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***ELEPHAS CELEBENSIS* (HOOIJER) FROM THE PLEISTOCENE OF JAVA**

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With 2 plates

In a recent monograph, Maglio (1973) states that *Stegodon hypsilophus* Hooijer (1954a) must be considered a synonym of *Elephas celebensis* (Hooijer, 1949). Though *Elephas celebensis* is smaller-toothed and more hypsodont than the "hypsilophous stegodont" of Java (width of M³ 42-52 mm against 62-64 mm; height-width index 106-116 against 87-89; Hooijer, 1954a, b; Maglio, 1973: 46, table 21), Maglio (1973: 47) considers the differences not great when the degree of variation of known samples (in other species) is allowed for.

Over the years, I studied molars of pygmy proboscideans from various Indonesian islands, and it never occurred to me that the Java pygmy would be same as that from Celebes until this suggestion was put forth by Dr. Maglio. I had described the Java form as a progressive *Stegodon* although I did notice the elephantid build of the molar ridges: "The structure of the ridges, with two large conelets at either end and a number of smaller conelets in between that form a transversely convex edge, is essentially elephantine" (Hooijer, 1954a: 100). However, a molar was cut in mid-sagittal plane, and in that section, which I illustrated, the valleys are closed in at the bottom, Y-shaped, as in a stegodont. Maglio (1973: 47) observed that this is because of intermediate columns in the middle of the crown, confluent with the ridges. A cut laterally of the median line would have produced a valley section open to the bottom, V-shaped, as in an elephantid. Re-examination of the specimen (in the Geological Museum at Leiden) showed that the type of valley reproduced was indeed an artifact of sectioning. The valleys are Y-shaped only in the middle. In a stegodont the molar valleys are Y-shaped in longitudinal section all over the width of the crown, producing enamel figures that approach each other more closely from side to side upon wear than in elephantids with their intermediate columns, in which the valleys

remain open on the sides till the bottom has been reached by wear. Thus, *Stegodon hypsilophus* has the elephantid build of the valleys. I agree with Maglio that the pygmy proboscidean of Java should be placed in *Elephas* rather than in *Stegodon*.

Occasionally such intermediate columns do develop in *Stegodon* molars: I showed their presence between the anterior two ridges of molars of *Stegodon trigonocephalus* Martin, viz., an M_3 sin. from Mata Menge in Flores, and an M_1 dext. from Sangiran in Java (Hooijer, 1972a: 19/20, pl. 2 fig. 1, pl. 3 fig. 1), but in certain early elephantid molars they occur all over.

In Celebes, along with *Elephas celebensis*, there occurs a pygmy stegodont, *Stegodon sompoensis* Hooijer (1964a), which differs from the Celebes pygmy elephant in having smaller and less high-crowned molar ridges, with Y-shaped valley sections and no intermediate columns. In Timor there occurs *Stegodon timorensis* Sartono (1969), a form that is equally small. Molars subsequently obtained from the islands of Timor as well as Celebes proved inseparable in size and relative height of the crown: the length of an M_3 from Celebes is 135 mm, the width 45 mm, and the height-width index 84, while in the M_3 from Timor the length varies from 118 to ca. 145 mm, the width from 42 to 47 mm, and the height-width index from 78 to 88 (Hooijer, 1969: 204-206; 1972a: 27-28; 1972b: 8). The observed variation in the sample from Timor includes the Celebes material, and there is nothing for it but to consider *Stegodon timorensis* a synonym of *Stegodon sompoensis*, which has five years' priority. This is the most progressive species of *Stegodon* known at present: in *Stegodon trigonocephalus* from Java these indices are only 46 to 68 in the last molars (Hooijer, 1955: 42).

Elephas celebensis has not so far been found in Timor. We have a good many specimens of pygmy proboscideans from that island but all of them are stegodontid and not elephantid (Hooijer, 1972a). I regarded *Elephas celebensis* as a stranded, diminutive descendant of *Elephas planifrons* Falconer & Cautley, which until recently was considered to be the most primitive species of true elephant, and which occurs in the Upper Siwaliks of India, in China, Java, and at Bethlehem, Israel (Maglio, 1973: 44). The presence of functional lower tusks in *Elephas celebensis* (Hooijer, 1954b) was puzzling until Maglio (1970: 19; 1973: 46) discovered vestigial incisive cavities in the mandible of *E. planifrons* and suggested that the mandibular tusks in *E. celebensis* reappeared possibly through paedomorphosis as a result of dwarfing.

The Java pygmy elephantid that I originally described as *Stegodon hypsilophus* but now recognize as *Elephas* is larger-toothed, less hypsodont, and with a lower laminar frequency (the number of ridges in 10 cm of antero-

posterior crown length, that is) in homologous molars than *Elephas celebensis*. The entire M³ in situ in a skull of *Elephas celebensis* from Tjangkange, Celebes (Hooijer, 1972b) is 52 mm wide, eleven-ridged, with a height-width index of 108 and a laminar frequency of 7, whereas the type M³ of "*Stegodon*" *hypsilophus* has a greatest width of 64 mm, a height-width index of 89 at most, and a laminar frequency of 6.

There is an entire, seven-ridged upper molar from Tji Pangglosoran in Java described by Van der Maared (1932: 173, pl. XVII figs. 1-2) as an M¹ sin. of *Elephas planifrons*. It is worn all over and shows lozenge-shaped enamel figures such as seen in worn ridges of *Elephas planifrons* as well as *Elephas celebensis*. It was placed in a distinct genus and species, *Stegoloxodon indonesicus* Kretzoi (1950), which I thought was rather far-fetched, being inclined to agree with Van der Maarel's identification (Hooijer, 1955: 107). Maglio (1973: 46) regards it as an M² of *Elephas celebensis*. The length of the Tji Pangglosoran molar is 125 mm, which is the approximate length of the type M² of *Elephas celebensis* (Hooijer, 1954b: 109). Unfortunately, the crown height of the Java specimen cannot be determined, but its width (54 mm) is greater than that in M² from Celebes (42-47 mm), and its laminar frequency (6.5) is less than that in the Celebes M² (7.5-8). Hence, the Tji Pangglosoran molar differs from its Celebes counterpart in the same points as does the Java M³, and the view that it represents the pygmy elephant (as an M² dext.) is most likely the correct one.

There are some hitherto unpublished specimens from the area of the Sangiran dome in Java that I was able to buy from local collectors, as well as some found in the Geological Museum in Bandung and at the Gadjah Mada University in Yogya. The visits to Indonesia in 1970 and 1972 during which this material was obtained were financed by the Netherlands Foundation for the Advancement of Tropical Research (Wotro) at The Hague.

In the Bandung Museum I found several molar portions from Sangiran showing lozenge-shaped enamel figures. One holds four ridges evidently of a lower molar as the occlusal surface is concave anteroposteriorly. It narrows markedly to the back: the basal widths of the ridges are 56, 53, 50, and 46 mm, respectively. The laminar frequency is 6, and the thickness of the enamel shown on all the ridges is 3 mm. The hindmost ridge is the least worn, and its height in the unworn state must have been about 40 mm (height-width index 87). Another fragment, with two worn ridges and parts of two more, has a basal width of 60 mm by the same laminar frequency (6). I also saw an upper molar portion comprising three ridges worn to lozenge-shaped figures, with the same laminar frequency and a greatest basal width of 57 mm. These specimens present exactly the same worn enamel patterns

as those in *Elephas celebensis*: expanded in the middle to the front, and straight behind except for a slight median projection. Unfortunately I cannot present photographs, but the shape of the enamel figures is that of the worn paratype upper molar of *E. celebensis* (Hooijer, 1949, pl. VIII fig. 3), also seen in lowers (Hooijer, 1954b, pl. XXI figs. 1, 4). Widths and laminar frequency are consistent, and are those found in the last molars of the Java pygmy elephant (Hooijer, 1954a). In *Elephas celebensis* from Celebes the width of M^3 does not exceed 52 mm, and the height-width index is over 100.

In the Bandung Museum there is the molar portion recorded by Von Koenigswald (1934: 192, pl. IV figs. 8-9) as the posterior part of a right lower milk molar (?) of *Elephas* sp. Going by the description and figures (the apparent absence of median intermediate columns, and the relative height as given: width 48 mm, height 40 mm, height-width index 83) I had referred this specimen to *Stegodon hysilophus* (Hooijer, 1955: 87). The actual specimen holds three ridges and the hind talonid of a left lower molar; ridge 3 from behind lacks three central conelets and shows a median column anteriorly, while its basal width is 44 mm. Ridge 2 from behind is 43 mm wide, and its (unworn) height is 37 mm, giving a height-width index of 86. Ridge 1 from behind is incomplete below. The laminar frequency at base is 8. I agree that the specimen represents *Elephas*. As lower molars are somewhat narrower than uppers of the same serial position the present specimen would seem to represent either a first or a second molar, more probably the first. The M_1 from Sompoh in Celebes (Hooijer, 1953a: 315-316, pl. XIX) is completely known. The molar width is 31 mm, the height 29 mm, height-width index 94, by a laminar frequency of 11. The M_2 of *Elephas celebensis* have widths of 37-48 mm and laminar frequencies of 7-9 (Hooijer, 1954b: 113), and the Java specimen would fit into this range although the height-width index would have been higher in the Celebes form, as it is in the upper molars referred to above. There are two more specimens of the first or second lower molar of *Elephas* from Sangiran in the Bandung museum collection bearing the same number (K 441) as that recorded by Von Koenigswald, with the same laminar frequency (8) at base: the anterior portion of a left specimen with five ridges and anterior talonid, the first two ridges worn, the second ridge damaged laterally and three apical conelets of ridge 5 broken off (table 1), and the posterior portion of a right specimen holding four ridges and the hind talonid, all unworn (table 2). As will be seen, the widths of these specimens vary from 44 to 56 mm, and the height-width indices from 75 to 80: the left specimen at least is wider than the M_2 of the Celebes *Elephas celebensis*, and the height-width indices are lower than in either the M_1 or the M_3 (94, and 107-115) of Celebes.

Table 1
Measurements and indices of M_2 sin. from Sangiran (K 441)

No. of ridge	1	2	3	4	5
Basal width	43	—	53	54	56
Unworn height	—	—	42	43	—
Height-width index	—	—	79	80	—

Table 2
Measurements and indices of M_1 dext. from Sangiran (K 441)

No. or ridge from behind	4	3	2	1
Basal width	41	43	44	44
Unworn height	32	33	33	34
Height-width index	78	77	75	77

The specimen of table 2, just as that recorded in 1934 by Von Koenigswald, I regard tentatively as M_1 rather than M_2 . It is most unfortunate that we do not know the number of ridges in this element. In the M^2 from Tji Panglosoran in Java the number of ridges is only seven. As lower molars may have a slightly higher ridge formula than uppers of the same serial position these M_1 or M_2 might have had seven or eight ridges.

The anterior portion of a left lower molar, with four ridges and a small part of a fifth ridge preserved, the anterior two ridges worn, was bought by me at Sangiran in September, 1970, and was said to be from near Glagah Hombo (pl. 1, right figs.). As far as preserved, it is only a trifle smaller than an entire, eight-ridged lower right molar likewise from Sangiran that I described and figured earlier (Hooijer, 1964b: 81-82, pl. I figs. 1-2) as DM_4 of *Stegodon hypsilophus*. The measurements of the Glagah Hombo Sangiran specimen are given in table 3, and those of the 1964 Sangiran specimen in table 4.

Table 3
Measurements and index of M_1 sin. from Sangiran

No. of ridge	1	2	3	4
Basal width	31	33	34	—
Unworn height	—	—	—	—
Height-width index	—	—	77	—

Table 4
Measurements and indices of M_1 dext. from Sangiran (entire)

No. of ridge	1	2	3	4	5	6	7	8	talonid
Basal width	33	36	36	—	39	39	38	33	24
Unworn height	—	—	—	—	—	—	26	26	ca. 22
Height-width index	—	—	—	—	—	—	68	79	—

The laminar frequency of the Glagah Hombo M_1 is just 10; that of the entire Sangiran M_1 is $9 \frac{2}{3}$. Both specimens have median columns between the anterior three ridges. The full length of the Sangiran M_1 is 90 mm, the molar height-width index is 67. In 1972, in the Sangiran collection kept at the Anatomy Department of the Gadjah Mada University in Yogya, I found a right horizontal ramus of the mandible with most of one molar in situ. This specimen bears the number S 212 and was very kindly given to me for study by Professor T. Jacob: it is shown on pl. 2. The molar in situ is broken off through ridge 7 and is rather damaged.

However, the basal widths of at least the anterior three ridges can be taken, and these are 31, 33, and 34 mm, respectively. The height of ridge 2, which is undamaged apically, is 25 mm, giving a height-width index of 76. The laminar frequency of specimen S 212 is 8 lingually, and 10 buccally at base, or 9 in the median line of the crown. An intermediate column is seen through the cement at least in the valley behind ridge 2.

It is clear that the three specimens just mentioned, the Glagah Hombo one, the entire Sangiran one, and the one in situ in the mandible recovered in 1972 are lower molars of the same serial position. Now in front of the molar in situ there are crown and root portions of another molar the outlines of which are seen on the edge of the jaw (pl. 2). A few mm in front of the molar in situ there is the posterior base of a crown, 33 mm wide, and truncated behind. The molar cut at the edge of the jaw is at least 65 mm long: there is in the anterior portion of the jaw a broken anterior root, constricted in the middle, 20 mm wide and 10-12 mm anteroposteriorly. Between it and the posterior portion there is an interval of about 20 mm that shows no trace of the tooth. This is the interval that we always observe in elephantid molars: the small anterior root supports the anterior two or three ridges only, and the remainder of the root mass is curved backward and well separated from the root in front.

I have a specimen that would fit in the position of the molar that is missing in the Sangiran mandible. It was bought at Trinil in November, 1972, and is from the left side of the lower jaw (pl. 1, middle figs.). The crown is worn, and only five ridges plus the posterior talonid are preserved. The posterior root mass, recurved posteriorly, is there, but nothing of the anterior root. Comparison with more complete specimens shows that two or three ridges are broken off in front, giving a total of seven or eight. The width of the 4th, 3rd, and 2nd ridges from behind are 30.5, 31.5, and 31.5 mm, respectively; the last ridge is incomplete lingually at base. The foremost preserved ridge is worn down to these base of the crown, and the others show wrinkled enamel with median expansions. Three full ridges occupy an anteroposterior length of 25 mm, giving 12 for the laminar frequency. If there had been

seven ridges and the anterior talonid, or eight ridges in all, the length of the crown would have been just about 65 mm.

The incomplete specimen just described I interpret as DM_4 , and the molar in situ in the Sangiran mandible as M_1 . Thus, the M_1 of the Java pygmy elephant also represented by the entire, isolated Sangiran specimen, is 90 mm long by a greatest width of 39 mm, eight-ridged, with a laminar frequency of 9 to 10. The DM_4 of the pygmy elephant, as represented by the crown and root remains in the Sangiran mandible and the incomplete, isolated Trinil specimen, is about 65 mm long by a greatest width of about 33 mm, seven- or eight-ridged, with a laminar frequency of 12.

Let us now compare these findings with the homologous teeth of *Elephas celebensis* from Celebes. The M_1 of *E. celebensis* is 85 mm long, 31 mm wide, eight-ridged, and has a laminar frequency of 11 (Hooijer, 1954b: 113). Its height-width index is 94. The DM_4 of *Elephas celebensis* from Celebes is not so well known: in the Sompoh collection it is represented only by the middle portion of a left specimen (Hooijer, 1953b: 226, pl. VII fig. 8), 22 mm wide, and with a laminar frequency of 13. The DM_4 as well as the M_1 from Java, therefore, are somewhat wider, with lower laminar frequencies, than the homologous molars from Celebes, the same differences we observed between the homologous upper molars of Java and Celebes.

There is an entire lower right milk molar from Sangiran (pl. I, left figs.) that cannot be but the DM_3 . It carries seven ridges between the talonids, and widens gradually from front to back: the anterior width is 21.5 mm, and that behind, 26 mm. The total length of the crown is 50.5 mm. All the ridges are worn, but the height of the last full ridge can be determined with reasonable certainty as 18 mm, giving a height-width index of 70. The laminar frequency of the Sangiran DM_3 , may be given as 14, or 16 (there are almost four full-sized ridges in an anteroposterior length of 25 mm). The DM_3 from Celebes is known from an entire, rather much worn specimen, 32 mm long, 20.5 mm wide, six-ridged, with a laminar frequency of 20 (Hooijer, 1954b: 113; figured in Hooijer, 1953b, pl. VII figs. 5-6). In the Java specimen the enamel figures of the moderately worn ridges show median expansions and intermediate conules; in the more worn Celebes specimen the enamel figures of the ridges are confluent in the middle but separate on the sides. The Java specimen is the larger, with a lower laminar frequency, and its height-width index (70) is in keeping with those obtained from other Java molars, rather less than those of Celebes molars and milk molars.

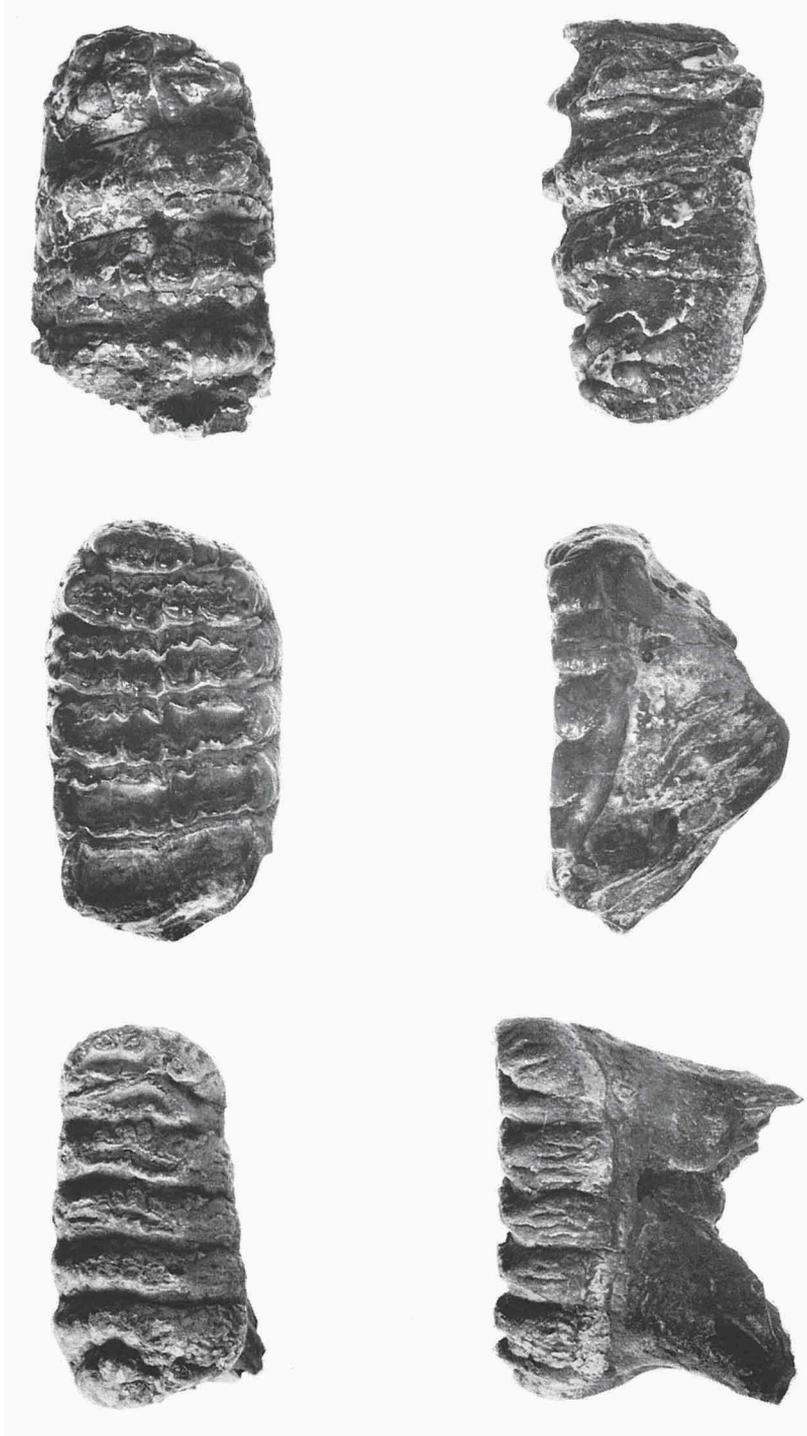
This is all the material I have available at the moment of the pygmy elephant of Java. The differences from *Elephas celebensis* of Celebes are consistent in every molar or milk molar we have been able to compare. It is

clear that in the process of reduction in size and relative heightening of the molar crowns the Java pygmy elephantid is less advanced than that of Celebes. Yet, the two island forms may be accommodated in a single species, as advocated by Maglio. Within the species *Elephas planifrons*, which both of us believe to be the mother species from which the island forms sprang, last upper molar widths range from 86 to 111 mm, height-width indices from 80 to 110, and laminar frequencies from 2.6 to 5.5 (Maglio, 1973: 45). In view of the consistent differences in the morphology of the molars it would seem expedient, however, to retain distinct subspecific names for the Celebes and the Java pygmy forms of *Elephas celebensis*, the former becoming *Elephas celebensis celebensis*, and the latter *Elephas celebensis hypsilophus*, no matter how utterly meaningless, and even downright misleading the name *hypsilophus* is for the subspecies of *Elephas celebensis* that is the less hypsilophous of the two. Even though a better sample is now available than was known to Dr. Maglio there is no overlap in size or relative crown height between the two insular forms: in *E. celebensis celebensis* molars the height is from 5 per cent less to 15 per cent greater than the width, and in *E. celebensis hypsilophus* molars the height is 30 to 10 per cent less than the width, as in the most primitive *Elephas planifrons*. Whether *E. celebensis hypsilophus* had functional premolars and external mandibular incisors, too, we do not know as yet, but these are primitive elephantid characters occurring in the gomphothere ancestors of the elephantids, and it is probable that these will be found to occur in the Java pygmy form as well.

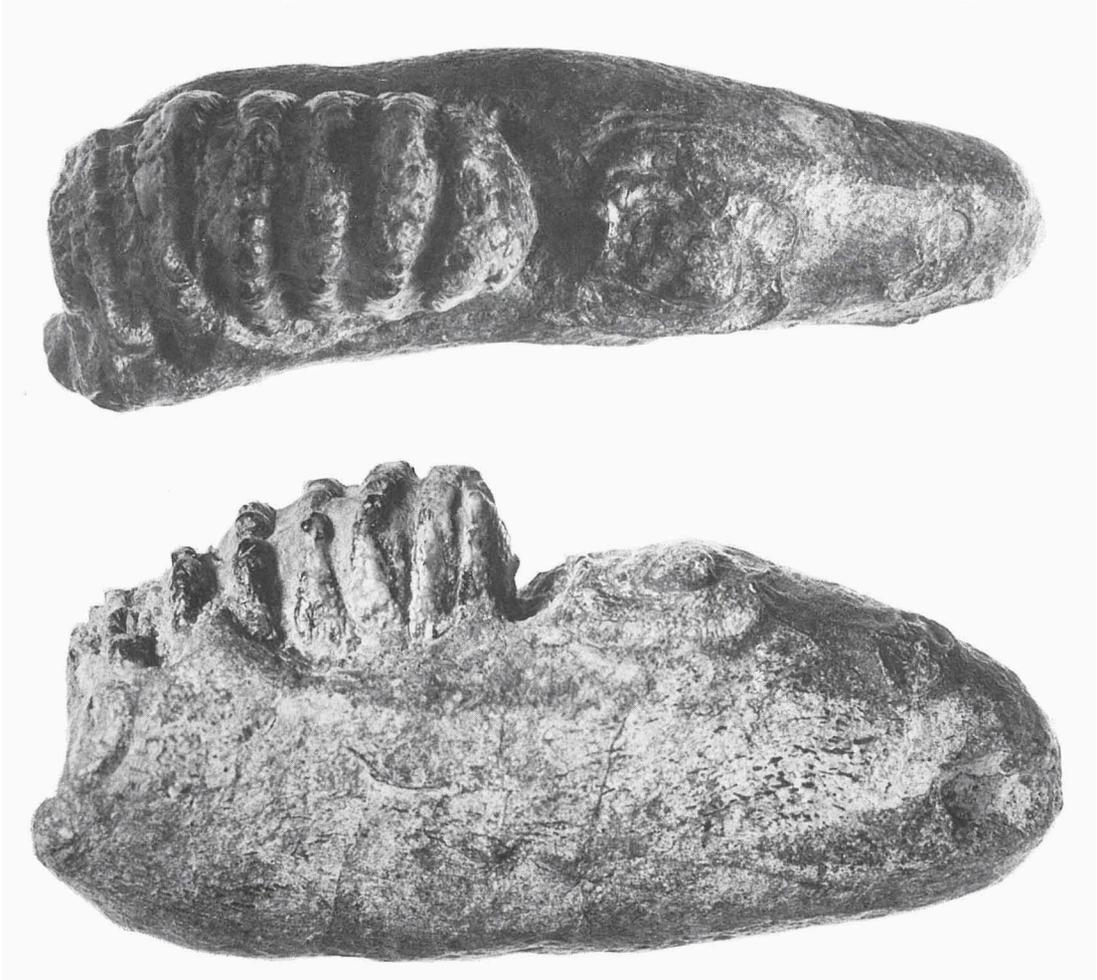
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Elephas celebensis hysilophus (Hooijer). From left to right; DM₃ dext., Sangiran, Java; DM₄ sin., Trimi, Java; M₁ sin., Sangiran, Java; crown (top) and external (bottom) views. All figs. nat. size, C. Hoorn phot.



Elephas celebensis hypsilophus (Hooijer), right horizontal ramus of the mandible with DM₄ broken off and anterior portion of M₁, Sangiran, Java; crown (top) and external (bottom) views. 4/5 nat. size. C. Hoorn phot.