest in the posterior part of the interalveolar fossa, leading upward into the posterior eminences of the premaxillaries which mark the interalveolar fossa off from the anterior nares.

The anterior nares form an opening of large extent, with sloping sides, just above the orbits. The right postorbital process is broken off, but the left shows that the posterior border of the orbit is 3 cm in advance of the anterior border of the nasal opening. The latter is one and one-half as wide transversely as it is anteroposteriorly. It is overhung by the (damaged) median anterior tips of the nasals.

The fronto-parietal region of the skull is flattened anteroposteriorly, but convex transversely. Of the temporal fossae the right is superficially injured, but the left is undamaged. The fronto-parietal crests which border it superiorly show that the temporal contraction of the skull is not very marked; the narrowest width of the fronto-parietal surface between the temporal fossae is just on a level with the posterior border of the nasal opening. Behind, the parietal region is well marked off from the occiput by the supraoccipital crest, which is only slightly indented in the median line.

The occipital surface of the skull is flattened and eroded, showing the air-cells almost all over. The hollow for the ligamentum nuchae commences ca. 13 cm above the foramen magnum (which measures 8 cm transversely, and ca. 7½ cm vertically), and is ca. 14 cm wide and high, with a depth of about 5 cm.

The principal measurements of the present Java skull are presented in table 20.

As will be seen from the table, in which the measurements of the type skull of *Stegodon ganesa* are given too (first column), the present skull is hardly inferior in size to *Stegodon ganesa*, the presumed male of *Stegodon insignis*. As in that skull, the skull from Grobogan has very large premaxillaries, and an incisive fossa of great extent and depth. The width between the temporal fossae (50 cm) is the same in both skulls, but the postorbital width is greater in *Stegodon ganesa* (66 cm) than in the present skull of *Stegodon trigonocephalus* (56 cm); the skull to be considered next, however, has the postorbital width almost equal to that of *Stegodon ganesa*. Moreover, as already remarked by Martin, Dubois, and Janensch, in *Stegodon ganesa* the vertex is rounded, the fronto-parietal region passing smoothly into the occipital region, while in the Java *Stegodon* these two regions are marked off from each other by a supraoccipital crest.

The principal difference between the skull of *Stegodon ganesa* and the present skull of *Stegodon trigonocephalus*, however, lies in the high position of the nasal opening in the Java skull, which has its posterior border on a level with the temporal contraction, and its anterior border slightly behind the orbit. In *Stegodon ganesa* (Falconer and Cautley, 1846, pls. 21-23) the temporal fossae are most closely approximated behind the nasal opening, and the posterior border of the orbit is behind the anterior border of the nasal opening. Further skulls from Java to be described below show that in *Stegodon trigonocephalus* the anterior nares are not invariably elevated to the same degree, however.

The tusks are much the larger in *Stegodon ganesa*, measuring 23 cm in diameter against 14½ cm at most in the present Java skull. There is another skull of *Stegodon ganesa*, described but not figured by Lydekker (1876), which is stated to be very similar to the type but for the presence of a frontal torus. The tusks in the second *Stegodon ganesa* skull are smaller, the diameter of an incisive sheath below the infraorbital foramen being 20 cm against 29 cm in that first described.

In the Java as well as in the Siwalik species of *Stegodon* the tusks are rather closely approximated (15 cm in *Stegodon ganesa*: Falconer, 1868 I, p. 454), which seems to indicate that the animal would have been unable to lower its proboscis between the tusks, as living elephants can and do. This is also shown in the restoration of *Stegodon ganesa* presented by Osborn (1942, p. 872, fig. 755), in which the trunk hangs down to the right or to the left side of the pair of tusks. Osborn (l.c., p. 857, fig. 733) has afterwards changed the original restoration of the *Stegodon ganesa* tusks as given by Falconer and Cautley (1846, pl. 23), allowing a sufficient space for the descent of the proboscis between the butts. In Osborn's restoration the tusks diverge from their bases, and have their extremities turned inward, whereas in Falconer's restoration the extremities of the tusks turn outward.

The next skull (Coll. Dub. no. 4980, from Grobogan, Solo valley) is very similar to the last; it has the premaxillaries (Coll. Dub. nos. 3828 and 3829) as well as both tusks (Coll. Dub. nos. 3823-3827, and 3830-3832) preserved (pl. VI figs. 1-2).

The left side of the occiput, and the left parietal, squamosal, frontal, and maxillary are rather damaged, but on the right side the skull is well preserved apart from superficial damage along the parieto-frontal crest, and the loss of the zygomatic arch between the lateral anterior process of the squamosal and the infraorbital foramen. The occipital condyles are partially preserved, the skull base is very deficient, and nothing of the molars or the palate can be seen. The anterior part of the skull is slightly asymmetrical in that the right premaxillary is more inclined downward than that on the left side; this does not seem to be due to post-mortem crushing, however. The tusks are ca. 16 cm in diameter basally, and are only 10 cm apart at the anterior end of the premaxillaries, just as in the preceding skull.

The premaxillaries are as well developed as those in the preceding specimen; the interalveolar fossa is of exactly the same shape and extent, and so are the median anterior eminences. The nasal opening is likewise large, and placed rather high up the skull, with its anterior border 6 cm behind the posterior border of the orbit. The nasal opening has its posterior border on a level with the temporal contraction, again as in the last specimen. The region behind the nasal opening is even more shortened in the present specimen than it is in the last, and it is slightly concave anteroposteriorly in the median line instead of merely flat. The tip of the nasals is damaged. The supraoccipital crest is well marked.

As a whole, skull no. 4980 is slightly shorter, and thereby somewhat wider than no. 4979 (table 20).

The tusks of Coll. Dub. no. 4980 have been mounted on the skull (pl. VI figs. 1-2). The left tusk is the longer and heavier; it measures 16 by 16½ cm in cross section at the alveolar border, and for a length of about 150 cm it projects forward in a gentle upward curve, then it begins to turn outward on its line of projection. The diameters at 75 cm from the alveolar border are 15½ cm horizontally, and 16½ cm vertically; at 150 cm from the alveolar border it measures 13½ cm horizontally, and 15 cm vertically in cross section. At 200 cm the cross section is dorsoventrally compressed, 12½ cm horizontally, and 10 cm vertically. At the broken tip, which is 240 cm from the alveolar border, the diameters are 10 cm horizontally, and 7 cm vertically.

The right tusk is less heavy than the left; the horizontal and vertical diameters are 15 by 15½ cm at the alveolar border, 14½ by 15½ cm at 75 cm from the alveolar border, 11½ by 14 cm at 150 cm, and 12½ by

8½ cm at the broken tip, which is 190 cm from the alveolar border. At this point the outward curvature of the right tusk is already evident, although its preserved portion is some 50 cm shorter than that of the left tusk.

The two tusks are closely approximated over most of their length: at the alveolar border the interval is 10 cm; at 75 cm from the alveolar border the tusks are not more than 5 cm apart, a distance that is reduced to barely 2 cm at 150 cm from the alveolar border. From this point on the tusks, however, begin to diverge, and at the broken tip of the shorter right tusk the interval between the two tusks is again 5 cm.

In their general upward and apically outward curve the tusks of the present Java skull closely resemble those of *Stegodon ganesa* as they have been reconstructed by Falconer (Falconer and Cautley, 1846, pl. 23 fig. 2). Only the left tusk of this Siwalik skull was in situ (l.c., pl. 21), and the right tusk was simply reconstructed after the left, giving a perfectly symmetrical arrangement of the tusks. In the present case there is no shade of doubt that the two tusks are mounted exactly in the position they had during the life of their quondam owner. Thus, after all, Falconer's reconstruction of the tusks of *Stegodon ganesa* does not seem to be as incorrect as Osborn (1942, p. 857, in the legend to fig. 733) supposed it to be. Osborn's statement hat in none of the proboscideans the tusks are turned outward at the tip now proves to be wrong, for they do in the present skull of *Stegodon trigonocephalus*.

The present Java skull offers decisive proof that the tusks in a *Stegodon* may be closely appressed so as to leave no space for the descent of the trunk in between, no matter how abnormal the whole arrangement may look. It is, therefore, quite possible that *Stegodon ganesa* had the same arrangement of the tusks, as indeed it was originally conceived by Falconer.

Two skull fragments deserve special notice as they represent the anterior premaxillary eminences: Coll. Dub. no. 4450 is of the right side, Coll. Dub. no. 4911 of the left. The eminences are as well developed as those in the two skulls just described, arched anteroposteriorly, narrow behind, but wide in front. They fall off steeply toward the median line, but pass gradually into the upper surface of the premaxillary laterally (pl. XVII figs. 4-5). These structures are quite unlike anything seen in *Elephas maximus*, in which the premaxillaries are not, or hardly elevated in the median line anteriorly.

TABLE 20

Measurements of the skull of *Stegodon ganesa* and of *Stegodon trigonocephalus* (in cm)

	Stegodon ganesa	Coll. Dub. nos. 4979 ♂	4980 ♂	5005 ♀	4982
Length from middle of occipital crest to end of premaxillaries	121	106	97	ca. 80	—
Length from basion to idem	99	96	ca. 90	ca. 75	—
Length from occipital crest to posterior border of anterior nares	—	23	18	ca. 23	25
Length from anterior border of anterior nares to end of premaxillaries	—	68	66	ca. 45	—
Width of occiput	73	70	70	—	49
Temporal contraction	50	50	54	—	33
Postorbital width	66	56	64	—	41
Infraorbital width	ca. 55	35	ca. 40	ca. 23	26½
Premaxillary width	—	—	43	25	28
Height from palate to vertex	—	78	—	ca. 66	60
Height of occiput (from basion)	62	57	ca. 58	ca. 40	41½
Diameter of tusks	23	14½	16	7	ca. 9
Anterior nares, width	40	ca. 33	ca. 35	—	20
Anteroposterior diameter of idem	—	22	ca. 20	ca. 11	10

Coll. Dub. no. 5005, with premaxillaries (Coll. Dub. nos. 4420-4421) is an adult skull with both M3s in place, which have already been dealt with above in the molar section. It originates from Kedoeng Panas (pl. I fig. 1). Only the right occipital condyle is preserved. The left side of the cranium is for the greater part lost, as well as all of the skull base. On the right side the occipitals, parietal, and squamosal are present but the whole of the zygomatic arch and the lateral boundary of the anterior nares with frontal, premaxillary, and maxillary are missing.

The premaxillaries in front of the anterior nares are rather well preserved, each holding a tusk with a diameter of only 7 cm, yet fully adult as their diameters at the level of the infraorbital foramen are the same as those at the alveolar borders of the premaxillaries, where they have broken off. The tusks are only 7 cm apart, again, much too close for a trunk to be lowered between them. The interalveolar fossa is correspondingly small, at most 5 cm wide, with the sides sloping upward and outward, and 7 cm deep, with a length of ca. 30 cm between the anterior and posterior premaxillary eminences.

Of the nasal opening only the anterior and posterior borders remain, and even the right postorbital process is incomplete. From the position of the preserved portion of the postorbital ridge of the frontal it is clear that the orbit is slightly in advance of the nasal opening, as it is in Coll. Dub. nos. 4979 and 4980, too. The fronto-parietal crest being broken away, it is impossible to locate the temporal contraction. The nasal tips are damaged, but the fronto-parietal region behind it is undamaged and flattened in the median line. The supraoccipital crest is well marked, and even overhangs the occiput in the middle behind. The shape and extent of the hollow for the insertion of the nuchal ligament are not clear from the damaged occipital region.

The present skull (Coll. Dub. no. 5005), the dimensions of which are given in table 20, agrees with the two large skulls dealt with previously in the high position of the anterior nares, but is decidedly smaller, notably in the diameters of the tusks and the size of the premaxillaries. It is extremely probable that these differences are simply due to a difference in sex of their former owners, Coll. Dub. nos. 4979 and 4980 representing males, and Coll. Dub. no. 5005 a female. If this is true, the sexual divergence in *Stegodon trigonocephalus* is still much less marked than that in *Stegodon insignis*, the presumed female of *Stegodon ganesa*.

The remaining skulls of *Stegodon trigonocephalus* in the Dubois collection (nos. 4964, 4977, and 4978, all from Trinil) are much less well preserved than those dealt with above. The first and second of these possess the greater part of the premaxillaries, and the palate, but the cranial dome and the occipital parts are gone. The tusks in Coll. Dub. no. 4964 are 9 to 9½ cm in diameter, and the interval between them is 5½ cm; the premaxillary width is 27 cm. In Coll. Dub. no. 4977 the tusks are only 6½ cm in diameter, with an interval of 5 cm. Coll. Dub. no. 4978 has the cranial part, but it is so defective that none of the usual measurements can be given. The premaxillaries are much damaged, and the tusks seem to have fallen out; the diameter of their alveoli is about 9 cm. The infraorbital foramina are 4½ cm high, and 3 cm wide. The borders of the nasal opening are only partially shown; from the position of the postorbital ridge of the frontal, seen on the right side, it appears that the anterior nares were not entirely behind the orbit, as was the case in the skulls described above. The anterior border of the nasal opening is about 3 cm in front of the posterior border of the orbit. From what remains of the right fronto-parietal crest it is further evident that the temporal contraction is slightly behind the nasal opening, but the post-nasal region of the skull appears to be flattened, with a supraoccipital crest marking it off from the occiput, as in the foregoing skulls. Curiously enough, the two occipital condyles are perfect: the width over their lateral surfaces is 17½ cm, their antero-posterior diameter, 9½ cm. The foramen magnum is 7½ cm wide and high.

There are two subadult skulls in the Java collection, with M^2 in use, and M^3 worn only at the anterior ridges, Coll. Dub. nos. 4981 and 4982. The first of these, from Trinil, is very much injured superiorly, from the premaxillaries (of which only the lower parts are preserved) up to the occiput; even the nasal fossa is not shown. Apart from the palate with the molars already described, the only well preserved part of the skull is the lower portion of the occiput, with the condyles, which together measure 17 cm transversely, 8 cm anteroposteriorly, and which enclose a foramen magnum 7 cm wide.

The second subadult skull (Coll. Dub. no. 4982, pl. IV figs. 1, 3) is one of the best preserved specimens. The main defects of this skull are the loss of the anterior portions of the premaxillaries and the tusks, of the middle portions of the zygomatic arches, and of the superior and posterior borders of the left orbit.

The skull base is nearly perfect, with the two condyles, measuring 18 cm transversely, and 8½ cm anteroposteriorly. The foramen magnum is 7 cm wide, but less than 6 cm high (superior border broken). The tympanic bullae appear to be slightly more swollen than those of *Elephas maximus* L.; their exposed length is ca. 12 cm up to the median anterior point, and their width from the inner border of the canal for the internal carotid artery to the lateral anteroposterior ridge is 7 cm. The basioccipital width is 6 cm. The skull width over the lower borders of the external auditory meatus is 47½ cm, and the least width over the pterygoid wings of the alisphenoids, 19 cm. The squamosals, which lack the lateral anterior process, are concave transversely in front, and convexo-concave from before backward; their postglenoid ledges are perhaps more raised than those in the living Asiatic elephant. The last molars, of which the anterior ridges only are worn, but which have been fully exposed, extend backward and upward to the median anterior point of the basisphenoid. Between the anterior ends of the M^3s the palate is only 6 cm wide, and the width over their outer surfaces is 24 cm.

The anterior palatine ridges are well shown, but the extremity of the premaxillaries is lost. The interalveolar fossa is at most 8 cm wide and deep in its middle part, the bottom gradually sloping upward to the front as wel as behind. In front of the posterior premaxillary eminences it is still 5 cm wide. The infraorbital foramina are narrow (3½ cm) but high (7 cm). The orbit is less advanced in position, or, rather, the anterior nares are placed more forward than in the skulls described above, for the posterior border of the orbit is well behind the anterior border of the nasal opening, viz., about 4 cm. Further, the constriction of the forehead is decidedly behind the nasal opening, some 7 cm. The nasal tips are broken, and the fronto-parietal region is slightly convex from before backward, although it is distinctly marked off from the occiput by the supraoccipital crest. The hollow for the insertion of the nuchal ligament commences about 8 cm above the foramen magnum, and is 9 cm wide by a depth of at least 6 cm.

The measurements (table 20) show the present subadult skull to be smaller than the two presumed males Coll. Dub. nos. 4979 and 4980, except in the length from the supraoccipital crest to the posterior border of the anterior nares. This means that the anterior nares are relatively more advanced in position in the subadult skull than in the adult. There is some variation in the position of the anterior nares relative to the orbit even among adult skulls, however, for, as mentioned above, in Coll. Dub. no. 4978 the anterior border of the anterior nares is 3 cm in advance of the posterior border of the orbit, while in the remaining adult skulls the anterior nares are entirely behind the orbits.

In the Dubois collection from Java there are further two occipital parts of *Stegodon* skulls, Coll. Dub. nos. 4973-4974, and 4355-4356. The first of these has the right exoccipital as well as the left condyle incomplete. The height and width of the occiput are ca. 44 cm, and ca. 60 cm, respectively. The condylar width is ca. 18 cm, and a condyle measures 9½ cm antero-posteriorly. The other occipital fragment, originating from Nongko near Padas Malang, lacks the basal parts, and gives ca. 64 cm for the greatest width. As in the preceding specimens, the supraoccipital crest is well defined; the parietal appears to be slightly concave antero-posteriorly in the median line, as is that in Coll. Dub. no. 4980, too.

In summary, the skull of *Stegodon trigonocephalus* is characterized by the flatness and shortness of the fronto-parietal region, which may be even slightly concave anteroposteriorly, the distinctly marked supraoccipital crest, the comparatively slight temporal contraction, and the high position of the large anterior nares, which are mostly behind the orbits in adults. In males, the premaxillaries are very large, with a deep and extensive interalveolar fossa, as in *Stegodon ganesa*; the tusks are closely approximated and large, although they do not attain the huge dimensions of the male Siwalik form. Female skulls have small tusks and premaxillaries, but further resemble the male closely in cranial characters. The tusks in one male specimen (Coll. Dub. no. 4980) are extremely similar in arrangement to those of *Stegodon ganesa* as reconstructed by Falconer, turning outward at the tip, and closely approximated over most of their length (pl. VI figs. 1-2).

There can be no question (there never has been, as far as I know) as to whether stegodonts possessed trunks. The long limbs, short neck, abbreviated mandibles without tusks, reduced nasal bones, and backwardly shifted anterior nares of *Stegodon* are sufficiently similar to those of a modern elephant to indicate that, like the latter, *Stegodon* had a long and heavy proboscis. The fossil form, perhaps, needed a proboscis even more than the living because of the extraordinary development of its tusks. *Stegodon* had no room for the trunk between the tusks, however. It is clear from the specimen in the Dubois collection that the proboscis could not be lowered between the tusks for at least two meters distance from their point of emergence from the premaxillaries. Even in the earliest Elephantinae (*Archidiskodon*) the tusks are more widely spaced at their free bases, as we shall see further on. It follows, therefore, that the elephantine skull is more fitted to the possession of a proboscis than is that of a stegodont.

TUSKS

Apart from a few tusks that belong to *Stegodon* skulls preserved in the Dubois collection, and described in connexion with these skulls, there are a great number of fragmentary or complete tusks in the Java collection. Their specific identity is uncertain. Since, however, as shown by the molars and skulls, *Stegodon* is the predominant proboscidean in the collection, we may well assume that the majority of the specimens do represent *Stegodon trigonocephalus*.

Coll. Dub. no. 147, Trinil. Young tusk, describing one-fourth of a circle (radius 42 cm) from basal end (diameter 55 mm) to the point.

Coll. Dub. no. 150, Trinil. Fragment of tusk, length 63 cm, cross section slightly oval (11½ by 10½ cm).

Coll. Dub. no. 151, Trinil. Proximal fragment of tusk, length 58 cm, greatest diameter 10 cm; at distal end, 9½ by 8½ cm.

Coll. Dub. no. 3820-3821, Pengilan. Tusk portion, length 78 cm from basal end to tip, measured along the outer curve. Basal diameter 11½ cm.

Coll. Dub. no. 3833. Tusk fragment, length 50 cm, diameter ca. 15½ cm. Pulp cavity shown at proximal end, oval in cross section, 8 by 6½ cm.

Coll. Dub. nos. 3834-3838, Kedoeng Broeboes. Tusk with a length of 163 cm along the outer curve, and 150 cm in a straight line from base to (broken) tip. Diameter 13½ cm at base; pulp cavity 8½ cm in diameter at base, and extending about 75 cm into the tusk. Diameter of tusk at this level, 13 cm, diminishing to 10½ by 10 cm at 125 cm from the base. Diameter at broken distal end, 7½ cm.

Coll. Dub. no. 3840-3842. Tusk portion, length 100 cm along the outer curve, proximal diameter 12 cm. The pulp cavity has a diameter of 11 cm proximally, and is about 75 cm long. Diameter of tusk at distal end, 11 cm.

Coll. Dub. nos. 3843-3845, Tritik. Tusk portion, length 90 cm, diameter 14½ cm at one end, and 13 cm at the other.

Coll. Dub. nos. 3851-3852, ? Kedoeng Broeboes. Basal tusk fragment, 50 cm long, diameter 16½ cm.

Coll. Dub. nos. 3853-3855, Kali Gedeh. Three fragments of tusk, total length 105 cm, diameter 14 cm (extended by mud-filled longitudinal cracks).

Coll. Dub. no. 3856. Heavy fragment of tusk, length 50 cm, diameter 16 cm.

Coll. Dub. nos. 3857-3862, Trinil. Tusk, complete, with pulp cavity almost closed, length 142 cm along the outward curvature, and 134 cm from base to tip. Greatest diameter 10 cm; at middle of length, 9½ by 9 cm. At 12 cm from the tip the diameter is 7 cm. The tip has a wear facet at the inner curve, with a length of only 10 cm.

Coll. Dub. nos. 3863-3865, Trinil. Tusk, base and tip lost, length 95 cm along the outer curve, basal contour oval, with diameters 10½ and 9½ cm (pulp cavity 3 cm across); at distal end, 7½ by 6½ cm.

Coll. Dub. nos. 3867-3871, Trinil. Tusk, ca. 150 cm long following the outward curvature, and ca. 140 cm across the chord of its curve. Basal diameter 10 cm, a diameter that does not change until about 80 cm from the base, at which level the diameter perpendicular to the plane of curvature is 9 cm. The flattening becomes more pronounced toward the tip, the greater and smaller diameters of the cross section being 9½ and 8 cm at 45 cm from the tip, and 8 by 6½ cm at 15 cm from the tip. The tip is not rounded but rather chisel-shaped, with a transverse edge over its greatest diameter.

Coll. Dub. nos. 3872-3875, Trinil. Long but slender tusk, measuring 162 cm along outer curve, and 143 cm across the chord of its curve. Diameters proximally 9 cm; in the middle of its length 9 cm in the plane of curvature but only 8 cm perpendicular to that plane. At the distal end the tusk turns slightly outward on its line of projection, and is very much compressed in cross section.

Coll. Dub. nos. 3876-3880, Trinil. Tusk, total length unknown as one of the central fragments is lost. Tip pointed, diameters 9½ by 8½ cm at 50 cm from tip, and 11½ by 11 cm at 70 cm from base, keeping these diameters down to the base.

Coll. Dub. nos. 3881-3887, Trinil. Fragments of large tusk, length at least 180 cm along outer curve, ca. 150 cm across the chord of its curve.

Proximal end oval, 13 by 12 cm, and distal end 7½ by 6½ cm, the greater diameters in the plane of curvature.

Coll. Dub. nos. 3888-3894, Nongko. Fragments of tusk, at least 145 cm long, and 14 cm in diameter proximally against 11½ by 10½ cm at the distal end.

Coll. Dub. nos. 3895-3900, Trinil. Tusk, measuring 104 cm along the outward curvature, and 95 cm in a straight line from base to tip. Base 9 by 8½ cm in diameter (pulp cavity 57 mm in diameter), flattening in the plane of curvature to 68 by 55 mm at 81 cm from the base.

Coll. Dub. nos. 3901-3906, Dompring. Short tusk fragments, varying in diameters of cross section from 14½ by 14 cm to 13½ by 11½ cm.

Coll. Dub. no. 3909, between Dekes and Wadegan. Tusk fragment, length 60 cm, diameter 15 cm.

Coll. Dub. nos. 3910-3915, ? Trinil. Large tusk, much decayed, at least 150 cm in length, and 11 cm in diameter proximally.

Coll. Dub. nos. 3916-3920, Trinil. Tusk, 146 cm in length along the outer curve, 137 cm in a straight line from base to tip; basal contour 12 by 11 cm in diameter; at 45 cm from tip: 106 by 92 mm. The flattening is in the plane of curvature.

Coll. Dub. nos. 3921-3922, Tinggang. Tusk, 115 cm in length following the outward curvature; 107 cm as a chord of its curve, basal diameter 10 cm.

Coll. Dub. nos. 3923-3925, Trinil. Small tusk, 70 cm long along outer curve, basal diameter 83 mm, flattened at the point.

Coll. Dub. nos. 3926-3927, Trinil. Young tusk, describing one-fourth of a circle (radius 25 cm) from basal end (diameter 65 mm) to the point.

Coll. Dub. no. 3932, Pengilan, is a tusk fragment, 8½ to 9 cm in diameters, in which the pulp cavity diminishes in diameters from 60 mm to 17 mm over a length of 25 cm.

Coll. Dub. nos. 3934-3935, Kebon Doeren. Portion of tusk, 60 cm long, cross section rounded basally with a diameter of 10 cm, but much flattened distally. This is, however, the result of natural use as shown by the eccentric position of the centre of the pulp cavity.

Coll. Dub. nos. 3936-3937, Dompring, are fragments of a large tusk, 14½ cm in diameter, in which the pulp cavity diminishes in diameters from 48 mm to 16 mm over a length of 23 cm.

Coll. Dub. nos. 3938-3939, Trinil. Tusk, 12 cm in diameter, pulp cavity diameter diminishing from 90 mm to 18 mm in 56 cm of length.

Coll. Dub. no. 3952 is a short tusk, worn very bluntly at the tip, and having a length of only 28 cm all over. The pulp cavity is very shallow, its apex extending only 7 cm into the tusk, which has a basal diameter of 7½ cm. The degree of curvature is slight, and the diameters remain much the same (8 to 8½ cm) throughout its length. The surface is fluted, showing the tusk to be very slightly spirally curved.

Coll. Dub. no. 3979, Trinil. Young tusk, proximal fragment. Length 26 cm, diameters 50 by 44 mm proximally, and 32 by 23 mm distally, flattened in the plane of curvature.

Coll. Dub. nos. 4016-4021. Premaxillaries and anterior parts of maxillaries of skull with both tusks (tip of left broken off but preserved). The width over the premaxillaries is 28 cm, their height, 12 cm. The two tusks are 9 cm apart at their alveolar borders, at which level their diameters are 60 mm horizontally, and 63 mm vertically. The tusks project only some 20 cm beyond their alveoli, are perfectly parallel, and are rounded off at their tips, thus having evidently been put to use by the animal.

Coll. Dub. no. 4022, Kedoeng Broeboes. Proximal fragment of young tusk, length 28 cm, diameters 54 mm proximally, and 47 mm distally.

Coll. Dub. nos. 4027-4028, Kedoeng Madoh. Distal fragment of tusk, length 47 cm, diameters 83 by 75 mm, tip flattened in plane of curvature.

Coll. Dub. nos. 4025-4026, Kedoeng Madoh. Proximal fragment of tusk, length 35 cm, diameters 85 by 80 mm.

Coll. Dub. nos. 4029-4033, ? Solo valley. A slightly curved tusk, ca. 7 cm in diameter proximally, where only a thin wall around the pulp cavity remains. The pulp cavity does not extend into the tusk for more than 22 cm. At 65 cm from the base the diameters are 75 by 68 mm; at 85 cm from the base the flattening is slightly more marked (70 by 60 mm), and is in the plane of curvature.

Coll. Dub. nos. 4034-4040, ? Solo valley. Tusk, 9 cm in diameter at the proximal end (pulp cavity diameter 7½ cm), and measuring about 145 cm along the outer curve to the (damaged) tip. The pulp cavity extends to 60 cm from the base, at which level the diameter of the tusk is still 9 cm. At 100 cm from the base the cross section forms an oval, 80 by 63 mm, flattened in the plane of the curvature. At 130 cm from the base the greater and smaller diameters of the tusk section are 65 and 50 mm.

Coll. Dub. nos. 4402-4410, Kali Gedeh. Large tusk, flattened at the tip as a result of natural use, but assuming a circular cross section already some 36 cm from the tip, at which level the diameter is 11 cm. It attains a diameter of 13 cm at 85 cm from the tip. As far as can be judged from the available fragments, the total length of the tusk must have been over 2 m.

There remain a small number of tusks (Coll. Dub. nos. 1581 and 1783) from Trinil, at most 18 mm in diameter, on which the enamel cappings are preserved. At most 15 mm long, these enamel investments on the tusks (which are quite flattened in this early stage of development) seemingly offer initial protection for the erupting incisor. If these specimens represent milk incisors, which seems most likely, they are much larger than their homologues in the living Asiatic elephant (cf. Pohlig, 1888, p. 45 fig. 4). The two most complete specimens (in Coll. Dub. no. 1783) are 13 cm, and 14 cm long, respectively, while the deciduous incisor in *Elephas maximus* L. (Leiden Museum, cat. c) is only 6 cm long, and 11 mm in diameter at most.

POSTCRANIAL SKELETON

The postcranial skeletal remains of Proboscidea from Java in the Dubois collection are here referred to under the head *Stegodon trigonocephalus*, although it is possible that a few specimens of *Elephas* are included. Certain specimens most probably belonging to *Elephas* will be found mentioned in the chapter on *Elephas hysudrindicus* (below, p. 129).

Of the atlas one almost complete specimen is preserved, viz., Coll. Dub. no. 3726 (Trinil). It lacks the right transverse process, and is damaged along the margins of the left facies articularis cranialis. Coll. Dub. nos. 3729 (Trinil) and 10137 (Tinggang) represent right halves, and nos. 3645 (? Trinil) and 11652 (Trinil), left halves. The processus transversus is entire only in Coll. Dub. nos. 3726 and 3645. The lateral length of the corpus is 9 cm; the facies articularis cranialis measures 10 cm vertically, and 6 cm transversely; the facies articularis caudalis is 9 by 7 cm; the foramen transversarium is 3 cm in diameter, that for the first cranial nerve, 1¼ cm. In all these measurements the Dubois collection specimens agree exactly with that recorded from Trinil by Pohlig (1911, p. 197, pl. XXVI fig. 1). The total height of Coll. Dub. no. 3726 is 17 cm; that of Coll. Dub. no. 3645, 18 cm; Pohlig (l.c.) gives only 15½ cm. Eleven unidentified proboscidean atlases from the Siwaliks figured by Falconer and Cautley (1847, pl. 46) vary in height from 17 to 25½ cm (Falconer, 1868 I, p. 478/79).

The epistropheus is the first of a series of ten vertebrae from Trinil (Coll. Dub. nos. 3225-3227), all of a single fully adult individual. They comprise six cervical and four thoracic vertebrae (pl. VIII fig. 1). The transverse processes of the right side are incomplete, and the arches of vert. cerv. VI and VII are broken off (although the processus spinosus of each is preserved). The extremities of the spinous processes of the thoracic vertebrae are missing, but otherwise the specimens are perfect.

Pohlig (1911, p. 199), who studied the vert. cerv. III-VI of a single individual from Trinil, came to the conclusion that the neck of *Stegodon* is relatively longer than that in *Elephas*. The point is somewhat difficult to make, however, as the thickness of the intervertebral fibro-cartilages cannot exactly be determined even though the vertebrae were conjoined when found. My own observations on the *Stegodon* vertebrae and those of *Elephas maximus* lead to the opposite conclusion: in *Stegodon* the neck is shorter, by the same width, than in *Elephas*. This follows from the comparison of Coll. Dub. nos. 3225-3227 with the adult female and male of *Elephas maximus* in table 21; a subadult female of *Elephas maximus* with the same length of neck as our *Stegodon* has narrower vertebrae.

TABLE 21

Cervical vertebrae of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

	Stegodon	*Elephas maximus*		
		subad. ♀	ad. ♀	ad. ♂
Ventral length [1])	30	30	34	37
Width of epistropheus	22	19	21	24½
Width of vert. cerv. VII	26	22	23½	27

There are three specimens of the epistropheus with the arch preserved, viz., that of Coll. Dub. nos. 3225-3227 (Trinil), no. 3565 (Trinil), and no. 3727; the transverse processes of the second and third of these are missing. Others have only the corpus (Coll. Dub. nos. 3567 (? Pati Ajam), 3578, 3660, 3661 (all from Trinil), and 3667 (Prameran)). There is also an isolated arch (Coll. Dub. no. 3814, from Prameran); the width of its foramen vertebrale is 6 cm. Measurements of the best preserved specimens are contained in table 22.

An epistropheus from Trinil figured by Pohlig (1911, p. 198, fig. 1) is only slightly larger (ventral length, 12½ cm; total height, 22 cm). Two Siwalik specimens (Falconer and Cautley, 1847, pl. 47 figs. 1-2) are decidedly larger, with ventral lengths of 15-18½ cm, and total heights of 27-34½ cm.

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1) Measured from base of dens epistrophei to fossa of vert. cerv. VII.

TABLE 22

Measurements of epistropheus of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	3225-3227	3565	3727	3567	3660	3661
Ventral length from dens to fossa vertebrae	11½	11½	ca. 11½	—	11½	12½
Width over facies articulares craniales	19	17½	—	19	—	ca. 17
Width of fossa vertebrae	13½	12½	—	—	12½	—
Width over processus articulares caudales	11	ca. 11	—	—	—	—
Width of foramen vertebrale	5½	6	5½	—	—	6½
Height of idem	6	6	6½	—	—	—
Height of facies articularis cranialis	8	ca. 8	—	10½	—	—
Total height from lower border of fossa to top of spine	20½	20	ca. 20	—	—	—

The cervical vertebrae III-VII of Coll. Dub. nos. 3225-3227 all have a broad and flat corpus difficult to distinguish between unless the transverse processes are preserved. The foramen transversarium becomes lower in position as it is traced backward, and is absent in vert. cerv. VII that is, of course, distinguished by having facets behind for articulation with part of the head of the first rib. The transverse process has a forward projection below the foramen transversarium that becomes larger; the total width, and that of the arcus over the articular processes increase as one passes backward along the series. The processus spinosus is rudimentary in vert. cerv. III and IV, and becomes 5 cm long in vert. cerv. V. Those of vert. cerv. VI and VII, broken at their bases, are at least 14 cm and 20 cm long, respectively. They are remarkable for having a median perforation, about 5 cm high and 12-14 mm wide (pl. VIII fig. 3). Similar perforations have been recorded by Pohlig (1911, p. 203) in the processus spinosus of some thoracic vertebrae of the Trinil *Stegodon*.

TABLE 23

Measurements of vertebrae of *Stegodon trigonocephalus* (in cm)

	Coll. Dub. nos. 3225-3227								
	cervical					thoracic			
	III	IV	V	VI	VII	I	II	III	IV
Length of corpus	4½	4	4	4	4½	6	5½	5½	5
Greatest width	23	23	23	25	26	26	25	23	—
Width of fossa	14	14	—	12	12	—	11½	11½	10½
Height of idem	11	11½	—	—	10½	—	—	9	9

	Coll. Dub. nos. 3225-3227								
	cervical					thoracic			
	III	IV	V	VI	VII	I	II	III	IV
Width of foramen vertebrale	6	6	6½	—	—	8	6½	5½	6
Height of idem	5	5	5	—	—	7	7	6½	6
Width over processus articulares craniales	12	13½	14	—	—	16	13	10	8
Total height	18	18½	—	—	—	—	—	—	—
Width of foramen transversarium	2½	2½	3	3					
Height of idem	4½	4	3½	—					

Various isolated and incomplete cervical vertebrae, all originating from Trinil, are recorded in table 24. Their presumed serial number is judged by the position of the foramen transversarium.

TABLE 24

Cervical vertebrae of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	3700	3675b	3751	3618	3607
Vert. cerv.	III or IV	III or IV	IV or V	V	VI
Length of corpus	4½	4	4½	4½	4
Width of fossa	ca. 13	12½	ca. 12½	—	13
Height of idem	12	—	—	13	11½

There remains one damaged, yet sufficiently characteristic, vert. cerv. VII (Coll. Dub. no. 3617, from Trinil), of which no measurements can be given.

The thoracic vertebrae of Coll. Dub. nos. 3225-3227 (Trinil) are of a single individual. It will be noticed from table 23 that the foramen vertebrale is wider than high in vert. thor. I in contradistinction to that in vert. thor. II and III. Both the greatest width and that over the processus articulares craniales decrease as they are traced backward; the costal facets become higher in position, and the transverse processes diminish in size and are placed higher up, while the spinous processes become more inclined backward. Their total height cannot be given as the extremities are lost.

None of the remaining anterior thoracic vertebrae have the arch complete. Coll. Dub. no. 11653 (Trinil) is a vert. thor. I larger than that in the series (greatest width 29½ cm). Coll. Dub. nos. 3549 and 3649 (both from Trinil) represent vert. thor. II; the costal facets behind are just above the middle of the height of the fossa. In vert. thor. III the costal facets have their upper borders almost on a level with that of the fossa vertebrae; such a specimen (Coll. Dub. no. 3634, Trinil) has a fossa 12 cm wide, and thereby is again larger than its homologue in the series mentioned above. Two isolated vertebrae presumably represent vert. thor. IV as they agree closely with that of Coll. Dub. nos. 3225-3227 in the position of the posterior costal facets. The upper borders of the posterior costal facets are just above that of the fossa, which is less broad than that in the preceding vertebrae, and begins to assume a subtriangular shape. The width of the fossa in these two specimens (Coll. Dub. nos. 3564 and 3583, both from Trinil) is ca. 9½ cm, less than that in vert. thor. IV of the series; the greatest width of one specimen (Coll. Dub. no. 3564) amounts to 21½ cm.

It is impossible to determine the exact serial position of other thoracic vertebrae. Among a number of isolated chest vertebrae, mostly from Trinil, an appreciable amount of variation in size is shown, which undoubtedly is largely of a sexual nature. In one of the specimens (Coll. Dub. no. 3554, Trinil) the corpus is 6 cm long, the fossa vertebrae 9 cm wide and 8 cm high, while in another (Coll. Dub. no. 3624, Trinil) that is not even fully adult as the cranial epiphysis is lost, the fossa is 13 cm wide and at least 11 cm high.

There is a series of six thoracic vertebrae (Coll. Dub. nos. 3223-3224, Ngandjar, pl. VIII fig. 2), all of the same individual, and consecutive. While in the anterior two there still are two costal facets on each side, the posterior facing backward, and smaller than the anterior, in the following four vertebrae there is but one facet for the head of the rib. Even in the last preserved vertebra the costal facet, although smaller than that in the others, still is quite distinct; apparently this was not the last thoracic vertebra yet. In table 25 the vertebrae are numbered from 1 to 6; their exact serial numbers cannot of course be determined. The vertebrae numbered 1 and 2 have incomplete arches; in nos. 3-6 the processus spinosi are progressively inclined backward, and the transverse processes become slightly less expanded laterally.

TABLE 25

Measurements of thoracic vertebrae of *Stegodon trigonocephalus* (in cm)

	Coll. Dub. nos. 3223-3224					
	1	2	3	4	5	6
Length of corpus	6¼	6½	6¼	6½	6½	6½
Greatest width	ca. 20	18½	18	17½	17	17
Width of fossa	9½	10	10	10	10	10
Height of idem	7½	8	7½	8	8	8
Width of foramen vertebrale	6	—	5½	5½	5½	5½
Height of idem	—	4	4	4	4	4
Width over facies articulares craniales	—	—	8	7	7	7
Total height	—	—	23½	22½	22	21½

The present series of posterior thoracic vertebrae agrees best with vert. thor. XIV-XIX of *Elephas maximus*. There remain five isolated posterior thoracic vertebrae (Coll. Dub. nos. 3590, 3635, 3642, 3724 (all from Trinil), and 11654) with the arches preserved; one (Coll. Dub. no. 3642) has two costal facets on each side, and thus is more anterior in position than the others, which have only one costal facet on each side of the corpus [1]).

Of two lumbar vertebrae from Trinil (Coll. Dub. nos. 3555 and 3616), characterized by the absence of costal facets, the first has a fossa 11½ cm wide and 9 cm high. The transverse process does not extend as far down as that of the second, which has a fossa 15 cm wide and 10 cm high. In these characters the two specimens agree with the first and the third lumbar vertebrae of *Elephas maximus*, respectively.

There are no sacral vertebrae in the collection from Trinil studied by Pohlig (1911), but in the Dubois collection from that locality there are four specimens, the best of which (Coll. Dub. no. 3643) most probably represents vert. sacr. I. The arch is missing, but the characteristic transverse process with the large surface for the ilium is well shown; its lower margin is on a level with that of the corpus. The greatest width is 24 cm; the corpus is 7½ cm long; the fossa 12 cm wide and 8 cm high, much smaller than the caput which is 14½ cm wide and 9 cm high. The width of the foramen vertebrale is 9 cm. The second sacral vertebra (Coll. Dub. no. 3552) is lower, with a fossa of 12½ by 7 cm, and a foramen vertebrale 8 cm wide. The remaining sacral vertebrae (Coll. Dub. nos. 3577 and 3619) are very incomplete; the last, with a caput of ca. 11 by 7½ cm, has the corpus fused with that of another vertebra with the same ventral length (7 cm).

There are no caudal vertebrae in the Dubois collection.

Most of the costae in the Dubois collection are so fragmentary that nothing can be gained from them. The most complete specimen, of the left side, is Coll. Dub. nos. 8360-8361 (Trinil), with a length of 98 cm along the curvature. One of the first ribs, of the left side, belonging to the same individual as the cervical and thoracic vertebrae of Coll. Dub. nos. 3225-3227, is 33 cm long as far as preserved; its greatest diameter is 6½ cm.

Although there are a great number of scapulae in the proboscidean collection from Java, there is not a single complete specimen; all are damaged

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1) Pohlig (1911, pp. 203 and 204) refers to a vert. thor. XVII as figured on his pl. XXVI figs. 25 and 25a, and to a vert. lumb. I as figured on pl. XXVI figs. 28 and 28a. These figures must have been transposed, for figs. 25 and 25a represent a lumbar vertebra (without costal facets), and figs. 28 and 28a give a thoracic vertebra, with two costal facets.

along their posterior and anterior borders. A few specimens at least have both the glenoid cavity and the upper margin at the spina scapulae preserved, which gives the total height, but anteroposterior diameters can be given only of the collum scapulae and further downward.

The spina scapulae is best preserved in Coll. Dub. no. 4429, from Trinil, with the acromion at its proximal end almost entire, projecting forward and downward (pl. IX fig. 3). The tuber spinae is broken off; its origin is only 5 cm above the notch of the acromion, and thereby is placed lower than that in *Elephas maximus*. The height of the tuber spinae at its base is 14 cm; its upper border is just midway between the anterior border of the glenoid cavity and the upper end of the scapula. The anterior border of the bone is damaged just above the neck, but the lower border behind the glenoid cavity is complete back to the caudal point. The length from this point to the posterior border of the glenoid cavity is 35 cm, and the length from the caudal point to the top of the scapula at the spina scapulae is 58 cm. The greatest anteroposterior diameter of the infraspinous fossa (behind the spina) is 37 cm. Further measurements are given in table 26.

Coll. Dub. no. 4313 (Trinil) is the largest scapula in the collection; like the foregoing specimen it is of the left side. The greatly thickened top is preserved, but the posterior part of the fossa infraspinata as well as most of the spina scapulae and its appendages are lost. The spina is very high (transversely) at its proximal end; the anterior margin of the bone is incomplete.

Coll. Dub. nos. 4392-4397 (Trinil) is likewise a left scapula complete from the glenoid cavity to the top, but with the borders of the supra- and infraspinous fossae damaged. It is intermediate in size between the two above mentioned scapulae.

Coll. Dub. nos. 4247, 9042, and 9054 are left scapulae, all originating from Trinil, with the top damaged and the tuber scapulae incomplete; the height as far as preserved is given in table 26. Coll. Dub. nos. 4555 and 6530, both Trinil specimens, and of the left side, belonged to immature individuals as the distal epiphyses are gone. Neither the acromion nor the tuber spinae are preserved in any of these specimens.

Only two right scapulae, Coll. Dub. nos. 4826 and 7090-7092, both from Trinil, are preserved from the glenoid cavity up to almost the distal end of the spina, but are damaged along their borders, as usual. Of the distal fragments, Coll. Dub. no. 4759 (Kedoeng Broeboes) is of the right side; Coll. Dub. nos. 4432 (Trinil) and 4730 (Trinil) are of the left side. There remain only proximal fragments, with the glenoid cavity: Coll. Dub. nos. 3035 (Trinil), 4251 (Ngandjar), 4377 (Kedoeng Broeboes), 4817 (Ke-

TABLE 26

Measurements of scapula of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4429	4313	4392	4247	9042	9054	4555	6530	4826	7090	3035
Height from anterior border of glenoid cavity to top	62	72	65	53+	53+	56+	59+	46+	52+	52+	—
Anteroposterior diameter of collum scapulae	15	18½	17	16½	17	15½	15	14	18	—	15
From tuber scapulae to posterior border of glenoid cavity	17	19	18	—	—	—	16½	—	—	—	16
Anteroposterior diameter of glenoid cavity	13	15	ca. 14	ca. 14	—	ca. 14	13	—	ca. 15	—	—
Transverse diameter of idem	9½	10½	—	—	—	—	8½	—	9½	—	—
Greatest transverse diameter of spina scapulae from surface of supraspinous fossa	9½	13	—	11	—	9½	9	8½	10	—	—

Coll. Dub. nos.	4251	2398	4686	4692	4696	4708
Anteroposterior diameter of collum scapulae	17½	20	16	17	17½	—
From tuber scapulae to posterior border of glenoid cavity	20½	22	19	19½	18	19½
Anteroposterior diameter of glenoid cavity	15	ca. 16	ca. 14	15	13½	15
Transverse diameter of idem	10½	ca. 11	—	ca. 11	—	11½

doeng Broeboes), 4838 (Kedoeng Broeboes), and 8448 (Trinil) are of the right side, while Coll. Dub. nos. 2398 (Kedoeng Broeboes), 4338 (Kedoeng Broeboes), 4451, 4686 (? Trinil), 4692 (Trinil), 4696 (? Tritik), 4708 (Bangle), 4726 (Bangle), 4771 (Bogo), 4922 (? Bogo), and 10389 (Kedoeng Broeboes) are proximal fragments of left scapulae. Many of these are too incomplete for measurement; such measurements as can be given will be found in table 26.

The range of variation shown in the present series of *Stegodon* scapulae includes the specimens figured by Pohlig (1911, pl. XXVI fig. 22, pl. XXVII figs. 1, 1a). Mention is made of a scapula fragment (no. 1842; Pohlig, l.c., p. 205) that measures 27 cm anteroposteriorly between the glenoid cavity and the collum (22 cm at most in the present series). It might well have belonged to *Elephas*; there is a scapula fragment in the Dubois collection from Tinggang that is of decidedly larger size than the others, and that will be referred to below under the head *Elephas hysudrindicus*.

The proboscidean humeri from Java described by Pohlig (1911, p. 206, pl. XXVII fig. 2 and fig. 7) and Stehlin (1925, p. 9, figs. 1-3) are incomplete, but Van der Maarel (1932, p. 188, fig. 29) had at least one entire specimen. In the Dubois collection from Java there are six humeri preserved from caput down to trochlea, as well as numerous distal and proximal portions. The largest humerus that I refer to *Stegodon* (there is one larger, but this belongs to *Elephas*; below p. 129) has a length from caput to medial distal condyle of 80 cm; it is of the left side. Coll. Dub. nos. 4260 and 4277, from Djambe Pati Ajam, has the lateral tuberosity injured; its total length probably was 5 cm more. The head and the lateral condyle are somewhat damaged, but the bone is at once distinguished from that of a recent Asiatic elephant by the relatively larger head and the greater prominence of the deltoid crest, which make the proximal third of the *Stegodon* humerus heavier relative to the distal parts than in the living animal. The supinator ridge above the distal lateral epicondyle is not, or hardly, more prominent than that in *Elephas maximus*, however. The trochlea appears to be somewhat more distinctly constricted between the two condyles in *Stegodon* than in *Elephas*; at this point many of the distal fragments are broken, and only the larger, the medial condyle, remains.

A smaller but almost perfectly preserved right humerus from Trinil (Coll. Dub. no. 2900; pl. IX fig. 2) differs, again, from that of the recent Asiatic elephant in the much more prominent deltoid ridge, which, when seen from above, projects further outward, to above the lateral epicondyle, which is not the case in *Elephas* (cf. Adams, 1877-1881, pl. XVI). In proportion to the length, both the proximal width and the caput are larger in *Stegodon* than they are in *Elephas*; the trochlea is also wider relatively in *Stegodon* than in *Elephas*, but this difference is not as marked as that in the proximal parts of the humerus. This will be evident from the comparison of the various ratios of the *Stegodon* humerus given in table 27 with those of the *Elephas* humerus (fossil and recent) given in table 66.

Coll. Dub. nos. 4275-4276 (Ngandjar) is a left humerus with only the anterior part of the lateral tuberosity and the upper part of the supinator ridge missing. In all its ratios it is a typical *Stegodon* humerus.

TABLE 27

Measurements of humerus of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4260	2900	4275	4316	533
1. Length from caput to medial condyle	80	65½	69½	63½	69
2. Width over caput and posterior part of lateral tuberosity	23½	20	20½	ca. 18	—
3. Caput, anteroposterior diameter	—	15½	16	—	—
4. Transverse diameter of idem	ca. 14	12	12	—	—
5. Greatest diameter of shaft over deltoid tuberosity	22	17½	18	ca. 15	19
6. Least diameter at middle of shaft	9	6½	6½	6	6½
7. Greatest distal width	24	20	23	—	—
8. Width of trochlea	21½	16	17½	14½	—
9. Anteroposterior diameter of medial condyle	16	13	13½	13	ca. 13
10. Idem of lateral condyle	—	10	11	—	—
11. Ratio 2 : 1	0.29	0.31	0.30	—	—
12. Ratio 3 : 1	—	0.24	0.23	—	—
13. Ratio 5 : 1	0.28	0.27	0.26	—	0.28
14. Ratio 8 : 1	0.27	0.24	0.25	0.23	—
15. Ratio 2 : 7	0.98	1.00	0.89	—	—

Coll. Dub. nos. 4316 and 533 (both from Trinil) are a right and a left humerus, both damaged at the caput and lateral tuberosity, and lacking parts of the lateral condyle and epicondyle. The few ratios that can be given agree with those of the others, and differ from those of fossil and recent *Elephas* (table 66).

Of the proximal humerus fragments, Coll. Dub. nos. 4836 and 4869 (both Kedoeng Broeboes) as well as 4913 (? Bogo) have a damaged caput, and lack the lateral tuberosity. Coll. Dub. nos. 4895 (Kedoeng Broeboes) and 4921 (? Bogo) represent only the caput. All these specimens are of the right side. Proximal humerus fragments of the left side are Coll. Dub. nos. 4248 (Kedoeng Broeboes), 4307 (? Kedoeng Broeboes), 4329, 4488 (Kedoeng Broeboes), 4639 (Pati Ajam), 4651 (Trinil), 4828 (? Trinil), 4896 (Kedoeng Broeboes), 4920 (? Bogo), and 4930 (Tegoean), of which nos. 4639, 4651, and 4896 merely comprise the head. Measurements are contained in table 28.

TABLE 28

Proximal measurements of humerus of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4248	4307	4329	4488
Width over caput and posterior part of lateral tuberosity	21	—	—	ca. 24
Caput, anteroposterior diameter	—	ca. 19	ca. 20	—
Transverse diameter of idem	ca. 13	ca. 14	ca. 14	—
Greatest diameter of shaft over deltoid tuberosity	—	—	ca. 22	22

Distal fragments of humeri are more numerous; those of the right side are Coll. Dub. nos. 360 (Nongko, Padas Malang), 4302 (Trinil), 4308 and 4832 (Kedoeng Broeboes), 4522 and 4523 (Tegoean), 4571 (Bogo), 4667 and 4837 (Kedoeng Broeboes), 4728 (Trinil), and 4928 (Tegoean). Distal portions of left humeri are Coll. Dub. nos. 4317 (Trinil), 4331, 4619 (Tegoean), 4786 (Trinil), 4875 and 4876 (between Tegoean and Kebon Doeren), and 8707 (Tegoean). A number of distal fragments of humeri have only the medial condyle preserved, the lateral having broken off at the trochlea constriction. Of these specimens, Coll. Dub. nos. 4640 (Pati Ajam), 4733, 4880 and 4909 (Kedoeng Broeboes), 4839 (Kedoeng Broeboes), 4843 (Bogo), 4888 (Kali Gedeh), 4914 (Bogo), 4934 (? Tegoean), and 9048 (Trinil) are of the right side, while Coll. Dub. nos. 2087 (Tegoean), 4652 (Trinil), 4729, 4813 (Kedoeng Broeboes), and 4844 and 4846 (Bogo) are of the left side. Measurements are presented in table 29.

TABLE 29

Distal measurements of humerus of *Stegodon trigonocephalus* (in cm)

Coll Dub. nos.	360	4302	4308	4522	4667	4728
Greatest distal width	—	26	27	24½	ca. 21	24
Width of trochlea	ca. 20	18	21	17	15½	19
Anteroposterior diameter of medial condyle	—	15	—	15	13	15
Idem of lateral condyle	12	12	—	—	—	12
Coll. Dub. nos.	4317	4331	4619	4786	4875	4733
Greatest distal width	ca. 20	25½	23	24	26	—
Width of trochlea	16½	—	—	17½	18	—
Anteroposterior diameter of medial condyle	13	15½	ca. 13	13½	14½	16½
Idem of lateral condyle	11	—	—	12	—	—

There remain several portions of the shaft of the humerus, both of young and of adult individuals. Four specimens, all except one of the right side, Coll. Dub. nos. 9405, 7057, 7910, and 6793 (all of Trinil) represent successive growth stages, showing the increasing saliency of the supinator ridge and of the deltoid ridge during ontogeny (pl. VIII figs. 4-7). Shafts of right humeri include Coll. Dub. nos. 4513-4514 (Trinil), 4569 (Bogo), 4580 (Bogo), 4701, 4748 (Pati Ajam), 4811 (? Kedoeng Broeboes), 4840 (Bogo), 4858 (Trinil), 4885 (Trinil), 7085 (Trinil), and 10565 (Trinil), while shafts of left humeri include Coll. Dub. nos. 4294 (Trinil), 4841 (Bogo), 6732 (Trinil), and 8455 (Kedoeng Broeboes).

The large distal portion of a left humerus discussed by Stehlin (1925, p. 9, figs. 1-3) is stated to be 21 cm wide, which must be the trochlear width (judged by the figures given by Stehlin the greatest distal width is about 24 cm). If this is so, the Limbangan humerus is to the higher side of the range of variation of measurements here found for *Stegodon trigonocephalus*. Neither the shallowness of the coronoid fossa nor the great extent of the olecranon fossa appear to me to be characters of special importance, and the lateral narrowing of the trochlea and the obliquity of its medial boundary find their explanation in the rolled condition of the specimen; the margins of the trochlea are obscured by superficial damage.

There are one entire right radius (Coll. Dub. nos. 6735 and 8395, Trinil), and three entire left radii (Coll. Dub. nos. 6726, 6727, and 8814; all from Trinil). The shaft is slightly less curved than that in *Elephas*, but, in contradistinction to Pohlig (1911, p. 206), I do not find the fossil radii to be more twisted than those in the living Asiatic elephant, which the fossils further resemble closely in the configuration of the proximal and distal articular surfaces. In proportion to the total length, the greatest widths of these surfaces are greater in *Stegodon* than in *Elephas* (a point not noticed by Pohlig, l.c.), as appears from table 30.

TABLE 30

Measurements of radius of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

Coll. Dub. nos.	6735	6726	6727	8814	*Elephas maximus* subad. ♀	ad. ♀	ad. ♂
1. Total length	54	55	56½	57	61	61½	75
2. Greatest proximal width	9	—	10½	10	9	9	10
3. Greatest distal diameter	14	12	14	13½	12½	13	14
4. Ratio 2 : 1	0.17	—	0.19	0.18	0.15	0.15	0.13
5. Ratio 3 : 1	0.26	0.22	0.25	0.24	0.20	0.21	0.19

One proximal radius fragment from Kedoeng Broeboes, of the left side (Coll. Dub. no. 10736) has a greatest width of 14 cm, much larger than that in any of the complete radii. Therefore, it is probably referable to *Elephas*, but this cannot be definitely settled for the incomplete specimen. Three distal radius fragments, all of the right side, Coll. Dub. nos. 8926 (Kedoeng Broeboes), 10213 (Pati Ajam), and 10261 (? Bangle) are not, or hardly, larger than those of the entire radii mentioned above, their greatest diameters being 13½-14½ cm. The shaft of an immature left radius from Trinil (Coll. Dub. no. 6794) has a length of 30 cm without the proximal and distal epiphyses.

Of the ulna there are two entire right specimens and one entire left specimen, somewhat injured distally: Coll. Dub. nos. 4615, 4770 and 4894, and 6531, all from Trinil. As noted by Pohlig (1911, p. 206), the olecranon in the *Stegodon* ulna is rather elongated, the processus anconaeus is more prominent, and the incision of the humeral articular surface for the radius appears to be less deep than that in *Elephas*. As follows from the measurements and ratios in table 31, the olecranon is not more developed in *Stegodon* than it is in *Elephas*, for the ratio of the length of the ulna without the olecranon to the total length is the same in both (ratio 7). There is, however, an important difference, again, in relative width: in *Stegodon* the humeral articular surface as well as the distal part of the lateral surface are wider relative to the length than in *Elephas* (ratios 8 and 9). The entire left ulna from Trinil described by Pohlig (1911, p. 206, pl. XXVII fig. 3) is 64 cm long, and 16 cm wide proximally; the medial length is not given.

Among the proximal ulna fragments from Java there are several of much larger size than the complete *Stegodon* ulnae recorded above; these will be recorded under the head *Elephas hysudrindicus*. Unfortunately in most of these portions the smaller, lateral part of the humeral articular surface is broken away so that the proximal width cannot be given. The proximal ulna fragments of the right side are Coll. Dub. nos. 481 (Trinil), 2399 (Trinil), 4400-4401 (Trinil), 4493 (between Tegoean and Kebon Doeren), 4592-4593 (Pati Ajam), 4616 (between Tegoean and Kebon Doeren), 4647 (Trinil), 4666 (? Kedoeng Broeboes), 4783 (Trinil), 4801 (Tritik), 7095

TABLE 31

Measurements of ulna of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

Coll. Dub. nos.	4615	4770	6531	*Elephas maximus* subad. ♀	ad. ♀	ad. ♂
1. Greatest length	62	60½	63	70	72½	85
2. Medial length from humeral articular surface to cuneiform facet	50	49	49½	55	59	70½
3. Width of humeral articular surface	16	16½	—	16	16	19
4. Width at middle of shaft	8	8	7½	7	7½	9
5. Width of lateral surface, distally	12	ca. 11½	—	10	10½	13
6. Width of cuneiform facet	7½	ca. 8	8	9	8½	10½
7. Ratio 2 : 1	0.81	0.81	0.79	0.79	0.81	0.83
8. Ratio 3 : 2	0.32	0.34	—	0.29	0.27	0.27
9. Ratio 5 : 2	0.24	—	—	0.18	0.18	0.18
10. Width of medial portion of humeral articular surface	8	7½	6½	7½	7½	9

(? Trinil), 8144 (Kedoeng Broeboes), 8567 (Trinil), 9068 (Trinil), and 9083 (? Trinil). Proximal fragments of left ulnae include Coll. Dub. nos. 2086 (between Tegoean and Kebon Doeren), 2088 (Tegoean), 4254 (Trinil), 4269 and 4951 (Pati Ajam), 4278 and 4949 (Djambe Pati Ajam), 4565 (Bogo), 4570 (Bogo), 4576 (Bogo), 4649 (Trinil), 4721 (Trinil), 4803, 4878 (Kedoeng Broeboes), 4938 (? Tegoean), 4950 and 4956 (Pati Ajam), 5396, 6529 and 467 (Kedoeng Broeboes), 6733 (Trinil), 6750 (Trinil), 8943 (Trinil), and 10193. Their measurements are contained in table 32.

TABLE 32

Proximal measurements of ulna of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	481	2399	4400	4592	4616	4647	4783	4801
Width of humeral articular surface	—	21½	18	ca. 19	18	18	16	—
Width of medial portion of idem	7½	—	8	9	7½	8½	6½	7½
Width at middle of shaft	—	—	8½	ca. 10½	8½	—	7½	8½

Coll. Dub. nos.	2086	4254	4278	4649	4721	4950	6529
Width of humeral articular surface	—	17	—	16	16	—	19
Width of medial portion of idem	9½	8	—	7½	8	ca. 7	8
Width at middle of shaft	—	—	ca. 10	—	7	7	9½

Distal portions of right ulnae are Coll. Dub. nos. 4648 (Trinil), 4682 (Kedoeng Broeboes), 4720, and 4802 (Tritik); the distal portion Coll. Dub. no. 4769 (Trinil) is of the left side (table 33).

TABLE 33

Distal measurements of ulna of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4648	4682	4802	4769
Width of lateral surface	11½	12	11	11
Width of cuneiform facet	9½	—	ca. 9	ca. 9½

A left magnum from Trinil (Coll. Dub. no. 11655), almost undamaged, is the only carpal bone of *Stegodon* in the Dubois collection; this bone is not represented in the Java collection studied by Pohlig (1911, p. 206). The proximal surface, articulating with the lunar, and also with the scaphoid medially, is concavo-convex from before backward, and resembles that in *Elephas maximus* closely. The medial surface, with facets for the trapezoid proximally, and for the second metacarpal distally, is lower relatively than that in the living Asiatic elephant. The facet for the second metacarpal is somewhat more extended behind than in that species. The lateral surface,

TABLE 34

Measurements of magnum of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

	Stegodon trigonocephalus	*Elephas maximus*
Greatest proximal width	9	7½
Anterior proximal width	7½	6½
Anteroposterior diameter of proximal surface	9	7½
Greatest height, medially	8	7½
Idem, laterally	7	6½
Posterior height	8½	8
Anterior height	6½	5½

which has a large facet for the unciform in the proximal half, and a non-articular fossa in the distal half, is also lower relatively than that in the living form. Unfortunately the distal surface, for the third metacarpal, is damaged anteriorly and laterally, but the posterior surface, again, is relatively higher than that in *Elephas maximus* (table 34).

With a magnum of these proportions, the carpus of *Stegodon* must have been more shortened relative to its width than that in *Elephas maximus*.

The pelvis of *Stegodon* has been dealt with at some length by Pohlig (1911, pp. 207-208, figs. 4-5). He found the ilium to be wider, and the symphysial part of the pelvis to be longer than that in *Elephas*. In none of the Dubois collection specimens the ischium or the pubis are complete, so that the length of the symphysis cannot be given. The differences I observed between the pelvis of *Stegodon* and that of *Elephas* are the following. The wing of the ilium is less curved upward and backward medially, and less curved downward and forward laterally in *Stegodon* than in *Elephas*. In *Elephas maximus* the tuber sacrale is more elevated, and the tuber coxae is more distinctly downcurved than those in the *Stegodon* ilium; consequently the gluteal surface of the ilium is more distinctly concave in its medial half, and more convex laterally in *Elephas* than in *Stegodon*. Besides in the flattened wing of the ilium, the *Stegodon* pelvis is also distinguished from that of *Elephas* by its relatively longer corpus ossis ilium, which does not expand as rapidly into the ala ossis ilium in *Stegodon* as it does in *Elephas*. Unfortunately the postacetabular part of all pelves is very incomplete; at most only the acetabular branches of ischium and pubis remain.

There is some variation in the direction of the acetabular branch of the pubis: in some specimens it is more distinctly curved inward than in others, in which it is directed more caudally and ventrally. There seems to be little doubt that this is a sexual variation, the first mentioned specimens representing females, the last mentioned, males. The foramen obturatum is complete in none of the specimens available to me; from the figure given by Pohlig (l.c., fig. 5) it would seem to be proportionally larger than that in *Elephas*.

The best specimen of the pelvis is Coll. Dub. nos. 4389-4391, from Trinil (pl. IX fig. 4), a left os coxae with the ilium damaged only along the crista iliaca and the tuber sacrale. From the direction of the ramus acetabularis ossis pubis I would judge this to have belonged to a male. The corpus of the ischium is broken off. The flattened gluteal surface of the ala ossis ilium, and the relatively long corpus of the ilium distinguish it from an *Elephas* pelvis.

A right ilium from Trinil (Coll. Dub. no. 4782), with the crista iliaca almost entirely preserved, has the same diagnostic characters as the last specimen. A right and a left os coxae from Trinil (Coll. Dub. nos. 2891a and 2891b), probably of the same individual, lack the ischia, and the pubes do not make a contact in the median line. The ilia are incomplete superiorly as well as medially. A left os coxae (Coll. Dub. nos. 4236-4238), probably from Tinggang, has the ilium preserved up to the tuber sacrale but lacks the postacetabular portion. Another left os coxae, Coll. Dub. no. 3034, from Trinil, lacks the acetabular portion of the pubis but shows the tuber coxae. Measurements of these specimens are presented in table 35.

TABLE 35

Measurements of the pelvis of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

						Elephas maximus		
Coll. Dub. nos.	4389	4782	2891	4236	3034	subad. ♀	ad. ♀	ad. ♂
Greatest width of ilium	75	ca. 68	—	—	—	66	65	75
Least width of ilium above acetabulum	16	14	13½	17	13	13	15	17
Diameter of acetabulum	ca. 13	13½	13	13½	ca. 13	12	12	14
Height from anterior border of acetabulum to top of ilium	60	56	—	61	—	53	54	58
From acetabulum to tuber coxae	39	—	30	—	23	30	30	35
Coll. Dub. nos.	4375	4577	8491	8492	3480	4257	7069	7073
Least width of ilium above acetabulum	19	18	16½	16	18	13	12	—
Diameter of acetabulum	—	—	13	12½	—	—	—	15

All of the remaining specimens of os coxae lack most of the wing of the ilium, and the postacetabular portion as well. The right os coxae is represented by the following specimens: Coll. Dub. nos. 482A, 4375 (Kedoeng Broeboes), 4489 (Kedoeng Broeboes), 4577 (Bogo), 4582 (Bogo), 4612 (Kali Gedeh), 4663 and 4668 (Kedoeng Broeboes or Bogo), 4818 (Kedoeng Broeboes), 4833 and 4834 (Trinil), 4899, 8447 (Trinil), 8491 (Trinil), and 8492 (Trinil). Of the left os coxae there are the following: Coll. Dub. nos. 4479 (merely the ramus acetabularis ossis ischii), 3480 (Pati Ajam), 4257 (Trinil), 4628 (? Trinil), 4747 and 4752 (Pati Ajam), 7069 (Trinil), 7073 (Trinil), and 7074 (Trinil). Remaining fragments of the ilium include Coll. Dub. nos. 481A, 4319, 4320, 4323, 4326 (all between Dekes and Wadegan), 4524 (Bogo), 4562 (Bogo), 4572 (Bogo), 4727 (Prameran), 4749 (Pati Ajam), 4787, 4788 and 4863, 4845 (Bogo), 4862, and 5050 (Trinil).

Femora are well represented in the Dubois collection from Java, but only seven specimens are practically complete. All of these, although varying somewhat size, prove to belong to *Stegodon,* as their transverse diameters are consistently larger relative to the length of the bones than is the case in *Elephas* (table 36).

TABLE 36

Measurements of femur of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

								Elephas maximus		
Coll. Dub. nos.	2890	4298	4315	4242	4314	2889	4289	subad. ♀	ad. ♀	ad. ♂
1. Length from caput to medial condyle	90	88	82	89	82	101	98	89	90	106
2. Greatest proximal diameter over caput and great trochanter	32	—	29	31½	29	35½	ca. 37	24	25	31½
3. Least width of shaft	11½	11½	11	11½	11½	13½	14	9½	10½	12
4. Anteroposterior diameter, same level	7½	7	7½	7	7	8½	9	6	6½	7½
5. Greatest distal width	20	19	19½	18+	19	23	24½	15½	17½	20
6. Distal condyle width	—	16½	16	—	—	20½	ca. 20	14	15	17½
7. Diameter of caput	14	13	13	12½	13	15½	ca. 15	11½	11½	12½
8. Distal anteroposterior diameter, medial side	20½	20	20	19½	—	22½	22½	16½	17½	19½
9. Idem, lateral side	—	15	17	—	16½	20	ca. 19	14½	15½	17
10. Ratio 2 : 1	0.36	—	0.35	0.35	0.35	0.35	ca. 0.38	0.27	0.28	0.30
11. Ratio 3 : 1	0.13	0.13	0.13	0.13	0.14	0.13	0.14	0.11	0.12	0.11
12. Ratio 5 : 1	0.22	0.22	0.24	--	0.23	0.23	0.25	0.17	0.19	0.19
13. Ratio 6 : 1	—	0.19	0.20	—	—	0.20	ca. 0.20	0.16	0.17	0.17
14. Ratio 7 : 1	0.16	0.15	0.16	0.14	0.16	0.15	ca. 0.15	0.13	0.13	0.12
15. Ratio 8 : 1	0.23	0.23	0.24	0.22	—	0.22	0.23	0.19	0.19	0.18

Of the right femora, Coll. Dub. no. 2890 (Trinil) lacks the lateral distal condyle but is perfect otherwise (pl. IX fig. 1). Coll. Dub. nos. 4298-4300 is damaged at the great trochanter as well as above the trochlea; nos. 4315 and 4827 (Trinil) is damaged at the middle of the shaft. Of the left femora, Coll. Dub. nos. 4242-4243 (? Tinggang) lacks the distal condyle, Coll. Dub. nos. 4314 and 4487 (Trinil) is damaged at the inner border of the medial condyle. Two larger left femora, Coll. Dub. no. 2889, probably from Trinil, and Coll. Dub. nos. 4289 and 4864, are damaged proximally, at the great trochanter, but the greatest proximal width can be given.

Of the proximal fragments of right femora, Coll. Dub. no. 4657 (Kedoeng Broeboes) lacks the caput; Coll. Dub. no. 4829 has most of the caput. One proximal fragment (Coll. Dub. no. 4932) is so large that it must be referred to *Elephas*. There are two proximal fragments of left femora: Coll. Dub. nos. 4494 and 4497 (Trinil), as well as various isolated capita: Coll. Dub. nos. 4335 (Kedoeng Broeboes), 4575 (Bogo), 4586 (Pati Ajam), 4630 (Pati Ajam), 4641 (Pati Ajam), 4734, and 4755 (Pati Ajam). The measurements of these specimens are given in table 37.

TABLE 37

Proximal measurements of femur of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4829	4497	4575	4586
Greatest diameter over caput and great trochanter	33	28½	—	—
Diameter of caput	14	12	16½	12½

Distal portions of right femora include Coll. Dub. nos. 4304 (Kedoeng Broeboes), 4490 (Kedoeng Broeboes), 4500 (Trinil), 4706 (Tegoean), 4719, 4861, 4887 (Kali Gedeh), 4917 (?Bogo), and 4952 (Pati Ajam). Distal parts of left femora are the following: Coll. Dub. nos. 4250 (Trinil), 4284 (Kedoeng Broeboes), 4306 (Bogo), 4310 (Kedoeng Broeboes), 4330, 4381 (Kedoeng Broeboes), 4581 (Bogo), 4633 (Pati Ajam), 4687 (Tegoean), 4688 (Tegoean), and 4699. The measurements of the specimens are given in table 38.

TABLE 38

Distal measurements of femur of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4500	4706	4861	4250	4284	4306	4330	4581	4699
Greatest width	18	19½	18	—	22	20½	25½	—	22
Condyle width	—	—	16	—	—	17½	22½	—	20
Anteroposterior diameter, medial side	18½	—	20½	20½	—	21	25	22½	22½
Idem, lateral	16	16	16½	—	—	19	—	—	19

TABLE 39

Measurements of tibia of *Stegodon trigonocephalus* and of *Elephas maximus*

(in cm)

													Elephas maximus		
Coll. Dub. nos.	4318	4379	4644	4645	4868	9069	4428	4643	4717	4784	4859	6717	subad. ♀	ad. ♀	ad. ♂
1. Length from intercondyloid eminence to middle of distal surface	56	57½	47	48½	—	48	60½	44	54	58	49½	45½	55½	50	66
2. Greatest proximal width	21	20	16	18	—	—	23½	14	20	22½	18	—	16	17	19½
3. Greatest proximal anteroposterior diameter	15	16	12	13	12	12	16½	11½	15	16	13	13	12½	13	14½
4. Least width of shaft	8½	9½	7	7½	8½	8	9	7	8½	10	8	7	8	7½	8
5. Least antero-posterior diameter of shaft	7½	8	5½	5½	7	6½	8	5½	7½	8	5½	5½	6	5	6½
6. Greatest distal width	17	17	12½	14½	—	14½	17½	12	16	19	14½	12	13½	14	15½
7. Greatest distal anteroposterior diameter	13	13½	10½	10	—	11	14½	9½	13	14	10½	9½	10	8	11½
8. Ratio 2 : 1	0.38	0.35	0.34	0.37	—	—	0.39	0.32	0.37	0.39	0.36	—	0.29	0.34	0.30
9. Ratio 3 : 1	0.27	0.28	0.26	0.27	—	0.25	0.27	0.26	0.28	0.28	0.26	0.29	0.23	0.26	0.22
10. Ratio 4 : 1	0.15	0.17	0.15	0.15	—	0.17	0.15	0.16	0.16	0.17	0.16	0.15	0.14	0.15	0.12
11. Ratio 6 : 1	0.30	0.30	0.27	0.30	—	0.30	0.29	0.27	0.30	0.33	0.29	0.26	0.24	0.28	0.24
12. Ratio 7 : 1	0.23	0.23	0.22	0.21	—	0.23	0.24	0.21	0.24	0.24	0.21	0.21	0.18	0.16	0.17

Three femoral shafts of young individuals from Trinil, lacking the proximal and distal epiphyses, two of the right side (Coll. Dub. nos. 6792 and 9082), and one of the left side (Coll. Dub. no. 6725), have lengths of 37, 50, and 53 cm, respectively. Two subadult bones, lacking only the proximal epiphyses, one of the right side (Coll. Dub. nos. 4882-4883, Trinil), and one of the left side (Coll. Dub. no. 4288, Trinil), are 77 and 74 cm long, respectively. Remaining femoral shaft fragments are less complete.

The Dubois collection from Java contains six entire (or almost entire) right tibiae, and an equal number of left tibiae of *Stegodon*, a larger number than that of the entire specimens of any other of the long bones. The right tibiae are Coll. Dub. nos. 4318 (Trinil), 4379-4380 (Kedoeng Broeboes), 4644 (Trinil), 4645-4646 (Trinil), 4868 (Kedoeng Broeboes), and 9069 (Solo Valley). Those of the left side are Coll. Dub. nos. 4428 (Trinil), 4643 (Trinil), 4717-4718 (Soember Soeka), 4784-4785 (Trinil), 4859-4860 (Trinil), and 6717 (Trinil). The measurements and ratios of these bones compared with those of recent *Elephas maximus* in table 39 bear out, again, that the bones of *Stegodon trigonocephalus* are more expanded in relation to their length than those of *Elephas*: the ratios of the transverse and anteroposterior diameters to the length are almost invariably greater in *Stegodon* than in *Elephas*. The tibia described and figured by Pohlig (1911, p. 210, pl. XXVII fig. 5) is within the variation limits of the Dubois collection specimens.

Proximal portions of right tibiae are Coll. Dub. nos. 4303 (Kedoeng Broeboes), 4332 (Kedoeng Broeboes), 4578 (Bogo), 4662 (Kedoeng Broeboes or Bogo), 4689 (Tegoean), 4773 (Bogo), and 8153 (Kedoeng Broeboes); to left tibiae belong Coll. Dub. nos. 4567 (Bogo), 4732 (Kali Gedeh), 4772 (Bogo), 4778, 4830 (?Kedoeng Broeboes), 4877 (Kedoeng Broeboes), 4919 (?Bogo), 4931 (?Tegoean), 4941 (?Tegoean), and 10564 (Tritik). The measurements are given in table 40.

TABLE 40

Proximal measurements of tibia of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4303	4578	8153	4778	4830	4919
Greatest width	18½	18	15½	17½	25½	—
Greatest anteroposterior diameter	14½	—	13	14	16	13

The distal portions of tibiae, of the right side, are Coll. Dub. nos. 4614 (Trinil), 4683, 4751 (Pati Ajam), 4912 (Bogo), 4915 (Bogo), 9353 (Trinil), and 10213 (Pati Ajam); those of the left side are Coll. Dub. nos. 2397, 2400, 2401 (?Kedoeng Broeboes), 4311-4312 (Kedoeng Broeboes), 4452, 4611 (Kedoeng Broeboes), 4658 (Bogo), 4661, 8908, 8927, 9354 (Trinil), and 10250. Measurements are given in table 41.

TABLE 41

Distal measurements of tibia of *Stegodon trigonocephalus* (in cm)

Coll. Dub. nos.	4614	4751	4915	9353	2397	4311	4452	4611	4658	9354
Greatest width	17	—	15½	13	18	19½	16	16	16	14½
Greatest antero-posterior diameter	—	12½	13	10	13½	14	—	12½	11½	10½

There remain a number of shafts of tibiae, as follows: Coll. Dub. nos. 4253 (Tegoean), 4339-4340 (?Kedoeng Broeboes), 4939 (?Tegoean), 6713, 6719 (Trinil), 6729 (Trinil), 6795 (Trinil), 8446 (Trinil), 9846 (Trinil), all of the right side, as well as Coll. Dub. nos. 4252 (Tegoean), 4496 and 4498 (Kedoeng Loemboe), 6736 (Trinil), and 8445 (Trinil), which are of the left side.

Beside the complete shaft of an immature right fibula (Coll. Dub. no. 6763, Trinil) there are only proximal and distal portions of the fibula. The proximal and distal portions of a left fibula (Coll. Dub. nos. 10571-10572, Ngandjar) very probably belonged to the same individual, but do not fit together. The immature shaft is 34 cm long; the epiphyses are gone. Those of Coll. Dub. nos. 10571-10572 agree in configuration with those of *Elephas maximus* but appear to be rather large: the proximal end measures 7 by 6½ cm, the distal, 11 by 9½ cm. Coll. Dub. no. 10131 contains a proximal fragment of a right fibula that is ca. 7 cm in diameter both ways, while Coll. Dub. no. 6730 (Trinil) is a small distal shaft fragment of another right fibula that had the epiphysis not united yet.

A right astragalus from Trinil (Coll. Dub. no. 7515) is damaged along the medial ridge of the trochlea, and at the ridge separating the navicular facet from the medial of the calcaneum facets. A right astragalus from Trinil has already been figured by Pohlig (1911, pl. XXVII fig. 12). A difference between the present fossil bone and an astragalus of *Elephas maximus* is found in the direction of the non-articular fossa between the two large calcaneum facets; in the fossil astragalus this fossa, narrow above, and widening distally, runs more nearly vertical than that in *Elephas*, in which its course is oblique, from near the medial proximal angle to the lateral distal angle of the posterior surface. As a result, the medial facet for the calcaneum is wider, and the lateral narrower proximally in *Stegodon* than in *Elephas*. The Trinil astragalus figured by Pohlig (l.c., fig. 12a) presents just the same distinguishing character. However, we might expect much individual variation in characters of this kind, and they are probably unfit even for generic differentiation (the astragalus of *Elephas antiquus* figured by Trevisan (1948, p. 45, fig. 33, upper figs.) is much more nearly "stegodontine" than that of *Elephas maximus* examined by me (Leiden Museum, reg. no. 9376), and the series of Siwalik astragali presented by Falconer and Cautley (1847, pl. 54) shows astonishingly much variation in the development of the said fossa).

The measurements (table 42) show that the astragalus of *Stegodon* is more expanded anteroposteriorly as well as vertically by the same width than that of *Elephas maximus.*

TABLE 42

Measurements of astragalus of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

	Stegodon trigonocephalus	*Elephas maximus*
Greatest width	11½	11½
Greatest height	12	10
Lateral height	8	7
Anteroposterior diameter from trochlea to medial calcaneum facet	8	6

A right calcaneum, damaged at the lateral surface distally, and lacking small parts of the fibular and cuboidal facets, likewise originates from Trinil (Coll. Dub. no. 4722), but is not of the same individual as the astragalus just mentioned. It differs, again, from that of *Elephas maximus* in the less oblique direction of the fossa separating the two astragaline articular surfaces. The fossa runs almost vertically instead of from the medial side proximally to the lateral distal angle, and thus makes the lateral facet for the astragalus narrower, and the medial wider proximally than in *Elephas*. Further, the proximal extremity of the corpus is more expanded in the fossil than in the living form by the same greatest distal width, as appears from table 43.

TABE 43

Measurements of calcaneum of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

	Stegodon trigonocephalus	*Elephas maximus*
Greatest distal diameter over fibular facet and medial astragaline facet	ca. 12½	12
Greatest height	17½	14½
Anteroposterior diameter of corpus above the sustentaculum	9½	7

There is also a battered right calcaneum from Djambe Pati Ajam (Coll. Dub. no. 4777), but of this specimen no measurements can be given.

The only complete proboscidean metapodial in the Trinil collection is a left fourth metatarsal (Coll. Dub. no. 9073), articulating with the cuboid and also with the ectocuneiform; the proximal surface is damaged behind only. The only difference observed between the present fossil metatarsal and its homologue in *Elephas maximus* (table 44) is that the proximal width is equal to the distal width, while in the recent Asiatic elephant the proximal width is less than the distal. The width at the proximal end is greater relative to the length in the fossil than in the living species, but there is no difference in relative distal width.

TABLE 44

Measurements of metatarsal IV of *Stegodon trigonocephalus* and of *Elephas maximus* (in cm)

Coll. Dub. no.	9073	*Elephas maximus*		
		subad. ♀	ad. ♀	ad. ♂
1. Greatest length	12½	10	10½	11½
2. Proximal width	7	5½	5	5½
3. Least width of shaft	5	4	4	4½
4. Distal width	7	6	5½	6½
5. Ratio 2 : 1	0.55	0.55	0.5	0.5
6. Ratio 4 : 1	0.55	0.6	0.5	0.55

Such is the postcranial skeleton of the common Java *Stegodon*. A few facts that have emerged from the present study may be summarized here. The neck of *Stegodon* is probably shorter than that in *Elephas* (*maximus*); the scapula has its acromion placed less high; the humerus has a relatively larger caput and a more prominent deltoid crest, and is more expanded proximally and distally relative to the length than in *Elephas*, a distinction that also holds for the other long bones (radius, ulna, femur, tibia); the ilium is more flattened, and has a relatively longer corpus in *Stegodon* than in *Elephas*; the carpal and tarsal bones are thicker in the former than in the latter. Undoubtedly the Java *Stegodon* had stouter limbs and feet than the living Asiatic elephant.

Stegodon hypsilophus Hooijer

Elephas sp., Von Koenigswald, De Ing. in Ned. Indië, vol. 1, sect. IV, 1934, p. 192, pl. IV figs. 8-9.

Stegodon hypsilophus Hooijer, Zool. Med. Museum Leiden, vol. 33, no. 14, 1954, p. 92, pl. XIX.

In a collection of fossil vertebrates made by Dr. J. Cosijn North of Djetis and Perning, Eastern Java, and preserved in the Geological Museum at Leiden I recently observed two upper last molars widely different from those of the common Java *Stegodon trigonocephalus*. These specimens have been described as *Stegodon hypsilophus* (Hooijer, 1954a), and the diagnosis runs as follows: "A *Stegodon* of very small size; width of M^3 64 mm. Ridges highly elevated; four-fifths to almost fully as high as wide. At least ten ridges in the upper last molar. Three to eight conelets on each ridge, ridges convex transversely at the apex. No trace of median cleft" (Hooijer, l.c., p. 92). The type originates from the Djetis deposits, Middle Pleistocene.

Although it evidently is a rare member to the Pleistocene fauna of Java *Stegodon hypsilophus* might conceivably be present in collections made by others, and so it is. In 1934 Von Koenigswald figured the anterior portion of a right lower molar, from the Djetis deposits, that is 48 mm wide by an unworn height of 40 mm. These measurements are very close to those of the DM_4 of *Elephas hysudricus* (Osborn, 1942, p. 1348, records a DM_4 46 mm wide and 38 mm high), and even the laminar frequency is the same, viz., 8 in both, but I do not agree that the Java specimen belongs to *Elephas*. Because of the absence of median expansions to the ridges, and in view of the apparently narrow bases of the valleys, to which may be added the few (about 5) and large conelets, the specimen figured by Von Koenigswald would seem to represent a stegodont. It is, however, much too high-crowned for *Stegodon trigonocephalus*, a DM_4 of which is only 26 mm high by a width of 47 mm (table 11). Hence, there is nothing against referring the specimen to the present species, of which it is probably the first lower molar.

In the Dubois collection there is the distal portion of a left humerus, Coll. Dub. no. 4621, from Kedoeng Broeboes, that is notoriously small, yet perfectly adult as the distal epiphysis is fused. Unfortunately the lateral epicondyle and the supinator ridge above it are broken off. The few measurements that can be given (table 45) show that it is about one-half the size of that of *Elephas hysudrindicus*, and well below the range of variation of measurements in *Stegodon trigonocephalus* and in *Elephas maximus*. There is every reason to refer this humerus provisionally to our pygmy *Stegodon hypsilophus*, first described (Hooijer, 1954a) from the Djetis deposits. Since at Kedoeng Broeboes both the Djetis and the Trinil deposits occur (Von Koenigswald, 1934, p. 188) the present find might be from the Djetis beds as well as the holotype.

TABLE 45

Measurements of humerus of *Stegodon* and *Elephas* (in cm)

	Stegodon hypsilophus	*Stegodon trigonocephalus*	*Elephas hysudrindicus*	*Elephas maximus*
Width of trochlea	12	14½—21½	24½	15½—18
Anteroposterior diameter of medial condyle	ca. 10	13—16½	18½	11½—13
Idem of lateral condyle	ca. 8	10—12	15	10—11½

In his work on the Limbangan fauna of Java, Stehlin (1925, p. 9) remarks upon a proboscidean tibia of very small dimensions. The proximal width of the bone is given as 11 cm, whereas, as we have seen above, in *Stegodon trigonocephalus* the proximal width of the tibia varies from 14 to 25½ cm, and in *Elephas maximus* from 16 to 19½ cm (tables 39 and 40). The Limbangan tibia is smaller even than that of *Archidiskodon celebensis,* the proximal width of which is 12½ cm (Hooijer, 1949, p. 217). It is, therefore, quite probable that it represents the pygmy stegodont of Java now under discussion.

As stated above in the chapter on Pleistocene stratigraphy, the Limbangan fauna has been provisionally correlated with the Trinil fauna by Von Koenigswald, but in my opinion the association of *Archidiskodon planifrons* (*Elephas* spec. III of Stehlin) and *Elephas hysudrindicus* (*Elephas* spec. I and II of Stehlin) indicates that it might better be paralleled with the Djetis fauna. If *Stegodon hypsilophus* is typical of the Djetis fauna, and of that fauna only, its presence in the Limbangan fauna affords additional support for the view that the Limbangan fauna should be equated to the Djetis.

Consequently, it appears that remains of *Stegodon hypsilophus* have been collected or described at four occasions previous to 1954, viz., by Dubois, by Stehlin, by Cosijn, and by Von Koenigswald, and all these finds are, or may be, from the Djetis beds. *Stegodon hypsilophus* exceeds all other known stegodont species in the great relative height of the crown; the measurements of the left M^3 previously described (Hooijer, 1954a) are given in table 46.

TABLE 46

Unworn ridges of M^3 of *Stegodon hypsilophus*

No. of ridge from behind	(x + 8)	(x + 7)	(x + 6)	(x + 5)	4	3	2	1	talon
Width	59	64	63	62	59	53	45	41	32
Height	49	54	57	54	52	49	44	39	34
Height-width index	83	84	90	87	88	92	98	95	106

Stegodon hypsilophus is more hypsodont than *Stegodon insignis* (table 4), and even than *Stegodon trigonocephalus* (table 17), the most progressive species of the genus known before. It demonstrates that, in the progressive heightening of the ridges, the stegodonts have proceeded further than we used to know, almost up to the stage represented by *Archidiskodon planifrons* (table 53).

With the present species we leave the Stegodontinae, and pass on to the next subfamily of Proboscidea, the Elephantinae.

Subfamily ELEPHANTINAE Gill

Genus ARCHIDISKODON Pohlig

Archidiskodon celebensis Hooijer

Archidiskodon celebensis Hooijer, Zool. Med. Museum Leiden, vol. 30, no. 14, 1949, p. 206, pls. VIII-IX; Chronica Naturae, vol. 105, 1949, p. 149; The Scientific Monthly, vol. 72, 1951, p. 5; Zool. Med. Museum Leiden, vol. 31, no. 28, 1953, p. 311, pl. XIX; Ibid., vol. 32, no. 20, 1953, p. 221, pl. VII; Ibid., vol. 33, no. 15, 1954, p. 103, pls. XX-XXII.

The present species was first described a couple of years ago from a collection of fossil vertebrates entrusted to me by Prof. Dr. A. J. Bernet Kempers, Head of the Archaeological Survey of the then Dutch East Indies, and found by Mr. H. R. van Heekeren at Sompoh, Beroe, and Tjeleko, in the Sopeng district, about 100 km N.E. of Macassar in Southwestern Celebes. The associated fossils, of which a stegodont, an extinct endemic suid (*Celebochoerus heekereni*), and a gigantic land tortoise (*Testudo margae*) may be mentioned, point to a fauna of a very peculiar insular character, and do not permit of a parallelization of the Celebes fauna with other fossil faunas in Southeastern Asia, although their Pleistocene age seems beyond question.

The diagnosis of *Archidiskodon celebensis* (Hooijer, 1954b, p. 104) runs as follows: "An *Archidiskodon* one-half as large in linear dimensions as *A. planifrons* (Falconer et Cautley); plate formula: M1 $\overline{8}$ M2 $\overline{9\text{-}10}$ M3 $\overline{11}$; molar plates low as in *A. planifrons*, with thick enamel, expanded in the median line, forming an imperfect loxodont sinus when worn, separated by V-shaped valleys; plentiful cement also on outer sides of plates. Molar crowns relatively narrower than the average in *A. planifrons*, roots long. Functional premolars both in upper jaw ($P^{3\text{-}4}$) and in mandible (P_4), about two-thirds as large as their homologues in *A. planifrons*. The mandible is downturned anteriorly, symphysis tuskless (? female) or provided with vertically compressed and grooved incisors (? male)".

Unfortunately the *Stegodon* associated with *Archidiskodon celebensis* is only poorly represented in the Celebes collection; it evidently was much less common than the archidiskodont (Hooijer, 1953b). In my first paper on the Celebes elephantine (Hooijer, 1949) I described two fragments of limb bones, characterized by their very small size. There is more post-cranial skeletal material of proboscideans in the Van Heekeren collection that has not yet been described, and that will be referred to below. All the remains point to individuals definitely smaller than *Elephas maximus* or *Stegodon trigonocephalus*. If some of this material belongs to the stegodont instead (the incomplete bones at hand do not permit of a distinction between *Stegodon* on the one hand, and *Archidiskodon* on the other), the stegodont of Celebes would be a pygmy species, closely comparable to *Archidiskodon celebensis* as to size. In that case, the Celebes *Stegodon* undoubtedly represents a new species, as the molars of the only other pygmy stegodont at present known, *Stegodon hypsilophus* Hooijer (1954a) from Java, are more hypsodont than those of the Celebes form (and of any other stegodont, for that matter). Pending the solution of this problem, only to be arrived at upon the study of more complete specimens not now available, all the fragmentary bones may be referred to *Archidiskodon celebensis*.

The proximal portion of a right scapula from Tjeleko is just one-half the size of that of *Elephas hysudrindicus*, and about two-thirds that of the scapula of *Stegodon trigonocephalus* and of *Elephas maximus* (table 47).

TABLE 47

Measurements of scapula of various proboscideans (in cm)

	Archidiskodon celebensis	*Stegodon trigonocephalus*	*Elephas hysudrindicus*	*Elephas maximus*
Anteroposterior diameter of collum scapulae	11½	14-20	23	17-19
From tuber scapulae to posterior border of glenoid cavity	12	16-22	23½	17½-21½
Anteroposterior diameter of glenoid cavity	ca. 9½	13-15	19	13½-16
Transverse diameter of idem	5½	8½-11½	13½	7½-10

A broken proximal fragment of a right radius from Sompoh is too much damaged at its humeral articular surface for measurement. The proximal part of a left radius from Tjeleko has a humeral articular surface the anteroposterior diameter of which is 4 cm. The same measurement in *Stegodon trigonocephalus* shows the Celebes specimen to be about two-thirds its size: Coll. Dub. no. 6727, 6½ cm; Coll. Dub. no. 8814, 6 cm. In the large proximal radius fragment from Kedoeng Broeboes (Java) probably referable to *Elephas* (Coll. Dub. no. 10736) the anteroposterior diameter of the humeral articular surface is 8 cm, twice that in the Celebes radius.

The distal portion of a left radius from Tjeleko has a greatest diameter of ca. 9½ cm, again about two-thirds of that in *Stegodon trigonocephalus* (12-14½ cm), and in *Elephas maximus* (12½-14 cm).

The distal portion of a right ulna from Beroe has already been described and figured (Hooijer, 1949, pp. 215-217, pl. IX fig. 2). In the collection from Beroe there is also a small proximal fragment of a left ulna, without the olecranon and the lateral part of the humeral articular surface. The medial portion of that surface has a width of only ca. 4 cm, as opposed to 6½-9½ cm in *Stegodon trigonocephalus,* and 7½-9 cm in *Elephas maximus.*

A distal epiphysis of a left ulna from Sompoh is smaller than that of the adult ulna from Beroe; its cuneiform facet measures only 6½ cm transversely, while it is 8 cm in width in the Beroe ulna.

In the collection from Tjeleko there is the acetabular portion of a left os coxae. The branches of ischium and pubis are broken off, and only the basal part of ilium is preserved. The least width of the ilium above the acetabulum is ca. 11 cm (12-19 cm in *Stegodon trigonocephalus,* 13-17 cm in *Elephas maximus*). The diameter of the acetabulum of the Tjeleko specimen is only 8½ cm, against 12½-15 cm in *Stegodon trigonocephalus,* and 12-14 cm in *Elephas maximus.* As far as this specimen permits judgment, the expansion of the ilium is more rapid than that in *Stegodon*, and resembles that seen in *Elephas.* There is also a ramus acetabularis ossis ischii, of the left side, from Sompoh, and a fragment of the ilium, likewise from Sompoh, showing part of the iliac crest.

The distal portion of a right femur from Tjeleko is decidedly smaller than that either in *Stegodon trigonocephalus* or in *Elephas maximus* (table 48).

TABLE 48

Measurements of femur of various proboscideans (in cm)

	Archidiskodon celebensis	*Stegodon trigono-cephalus*	*Elephas maximus*
Greatest distal width	10½	18-25½	15½-20
Distal condyle width	ca. 8	16-22½	14-17½
Distal anteroposterior diameter, medial side	11	19½-25	16½-19½
Idem, lateral side	9½	15-20	14½-17

The proximal portion of a left tibia, from Sompoh, has already been described and figured (Hooijer, 1949, pp. 216-217, pl. IX figs. 3-4). There is further only the proximal portion of a right tibia, from Beroe, without the epiphysis, and, therefore, immature.

Archidiskodon planifrons (Falconer et Cautley)

Elephas planifrons Falconer and Cautley, Fauna Antiqua Sivalensis, London, 1845, pl. 2 fig. 5, pl. 6 figs. 4-6, pls.9-11, pl. 12 figs. 1-12, 13A; 1846, pl. 14 figs. 8-9, pl. 18 fig. 7, pl. 18A figs. 1-2; Owen, Odontography, London, 1845, vol. 2, pl. 147 figs. 1-2; Falconer, Pal. Mem., vol. 1, 1868, pp. 20, 68, 423, 427, 429-433, 450; Lydekker, Cat. Siw. Vert. Indian Mus., part 1, Calcutta, 1885, p. 77, Cat. Foss. Mamm. Br. Mus., part 4, London, 1886, p. 98 figs. 23-25; Pilgrim, Rec. Geol. Surv. Ind., vol. 40, 1910, p. 200, Ibid., vol. 43, 1913, pp. 294, 323.

Elephas hysudricus (pro parte) Falconer and Cautley, Fauna Antiqua Sivalensis, London, 1845, pl. 8 fig. 2.

Elephas (Loxodon) planifrons, Falconer, Pal. Mem., vol. 1, 1868, pp. 110-111, vol. 2, 1868, pp. 6, 91, 93, 94, 108.

Loxodon planifrons, Lydekker, Mem. Geol. Surv. Ind., ser. 10, vol. 1, 1880, p. 275.

Leith-Adamsia siwalikiensis Matsumoto, Jap. Journ. Geol. Geogr., vol. 5, 1927, p. 213; Dietrich, N. Jahrb. f. Min., Referate, III, 1928, p. 338.

Archidiskodon planifrons, Colbert, Trans. Amer. Phil. Soc. Philad, n.s., vol. 26, 1935, p. 33; Teilhard de Chardin and Trassaert, Pal. Sinica, ser. C, vol. 13, fasc. 1, 1937, p. 43, pl. XII fig. 3; Osborn, Proboscidea, vol. 2, New York, 1942, p. 950, figs. 831-846; Hooijer, Leidse Geol. Med., vol. 20, 1955 (in the press).

Archidiskodon cf. *planifrons*, Hopwood, Pal. Sinica, ser. C, vol. 9, fasc. 3, 1935, p. 88, pl. VIII fig. 1.

Paleoloxodon sp.,Chakravarti, Quart. Journ. Geol. Min. Met. Soc. India, vol. 9, 1937, (pp. 39-42), pl. VI.

Archidiskodon praeplanifrons Von Koenigswald, Eclogae Geol. Helv., vol. 43, 1951, p. 272, figs. 1-2; Hooijer, Zool. Med. Museum Leiden, vol. 32, no. 20, 1953, pp. 255, 227.

Elephas spec. III, Stehlin, Wet. Med. Dienst Mijnb. Ned. Indië, no. 3, 1925, p. 8, pl. II fig. 2.

"The enamel ridges on the molars of this species are intermediate in height between those of *Stegodon insignis* and those of *Euelephas hysudricus*; when worn the crowns present lozenge-shaped cross-sections of the ridges, often with detached cylinders of enamel near the median line of the tooth; the enamel is of great relative thickness, and much crenulated or crimped in the higher portions of the ridges, but inferiorly this crimping is absent; this causes a great difference in the appearance of the crown-surface of a little-worn and a much-worn tooth. The molars of the species are readily distinguished from those of the Stegodons by the cement completely filling up the intervals between the enamel ridges. The present species is further distinguished from all other species of elephants, both recent and fossil, as far as is at present known, by having been furnished with two pairs of premolars in both upper and lower jaws, in which respect it agrees with many species of *Mastodon*" (Lydekker, 1880, p. 275).

The above quoted diagnosis given by Lydekker seventy-five years ago still holds good as far as it goes; we might only add that *planifrons* molars can be distinguished from those of *Stegodon* by having V-shaped valleys, open down to the bottom, whereas *Stegodon* has Y-shaped valleys, closed in at the bottom. Consequently the enamel figures do not approach each other as closely in advanced stages of wear in *Archidiskodon* as they do in *Stegodon*.

The oldest occurrence of this species in Asia is in the Tatrot zone, basal Upper Siwaliks and basal Pleistocene, as first recorded by Lewis (1937, p. 198). The molar from the Tatrot zone on which Lewis based his statement as to the occurrence of *Archidiskodon* in the Tatrot zone was recently described and figured (Hooijer, 1955). Further material of *Archidiskodon* in the Lewis collection from the Upper Siwaliks will be described below.

The American Museum collection studied by Osborn (1942, pp. 950-960) has increased our knowledge of the individual variation of the molars of *A. planifrons*, a variation that is attributed partly to male or female sex, and partly to progressive evolution or to ascending mutations ranging into higher geologic levels. We lack, however, stratigraphic control on these fossils.

The occurrence of *A. planifrons*-like molars in the Early Pleistocene of Europe and Africa has already been discussed in previous papers (Hooijer, 1953d, 1955). It seems that on the three continents, Europe, Asia, and Africa, there has been independent, contemporaneous progression from the *Archidiskodon planifrons* stage into forms with an increased number of plates and higher crowns. According to Osborn (1942, p. 934) the archidiskodonts migrated to the hospitable plains of North America, and culminated in *Archidiskodon imperator* (Leidy).

A new fact might have occupied a central position in the Osbornian conception of the origin, migration, and evolution of *Archidiskodon*, had it been known in time. This is the existence, in the Pleistocene of Celebes, of a pygmy species of *Archidiskodon*, in almost every way a fifty per cent scale reduction of *A. planifrons*, sharing with this species the development of premolars, but definitely more primitive than *A. planifrons* in being occasionally furnished with lower incisive tusks. *Archidiskodon celebensis* Hooijer (1949, 1953a, 1953c, 1954b) is the most primitive species of its genus known at present (see this paper, pp. 89-92).

There is material referable to the present species in the Dubois collection, both from Java and from the Punjab, as well as in the Lewis collection, made during the Yale North India Expedition in 1932. This material, which belongs to the Peabody Museum of Yale University, New Haven, Conn., U.S.A., has been kindly sent to me for study by Dr. J. T. Gregory. The material from Java will be described first.

Among the *Stegodon* material in the Dubois collection from Java there are a few specimens of *Archidiskodon planifrons*:

Coll. Dub. nos. 3381 and 3413, 500 m N.W. of Karang Djati (pl. XI figs. 1, 2, 4, 6). Right and left DM_4. Both milk molars are worn to the hindmost plate, and are incomplete anteriorly; of the right DM_4 five, of the left, four plates remain. The large posterior talonids have four, and five conelets, respectively, hardly worn. The hindmost plate of the left DM_4 shows four conelets, not yet worn out; the two in the centre are separated from the buccal and the lingual conelets by clefts. The median portions of the enamel figures of the plates are expanded; the enamel is slightly crimped and rather thick for so small a tooth. The valleys are V-shaped: there is cement all the way down to the bottom, as seen in the broken front plates. Although the expansions of the plates obstruct the valleys in the median line, the lingual and buccal parts of the valleys remain open. Measurements are presented in table 49.

The measurements of two DM_4s of *A. planifrons* are on record, viz., those of a British Museum specimen (Falconer and Cautley, 1845, pl. 12 figs. 8, 8a; Falconer, 1868I, p. 433), and those of an American Museum specimen (Osborn, 1942, p. 954, fig. 837). Lydekker (1880, p. 276) mentions two DM_4s in the Indian Museum, but does not state the measurements.

TABLE 49

Measurements of DM_4 of *Archidiskodon planifrons*

	Coll. Dub. no. 3381	Coll. Dub. no. 3413	Brit. Mus.	Amer. Mus.
Length	—	—	113	121
Width	57	56	61	63
Laminar frequency	7	7	7	6½

The laminar frequencies of the Javanese specimens agree well with those from the Siwaliks; the widths, however, are slightly less. It should be noted, however, that in *Archidiskodon meridionalis* the width of DM_4 varies even from 43 to 71 mm (Adams, 1877-81, p. 190). The laminar frequency in the latter species varies from 6½ to 8, with an average of 7½.

Coll. Dub. no. 2383, Tritik (pl. XI figs. 3, 5). This fragment comprises three plates of a left DM^4, the hindmost unworn. The enamel figure of the anterior plate shows the median enamel loops, forming expansions in the median line which are so characteristic of the present species. The middle plate exhibits six conelets; the hindmost plate five, of which the buccal is on a lower level than the others. The two central conelets are separated from those buccally and lingually by clefts, thereby showing the same elephantine build as the hindmost plate of the left DM_4 mentioned above. The present specimen belongs to the upper jaw as its plates diverge crownward.

Again, the measurements of only two specimens of DM^4 of *A. planifrons* are on record, viz., those of a British Museum specimen (Falconer and Cautley, 1845, pl. 6 figs. 4-5; Falconer, 1868I, p. 427), and those of a specimen from Tjidjoelang, Java, given by Von Koenigswald (1951, p. 270, figs. 1a, 1b).

TABLE 50

Measurements of DM^4 of *Archidiskodon planifrons*

	Coll. Dub. no. 2383	Brit. Mus.	Java (Tjidjoelang)
Length	—	102	112
Width	57	61	54
Height	45	35	ca. 30
Height-width index	79	57	ca. 56

Table 50 shows that, while in width the Dubois collection specimen is intermediate between the DM^4s from the Siwaliks and Java respectively, in height it exceeds both. This discrepancy might well be due to the fact that both in the British Museum specimen and in that from Java the height was taken at the hindmost plate, the only unworn plate (Von Koenigswald, 1951, p. 270). The last plate is commonly lower than the full plates. Incidentally, it will be observed than the Java DM^4 recorded by Von Koenigswald agrees perfectly with that of the Siwaliks in this respect. Von Koenigswald, who referred the Tjidjoelang DM^4 to a new species, *A. praeplanifrons,* did so on the ground of the supposed association of this milk molar with a large premolar, which latter he identified as P^3. Since there is no proof that the two specimens are from one and the same individual, and the Javanese premolar as such fits in well with the dentition of *A. planifrons* as a P^4, there is no need for the erection of a new species of *Archidiskodon* for the Tjidjoelang fauna of Java (cf. Hooijer, 1953c, pp. 225 and 227). It is interesting to note that the DM^4 of *Archidiskodon celebensis* (Hooijer, l.c., p. 225) has a height-width index of ca. 78, very similar to that of the Dubois collection specimen of DM^4 of *A. planifrons.*

Two specimens of *A. meridionalis* DM^4 recorded by Weithofer (1890, p. 151), one 54 mm wide and 63 mm high, and the other 62 mm wide and 45 mm high, have height-width indices of 117 and 73, respectively, which shows that *A. meridionalis* varies between wider limits than shown above in three specimens of *A. planifrons.*

In the Dubois collection specimen of DM^4 from Java, three plates and three cement intervals occupy an anteroposterior length of 48 mm, which gives a laminar frequency of 6. The same figure holds for the Javanese DM^4 figured by Von Koenigswald (1951, fig. 1a), while the Siwalik specimen has a laminar frequency of ca. 6½. In *A. meridionalis* the laminar frequency of DM^4 is about 7 (Weithofer, l.c.), but may even be 8 (Adams, 1877-81, p. 190, pl. XVII fig. 8).

The prize specimen in the Dubois collection from the Upper Siwaliks of the Punjab is a skull of *Archidiskodon planifrons,* collected at Naliwala on the Somb Nuddy opposite Haripoor, Sirmur State (Coll. Dub. no. 4963; pl. XII figs. 1-2). It lacks most of the right half of the occiput, as well as the right parietal behind the temporal contraction, which, however, are preserved on the left side, where only the zygomatic arch is lost. The right occipital condyle is missing, but the glenoid fossa of the squamosal is preserved on either side. The pterygoids are incomplete, but on the palate most of the last molars can be seen.

The molars are much worn down, and show the enamel figures of the posterior six plates, all worn to single figures with the characteristic median expansions except for the penultimate plate, which shows two figures separated by a median cleft. The last plate shows four conelets; the talon, two; it is preserved in the right M^3 only. In front of the sixth plate from behind the crown surface is worn flat and consists entirely of dentine; the plate formula, therefore, cannot be determined. The length of the crown, as far as preserved, is 170 mm; the width at the fourth plate from behind (the sides of the molars are broken more to the front) is 76 mm. The laminar frequency of the molars is 5½, which is rather high, but they certainly are the last molars as there is no trace of molars behind.

The premaxillaries are not complete; the right is broken off 12 cm in front of the infraorbital foramen, and the left, 9 cm. The tusk alveoli are filled with matrix; their diameters are only 6 cm transversely, and 5 cm vertically at the broken ends of the premaxillaries. In contradistinction to what we find in stegodonts, the tusks are well separated; the interval between them is not less than 11½ cm (only 5 cm in a *Stegodon* skull with tusks of the same size: Coll. Dub. no. 4977). The interalveolar fossa is correspondingly wide, and has a broad, flat bottom, 5½ cm deep at most. Behind it flattens out between the orbits. The posterior eminences of the premaxillaries, just in front of the nasal opening, are slightly developed; at this level the skull surface is much depressed.

The infraorbital foramina are small, only 3 cm in diameter. The zygomatic processes of the maxillaries are heavy, and spring out abruptly from the surface of the cheek, much more so than in an *Elephas* or *Stegodon* skull its size. The transverse width of the zygomatic process of the maxillary, from the inner border of the infraorbital foramen to the anterior border of the orbit, is not less than 12 cm. As the width between the inner borders of the infraorbital foramina is only 25 cm, the skull is twice as broad at the anterior borders of the orbits as it is just below the orbits. A bone projection at the middle of the height of the anterior border of the orbit represents the tiny lacrimal.

The superior borders of the orbits are raised above the interorbital surface, which is concave from side to side. In the median line, the upper surface of the skull is 7 cm below the line connecting the supraorbital rims. The postorbital process of the frontal is very prominent laterally (that on the right side is incomplete), making the skull much broader (about one-third) at the posterior than at the anterior borders of the orbits. The marked lateral projection of the orbits constitutes a significant difference between this *Archidiskodon* skull and one of *Elephas* or *Stegodon.*

The nasal opening is curiously small for so broad a skull; it is much less wide than the premaxillaries (see measurements in table 51), and is placed rather high up on the skull, with its anterior border just behind the line connecting the posterior borders of the orbits. It is very narrow anteroposteriorly (less than one-third of its width), and its posterior border is much higher than that in front: the skull surface in front of the anterior nares is concave, that just behind, slightly convex transversely. The anterior median nasal tips are well developed, with a length of 4 cm, and a width at base of ca. 8 cm. They project slightly downward rather than upward as in *Elephas.*

The fronto-parietal surface of the skull is very flat both anteroposteriorly and transversely between the temporal fossae. The fronto-parietal crests converge rather strongly behind the very prominent postorbital processes to a level 12 cm behind the nasal opening, half-way between the nasal opening and the supraoccipital crest, where the least width between the temporal fossae is only one-half the postorbital width. Behind this constriction the crests on the parietals become less well defined as they diverge posteriorly, forming the hinder margins of the temporal fossae. The parietal surface remains flat in its middle part up to the supraoccipital crest, which is indented in the median line.

The occiput is very low, only three-fifths its greatest width, with a hollow for the nuchal ligament commencing 8 cm above the foramen magnum, 10 cm wide, and about 6 cm deep. On either side the exoccipitals are swollen, although by no means as much so as those in *Elephas maximus*. The foramen magnum measures about 7 cm transversely, and 5 cm vertically. The condyle is 8 cm long.

TABLE 51

Skull measurements (in cm) of *Archidiskodon planifrons*

	Falconer and Cautley, 1845, pls. 9-10	Coll. Dub. no. 4963
Length from middle of occipital crest to tip of nasals	28	28
From occiput to anterior margin of orbits	53	51
Width of occiput	55	52
Temporal contraction	36	34
Postorbital width	ca. 69	66
Width at anterior borders of orbits	ca. 51	49
Width of premaxillaries at level of infra-orbital foramina	32	30
Height from palate to vertex	ca. 55	54
Height of occiput (from basion)	35	31
Anterior nares, width	22	21
Anteroposterior diameter of idem	7	6
Depth from surface of molar to brow at contraction between temporal fossae	ca. 55 [1]	51
Orbit, anteroposterior diameter	11½	12
Transverse diameter of idem	11½	—

In all its peculiar characters, such as the small and widely spaced tusks, the small infraorbital foramina, the sudden expansion of the skull at the orbits, the transverse concavity of the interorbital surface, the small size of the anterior nares, and their position just behind the very prominent postorbital processes, the flatness of the fronto-parietal surface between the temporal fossae, and the low and slightly expanded occiput (the width of which is less than the postorbital width), the present Naliwala skull agrees perfectly with the skull of *Archidiskodon planifrons* figured by Falconer and Cautley (1845, pls. 9-10). As is evident from the measurements in table 51 the skull collected by Dubois is only a trifle smaller than that figured in the Fauna Antiqua Sivalensis; the resemblance, indeed, could hardly have been closer.

Coll. Dub. no. 3071, Naliwala on the Somb Nuddy opposite Haripoor,

1) Falconer (1868 I, p. 430) gives this depth as 40 cm (16 in.), but it is evident from the figure (Falconer and Cautley, 1845, pl. 10 fig. 1) that it is about 55 cm, the same as the length from the occiput to the anterior margin of the orbit.

Sirmur State, Punjab (pl. XIII fig. 4). A right ramus of the mandible with M_2 in situ. This is a fine specimen; the antero-buccal corner only is damaged. There are ten plates, all worn; the last plate is quite small, but there is a "heel" behind it, hidden below the cement. Behind and below the molar there is the (empty) alveolus for M_3. The ramus is broken off a few cm behind M_2, and the symphysial part is not preserved either. There are three small mental foramina below the anterior part of the molar. The tenth plate is seen only as a central enamel ring; plate 9 has four conelets, the two in the middle with a tendency to subdivide; plate 8 has five conelets, three small ones in the centre, and the buccal and lingual elongated transversely. In plates 7 and 6 from the front the buccal and lingual enamel figures become more elongated transversely, and the central figures, single, are expanded backward. The enamel figures are entire in plates 5, 4, 3, and 2 from the front, with median expansions both to the front and behind, in the manner so characteristic of the present species (cf. Falconer and Cautley, 1845, pls. 11-12). The anterior plate and talonid are only partially preserved; their buccal halves are gone. Cement is abundant, both in the valleys and on the buccal and lingual surfaces of the molar. The measurements of this and of the following specimens of M_2 of *Archidiskodon planifrons* are presented in table 52.

Coll. Dub. no. 3046, around Haripoor, Punjab (pl. X fig. 3). M_2 dext. in situ in a ramus fragment. Seven plates are preserved; the anterior end broken off. Between the second and third plates from behind is an extra half-plate that extends from the lingual border only to the median line of the crown. The posterior talonid is low and partially embedded in cement. The first plate from behind has five, the second, six conelets. The third plate from behind has two transversely elongated enamel figures between which there is the central figure, with two small posterior lobes. The remaining four plates have enamel figures continuous from side to side, each with pointed median expansions both anteriorly and posteriorly; the enamel is slightly crimped. As in the preceding specimen, there is cement all around the crown. The laminar frequency is lower than that of the Naliwala M_2 (table 52).

Coll. Dub. no. 3094, around Haripoor, Punjab. Right mandibular ramus with M_2. The molar is so large that I would have classed it as M_3 were it not that in the broken surface of the ramus behind the molar there are remains of yet another molar, deeply buried in the bone. The anterior part of the crown has crumbled away, but the outline of the crown is very clearly shown in the mandible. The crown is somewhat constricted at the level of the third plate from the front, at the point of junction of the anterior and the main root. The fourth plate from the front is the first preserved up to the occlusal surface; like in the two plates behind it, its enamel figure is slightly crimped, continuous from side to side, and expanded in the median line. In plates 7 and 8 from the front the buccal and lingual conelets have not yet joined the central figure, which is expanded in its centre. Plates 9 and 10 have five conelets each, while plate 11 may have four conelets only; it is partially covered by cement, and so is the hind talonid, a rather small affair as the crown is rounded off behind. The cement coat, several mm thick, covers up the lingual and buccal surfaces of all the plates.

The ramus is higher at the outer alveolar border than that in Coll. Dub. nos. 3071 and 3046, and the present M_2 is wider, too, but in laminar frequency the M_2 in Coll. Dub. no. 3094 is intermediate between the two preceding specimens (table 52).

Yale Peabody Museum no. 14567, Yale North India Expedition loc. no. 50 [1]), Punjab (Survey of India Map no. $53\frac{B}{13}$, B-3), coll. G. E. Lewis, September 17, 1932 (pl. XIII fig. 1). Left ramus of the mandible with M_2. The molar is interesting as it tapers markedly posteriorly; yet there can be no doubt as to its serial position. The anterior talonid and part of the first plate, as well as part of the posterior talonid are lost, but for the rest the molar is perfect. The enamel figures of the third and fourth plates from the front have long median posterior enamel lobes, extending across the valleys. Plates 5 to 8 inclusive present tripartite figures, the central being the smallest in plate 5, but the largest in plates 7 and 8 from the front. Plate 9 is barely touched by wear, and is rather narrow as the plates begin to diminish in transverse diameters from plate 7 on backward. Plate 10 is low; like the posterior talonid it is enclosed in the crown cement that extends all along the buccal and lingual surfaces of the crown and covers the bases of the plates.

Yale Peabody Museum no. 14565, Yale North India Expedition loc. no. 47 B, Punjab (Survey of India Map no. $53\frac{B}{13}$, B-3), coll. G. E. Lewis, September 17, 1932. This number comprises two fragments of lower molars, holding four plates each, with the characteristic tripartite or centrally expanded enamel figures of *Archidiskodon planifrons*. The width (70-73 mm)

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1) Dr. G. E. Lewis's localities 47-51 are close together, about 3 miles S. W. of Pinjaur (lat. 30° 47′ N., long. 76° 53′ E.). In Fieldnotes (Sept. 17, 1933, p. 92) Dr. Lewis wrote: "All these specimens (nos. 47-54) I tentatively judge to be of Pinjor age; they occur at practically the same level — without more than 150′ variation — some 200′-300′ below the first Boulder Conglomerate above them" (information kindly supplied by Dr. J. T. Gregory, in litt., May 31, 1955).

TABLE 52

Measurements of M_2 of *Archidiskodon planifrons*

	Coll. Dub. nos. 3071	3046	3094	Y.P.M. 14567	Osborn, 1942, pp. 949, 954		
Length	205	—	261	ca. 220	204	178	—
Width	76	83	94	76	71	95	90+
Width-length index	37	—	36	ca. 35	35	53	—
Laminar frequency	5	4	4½	5	5	—	ca. 4
Height of ramus	140	142	166	146	—	—	—

and the rather high laminar frequency (about 7) point to DM_4 or M_1.

Yale Peabody Museum no. 14568, Yale North India Expedition loc. no. 51, Punjab (Survey of India Map no. $53\frac{B}{13}$, B-3), coll. G. E. Lewis, September 17, 1932 (pl. X fig. 2). Left mandibular ramus with posterior portion of M_3. Five plates are shown on the occlusal surface as far as preserved; the hindmost with four, the penultimate with five conelets, worn to enamel rings. The three plates in front show enamel figures continuous from side to side, with weak median dilatations. The plates are widely spaced; the cement-filled valleys are much wider anteroposteriorly than are the enamel figures, and the laminar frequency is 3½-4. The greatest width of the M_3 is 100 mm. The anterior wall of the alveolus for the main root of the molar is preserved, showing that the main root supported seven plates in all. The front part of the crown, supported by the anterior root, probably bore three more plates (cf. Falconer and Cautley, 1845, pl. 12; Osborn, 1942, p. 959 fig. 845), which would make for a total of ten plates, unless the long, cement-coated heel of the molar contains one or two additional plates, in which case the plate formula is x11x or x12x.

In its great width and low laminar frequency the present molar closely resembles the M_3s listed by Osborn (1942, pp. 949, 954).

The lower surface of the ramus is swollen, and shows two pathological perforations, placed below the posterior margin of the molar. This inflammatory thickening of the lower surface of the ramus probably set in as alveolar ostitis, an interesting case of palaeopathology.

Yale Peabody Museum no. 14566, Yale North India Expedition loc. no. 49, Punjab (Survey of India Map no. $53\frac{B}{13}$, B-3), coll. G. E. Lewis, September 17, 1932. Fragment of right maxillary with M^2. The anterior part of the molar is worn flat; there are eight plate figures, well spaced, slightly crimped, and expanded anteroposteriorly in their centres, over one-fifth of their width. The posterior plate has nine conelets, partially fused. The greatest width of the molar is 91 mm, and the laminar frequency is

4½. Behind the molar the maxillary is broken off along the anterior wall of a large alveolus, the alveolus for the last molar, which is not preserved.

Yale Peabody Museum no. 13826, Yale North India Expedition loc. no. 47, Punjab (Survey of India Map no. $53\frac{B}{13}$, B-3), coll. G. E. Lewis, September 17, 1932. A detached left upper molar, M^3 sin. This specimen, incomplete anteriorly, carries eleven plates, and gradually diminishes in width from the fourth plate on backward. As M^2 in *Archidiskodon planifrons* has nine plates at most, and as, moreover, the shape of the crown is typical of a last molar, the present specimen would seem to represent M^3. It is, however, clearly more progressive than the last upper molar in the Yale Peabody Museum collection previously described (Hooijer, 1955) in its higher laminar frequency, which is nearly 5½. The typical laminar frequency for *A. planifrons* last molars is 3-4 (see Hooijer, 1953d, pp. 196-198). Osborn has, however, recorded last upper molars of *Archidiskodon planifrons* with laminar frequencies of 5½ and even 5½-6 (Osborn, 1942, p. 954); such specimens he considers attributable to progressive evolution or to ascending mutations ranging into higher geologic levels. Lewis's specimens are Upper Siwalik, probably Pinjor zone, as were the specimens collected by Barnum Brown and recorded by Osborn (l.c., pp. 950-960). It is of interest to note that the M^3 collected by Lewis in the Tatrot zone, basal Upper Siwaliks, below the Pinjor zone, fully described elsewhere (Hooijer, 1955), has a laminar frequency of about 4, and thus belongs to the primitive stage of *A. planifrons*.

The present specimen is characterized by its thick enamel (4 mm), and the expanded central portions of the enamel figures. The posterior plates have either five or six conelets; of the last plate only the central conelet is seen above the cement. The greatest width, in the front part of the crown, is 89 mm. Height measurements cannot be given.

Coll. Dub. no. 3106, around Haripoor, Punjab. This is a detached right upper last molar, with six worn and five unworn plates. One or two plates are missing in front. It is of the same progressive type as Yale Peabody Museum no. 13826 just recorded, having a laminar frequency of nearly 5. The unworn plates increase in width and height from the posterior plate to the fifth plate from behind, and they carry five or six conelets each. In plates 6 and 7 from behind, slightly worn, there are five conelets, but in plates 8 and 9 there is a median cleft, with two partially fused conelets on either side. Between plates 10 and 11, with single enamel figures, there is an accessory pillar at the buccal entrance to the valley. The anterior end of the crown is broken. There is a coat of cement all around the crown.

TABLE 53

Measurements of M^3 of *Archidiskodon planifrons* (Coll. Dub. no. 3106)

No. of plate from behind	5	4	3	2	1	talon
Basal width	91	87	84	73	58	48
Total height	88	87	82	74	61	42

As will be seen from table 53 the unworn plates of this specimen are very nearly as high as wide, as is characteristic of the present species.

In 1937 Chakravarti described at some length a fragment of an upper molar originating from Parkalta near Jammu as *Palaeoloxodon* spec. This find is recorded in Osborn (1942, pp. 1188 and 1418) but has not been commented upon. Since the specimen evidently is incorrectly identified I wish to discuss it here.

Although Chakravarti made comparisons with various types of proboscideans, he failed to recognize the affinities of this specimen with *Archidiskodon planifrons*, which he dismissed as follows: "It differs from *Archidiskodon planifrons* in that the crests are not arcuate or arched transversely, they do not show any indication of being subdivided into conelets, and that the worn enamel crests present a different pattern" (Chakravarti, 1937b, p. 41). A glance at Chakravarti's illustrations (l.c., pl. VI), however, reveals that the first two arguments are irrelevant, and that the third argument is incorrect. The Parkalta fragment is so much worn down that the enamel figures are continuous from side to side, and hence could not possibly show either the transversely arched plates or the individual conelets any more. The median expansions of the enamel figures of the fragment from Parkalta, some pointed (as in Coll. Dub. no. 3046: pl. X fig. 3), and some more rounded (as in Coll. Dub. no. 3071: pl. XIII fig. 4) are exactly those that characterize *Archidiskodon planifrons* molars. There are various examples of molars worn down to the same degree, with the same median expansions of the plate figures, in the atlas by Falconer and Cautley (1845, pl. 11 figs. 1, 4, 5, and 7; pl. 12 fig. 5). In his description Chakravarti points out a number of characters, the great width (110 mm), thick enamel (4-5 mm), low laminar frequency (the anteroposterior width of one plate is given as 28 mm, which makes for a laminar frequency of just over 3½), and the plentiful cement. This upper molar represents an M^3 of *Archidiskodon planifrons*, of a primitive stage such as that from the Tatrot zone described at an earlier occasion (Hooijer, 1955).

Stegoloxodon indonesicus Kretzoi species inquirenda

Archidiskodon planifrons Van der Maarel, Wet. Med. Dienst Mijnb. Ned. Indië, no. 15, 1932, p. 173, pl. XVII figs. 1-2.

?*Archidiskodon planifrons* Van der Maarel, Wet. Med. Dienst Mijnb. Ned. Indië, no. 15, 1932, p. 176, pl. XV figs. 5-6.

Palaeoloxodon, Osborn, Proboscidea, vol. 1, New York, 1936, pp. 365 and 787.

Palaeoloxodon, Dietrich, Palaeontographica, vol. 94 A, 1942, p. 83.

Stegoloxodon indonesicus Kretzoi, Földtani Közlöny, vol. 80, 1950, p. 405.

The present new generic and specific name has been introduced by Kretzoi (1950) for an upper molar from Tji Pangglosoran, Java, described and figured by Van der Maarel (1932, p. 173, pl. XVII figs. 1-2) as a left M^1 of *Archidiskodon planifrons*. To the same species Van der Maarel (l.c., p. 176, pl. XV figs. 5-6) provisionally refers a smaller, lower molar from Kali Bioek. Van der Maarel's identifications have been doubted at by Osborn (1936, pp. 365 and 787) as well as Dietrich (1942, p. 83), who believe the specimens to represent a primitive *Palaeoloxodon*. The last mentioned author adds that Van der Maarel's specimens indicate that *Archidiskodon planifrons* may have given rise to primitive palaeoloxodonts in the Far East, but leaves it at that. Kretzoi goes much further, and claims the Tji Pangglosoran molar to represent an ancestral *Loxodonta*. In his own words (Kretzoi, 1950) "It is separable from all known fossil forms of the *Palaeoloxodon*-group by decidedly more rhomboidal ridgeplates, comparable only with *Loxodonta* (representing a very advanced stage; teeth hypsodont, angusticoronat, endioganal, median sinus extremely expanded). This very primitive type shows all the characters, evolved in *Loxodonta*, in well marked, but deep stage".

In view of the interest taken in the fossil Java specimens by the above quoted authors it is certainly worth while to examine them closely, in an attempt to settle their probable relationships. Fortunately, Van der Maarel has not only described, but also excellently figured his specimens, which facilitates their comparison with other fossil types.

To begin with, it is clear that the supposed left M^1 from Tji Pangglosoran in reality is of the right side: in this upper molar the concave side is the lingual side, not the buccal, and the anterior talon is placed buccally, not lingually. However, as Van der Maarel correctly observed, the present molar resembles *Archidiskodon planifrons* in the small relative height of the plates, the presence of median expansions to the plate figures, and the thick enamel. With a formula of x7x, a length of 125 mm, and a greatest width of 54 mm (Van der Maarel, l.c., p. 175), the Tji Pangglosoran molar is narrower than the M^1s of *A. planifrons* on record, which vary in width from 69 to 90 mm (Osborn, 1942, pp. 949 and 954). The laminar frequency of the Java M^1 can be calculated as 6½, which is rather high as in the specimens listed by Osborn (l.c.) the laminar frequencies vary from 3½ to 4½ only. The last mentioned difference is not as significant as it might seem, for Osborn (l.c.) also lists an M^3 of *A. planifrons* with a laminar frequency of 5½-6, and the laminar frequency is normally higher in M^1 than in M^3. The molars of *A. planifrons* are very variable in width, too, and it seems doubtful whether the difference in width could not be accounted for by individual variation. In the absence of other distinguishing characters a difference of this kind, to my judgment, would not justify a specific, let alone a generic differentiation of the Tji Pangglosoran M^1 from *Archidiskodon planifrons*. What seems to have induced Osborn, Dietrich, and Kretzoi to disagree with Van der Maarel's identification are the shapes of the enamel figures of the plates; in the slightly worn posterior plates the figures of the buccal and lingual conelets are smaller than those of the central conelets (lat. an. med. lam.; Dietrich, l.c., p. 83), and in the more worn plates the median sinus is much expanded. Neither of these characters militate against the identity of the Java molar with *Archidiskodon planifrons,* however. Although in most cases the plates of the molars of the latter species are worn thus, that the buccal and lingual conelets present wider enamel figures than those placed in the centre (lat. lam. med. an.), a structure more or less reminiscent of the mastodonts with their large buccal and lingual cones, the more elephantine division into a large central and smaller lateral enamel figures also occurs (cf. Falconer and Cautley, 1845, pl. 12 fig. 5a, and Osborn, 1942, p. 956, fig. 832). The median expansions of the full plate figures (cf. Falconer and Cautley, 1845, pl. 11 figs. 1, 4, and 5; 1846, pl. 14 figs. 8-9) are highly characteristic of early archidiskodonts. Two of the Siwalik specimens just referred to, viz., those of pl. 11 fig. 4, and pl. 14 fig. 8 of Falconer and Cautley (1845-1846) were taken by Matsumoto (1927b) to represent a new genus and species, *Leithadamsia siwalikiensis,* a form supposed to stand at the starting point of the entire "phylum" of the loxodontine elephants. This has been accepted neither by Dietrich (1928) nor by Osborn (1942, p. 1291), and *Leithadamsia siwalikiensis* can, therefore, be regelated to *Archidiskodon planifrons.* It is interesting to note that the two specimens selected by Matsumoto are rather narrow-crowned, as is Van der Maarel's specimen, and that both Matsumoto and Kretzoi regarded their specimens as ancestral to *Loxodonta.*

We have also to consider the second specimen referred, although with a query, to *Archidiskodon planifrons* by Van der Maarel (1932, p. 176, pl. XV figs. 5-6) as a left DM_4. It is rolled, and some of the anterior plates are so much worn down that the plate formula cannot be given, although there probably were seven plates, plus the talonids. The length is given as 104 mm, the greatest width as 46 mm. The width must originally have been some mm greater, as the greater part of the cement covering the inner and outer edges of the plates is lost (cf. Van der Maarel, l.c., p. 184), but nevertheless it is rather small when compared with the DM_4s of *Archidiskodon planifrons* discussed in the present paper (table 49), which are 56 mm wide at least. The laminar frequency of Van der Maarel's specimen is 7½, which is rather high with a view to the fact that the molar is much worn down; in a lower molar the plates diverge rootward, and the laminar frequency of the occlusal surface consequently becomes lower with advancing wear. Again, do these differences warrant a generic distinction? In my opinion they do not.

Van der Maarel (1932, p. 184) also considered the possibility that the Kali Bioek DM_4 belonged to *Elephas hysudricus*, but found the DM_4 of that species to be much larger (a specimen figured by Falconer and Cautley, 1845, pl. 7 fig. 8, measures 140 by 56 mm; another specimen that is but slightly shorter and wider (137 by 58 mm), figured by Falconer and Cautley, 1845, pl. 8 fig. 4; 1846, pl. 13A fig. 7 (cf. Falconer, 1868 I, p. 429), is considered an M_1 by Lydekker (1880, p. 279) as well as by Osborn (1942, p. 1343), although questionably). Moreover, these specimens have nine or ten plates, whereas the Kali Bioek specimen apparently had seven only. The DM_3 of *Elephas hysudricus* has seven plates but is smaller than the Kali Bioek specimen (length 74-79 mm, width 38-41 mm; Osborn, 1942, pp. 1343 and 1348). The DM_3 of *Archidiskodon planifrons* is smaller still (61 by 36 mm; Osborn, 1942, p. 949), and has only six plates. The Kali Bioek specimen evidently has the closest resemblance to the DM_4 of *Archidiskodon planifrons*, with which it agrees in plate formula, thick and slightly crimped enamel, median anterior expansions of the plate figures, and relatively low plates; the last plate in Van der Maarel's specimen does not exceed 42 mm in height (width 46 mm). In the pair of DM_4s of *Archidiskodon planifrons* from Java discussed above (Coll. Dub. nos. 3381 and 3413), which resemble Van der Maarel's specimen very closely (cf. Van der Maarel, 1932, pl. XV fig. 5 with figures 1 and 6 on pl. XI) except in their greater width, the last plate is 38 mm high in its slightly worn state, and could not have exceeded 45 mm in height when unworn.

In conclusion, I would consider the obvious resemblance of the Tji Pangglosoran and the Kali Bioek specimens to *Archidiskodon planifrons* to be more significant than the differences, viz., the lesser width and higher laminar frequency. Elephantine molars are liable to much individual variation in width as well as in laminar frequency, a variation that increases the greater the number of specimens known. It is evidently going too far to base a new genus and species of proboscideans on these specimens. Less drastically, they could be interpreted provisionally as representing a narrow-crowned variety of *Archidiskodon planifrons*, or even left without a specific designation for the present, as Dietrich (1942, p. 83) advised to do. Since the specimens have received a name, they might be allowed to stand as such for the time being, but I am fairly certain that further material of *Archidiskodon planifrons* from Java will remove all doubt in this matter, and prove that they are not really separable from that species.

Genus ELEPHAS Linnaeus

Elephas hysudricus Falconer et Cautley

Elephas hysudricus Falconer and Cautley, Fauna Antiqua Sivalensis, London, 1845, pl. 1 fig. 3, pls. 4-5, pl. 6 figs. 1-3, pl. 7, pl. 8 figs. 1, 3-4, pl. 12B fig. 4, pl. 12C fig. 6; 1846, pl. 13A fig. 7, pl. 13B fig. 7; Falconer, Pal. Mem., vol. 1, 1868, pp. 20, 77, 112, 422, 425-426, 428-429, 437-438, 440; Lydekker, Cat. Siw. Vert. Indian Mus., part 1, Calcutta, 1885, p. 74, Cat. Foss. Mamm. Br. Mus., part 4, London, 1886, p. 116; Pilgrim, Rec. Geol. Surv. Ind., vol. 40, 1910, p. 200, Ibid., vol. 43, 1913, p. 324.

Elephas planifrons (pro parte) Falconer and Cautley, Fauna Antiqua Sivalensis, London, 1845, pl. 12 fig. 13.

Euelephas hysudricus, Lydekker, Mem. Geol. Surv. Ind., ser. 10, vol. 1, 1880, p. 278.

Hypselephas hysudricus, Colbert, Trans. Amer. Phil. Soc. Philad., n.s., vol. 26, 1935, p. 33; Osborn, Proboscidea, vol. 2, New York, 1942, p. 1340, figs. 1198-1203, 1206, 1210-1215.

non *Hypselephas hysudricus*, Colbert, Bull. Amer. Mus. Nat. Hist., vol. 74, 1938, p. 415, fig. 60.

?*Hypselephas hysudricus*, Colbert, Trans. Amer. Phil. Soc. Philad., n.s., vol. 32, 1943, pp. 405, 421, pls. XIX fig. 3, XXIV-XXVI, XXXII.

The present species is similar to *Elephas maximus* L. in cranial characters, differing mainly in its more vaulted vertex, deeply concave frontals, and lower position of the orbit. The number of molar plates is somewhat less in the fossil species than in the homologous molars of the living Asiatic elephant, and, above all, the height of the plates is less in the fossil than in the living species. As Lydekker (1880, p. 280) wrote: "The height of the ridges of the molars of this species is much less than in the Indian elephant: the height of the eighth ridge of the last upper molar of the former species averaging about 5½ inches" (140 mm) "and in the latter upwards of 8 inches" (203 mm) "the plates of the one are also much thicker than those of the other". Osborn (1942, p. 1340), who described a wealth of new material collected by Barnum Brown in the

Upper Siwaliks of the Simla Foothills, Punjab, states: "Molar crowns low; ridge-plates convexo-concave, reversed above and below, rudimentary "loxodont sinus". Ridge-plate formula: M3 $\frac{18+}{17\text{-}18\text{-}19}$". In giving this formula Osborn does not take into account that Lydekker had given lower figures for M^3: "In two crania in the Indian Museum, in which the last true molar is in use, the tooth in one instance has thirteen ridges and talons, and in the other seventeen ridges" (Lydekker, 1880, p. 279).

In 1938 Colbert first recorded *Elephas hysudricus* from the Upper Irrawaddy beds of Burma, of Lower Pleistocene age. Until then, this species was not known to occur beyond the Siwalik Hills (Pinjor zone) and adjacent regions. It seems to me that the molars from the Upper Irrawaddies identified by Colbert (1938, pp. 415-417) as *Elephas hysudricus* are too hypsodont to be referred to the present species: the height of M^3 is given by Colbert (l.c., p. 417) as 212, and 178 mm respectively, while in Falconer's series as well as in that described by Osborn M^3 is only 137 to 138 mm high at most (Osborn, 1942, pp. 1343 and 1348). The great height of the upper last molars from the Upper Irrawaddy beds suggests *Elephas maximus* L. or *Palaeoloxodon namadicus* (Falconer et Cautley) rather than the comparatively low-crowned species now under discussion. On the other hand, the number of plates in M^3 (given by Colbert as 13) is too low for this molar to be referred either to *E. maximus* or to *P. namadicus*. Without examination of the original specimens from Burma I can only signalize the fact that they do not appear to belong to *E. hysudricus*. The material subsequently recorded by Colbert (1943, pp. 405 and 421) from the Upper Irrawaddy beds seems to be too fragmentary to allow of a specific identification. An incomplete left lower molar (M. C. Z. no. 6257) placed by Colbert (1943, p. 406, pl. XXVI fig. 2) under *E. hysudricus* as M_3 is rather narrow (67 mm) and low-crowned (126 mm), but the same specimen is mentioned elsewhere (Colbert, 1943, p. 423) as *Elephas* sp., possibly *Palaeoloxodon namadicus*. This specimen originates from Eastern Burma, near the Yunnan border, and its precise locality is unknown. The width and height of this molar suggest M_2 rather than M_3 (cf. tables 62-63); it should be noted that the specimen is given in the list (Colbert, 1943, p. 402) as "MCZ No. 6257, *Elephas* sp. Left M_2".

At this moment, therefore, the specific identity of the *Elephas* from the Lower Pleistocene Upper Irrawaddy beds of Burma must be considered uncertain.

The Dubois collection contains one M^3 referable to the present species. It was collected around Haripoor on the Somb Nuddy, Sirmur State, Punjab, in 1895; the precise locality is not known. The specimen (Coll. Dub. no. 3103) represents a large portion of a right upper last molar, with nine plates (pl. XIV figs. 3-4). There is no room for any doubt as to its specific identity: the plates, all unworn, although broad at the base, remain relatively low, and, when seen in side view, are slightly S-shaped, convexo-concave as noted in Osborn's diagnosis. To describe the specimen more detailed: the plates diminish in width and height toward the back; basally they are convex both buccally and lingually, and the sides converge toward the summits which carry from four to seven conelets. The conelet width is about one-half the basal width. At the base (roots are missing) the plates are slightly expanded in the median line. The laminar frequency of this molar is 6. The basal width and the total height of the anterior plate are 95 mm and 131 mm, respectively; those of the two plates following behind are the same. These measurements are just intermediate between those of two M^3s of the present species recorded by Osborn (1942, p. 1348, table XVII), in which the laminar frequency is 5½ to 6½. From the third plate on backward the dimensions of the plates decrease gradually until, in the hindmost preserved plate, the basal width is only 77 mm and the total height ca. 95 mm. The plate formula, of course, cannot be determined, but in all observable characters it is a typical *Elephas hysudricus* M^3.

The Dubois collection contains further a right ramus of the mandible of a young individual, from the same general area as the M^3 dealt with above. It holds the last milk molar, DM_4, as well as part of the DM_3, and is Coll. Dub. no. 3055 (pl. XIII fig. 3). The penultimate milk molar is much worn down, and incomplete anteriorly, but the DM_4 is entire, and five plates are worn only. The anterior talonid is large, and has a tripartite enamel figure. The first plate shows a median cleft, and the buccal figure extends backward toward the median line, to make a contact with a median loop of the second plate, across the valley. Median expansions of the plates are also seen in the valleys between plates 2 and 3, and between plates 3 and 4. As in *Archidiskodon planifrons,* these expansions are caused by the intermediate conules, and are best observed in a slightly advanced stage of wear. Often they appear first as an isolated enamel ring, as, e.g., in the valley behind plate 3: with further wear the median conule merges with the main enamel figure, forming a loop to its border. Precisely the same structural details are seen in the DM_4 of *E. hysudricus* figured by Falconer and Cautley (1845, pl. 7 fig. 9); the median cleft in the anterior plate appears also in a specimen figured by Osborn (1942, p. 1346, fig. 1203: A. M. 19786) that is only slightly less worn than our specimen.

The seven or eight conelets of plate 4 from the front are not yet worn out. Plate 5 shows only five conelets; the remaining four plates are covered by cement, not having cut the gums yet. Cement fills up all the valleys, and even covers the sides of the plates. The total length of the DM_4 is 134 mm, the greatest width 48 mm. Of the nine plates, eight occupy 10 cm of anteroposterior length.

The present specimen is intermediate between the DM_4 of *E. hysudricus* recorded by Falconer (1868 I, p. 428: 140 by 56 mm), and Osborn's specimens (Osborn, 1942, p. 1348: length 112-133 mm; width 46-55 mm). The laminar frequency (8-8½ according to Osborn) and the plate formula (8+-10) conclusively show our specimen to be referable to *Elephas hysudricus.*

Of each of the three lower molars of the present species there is a specimen in the Dubois collection:

Coll. Dub. no. 3123, Haripoor on the Somb Nuddy, Sirmur State, Punjab. Left ramus of the mandible with M_1 and part of M_2. The first molar is much worn down, incomplete anteriorly, with five plates remaining. The enamel figures are expanded in the centre. Of the M_2 only parts of the first two plates remain. The width of M_1 is 69 mm, the laminar frequency is 7½. The M_1s listed by Osborn (1942, p. 1348) vary in width from 64 to 73 mm, and in laminar frequency from 5½ to 7.

Coll. Dub. no. 3102, around Haripoor, Punjab. Left mandibular ramus with M_2. This slightly worn molar carries eight plates, but a few are missing anteriorly. The surface of the specimen is corroded; this evidently is a surface find, weathered out of the rock. The total height is approximately 95 mm, the basal width 73 mm. The laminar frequency is 6½, again somewhat higher than those in Osborn's specimens of M_2 (5-6), although the width and height of the Dubois collection M_2 are within the limits of these specimens.

Coll. Dub. no. 3063, around Haripoor, Punjab. Fragment of M_3 dext., comprising some five plates. The height of the unworn last plate, 88 mm, exceeds the basal width, which is 81 mm. An M_3 mentioned by Osborn (1942, p. 1348) is 91 mm high and 78 mm wide. The laminar frequency of our specimen, as well as that of Osborn's, is 5.

Elephas hysudrindicus Dubois

Euelephas namadicus Martin, Samml. Geol. Reichsmus. Leiden, vol. 4, 1887, p. 53, pl. VI fig. 3; Ibid., vol. 4, 1888, p. 106, pl. XII fig. 2.

Euelephas hysudricus Martin, Samml. Geol. Reichsmus. Leiden, vol. 4, 1887, p. 57, pl. VI fig. 2; Ibid., vol. 4, 1888, p. 112, pl. XII fig. 3.

Elephas indicus Dubois, Natuurk. Tijdschr. Ned. Indië, vol. 51, 1891, p. 94.

Elephas hysudrindicus Dubois, Tijdschr. Kon. Ned. Aardr. Gen., ser. 2, vol. 25, 1908, p. 1258; Dietrich, Sitz. Ber. Ges. naturf. Fr. Berlin for 1924, 1926, p. 135.

Palaeoloxodon hysudrindicus, Osborn, Proboscidea, vol. 2, New York, 1942, p. 1302, fig. 1160.

Elephas sp., Janensch, in Selenka and Blanckenhorn, Die Pithecanthropus-Schichten auf Java, Leipzig, 1911, p. 194, pl. XXIII fig. 5, textfig. 17; Von Koenigswald, Wet. Med. Dienst Mijnb. Ned. Indië, no. 23, 1933, p. 110.

Elephas spec. I, Stehlin, Wet. Med. Dienst Mijnb. Ned. Indië, no. 3, 1925, p. 6, pl. I fig. 3, pl. II fig. 1.

Elephas spec. II, Stehlin, Wet. Med. Dienst Mijnb. Ned. Indië, no. 3, 1925, p. 7, pl. I fig. 4.

Elephas ? maximus L. *fossilis* Van der Maarel, Wet. Med. Dienst Mijnb. Ned. Indië, no. 15, 1932, p. 168, pl. XVI figs. 1-3, textfigs. 26-27.

Elephas ex aff. *namadicus* Von Koenigswald, Wet. Med. Dienst Mijnb. Ned. Indië, no. 23, 1923, p. 89; De Ing. in Ned. Indië, vol. 1, sect. IV, 1934, pp. 191, 193, 194, pl. IV fig. 10; Wet. Med. Dienst Mijnb. Ned. Indië, no. 28, 1940, p. 59, pl. III fig. 13.

The present species was described by Dubois in 1908 somewhat as follows: It is very close to *Elephas hysudricus*, but even closer to the living Asiatic species of elephant. The molars resemble those of *Elephas indicus* (i.e., *Elephas maximus*) very much, although the number of plates (in the last molars) does not exceed 19. The skull is much more similar to that of the Siwalik than to that of the living species, especially in profile, the greater lateral development of the parieto-frontal bosses, and the straight tusk alveoli. The width between the temporal fossae is, however, greater than that in *Elephas hysudricus*; in this respect it approaches the living species, of which it undoubtedly is the immediate ancestor (Dubois, 1908, p. 1257/58).

Later authors considered *Elephas hysudrindicus* probably identical with *Palaeoloxodon namadicus*, thereby losing sight of the fact that Dubois had emphasized the cranial resemblance between his species and *Elephas hysudricus*, which latter is very different from *Palaeoloxodon namadicus* in cranial characters. For one thing, *Elephas hysudricus* lacks the prominent transverse parieto-frontal crest that is so highly characteristic of *Palaeoloxodon namadicus* (see Falconer and Cautley, 1845, pls. 12A, 12B fig. 1).

The skull of *Elephas hysudrindicus* Dubois to be described in the following pages fully justifies Dubois's foundation of a new species of fossil elephant for the Pleistocene of Java, for it is different from either *Elephas hysudricus* or *Elephas maximus*, combining certain characters of the two in a very remarkable way, while it is not identical with *Palaeoloxodon namadicus* either.

The skull (Coll. Dub. nos. 4968-4969, pl. XIV figs. 1-2) originates from Tinggang, Solo valley, and evidently belonged to a fully grown male. The occiput is broken off, and the right side is very defective, the parietal expansion behind the temporal contraction, the right border of the nasal opening, and the right zygomatic process of the maxillary are lost, while the right premaxillary lacks the lateral part, being broken off through the alveolus for the tusk. On the left side, however, the boundary of the temporal fossa, the nasal opening, the orbit, and the base of the premaxillary are preserved. The squamosals, the zygomatic arches, and the molars are missing, except for a portion of the M^3 sin. (Coll. Dub. no. 4970).

The parieto-frontal region of the skull is very remarkably shaped. The skull is very broad and flat superiorly behind the temporal fossae, and even slightly depressed in the middle. At the level of the posterior borders of the temporal fossae, where the parietal crests forming the upper boundaries of the fossae run out transversely, the parieto-frontal surface curves downward rather abruptly, and then curves forward and upward again so as to form an extensive concavity just above the median tips of the nasals. The depth of this supranarial or frontal depression from a line drawn over the middle of the parieto-frontal eminence and the nasal tip is not less than 8 cm, very close to that found in *Elephas hysudricus* if we take into account that the nasal tip is incomplete in the Java specimen. The anteroposterior extent of the frontal concavity is 23 cm. The hollow flattens out on either side toward the parieto-frontal crests, which approach each other on the upper surface of the skull to a distance of 39 cm. The frontal concavity is placed at the narrowest part of the forehead, which is, however, much less narrow than that in *Elephas hysudricus* (cf. Falconer and Cautley, 1845, pl. 4), as already stated by Dubois in his diagnosis given above. The temporal contraction is ca. 10 cm behind the posterior border of the nasal opening.

The nasal tips are large, 14 cm wide at the base, and about 5 cm long. They end rather squarely in front, and must have been longer when complete. The nasal opening is of enormous size, wider even than the temporal contraction. It curves forward at either end, to a point just in advance of the posterior border of the orbit. It is bounded in front by huge posterior eminences of the premaxillaries, which indent the nasal fossa in the middle, so that the least anteroposterior distance from their hinder surfaces to the nasal tips (as far as preserved) is only 9 cm. The lateral anteroposterior diameter of the nasal opening is ca. 20 cm.

The frontal crests diverge anteriorly and run out into the postorbital processes, thereby forming the lateral boundaries of the nasal opening. They curve slightly upward in their course, making the region between the temporal contraction and the orbit concave anteroposteriorly in profile. A straight line drawn from the convex parietal behind the temporal fossa to the summit of the orbit is 6 cm above the frontal crest beside the nasal tips.

The postorbital process is very low in position, viz., below the median anterior border of the nasal opening. The distance from the postorbital process to the hinder margin of the temporal fossa, where the parietal crest curves outward and is transverse in its course, is 31 cm; this is the greatest width of the temporal fossa. The postorbital width of the skull is 70 cm, approximately equal to that in *Elephas hysudricus* (see table of measurements). The orbit is almost round, ca. 10 cm in diameter, and shows the lacrimal in the middle of its anterior border. The zygomatic process of the maxillary in front of it is not much expanded laterally; the skull width over the anterior borders of the orbits is 58 cm, while that of the premaxillaries at the level of the infraorbital foramina is 50 cm. In *Elephas hysudricus* the difference between the orbital width and the proximal premaxillary width is more marked. The lower border of the infraorbital foramen is lost.

The premaxillaries are very well developed, with a large interalveolar fossa, ca. 10 cm in width and at least as deep. The diameter of the left incisive sheath is 18 cm; it is broken off some 10 cm in front of the infraorbital foramen on the left side, but is twice as long in the median line. The posterior eminences of the premaxillaries, with a median groove in between, project into the nasal fossa, and are slightly raised above the level of the upper border of the orbit and the upper surface of the premaxillaries. They fall down abruptly anteriorly into the interalveolar fossa, which has a length of 32 cm as far as preserved. The alveoli of the tusks are filled with matrix, and about 14 cm in diameter.

The chief characteristics of the skull of *Elephas hysudrindicus* are the deep frontal concavity, placed at the narrowest part of the forehead, the very extensive nasal opening, placed behind the orbit, the concave postorbital region as seen in profile, the large posterior premaxillary eminences, the low position of the orbit, and the very large premaxillaries and interalveolar fossa.

As compared with the skull of *Elephas hysudricus* (Falconer and Cautley, 1845, pls. 4-5), that of *Elephas hysudrindicus* is much less narrow at the temporal contraction, thereby marking a step in the direction of *Elephas maximus*. On the whole, however, the resemblances of the Java skull are with *Elephas hysudricus*, with which it shares the convexo-concave parieto-frontal profile, the extensive nasal opening, and the extremely low position of the orbit, which is placed below the anterior border of the nasal opening. The orbit and the tusks are smaller in the Java species than in *Elephas hysudricus*.

TABLE 54

Skull measurements of *Elephas hysudricus*, *Elephas hysudrindicus*, and *Palaeoloxodon namadicus* (in cm)

	Elephas hysudricus	*Elephas hysudrindicus*	*Palaeoloxodon namadicus* ♀	*Palaeoloxodon namadicus* ♂
Width of occiput	97	—	76	107
Temporal contraction	27	39	51	69
Median depth of frontal concavity	11	8	—	—
Greatest anteroposterior width of temporal fossa	30	31	—	—
Postorbital width	ca. 73	70	63	81
Width at anterior borders of orbits	65	58	51	63
Premaxillary width	47	50	—	50
Width of interalveolar fossa	7½	ca. 10	15	[1]
Depth of idem	16½	10+	—	—
Diameter of tusk	19	ca. 14	7	20
Anterior nares, width	47	44	37	51
Least anteroposterior diameter of idem	9	9	—	—
Diameter of orbit	17	ca. 10	16	24

The skull of *Elephas hysudrindicus* differs from that of the living *Elephas maximus* in much the same points as does that of *Elephas hysudricus*, viz., in its deeply concave frontals, the anteroposterior concavity of the frontal crests from temporal contraction to postorbital process, the position of the orbit below the median anterior border of the nasal fossa, and in its huge premaxillaries and interalveolar fossa. All these characters are less marked in the skull of *Elephas maximus*: the frontals are never concave to the degree seen in the fossil Java skull, nor are the frontal crests; the orbit is higher in position relative to the nasal opening, and even in large males the interalveolar fossa is less developed. However, in its less marked temporal contraction the skull of *Elephas maximus* differs from that of the Siwalik species as much as does that of *Elephas hysudrindicus*.

Needless to say that the Java fossil species of *Elephas* is not identical with *Palaeoloxodon namadicus*. Both the female skull figured by Falconer and Cautley (1845, pls. 12A and B), and the male described by Pilgrim (1905) are characterized by an overhanging transverse parieto-frontal crest, and added to that the temporal contraction is much less marked than that in *Elephas hysudrindicus*. The extreme divergence of the tusk alveoli, and the broad and shallow interalveolar fossa in between are further characters in which the male of *Palaeoloxodon namadicus* differs from the skull of *Elephas hysudrindicus* described above.

Now that we have examined the skull of *Elephas hysudrindicus*, there

1) Proximal width, 10 cm; distal width, 33 cm (Pilgrim, 1905, p. 209).

remains the dentition. As shown in the synonymy, Dubois originally (1891) identified the fossil elephant molars from Java as belonging to the living Asiatic species. Later (Dubois, 1908, p. 1258), he found the fossil skull to be specifically distinct from that of *Elephas maximus*, and states that the number of plates (in the last molars) of the fossil species does not exceed 19. Fossil lower last molars of the elephant subsequently mentioned by Van der Maarel (1932, p. 168, pl. XVI figs. 1-3) and Von Koenigswald (1934, p. 193, pl. IV fig. 10; 1940, p. 60, pl. III fig. 13) have more plates, at least 21, and at least 19, respectively. This does not prevent us from referring them to Dubois's species, however, as the nineteen-plated M_3 sin. from Kedoeng Broeboes (Coll. Dub. no. 2343) figured by Osborn (1942, p. 1302, fig. 1160, lower right) is incomplete behind; the last plate still has a height of 105 mm, and from comparisons with entire specimens it is evident that there were at least four more plates to follow (pl. XVI figs. 2-3). This, incidentally, brings the fossil form within the limits of the recent; the number of plates in the last molars of *Elephas maximus* varies from 22 to 27 (Owen, 1840-45, p. 635). On the other hand, the M_3 dext. (Coll. Dub. no. 2342, pl. XV fig. 5) also figured by Osborn (1942, p. 1302, fig. 1160, upper right), entire at both ends, has only 19½ plates, which is below the variation limits of the living Asiatic species. Osborn (l.c.) takes these two M_3s as coming from the same individual, but this is obviously wrong.

As already observed by Stremme (1911, p. 144), in its number of plates *Elephas hysudrindicus* is closer to *Palaeoloxodon namadicus* than to the recent *Elephas maximus*. Last lower molars of the Narbada species figured by Falconer and Cautley (1845, pl. 12C figs. 4-5) include only one entire specimen, and it has 20 plates (Falconer, 1868 I, p. 437). Lydekker (1880, p. 280) attributes 19-20 plates to the M_3 of *Palaeoloxodon namadicus*. The molars of the last mentioned species, according to Lydekker (l.c., p. 281) "differ from those of *E. indicus* (apart from the difference in the number of ridges), by the worn dentine surfaces being thicker and presenting no curve towards the apex; the enamel is also thicker. In the crimping of the enamel plates the two species are very much alike".

A fossil upper molar from the Pleistocene of Japan figured by Adams (1868, p. 497) as *Elephas indicus*, according to Lydekker (1886, p. 168/69, fig. 29) may pretty safely be referred to *Palaeoloxodon namadicus*, while finally Osborn (1942, p. 1334, fig. 1189) "regards it as referable either to *Palaeoloxodon namadicus naumanni*, *P. namadicus namadi*, or *P. hysudrindicus*. Observe crimping or plication of the enamel and absence of "loxodont sinus", resemblance to *Elephas indicus* grinders. Observe similar plication or crimping in the type (Fig. 1160) of *P. hysudrindicus*".

Another fossil upper molar from Japan described and figured by Matsumoto (1927a, p. 57, pl. XXVII figs. 2-3) as *Elephas indicus buski* is regarded by Osborn (1942, p. 1333, fig. 1188) as probably referable to *Palaeoloxodon*, noting, however, that the plates "are much more widely interspaced than in Dubois' type superior molar (Fig. 1160) of *Palaeoloxodon hysudrindicus*" (Osborn, l.c., p. 1334).

Palaeoloxodon namadicus does not invariably present a "loxodont sinus"; as noticed by Patte (1931, p. 747), the median expansions of the plate figures are rudimentary in one specimen (Falconer and Cautley, 1845, pl. 12D fig. 3), and absent in two (Falconer and Cautley, 1845, pl. 12C fig. 5; 1846, pl. 13 fig. 1a). Patte (l.c.) further observed: "Cette dilatation est inexistante chez l'Eléphant actuel d'Asie...", but the worn plates of a recent M3 dext. of *Elephas maximus* studied by Pontier (1930, p. 7, pl. II fig. 1) "présentent à la partie médiane et surtout en arrière un assez fort sinus loxodonte saillant dans la vallée...", although he adds that this does not normally occur.

It follows from the above digression that the molars of *Palaeoloxodon* and *Elephas* may be deceivingly similar, no matter how different their skulls. Unless the molars are complete or their serial positions known, identification of isolated specimens may be a delicate problem. In the following study of the elephant molars from Java, therefore, special reference will be made to the distinguishing characters of *Palaeoloxodon namadicus* and *Elephas maximus*.

There is only one complete milk molar of *Elephas hysudrindicus* in the Dubois collection (no. 1646, Kedoeng Broeboes), a DM3 dext. in a portion of the ramus (pl. XIII fig. 2). It carries seven plates, worn except the last two that are completely covered by cement. The anterior talonid as well as the first plate present a median cleft, likewise visible in *Elephas maximus* when in the same stage of wear (Leiden Museum, cat. ost. c, from Sumatra). The enamel figures of plates 2 and 3 from the front are single, and unexpanded; those of plates 4 and 5 exhibit 5-6 conelets. The enamel is very thin, hardly one mm in thickness, and finely grooved vertically on the sides. The width increases from 19 mm at the front plate to 30 mm behind, some cement included; the overall length of the Kedoeng Broeboes specimen is 65 mm. The height cannot be given as the basal part of the crown is embedded in the ramus behind, but the parallel-sided plates resemble those of *Elephas maximus* closely, also in the configuration of the enamel figures and the extremely thin enamel. The DM3 of *Elephas maximus* used for comparison has seven plates, of which the first is 22 mm, the last, 28 mm wide, by a total length of only 59 mm. Thus, the fossil

Java DM_3 is longer than its homologue in the living species, widens more distinctly from front to back, but has the same plate formula. Unfortunately the DM_3 of *Palacoloxodon namadicus* is unknown (Lydekker, 1880, p. 280). A referred baby skull from Yenchingkou, Wanhsien, Szechwan, described by Young (1939, pp. 328-330, figs. 5-6) has a DM_3 with eight plates, plus the talonids, with a length of 64 mm, and a width of about 25 mm.

Coll. Dub. no. 2226 (Trinil) is the anterior part of a DM^4 dext., with four plates. Only the anterior talon and the first plate are worn. The plates present 6-7 conelets; their greatest width is 54 mm, the height, ca. 95 mm. The laminar frequency is ca. 8, lower than that in the DM^4 of *Elephas maximus* (table 55). A worn DM^4 sin. (Coll. Dub. no. 2499, Kedoeng Loemboe) has seven plates; some are lost in front. The greatest width is 58 mm, in which it exceeds the recent specimens (table 55); the height of the last plate (worn) is about 80 mm. The enamel is crinkled, thin, and the figures are weakly expanded in the middle. The laminar frequency varies from 9 (at the lingual side) to 10 (buccally). A similar fragment, with three plates only (Coll. Dub. no. 2497, Kedoeng Broeboes), is 55 mm wide.

TABLE 55

Measurements of DM^4 and DM_4 of *Elephas maximus*

Leiden Museum,	DM^4 length	DM^4 width	DM^4 laminar frequency	DM_4 length	DM_4 width	DM_4 laminar frequency
cat. ost. f (Sumatra)	125	53	8½	155	49	8-9
Verh. n	ca. 120	50	9½-10	140	48	9-9½
Verh. m (Sumatra)	ca. 120	57	10	142	54	9-9½
reg. no. 3697	135	55	9	155	53	9-10

The DM^4 of *Palaeoloxodon namadicus* is unknown (Lydekker, 1880, p. 280), but the DM_4 (Falconer and Cautley, 1845, pl. 12C figs. 2-3) has 9-10 plates (against 11-12 in *Elephas maximus*); the length in the two known specimens is 132-140 mm; the width, 45-48 mm (Falconer, 1868 I, p. 437).

The posterior part of what is probably an M^1 (Coll. Dub. no. 1748, Bogo) is 58 mm wide by a height of the unworn plate of 142 mm. The unworn posterior portion of an M_1 dext. (Coll. Dub. no. 1751, Kedoeng Broeboes) holds four plates, is at most 58 mm wide, and 110 mm high; its laminar frequency is only 6, which is less than that in *Elephas maximus* (table 56). The M_1 of *Palaeoloxodon namadicus* (Falconer and Cautley, 1845, pl. 12D figs. 1-2) has 12-13 plates (there are up to 14 in *E. maximus*), with a length of 185-187 mm, and a width of 56-63 mm (Falconer, 1868 I, p. 438).

TABLE 56

Measurements of M^1 and M_1 of *Elephas maximus*

Leiden Museum,	M^1 length	M^1 width	M^1 laminar frequency	M_1 length	M_1 width	M_1 laminar frequency
cat. ost. d	155+	60	7½	160+	59	7-8
cat. ost. k (Sumatra)	ca. 185	60	7	ca. 200	56	7½

A good specimen of M^2 dext. of the present species has already been described and figured by Martin (1888, p. 106, pl. XII fig. 2), as *P. namadicus*. Incidentally, Martin considered the molar to have only nine plates, because the 8th and 9th plates from behind, worn to a common dentine surface, are so much narrower than the plates following behind, but the fact is that these foremost preserved plates are worn down beyond the border of the crown, into the roots. The roots, well set off from the crown, are just as wide below plates 8-9 from behind as they are further back (ca. 42 mm), which indicates that the molar must have had more than nine plates, quite possibly up to twelve, as is the number of plates to M^2 of *Palaeoloxodon namadicus* (Lydekker, 1880, p. 280). The greatest width of the Java specimen (Geol. Mus. Leiden no. 18261), 78 mm at the sixth plate from behind, and the laminar frequency (6-6½) closely resemble those of M^2 of *Elephas maximus* (table 57).

TABLE 57

Measurements of M^2 of *Elephas maximus*

Leiden Museum,	length	width	height	height-width index	laminar frequency
cat. ost. b (Sumatra)	ca. 205	78	—	—	7
cat. ost. e (Sumatra)	—	70	—	—	7
cat. ost. j (Ceylon)	210+	67	—	—	6-7
cat. ost. n (Sumatra)	ca. 220	74	—	—	6½-7
Coll. Dub. no. 1362 (recent)	208	73	—	—	8
Paris Lab. Anat.	196	70	163	233	8
Paris Lab. Anat.	176	66	157	238	9
Paris, Coll. Fromaget	220	74	ca. 140	—	8
id.	210	72	170	236	7-7½
id.	200	76	180	237	7
id.	ca. 200	72	155	215	7
id.	ca. 210	76	160	211	7½

There are two partial M^2s in situ in maxillary fragments, with parts of M^3 in situ behind: Coll. Dub. no. 3404 is of the right side, and Coll. Dub. no. 4259 of the left. Both are from Tegoean, and so very similar as to make it extremely probable that they formed part of the same individual. Of the M^2 6 plates are preserved, all worn; the greatest width is 79 mm, and the laminar frequency is 5, lower than that in any of the recent specimens (table 57). The enamel is crinkled and about 2 mm in thickness; the enamel figures are weakly expanded in the middle, and in the anterior plates are recurved backward at either end, most markedly so at the buccal side. The hinder end of an M^2 dext. (Coll. Dub. no. 2356, Tinggang) holds four plates, of which the anterior are slightly worn. An M^2 sin. (Coll. Dub. no. 1809, Djambe) possesses ten plates, all worn but the last. Finally, the hinder end of an M^2 sin. (Coll. Dub. no. 2247) carries five plates and a half, all worn. In its enamel pattern it is very close to the specimen figured by Martin referred to above. The measurements of these specimens are given in table 58.

TABLE 58

Measurements of M^2 of *Elephas hysudrindicus*

	width	height	height-width index	laminar frequency
Martin, 1888	78	—	—	6-6½
Coll. Dub. nos. 3404	79	—	—	5
2356	72	155	215	6-6½
1809	70	158	226	ca. 7
2247	77	—	—	8
2286	83	—	—	8
2279	81	145+	180+	7½
3536	76	170	224	6½
2152	82	182	222	7
2230	76	150+	197+	8
3535	63	137	217	6

In table 58 I have included six specimens that could be either M^2 or M^3; there is hardly any difference in width and height of the plates, or in laminar frequency, between the penultimate and the last molars, and, therefore, the exact serial position of an incomplete specimen cannot be determined if the hinder end is not shown (an M^3 gradually tapers off behind, while an M^2 ends more abruptly behind). Coll. Dub. no. 2286 (Kedoeng Broeboes) is a worn anterior portion, with five plates shown; of the remaining specimens, Coll. Dub. nos. 2279, 2152 (Tegoean), and 3535 consist of four plates; Coll. Dub. nos. 3536, and 2230 (Kedoeng Broeboes) of three plates only.

The M^2 dext. from the Mogok caves, Burma, referred to *Palaeoloxodon namadicus* by Colbert (1943, p. 418, pl. XXIX fig. 2) has about eleven plates; the full length and height cannot be determined, but the width is 86 mm, and the laminar frequency is 5½. Very similar is a left M^2 (or M^3) that I recorded from Samarinda, Borneo (Hooijer, 1952a). There are five plates and a half, 84 mm wide, and ca. 180 mm high, which gives a height-width index of ca. 214, while the laminar frequency only amounts to 5½. These referred specimens of *Palaeoloxodon namadicus,* like some of those of *Elephas hysudrindicus* from Java (table 58), tend to be wider, and to have lower laminar frequencies than their homologues in the living Asiatic elephant (table 57).

The upper last molar of *Elephas hysudrindicus* belonging to the type skull from Tinggang described above (Coll. Dub. nos. 4968-4969) is a partially preserved M^3 sin. (Coll. Dub. no. 4970). It holds five plates, unworn (the top of the anterior plate is broken off), decreasing in width from 89 mm to 81 mm, and in height from ca. 170 mm to ca. 160 mm over a distance of four plates. The laminar frequency of this specimen is 7. Much better preserved is an M^3 sin. from Kebon Doeren (Coll. Dub. no. 2359) figured by Osborn (1942, p. 1302, fig. 1160, left figs.). Fifteen plates are present; Osborn indicates them as nos. 5-19, presuming four plates to be missing in front. Only the last three plates are unworn. As seen in Osborn's figure there are weak median dilatations to the enamel figures of plates 8-10, while in the slightly worn plates there is a subdivision of the enamel figures into a laminar central portion and annular lateral portions. The greatest width of the molar, at the second preserved plate from the front, is 95 mm, a width that decreases to 67 mm at the third plate from behind, the largest unworn plate, which has a height of 175 mm. The laminar frequency is 7.

There is another isolated M^3, of the right side, originating from Kedoeng Broeboes (Coll. Dub. no. 2501), that is broken off anteriorly through the twentieth plate from behind; eleven of the preserved plates are worn. The anterior, greatest width is 86 mm; exactly how many plates are lost in front cannot be made out, but I would judge about three plates to be missing, making a total of 23 plates, which brings this molar within the variation limits of the living Asiatic elephant. It is, at any rate, clear that the number of plates to M^3 of *Elephas hysudrindicus* may exceed 19, the number stated by Dubois (1908, p. 1258). The height of the foremost unworn plate of Coll. Dub. no. 2501, the twelfth from the front, is 180 mm, and the width of that plate is 81 mm. At the fifth plate from behind, the width is 74 mm by a height of ca. 165 mm. The third plate from behind is only 67 mm wide, and ca. 140 mm high. It will be noticed that this plate is much less high than the corresponding plate in the preceding specimen.

The state of preservation of the specimens does not permit of a more detailed comparison, but with a view to the amount of variation seen in only four specimens of M^3 of *Elephas maximus* (table 59) it would seem unwise to attach any significance to differences of this kind.

The specimens mentioned in table 59 are: a, Leiden Museum, cat. ost. c; b, Leiden Museum, cat. ost. g; c, Leiden Museum, reg. no. 1213; d, Geological Museum Leiden, no. 18274 (recent). In each of the specimens we observe that both the width and the height of the plates increase when passing forward along the molar crown. In specimens a and c the increase in width continues until we reach the eleventh plate from behind; in specimens b and d the plates increase in width only until the seventh plate has been reached. In the last two specimens the height goes on to increase still further, viz., until the eleventh plate in specimen b, and until the ninth in specimen d. In specimen c, however, the height increases only until the fifth plate from behind. It seems that in specimen a the greatest height had not yet been attained in plate 7 from behind which is the foremost unworn plate, and thus the maximum height is not available in this specimen.

The amount of variation in height-width index is greatest in the posterior plates (e.g., from 203 to 304 in plate 2 from behind), but more forward the indices tend to become less different, and from plate 6 from behind on forward the difference between the largest and the smallest observed index is less than ten per cent of the latter.

Table 59 shows that a difference in height-width index such as that found between the third plates from behind in Coll. Dub. no. 2359 (width 67 mm, height 175 mm, index 261) and in Coll. Dub. no. 2501 (width 67 mm, height ca. 140 mm, index ca. 209) is less than that found in *Elephas maximus* (214-287). With the exception of the posterior four plates of the rather high-crowned specimen c the observed height-width indices of the plates of M^3 of *Elephas maximus* remain between the limits 200 and 276 (with a peak between 230 and 240), which means that the plates of the M^3 of *Elephas maximus* are at least twice as high as wide.

Table 60 gives the greatest width and the greatest height of the above mentioned Leiden specimens as well as those of seven Paris specimens of M^3 of *Elephas maximus*, and the indices based thereon, which keep within the limits indicated.

We may now proceed with the fossil Java specimens. The M^3s of the right and left maxillaries from Tegoean (Coll. Dub. nos. 3404 and 4259), of which nine plates are preserved on both sides, are unworn, and carry from 5 to 7 conelets on each plate. Both the greatest width and the greatest

TABLE 59

Unworn ridges of M^3 of *Elephas maximus*

No. of plate from behind	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Width of specimen a	42	44	52	52	55	59	63	67	71	72	72	74	74	74
b	37	50	56	60	60	67	73	75	76	76	74	75	77	77
c	44	48	54	57	62	65	69	69	70	73	75	75	74	73
d	49	60	64	67	70	71	74	74	74	75	73	72	74	74
Height of specimen a	96	105	112	120	132	142	154	—	—	—	—	—	—	—
b	96	103	121	131	142	155	171	183	188	197	200	202	202	202
c	131	146	155	160	165	163	165	163	—	—	—	—	—	—
d	104	122	137	155	160	163	168	173	178	177	178	181	182	—
Height-width index														
of specimen a	229	239	215	231	240	241	244	—	—	—	—	—	—	—
b	259	206	216	218	237	231	234	244	247	259	270	269	262	262
c	298	304	287	281	266	251	239	236	—	—	—	—	—	—
d	212	203	214	231	229	230	227	234	241	236	244	251	246	—

height can be measured, and these are given in table 61, as well as the laminar frequencies, which are the same as those of the preceding specimens.

TABLE 60

Measurements of M^3 of *Elephas maximus*

Leiden Museum,	length	width	height	height-width index	laminar frequency
cat. ost. c	285	74	154+	208+	8-9
cat. ost. g	ca. 320	81	202	249	8-10
reg. no. 1213	ca. 320	75	165	220	7-9
Geol. Mus. Leiden no. 18274 (recent)	ca. 285	76	182	240	7-9
Paris Lab. Anat.	ca. 280	85	183	215	6-6½
id.	ca. 290	78	210	269	8
id.	231	79	194	245	7-7½
id.	ca. 270	77	170	221	7
id.	ca. 300	77	180	234	7-7½
Paris, Coll. Fromaget	250	75	180	240	7
id.	250	80	190	238	7

There is an M^3 sin., broken through the ninth plate from the front (Coll. Dub. no. 3532, Tegoean), of which only the anterior two plates are worn. There are sixteen plates, but the posterior end is broken off, and apparently about four or five plates are missing. The greatest width and height (table 61) are in the region of the 4th to 6th plates. The height decreases gradually from 170 mm at the 10th plate to 125 mm at the 16th, at which plate the molar is broken off. The laminar frequency is slightly lower than that in the foregoing specimens.

The hinder end of an M^3 dext. from Krangit, Pati Ajam (Coll. Dub. no. 2352, pl. XV figs. 3-4) comprises eight plates; all but two of the plates are worn. The third plate from behind is 71 mm wide, and ca. 140 mm high. Another posterior portion of an M^3 dext. (Coll. Dub. no. 11656, pl. XV figs. 1-2) holds ten plates, six of which worn. In this specimen the third plate from behind measures 58 mm in width by a height of 137 mm. This is a rather narrow and high-crowned specimen; unfortunately the greatest height is not available. The height-width index of the third plate from behind (236) is intermediate between those of Coll. Dub. nos. 2359 and 2501 (261 and ca. 209, respectively), while in greatest width it is exceeded by all the other specimens.

There remains one hinder end of an M^3 dext. (Coll. Dub. no. 2030, Kedoeng Broeboes pl. XVI fig. 1) holding eight plates, of which two only are worn. The third plate from behind measures 65 by 150 mm (height-width index 231); the greatest height that can be observed (ca. 180 mm) equals that in Coll. Dub. no. 2501, but the present specimen is narrower. On its slightly worn plates, four or five conelets can be seen, just as in the slightly worn plates of Coll. Dub. nos. 2352 (pl. XV fig. 4) and 11656 (pl. XV fig. 1). These soon wear out into a tripartite figure, of which the central part is wider transversely than those on either side. Weak median dilatations are seen in some of the entire enamel figures of the more worn plates. In side view, the plates are slightly S-shaped (Coll. Dub. no. 2030, pl. XVI fig. 1), as they are in the M^3 sin. (Coll. Dub. no. 2359) already figured by Osborn (1942, p. 1302, fig. 1160, left figs.).

The measurements of M^3 of *Elephas hysudrindicus* presented in table 61 indicate that the fossil Java species had wider molars than the living Asiatic elephant, and also lower height-width indices, only up to 209 in *Elephas hysudrindicus*, which is about the lower limit of variation observed in *Elephas maximus*.

TABLE 61

Measurements of M^3 of *Elephas hysudrindicus*

	length	width	height	height-width index	laminar frequency
Coll. Dub. nos. 4970	—	89	ca. 170	—	7
2359	210+	95	175	184	7
2501	270+	86	180	209	7
3404	—	89	173	194	7
4259	—	93	170	183	7
3532	270+	90	178	198	6½-7
2352	—	94	—	—	6½-7
11656	—	80	—	—	7-8
2030	—	81	ca. 180	—	7

Of the M^3 of *Palaeoloxodon namadicus* only worn specimens are available (Falconer and Cautley, 1845, pl. 12B fig. 3; 1846, pl. 13 figs. 1-2), of which the greatest height cannot be determined. The width of the first mentioned specimen is 94 mm, that of the second even 106 mm (Falconer, 1868 I, pp. 435 and 439), while the laminar frequencies of these specimens are $6^1/_3$, and $5^1/_2$, respectively. These data indicate that *Palaeoloxodon namadicus* has wider last molars, with lower laminar frequencies, than has *Elephas hysudrindicus*, which, as we have seen above, differs, in turn, in the same points from *Elephas maximus*.

Stehlin (1925) has figured, but not identified, two upper molars from Limbangan, Java, viz., the worn anterior end of a left M^3 (l.c., pl. I fig. 3), and the posterior portion of a right M^3 (l.c., pl. I fig. 4). The first specimen, with a width of 8 cm, and a laminar frequency of almost 7 (Stehlin, l.c., p. 7), is within the variation limits of *Elephas hysudrindicus* (table 61). The second specimen, however, as correctly observed by Stehlin (l.c., p. 8), is small, and rather narrow; the eighth plate from behind is 58 mm wide, and its height is given as 13 cm, which gives a height-width index of about 220. Evidently both the width and the height would increase further to the front (the specimen comprises only the posterior eight plates), but nevertheless this Limbangan M^3 remains exceptionally narrow, the eighth plate from behind being equal in width and in height to the third plate from behind in a narrow-crowned Dubois collection specimen (no. 11656). The eighth plate from behind in the latter specimen is 75 mm wide (a width that increases to 80 mm in the tenth plate), and the height of the worn plate is just 130 mm, but was certainly over 160 mm high in the unworn state, as the foremost unworn plate (the fourth from behind) is already that high. Although there is no counterpart of Stehlin's specimen among the Dubois collection M^3s, it could be interpreted as a narrow-crowned variation of the fossil Java elephant. Stehlin also remarks upon the strongly pointed hinder end of the molar, which indicates that it is an exceptional specimen. The laminar frequency is stated to be 8½, higher than that observed in the present collection.

In the Dubois collection there are few specimens of M_2, and none of these is complete. Coll. Dub. no. 2355 is a portion of a left M_2 with five plates, all worn, forming an occlusal surface slightly concave antero-posteriorly. The plates do not distinctly diverge rootward, as they do in an M_3; the greatest width is 69 mm, and the laminar frequency is 6. Another left M_2 (Coll. Dub. no. 3527, ? Trinil) holds five plates, two of which worn, with a width of 67 mm, and a height of 124 mm. The laminar frequency increases from 5 at the base to 6 at the top. A further specimen, likewise of the left side (Coll. Dub. no. 2331, Grobogan), with five plates, all unworn, is damaged lingually so that the width cannot be taken. The plates are about 145 mm high, and the laminar frequency is ca. 7½.

Stehlin (1925, pl. II fig. 1) figured a right mandibular ramus from Limbangan, in which the M_2, of which only four worn plates remain, is 65 mm wide, and the laminar frequency amounts to ca. 5.

Table 62 shows that the above mentioned fossil specimens of M_2 are within the limits of variation of their recent homologues, with the exception of Coll. Dub. no. 2331, which is slightly higher than the recent.

The M_2 sin. of *Palaeoloxodon namadicus* figured by Falconer and Cautley (1845, pl. 12D fig. 3) has 13 plates by a length of 259 mm, and a width of 84 mm (Falconer, 1868 I, p. 438), greater than that in any of the fossil Java or the recent specimens.

TABLE 62

Measurements of M_2 of *Elephas maximus*

	length	width	height	height-width index	laminar frequency
Leiden Museum,					
cat. ost. b (Sumatra)	ca. 220	73	—	—	5-5½
cat. ost. e (Sumatra)	—	64	—	—	5½
cat. ost. j (Ceylon)	225+	66	—	—	5
cat. ost. n (Sumatra)	ca. 235	72	—	—	5
Paris Lab. Anat.	194	58	120	207	8
id.	ca. 200	71	140	197	5
Paris, Coll. Fromaget	265	67	125	187	6-7
id.	ca. 220	65	125	192	7
id.	ca. 180	70	ca. 120	—	6
id	250	64	120	188	6-7
id.	180+	63	115	182	5½-6

The M_3s already figured by Osborn (1942, p. 1302 fig. 1160) are the best specimens of last lower molars in the Dubois collection. The specimen described by Martin (1887, p. 53, pl. VI fig. 3, as *E. namadicus*) comprises the last twelve plates of an M_3 sin., of which eight plates are worn. The tripartite enamel figures of the anterior four plates, with the central figure wider transversely than those on either side, are as those in slightly worn plates of *Palaeoloxodon namadicus* in general (Falconer and Cautley, 1845, pls. 12C and 12D) as well as like those in *Elephas maximus*. Martin (l.c., p. 55) states that this specimen is essentially different from *Elephas maximus*, but I find it exceedingly similar to the M_3 of the living Asiatic elephant; a thorough comparison of the fossil specimen (Geol. Mus. Leiden, no. 13757) with the corresponding portion of an isolated left M_3 of *Elephas maximus* (Leiden Museum, cat. ost. h) does not reveal any significant differences. The foremost unworn plate in the fossil M_3, the fourth from behind, is 127 mm high and 62 mm wide; the corresponding plate in the recent specimen measures 128 by 63 mm. The greatest width of the fossil M_3, at the twelfth plate from behind, is 82 mm, that of cat. ost. h, 77 mm. In the recent specimen the posterior plates are somewhat more distinctly recurved backward basally, and the hinder end is more markedly curved upward than that in the fossil specimen, differences probably correlated with the lesser number of plates in the fossil molar.

Stehlin's Limbangan specimen (Stehlin, 1925, p. 7, pl. II fig. 1) has only the anterior ten plates, of which the width cannot be determined; the height of the 7th plate from the front is 125 mm, and the laminar frequency is ca. 5 at the middle of the height but rises to ca. 8 at the apex. The last lower molars from Sentang Kedoeng Klampo, Java, described by Van der Maarel (1932, pp. 168-173, pl. XVI figs. 1-3), have at least 21 plates, and Van der Maarel rightly stresses the close resemblance between the fossil and recent specimens of *Elephas maximus*, although he indicates the possibility of their belonging to *Elephas hysudrindicus*. The mandible figured by Von Koenigswald (1934, pl. IV fig. 10) as *Elephas* ex aff. *namadicus*, although the width of M_3 is only 6½-7 cm, has at least 19 plates. There are small but definite median expansions to the enamel figures of some of the anterior plates, and these also show up in the M_3 sin. from Kedoeng Broeboes in the Dubois collection (pl. XVI fig. 2; Osborn, 1942, p. 1302 fig. 1160, lower right). As said above, this specimen is incomplete behind, and it must have had at least 23 plates, of which 19 remain. There is an extra half-plate on the buccal side between the second and third plates from the front (pl. XVI fig. 2), or, rather, the lingual portions of plates 2 and 3 are fused, anomalies of a kind we also encounter in living elephants. Narrow posterior enamel expansions in plates 3-5 from the front lend the specimen an archaic look, for these expansions are not developed to the same degree in *Elephas maximus*. However, in relative crown height there is no difference between the fossil and the recent M_3 (table 63).

TABLE 63

Measurements of M_3 of *Elephas maximus*

	length	width	height	height-width index	laminar frequency
Leiden Museum,					
cat. ost. c	250+	78	—	—	6
cat. ost. h	ca. 390	77	150	195	5-6
reg. no. 1213	280+	79	—	—	5½-7
Paris Lab. Anat.	ca. 320	78	126	162	6-7
id.	ca. 370	82	178	217	5-6
id.	ca. 320	80	122	153	6-7
id.	ca. 350	72	135	188	6-7
Paris, Coll. Fromaget	290	85	135	159	5-6
id.	ca. 240	76	ca. 130	—	5½-6
id.	250	70	ca. 115	—	6
id.	ca. 300	72	ca. 120	—	5½-6
id.	ca. 275	78	145	185	5-7

The M_3 dext. (Coll. Dub. no. 2342, pl. XV fig. 5; Osborn, 1942, p. 1302, fig. 1160, upper right) is entire with 19½ plates, and when compared with a recent M_3 of *Elephas maximus* with 25 plates (Leiden Museum, cat. ost. h) shows only differences such as might be expected between specimens with different plate numbers: the hinder end is less upturned, and the plates are less recurved backward basally in the fossil than in the recent specimen, but in relative crown height the fossil is within the variation limits of *Elephas maximus*. In the living form the posterior plates of M_3 are so close together apically that they radiate like the sticks of a fan, and this is not the case to the same extent in the fossil species (pl. XVI fig. 3).

A corroded left ramus of the mandible (Coll. Dub. no. 10553) holds the posterior eight plates of an M_3, all worn. The anterior portion of what probably is M_3 in situ in a fragment of the right ramus (Coll. Dub. no. 2396) has a greatest width of 80 mm. Further specimens are isolated.

Coll. Dub. no. 403 (Pati Ajam) is the hinder end of an M_3 sin., with curved plates, as usual. The width of the third plate from behind is only 50 mm, the height slightly over 110 mm. Coll. Dub. no. 1758, part of an M_3 dext., has three plates only the anterior of which is worn. The laminar frequency is 6 at the base, and increases to 8 at the top. That of Coll. Dub. no. 1781 (Kedoeng Broeboes), three plates of an M_3 dext., all unworn, even increases to 9 at the apex. Coll. Dub. no. 2139 (Kedoeng Broeboes) comprises the posterior five plates of an M_3 sin., all worn except two; the plates are rather widely spaced, curve forward at the apex, and curve sharply backward toward the bases. The height of the penultimate plate is ca. 100 mm. Coll. Dub. no. 2273 contains about four plates of an M_3 dext., incomplete basally, narrowing from ca. 60 mm below to ca. 45 mm in anteroposterior length at the top; the first two plates are just touched by wear. Coll. Dub. no. 2247, two entire and two broken plates of an M_3 dext., have only few (four) large conelets apically, the second from the buccal side being the largest. Coll. Dub. no. 2327 (Nongko) is the hinder end of an M_3 dext. with three worn and two broken plates. Coll. Dub. no. 2361 (Kedoeng Broeboes) is a large portion of an M_3 sin., with nine plates, the first four worn. The lateral conelets wear into more or less annular figures, while the central portion (two, or three conelets) coalesce first into a laminar figure. The plates are sharply recurved backward toward the base, and are strongly convergent upward. Coll. Dub. no. 2408 comprises four plates and a half of an M_3 dext., all unworn. Coll. Dub. no. 3524 consists of two plates, presumably of an M_3 sin., worn to four enamel figures each, of which the lateral are smaller than the others. The measurements of all these specimens are given in table 64.

The comparison between tables 63 and 64 shows that the fossil M_3 can hardly be distinguished from the recent; the former may attain higher laminar frequencies than the latter, although it does not attain the same high plate formula as does the living species.

TABLE 64

Measurements of M_3 of *Elephas hysudrindicus*

	length	width	height	height-width index	laminar frequency
Martin, 1887	—	82	127	155	6
Stehlin, 1925	—	—	125	—	5-8
Van der Maarel, 1932	315	87	—	—	—
Von Koenigswald, 1934	270+	70	—	—	—
Coll. Dub. nos. 2342	297	70	115	164	7
2343	324+	80	150	188	5-6
10553	—	80	—	—	6
1758	—	76	ca. 125	—	6-8
1781	—	75	130	173	6-9
2139	—	77	—	—	5-6
2273	—	72	—	—	—
2247	—	87	136	156	6-7½
2361	—	72	145	201	6-8
2408	—	74	135	182	6-8
3524	—	76	—	—	5-8

The M_3 sin. of *Palaeoloxodon namadicus* figured by Falconer and Cautley (1845, pl. 12C fig. 4) has 20 plates; the length is 373 mm, the width, 79 mm, and the laminar frequency is 5. Another (l.c., pl. 12C fig. 5) is 355 mm long, and 94 mm wide (Falconer, 1868 I, p. 437). The maximum width of M_3 in a mandible recorded by Chakravarti (1938) is 97 mm, which shows, once more, that *Palaeoloxodon namadicus* is larger than the fossil Java species.

There are various postcranial skeletal remains in the proboscidean collection from Java that should be referred to *Elephas*, *E. hysudrindicus*. They are distinguished, above all, by their superior size from those of *Stegodon trigonocephalus*. Important structural differences are observed, e.g., in the humerus, which is more slender relatively in *Elephas* than it is in *Stegodon*, and thereby is much larger, too.

Coll. Dub. no. 4240, from Tinggang, is the proximal part of a left scapula of which the collum measures 23 cm anteroposteriorly; Pohlig (1911, p. 205) mentions a fragment of larger size. The glenoid cavity is larger than that in the scapulae referred to *Stegodon* (above, table 26).

Coll. Dub. no. 2901, again from Tinggang, Solo valley, is a huge right humerus, with a length from caput to medial condyle of 113½ cm. It differs from that of *Stegodon* in the lesser prominence of the deltoid ridge, and the relatively smaller proximal parts, and therein agrees with recent *Elephas maximus*. The various ratios of the humerus given in table 66 show that the fossil Tinggang humerus, alhough larger than the recent bones, differs as much in proportions from those of *Stegodon* (table 27) as do those of living *Elephas maximus*.

TABLE 65

Measurements of scapula of fossil and recent *Elephas* (in cm)

	Elephas hysudrindicus	*Elephas maximus* subad. ♀	ad. ♀	ad. ♂
Anteroposterior diameter of collum scapulae	23	17	17	19
From tuber scapulae to posterior border of glenoid cavity	23½	17½	18½	21½
Anteroposterior diameter of glenoid cavity	19	14	13½	16
Transverse diameter of idem	13½	8	7½	10

There are further a distal portion of a right humerus (Coll. Dub. no. 4337) and that of a left humerus (Coll. Dub. no. 4491), both from Kedoeng Broeboes, in which the anteroposterior diameter of the medial condyle is 18½ cm; the shaft of a left humerus from Kebon Doeren (Coll. Dub. no. 4590) measures 19½ cm over the deltoid tuberosity, and its least width is 10½ cm, as it is in the large Tinggang humerus, too.

TABLE 66

Measurements of humerus of fossil and recent *Elephas* (in cm)

	Elephas hysudrindicus	*Elephas maximus* subad. ♀	ad. ♀	ad. ♂
1. Length from caput to medial condyle	113½	73	75	88
2. Width over caput and posterior part of lateral tuberosity	26	17½	20	22½
3. Caput, anteroposterior diameter	22	15	15	17½
4. Transverse diameter of idem	17½	10	10½	13
5. Greatest diameter of shaft over deltoid tuberosity	ca. 20	13	13½	15½
6. Least diameter at middle of shaft	10½	6	6½	9
7. Greatest distal width	32	20½	21	24
8. Width of trochlea	24½	15½	16	18
9. Anteroposterior diameter of medial condyle	18½	11½	12	13
10. Idem of lateral condyle	15	10	10	11½
11. Ratio 2 : 1	0.23	0.24	0.27	0.26
12. Ratio 3 : 1	0.19	0.21	0.20	0.20
13. Ratio 5 : 1	ca. 0.18	0.18	0.19	0.18
14. Ratio 8 : 1	0.22	0.21	0.21	0.20
15. Ratio 2 : 7	0.81	0.85	0.95	0.94

The proximal portion of the humerus from the Narbada Beds assigned to *Palaeoloxodon namadicus* by Falconer and Cautley (1847, pl. 48 fig. 1) is much larger than that of *Elephas hysudrindicus*; the proximal width is 36½ cm, and the head measures 30 by 20½ cm. This tends to show, once more, that the Java fossil elephant is not the same as the Narbada species.

Coll. Dub. nos. 4290-4291 is a very large right ulna, without the distal end, that measures 95 cm in length as far as preserved; it is 77 cm from the medial humeral articular surface down to the broken distal end. This bone exceeds those referred to *Stegodon trigonocephalus* (table 31) in size (table 67). Coll. Dub. no. 4378 (Kedoeng Madoh) is a similar fragment, but its humeral articular surface is very incomplete. Coll. Dub. no. 4579 (Bogo) has a humeral articular surface of the same width as the trochlea of the large *Elephas* humerus from Tinggang recorded above. Coll. Dub. nos. 4635 and 4831 (Kedoeng Broeboes), both of the right side, and a left fragment (Coll. Dub. no. 483 a, Nongko near Padas Malang) lack the lateral portion of the humeral articular surface, but the medial part of that surface is as large as that in the others (table 67).

TABLE 67

Measurements of ulna of *Elephas hysudrindicus* (in cm)

Coll. Dub. nos.	4290	4579	4635	4831	483a
Width of humeral articular surface	—	24½	—	—	—
Width of medial portion of idem	12	10+	10½	11	11+
Width at middle of shaft	13	—	—	12	ca. 12½

There is also a distal ulna fragment, of the right side (Coll. Dub. no. 4273, Wadegan). The width of its lateral surface is not less than 15 cm, against 11-12 cm in *Stegodon trigonocephalus*. Unfortunately the cuneiform facet is incomplete medially.

The ulna from the Narbada Beds assigned to *Palaeoloxodon namadicus* by Falconer and Cautley (1847, pl. 48 fig. 2) has a proximal width of 25½ cm, only slightly greater than that of Coll. Dub. no. 4579.

There is only one femur fragment from Java in the Dubois collection that must be referred to *Elephas*. The proximal portion of a right femur (Coll. Dub. no. 4932, probably from Tegoean), has a greatest diameter over caput and great trochanter of 42 cm. If the ratio of the proximal diameter to the total length may be taken as 0.28, as in *Elephas maximus* (see table 36), the length of the fossil femur would have been 150 cm, one and one-half times that of the largest *Stegodon* femur from Java. Von Koenigswald (1933, p. 90) has recorded a femur from Koewoeng of at least 130 cm, under the head *Elephas* ex aff. *namadicus*.

Elephas maximus Linnaeus

"It is a striking circumstance that we have not as yet discovered the direct ancestry of either of the typical living elephants" (Osborn, 1942, p. 1307). Even *Elephas hysudrindicus*, regarded by Osborn (in Hopwood, 1935a, p. 55) as an advanced member of the *Palaeoloxodon namadicus* group, fails to meet all the conditions ancestral to *Elephas maximus*.

The past distribution of *Elephas maximus* in Southeastern Asia raises some points of interest and difficulty. Has the Asiatic elephant ever lived in Java in the wild state? Two partial plates of elephant's molars have been recorded from the post-Pleistocene Sampoeng rock-shelter by Dammerman (1934, p. 482, pl. 11 fig. 1), who states that they exactly match those of the recent Sumatran elephant. Might not these equally well represent a late survivor of the *Elephas hysudrindicus* stock? We know that it continued to exist in Java within Upper Pleistocene times (Ngandong fauna: Von Koenigswald, 1935a, p. 190; 1939, p. 45).

Representations of the elephant on the Borobudur (which dates from ca. 800 A. D.) have led Deraniyagala (1950, p. 10) to believe in the existence of a Java race of the Asiatic elephant (*Elephas maximus sondaicus*) that would have become extinct about the twelfth century A.D. However, the Hindu immigrants who erected this monument knew the elephants from India, and further the Hindu ornaments in Java are not influenced by the local flora or fauna (Krom, 1943, p. 56). Elephants very probably have been introduced by the Hindu, who even might have put these animals to use when building this very stupa, but there does not appear to be conclusive evidence for the Asiatic elephant's natural subsistence in Java within historic times.

A speculation of sufficient interest in the present context to be mentioned here was published by Case (1939), who relates the Makara gargoyle of the Borobudur to mastodonts, assuming "that the sculptors were attempting to represent an archetypal form of proboscidean suggested by the discovery of a fossil Mastodon. Such a skull was perhaps preserved in some temple and its characters persisted in a stylized religious art" (l.c., p. 570). On this I received the following comment by Dr. Deraniyagala (in litt., January 23, 1951): "I have suggested that the Makara gargoyle (vide figures by Case) are modern man's dim memory of the prehistoric hippopotami of Ceylon, India and Java. The lower tusks are transferred to the upper jaw, but the fact that it is a semi-aquatic beast is portrayed by the stream of water always shown gushing from its jaws. I published this account in the Indian Journal, Science and Culture many years ago".

The question as to whether the living elephants of Northern Borneo are autochthonous or introduced by man is still in dispute, although most modern authors incline to the latter view. Pocock (1943, p. 278) refers the Borneo elephant to the Sumatran race, but it is regarded as a distinct race (*Elephas maximus borneensis*) by Deraniyagala (1950, p. 10), apparently on insufficient grounds.

The Sumatran elephant, originally described as a distinct species by Temminck (1847, p. 91), in the opinion of modern authors is at most subspecifically distinct from typical *Elephas maximus maximus* from Ceylon. In the collections from various limestone caves in the Padang Highlands, Central Sumatra, made by Dubois in the years 1888 to 1890, there are a number of more or less complete molars of the elephant, which will now be considered.

Coll. Dub. no. 640 (Lida Ajer cave, Central Sumatra) comprises a DM_3 sin. with seven plates, and talonids (pl. XVI figs. 4-5). Only the anterior two plates are worn; they exhibit median clefts. The lingual edges of the plates are damaged, and the base of the crown is not completely preserved either, but the total length of the crown can be measured, and is 72 mm, which is longer than that both in *Elephas maximus* (59 mm) and in *Elephas hysudrindicus* (65 mm). The height of the crown of the Sumatran cave specimen is at least 43 mm.

The anterior portion of a right DM_3 (Coll. Dub. no. 973, Sibrambang cave) with four plates, is at most 34 mm wide (28 mm in *Elephas maximus*; 30 mm in *Elephas hysudrindicus*); the full height of the crown is 46 mm.

The greater part of a DM^4 sin. (Coll. Dub. no. 747b, Sibrambang cave), of which only the anterior plate is worn, holds eight plates. The width is 50 mm, the greatest observed height is 83 mm, and the laminar frequency is 10, as it is in recent specimens (table 55).

A DM_4 sin. (Coll. Dub. no. 1142a, Lida Ajer cave) holds nine plates; some are lost behind. Two plates are worn; the crown is incomplete lingually, and the greatest width cannot be taken. The laminar frequency is 9 at the lingual, and 10 at the buccal side. A DM_4 dext. broken off behind the seventh plate from the front (Coll. Dub. no. 878a, Sibrambang cave), with three worn plates, is 45 mm wide behind, and 72 mm high. The laminar frequency runs from 8 at the base to 10 at the top. Another anterior portion of a DM_4 dext., with six plates (Coll. Dub. no. 747c, Sibrambang cave) is only about 38 mm wide, and has a laminar frequency of 9. These specimens are somewhat narrower than their recent homologues (table 55), although they agree in laminar frequency.

There is no indubitable specimen of M^1 in the Sumatran cave collection, but of the first lower molar there is an entire specimen, of the left side (Coll. Dub. no. 747a, Sibrambang cave, pl. XVII figs. 1-2). Nine of the thirteen plates are worn, forming an occlusal surface that is concave anteroposteriorly; the plate figures of the first four plates are entire, with weak median expansions, while those of plates 5-6 are tripartite, the central figure being the largest. In plates 7-9 the central part is seen to consist of three conelets; five conelets also show up in the unworn posterior plates, which are damaged apically. All the plates are recurved backward basally, and converge crownward, most markedly so those placed at the back end. The greatest length of the crown is 167 mm, the width is 41 mm anteriorly but increases to 53 mm behind. The greatest observed height is 107 mm. The laminar frequency is 7 lingually, and 8 buccally, taken at the middle of the height of the crown.

Coll. Dub. no. 1142b is another M_1 sin., from the Lida Ajer cave, with nine plates preserved but incomplete at either end as well as buccally. The greatest width is 50 mm; the laminar frequencies are the same as those of the preceding specimen.

A right and left M_1, undoubtedly of the same individual, Coll. Dub. nos. 976 and 868, originate from the Lida Ajer cave. Both are incomplete behind: the right M_1 has ten plates, the left, eleven. Four plates are worn; the width is ca. 45 mm in front, increasing to 54 mm behind by a greatest height of 107 mm. The laminar frequency is 6-7 at the base, and rises to 9 at the apex of the crown. When these figures are compared with those in table 56 it will be seen that the cave specimens are not as wide as the corresponding recent.

The anterior portion of what probably is an M^2 sin. (Coll. Dub. no. 876, Lida Ajer cave), has four plates. There are further three hinder ends of M^2 dext., all from the Sibrambang cave. Coll. Dub. no. 803 holds six plates, Coll. Dub. no. 872, seven, and Coll. Dub. no. 877 only five. The measurements given in table 68 show that the widths are either below the range of variation of the recent M^2 (table 57), or to the lower side of that range.

TABLE 68

Measurements of subfossil M^2 of *Elephas maximus*

Coll. Dub. nos.	width	height	laminar frequency
876	61	—	6-8
803	69	—	5-6
872	67	—	6-7
877	71	137+	ca. 7

There is no recognizable specimen of the lower second molar in the cave collection.

The last upper molar is well represented in the Sumatran collection; there are five hinder ends, all much worn down, three of which of the right side. Most of the specimens are gnawed at their bases by porcupines. Coll. Dub. no. 743 (Sibrambang cave) has ten plates of which only the last two are unworn; the third plate from behind is 65 mm wide, and the height is 133 mm, but would have been about 140 mm in the unworn state, whereby it agrees with recent specimens. This specimen is rather strongly curved, which makes the laminar frequency lower at the lingual surface (7) than buccally (8). The second specimen (Coll. Dub. no. 871) has ten plates also, five of which worn but the remaining damaged apically. This is a rather narrow specimen (table 69). Coll. Dub. no. 874 (Lida Ajer cave), with nine plates preserved, has only the last plate unworn; the plates are more widely spaced than those in the preceding last molars. Coll. Dub. no. 875 is of the left side, and originates from the Sibrambang cave. Of the nine plates, three are unworn. It is narrow behind (the third plate is only 51 mm wide, by a height of ca. 120 mm), but increases in width to 76 mm already at the seventh plate from behind. Finally, Coll. Dub. no. 879, a left M^3 from the Sibrambang cave, lacks the last plate; the third plate from behind is 50 mm wide, and 149 mm high, a rather hypsodont specimen further remarkable because of its high laminar frequency (8-9). The ninth plate from behind is worn down to a height of only about 45 mm; the fourth plate from behind is about 150 mm high, but evidently the molar was still higher more to the front. The measurements of this series of upper last molars are given in table 69.

TABLE 69

Measurements of subfossil M^3 of *Elephas maximus*

Coll. Dub. nos.	width	height	laminar frequency
743	71	—	7-8
871	63	—	7
874	75	—	6
875	76	—	6
879	74	150+	8-9

It is evident from table 60, in which the measurements of M^3 of *Elephas maximus* are presented, that the subfossil M^3 from Sumatra are either below, or to the lower side of the range of variation of width measurements of the living form.

Of the lower last molars in the Sumatran cave collection only two specimens have to be mentioned. Coll. Dub. no. 873, from the Sibrambang cave, represents ten plates of an M_3 dext., broken at either end. All the plates are worn; they converge crownward. The hinder plates show five conelets each, of which the three in the centre coalesce to a laminar enamel figure before they are fused with the marginal conelets. In the anterior plates there are seen narrow median expansions, but these are even more clearly developed in the second specimen, nine plates and a half of an M_3 sin. from the Sibrambang cave (Coll. Dub. no. 802, pl. XVII fig. 3). In the last specimen, the anterior plates are much worn down, and their enamel figures show the "loxodont sinus", making a contact across the valley in the median line. Even the fourth and fifth plates from behind are expanded in the middle, while the hindmost plates show the usual division into a broad central and small rounded marginal enamel figures. The greatest width of Coll. Dub. no. 873 does not exceed 64 mm; the laminar frequency is 5 lingually, and 6 at the buccal side. The greatest width of the figured specimen (Coll. Dub. no. 802) is 67 mm, and its laminar frequency is 6 on both side surfaces. Although the laminar frequencies of the cave specimens of M_3 agree with those of the living Asiatic elephant (table 63), none of the recent specimens is as narrow, the least width observed being 70 mm, which is also the minimum observed in the series of M_3 of *Elephas hysudrindicus* (table 64).

The cave fauna of Sumatra does not contain extinct species; it has been referred to the prehistoric portion of the Holocene by Dubois (1891, p. 93). In previous studies on various species of mammals contained in the prehistoric fauna of Central Sumatra, such as the orang-utan, porcupine, tiger, Malay tapir, and the Java and Sumatran rhinoceroses, I found as a rule the cave specimens to average larger than their recent homologues. It is evident that the amount of time that has elapsed since the deposition of the cave material has been sufficient for a subspecific advance to have taken place. In the case of the Sumatran elephant the change in the course of time as reflected in the material at hand appears to have been slight: the subfossil milk molar is larger, and the molars in general are narrower than the corresponding recent.

There does not seem to be sufficient evidence yet to justify a subspecific distinction of the Sumatran cave elephant, but the specimens recorded above indicate that such a distinction might eventually be made when more completely preserved specimens will be available. Unfortunately there is only an infinitesimally small chance that the skull of the prehistoric elephant of Sumatra will ever be found, for bone is very scarce in the cave collection due to the action of porcupines that have eaten away almost all the softer parts of the mammalian teeth and left almost no bones at all. The available elements of the dentition, however, suggest that the cave elephant of Sumatra had narrower-crowned molars than the living, although the difference is one of averages only, and should be studied in larger series than are at present available.

The Ratnapura beds of Ceylon contain several molars that can hardly be distinguished from those of the living Asiatic elephant; Deraniyagala (1944, p. 50) has described them as *Elephas maximus sinhaleyus*. It is worthy of note that Deraniyagala noticed the fossil molars to be somewhat smaller than those of the living Asiatic elephant, although the study of his tables of measurements (Deraniyagala, 1944, tables VII and VIII) does not bear this out. The various specimens of M_2 recorded from Ceylon are rather wide (72-76 mm); when these figures are compared with those in table 62 they will be seen to exceed those of recent *Elephas maximus*, both from Ceylon and from Sumatra. Other fossil Ceylon molars remain within recent limits, a few (an M^2 60 mm wide, an M^3 56 mm wide) are below the range of variation found in the living Asiatic elephant. Since these specimens are associated with hippopotami indistinguishable from *Hippopotamus sivalensis palaeindicus*, a terminal form of Asiatic hippopotamus with greatly enlarged I_1 and I_3 (vide Hooijer, 1950, p. 57) from the Narbada beds, their geologic age is at least Middle Pleistocene unless, as Deraniyagala (l.c., p. 53) suggests, there was redeposition of the Ratnapura beds during late Pleistocene times by which the *Elephas* material was mixed up with the older fossils [1]).

In early historic times the Asiatic elephant had an extensive distribution, ranging Westward to the Syrian desert (Deraniyagala, 1950; Arnold, 1953). At present they do not range Westward beyond India. The future of the elephant looks grim. As Deraniyagala (1950, p. 15) writes: "... with man's rapid spread over the earth, ... his valued assistant in labor, war, the hunt, and even as executioner, is doomed to extinction within two centuries. The only avenue of survival is through total domestication, but as tamed elephants can only be kept by a very few, this will not materialize". To strike a more optimistic note at the end (Colbert, 1955, p. 416): "However, modern man is a lover of elephants, and it is probable that he will do his best to see that these noble mammals do not disappear from the face of the earth".

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1) Deraniyagala (1944, pp. 45-46) also describes Ceylon races of *Elephas hysudricus* and of *Palaeoloxodon namadicus*, but these do not appear to me to be well founded, and Deraniyagala (l.c.) writes that his identifications should be regarded as tentative.

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EXPLANATION OF THE PLATES

Plate I

Fig. 1, *Stegodon trigonocephalus* Martin, adult female skull, Kedoeng Panas, Java, Coll. Dub. no. 5005, right view.

Figs. 2-3, *Stegolophodon stegodontoides* (Pilgrim), M_3 sin., Haripoor, Punjab, Coll. Dub. nos. 3133 and 3140; fig. 2, crown view; fig. 3, lingual view.

Fig. 1, $^1/_8$ natural size; figs. 2-3, ½ natural size.

Plate II

Figs. 1-2, *Stegodon insignis* (Falconer et Cautley), M^3 dext., Jamni, Punjab, Coll. Dub. no. 3062; fig. 1, crown view; fig. 2, lingual view.

Figs. 3-6, *Stegodon trigonocephalus* Martin; fig. 3, DM_3 dext., Pengilan, Java, Coll. Dub. no. 1647h, crown view; fig. 4, DM^3 dext., Trinil, Java, Coll. Dub. no. 1647b, crown view; figs. 5-6, DM^4-M^1 sin., Kedoeng Broeboes, Java, Coll. Dub. no. 4821; fig. 5, buccal view; fig. 6, crown view.

Figs. 1-2, 5-6, ½ natural size; figs. 3-4, ¾ natural size.

Plate III

Stegodon trigonocephalus Martin; fig. 1, DM^3 sin., Trinil, Java, Coll. Dub. no. 1647a, crown view; fig. 2, M_2 sin., Tegoean, Java, Coll. Dub. no. 2231, crown view; fig. 3, left ramus of the mandible with DM_4-M_1, Trinil, Java, Coll. Dub. no. 144, crown view; fig. 4, juvenile palate with $DM^{2\text{-}3}$ on both sides, Kedoeng Panas, Java, Coll. Dub. no. 1780, crown view; fig. 5, DM^2 sin., Trinil, Java, Coll. Dub. no. 1581, crown view; fig. 6, juvenile mandible with DM_4 on both sides, Trinil, Java, Coll. Dub. no. 2892, crown view.

Figs. 1 and 5, ¾ natural size; figs. 2 and 4, ½ natural size, fig. 3, $^3/_7$ natural size; fig. 6, $^1/_4$ natural size.

Plate IV

Stegodon trigonocephalus Martin; figs. 1 and 3, subadult skull, Coll. Dub. no. 4982; fig. 1, right view; fig. 3, anterior upper view; fig. 2, left ramus

of the mandible with M_{2-3}, Trinil, Java, Coll. Dub. no. 2896, lingual view.
Figs. 1 and 3, $^1/_6$ natural size; fig. 2, $^1/_5$ natural size.

Plate V

Stegodon trigonocephalus Martin; figs. 1-2, M^2 dext., Trinil, Java, Coll. Dub. no. 2364; fig. 1, crown view; fig. 2, lingual view; fig. 3, M_3 sin., Kedoeng Broeboes, Java, Coll. Dub. no. 2422, crown view; fig. 4, M_3 dext., Soedo, Java, Coll. Dub. no. 3500, crown view.
All figures ½ natural size.

Plate VI

Stegodon trigonocephalus Martin; figs. 1-2, adult male skull with tusks, Grobogan, Java, Coll. Dub. no. 4980; fig. 1, left view; fig. 2, posterior left view.
Fig. 1, $^1/_{20}$ natural size; fig. 2, ca. $^1/_{15}$ natural size.

Plate VII

Stegodon trigonocephalus Martin; figs. 1 and 3, adult male skull, Grobogan, Java, Coll. Dub. no. 4979; fig. 1, anterior upper view; fig. 3, left view; fig. 2, M^3 dext., Coll. Dub. no. 4975, crown view; fig. 4, M^2 dext., Kebon Doeren, Java, Coll. Dub. nos. 3462-3463, crown view.
Figs. 1 and 3, $^1/_{10}$ natural size; fig. 2, $^1/_5$ natural size; fig. 4, $^1/_2$ natural size.

Plate VIII

Stegodon trigonocephalus Martin; fig. 1, vert. cerv. II-VII and vert. thor. I-IV of a single individual, Trinil, Java, Coll. Dub. nos. 3225-3227, left view; fig. 2, vert. thor. XIV-XIX of a single individual, Ngandjar, Java, Coll. Dub. nos. 3223-3224, right view; fig. 3, processus spinosus of vert. cerv. VII of the individual of fig. 1, anterior view, showing median perforation; figs. 4-7, anterior views of juvenile humeri from Trinil, Java, showing ontogenetic development of supinator ridge and of deltoid crest; fig. 4, humerus dext., Coll. Dub. no. 9405; fig. 5, humerus sin., Coll. Dub. no. 7057; fig. 6, humerus dext., Coll. Dub. no. 7910; fig. 7, humerus dext., Coll. Dub. no. 6793.
Fig. 1, $^1/_5$ natural size; fig. 2, $^1/_4$ natural size; fig. 3, $^1/_2$ natural size; figs. 4-7, $^1/_6$ natural size.

Plate IX

Stegodon trigonocephalus Martin; fig. 1, femur dext., Trinil, Java, Coll. Dub. no. 2890, anterior view; fig. 2, humerus dext., Trinil, Java, Coll. Dub. no. 2900, anterior view; fig. 3, scapula sin., Trinil, Java, Coll. Dub. no. 4429, outer view; fig. 4, os coxae sin., Trinil, Java, Coll. Dub. no. 4389-4391, outer view; fig. 5, DM_3 dext., Mantingan, Java, Coll. Dub. no. 1647f, crown view; fig. 6, DM_3 dext., Kedoeng Broeboes, Java, Coll. Dub. no. 1647d, crown view.

Figs. 1-2 and 4, $^1/_8$ natural size; fig. 3, $^1/_6$ natural size; figs. 5-6, $^3/_4$ natural size.

Plate X

Fig. 1, *Stegodon trigonocephalus* Martin, M_3 dext., Coll. Dub. no. 2326, crown view.

Figs. 2-3, *Archidiskodon planifrons* (Falconer et Cautley); fig. 2, left mandibular ramus with M_3, Punjab, Yale Peabody Museum no. 14568, crown view; fig. 3, right mandibular ramus with M_2, Haripoor, Punjab, Coll. Dub. no. 3046, crown view.

Fig. 1, $^1/_3$ natural size; fig. 2, $^3/_8$ natural size; fig. 3, $^1/_2$ natural size.

Plate XI

Archidiskodon planifrons (Falconer et Cautley); figs. 1-2, DM_4 dext., 500 m N.W. of Karang Djati, Java, Coll. Dub. no. 3381; fig. 1, crown view; fig. 2, buccal view; figs. 3 and 5, DM^4 sin., Tritik, Java, Coll. Dub. no. 2383; fig. 3, buccal view; fig. 5, crown view; figs. 4 and 6, DM_4 sin., 500 m N.W. of Karang Djati, Java, Coll. Dub. no. 3413; fig. 4, lingual view; fig. 6, crown view.

All figures ¾ natural size.

Plate XII

Archidiskodon planifrons (Falconer et Cautley), adult skull, Naliwala, Punjab, Coll. Dub. no. 4963; fig. 1, anterior upper view; fig. 2, right view.

Both figures $^1/_6$ natural size.

Plate XIII

Figs. 1 and 4, *Archidiskodon planifrons* (Falconer et Cautley); fig. 1, M_2 sin., Punjab, Yale Peabody Museum no. 14567, crown view; fig. 4, M_2 dext., Naliwala, Punjab, Coll. Dub. no. 3071, crown view.

Fig. 2, *Elephas hysudrindicus* Dubois, DM_3 dext., Kedoeng Broeboes, Java, Coll. Dub. no. 1646, crown view.

Fig. 3, *Elephas hysudricus* Falconer et Cautley, DM_{3-4} dext., Punjab, Coll. Dub. no. 3055, crown view.

Figs. 1, 3, and 4, ½ natural size; fig. 2, ¾ natural size.

Plate XIV

Figs. 1-2, *Elephas hysudrindicus* Dubois, adult male skull, Tinggang, Java, Coll. Dub. nos. 4968-4969; fig. 1, anterior upper view; fig. 2, left view, showing concave postorbital region, projecting nasal tips, and low position of orbit.

Figs. 3-4, *Elephas hysudricus* Falconer et Cautley, M^3 dext., Punjab, Coll. Dub. no. 3103; fig. 3, buccal view; fig. 4, anterior view, showing full height and width of crown.

Figs. 1-2, $^1/_8$ natural size; figs. 3-4, $^1/_2$ natural size.

Plate XV

Elephas hysudrindicus Dubois; figs. 1-2, M^3 dext., Coll. Dub. no. 11656; fig. 1, crown view; fig. 2, buccal view; figs. 3-4, M^3 dext., Krangit, Java, Coll. Dub. no. 2352; fig. 3, buccal view; fig. 4, crown view; fig. 5, M_3 dext., Coll. Dub. no. 2342, crown view.

Figs. 1-4, $^1/_2$ natural size; fig. 5, $^2/_5$ natural size.

Plate XVI

Figs. 1-3, *Elephas hysudrindicus* Dubois; fig. 1, M^3 dext., Kedoeng Broeboes, Java, Coll. Dub. no. 2030, lingual view; figs. 2-3, M_3 sin., Kedoeng Broeboes, Java, Coll. Dub. no. 2343; fig. 2, crown view; fig. 3, buccal view.

Figs. 4-5, *Elephas maximus* Linnaeus, DM_3 sin., Lida Ajer cave, Sumatra, Coll. Dub. no. 640; fig. 4, lingual view; fig. 5, crown view.

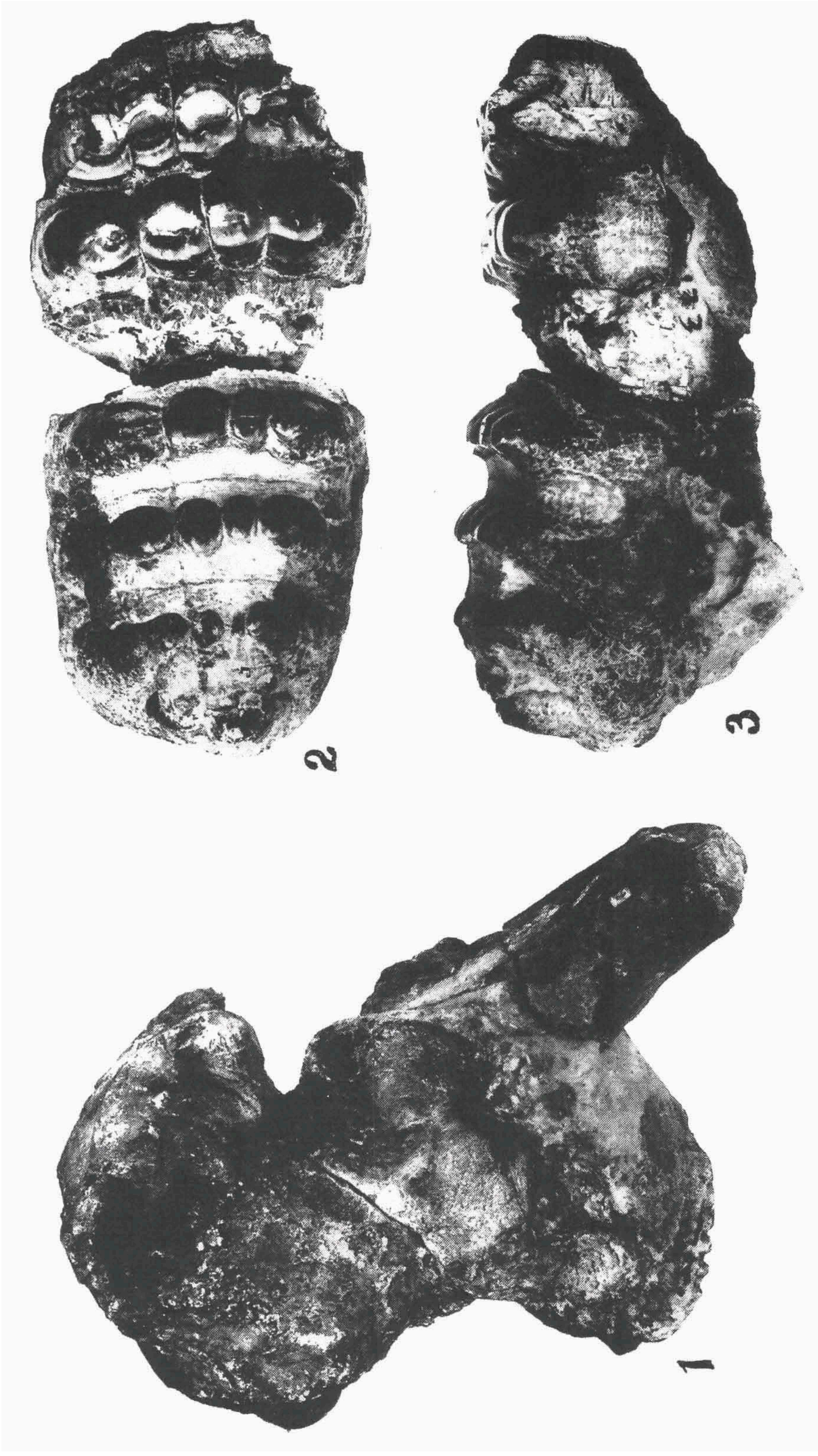
Fig. 1, $^1/_2$ natural size; figs. 2-3, $^3/_8$ natural size; figs. 4-5, $^3/_4$ natural size.

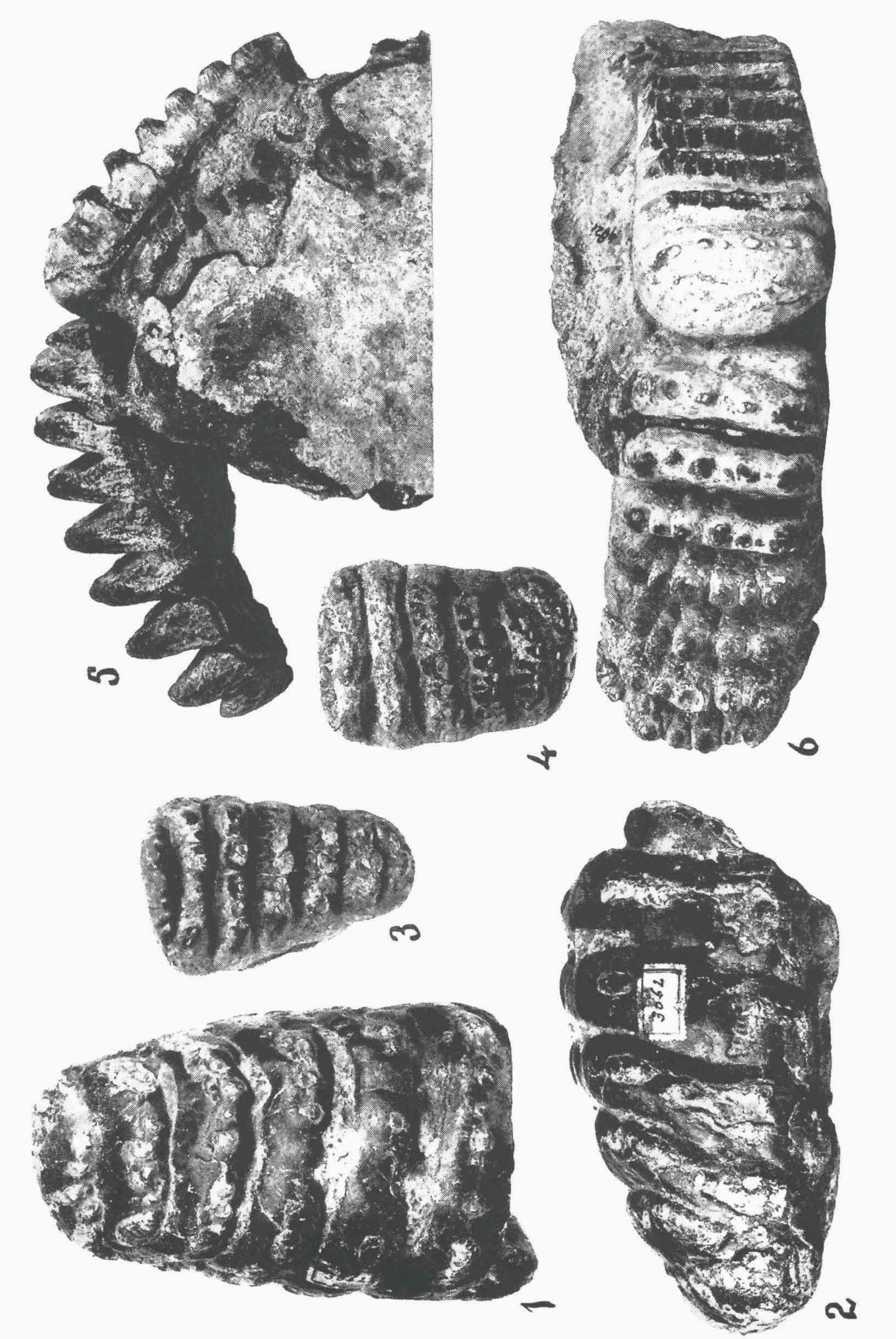
Plate XVII

Figs. 1-3, *Elephas maximus* Linnaeus; figs. 1-2, M_1 sin., Sibrambang cave, Sumatra, Coll. Dub. no. 747a; fig. 1, crown view; fig. 2, lingual view; fig. 3, M_3 sin., Sibrambang cave, Sumatra, Coll. Dub. no. 802, crown view.

Figs. 4-5, *Stegodon trigonocephalus* Martin, left premaxillary eminence, Coll. Dub. no. 4911; fig. 4, anterior view; fig. 5, upper view.

Figs. 1-3, $^1/_2$ natural size; fig. 4, $^3/_4$ natural size; fig. 5, $^1/_3$ natural size.

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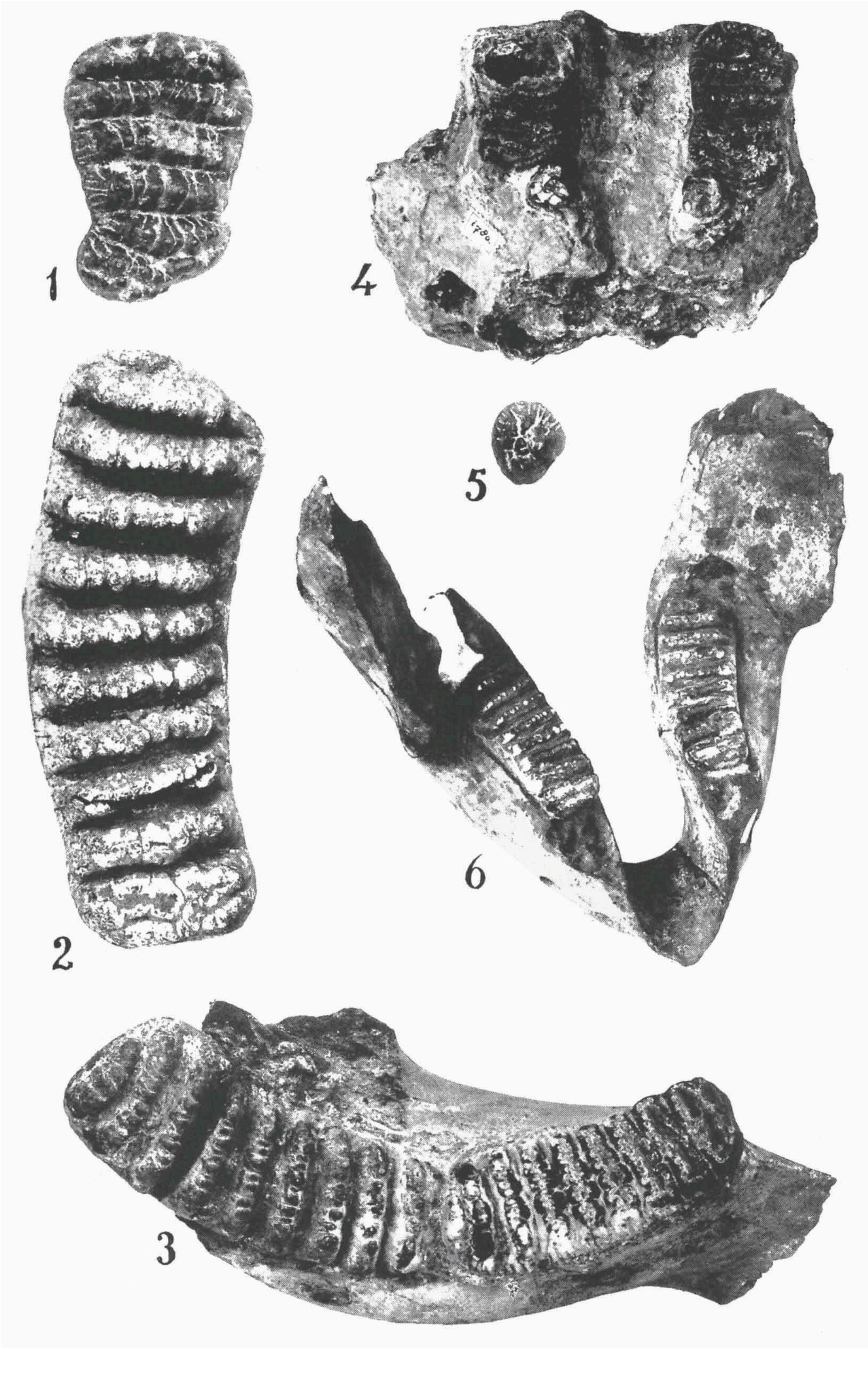
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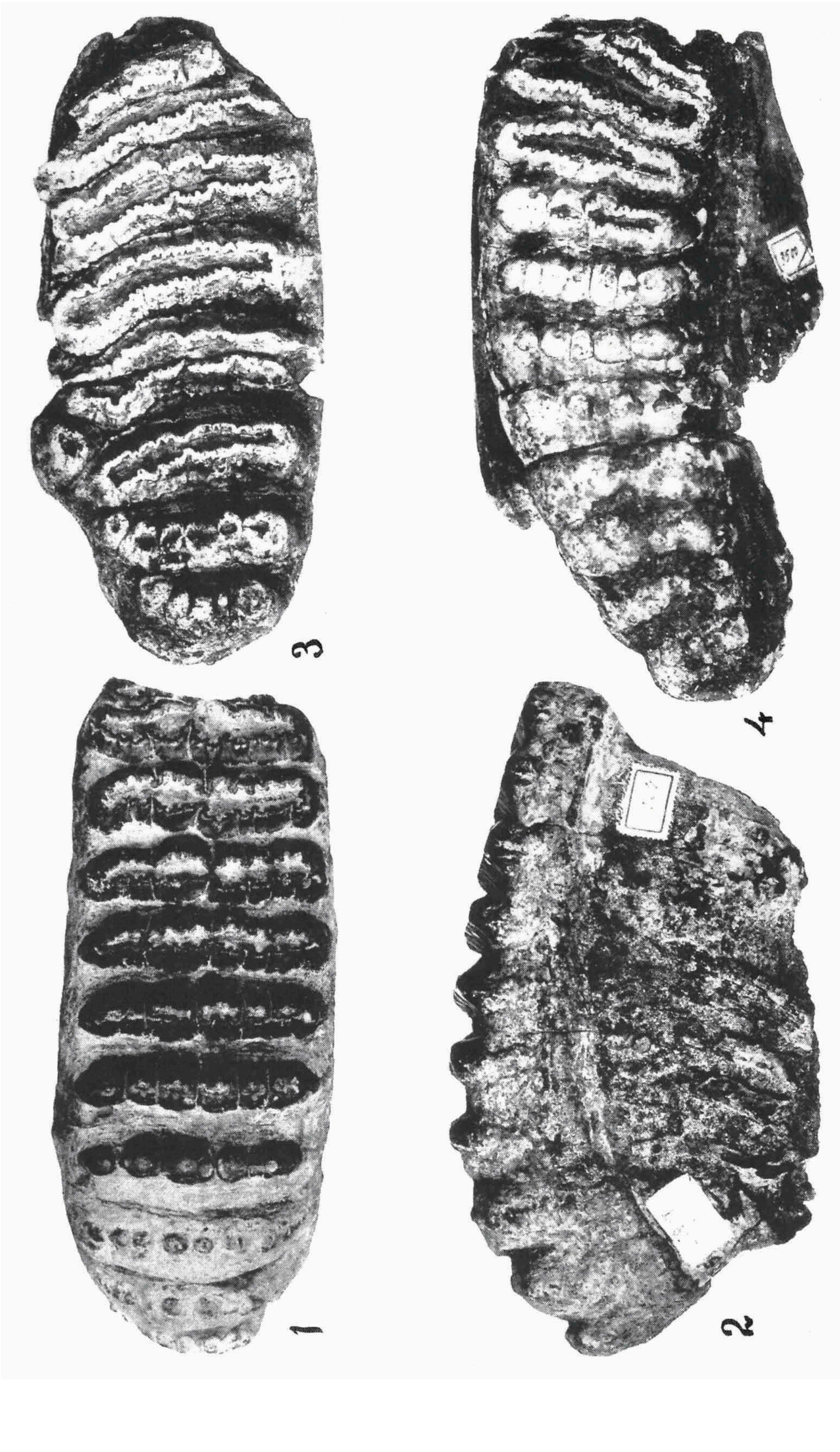

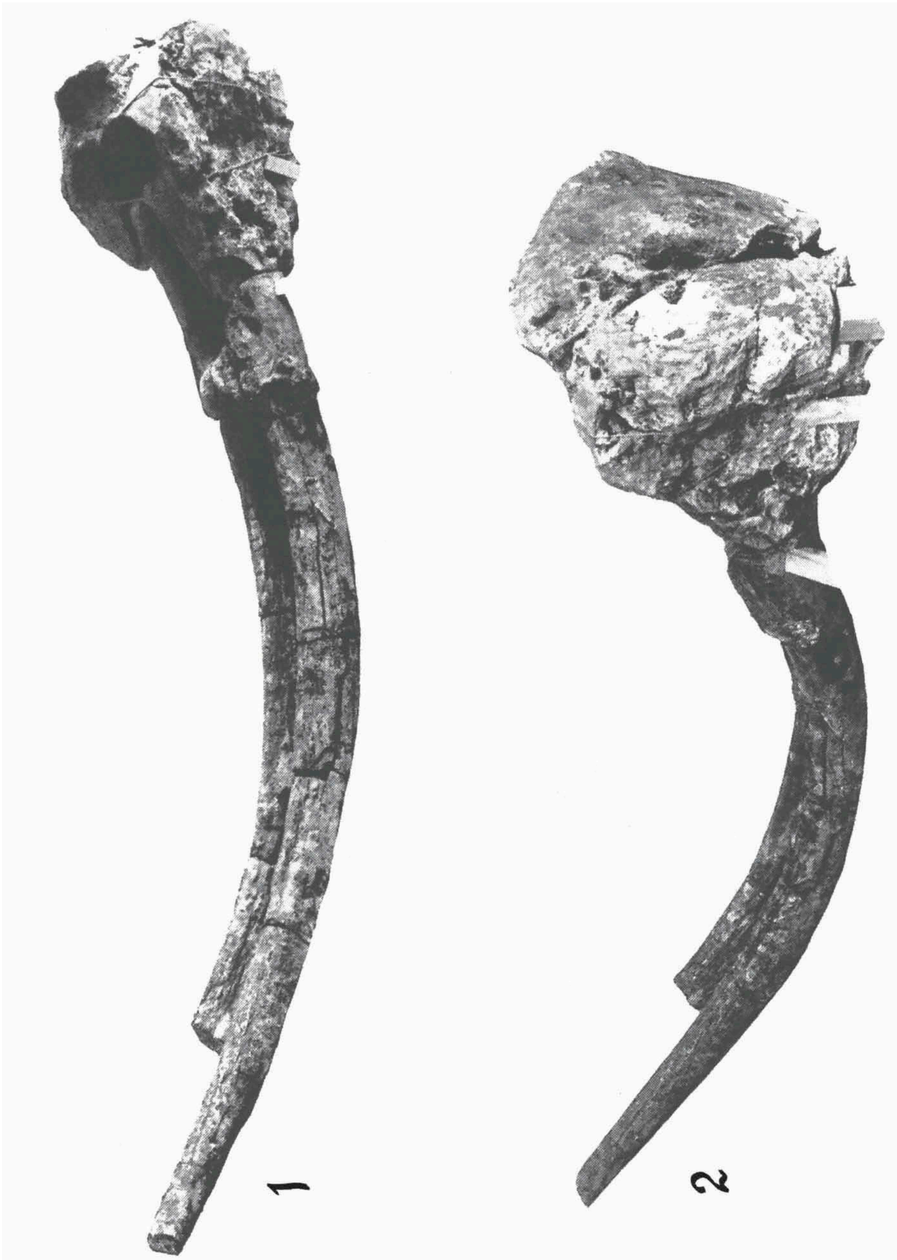
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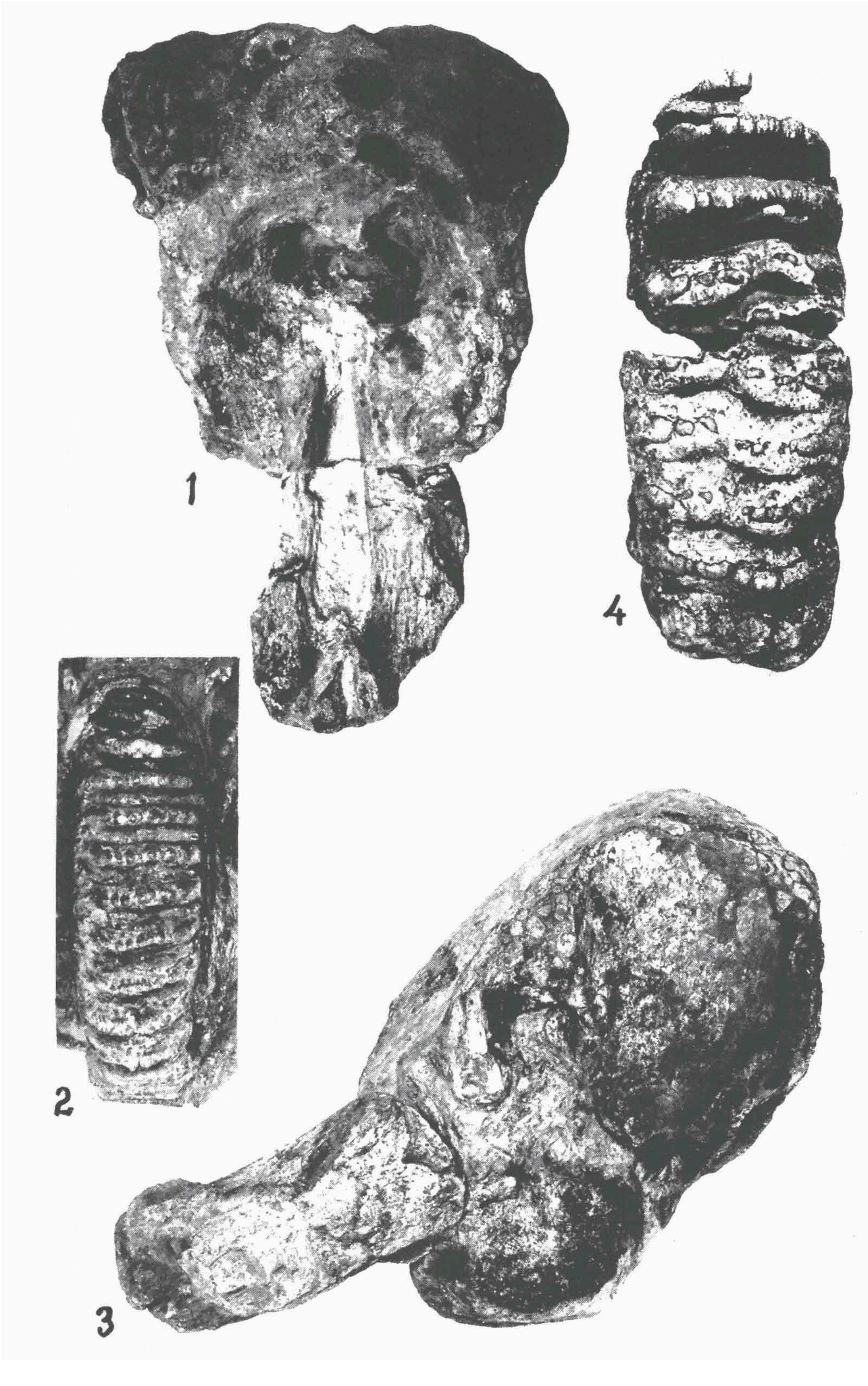
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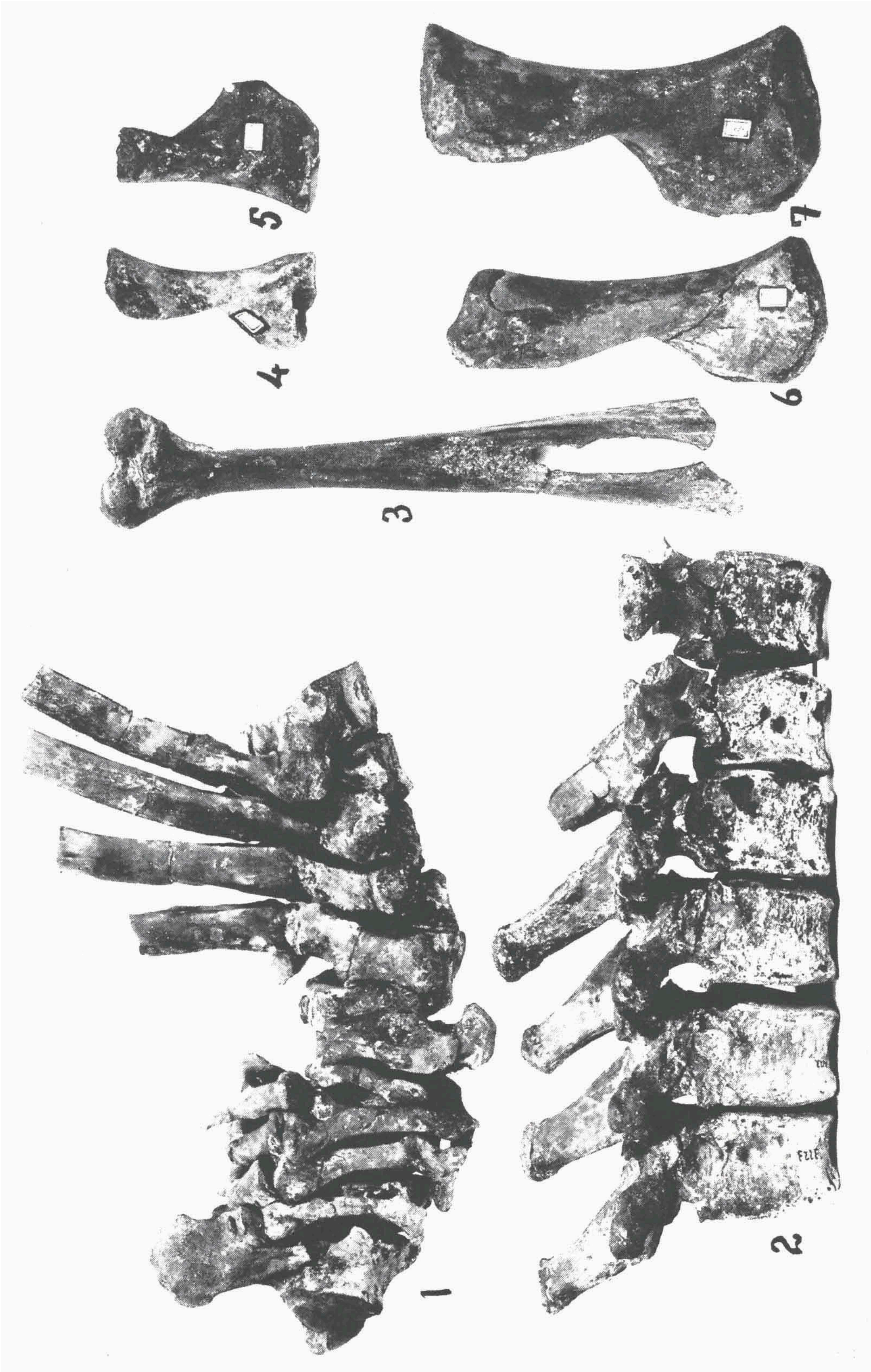
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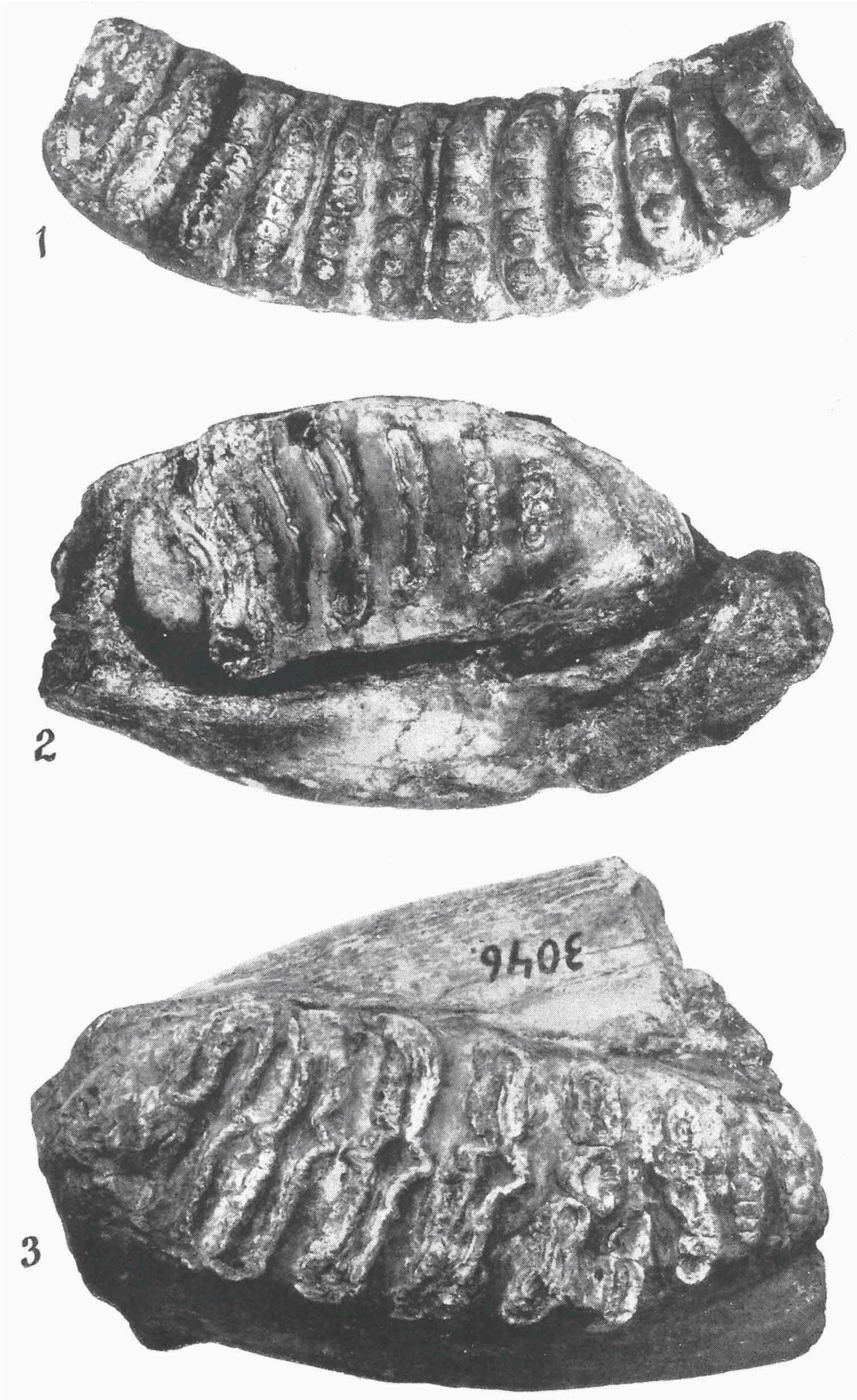
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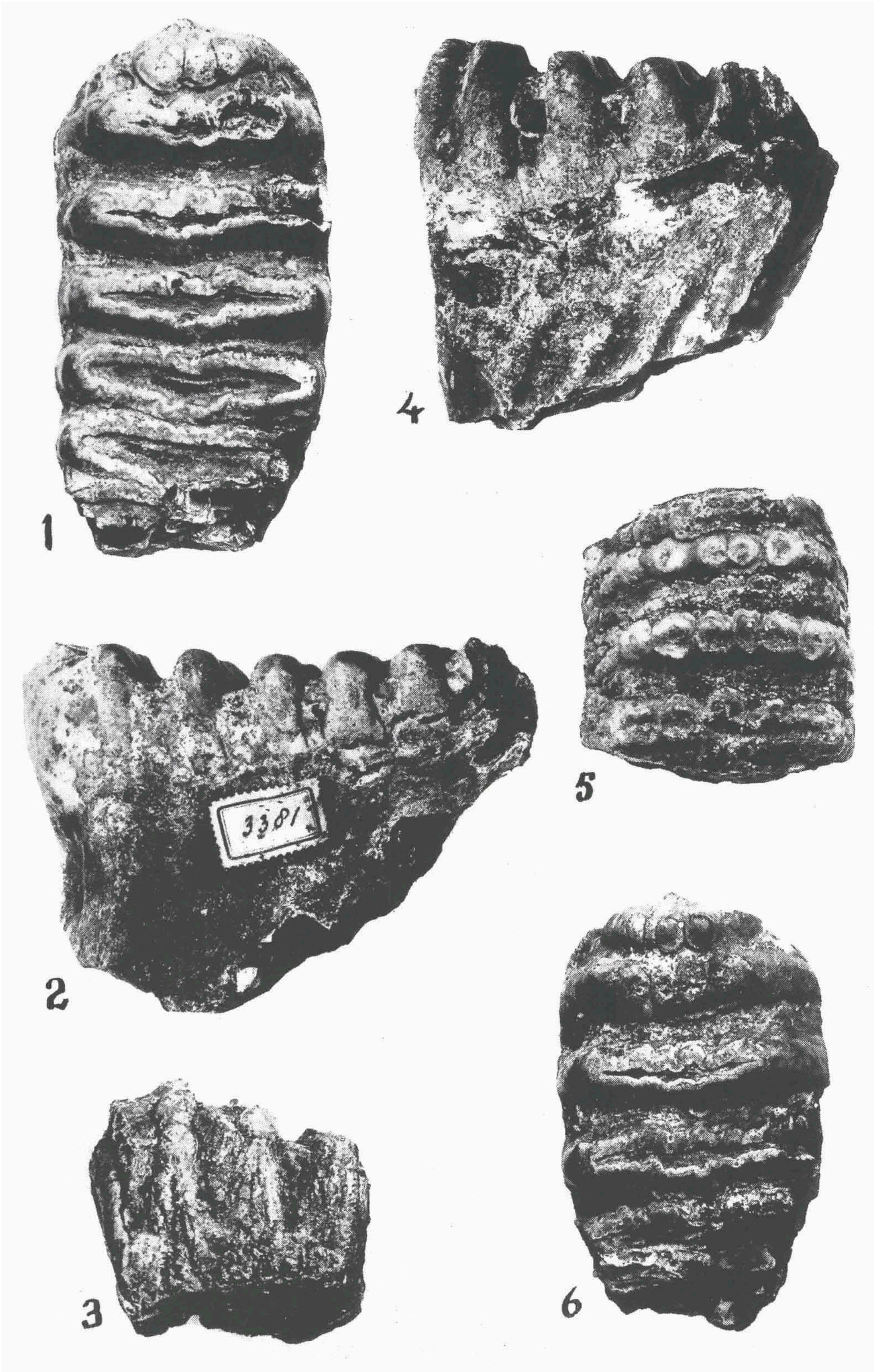
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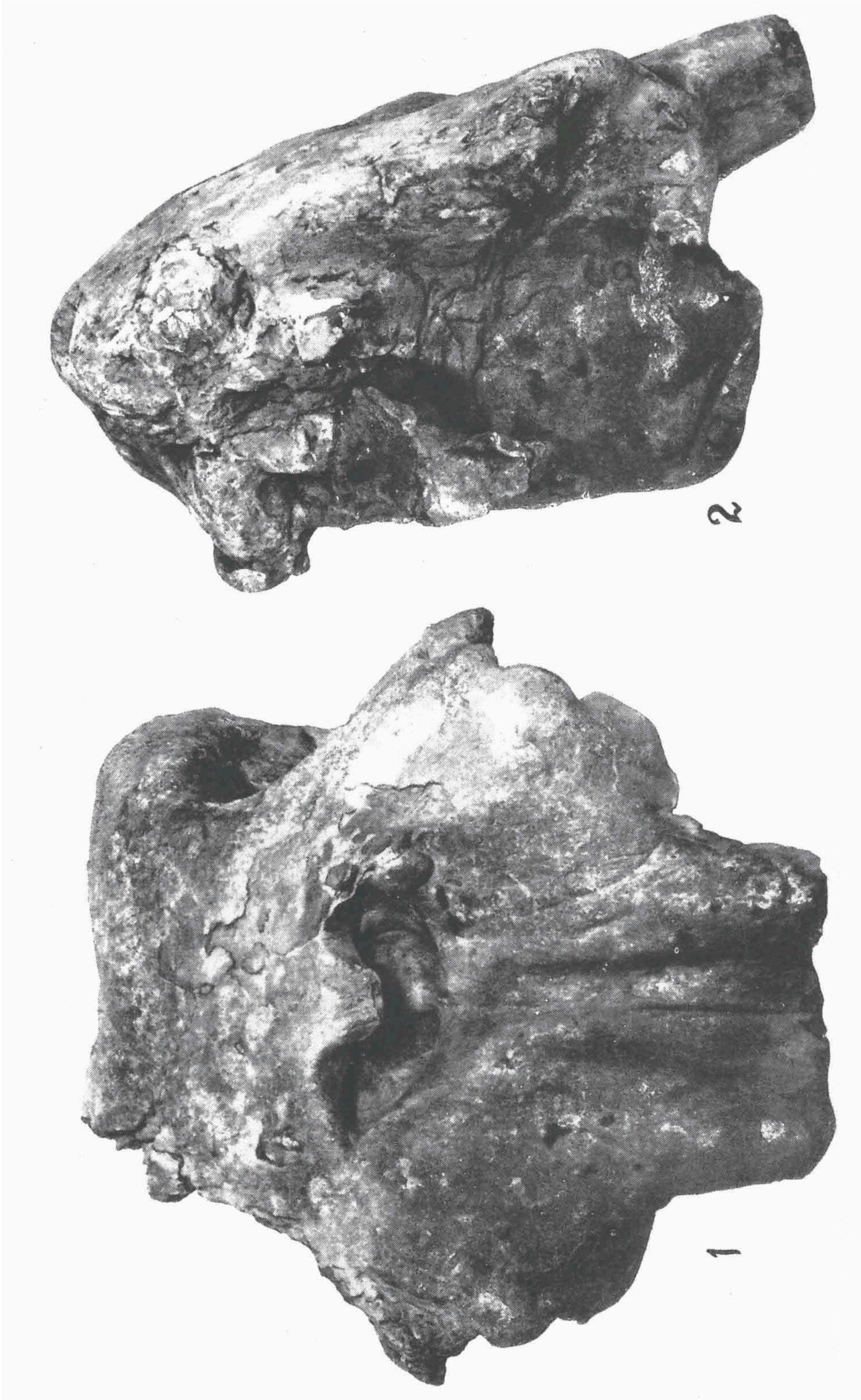
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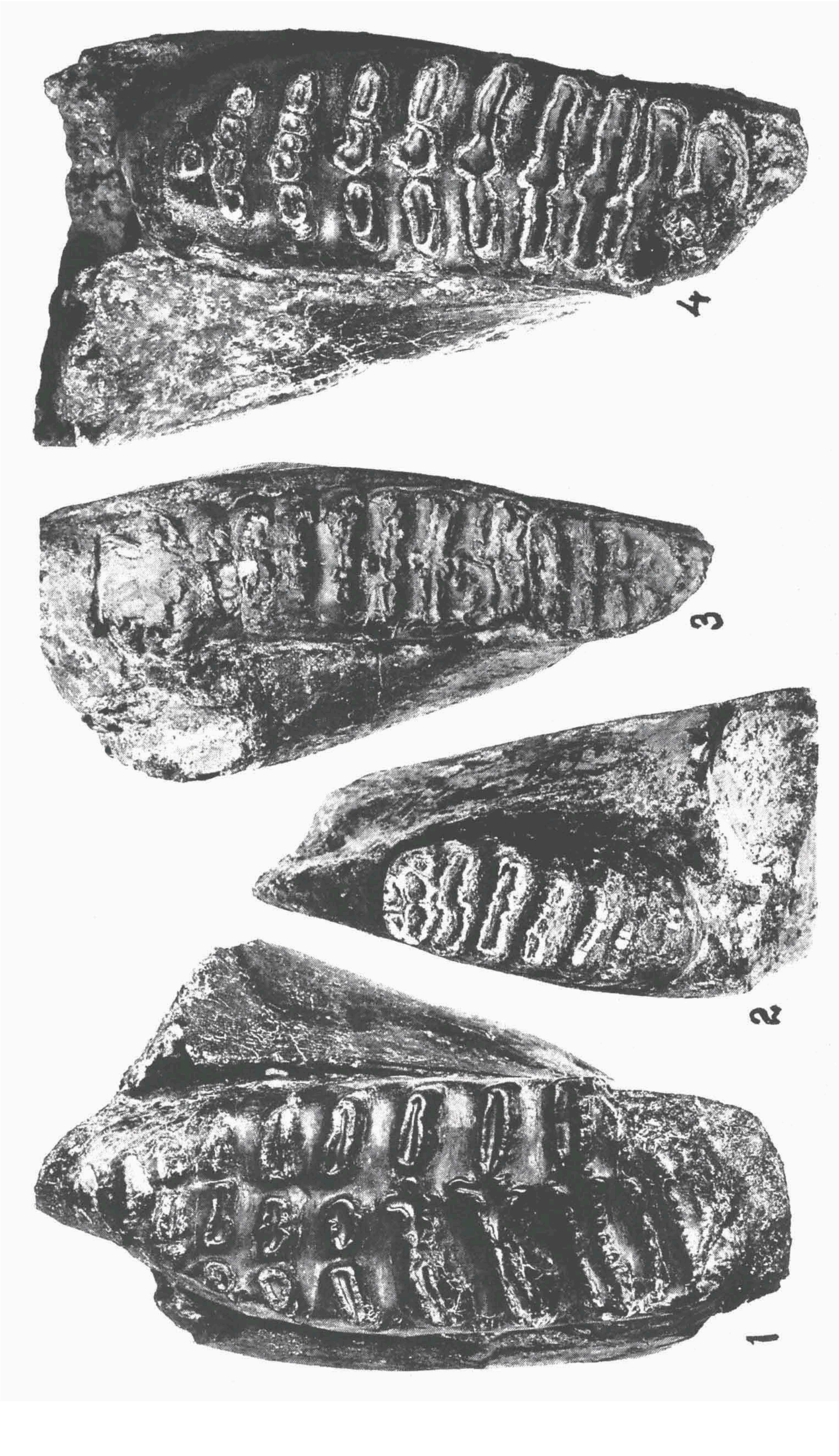
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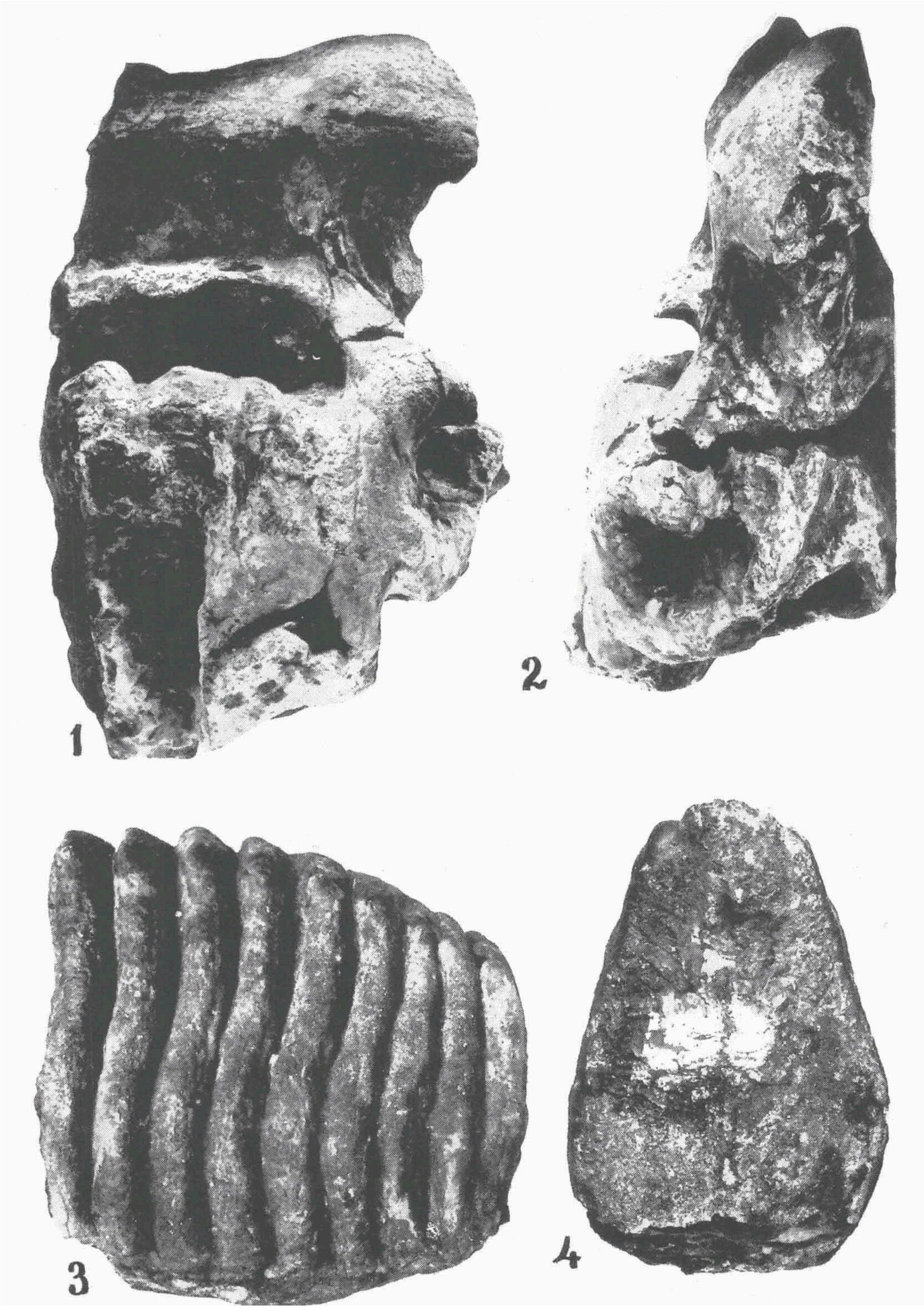
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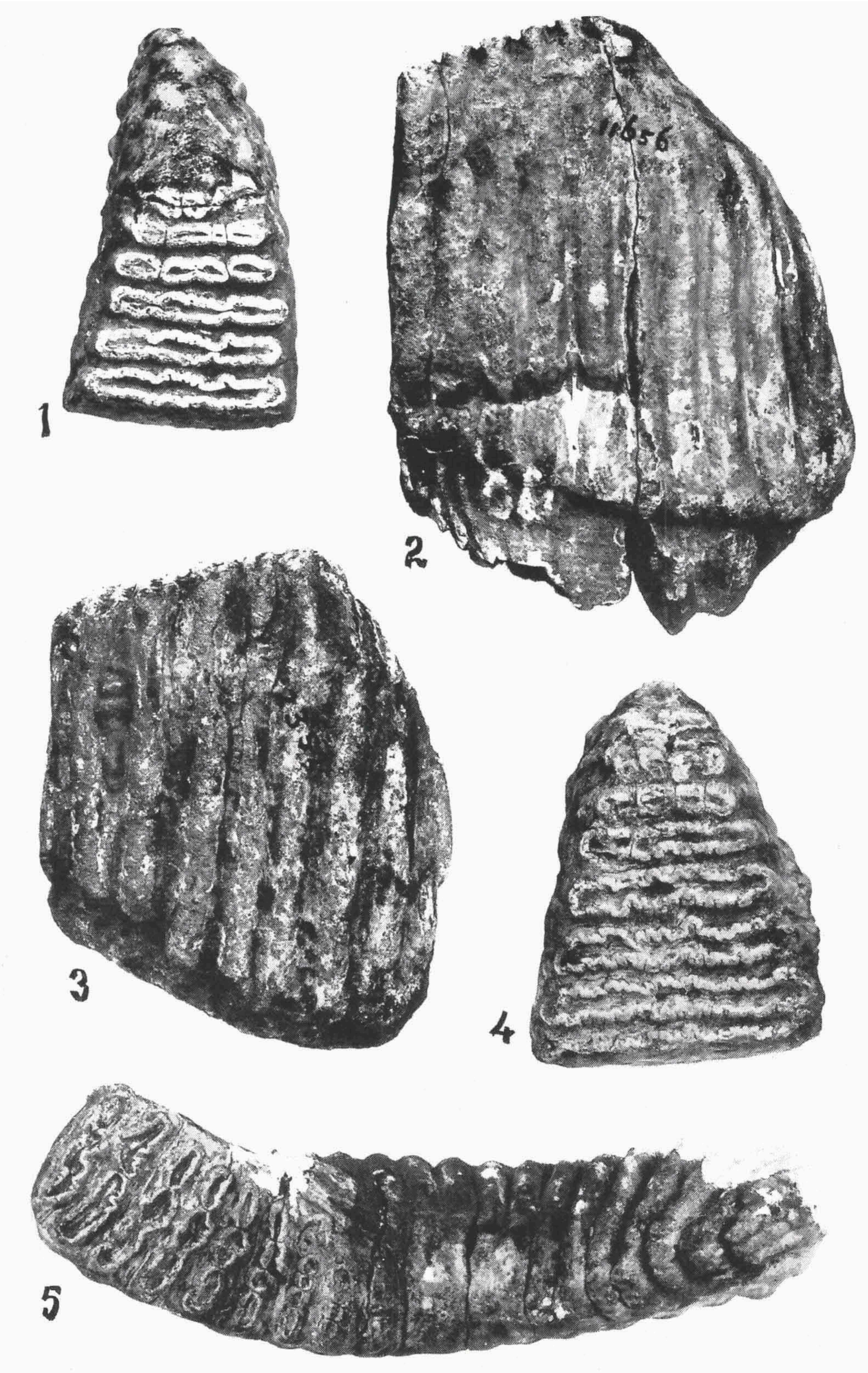
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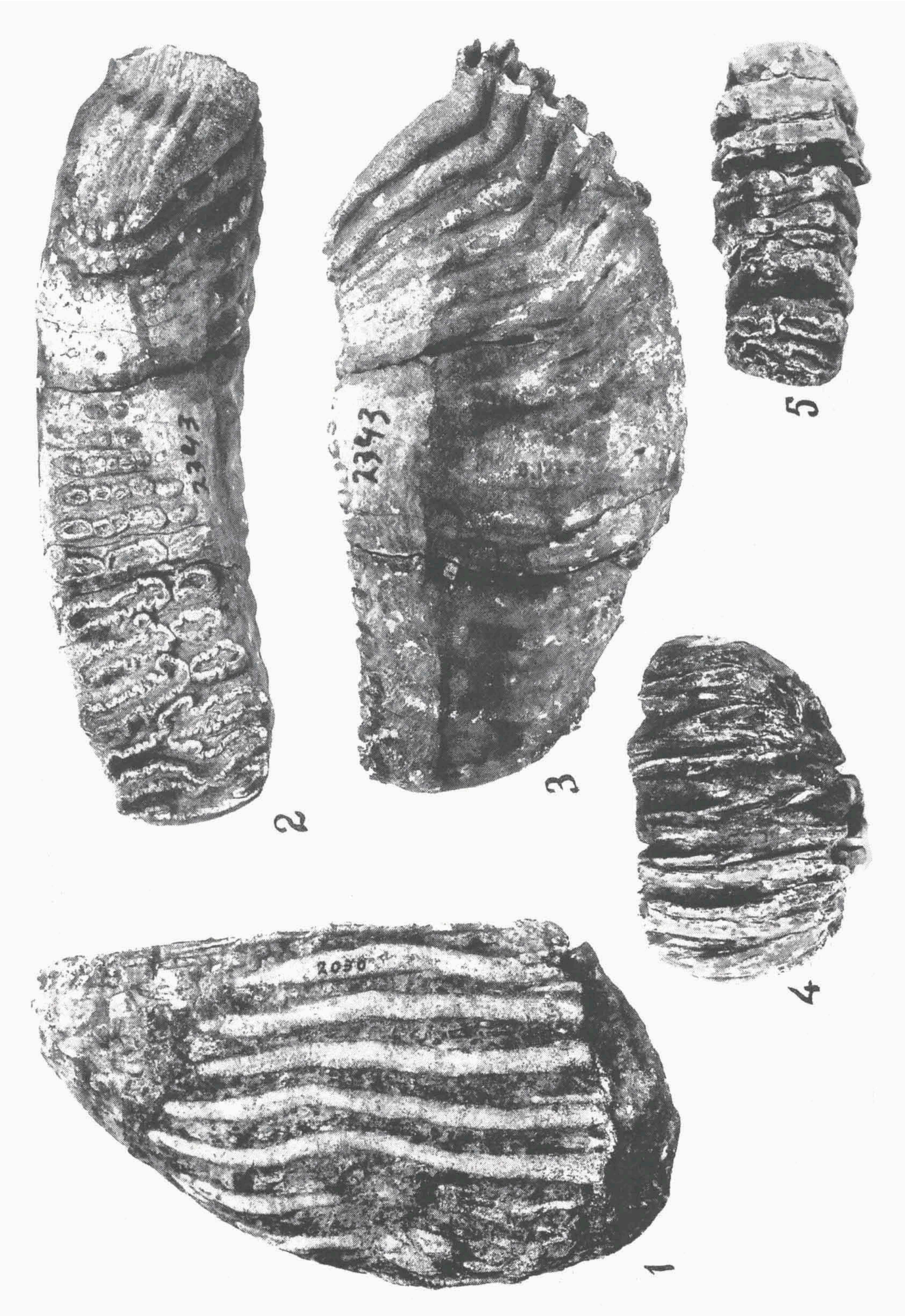
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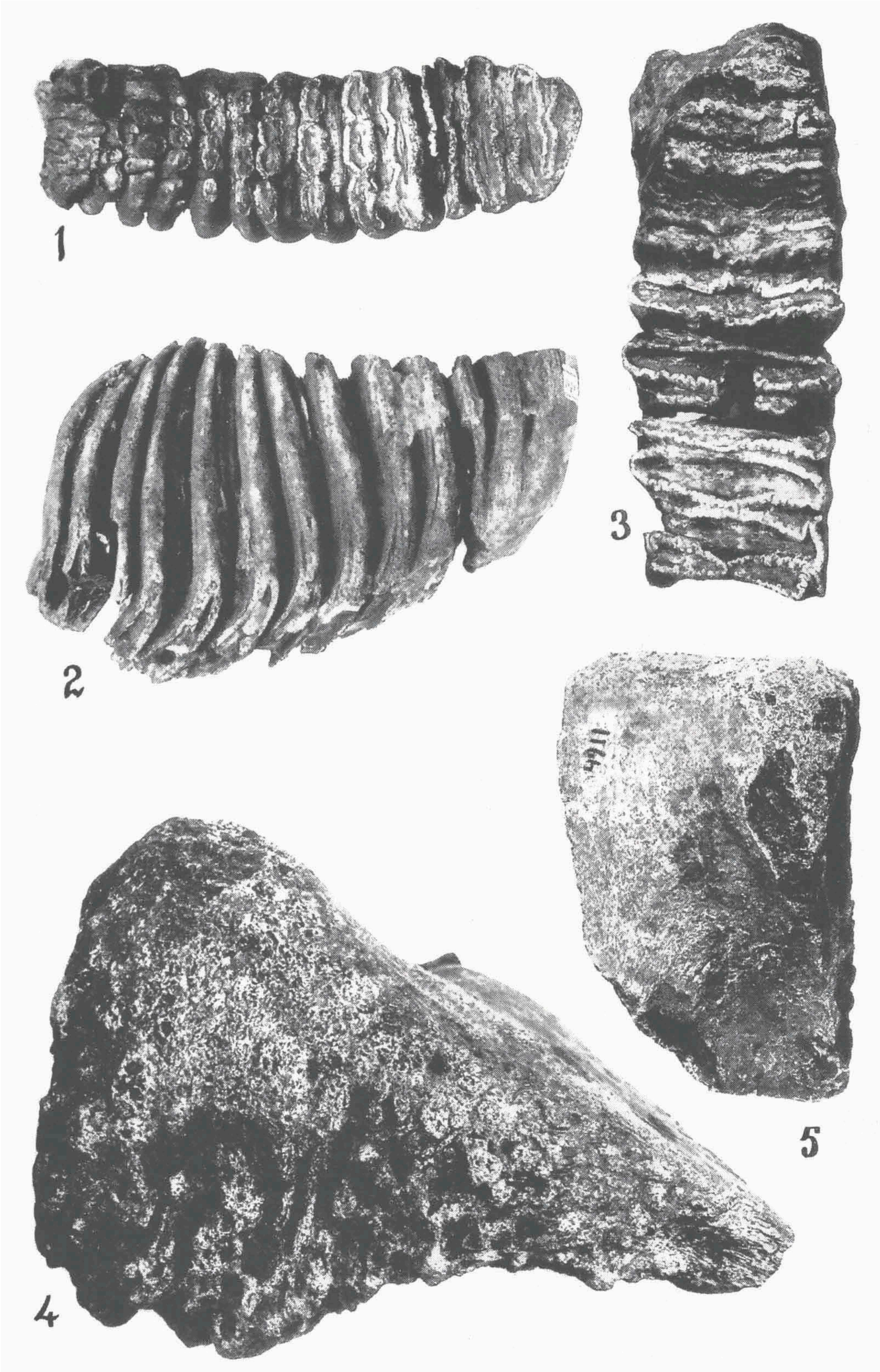
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