PREHISTORIC TEETH OF MAN AND OF THE ORANG-UTAN FROM CENTRAL SUMATRA, WITH NOTES ON THE FOSSIL ORANG-UTAN FROM JAVA AND SOUTHERN CHINA

by

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with pls. I-IX and 2 diagrams

> ... there is one point which has delayed the right conception and understanding of the evolutionary process for a long time. This was the idea that the older the morphological age of the human form is, the more it must approach the living anthropoids. This conclusion did not take into account that the big apes, too, must have undergone essential changes during the same period of time in which man evolved.
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> WEIDENREICH, Apes, Giants, and Man, Chicago, 1946, p. 11/12.

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INTRODUCTION

Man's natural interest in his nearest relatives has built up an enormous literature with reference to the orang-utan, *Pongo pygmaeus* (Hoppius) (*Simia satyrus* auct.). The species is living today in northern Sumatra and in northern, western and southern Borneo. On the ground of size, colour, the development of cheek callosities, and cranial differences which were thought to be of systematic importance, the early authors have distinguished various species. In the opinion of modern authors, however, the Sumatran and Bornean orang-utan are conspecific, and it is believed that they are not separable even subspecifically (Harper, 1945, p. 164).

The discovery of prehistoric and fossil teeth of the species beyond its present habitat has proven that *Pongo pygmaeus* (Hoppius) is a relict form. In prehistoric times the animal was more widely distributed over the island of Sumatra, at least to the central portion of the island, and in the Pleistocene it roamed the forests in Java and southern China as well.

The study of the prehistoric and fossil teeth collected by Eug. Dubois more than half a century ago in the islands of Sumatra and Java was undertaken in order to establish whether the species has undergone a certain amount of differentiation in the course of time. The result is affirmative; the dental characteristics of the recent orang-utan, used in so many studies relative to the comparative anatomy of man and the apes, are shown in the present paper to be the outcome of an evolutionary change since the emergence of the species early in the Pleistocene. It even has been possible to distinguish subspecies in the time dimension. The most conspicuous and least unexpected difference between the fossil and subfossil teeth on one hand, and the recent on the other, consists in the excess in size of the former over the latter. In addition, seven trends in the dental evolution were revealed, all stamping the forerunner of the orang-utan as a more simian form than the recent; still further removed in structure from man in the points which differentiate the recent orang-utan from recent man. The details are given in the chapters dealing with the various types of teeth separately, and are summarized in the concluding chapter of this work.

The following is a survey of the literature.

In the early years of his search for the forerunner of man Dubois made a collection of teeth from caves in the Padang Highlands, Central Sumatra. It seems necessary to restate the considerations that induced Dubois to seek for the "missing link" in this part of the earth, since even Weidenreich (1942) is not aware of them. They are (cf. Dubois, 1888): 1. the supposition of Darwin, that man has lost his hairy coat in a warm climate, and 2. the remark of Wallace that a study of the cave fauna in those regions of the earth where anthropoid apes are still living today might furnish evidence of the history of descent of man. The alleged occurrence of an ape allied to or identical with the orang-utan in the Siwalik fauna (Falconer, 1868, I, p. 304, II, p. 578) already led Lydekker to the conclusion that the ancestral home of the larger Pongidae was probably the Oriental region (Dubois, 1888, p. 159/60).

From the close resemblance of the Sumatran cave teeth to those of the species still inhabiting the island Dubois thought this fauna to be too young for his purpose of finding *Pithecanthropus,* and, in 1890, after two years' exploration in Sumatra, he set foot on Java, the island which within a few years would supply him the desired fossils. Dubois referred the cave fauna of Sumatra to the prehistoric portion of the Holocene (Dubois, 1891, p. 93) and never returned to this subject in his subsequent papers.

The two molars from Trinil which were adequately figured by Dubois only in 1924, and attributed by him to *Pithecanthropus erectus* (Dubois) have been stated to belong to the orang-utan by Miller (1923), Weidenreich (1937) and Von Koenigswald (1940). This identification is made the more probable by the finds of undoubted orang-utan teeth in the Pleistocene of Java by Von Koenigswald (1939, 1940).

About a decade ago, the orang-utan was traced into China. Pleistocene teeth from Chinese drug stores and supposed to originate from the Kwangsi caves were recorded as such almost simultaneously by Pei (1935) and Von Koenigswald (1935). Previously they had been described as "? *Aeluropus* sp." by Young (1932). The latter specimens originate from the province of Yunnan. The orang-utan has been found up to now only in the south of China. In the Chou Kou Tien fauna the orang-utan has so far not been met with, but Von Koenigswald (1935, p. 879) records teeth of "cf. *Sinanthropus*" which were bought together with those of the orang-utan in Chinese drug stores; this material is supposed to come from the Kwangsi province.

Lately Weidenreich (1942, p. 65) wrote: "The knowledge of early man in Indonesia is thus far restricted to Java. Nothing has been known about occurrences in other Indies islands. But Dubois collected fossil and subfossil teeth of an orang-utang from caves of Sumatra. This anthropoid was a contemporary of *Pithecanthropus* not only in Indonesia but also in the south-east of the Asiatic mainland. If orang-utang migrated from Java into Sumatra during the Lower Pleistocene and lived there, why could not *Pithecanthropus* do likewise?"

In fact, we have no evidence whatever yet that mammals migrated from Java into Sumatra during the lower Pleistocene. But the caves in central Sumatra examined by Dubois indeed yield a number of species which we find in the Pleistocene of Java too. As has been proven for some, but is probable for all of them, they are represented by distinct races other than those which we find today in Sumatra and/or Java. I mention the following:

Acanthion brachyurus (L.) subsp.
Panthera tigris (L.) subsp.
Panthera pardus (L.) subsp.
Helarctos malayanus (Raffles) subsp.

Elephas maximus L. subsp.
Tapirus indicus Desmarest subsp.
Rhinoceros sondaïcus Desmarest subsp.

Of the above list the porcupine and the tiger have a subspecies in Sumatra and one in Java, the panther is extinct now in Sumatra, and the bear, the elephant and the tapir have vanished from Java, the rhinoceros has nearly so.

The cave fauna from the Padang Highlands in Sumatra, as far as represented in the Dubois collection (I have not heard of any subsequent collecting of mammalian remains in these caves) does not contain, however:

Manis palaeojavanica Dubois
Crocuta sinensis (Owen) (= *C. bathygnatha* (Dubois))
Stegodon trigonocephalus Martin
Hippopotamus sivajavanicus (Dubois)
Hippopotamus koenigswaldi Hooijer
Hippopotamus namadicus Falconer et Cautley
Sus brachygnathus Dubois
Sus macrognathus Dubois
Axis lydekkeri Martin
Duboisia kroesenii (Dubois)
Bubalus palaeokerabau Dubois
Rhinoceros kendengindicus Dubois

which list (far from complete) only contains extinct forms. Why should the Primates be an exception to the rule that the Sumatran cave fauna contains only living species? The orang-utan, together with other recent apes and monkeys, must be added to the first given list, and *Pithecanthropus* would only logically appear in the second list, of extinct species. And, in fact, it does.

In the Sumatran cave collection there is not a single tooth which one could refer without reasonable doubt to *Pithecanthropus*.

I have found some hominid teeth in the Dubois collection from Sumatra, but they are indistinguishable from the corresponding elements in the dentition of recent man. I may refer the reader to pp. 182-187 of the present paper for their description and discussion.

On pp. 272-280 reference is made to the two molars which Dubois referred to his *Pithecanthropus erectus*. I cannot but confirm the statements of Miller, Weidenreich and Von Koenigswald as to their belonging to the orang-utan.

The list of recent material is given below; the measurements of the recent teeth are given in the tables at the end of this work. The measurements of the subfossil teeth are given in the sections dealing with the incisors, canini, premolars, molars and milk teeth separately. Of each set of measurements

I give the mean: M. If the number of variates is n, the standard deviation $\sigma = \sqrt{\frac{\text{sum of squares of deviations}}{n}}$. The standard deviation is a measure of the variability about the mean. 68.3 % of the variates will be found within the limits M ± σ, 95.5 % of the variates between the limits M ± 2 σ and 99.7 % between M ± 3σ (Droogleever Fortuyn, 1927, p. 12). A measure of the variation as a percentage of the mean is given by the Pearsonian coefficient of variation $C = \frac{\sigma}{M} \times 100$.

The subfossil teeth were found to average a little larger than the recent. To determine whether or not the difference in size has statistical significance one has to compute the mean error or standard error $E_M = \frac{\sigma}{\sqrt{n}}$. Differences from the mean greater than three times E_M have statistical value. If two sets of measurements are compared, viz., those of the recent and those of the subfossil teeth, the difference between the means has statistical significance if it is three times greater than the standard error of this difference $E_{\text{diff.}}$. The latter is found by the formula (cf. Droogleever Fortuyn, 1929, pp. 33, 35) $E_{\text{diff.}} = \sqrt{E_{\text{Mrec.}}{}^2 + E_{\text{Msubfoss.}}{}^2} = \sqrt{\frac{\sigma\ \text{rec.}^2}{n_{\text{rec.}}} + \frac{\sigma\ \text{subfoss.}^2}{n_{\text{subfoss.}}}}$. I am greatly indebted to Miss M. C. Kerkhoven for assistance in computing the various means, standard deviations and coefficients of variation.

The recent material used for this study is from the Leiden Museum (49 skulls), and the Zoological Museum (25 skulls) and Zoological Laboratory (7 skulls) of the university at Amsterdam. My thanks are due to Prof. Dr. L. F. de Beaufort and to Prof. Dr. J. E. W. Ihle at Amsterdam for the loan of the specimens kept in the institutions under their charge.

LIST OF ORANG-UTAN SKULLS EXAMINED 1)

1. L.M., reg. no. 288.12, ♀, right bank of the Barito river, Boetok, Borneo. P. te Wechel don., 15-1-1913. (Skull of neonatus).

Infants with complete milk dentition

2. L.M., cat. e. Borneo.
3. A.M., A 11. Borneo.
4. A.M., ♂. Sumatra. Mrs. Colenbrander don. From the Amsterdam Zoological Garden, 30-8-1931.

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1) L.M. = Leiden Museum, A.M. = Zoological Museum at Amsterdam, A.Z. = Zoological Laboratory at Amsterdam.

5. L.M., reg. no. 288.5 ♂, Borneo, see 1.
6. A.M., A 19. Borneo, coll. Vrolik.
7. L.M., cat. f. Borneo.
8. L.M., cat. h. ♂, Borneo.
9. L.M.. cat. o. Borneo, received in 1861.
10. L.M., cat. c. ♂, Borneo, from the Rotterdam Zoo, 1876.
11. A.Z., no. 202. From the Amsterdam Zoo, 1912.
12. A.M., A 8. ♂, Borneo, coll. Vrolik.
13. A.Z., no. 10, no data.
13a. L. M., cat. c 2. Pontianak, Borneo. From Diard.
14. A.Z., no. 203. From the Amsterdam Zoo, 1913.

Juveniles I (M^1 erupted)

15. L.M., cat. m. ♂, southern Borneo. From S. Müller.
16. L.M., reg. no. 288.13. ♀, Borneo, see 1.
17. L.M., cat. n. Southern Borneo. From Schwaner.
18. A.M., A 20. Borneo.
19. L.M., cat. w. ♀, Atjeh, N. Sumatra. From the Rotterdam Zoo, 1892.
20. A.M., A 10. Borneo, coll. Vrolik.
21. A.M., S.E. Borneo. Van Stagen don., from the Rotterdam Zoo, 12-1-1932.
22. A.M., Coll. A. C. Wertheim, 1923.
23. A.Z., no. 200.
24. L.M., reg. no. 288.7. ♀, Borneo, see 1.
25. L.M., cat. g. ♂, southern Borneo, from Reinwardt.
26. A.M., A 9. Borneo.
27. L.M., cat. b. ♀, southern Borneo, from Reinwardt.

Juveniles II (M^2 erupted)

28. L.M., cat. x. ♀, Borneo. From Prakke, 1894.
29. A.Z., no. 200a. ♀, from the Amsterdam Zoo, 23-1-1922. M_3 almost in place, the left are malformed.
30. L.M., reg. no. 288.4. ♀, Borneo, see 1.
31. L.M., cat. z. ♀, western Sumatra. From the Zoological Garden at The Hague, February 1896.
32. L.M., cat. l. ♀, southern Borneo. From S. Müller.
33. L.M., cat. d. ♂, Kotingan, S. Borneo. From S. Müller.
34. A.M., ♂, Tjalang, S. W. coast of Achin (Atjeh), N. Sumatra. Th. Mollinger don., 1-9-1920.
35. L.M., reg. no. 1799. ♂, Deli, Sumatra. From the Rotterdam Zoo, 20-12-1929.

Adult males

36. A.M., „Piet II". From the Amsterdam Zoo, 27-1-1941.
37. L.M., cat. a. Kotingan, southern Borneo. From S. Müller.
38. L.M., cat. p. Sumatra, from S. Müller.
39. L.M., reg. no. 1852. Langsa district, Deli, Sumatra. From the Rotterdam Zoo, 26-6-1930.
40. A.M., from the Rotterdam Zoo, 12-10-1937.
41. L.M., cat. i. Southern Borneo, from S. Müller.
42. A.M., Tamiang district, Koeala Simpang, Sumatra. Imported 6-9-1928, from the Amsterdam Zoo, 17-6-1932.
43. L.M., reg. no. 3244. D. v. Mullem don.
44. L.M., reg. no. 3245. D. v. Mullem don.
45. L.M., reg. no. 285. Koetei, S. E. Borneo, from J. M. Kampmeinert, 17-12-1912.
46. L.M., cat. a 2. Batak district, Sumatra, from Mr. Piepers, January 1904.

47. A.M., from the Amsterdam Zoo, 19-4-1933.
48. A.M., A 18. Borneo, coll. Vrolik.
49. A.M., S 15. Borneo, coll. Vrolik.
50. A.Z., no. 171, no data.
51. L.M., reg. no. 288.2. Borneo, see 1.
52. L.M., cat. q. Sumatra, from S. Müller.
53. A.M., Sumatra. From the Amsterdam Zoo, 11-9-1927 (imported April 1927).
54. L.M., reg. no. 288. 3, Borneo. see 1.
55. A.M., A 14. Borneo, coll. Vrolik.
56. A.M., Deli, Sumatra. coll. De Bussy.
57. L.M., cat. b 2. Deli, Sumatra, from the Rotterdam Zoo, 15-3-1905.
58. A.M., A 13. Borneo.
59. L.M., reg. no. 1801. Deli, Sumatra, from the Rotterdam Zoo, 28-12-1929.

Adult females

60. L.M., cat. v. Sambas, western Borneo. Presented by D. W. Horst, 1892. The lower jaw is missing.
61. L.M., reg. no. 4602. Sambas, western Borneo. From the collection of E. Dubois, 1941.
62. L.M., cat. y. Sintang, Borneo. Presented by Prakke, April 1894.
63. L.M., reg. no. 288.10. Borneo, see 1.
64. L.M., reg. no. 4605. Sambas, western Borneo. From the collection of E. Dubois, 1941.
65. L.M., cat. j. Southern Borneo, from S. Müller.
66. L.M., reg. no. 288.9. Borneo, see 1.
67. L.M., cat. u. Presented by Queen Wilhelmina of the Netherlands, February 1886.
68. L.M., reg. no. 4264. From the Rotterdam Zoo, 9-11-1940.
69. A.M., A 7. Borneo. coll. Vrolik.
70. A.M., Langkat, E. Sumatra. From the Amsterdam Zoo, 10-1-1936.
71. A.M., S 16. Borneo.
72. A.M., Van Dijk don. From the Amsterdam Zoo, 20-6-1938.
73. A.Z., no. 204. Moeara Tebeh, Borneo. Dr. J. Salm leg., Dr. Went don.
74. L.M., reg. no. 288.6. Borneo, see 1.
75. L.M., reg. no. 4054. H. L. Blonk don., 12-9-1939.
76. L.M., reg. no. 288. 8. Borneo, see 1.
77. L.M., reg. no. 1298. Deli, Sumatra. From the Rotterdam Zoo, 25-3-1924 (imported as adult 10-9-1921).
78. L.M., reg. no. 1782, Deli, Sumatra, from Blazer, 15-10-1929.
79. L.M., cat. k., southern Borneo, from S. Müller.
80. A.M., eastern Sumatra. W. Ledeboer don., from the Amsterdam Zoo, 22-12-1930.

Of the 45 adult skulls five exhibit supernumerary molars. No. 40 has an M^4 sin., about of the size of a premolar. No. 52 has a large alveolus for the fourth molar on either side of the maxilla, the teeth are unfortunately lost. No. 53 possesses two unequally shaped fourth molars in the mandible, the right is larger than the left but smaller still than the third molar. It has erupted obliquely forward against the base of the crown of the right M_3. The enamel is destructed and this has given rise to caries on the approximal surfaces of both molars. No. 72 has two impacted fourth molars in the mandible, of which the left is small and malformed. No. 75 has likewise an M_4 on both sides, and in this case lack of space for them has prevented complete eruption. They are inclined forward, but on the posterior surface of the M_3 there is no caries.

Caries is shown in not less than seven of the 45 adult skulls. In no. 40 there are carious cavities on the crowns of M_1 and M_2 sin., and in the right and left M^1. In other cases the caries occurs on the interproximal surfaces of the teeth, and, with one exception symmetrically on both sides. In nos. 53 and 66 the interproximal surfaces of P^3 and P^4 are attacked on both sides, in no. 45 the surfaces of M^2 and M^3, in no. 54 the surfaces of P_4 and M_1 of the right side only. In nos. 61 and 79 caries started between the central upper incisors. Of these seven skulls four (nos. 45, 61, 66 and 79) are from animals from the wild state.

Abnormal positions of teeth were observed in various cases. So in no. 47 the permanent upper C erupt in the palate; the deciduous canines are still present. In no. 69 the right P^4 has erupted external to the arch, in the anterior zygomatic root besides the M^1. There is no diastema between the P^3 and the M^1, and as the P^3-C diastema only is four mm longer than that on the left side the right toothrow does not extend as far backward as the left. This case has been noted by Colyer (1936, p. 197, fig. 239). The third molar is tilted forward in the right maxilla of nos. 38 and 50. The anterior premolar is tilted outward in the mandible of no. 58.

Before passing to the descriptions of the subfossil orang-utan teeth I give a description and discussion of the human teeth, the only evidence up to now of the presence of man in the prehistoric cave fauna of central Sumatra:

Homo sapiens L. subsp. (pl. I figs. 1-5)

Coll. Dub. no. 11471 (pl. I figs. 1-3), Lida Ajer cave.

The specimen is a right upper central incisor, perfectly preserved.

The tooth is worn to a somewhat little extent; the dentine has just become exposed on the incisal border. The labial surface is convex vertically and flat in transverse direction. Two ill-defined grooves run vertically from the cutting edge at approximately one-third and two-thirds of the width of the crown. They do not extend to the gingival border which is regularly convex toward the root from side to side. The medial (mesial) and lateral (distal) borders of the labial surface are rounded, the latter slightly more than the former. They converge toward the base of the crown.

The lateral and medial surfaces of the crown both have borders which are concave toward the lingual side, and which meet at the cutting edge. Their gingival borders are much produced toward the crown in the centre; this concavity toward the root is a little more pronounced at the medial than at the lateral surface. Both surfaces are convex in all directions, and possess a contact facet, of which the lateral is smaller and situated nearer to the cutting edge than that on the medial surface.

The lingual surface of the crown is concave from above downward and is depressed in the centre due to the presence of distinct ridges which run from the medio-incisal and the latero-incisal angles and converge toward the base, where they join the cingulum. The surface is strongly convex from side to side across the cingulum, and the gingival line presents a convexity toward the root which is nearer to the medial than to the lateral side. The "tuberculum dentale" is represented by a ridge which extends from the base for half the height of the crown along the medial marginal ridge, making it appear twice as broad in its gingival half as the lateral marginal ridge.

The root is a short and blunted cone. It is flattened on its labial surface and even slightly depressed longitudinally on the latero-lingual side. The medial surface is a little swollen.

The dimensions are given in table 1.

TABLE 1

Measurements of I^1 of prehistoric and recent man and of *Sinanthropus pekinensis* (Black)

		Homo sapiens L. subsp.		*Sinanthropus pekinensis*
		Lida Ajer cave	(Cohen, 1920, p. 150)	(Black) (Weidenreich, 1937, p. 17)
Crown:	transverse	8.2	6.9-10.6	9.8-10.8
	antero-posterior	6.5	5.6-8.8	7.5-8.1
	vertical	(10.4)	8.5-14.5	13.3
Root:	transverse	6.5		5.1-8.2
	antero-posterior	5.2		6.4-7.6
	vertical	8.0		11.5-20.7

The dimensions are seen to fall within the limits of recent man, and, with the exception of the width of the root, below the variation limits found by Weidenreich in five specimens of I^1 of Peking Man. The height of the crown of our specimen is given in parantheses as the tooth is worn. The *Sinanthropus* incisor differs from that in recent man, apart from its greater average dimensions, in the fact that the axis of the crown courses in the same direction as that of the root (Weidenreich, 1937, p. 17). In recent man the longitudinal axis of the crown and that of the root form an obtuse angle (Cohen, 1920, p. 33), this is also the case in our subfossil incisor.

The lingual surface of the crown of the upper incisors in recent man presents some variations which occur in all races but with a greater frequency in some than in others. Our knowledge on this point still rests upon a paper of Hrdlička (1920). He describes (l.c., p. 447) shovel-shaped incisors as having a lingual triangular to rounded or oblong, deep fossa, bounded laterally and generally also at the cutting edge, by a stout rim of enamel. In typical cases the marginal ridges are folded over the ordinarily built lingual surface; they may actually meet and even overlap or unite in degenerate lateral incisors. They were found to occur more frequently among the coloured races than in whites. The same holds for the incisors distinguished as "semi-shovel", in which the enamel rim is distinct but the enclosed fossa is shallow.

The present prehistoric Sumatran tooth represents the semi-shovel shaped type of Hrdlička. In table 2 I give the numbers of central upper incisors examined (n), the percentage of semi-shovels (A) and the mean error E_A of the percentage, which is found by the formula $E_A = \sqrt{\frac{A \times (100-A)}{n}}$ (Droogleever Fortuyn, 1929). Hrdlička (1920, p. 453) gives only the numbers and the percentages, but not their mean errors. Since deviations as great as three times the mean error may be expected, several of Hrdlička's conclusions, drawn from the percentages alone, are untenable.

TABLE 2

	males			females		
	n	A	E_A	n	A	E_A
American Whites	1000	7.6	0.84	1000	5.2	0.70
American Negroes	618	7.6	1.06	1000	8.0	0.86
Hawaiians	42	38.1	7.49	76	44.7	5.70
Chinese	1094	23.4	1.28	208	12.5	2.29
Japanese	344	18.0	2.07			

Sexual differences occur only in the Chinese, where the percentage of semi-shovels in the females is rather low and remains constantly below that for the males [1]. It can also be seen that there is no difference of statistical significance between the percentages found in the Whites and the Negroes on one hand, and between those of the Hawaiians, Chinese and Japanese on the other.

The shovel-shape is not influenced by the configuration of the tuberculum dentale (Hrdlička, 1920, pp. 446, 465); the latter varies independently from

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[1] The Chinese females exceed the males in the percentage of shovel-shaped incisors, and if the shovel and semi-shovel incisors are taken together the difference disappears.

the degree of lateral overgrowth of the enamel. As Weidenreich (1937, p. 17) calls it, the configuration of the basal tubercle does not affect the shape of the lingual surface more than the way in which the handle is fixed to the shovel. Variations in the development of the tuberculum dentale are represented by De Terra (1911, p. 365 fig. 179, after Zuckerkandl), Hrdlička (1920, pl. I) and Cohen (1920, p. 29 fig. 5). Its shape in the prehistoric human incisor from Sumatra resembles that in the specimens represented as the second and third from the left in the first row of Hrdlička's plate.

A shovel-shaped incisor must be stronger than a flat-surfaced tooth, and Hrdlička (1920, p. 464) supposes that the original call for the development of the shovel-shape was a call for strengthening. The great frequency of this condition in the present day yellow-brown peoples, however, is explained as probably being a hereditary persistence from earlier times rather than as resulting from the greater call upon the teeth. Weidenreich (1937) found shovel-shaped incisors in *Sinanthropus,* which he regards as ancestral to the Mongol race. This opinion is debated by Adloff (1938) who regards the shovel-shape as a regressive variation without phylogenetic importance.

Coll. Dub. no. 11472 (pl. I figs. 4-5), Lida Ajer cave.

In the collection from the Lida Ajer cave there is moreover a human left upper molar, characterized by its rounded cusps 1), and the absence of any secondary wrinkling on the enamel.

The crown is four-sided with well rounded angles. The postero-buccal angle is less marked than the others, the metacone being placed more anteriorly and inward than the hypocone. The paracone angle is even acute. The two buccal cusps in the slightly worn state of the present molar are hardly separated from each other; a very fine line is seen between them, indicating that the paracone is the larger. This buccal groove does not continue on the outer surface of the crown.

Paracone and metacone form together the buccal marginal ridge, gradually curving inward posteriorly, with an almost vertical outer surface and descending less steeply to the inside toward the central fossa of the crown. The paracone has a ridge descending inward from the tip down to the base of the protocone. Between this ridge and the elevated anterior border of the crown there is a transverse groove. The protocone is a broad and rounded cusp; it is blunter than the outer cusps and considerably larger.

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1) The cusps of the upper molar are designated as follows:

antero-buccal: paracone	antero-lingual; protocone
postero-buccal: metacone	postero-lingual: hypocone

The inner slope of the metacone meets the protocone at a higher level than that of the paracone. The protocone is separated from the paracone by a deep longitudinal fissure, which passes anteriorly at right angles into the groove between the ridge on the inner paracone slope and the anterior edge of the crown. Posteriorly it cuts into the saddle between protocone and metacone and then joins the groove surrounding the hypocone. The latter forms a pit at the point where protocone, metacone and hypocone meet. The hypocone is a small and blunt cone, only one-half as large antero-posteriorly as the protocone, and occupying less than one-half of the width of the crown. It is convex toward the centre of the crown and less well separated from the metacone than from the protocone, the fissure between hypocone and protocone being more marked than that between the posterior cusps.

The lingual fissure does not run over onto the lingual surface, which is smoothly convex from before backward. There is no trace of a Carabelli cusp. In the upper third of the crown there is a horizontal groove all around in the enamel, a developmental defect. What is left of the roots allows the conclusion that there was a single lingual root and two roots on the buccal side.

What is the serial position of the present molar? The hypocone is decidedly smaller than the metacone, indicating that the tooth is almost certainly not the first molar, since from M^1 to M^3 we observe a progressive diminution in size of the hypocone, successive stages of fusion of this cusp with the protocone, finally resulting in a three-cusped tooth. The present molar has a small anterior contact facet, and none on the posterior side. However, the crown is so little worn that the molar behind it, if any, may very well not have been in place long enough to leave a facet on its neighbour. In the relative size and position of the cusps, in their lowness, and in the degree of inclination of the lingual surface the cave molar invariably shows a greater resemblance to M^2 than to M^3. Its measurements are given in table 3.

TABLE 3

Measurements of M^2 (?) of prehistoric and of M^2 and M^3 of recent man

	Homo sapiens L. subsp.		
	Lida Ajer cave	(Adloff, 1908, p. 29)	
	M^2(?)	M^2	M^3
Antero-posterior	9.4	7.0-11.8 (12.5)	4.8-11.7 (13)
Transverse	12.1	9.0-14.7 (16)	5.9-14.8 (15)

The range of variation of the dimensions of M^2 and M^3 includes all living races of man. The maximum values given in parantheses are those recorded by Campbell (1925, p. 17) for the Australian aboriginal. In this, apparently the most primitive race of man, the M^2 shows invariably four well-defined cusps, while in M^3 the hypocone is reduced only in 23 per cent (Campbell, l.c., p. 15). In Europeans the three-cusped type occurs in 54 per cent of M^2 and even in 71 per cent of M^3 (Zuckerkandl, in: Cohen, 1920, pp. 93 and 96). Since four cusps may thus be found both on M^2 an M^3 in any race, the present molar is of no significance in indicating relationships of the prehistoric Sumatran cave man.

Prehistoric human remains have been recorded from Sumatra from the Oeloe Tjanko cave in upper Djambi (Sarasin, 1914) and from a kitchen midden at Bindjai Tamiang, 50 m S. and at a distance of 50 km from the mouth of the Tamiang river in N. Sumatra (Schürmann, 1931). The remains examined by Sarasin were associated with a culture which used almost exclusively obsidian as material for its tools and belong to a gracile variety of man with small teeth, perhaps a Veddah-form. Those from the Bindjai Tamiang kitchen midden consist of a few skull fragments, hardly sufficient for a racial determination. Wastl came to the conclusion that they show Papua-Melanesoid racial characters (Von Heine-Geldern, 1945, p. 130).

The incisor from the Lida Ajer cave near Pajakombo described in the present paper does not allow a final racial determination. It can only be said that it is less probable that it belonged to a White or to a Negro than to a Yellow-Brown. Its age and locality at once rule out the former supposition.

I do not consider the two teeth described above as evidence of human inhabitation in the prehistoric Sumatran caves. There is absolutely no other evidence of the presence of man and there are no signs of human agency on the teeth of the various species found in the caves. How all these animals were brought into the caves is still a moot question. An attribution to water transportation or to the work of some carnivores such as *Panthera* and *Helarctos* by which the animal remains were accumulated are among the possibilities. Porcupines may have dragged dry bones and jaws into the caves in which they lived. The human molar is gnawed at by porcupines, and so are most of the teeth from the cave deposits. The occurrence of teeth with the roots partially or completely gnawed off by porcupines is known from Pleistocene caves in southern China too.

Pongo pygmaeus palaeosumatrensis nov. subsp.

Diagnosis: Teeth averaging larger than, but identical in specific characters to those of recent *Pongo pygmaeus pygmaeus* (Hoppius).

I^2 and I_2 less reduced in size relative to I^1 and I_1, I_2 distinctly more hypsodont, C particularly large, and the male upper C distinctly less hypsodont than in recent orang-utan. The sexual difference in the size of the C tends to be greater than that in the recent form. P_3 much larger when compared to P_4 than in the latter. The preponderance in size of M^2 over M^1 and M^3 much more stressed, and M_2 also decidedly larger in comparison to M_1 and M_3 than in the recent orang-utan.

Holotype: The left M_3 (Coll. Dub. no. 11473/152) figured on pl. VIII fig. 11 of the present paper.

Locality: Sibrambang cave, Padang Highlands, Central Sumatra. About one-half of the collection of 3170 teeth is from this cave. One-third of the collection is from the Lida Ajer cave, one-ninth from the Djamboe cave.

Age: Early Holocene.

INCISORS

I^1 (pl. I figs. 6-15)

The upper central incisor is represented in our cave material by 47 specimens; nos. 1-24 are of the right side, the others of the left. Nos. 1-11 and 25-31 are unworn. The specification of the specimens is as follows:

12 I^1 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11474/1, 2, 4, 7, 8, 11, 13, 14, 16, 18-20.

9 I^1 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11475/27, 28, 30-32, 36, 39, 43, 45.

7 I^1 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11476/3, 9, 10, 12, 21-23.

10 I^1 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11477/25, 26, 29, 35, 38, 40-42, 44, 46.

1 I^1 dext., paratype, Djamboe cave, Coll. Dub. no. 11478/6.

2 I^1 sin., paratypes, Djamboe cave, Coll. Dub. no. 11479/33, 47.

4 I^1 dext., paratypes, cave not specified, Coll. Dub. no. 11480/5, 15, 17, 24.

2 I^1 sin., paratypes, cave not specified, Coll. Dub. no. 11481/34, 37.

The labial surface of the crown is convex both in vertical and in transverse direction. It may be perfectly smooth, but more often shows a number of shallow vertical grooves, especially toward the cutting edge. The medial border is higher and more defined than the lateral; in its occlusal half it even may form an edge. The incisal border or cutting edge may be straight or slightly convex from the medio-incisal angle outward to the latero-incisal angle, which is always more rounded than the medio-incisal angle. In its lateral third the cutting edge also may fall off steeply, giving the tooth a much less symmetrical appearance. In the middle of the tooth the cutting edge presents a tubercle of variable development. It may be so small as to be almost invisible, but mostly it is defined by notches on either side, and it may rise distinctly above the level of the edge. It may be flanked by two to four similar but lesser developed tubercles.

The labial surface may pass gradually into the lateral surface, especially when the latero-incisal angle is blunted. In the more symmetrically shaped teeth the lateral border of the outer surface is less rounded, but always less clear than the medial border of the labial surface.

Lateral and medial border of the labial surface converge toward the root; the gingival border is always shorter than the incisal border. The gingival border may be convex toward the root from side to side, with the greatest convexity central, medial or lateral; it may be straight from side to side, and even concave toward the root in the medial half.

The medial and lateral surfaces of the crown are triangular, with an acute angle at the cutting edge. The medial surface is larger than the lateral, and the gingival border presents a concavity toward the root which is deeper at the medial than at the lateral side. The medial surface is almost straight vertically and flat or somewhat convex from labial to lingual. Some specimens show a depression in the middle of the medial surface near the gingival line. The lateral surface is convex in both directions, but may show also a faint central depression near the base of the crown.

The lingual surface of the I^1 is bordered medially and laterally by ridges from the angles of the cutting edge down to the base where they join a cingulum. Both the ridges and the cingulum are very variable in development. The marginal ridges may not project inward, leaving the incisal third of the crown flat from side to side, but they may be so prominent as to make the surface concave transversely above the cingulum. The medial ridge is higher than the lateral, especially in the less symmetrical teeth; it joins the cingulum at a point which is either on a higher or on a lower level than that where the lateral ridge joins the cingulum. At the base the lingual surface is strongly convex from side to side across the cingulum, which varies from a low ridge to one occupying half of the height of the crown (pl. I fig. 14). The surface above the cingulum is concave vertically (and also from medial to lateral if the marginal ridges are prominent) and is covered with a system of vertical grooves and ridges of which one culminates in the central tubercle on the cutting edge mentioned above. In the middle of the tooth the ridges most often are stronger and they may unite in an eminence with several finger-like prolongations, or in an undivided pointed tubercle. This tubercle may or may not be separated from the cingulum.

The six unworn subfossil specimens figured in pl. I figs. 6-15 show that the basal lingual tubercle varies independently from the development of cingulum or marginal ridges.

The root is preserved to a greater or lesser extent only in nine specimens.

In cross-section it is three-sided with rounded angles; it tapers toward the tip, most rapidly in the apical half which may be bent inward. The lateral surface most often shows a longitudinal depression, which may be present on the medial surface too.

The measurements are given in table 4. The transverse diameter was taken in the region of greatest width, high up the crown, the antero-posterior or labio-lingual diameter is taken at the greatest convexity of the cingulum, and the vertical diameter is measured at the labial surface, of course only in unworn specimens. As in the subfossil teeth the root is gnawed off by porcupines sometimes even over the base of the enamel it is not possible to determine the exact height for all unworn cave teeth. The height index $\frac{\text{transverse diameter} \times 100}{\text{vertical diameter}}$ could be determined for 11 specimens from the caves, and only for 4 recent.

TABLE 4

Measurements of I^1 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Transverse	14.9	17.3	14.2	16.3	17.4	14.8	15.7	16.8	14.9	14.2
Antero-posterior	12.8	12.8	11.4	12.3	13.6	11.5	13.3	13.6	12.0	11.4
Vertical	18.2	—	15.8	—	17.7	17.3	16.4	—	14.5	14.8
Height index	81.9	—	89.9	—	98.3	85.6	95.7	—	102.8	95.8

No. of specimen	11	12	13	14	15	16	17	18	19	20
Transverse	14.1	15.6	14.1	—	—	—	16.0	12.8	13.3	13.6
Antero-posterior	13.2	14.3	12.4	14.0	12.8	11.7	—	—	—	—
Vertical	—	—	—	—	—	—	—	—	—	—
Height index	—	—	—	—	—	—	—	—	—	—

No. of specimen	25	26	27	28	29	30	31	32	33	34
Transverse	17.7	17.0	13.6	14.9	14.6	13.7	—	—	—	13.5
Antero-posterior	14.4	13.3	11.8	12.0	—	—	11.4	12.3	13.2	—
Vertical	20.5	—	17.3	17.0	17.4	—	—	—	—	—
Height index	86.3	—	78.6	87.6	83.9	—	—	—	—	—

No. of specimen	35	36	37
Transverse	15.4	12.8	13.0
Antero-posterior	—	—	—
Vertical	—	—	—
Height index	—	—	—

The recent teeth show the same structural variations as do the prehistoric teeth, without preference to Sumatra or Borneo. Incisors with and without a basal lingual tubercle and with or without inward folded marginal ridges occur side by side. The same variations occur in recent man (see p. 184/185).

The six specimens figured in the present paper show that the upper I of the orang-utan are not always shovel-shaped, as stated by Weidenreich (l.c., p. 18/19). Those of figs. 7 and 10 on plate I have indeed inward folded marginal ridges, but in the others (figs. 6, 8, 13 and 14) the medial and lateral borders of the lingual surface are not elevated.

The only difference between the subfossil and the recent teeth I have found is that the subfossil teeth average larger than the recent. In table 5 I give the number of variates n, the means M of the observed ranges, the standard deviations σ and the Pearsonian coefficients of variation C. The standard error $E_{diff.}$ of the difference between the means of the recent and the subfossil specimens is given for each measurement and for the height index. It will be seen that the difference between the means is always less than three times its standard error, so that the recent and the subfossil teeth cannot be separated statistically.

TABLE 5

I^1	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Transverse recent	5	14.0	1.13	8.07	0.58	1.6
Id. subfossil	27	14.9	1.46	9.79		
Antero-posterior recent	23	12.5	1.24	9.92	0.32	0.6
Id. subfossil	23	12.7	0.93	7.32		
Vertical recent	5	16.6	0.81	4.88	0.60	0.7
Id. subfossil	11	17.0	1.58	9.29		
Height index recent	4	85.2	9.19	10.79	5.08	0.9
Id. subfossil	11	89.7	7.19	8.02		

We can only say that the upper central incisor has the tendency to become smaller in the course of time. In the other incisors dealt with below the differentiation has proceeded further, and it is possible to distinguish the subfossil specimens statistically from the recent. In the I^1 the height index averages higher in the subfossil specimens than in the recent; this means that the upper central incisor has the tendency to become more hypsodont, a tendency to be observed also in the I^2 and in the canines.

I^2 (pl. I figs. 16-21)

Of the upper lateral incisor we have 55 specimens; nos. 1-31 are of the right side. Nos. 1-5 and 32-34 are unworn, the others worn to a greater or lesser extent, nos. 27-31 and 51-55 even so that none of the usual measurements can be taken exactly. The specification of the specimens is given here:

8 I^2 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11482/5, 7, 13, 15, 18-20, 27.
14 I^2 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11483/32, 34, 35, 37-43, 52-55.

14 I^2 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11484/2, 8-11, 14, 17, 24-26, 28-31.
6 I^2 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11485/36, 46-50.
3 I^2 dext., paratypes, Djamboe cave, Coll. Dub. no. 11486/6, 21, 22.
6 I^2 dext., paratypes, cave not specified, Coll. Dub. no. 11487/1, 3, 4, 12, 16, 23.
4 I^2 sin., paratypes, cave not specified, Coll. Dub. no. 11488/33, 44, 45, 51.

The labial surface of the crown is convex as in the central upper incisor but the central portion of the cutting edge rises into a well-formed point. The edge slopes away from the tip more steeply to the latero-incisal angle than to the medio-incisal angle. The sides of the tip meet under an angle of 90° or less (obtuse angles are found occasionally in recent specimens, see below), and the lateral is longer than the medial, so that the latero-incisal angle is closer to the gingival line than the medio-incisal angle. The latter angle is always less rounded than the latero-incisal angle; from these angles the medial and the lateral border converge toward the gingival line. The lateral border is always more rounded than the medial border which even may present an edge, as in the central upper incisor. The gingival border is convex toward the root from side to side; it is most produced toward the lateral side.

The medial surface of the crown is triangular like in the I^1, and is higher than the lateral surface. It is straight or somewhat convex vertically and convex from labial to lingual toward the medio-incisal angle. The gingival line presents a deep concavity toward the root.

The lateral surface of the crown is convex both vertically and labio-lingually, and may present a central depression toward the gingival line which is but slightly concave toward the root in the middle. Its borders are less defined than those of the medial surface.

The lingual surface possesses marginal ridges from the medio-incisal and the latero-incisal angle to the cingulum which they join. The medial marginal ridge passes gradually into the cingulum but the lateral may form an angle with the cingulum, and at their junction there may be a pit. The cingulum is variable in height as in the I^1. The surface above the cingulum is concave vertically, and convex or straight transversely, but never concave. It shows some vertical grooves and ridges of which the central have best developed. There even may be a basal lingual tubercle (no. 40, pl. I fig. 18).

The figured specimens (pl. I figs. 16-21) show the variation in the angle formed by the union of the lateral and medial part of the cutting edge to form the tip, and that in the development of marginal ridges and cingulum. Among the few unworn subfossil specimens I have not found an angle between the sides of the tip greater than 90°, as shown in the I^2 of a recent skull (no. 31, pl. I fig. 17). Occasionally the medio-incisal angle may be elevated into a cusp, as shown in the figures of Selenka (1898, p. 78 fig.

102), Hrdlička (1920, pl. III) and Remane (1921, p. 102 fig. 22g). I found the beginning of such an accessory cusp in one recent specimen (no. 35).

The root is preserved in 35 specimens. It is flattened laterally, and often bears medial and lateral longitudinal grooves. At the gingival border it is usually much depressed medially. The apex may be bifurcated, and curved inward.

The measurements and the height index are given in table 6.

TABLE 6

Measurements of I^2 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Transverse	8.6	9.7	8.7	9.5	9.6	9.5	8.5	8.9	10.1	8.8
Antero-posterior	8.6	9.8	—	—	8.3	8.8	9.3	9.5	10.0	9.8
Vertical	11.7	12.9	—	—	—	—	—	—	—	—
Height index	73.5	75.2	—	—	—	—	—	—	—	—

No. of specimen	11	12	13	14	15	16	17	18	19	20
Transverse	9.0	9.1	9.3	11.4	9.3	9.1	10.8	10.6	10.8	8.7
Antero-posterior	8.7	—	9.5	11.8	9.4	—	—	9.6	—	8.6
Vertical	—	—	—	—	—	—	—	—	—	—
Height index	—	—	—	—	—	—	—	—	—	—

No. of specimen	21	22	23	24	25	26	32	33	34	35
Transverse	12.0	—	10.0	9.0	10.9	10.3	9.5	9.6	10.3	9.6
Antero-posterior	—	9.0	11.0	9.8	11.2	—	10.0	9.7	10.6	—
Vertical	—	—	—	—	—	—	12.1	—	14.0	—
Height index	—	—	—	—	—	—	78.5	—	73.6	—

No. of specimen	36	37	38	39	40	41	42	43	44	45
Transverse	9.1	8.0	8.7	9.3	10.3	9.6	10.2	8.9	9.4	8.8
Antero-posterior	9.6	—	—	9.0	—	10.1	—	—	11.6	8.5
Vertical	—	—	—	—	—	—	—	—	—	—
Height index	—	—	—	—	—	—	—	—	—	—

No. of specimen	46	47	48	49	50
Transverse	9.2	9.0	9.2	11.3	8.7
Antero-posterior	9.3	8.6	—	—	9.3
Vertical	—	—	—	—	—
Height index	—	—	—	—	—

For the lateral upper incisor I give the means, standard deviations, coefficients of variation and the standard errors of the differences between the means, as explained above. It became apparent that there is a difference of statistical significance between the recent and the subfossil teeth. As shown in table 7 the difference between the means of the transverse and that between the means of the antero-posterior diameters are greater than three times their standard errors. Like in the I^1 the height index averages higher in the subfossil than in the recent teeth.

TABLE 7

I^2	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Transverse recent	27	8.6	0.82	9.53	0.20	5.0
Id. subfossil	44	9.6	0.86	8.96		
Anterior-posterior recent	32	8.7	1.00	11.49	0.24	3.8
Id. subfossil	29	9.6	0.90	9.38		
Vertical recent	6	11.4	1.46	12.81	0.74	1.8
Id. subfossil	4	12.7	0.88	6.93		
Height index recent	6	72.7	4.97	6.84	2.27	1.1
Id. subfossil	4	75.2	2.02	2.69		

I_1 (pl. II figs. 1-7)

The central lower incisor is so symmetrically built that it is impossible to distinguish between a right and a left tooth. We possess 56 specimens, of which nos. 1-8 are unworn, specified as follows:

17 I_1, paratypes, Sibrambang cave, Coll. Dub. no. 11489/2, 4, 5, 7, 9, 17, 22-24, 32-39.
27 I_1, paratypes, Lida Ajer cave, Coll. Dub. no. 11490/3, 6, 10, 12-16, 18-21, 27-31, 41-50.
3 I_1, paratypes, Djamboe cave, Coll. Dub. no. 11491/1, 25, 40.
9 I_1, paratypes, cave not specified, Coll. Dub. no. 11492/8, 11, 26, 51-56.

The I_1 is characterized by its high and narrow crown and the cutting edge being at right angles to the long axis of the tooth. The cutting edge is the widest part of the crown, except in one specimen (no. 7, pl. II fig. 3) in which the sides of the crown are convex and the greatest width is found slightly above the middle of the height of the crown. The labial surface is usually convex, sometimes flat (pl. II fig. 7) from above downward and flat or slightly convex transversely above; it becomes more convex from side to side below. The gingival border is convex toward the root. Its medial and lateral borders are equally rounded and converge downward. The cutting edge, when unworn, presents a central tubercle which, as in the I^1, may be flanked by two to four lesser developed tubercles. From the central tubercle a vertical ridge is sometimes seen to descend on the labial surface; it becomes wider and less distinct below and does not extend beyond the incisal half of the crown.

The lateral and medial surfaces of the crown are triangular, as in all incisors, with an acute angle at the cutting edge. They increase in width downward, most rapidly in the gingival half. The gingival line presents a deep concavity toward the root: in the centre the enamel border is pushed upward to about one-third of the height of the crown, both on the medial and on the lateral surface.

The lingual surface is flat transversely above, it becomes convex downward where the cingulum forms a band which occupies about one-third of the height. It may be well marked off above and then its upper border is seen to present a convexity toward the root, with its sides passing gradually into the marginal ridges. In one case (no. 7, pl. II fig. 3) the marginal ridges are so distinct as to make the surface concave transversely above the cingulum. Most often, however, the cingulum is not marked off above, but the lower third of the lingual surface is always smooth. Above it the surface may show, as in the I^1, a system of fine vertical grooves and ridges of which one ends in the central tubercle on the incisal border.

The root is preserved in 21 teeth. It is much depressed laterally, somewhat swollen in its cervical half and tapers toward the tip. Both the medial and the lateral surface may be convex from labial to lingual, but on the lateral surface there may be a longitudinal depression which is absent or less stressed on the medial surface. This character, drawn from the recent specimens, enables us to determine nos. 11-17 as belonging to the right side, and nos. 18-22 as left teeth.

The recent teeth differ from the subfossil only in their smaller average size. One recent specimen (no. 30, pl. II fig. 5) shows better than any subfossil tooth the subdivision of the cutting edge into three mammelons. The latero-incisal angle is more rounded than the medio-incisal angle; this character is not constant, however. The figured cave teeth show the upper margin of the lingual cingulum distinctly marked (pl. II figs. 2-3) or not (pl. II figs. 1, 6) and the greater or lesser divergence upward of the medial and lateral surface. Nos. 7 and 8 (pl. II figs. 4, 7) are represented in side view to show the difference in the curvature of the labial and lingual surface. The specimens present the following dimensions (table 8):

TABLE 8

Measurements of I_1 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Transverse	8.7	8.8	10.4	9.0	9.8	10.5	10.0	10.6	10.3	—
Antero-posterior	10.7	10.7	10.8	8.9	11.3	11.3	9.8	9.5	10.0	10.7
Vertical	17.2	17.0	—	13.6	17.0	—	—	15.8	—	—
Height index	50.6	51.8	—	66.2	57.6	—	—	67.1	—	—

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	9.3	10.9	10.5	10.3	9.7	10.8	9.4	10.3	10.5	11.0

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	9.3	10.1	10.9	8.4	9.7	10.7	9.6	11.7	9.9	10.5

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	11.6	12.0	9.1	8.7	10.5	9.0	10.4	11.0	9.2	10.4

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	11.2	12.3	11.5	12.7	9.3	9.2	9.5	11.4	9.6	13.0

No. of specimen	51	52	53	54	55	56
Antero-posterior	10.5	8.4	10.5	9.6	13.1	10.4

The subfossil I_1 can be separated statistically from the recent. The difference between the means found for the antero-posterior diameter in the recent and in the cave specimens is greater than three times its standard error. In contradistinction to what we observed in the upper incisors, the height index averages lower in the subfossil teeth than in the recent.

TABLE 9

I_1	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Transverse recent	12	9.1	0.77	8.46	0.33	2.1
Id. subfossil	9	9.8	0.72	7.35		
Antero-posterior recent	51	9.5	0.90	9.47	0.19	3.7
Id. subfossil	56	10.2	1.09	10.69		
Vertical recent	6	14.8	0.91	6.15	0.71	1.8
Id. subfossil	5	16.1	1.35	8.39		
Height index recent	6	60.1	4.13	6.87	3.53	2.4
Id. subfossil	5	58.7	6.95	11.84		

I_2 (pl. II figs. 8-11)

The lateral lower incisor differs from the central in the latero-incisal angle of the crown being always more rounded than the medio-incisal angle. Its antero-posterior diameter usually exceeds that of the I_1 in the same skull, and the crown is slightly higher. The gingival border is pushed upward higher at the medial than at the lateral surface. The lateral border of the labial surface is more rounded than the medial border. Thus it is possible to determine the side to which a tooth belongs by the same characters as those of the upper incisors.

There are 154 specimens in the Dubois collection from Sumatra, nos. 1-80 are from the left side. Nos. 1-12 and 81-84 are unworn. Specification:

32 I_2 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11493/9-11, 34-37, 42-66.
24 I_2 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11494/83-92, 120-133.
31 I_2 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11495/1-4, 13-33, 70-75.
40 I_2 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11496/81, 82, 94-115, 136-151.
6 I_2 sin., paratypes, Djamboe cave, Coll. Dub. no. 11497/12, 38, 39, 67-69.
4 I_2 dext., paratypes, Djamboe cave, Coll. Dub. no. 11498/93, 116, 134, 135.
11 I_2 sin., paratypes, cave not specified, Coll. Dub. no. 11499/5-8, 40, 41, 76-80.
6 I_2 dext., paratypes, cave not specified, Coll. Dub. no. 11500/117-119, 152-154.

Besides the differences from the I_1 mentioned above there is a greater tendency toward the development of a central vertical ridge on the lingual surface. In an extreme variation (no. 5, pl. II fig. 10) it is a cone-like ridge with the tip at the cutting edge. Laterally of the ridge the incisal border falls away very steeply. Occasionally the latero-incisal angle bears a tubercle (no. 6, pl. II fig. 11).

The root is preserved in 70 specimens. It has the same characters as that of the I_1, its apex is often recurved toward the medial side.

TABLE 10

Measurements of I_2 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Transverse	9.2	10.4	10.6	9.5	8.5	10.0	8.2	10.9	8.5	9.8
Antero-posterior	10.8	10.9	10.8	—	11.5	10.6	10.1	—	—	10.7
Vertical	18.5	15.8	15.8	—	17.4	16.4	15.2	—	—	17.3
Height index	49.7	63.5	63.7	—	48.9	61.0	53.9	—	—	56.6

No. of specimen	11	12	13	14	15	16	17	18	19	20
Transverse	8.9	9.4	11.0	10.9	9.8	10.9	—	11.1	10.8	10.7
Antero-posterior	9.3	—	14.0	12.3	11.6	12.5	11.7	11.4	11.9	12.0
Vertical	15.4	18.0								
Height index	57.8	52.2								

No. of specimen	21	22	23	24	25	26	27	28	29	30
Transverse	11.8	10.4	9.4	—	9.4	—	9.6	9.5	10.3	11.7
Antero-posterior	12.1	11.1	10.2	11.0	11.6	11.4	10.7	11.6	11.9	11.5

No. of specimen	31	32	33	34	35	36	37	38	39	40
Transverse	11.1	—	—	9.2	—	—	—	—	—	—
Antero-posterior	12.7	9.8	11.9	10.0	11.3	10.8	9.6	13.9	11.4	11.0

No. of specimen	41	42	43	44	45	46	47	48	49	50
Transverse	—	—	9.8	9.9	8.7	8.8	9.7	—	9.3	—
Antero-posterior	10.9	9.4	11.1	10.2	8.8	10.0	10.6	10.7	10.5	10.8

No. of specimen	51	52	53	54	55	56	57	58	59	60
Transverse	—	10.2	—	10.4	8.6	—	8.9	—	—	—
Antero-posterior	11.6	—	10.2	10.5	9.2	11.1	10.4	10.0	9.8	9.7

No. of specimen	61	62	63	64	65	66	67	68	69	70
Transverse	9.0	8.4	9.1	9.0	—	10.9	8.5	10.4	9.0	10.2
Antero-posterior	—	9.0	—	—	10.2	—	—	11.3	9.5	12.2

No. of specimen	71	72	73	74	75	76	77	78	79	80
Transverse	9.7	9.6	—	—	—	9.7	9.7	—	9.4	9.7
Antero-posterior	9.6	11.0	12.1	10.8	10.8	10.9	10.5	10.6	9.2	—

No. of specimen	81	82	83	84	85	86	87	88	89	90
Transverse	10.2	9.1	9.2	9.1	8.8	9.0	8.5	10.5	10.6	8.9
Antero-posterior	11.7	11.6	11.2	10.3	9.7	9.6	8.7	12.0	10.4	10.8
Vertical	18.0	16.0	17.8	15.5						
Height index	56.7	56.9	51.7	58.7						

No. of specimen	91	92	93	94	95	96	97	98	99	100
Transverse	9.8	8.8	10.0	—	8.9	10.5	—	10.0	—	—
Antero-posterior	11.4	10.8	11.2	9.6	9.2	12.0	10.2	10.6	10.4	10.7

No. of specimen	101	102	103	104	105	106	107	108	109	110
Transverse	10.0	9.1	10.9	—	9.4	9.3	—	9.9	—	—
Antero-posterior	11.7	10.1	12.2	9.7	10.7	10.8	11.7	10.1	11.0	12.6

No. of specimen	111	112	113	114	115	116	117	118	119	120
Transverse	—	10.1	9.3	9.8	9.3	9.4	10.7	11.4	—	9.7
Antero-posterior	10.5	13.7	10.0	11.7	10.6	11.3	10.5	13.0	11.4	10.9

No. of specimen	121	122	123	124	125	126	127	128	129	130
Transverse	—	10.9	8.5	8.5	8.7	10.3	9.0	—	—	8.5
Antero-posterior	10.5	—	9.4	8.6	9.2	—	9.8	10.0	10.0	9.8

No. of specimen	131	132	133	134	135	136	137	138	139	140
Transverse	8.9	8.8	—	10.7	9.8	9.5	9.9	9.2	10.3	10.2
Antero-posterior	10.7	—	8.7	10.6	10.8	11.6	11.1	9.5	12.1	11.2

No. of specimen	141	142	143	144	145	146	147	148	149	150
Transverse	10.1	9.6	9.9	9.2	11.1	—	11.1	10.0	9.6	9.6
Antero-posterior	—	10.7	10.9	9.3	12.3	11.3	14.1	10.6	13.2	12.3

No. of specimen	151	152	153	154
Transverse	9.1	9.7	10.0	—
Antero-posterior	12.8	11.1	—	11.0

From table 11 it will be seen that in every case the difference between the means is greater than three times its standard error $E_{diff.}$ The subfossil I_2 are not only larger in all dimensions than the recent, but they also are relatively higher. The height index $\frac{\text{transverse diameter} \times 100}{\text{vertical diameter}}$ is lower in the subfossil than in the recent specimens, exactly what we found in the I_1. In the upper incisors the reverse is the case.

TABLE 11

I_2	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Transverse recent	17	8.9	0.71	7.98	0.18	4.4
Id. subfossil	112	9.7	0.80	8.25		
Antero-posterior recent	48	9.9	0.97	9.80	0.17	5.9
Id. subfossil	137	10.9	1.10	10.09		
Vertical recent	3	14.8	0.90	6.08	0.61	3.1
Id. subfossil	13	16.7	1.12	6.71		
Height index recent	3	64.7	4.07	6.29	2.68	3.1
Id. subfossil	13	56.3	4.64	8.24		

The upper incisors of *Pongo pygmaeus palaeosumatrensis* nov. subsp. are less hypsodont than the recent, and the lower incisors are more hypsodont. It is, however, only in the I_2 that the difference between the means of the index in the recent and that in the subfossil teeth has statistical significance.

From the fact that the lateral incisors in the cave collection, both those of the upper and of the lower jaw, differ to a greater extent from the recent than the central incisors do, it is evident that the I^2 and I_2 are undergoing a process of reduction. The difference in size between the central and the lateral incisor was not so great in prehistoric times as it is at the present day. This process of reduction of the lateral incisors is more advanced in the upper jaw than in the lower.

CANINI

Male upper C (pl. III figs. 1-4)

We possess 47 specimens; nos. 1-18 are of the right side. Nos. 1-6 and 19-27 are unworn. Nos. 10, 11, 13-18 and 37-47 consist of not completely formed crowns or crowns which are gnawed off at the base; nos. 8, 27, 30, 32 and 36 are much damaged or worn; of these specimens no measurements can be given. The material is specified below:

3 C♂ dext., paratypes, Sibrambang cave, Coll. Dub. no. 11501/16-18.
7 C♂ sin., paratypes, Sibrambang cave, Coll. Dub. no. 11502/25, 42-47.
9 C♂ dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11503/1-5, 12-15.
17 C♂ sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11504/20-23, 28-40.
6 C♂ dext., paratypes, Djamboe cave, Coll. Dub. no. 11505/6-11.
3 C♂ sin., paratypes, Djamboe cave, Coll. Dub. no. 11506/26, 27, 41.
2 C♂ sin., paratypes, cave not specified, Coll. Dub. no. 11507/19, 24.

The male upper C is a large conical tooth, elongated in antero-posterior direction. The anterior border is convex vertically and is rounded; the posterior border forms an edge and is straight or slightly concave from the tip to the base.

At the lingual surface there is a vertical groove, close to the anterior border and following its curve. Usually it is distinct only in the middle of its course, and fades away toward the tip and toward the base. It may have weakly developed (no. 20, pl. III fig. 3). Behind it the lingual surface forms a ridge which may, or may not, be defined posteriorly by a groove. If this posterior groove is as distinct as the anterior groove, the lingual surface as a whole is trilobate (no. 28, pl. III fig. 4). There also may be a sharp vertical groove near the base about in the middle of the lingual surface, and another one half way between anterior groove and the posterior border, which runs to the tip (no. 2, pl. III fig. 2). Instead of some distinct grooves the lingual surface behind the vertical ridge may show a number of minor grooves and ridges (no. 1, pl. III fig. 1).

The gingival line may be slightly concave toward the root along the labial surface; at the anterior border it is sometimes a little produced toward the crown. A cingulum is discernible only at the lingual surface, it may form a low cusp at the posterior border (no. 28, pl. III fig. 4).

The vertical diameter has been taken at the anterior border, in a straight line from the base of the enamel to the tip. The height index is that of the labial surface: $\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$

TABLE 12

Measurements of male upper C of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	9	12	19
Antero-posterior	23.9	19.1	18.4	19.6	23.4	21.9	—	18.8	21.2	24.6
Transverse	15.4	12.8	14.8	14.4	18.0	—	12.2	—	16.6	18.5
Vertical	33.5	24.0	26.0	29.0	34.0	—	—	—	—	32.0
Height index	71.3	79.6	70.8	67.6	68.8	—	—	—	—	76.9

No. of specimen	20	21	22	23	24	25	26	28	29	31
Antero-posterior	23.4	18.3	19.7	22.0	19.1	19.1	21.5	21.4	19.4	20.9
Transverse	16.2	14.6	16.5	15.8	12.0	14.8	15.5	—	15.5	—
Vertical	32.0	26.4	27.0	30.0	28.5	—	30.1	—	—	—
Height index	73.1	69.3	73.0	73.3	67.0	—	71.4	—	—	—

No. of specimen	33	34	35
Anterior-posterior	21.9	22.2	—
Transverse	16.8	—	13.0

TABLE 13

Upper C ♂	n	M	σ	C	$E_{\text{diff.}}$	$\frac{M_{\text{subf.}} - M_{\text{rec.}}}{E_{\text{diff.}}}$
Antero-posterior recent	17	18.3	1.82	9.95	0.58	4.5
Id. subfossil	21	20.9	1.74	8.33		
Transverse recent	19	14.3	1.08	7.55	0.49	1.8
Id. subfossil	18	15.2	1.79	1.18		
Vertical recent	5	28.8	1.17	4.06	1.01	0.6
Id. subfossil	12	29.4	3.01	10.24		
Height index recent	5	66.7	1.49	2.23	1.22	4.2
Id. subfossil	12	71.8	3.53	4.92		

There is a difference of statistical significance between the recent and the subfossil canini in the antero-posterior diameter and in the height index, in which the differences between the means are greater than three times their standard errors. The upper C of *palaeosumatrensis* is larger and less hypsodont than that of the recent form. As appears from the figures for the coefficient of variation the transverse diameter is especially variable in the recent, and the vertical diameter in the subfossil canini.

Female upper C (pl. III figs. 5-9)

The upper C of female orang-utans differs from that of male individuals in its smaller size, relatively lower crown and better developed lingual cingulum. It is represented in our collection by 35 specimens, nos. 1-19 are from the right side. Nos. 1-7 and 20-22 are unworn. The specification runs as follows:

6 C♀ dext., paratypes, Sibrambang cave, Coll. Dub. no. 11508/2-5, 17, 19.
9 C♀ sin., paratypes, Sibrambang cave, Coll. Dub. no. 11509/21-29.
10 C♀ dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11510/1, 9-16, 18.
5 C♀ sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11511/20, 32-35.
3 C♀ dext., paratypes, Djamboe cave, Coll. Dub. no. 11512/6-8.
1 C♀ sin., paratype, Djamboe cave, Coll. Dub. no. 11513/30.
1 C♀ sin., paratype, cave not specified, Coll. Dub. no. 11514/31.

In keeping with its smaller size, the labial surface of the female upper C is more convex from before backward than that of the male upper C. The anterior border of the crown is more rounded than the posterior; it may also form an edge (nos. 2, 20-22). Near the base of the crown it passes into a triangular prominence, the anterior formation of the cingulum. At this point the gingival line often presents a concavity toward the root. The posterior edge of the crown is longer than the anterior, and forms a prominence at the base which is less developed than that at the anterior side. Along the whole of the lingual surface the cingulum forms a band which most often is well marked off from the surface itself and which may bear a central tubercle (no. 3, pl. III fig. 7).

The anterior vertical groove on the lingual surface which occurs in the male upper C is not invariably present in the female upper C; it may be weakly developed and even completely absent. There is always a more or less defined vertical ridge anteriorly of the middle of the lingual surface, as in the male upper C; behind it the surface is depressed and possesses a number of minor grooves and ridges. A sharp vertical furrow in the middle of the lingual surface is characteristic for some specimens (nos. 23, 25 and 34, pl. III figs. 6, 8 and 9). Occasionally the latter furrow even cuts through the cingulum and is continued for some distance on the root (no. 34, pl. III fig. 9).

The root is preserved in 4 specimens only. It is conical; its antero-posterior diameter exceeds the transverse diameter. The body is regularly curved backward, the labial surface is convex, the lingual possesses a longitudinal depression.

As in the male canine I measured the vertical diameter of the crown at the anterior border; the height index is $\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$

TABLE 14

Measurements of female upper C of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	16.5	12.5	13.0	13.7	14.5	13.5	14.4	16.1	14.3	15.8
Transverse	12.8	10.3	9.1	9.8	10.4	11.3	—	11.8	11.5	12.6
Vertical	17.8	16.2	14.5	15.0	18.2	17.7	—	—	—	—
Height index	92.7	77.8	89.7	91.3	79.7	76.3	—	—	—	—

No. of specimen	11	12	13	14	15	16	17	18	19
Antero-posterior	15.0	15.0	16.2	14.3	15.1	14.0	12.6	13.9	12.8
Transverse	11.3	—	12.1	10.7	12.1	—	9.8	11.1	10.5

No. of specimen	20	21	22	23	24	25	26	27	28	29
Antero-posterior	13.0	15.3	13.4	14.5	15.8	13.4	13.2	13.4	12.8	13.0
Transverse	10.5	11.5	—	11.9	—	10.8	10.2	10.5	10.5	—
Vertical	15.0	16.6	15.1							
Height index	86.7	92.2	88.7							

No. of specimen	30	31	32	33	34	35
Antero-posterior	14.3	14.5	13.0	12.8	15.2	14.4
Transverse	10.8	—	10.8	10.5	11.1	12.5

Like the male upper canine, the upper canine of the females is larger in the subfossil race than in the recent. The difference in the height index has no statistical importance, but that in the antero-posterior diameter is greater than three times its standard error, as can be seen from table 15.

TABLE 15

Upper C♀	n	M	σ	C	$E_{\text{diff.}}$	$\frac{M_{\text{subf.}} - M_{\text{rec.}}}{E_{\text{diff.}}}$
Antero-posterior recent	23	12.9	0.86	6.67	0.26	4.6
Id. subfossil	35	14.1	1.12	7.94		
Transverse recent	23	10.3	0.91	8.83	0.25	2.8
Id. subfossil	28	11.0	0.89	8.09		
Vertical recent	6	15.0	0.67	4.47	0.50	2.4
Id. subfossil	9	16.2	1.24	7.65		
Height index recent	6	85.1	2.30	2.70	2.29	0.4
Id. subfossil	9	86.1	6.25	7.26		

Male lower C (pl. III figs. 10-13; pl. IV figs. 1-4)

There are 81 specimens of male lower C in the Dubois collection from Sumatra. Nos. 1-44 are of the right side, the others of the left. Nos. 1-7 and 45-51 are unworn. Nos. 34-44 and 70-81 consist of apical portions of the crown only, of which no measurements can be given. The specimens are specified here:

18 C♂ dext., paratypes, Sibrambang cave, Coll. Dub. no. 11515/1-3, 22-28, 36-43.
5 C♂ sin., paratypes, Sibrambang cave, Coll. Dub. no. 11516/69-73.
16 C♂ dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11517/4-18, 44.
17 C♂ sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11518/45-48, 57-64, 74-78.
5 C♂ dext., paratypes, Djamboe cave, Coll. Dub. no. 11519/19-21, 34, 35.
9 C♂ sin., paratypes, Djamboe cave, Coll. Dub. no. 11520/49-56, 79.
5 C♂ dext., paratypes, cave not specified, Coll. Dub. no. 11521/29-33.
6 C♂ sin., paratypes, cave not specified, Coll. Dub. no. 11522/65-68, 80, 81.

The crown of the male lower C is large and conical in shape. The basal portion is flattened on the side opposed to the lateral incisor, the medial surface. On this surface the lower margin of the enamel recedes considerably toward the crown.

The following description is based on a particularly well-developed specimen, no. 1 (pl. III figs. 11-13, pl. IV fig. 1).

The anterior and lateral surface of the crown form together about one-half of the surface of a cone, with the greatest convexity at the antero-external side. The tip is slightly bent posteriorly and inward. From the tip an edge descends on the posterior surface to near the base where it is met with a prominence. Another edge runs downward from the tip on the antero-internal side. It is shorter than the posterior edge and terminates above the highest point of the curvature of the gingival line. The posterior basal prominence is marked laterally by a short vertical and shallow groove, while medially the posterior edge and the prominence at its base are defined by a moderately deep groove which runs from the tip to the base. In front of this posterior groove there is a sharp ridge on the lingual surface. It begins at the tip and fades away near the base of the crown. This lingual ridge divides the surface of the crown between the antero-internal edge and the posterior edge into two unequal parts, a large and flattened triangular medial portion, slightly depressed in the middle, and a narrow posterior portion occupied by the posterior groove mentioned above.

The upward curvature of the gingival line along the medial surface is asymmetrically shaped. From its highest point, just below the antero-internal edge of the crown, it descends steeply to the anterior side, and more gradually to the posterior side. The lowest point of the gingival line is found at the postero-internal angle of the crown, just internally of the posterior prominence, and below the latter the enamel border again recedes, but only to a very little extent.

The cingulum forms a well-marked oblique ledge ascending from the postero-internal angle, internally of the posterior prominence, along the lower margin of the enamel to the antero-internal angle of the crown, where it rises into a triangular prominence with its apex continued into the antero-internal edge. Half-way between the lingual ridge and the antero-internal edge it forms a point, which passes upward into the median depression of the flattened medial portion of the crown. Between this point and the anterior edge there is a pit, above the cingulum. The cingulum fades away along the steep anterior descent of the enamel border at the antero-internal side, and it is not discernible along the horizontal lower margin of the anterior and outer surface of the crown.

In none of the other specimens the various characters of the tooth are all shown at the same time with the same clearness as in that described above. The antero-internal edge and the deep concavity toward the crown of the lower border of the enamel below it are invariably present, but the cingulum and the posterior prominence are less marked; the point on the cingulum in the middle of the medial surface is absent, but this seems to be only an individual peculiarity of tooth no. 1. The cingulum ascends gradually from the postero-internal angle to the base of the antero-internal edge which it joins with an upstroke. One specimen is remarkable for having the lingual ridge in a more anterior position than in the others, about half-way between the antero-internal edge and the posterior edge (no. 5, pl. IV fig. 4). It is sharply defined anteriorly and posteriorly by vertical grooves (the homologa of the median depression of the flattened triangular medial portion, and that of the posterior groove in the first described specimen). Thus it has some resemblance, as far as concerns its lingual surface, to an upper canine in which the lingual surface may also be trilobate (cf. pl. III fig. 4). The presence of a deep upward curve of the lower enamel border below the antero-internal edge and the fact that the tooth is not depressed in labio-lingual direction, however, distinguish it at once from an upper canine. The lingual ridge is sometimes very weak, and there is only a slight trace of the posterior groove (nos. 7 and 46, pl. IV figs. 2, 3). In one recent specimen (no. 33, pl. III fig. 10) both have well developed, but there is hardly any trace of a cingulum, while the flattened triangular medial portion between the lingual ridge and the antero-internal edge is not depressed in the middle. The depression which marks the posterior prominence on its lateral side is continued as a longitudinal depression on the root, preserved only in one specimen (no. 14). A similar depression occurs on the flattened medial surface of the root.

The vertical diameter has been taken at the antero-external side, and the height index is $\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$

TABLE 16

Measurements of male lower C of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	20.3	18.0	15.6	20.2	16.5	17.3	17.1	—	18.2	19.7
Transverse	19.4	—	13.5	16.7	16.2	15.8	15.0	15.0	15.1	16.2
Vertical	34.1	—	26.0	—	29.0	27.5	25.4	—	—	—
Height index	59.5	—	60.0	—	56.9	62.9	67.3	—	—	—

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	—	—	—	16.5	19.0	—	17.8	—	—	—
Transverse	12.4	13.1	16.8	12.8	—	17.1	15.6	16.0	14.1	—

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	16.0	17.5	—	—	—	17.0	—	—	20.5	17.5
Transverse	13.2	12.8	15.4	—	—	12.9	13.6	14.0	—	15.0

No. of specimen	31	32	33	45	46	47	48	49	50	51
Antero-posterior	16.4	—	19.6	16.9	18.4	16.7	15.4	16.4	15.9	15.0
Transverse	13.8	13.0	—	14.4	16.3	13.4	13.0	14.8	12.8	13.1
Vertical	—	—	—	24.4	27.4	27.3	23.8	28.5	24.7	22.2
Height index	—	—	—	69.3	67.2	61.2	64.7	57.5	64.4	67.6

No. of specimen	52	53	54	55	56	57	58	59	60	61
Antero-posterior	15.3	14.6	14.8	—	16.9	15.8	17.5	—	13.4	18.5
Transverse	12.1	13.1	12.2	14.6	12.2	13.0	15.3	—	12.6	16.0

No. of specimen	62	63	64	65	66	67	68	69
Antero-posterior	17.1	—	—	18.1	19.0	16.1	16.0	15.4
Transverse	13.0	—	13.8	15.5	15.7	13.2	13.0	14.0

TABLE 17

Lower C ♂	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	16	15.7	1.10	7.01	0.38	3.7
Id. subfossil	40	17.1	1.65	9.65		
Transverse recent	21	12.9	1.03	7.98	0.32	4.4
Id. subfossil	49	14.3	1.58	11.05		
Vertical recent	6	25.4	1.89	7.44	1.15	1.1
Id. subfossil	12	26.7	2.96	11.09		
Height index recent	6	61.7	5.11	8.28	2.39	0.6
Id. subfossil	12	63.2	4.01	6.34		

The subfossil male lower C is larger than the recent not only in its antero-posterior diameter but also in the transverse diameter, the standard errors of the differences between these measurements in the recent and the subfossil specimens being less than one-third of the differences themselves. The transverse and the vertical diameters are very variable in the subfossil canini. The height index averages lower in the recent than in the subfossil specimens, but without statistical significance; it can only be said that the tooth has a tendency to become higher.

Female lower C (pl. II figs. 12-18)

The female lower C differs from the male lower C in its smaller size, less hypsodont crown and better developed cingulum and posterior prominence. We have 50 specimens, of which nos. 1-19 are of the right side. Nos. 1 and 20-23 are unworn. Specification:

10 C ♀ dext., paratypes, Sibrambang cave, Coll. Dub. no. 11523/1-10.
8 C ♀ sin., paratypes, Sibrambang cave, Coll. Dub. no. 11524/21, 22, 45-50.
7 C ♀ dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11525/13-19.
18 C ♀ sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11526/20, 27-43.
1 C ♀ dext., paratype, Djamboe cave, Coll. Dub. no. 11527/23-26.
4 C ♀ sin., paratypes, Djamboe cave, Coll. Dub. no. 11528/23-26.
1 C ♀ dext., paratype, cave not specified, Coll. Dub. no. 11529/11.
1 C ♀ sin., paratype, cave not specified, Coll. Dub. no. 11530/44.

The female lower canine is often more flattened in medio-lateral direction than the male. The cingulum ascending from the postero-internal angle to the antero-internal edge is relatively stronger than that in the male lower C; the apex of the triangular prominence at the base of the antero-internal edge is only about one-third of the height of the crown below the tip. The crown is distinctly lower than that of the male lower canine. Like in the latter the posterior groove and the lingual ridge are variable in development; they are occasionally well pronounced (no. 1, pl. II figs. 16-17) but more often have weakly developed (nos. 17 and 20, pl. II figs. 13-14). The cingulum in some specimens is distinct also along the outer and the anterior surface (nos. 12, 16, 17 (pl. II fig. 12), 18, 25, 31 and 48).

The root, preserved in 12 specimens, is elongated in antero-posterior direction, the tip is slightly curved to the medial side. The medial surface is always more flattened than the lateral; on the medial side there may be a longitudinal depression along its entire length. A slight depression may occur on the lateral surface, as a continuation of the vertical groove laterally of the posterior prominence.

Like in the foregoing canine, the vertical diameter has been taken at the antero-external side, and the height index is $\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$

TABLE 18

Measurements of female lower C of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	13.5	13.7	16.7	13.0	15.3	12.3	13.8	12.8	12.4	12.5
Transverse	10.1	9.6	11.7	10.2	12.0	8.4	11.2	10.0	9.0	8.5
Vertical	17.7									
Height index	76.3									
No. of specimen	11	12	13	14	15	16	17	18	19	
Antero-posterior	12.1	13.0	—	13.5	11.8	13.9	13.5	14.7	—	
Transverse	10.0	9.7	9.2	9.9	8.7	9.8	9.2	11.0	9.6	
No. of specimen	20	21	22	23	24	25	27	28	29	30
Antero-posterior	12.0	13.4	13.7	12.4	12.0	13.6	12.4	15.0	13.5	13.5
Transverse	8.8	9.1	10.5	9.4	8.9	10.8	8.6	9.9	10.7	10.1
Vertical	16.6	17.8	16.0	16.4						
Height index	72.3	75.3	85.6	75.6						
No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	12.3	—	14.5	13.6	16.0	—	13.6	12.4	13.8	12.8
Transverse	8.8	10.7	11.4	10.5	—	10.5	10.0	10.2	10.7	10.4
No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	—	13.7	—	12.3	12.2	12.8	12.0	14.6	12.8	—
Transverse	9.6	10.1	10.9	8.6	9.3	9.1	9.8	10.3	—	10.1

It is evident from table 19 that, like the male lower C, the female lower C has the tendency to become more hypsodont in the course of time; the height index averages higher in the subfossil specimens than in the recent and the subfossil teeth are consequently lower-crowned. The same tendency has been observed in the upper canines, and in the male upper C the difference between the height indices in the recent and the subfossil teeth even has statistical significance.

TABLE 19

Lower C♀	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	23	12.3	1.09	8.86	0.28	3.6
Id. subfossil	42	13.3	1.10	8.27		
Transverse recent	22	9.1	1.05	11.54	0.26	3.1
Id. subfossil	47	9.9	0.86	8.69		
Vertical recent	6	15.7	1.44	9.17	0.67	1.8
Id. subfossil	5	16.9	0.72	4.26		
Height index recent	6	74.0	4.57	6.18	2.76	1.1
Id. subfossil	5	77.0	4.55	5.91		

The subfossil female lower C differs from its recent homologue both in the antero-posterior and the transverse diameter (difference between means greater than three times the standard errors of these differences).

The canines of the male and the female orang-utan, both in the upper and in the lower jaw, thus have been shown to have undergone a diminution in size since the time of the deposition of the teeth in the prehistoric caves of central Sumatra, and the difference in size is statistically significant. It has also been shown that the canines have the tendency to become more hypsodont; this differentiation is most pronounced in the male upper C in which it has statistical significance. We may thus safely predict a Pleistocene canine of the orang-utan to be again larger and less hypsodont than the subfossil specimens. And this is actually the case (below, p. 282).

The decrease in size is more stressed in the male canines than in those of the females. This means that the sexual difference in the size of the canines tends to become smaller in the course of time.

PREMOLARS

P^3 (pl. IV figs. 5-14; pl. V figs. 13-20)

Of the P^3 there are 199 specimens, nos. 1-97 are of the right side. Nos. 1-16 and 98-122 are unworn. The specimens are specified here:

57 P^3 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11531/1-10, 25-71.
51 P^3 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11532/98-116, 168-199.
29 P^3 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11533/11-15, 72-84, 86-96.
41 P^3 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11534/117-157.
9 P^3 dext., paratypes, Djamboe cave, Coll. Dub. no. 11535/16-24.
8 P^3 sin., paratypes, Djamboe cave, Coll. Dub. no. 11536/160-167.
1 P^3 dext., paratype, cave not specified, Coll. Dub. no. 11537/97.
2 P^3 sin., paratypes, cave not specified, Coll. Dub. no. 11538/158, 159.
1 P^3 and P^4 dext., paratype, Lida Ajer cave, Coll. Dub. no. 11539/85.

The anterior upper premolar is a bicuspid tooth; it has a large pointed cusp on the buccal side, the paracone, and a smaller and blunt lingual cusp, the protocone. Between them the occlusal surface presents a deep antero-posterior valley. The buccal surface of the crown is wider and less convex than the lingual and passes into the flattened anterior and posterior surfaces by obtuse but well-defined angles, while on the lingual side there are no angular prominences. The antero-external angle projects anteriorly, and it is by this character that the P^3 is at once distinguished from a P^4.

The crown is surrounded by a continuous ridge, the marginal ridge, of which the buccal part is elevated into the cutting edges of the paracone, and which rises lingually into the smaller protocone. The anterior edge ot the paracone is more steep than its posterior edge and descends rather low on the anterior side of the crown. From the base of the anterior edge of the paracone the marginal ridge ascends inward along the anterior surface of the crown which is depressed in the middle at the base, and culminates in the tip of the protocone. From the tip of the paracone a ridge runs inward and forward and joins the marginal ridge in front of the protocone. In front of this anterior transverse ridge we thus have a triangular depression, the fovea anterior, bordered buccally by the anterior edge of the paracone and lingually by the marginal ridge. From the tip of the protocone the marginal ridge descends backward, and then outward along the posterior border of the crown. Near the postero-external angle it runs upward into the posterior edge of the paracone. From the tip of the protocone, or somewhat behind the latter, there is an oblique ridge which runs about parallel to the anterior transverse ridge and which abuts upon the posterior edge of the paracone. The oblique ridge and the posterior marginal ridge enclose a posterior transverse fossa, and between the oblique ridge and the anterior transverse ridge there is the central fossa of the crown. Between these two main ridges one to four minor ridges descend from the tips of the two cusps into the central fossa.

The two main bucco-lingual ridges and the three fossae in which they divide the main antero-posterior valley of the crown are clearly shown only in very few specimens, three of the left and one of the right side (nos. 98, 99, 117 and 1, pl. V figs. 13-16). The anterior transverse ridge and the oblique ridge are cut into by the antero-posterior groove but have much more developed than the other ridges.

In the other specimens the supplementary ridges descending from the tips and the posterior edges of paracone and protocone more or less obliterate the basic pattern. An oblique ridge between protocone and posterior edge of paracone can no more be distinguished; it is thrown into several minor ridges. The anterior transverse ridge connecting the paracone with the marginal ridge in front of the protocone may be indistinct too (no. 2, pl. V fig. 17) but most often the latter ridge and the triangular anterior fossa in front of it are not affected by the wrinkling of the enamel. In one specimen (no. 16, pl. V fig. 18) the middle portion of the oblique ridge is represented by a point, and from this point the wrinkles radiate to all sides.

No. 121 (pl. V fig. 20) gives an example of a P^3 in which there are but few supplementary ridges but in which there is neither a continuous anterior transverse ridge nor an oblique ridge. In this case the fovea anterior is affected too; two small ridges descend from the anterior edge of the paracone into the fovea anterior. The buccal part of the anterior transverse ridge is represented by a ridge descending inward and forward from the tip of the paracone and bifurcating near the bottom of the antero-posterior valley. The remainder of the anterior transverse ridge consists of four irregularly elevated patches of enamel. There are two accessory ridges descending from the tip of the paracone of which the anterior is small and the posterior is continuous with the lingual part of the oblique ridge, which descends from slightly behind the tip of the protocone and which is flanked by two supplementary ridges. The buccal part of the oblique ridge has a more posterior position; it widens toward the middle of the tooth and is cut into by four very fine grooves. The posterior marginal ridge is cut into lingually by three fine radiating grooves. This pattern thus is much more simple than that shown in nos. 2 and 16 mentioned above.

The enamel border of the crown of the P^3 is much produced toward the roots on the buccal surface, especially at the anterior side. This gives the buccal surface of the crown an asymmetrical shape. In exceptional cases there is a trace of a buccal cingulum as a slight swelling along the anterior edge.

The roots are for the greater part preserved in 25 of the specimens only.

There are three roots, two buccal and one lingual. They are long and taper regularly to slender apices. In cross section the lingual root is the largest and the postero-external is the smallest. The external roots exhibit a posterior longitudinal depression and are elongated transversely in cross section. The inner root is more rounded or has an antero-posteriorly elongated cross section. Very often the roots are fused to a certain extent, especially the inner and the posterior outer root which may be united almost over their entire length.

There is a tooth in the collection from the Lida Ajer cave which has puzzled me for some time but which I feel now convinced to be an anomalous left P^3 of an orang-utan. Fortunately the specimen is only slightly touched by wear. Five views of the tooth are given on pl. IV (no. 123, figs. 5, 7, 9, 11, 13) together with the same views of a normal specimen which also has the greater part of the roots preserved (no. 122, pl. IV figs 6, 8, 10, 12, 14). When viewed from the buccal side the anomalous tooth has the typical asymmetrical shape of a normal P^3 (pl. IV figs. 5 and 6), with the anterior edge of the paracone descending more steeply and being longer than its posterior edge, and with the enamel border most produced toward the antero-external root. The buccal surface only is more developed in its antero-posterior diameter and consequently is relatively lower than that in the normal tooth. It is supported by two roots, of which the anterior is larger than the posterior. The latter root, however, extends further inward than that in the normal tooth (posterior views, pl. IV figs. 7 and 8). In the normal tooth the postero-external root does not pass internally beyond the lingual root, which alone supports the lingual portion of the crown with the protocone. In the anomalous specimen the posterior root is broad and partly overlaps the lingual root which is shifted to the antero-internal angle.

The antero-internal angle of the crown protrudes considerably, in contradiction to what we observe in a normal P^3 in which only the antero-external angle protrudes and the other angles are gently rounded. In the tooth under discussion, however, the antero-internal angle is even more prominent than the antero-external and the enamel border is pushed toward the antero-internal root to the same extent as toward the antero-external root. The protocone has extraordinarily developed, and in front of it there is a blunt antero-internal cusp, on a slightly higher level than that of the posterior marginal ridge. As seen in the inner views (pl. IV figs. 9 and 10) it is this accessory cusp that is supported by the lingual root, while the high protocone stands above the junction of the lingual root and the posterior root. In a normal tooth the lingual root supports the protocone.

The accessory cusp in front of the protocone is also shown in the anterior view (pl. IV fig. 11). The border of the enamel recedes toward the crown and is depressed in the middle of the anterior surface. From the prominence at the base of the anterior edge of the paracone a weak horizontal ledge runs to the accessory antero-internal cusp; below it the enamel is smooth and above it the surface is covered with fine vertical ridges. Above the accessory cusp a ridge ascends to the tip of the protocone. In a normal tooth we find an anterior marginal ridge gradually ascending from the base of the anterior edge of the paracone to the tip of the protocone (pl. IV fig. 12) and at the point of junction with the anterior transverse crest, at the antero-internal angle in front of the protocone, it may form an accessory cusp of small size. In my material of P^3, no. 122 excepted, I have not found such an accessory cusp, but it occurs frequently in the upper molars, as tuberculum accessorium superius anterius internum or protoconule (Selenka, 1898, p. 70; Remane, 1921, p. 54). In the upper premolars its occurrence has not been mentioned except by Remane (1921, p. 61) who found indications of a protoconule in a few specimens of P^4. This is in agreement with my observations (below, p. 216).

In the present specimen the occurrence of a well-developed protoconule coincides with an extraordinary development of the protocone and almost complete suppression of the antero-posterior valley. The protocone is nearly as high as the paracone and has steep edges. The wide antero-posterior valley which is so characteristic of upper bicuspids is represented only by a fine groove separating the apices of the two cusps. In anterior aspect the anomalous tooth deviates more from the normal than in any other.

In occlusal view (pl. IV figs. 13 and 14) the protocone has the normal position, viz., diametrically opposed to the paracone. The two tips are closely approximated and the fovea anterior is extended over the anterior incline of the protocone too and has lost its normal triangular shape. Behind the tips of these two cusps the marginal ridge encloses an area of the same shape as that in normal specimens. Due to the wear little has been left of the wrinkle pattern in this area, but there are still traces of the posterior transverse fossa and of accessory ridges from the protocone. The excessive development of the antero-internal angle of the crown makes the tooth wider in front than behind.

The anomalous subfossil tooth has no counterpart among the recent material, and it is difficult to ascertain whether the tooth has occupied a normal position in the toothrow or not. There is a small contact facet on the posterior surface behind the protocone; the tooth consequently seems to have made contact with the P^4 only at the lingual part of its posterior surface and might have been slightly rotated. In some recent skulls, however, we find the posterior contact facet on the P^3 in the same excentral position as that in the subfossil premolar without the tooth being rotated; this depends on the greater bulging out of the lingual part of the anterior surface of the posterior premolar. On the anterior surface of the anomalous tooth, below the anterior edge of the paracone, there is another, but not very distinct, contact facet. The latter facet must have been caused by interstitial wear between the premolar and the canine, the posterior edge of which in all probability lodged in the median vertical depression of the anterior surface of the premolar. The surface of the crown in front of the cusps has made no contact with the P_3, but that behind the cusps has a little suffered from wear against the P_4. Anyhow there must have been room enough for the protrusion of the antero-internal angle and the anomalous premolar may have occupied a normal position in the toothrow, perhaps slightly rotated with its postero-internal angle more backward than the postero-external angle. This would also bring the roots more in the normal position. It must have belonged to a large individual, for in size (antero-posterior 14 mm, transverse 16.5 mm) it is exceeded only by few subfossil specimens.

TABLE 20

Measurements of P^3 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	11.0	10.4	10.9	9.8	10.2	10.0	10.7	11.2	10.4	10.1
Transverse	12.6	14.9	13.9	12.1	—	11.2	—	14.3	12.9	13.0
Vertical	—	13.0	—	9.8	12.6	—	—	—	12.7	—
Height index	—	80.0	—	100.0	81.0	—	—	—	81.9	—

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	11.5	10.6	11.0	10.4	9.8	10.9	11.6	9.2	9.8	11.5
Transverse	16.7	13.3	15.1	14.4	14.9	13.7	13.7	12.1	13.3	15.4
Vertical	14.8	10.5	13.7	—	13.3					
Height index	77.7	101.0	80.3	—	73.7					

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	10.5	10.7	8.7	10.4	10.3	11.8	9.9	11.0	13.1	9.5
Transverse	15.3	13.7	11.0	16.4	13.2	14.9	12.2	13.1	14.8	—

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	9.6	10.5	11.5	9.7	10.6	10.0	11.0	10.7	9.8	10.8
Transverse	13.7	12.9	16.1	12.0	12.7	—	14.9	13.7	12.5	13.3

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	11.8	9.8	10.0	10.8	10.3	11.0	10.8	10.2	10.1	9.4
Transverse	13.9	13.1	12.8	13.7	12.5	14.1	15.2	—	12.6	11.2

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	9.0	10.3	9.7	10.2	9.5	—	10.7	9.1	10.7	10.9
Transverse	—	13.6	—	13.0	—	10.8	14.5	12.5	15.1	14.0

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	9.1	9.0	10.0	9.8	9.9	10.9	10.2	10.4	10.8	9.0
Transverse	11.8	10.8	12.0	—	11.8	14.2	12.8	14.0	12.8	10.5

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	10.7	11.5	11.2	10.8	10.2	11.0	11.0	10.8	10.6	12.1
Transverse	13.0	13.4	—	—	14.0	15.0	—	14.0	14.0	14.4

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	13.1	11.2	10.3	9.5	10.5	9.5	12.4	11.7	12.0	9.5
Transverse	16.6	—	13.6	11.5	14.6	13.6	16.5	16.1	16.5	13.0

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	12.0	11.2	9.4	11.6	11.3	9.8	10.5	10.7	10.4	9.7
Transverse	17.0	13.9	—	—	12.6	—	—	14.0	12.8	13.1

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	9.5	9.8	11.7	9.6	10.8	9.8	12.2	12.0	10.4	11.3
Transverse	12.3	12.8	15.5	12.2	—	12.5	13.0	16.5	12.7	14.0
Vertical	—	10.5	—	12.2	12.1					
Height index	—	93.3	—	78.7	89.3					

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	10.0	10.6	11.3	10.2	10.4	—	10.6	11.0	12.2	9.7
Transverse	12.5	14.8	13.1	12.6	13.0	12.8	15.5	13.1	14.8	12.2
Vertical	—	14.0	—	—	12.1	—	15.0	12.1	12.8	11.6
Height index	—	75.7	—	—	86.0	—	70.7	90.9	95.3	83.6

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	10.2	11.6	(14)	9.7	11.5	—	10.8	10.5	10.2	10.5
Transverse	12.1	14.3	(16.5)	14.0	14.4	13.4	14.1	13.7	13.0	13.1

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	10.5	11.5	11.9	12.1	13.2	11.3	11.1	11.7	10.4	11.9
Transverse	14.3	15.5	15.8	16.4	17.4	—	14.4	16.8	13.5	16.6

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	13.3	10.8	10.6	11.1	11.0	11.6	12.0	10.3	11.7	10.0
Transverse	15.8	16.0	15.2	15.7	15.0	13.8	14.9	12.1	13.8	13.1

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	11.3	9.6	13.0	11.0	—	13.2	10.4	9.7	—	12.6
Transverse	—	12.5	17.4	—	14.5	14.9	—	12.5	13.0	—

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	10.8	10.8	10.5	13.7	11.0	10.3	10.1	10.3	9.0	10.2
Transverse	12.3	—	15.0	15.8	—	13.5	14.6	13.4	11.4	13.4

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	10.3	11.0	10.4	9.5	10.2	9.2	11.3	10.7	11.9	10.3
Transverse	12.3	—	14.3	13.7	13.5	12.0	13.0	15.0	15.5	12.7

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	9.5	10.8	9.5	10.0	10.2	9.4	9.7	9.9	10.6	10.7
Transverse	12.6	14.0	12.0	13.0	—	13.0	12.0	12.6	14.7	13.5

No. of specimen	191	192	193	194	195	196	197	198	199
Antero-posterior	8.5	10.3	9.8	11.2	—	10.2	10.9	9.0	10.6
Transverse	12.4	12.6	12.5	14.0	12.7	12.4	13.1	—	13.7

The vertical diameter has been taken at the buccal surface, and the height index is $\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$. The P^3 of *Pongo pygmaeus palaeosumatrensis* differs statistically from the modern orang-utan P^3 in its greater antero-posterior and transverse diameters. In contradistinction to the canines, the anterior upper premolar has the tendency to become less hypsodont. The difference does not stand the statistical test, however. The vertical diameter is especially variable in the recent premolars (Pearsonian coefficient of variation C not less than 15.09!).

TABLE 21

P^3	n	M	σ	C	$E_{\text{diff.}}$	$\frac{M_{\text{subf.}} - M_{\text{rec.}}}{E_{\text{diff.}}}$
Antero-posterior recent	40	10.1	0.91	9.01	0.16	3.1
Id. subfossil	192	10.6	0.94	8.87		
Transverse recent	47	13.0	1.30	10.00	0.22	3.2
Id. subfossil	169	13.7	1.43	10.44		
Vertical recent	12	11.2	1.69	15.09	0.58	2.2
Id. subfossil	17	12.5	1.30	10.40		
Height index recent	12	88.8	8.17	9.20	3.17	1.3
Id. subfossil	17	84.7	8.73	10.31		

P^4 (pl. VI figs. 1-6)

The posterior upper premolar is represented by 277 specimens, of which nos. 1-143 are of the right side. Nos. 1-21 and 144-162 are unworn. Specification:

68 P^4 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11540/1-12, 88-143.
52 P^4 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11541/144-154, 237-277.
62 P^4 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11542/16-21, 29-84.
64 P^4 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11543/157-220.
10 P^4 dext., paratypes, Djamboe cave, Coll. Dub. no. 11544/13-15, 22-28.
16 P^4 sin., paratypes, Djamboe cave, Coll. Dub. no. 11545/155, 156, 223-236.
2 P^4 dext., paratypes, cave not specified, Coll. Dub. no. 11546/86, 87.
2 P^4 sin., paratypes, cave not specified, Coll. Dub. no. 11547/221, 222.
1 P^3 and P^4 dext., paratype, Lida Ajer cave, Coll. Dub. no. 11539/85.

The P^4 differs from the P^3 by having no antero-external angular prominence. Its angles are rounded, and sometimes the crown contour represents a fairly regular oval shape, with the long axis transversely. Most often, however, the anterior surface, which is not depressed in the middle at the base, is more flattened than the posterior. The crown is often a little wider antero-posteriorly to the lingual side than to the buccal side. The paracone and the protocone are a little nearer to the anterior border than to the posterior border, so that their posterior edges are a little the longer. The posterior marginal ridge is lower than the anterior.

There is a great variation in the pattern of the enamel wrinkles on the crown between the cusps of para- and protocone and the anterior and posterior marginal ridges, but some specimens show the same basic pattern as that of the anterior premolar, viz., two main bucco-lingual ridges which divide the antero-posterior valley into three fossae, an anterior, a central and a posterior fossa. The anterior transverse ridge differs in its course from that of the P^3; it originates buccally in front of the paracone instead of from the tip of the latter, and runs out into the tip of the protocone lingually.

In one rather small subfossil specimen (no. 1, pl. VI fig. 1) the anterior transverse ridge is straight and continuous, the only cross ridge to be distinguished. The latter ridge has equally well developed in one recent specimen (pl. VI fig. 2), which in addition has a strong oblique ridge that runs from the tip of the protocone to the postero-external angle. The two ridges thus form a V, which encloses the paracone. The cross ridges and the marginal ridges are finely grooved and from the tip of the paracone three short diverging ridges descend into the central fossa.

In none of the other specimens the basic pattern is so well shown as in that described above; the transverse ridges are subdivided by grooves and are more or less sinuous in appearance (e.g., no. 13, pl. VI fig. 3). The ridges also may diverge at a point a little outward from the tip of the protocone, forming a Y. One specimen has a distinct accessory cusp behind the protocone, a hypocone (no. 4, pl. VI fig. 4). This hypocone is separated from the protocone by a cleft, and from its apex a slight ridge runs outward and forward, forming an accessory stem to the Y. In four other specimens the hypocone is indicated as an elevation of the marginal ridge at the postero-internal angle of the crown (nos. 13 and 5, pl. VI figs. 3 and 5, and nos. 17 and 98).

At the point of junction of the oblique ridge and the posterior edge of the paracone the latter often shows a slight elevation which represents the metacone (cf. Remane, 1921, p. 59). An example is given on pl. VI (no. 5, fig. 5). In this specimen the main cross ridges are not distinctly shown. They are cut into by the antero-posterior groove and have not stronger developed than accessory ridges from the tip and the anterior edge of the paracone. The marginal ridges and the main ridges are not covered by fine grooves as in the two foregoing specimens.

Another accessory cusp may be found in advance of the protocone. Such a protoconule is indicated in five specimens (nos. 121, 144 (pl. VI fig. 6), and 145-147).

The roots are for the greater part present in 50 specimens. They have the same characters as those already described above for the P^3. In one specimen (no. 209) the buccal roots are curved inward, the apex of the small postero-external root lies on the posterior surface of the lingual root, that of the anterior buccal root has broken off.

No. 120 has a carious cavity on the posterior surface, near the lingual side. It is the only upper premolar attacked by this disease.

TABLE 22

Measurements of P^4 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	8.7	10.8	10.6	9.5	10.6	9.4	10.0	9.7	13.1	9.4
Transverse	11.1	14.2	13.6	13.1	13.2	13.7	13.7	14.2	13.1	12.5
Vertical	9.0					10.5	10.7			
Height index	96.7					89.5	93.5			

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	9.2	10.7	9.4	11.7	9.4	9.3	8.1	10.5	9.8	10.2
Transverse	12.4	13.5	12.8	15.3	12.4	13.0	10.4	14.0	13.2	13.8
Vertical						9.9		10.3		10.0
Height index						93.9		101.9		102.0

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	11.2	10.3	10.1	9.5	10.6	10.6	10.3	9.9	11.7	11.0
Transverse	14.8	14.1	13.5	13.5	13.5	13.6	15.0	12.0	16.3	14.8
Vertical	11.7									
Height index	95.7									

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	11.4	11.5	9.4	9.0	11.6	10.5	11.2	10.7	11.1	11.4
Transverse	17.7	15.0	13.4	13.0	15.2	13.0	15.4	13.9	14.9	16.5

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	10.1	10.7	10.8	8.8	10.5	9.5	10.2	10.4	11.6	9.5
Transverse	13.5	15.8	14.0	12.1	14.0	12.6	16.0	14.4	15.2	12.8

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	11.4	10.7	10.8	8.7	10.0	10.0	9.7	11.2	9.8	10.2
Transverse	14.5	14.0	13.7	12.5	13.7	13.4	13.4	—	13.6	14.2

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	9.2	10.0	10.2	11.3	10.0	10.7	11.4	9.7	9.8	10.3
Transverse	12.3	14.0	14.0	15.0	13.4	15.7	15.5	13.0	14.1	13.6

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	9.4	10.2	10.4	8.6	11.2	10.0	9.4	10.2	8.5	9.5
Transverse	13.3	14.0	14.2	12.4	14.8	—	12.5	13.4	12.4	12.0

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	9.7	11.2	10.3	9.5	10.0	8.6	10.3	10.0	10.3	9.6
Transverse	13.8	15.4	14.8	14.2	14.1	—	—	14.3	13.4	14.0

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	10.0	10.1	10.1	9.0	9.0	9.6	9.1	10.5	9.5	10.5
Transverse	13.2	12.7	14.5	13.1	13.6	13.7	13.5	12.2	—	14.4

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	9.8	12.6	11.4	10.5	10.0	8.2	10.2	10.4	8.8	9.5
Transverse	13.1	17.9	15.1	14.0	13.5	10.7	14.3	14.3	12.2	13.5

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	11.1	8.9	9.3	9.7	8.1	10.3	9.6	10.3	8.6	—
Transverne	15.1	12.8	12.3	13.0	—	12.4	12.8	13.7	12.5	12.8

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	10.4	10.8	9.4	9.7	10.1	9.7	10.3	9.8	9.4	10.1
Transverse	13.9	14.4	12.2	12.2	14.0	13.1	12.8	13.0	12.6	13.5

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	10.0	9.4	9.0	8.5	8.5	11.0	9.0	8.3	9.7	8.7
Transverse	14.1	12.7	11.8	12.6	11.3	14.0	12.0	11.3	13.3	11.1

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	9.9	9.0	9.0	9.3	10.7	9.8	10.2	10.1	10.4	11.1
Transverse	13.8	12.0	—	11.8	12.9	12.2	12.2	13.2	14.4	14.4
Vertical				9.4		10.2		9.5		11.0
Height index				98.9		96.1		106.3		100.9

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	10.4	8.8	9.5	8.8	10.6	10.8	10.5	10.8	9.0	10.9
Transverse	14.0	11.7	11.9	12.0	13.5	14.4	15.7	16.2	11.1	14.1
Vertical	11.2	9.4			11.0	11.5	11.4	11.4		
Height index	92.9	93.6			96.4	93.9	92.1	94.7		

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	10.5	10.7	10.4	10.4	11.2	9.2	11.0	9.0	9.5	9.6
Transverse	14.0	14.0	15.2	13.8	14.2	11.9	15.0	12.7	13.2	12.5

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	10.3	11.4	10.7	9.3	11.4	9.5	10.4	11.0	10.7	9.7
Transverse	13.5	15.1	15.4	12.7	16.0	12.7	15.2	13.4	14.5	13.5

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	10.1	10.5	10.5	8.7	10.2	10.3	10.6	10.5	9.3	11.5
Transverse	14.5	13.7	14.1	13.6	13.8	13.6	14.6	15.0	13.5	15.6

No. of specimen	191	192	193	194	195	196	167	198	199	200
Antero-posterior	11.2	8.5	11.1	9.8	9.4	10.3	11.0	10.2	9.2	10.0
Transverse	17.3	12.5	16.4	13.5	13.0	14.3	17.6	14.0	13.0	13.6

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	10.0	10.6	8.5	9.5	9.3	11.0	10.1	10.0	9.8	11.5
Transverse	13.4	15.5	11.8	13.5	12.0	16.6	13.0	13.5	14.5	14.8

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	11.9	10.7	10.6	10.8	11.5	11.0	10.6	9.2	10.7	10.0
Transverse	17.0	15.3	14.3	15.2	18.3	15.4	15.8	12.1	15.1	14.7

No. of specimen	221	222	223	224	225	226	227	228	229	230
Antero-posterior	11.0	8.6	10.7	10.3	11.7	8.3	8.7	9.8	9.6	11.4
Transverse	14.1	12.3	13.9	13.4	15.1	11.0	13.2	12.8	13.2	15.0

No. of specimen	231	232	233	234	235	236	237	238	239	240
Antero-posterior	10.7	9.5	10.0	10.2	10.0	9.1	9.3	8.5	10.0	11.0
Transverse	14.9	12.6	13.5	14.4	13.5	14.8	12.3	11.5	—	14.6

No. of specimen	241	242	243	244	245	246	247	248	249	250
Antero-posterior	9.3	9.6	10.8	9.4	8.5	9.6	10.5	9.7	8.3	10.6
Transverse	13.0	14.2	14.8	13.0	12.6	12.3	14.2	13.4	11.2	13.6

No. of specimen	251	252	253	254	255	256	257	258	259	260
Antero-posterior	11.6	10.5	10.1	10.7	9.3	8.5	9.3	9.3	9.4	9.1
Transverse	14.5	15.0	13.6	15.0	12.9	11.2	13.1	12.2	11.9	12.1

No. of specimen	261	262	263	264	265	266	267	268	269	270
Antero-posterior	9.3	9.8	10.7	10.3	10.4	9.6	8.6	9.4	9.8	10.4
Transverse	12.8	14.0	12.8	14.3	13.8	12.8	11.3	11.8	14.2	13.7

No. of specimen	271	272	273	274	275	276	277
Antero-posterior	9.7	9.0	9.5	10.5	9.2	10.7	10.5
Transverse	14.0	11.6	13.6	14.6	—	14.0	14.3

Like the P^3, the P^4 of *Pongo pygmaeus palaeosumatrensis* nov. subsp. differs from the corresponding tooth in the recent orang-utan in its really greater antero-posterior and transverse diameters, the differences between the means found for these measurements in the subfossil and in the recent specimens being greater than three times the standard errors of the differences. Both upper premolars present the tendency to become less hypsodont in the course of time, the height index in the recent specimens averaging higher than that in the cave specimens.

TABLE 23

P^4	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	39	9.4	0.84	8.94	0.14	4.3
Id. subfossil	275	10.0	0.87	8.70		
Transverse recent	50	12.7	1.18	9.29	0.18	5.6
Id. subfossil	265	13.7	1.31	9.56		
Vertical recent	12	9.7	1.13	11.65	0.38	2.1
Id. subfossil	17	10.5	0.82	7.81		
Height index recent	12	98.2	7.67	7.81	2.43	0.74
Id. subfossil	17	96.4	4.18	4.34		

In recent skulls of the orang-utan the P^3 is invariably longer, and most often also broader than the P^4. The relative height of the crown is greater in the P^3 than in the P^4. The cave material consists of isolated specimens, with the exception of no. 85 of P^3 and no. 85 op P^4 which were found together in situ in a small portion of a maxillary (Coll. Dub. no. 11539/85). As can be seen from the tables 20 and 22, in this case also the P^3 exceeds the P^4 in size. In the average the subfossil P^3 is longer (10.6 mm as opposed to 10.0 mm) than the P^4 but the transverse diameter is the same (13.7 mm) for both upper premolars.

P_3 (pl. IV figs. 15 and 16; pl. V figs. 1-7)

In the orang utan mandible the anterior premolar is adapted to the large C. The P_3 protrudes anteriorly on the outer side of the canine, and, to leave room for the latter, the anterior portion of the crown of the P_3 has shifted outward. So has the pair of confluent anterior roots, of which the lingual is almost completely suppressed. The canine, which begins to develop earlier but erupts later than the premolars, normally passes internally beyond the antero-external protrusion of the P_3. In one recent mandible (no. 58) the C has erupted externally of the anterior root of the P_3, and the anterior premolar consequently has been tilted outward. The normal occlusion, however, has been maintained: the pointed crown of the P_3 is wedged in between the upper C and the P^3.

In the cave collection from Sumatra we have 270 specimens of the P_3, nos. 1-126 are of the right side. Nos. 1-33 and 127-161 are unworn. Specification:

58 P_3 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11548/16-30, 84-126.
62 P_3 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11549/139-156, 182-225.
55 P_3 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11550/1-15, 44-83.
57 P_3 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11551/127-138, 226-270.
7 P_3 dext., paratypes, Djamboe cave, Coll. Dub. no. 11552/33-39.
16 P_3 sin., paratypes, Djamboe cave, Coll. Dub. no. 11553/160-175.
6 P_3 dext., paratypes, cave not specified, Coll. Dub. no. 11554/31, 32, 40-43.
9 P_3 sin., paratypes, cave not specified, Coll. Dub. no. 11555/157-159, 176-181.

The anterior lower P has a strong pyramidal crown, the protoconid. Due to the antero-external protrusion of the base of the crown, the long axis of the tooth is not found in antero-posterior direction but from antero-buccal to postero-lingual. The inner side of the crown is more flattened than the outer. On the antero-external angle the lower border of the enamel is considerably produced toward the roots.

There are three ridges from the tip of the protoconid, an anterior, a transverse and a posterior ridge. The anterior ridge is sharp and straight, or slightly curved inward near the base, where it is met with the cingulum. The latter forms a ledge and is almost invariably present from the base of the anterior ridge backward. In one specimen (no. 2, pl. V fig. 1) it is also visible in front of the base of the latter, as an ascending and gradually thickening ledge from the antero-external base of the crown. It forms no point at the base of the anterior ridge, as it often does (e.g., no. 1, pl. IV figs. 15, 16), but more backward it rises, as usual, into the prominent base of the transverse ridge which represents the metaconid. The anterior ridge, the cingulum and the transverse ridge or metaconid ridge enclose a fovea anterior or trigonid basin. This fossa is very variable in development; two extreme conditions are shown in nos. 127 and 128 (pl. V figs. 2-5). In the first the cingulum and the metaconid are practically absent, and between the anterior ridge and the metaconid ridge there is merely a flat triangular area with a faint vertical groove. In the other the basal ledge and the metaconid are unusually strong, and the trigonid fossa is much depressed. Notwithstanding the great difference in the trigonid fossa, the fossa behind the metaconid ridge (talonid fossa) is remarkably alike in the two specimens, as shown in the occlusal views (pl. V figs. 3 and 5). The ridge descending backward from the tip of the protoconid gradually curves inward, joining the posterior marginal ridge. The latter ridge again passes lingually into the metaconid ridge. The talonid fossa enclosed by these ridges is a depressed elongated area with an acute angle at the tip of the protoconid, and rounded below. At the point of junction of the posterior ridge from the protoconid and the posterior marginal ridge there may be a point, the hypoconid (e.g., no. 2, pl. V fig. 1). Another accessory cusp, the entoconid, has well developed at the postero-internal angle of the crown behind the metaconid in no. 25 (pl. V figs. 6, 7). It has even stronger developed than the metaconid and the hypoconid, also shown in this specimen. Remane (1921, p. 60) does not cite the occurrence of hypoconid and entoconid in the P_3 of the orang-utan, but mentions them for the chimpanzee.

The wrinkle system affects only the fossae, especially the posterior; the talonid fossa may show wrinkles radiating from its centre.

Behind the inferior prominence of the enamel at the antero-external angle the gingival line presents a slight concavity toward the roots below the base of the posterior ridge from the protoconid. Another upward curvature of the enamel border may occur at the lingual side, below the trigonid basin.

The roots are for the greater part preserved in 20 specimens. There is a confluent pair of posterior roots, of which the lingual is the larger, and a strong antero-external root. The latter is more or less triangular in cross section, and may show a posterior groove indicating that it is composed of a large buccal and a small lingual root.

In the mandible the P_3 is orientated with the metaconid ridge approximately transverse, but it may be rotated, with the antero-external root more to the buccal, and the postero-internal root more to the lingual side. I have measured the antero-posterior diameter along the long axis of the crown, over the antero-external protrusion and the postero-lingual angle. The transverse diameter has been measured at right angles to the latter. The vertical diameter is the greatest height of the crown on the antero-buccal side, and the height index is $\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$.

TABLE 24

Measurements of P_3 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	20.7	—	16.8	16.0	14.7	16.4	20.5	16.5	17.1	20.7
Transverse	12.6	12.5	10.0	9.6	10.4	12.0	13.0	11.3	11.8	12.0
Vertical	19.4	—	15.7	—	—	14.5	18.8	14.6	16.4	20.2
Height index	106.7	—	107.0	—	—	113.1	109.0	113.0	104.3	102.4

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	15.3	16.7	15.5	15.2	18.1	—	12.7	15.5	13.6	—
Transverse	12.2	9.9	10.6	10.3	12.8	11.3	8.7	11.1	10.2	9.5
Vertical	16.7	14.8	15.7	13.1	16.6	—	12.1	14.0	12.5	—
Height index	91.6	112.8	98.7	116.0	109.0	—	104.9	110.7	108.9	—

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	16.4	13.8	15.7	—	14.3	15.6	17.9	14.8	12.0	13.3
Transverse	11.4	9.7	11.1	9.4	9.3	10.8	12.2	9.4	8.2	9.2
Vertical	—	12.8	15.0	—	12.5	—	—	—	10.4	11.6
Height index	—	107.8	104.7	—	114.4	—	—	—	115.4	114.7

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	17.7	15.1	—	17.8	17.6	15.7	18.0	15.5	15.3	17.2
Transverse	11.9	11.3	11.4	11.5	11.2	10.0	11.3	11.4	9.8	11.4
Vertical	16.1	13.5	15.3							
Height index	109.9	111.8	—							

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	14.3	17.2	17.7	17.1	13.9	13.4	16.2	14.6	14.8	17.6
Transverse	10.2	11.3	12.2	11.7	9.4	9.2	11.4	10.7	10.2	11.4

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	19.2	15.3	18.5	12.4	17.0	19.3	19.0	15.6	16.8	17.4
Transverse	11.7	10.0	13.4	8.4	11.6	14.3	12.0	9.9	11.1	11.3

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	16.4	16.7	18.4	15.6	18.4	15.7	16.6	14.6	12.8	17.6
Transverse	11.2	12.3	11.0	10.4	11.9	10.6	10.8	10.3	8.6	12.5

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	16.1	15.4	15.5	15.8	13.1	14.3	20.0	15.2	17.8	16.5
Transverse	10.3	11.0	10.0	9.4	9.5	9.7	12.1	9.7	11.8	10.3

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	15.6	18.0	14.6	16.1	—	16.0	17.8	13.4	13.7	—
Transverse	11.1	11.9	—	9.2	11.0	11.7	11.3	9.1	8.5	11.1

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	—	14.8	14.0	15.7	14.8	14.8	—	14.9	15.5	15.3
Transverse	10.4	10.6	8.7	9.5	9.4	9.3	—	9.5	9.7	9.8

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	12.8	15.5	15.0	13.7	15.4	16.3	—	15.5	16.3	18.1
Transverse	8.5	10.3	9.6	9.5	9.6	10.7	9.4	9.3	10.4	11.7

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	16.0	14.3	16.8	14.7	15.0	13.6	—	—	15.7	15.1
Transverse	8.8	9.1	9.5	9.6	9.2	9.1	9.4	10.3	10.3	9.4

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	14.2	15.0	18.5	18.3	—	—	17.2	15.8	18.2	17.6
Transverse	9.8	10.5	12.2	12.0	10.4	9.4	12.3	11.1	12.7	13.0
Vertical							17.5	14.7	16.8	16.1
Height index							98.2	107.5	108.3	109.3

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	16.8	14.9	15.5	18.4	13.6	15.3	—	15.7	17.2	17.1
Transverse	11.4	9.9	10.9	11.2	9.3	10.3	9.2	10.5	11.3	11.4
Vertical	—	12.8	14.7	15.9	13.2	14.5	—	13.8	16.4	15.7
Height index	—	116.4	105.4	115.7	103.0	105.5	—	113.8	104.9	108.9

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	17.0	15.8	—	15.0	14.2	—	14.0	16.1	—	15.9
Transverse	12.1	10.3	10.2	—	9.9	9.2	9.0	10.7	9.4	10.8
Vertical	—	16.4	—	14.3	13.4	—	12.7	—	—	13.0
Height index	—	96.3	—	104.9	106.0	—	110.2	—	—	122.3

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	15.8	—	—	—	17.5	—	—	19.0	16.8	13.7
Transverse	11.0	11.8	9.6	9.0	11.5	10.7	10.3	12.8	12.4	9.0
Vertical	15.5	—	—	—	16.4	—	—	16.7	17.8	12.0
Height index	101.9	—	—	—	106.7	—	—	113.8	94.4	114.2

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	—	18.2	18.6	15.5	15.9	16.5	14.0	15.6	16.6	15.7
Transverse	12.3	10.3	11.4	10.0	10.1	10.5	8.7	10.4	11.8	10.8

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	16.6	15.0	13.9	17.0	16.2	17.5	14.5	14.8	12.8	16.2
Transverse	12.0	9.5	9.8	12.0	10.0	10.5	10.3	10.3	8.4	10.5

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	16.6	14.8	15.0	13.4	16.2	—	14.5	14.5	17.4	14.7
Transverse	10.9	10.7	9.5	8.7	10.7	11.1	10.0	9.7	12.0	9.4

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	17.0	19.5	15.6	16.0	15.7	13.8	—	13.7	13.1	14.8
Transverse	9.7	12.8	10.6	10.0	11.1	10.0	10.4	9.3	8.5	9.7

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	14.2	15.0	14.5	—	15.8	12.6	—	15.8	13.5	13.3
Transverse	9.1	10.0	10.0	11.0	10.4	8.7	10.6	9.6	9.7	8.7

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	—	14.3	13.6	13.2	—	14.0	14.7	15.1	18.8	12.5
Transverse	10.0	10.7	8.2	9.4	8.7	9.4	10.3	9.0	12.0	10.0

No. of specimen	221	222	223	224	225	226	227	228	229	230
Antero-posterior	19.5	14.6	17.4	15.0	17.1	15.0	13.5	16.0	13.1	15.7
Transverse	13.5	—	12.6	10.4	10.7	9.8	9.0	10.7	9.0	9.5

No. of specimen	231	232	233	234	235	236	237	238	239	240
Antero-posterior	17.2	15.2	14.6	21.8	16.7	18.4	15.5	19.5	18.6	12.8
Transverse	11.0	10.1	10.1	13.9	11.5	12.3	11.2	12.4	13.1	9.3

No. of specimen	241	242	243	244	245	246	247	248	249	250
Antero-posterior	15.7	—	14.4	19.0	15.8	16.7	15.5	13.0	16.3	18.0
Transverse	11.1	10.6	9.3	11.0	10.1	11.4	10.0	9.6	12.0	12.2

No. of specimen	251	252	253	254	255	256	257	258	259	260
Antero-posterior	15.6	14.6	14.8	15.1	18.8	14.8	—	15.6	17.5	18.2
Transverse	11.5	9.5	10.5	10.3	12.3	9.9	10.4	10.3	12.3	11.8

No. of specimen	261	262	263	264	265	266	267	268	269	270
Antero-posterior	15.0	17.0	—	—	19.7	14.3	17.0	15.5	16.9	14.3
Transverse	12.9	12.3	11.4	10.5	12.8	10.2	11.4	10.2	11.0	11.2

In the present case there is no significant distinction between the antero-posterior and vertical diameters of the recent and those of the subfossil specimens. The quotient in the last column of the table below exceeds three only for the transverse diameter. The variation is rather great, especially that in the vertical diameter (Pearsonian coefficient!). The height index, however, is not unusually variable. It averages higher in the subfossil specimens, which are consequently lower-crowned than the recent. In contradistinction to the upper premolars, the P_3 shows the tendency to become more hypsodont.

TABLE 25

P_3	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	46	15.0	1.91	12.73	0.31	2.9
Id. subfossil	236	15.9	1.79	11.26		
Transverse recent	47	9.8	1.06	10.82	0.17	4.1
Id. subfossil	266	10.6	1.21	11.42		
Vertical recent	15	14.5	2.39	16.48	0.69	0.4
Id. subfossil	45	14.8	2.09	14.12		
Height index recent	15	105.1	7.00	6.66	2.03	1.5
Id. subfossil	44	108.1	6.21	5.74		

P_4 (pl. V figs. 8—12)

We have 268 specimens of the P_4; nos. 1-123 are of the right side. Nos. 1-32 and 124-158 are unworn. The specification of the specimens is given below:

67 P_4 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11556/1-23, 80-123.
67 P_4 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11557/124-147, 226-268.

48 P_4 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11558/26-73.
60 P_4 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11559/148-156, 175-225.
7 P_4 dext., paratypes, Djamboe cave, Coll. Dub. no. 11560/24, 25, 74-78.
17 P_4 sin., paratypes, Djamboe cave, Coll. Dub. no. 11561/157-173.
1 P_4 dext., paratype, cave not specified, Coll. Dub. no. 11562/79.
1 P_4 sin., paratype, cave not specified, Coll. Dub. no. 11563/174.

The crown of the posterior lower premolar is four-sided, with rounded angles. The greater diameter runs from antero-buccal to postero-lingual. On the buccal surface the enamel border is produced toward the roots anteriorly.

There are two cusps, a buccal (protoconid) and a lingual (metaconid) placed on a transverse line distinctly nearer to the anterior than to the posterior border of the crown. In unworn specimens the metaconid is seen to be more prominent than the protoconid, though measured from the lower border of the enamel the protoconid is the higher of the two, due to the inferior protrusion of the gingival line on the buccal side anteriorly.

Protoconid and metaconid may be connected by a transverse ridge, the posterior trigonid ridge (Remane, 1921, p. 77), most often cut into by the antero-posterior sulcus. The anterior marginal ridge connects the anterior ridges from proto- and metaconid, and encloses with the posterior trigonid ridge an anterior fossa, the trigonid fossa. Nos. 147, 148 and 149 (pl. V figs. 9-12) illustrate the variation in size of the trigonid fossa in keeping with the greater or lesser proximity of the cusps. In no. 147 the cusps are widely separated and the trigonid fossa consequently is broad. In no. 149 the trigonid fossa is very small due to the closely approximated cusps. No. 148 presents an intermediate condition.

The posterior slopes of proto- and metaconid are longer than the anterior. The ridges descending backward from the tips of these cusps are continuous with the posterior marginal ridge and enclose a wide talonid fossa. In the latter fossa enamel wrinkles radiate from the centre, or rather from a central antero-posterior groove. We can distinguish several accessory cusps as elevations of the posterior marginal ridge, evidently corresponding to the main cusps of the lower molars. Most often there is a postero-buccal cusp or hypoconid. It is separated from the posterior protoconid slope by a notch and is shown in the three specimens mentioned above. Less frequent is the postero-lingual cusp, the entoconid. No. 148 (pl. V fig. 10) presents an entoconid. It is smaller and slightly more posterior in position than the hypoconid. Between the postero-internal cusp and the hypoconid, and close to the latter, the posterior marginal ridge may present a point, e.g., in no. 130 (pl. V fig. 11). This point seems to represent the hypoconulid, a cusp which Remane (1921, p. 60) failed to detect in the orang-utan P_4, but which was found by him to occur occasionally in gorilla, chimpanzee and gibbon. In my material the hypoconulid is indeed rarely present; I found it only four times (nos. 18, 128, 130 and 131).

The roots, preserved for the greater part in 26 of the specimens, consist of one confluent pair anteriorly, and one pair posteriorly. The buccal components are the larger and have shifted forward to a somewhat little extent. An aberrant root formation is shown in no. 227 (pl. V fig. 8). The anterior pair of roots is normal; the postero-buccal root, however, is not more anterior in position than the postero-lingual but is directed backward instead. Between the two buccal roots there is an accessory root in the middle of the buccal surface and with a slight upward curvature of the enamel border above it. The lingual roots have fused in no. 175.

Three cave specimens, viz., nos. 72, 73 and 179, are carious. In nos. 72 and 179 the postero-external angle is affected, while no. 73 has a carious cavity on the centre of the crown.

In the recent jaws the P_4 is rather frequently rotated with the metaconid more to the anterior side than the protoconid. In one jaw the right P_4 is rotated with its anterior surface facing inward. In the latter case there was evidently no call for more room, for the tooth takes up more space than it would have done in the normal position. I measured the antero-posterior diameter as the long axis of the crown, from antero-external to postero-internal, and the transverse diameter was taken at right angles to the long axis. The vertical diameter was taken at the protoconid. The height index is

$$\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$$

TABLE 26

Measurements of P_4 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	13.5	13.0	13.0	12.3	12.2	13.8	11.8	12.9	12.0	15.0
Transverse	11.1	11.3	10.4	10.0	10.8	10.8	10.5	10.5	9.7	12.4
Vertical	11.2	—	—	10.2	9.3	9.7	10.2	—	9.0	—
Height index	120.5	—	—	120.6	131.2	142.3	115.7	—	133.3	—

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	12.0	11.8	13.0	13.8	12.2	10.7	11.4	13.4	14.5	12.1
Transverse	9.7	10.5	10.7	11.9	10.3	9.1	9.7	11.0	12.7	10.6
Vertical	10.0	—	—	11.1						
Height index	120.0	—	—	124.3						

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	12.8	13.0	12.9	13.6	12.3	15.0	13.0	14.2	12.4	12.9
Transverse	11.0	11.0	11.2	11.5	9.5	12.0	10.8	11.7	10.8	10.6
Vertical	—	10.4	—	—	8.8	11.5	9.3	11.8	9.7	11.4
Height index	—	125.0	—	—	139.8	130.4	139.8	120.3	127.8	113.2

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	14.3	13.0	16.5	14.6	14.6	14.6	15.0	13.5	15.8	13.7
Transverse	12.7	11.2	13.4	12.1	12.6	10.7	12.7	12.0	12.5	11.5

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	11.8	12.7	13.5	13.0	12.0	11.1	13.6	13.5	16.0	11.0
Transverse	10.0	11.0	11.4	10.9	10.2	9.5	11.5	10.9	13.2	9.5

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	13.2	—	14.2	16.6	16.4	15.4	12.5	12.8	15.5	14.7
Transverse	10.8	12.3	12.7	14.0	13.1	12.7	11.0	12.0	13.0	12.5

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	15.4	14.8	15.4	13.0	15.3	12.5	13.0	14.7	11.5	12.3
Transverse	12.6	12.7	13.3	11.0	12.7	10.8	11.4	11.8	10.1	11.1

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	13.5	14.2	15.3	14.2	14.0	14.5	12.8	13.0	15.5	14.0
Transverse	11.3	—	13.1	12.0	11.1	12.0	10.7	11.4	12.8	12.4

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	13.0	12.1	12.7	12.2	14.5	13.0	13.2	12.1	13.3	15.2
Transverse	11.0	9.8	10.3	10.5	12.7	9.6	10.7	9.7	11.3	12.0

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	12.3	12.0	13.5	13.7	14.4	—	12.2	14.0	12.4	12.4
Transverse	10.4	10.3	11.3	11.4	12.0	—	11.0	11.2	10.0	10.4

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	14.6	12.4	12.7	12.8	13.0	13.6	14.6	14.1	12.4	13.4
Transverse	12.3	10.8	10.7	10.6	10.6	11.5	12.3	11.8	12.1	10.1

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	11.9	12.3	15.5	15.0	13.0	11.2	12.8	13.0	14.2	13.9
Transverse	9.6	10.2	12.3	12.7	10.4	9.3	10.7	10.9	12.2	12.5

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	12.7	11.0	14.5	13.5	12.0	13.3	13.7	12.8	13.7	15.6
Transverse	11.2	8.3	12.2	11.4	10.4	11.7	10.7	10.9	11.4	12.7
Vertical					10.4	—	10.4	10.8	10.6	—
Height index					115.4	—	131.7	118.5	129.2	—

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	14.5	11.8	14.0	13.6	14.3	12.1	13.2	12.9	13.2	12.7
Transverse	11.5	9.5	11.5	11.0	12.0	10.0	10.7	11.3	11.5	11.0
Vertical	11.7	9.4	—	9.0	—	8.4	—	—	9.0	—
Height index	123.9	125.5	—	151.1	—	144.0	—	—	146.7	—

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	13.5	11.9	13.5	14.5	13.0	11.8	14.2	14.2	13.1	12.3
Transverse	10.4	9.3	11.0	11.7	10.7	10.5	12.6	10.8	10.7	10.0
Vertical	11.5	—	—	—	—	—	—	—	10.3	10.7
Height index	117.4	—	—	—	—	—	—	—	127.2	115.0

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	12.4	14.5	11.0	14.1	12.8	14.2	14.3	13.3	14.2	13.9
Transverse	10.3	11.3	9.5	11.8	11.2	11.3	11.7	10.5	12.3	11.6
Vertical	9.0	11.8	9.3	10.8	—	10.3	10.7			
Height index	137.8	122.9	118.3	130.6	—	137.9	133.6			

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	12.2	11.9	14.1	13.0	13.9	12.5	13.7	14.0	13.1	13.2
Transverse	9.3	10.4	12.0	12.0	11.4	10.7	11.2	12.0	11.3	11.3

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	13.5	13.4	13.5	—	14.5	13.0	14.7	13.2	15.3	13.4
Transverse	11.3	10.7	12.0	—	12.5	11.1	12.2	10.4	12.7	10.0

No. of specimen	181	182	183	184	185	181	187	188	189	190
Antero-posterior	14.6	14.0	14.0	12.0	13.1	14.8	14.7	14.4	13.7	15.0
Transverse	11.7	11.5	11.0	10.5	11.5	12.4	12.1	11.7	11.8	12.3

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	12.7	12.8	12.0	14.8	12.0	13.3	13.7	13.3	12.2	11.8
Transverse	10.8	11.5	9.5	12.1	11.1	10.7	11.4	10.3	10.5	10.0

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	13.5	15.7	13.9	12.3	13.8	13.3	13.8	13.0	14.5	15.0
Transverse	11.2	12.4	11.8	10.8	12.0	11.5	12.0	10.0	12.3	12.0

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	15.2	10.8	15.7	13.2	14.0	15.5	12.1	13.3	13.5	16.7
Transverse	12.0	9.4	13.0	11.3	12.2	12.6	10.0	12.0	10.8	13.6

No. of specimen	221	222	223	224	225	226	227	228	229	230
Antero-posterior	13.9	16.2	13.3	12.6	15.0	14.4	13.0	13.2	11.5	14.2
Transverse	11.4	12.7	10.4	10.7	13.0	11.7	11.0	11.0	9.5	11.3

No. of specimen	231	232	233	234	235	236	237	238	239	240
Antero-posterior	11.7	13.0	13.5	13.0	13.7	13.1	12.5	14.0	12.2	12.6
Transverse	10.1	12.0	11.7	11.5	10.8	10.6	11.4	11.7	10.5	10.5

No. of specimen	241	242	243	244	245	246	247	248	249	250
Antero-posterior	13.1	13.7	13.8	14.7	12.9	14.5	12.3	14.7	12.7	—
Transverse	11.1	11.2	10.7	11.4	10.8	11.8	10.0	12.0	9.8	9.4

No. of specimen	251	252	253	254	255	256	257	258	259	260
Antero-posterior	14.0	12.0	12.5	12.8	16.5	14.1	14.3	13.1	15.0	12.2
Transverse	11.4	10.1	9.9	10.7	13.0	12.0	11.7	11.5	12.8	10.7

No. of specimen	261	262	263	264	265	266	267	268
Antero-posterior	13.5	11.4	12.0	14.0	11.4	12.8	12.2	11.6
Transverse	11.5	10.3	10.4	12.1	10.3	10.9	10.4	10.3

TABLE 27

P_4	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	46	12.9	1.33	10.31	0.21	2.4
Id. subfossil	263	13.4	1.19	8.88		
Transverse recent	46	10.4	0.87	8.37	0.16	1.9
Id. subfossil	265	10.1	1.49	14.75		
Vertical recent	12	10.2	1.14	11.18	0.37	0.0
Id. subfossil	33	10.2	0.95	9.31		
Height index recent	12	126.8	8.42	6.64	2.98	0.5
Id. subfossil	33	128.2	9.87	7.70		

The subfossil P_4 cannot be separated statistically from the recent. Like the P_3 it tends to become more hypsodont. The subfossil P_4 averages larger than the recent only in the antero-posterior diameter; the vertical diameters are the same. The transverse diameter in *palaeosumatrensis* averages lower (10.1 mm as opposed to 10.4 mm) than that in *Pongo pygmaeus pygmaeus* (Hoppius); this measurement in the cave material is extremely variable (Pearsonian coefficient 14.75!). The P_3 has undergone a much greater reduction in size than the P_4. This is significant; Remane (1931, p. 436) has pointed out that, among other points, the preponderance in size of P_3 over P_4 in apes and man indicates the pre-existence of a bigger upper C. The difference in size between P_3 and P_4 is much greater in *palaeosumatrensis* than in the recent form, in which P_3 is not so very much larger than P_4. It might thus be deduced from this fact that the ancestor of *palaeosumatrensis* had relatively still larger canines in the upper jaw than its descendants.

MOLARS

Upper M

When determining the serial position of loose molars one is often met with serious difficulties on account of their great similarity. When the series are examined in situ in the jaws, however, they can be seen to present a gradation of form as one passes along the series.

From M^1 to M^3 there is a progressive diminution in surface and height of the postero-external cusp or metacone. The postero-internal cusp (hypocone) likewise progressively diminishes in size from M^1 to M^3. In M^3 the posterior cusps may be reduced to an extent as to be practically absent.

In addition, the cusps do not retain the same position relative to each other throughout the series. The backward shifting of the hypocone is often well-marked. M^2 most often is larger than M^1 and is characterized by the posterior transverse contraction of the crown, or rather the widening of the anterior moiety, which makes the sides of the crown converge posteriorly instead of running nearly parallel as in M^1.

The hypocone is surrounded by a groove, the sulcus obliquus, which encroaches on the lingual border of the crown, may be down to the roots. In M^1 this sulcus is more distinct and more anterior in position on the lingual surface than in M^2. This, in my experience, is the most conspicuous point of difference between M^1 and M^2 in recent skulls. That the character also holds for the subfossil orang-utan is fortunately shown by portions of maxillaries in the cave collection with M^1 and M^2 together in situ. But, though this gradient is found within every series belonging to one and the same individual, it is impossible even by this character to determine every molar as representing either M^1 or M^2. In the M^2 of some skulls the vertical groove on the lingual surface of the crown is not situated more posteriorly than that in M^1 of other skulls. If the vertical groove is situated only slightly behind the middle of the lingual surface, it is practically certain that we are dealing with an M^1, and if the groove is distinctly nearer to the posterior border than to the anterior we have strong evidence of its being an M^2. There remain, however, loose specimens in which the situation of the sulcus obliquus gives no clue for the serial position.

The presence or absence of certain contact facets is of some importance in discriminating between the (worn) molars. M^1 may possess an anterior inferior pressure facet, caused by the erupting P^4. Such a facet, of course, can never exist on M^2, M^3 or M^4. The absence of a posterior contact facet characterizes the hindmost molar of the series. A certain percentage of the specimens thus singled out, however, must be M^4! Even M^2 cannot always be excluded, for in two of my recent skulls (nos. 62 and 73) the right M^3 has not developed.

The reduction of the posterior cusps cannot always be relied upon as indicative of the last molar. The M^2 in one skull may have much more reduced posterior cusps than the M^3 in another. Compare, e.g., the M^2 of skull no. 27 (pl. VI fig. 12) with the M^3 of skull no. 29 (pl. VII fig. 3). As isolated tooth the former would have been classed as a last molar, and the latter as an M^2! The posterior contact facet, if any, solves the problem for worn molars. Thus, with an apparent paradox, perfect and unworn molars may be more difficult to classify than worn specimens.

Notwithstanding the fact that it is simply impossible to determine the serial position of every molar with the same certainty as that of incisors and premolars, their descriptions have not been assembled. I am certain that the majority of the cave specimens has been correctly determined, and also that a certain number, on account of their atypical form, have necessarily been included into the group to which they do not belong, but to which they have the greatest resemblance. But, after all, these are exceptional cases.

M^1 (pl. VI figs. 7-11)

In the Sumatran cave collection there are 331 specimens of M^1. Nos. 1-160 are from the right side. Nos. 1-26, 161-173 and 193-203 are unworn. The specification of the specimens is given here:

99 M^1 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11564/1-16, 78-160.
80 M^1 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11565/161-168, 260-331.
43 M^1 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11566/18-24, 42-77.
63 M^1 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11567/193-224, 227-257.
17 M^1 dext., paratypes, Djamboe cave, Coll. Dub. no. 11568/25-41.
24 M^1 sin., paratypes, Djamboe cave, Coll. Dub. no. 11569/169-192.
1 M^1 dext., paratype, cave not specified, Coll. Dub. no. 11570/17.
2 M^1 sin., paratypes, cave not specified, Coll. Dub. no. 11571/258, 259.
1 M^1 and M^2 sin., paratype, Lida Ajer cave, Coll. Dub. no. 11572/225.
1 M^1 and M^2 sin., paratype, Lida Ajer cave, Coll. Dub. no. 11573/226.

The crown usually is a little wider transversely in front than behind. The buccal cusps, paracone anteriorly and metacone posteriorly, are somewhat more closely approximated and fall down to the base of the crown more steeply than the lingual cusps, protocone anteriorly and hypocone posteriorly. In the unworn state the tips of the buccal cusps are seen to be more pointed than those of protocone and hypocone. The protocone is the largest cusp. The paracone is more anterior in position than the protocone. As the hypocone often has distinctly shifted backward relative to the metacone, the protocone is opposed to the interval between the two outer cusps, but nearer to the paracone than to the metacone.

A ridge, the crista obliqua, connects the protocone with the metacone. Or rather its lingual origin lies somewhat behind the tip of the protocone (no. 12, pl. VI fig. 7). In the middle of its course it is most often interrupted by a groove (no. 10, pl. VI fig. 8). The wrinkle system may affect the whole surface between the four main cusps to an extent as to make the oblique ridge almost imperceivable.

In addition to the crista obliqua there is an (often reduced) transverse ridge from the tip of the paracone inward to a point in front of the protocone, the so-called protoconule (see below). Enclosed by this anterior transverse ridge and the anterior marginal ridge of the crown there is the fovea anterior, well shown in specimens 10 and 12 (pl. VI figs. 7, 8). The central fossa (fovea centralis) of the crown is divided by the crista obliqua into a trigon fossa anteriorly, and a hypocone fossa posteriorly. The trigon fossa is wider and deeper than the hypocone fossa, and the wrinkles radiate from their centres. Finally there is a posterior fossa between metacone and hypocone, bordered behind by the posterior marginal ridge. The posterior fossa often is confluent anteriorly with the hypocone fossa (no. 170, pl. VI fig. 9; in this specimen the anterior fossa is absent).

In keeping with the greater of lesser posterior displacement of the hypocone the crown has a more or less marked protrusion posteriorly to the inner side. The hypocone is the most isolated cusp, and the groove or sulcus obliquus which surrounds it trespasses on the lingual surface of the crown about midway between the anterior and the posterior border.

I have not been able to find structural differences between the recent and the subfossil molars. Of course there is the usual variation in the distinctiveness of the cusps and the degree of development of the wrinkles (compare, e.g., nos. 10 and 170, pl. VI figs. 8 and 9), but this variation is found both in the recent and the subfossil teeth, and, as we shall see later, also in the fossil molars of the orang-utan from Java and China.

The presence of accessory tubercles on the molars has been dealt with by Selenka (1898, pp. 66-73), Remane (1921, pp. 52-59) and Eckardt (1929, pp. 266-268). As accessory tubercle the protoconule (tuberculum accessorium superius anterius internum of Selenka, l.c., p. 70, fig. 88) is of great importance. I found it to occur in 44 of the 50 unworn cave specimens. It is shown in the three examples figured (nos. 12, 10 and 170), while in no. 3 (pl. VI fig. 10) there is seen to be a ledge ascending from the antero-internal angle of the crown that culminates in the protoconule. Most often there is only a short antero-internal vertical groove separating the protoconule from the protocone.

An accessory tubercle on the posterior marginal ridge and nearer to the metacone than to the hypocone, occurs only in 9 of the 50 unworn prehistoric specimens of M^1. It is shown in no. 170 (pl. VI fig. 9). A posterior inner accessory tubercle, close to the hypocone, is shown in no. 161 (pl. VI fig. 11) and was found in 7 of the 50 unworn molars.

In 16 recent unworn M^1 I found 14 protoconules, no postero-external, and 6 postero-internal accessory cusps.

TABLE 28

M^1	subfossil	recent	recent (Selenka)	
			♂	♀
protoconule	88	88	90	76
tub. access. post. extern.	18	0	0	3
tub. access. post. intern.	14	38	0	9

My percentages of occurrence of the various accessory cusps, based on 50 unworn prehistoric and 16 unworn recent specimens of M^1 can be compared to those found by Selenka (1898, p. 68) in table 28. It needs no comment that these figures do not allow a conclusion as to the greater or lesser frequency of occurrence of accessory tubercles on M^1 in prehistoric as compared to recent times.

Carious cavities occur in not less than 7 specimens, viz., no. 51 (protocone), no. 87 (paracone), nos. 17 and 263 (hypocone), no. 273 (middle of posterior surface), and nos. 289 and 325 (metacone).

As in all upper molars there are two outer and one inner root. They are preserved in 20 specimens. The lingual is the largest and has a longitudinal median groove both on its inner and on its outer surface. It may show a double apex. The outer roots are elongated transversely in cross section and may have longitudinal grooves on their broad surfaces too. In some specimens they are fused almost along their entire length.

The dimensions of the cave molars are given in table 29. Height indices could only exceptionally be given because of the very few unworn specimens that have an undamaged lower enamel border. The vertical diameter has been measured buccally, over the tips of paracone and metacone, and the height index is $\dfrac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$

TABLE 29

Measurements of M^1 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	11.1	12.1	14.3	12.6	14.8	12.2	11.6	12.6	12.9	13.2
Transverse	12.3	12.0	14.6	12.8	14.9	12.6	12.7	13.0	13.2	14.1
Vertical					9.1	8.7				8.0
Height index					163	140				165
No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	11.4	11.8	12.0	12.5	13.7	12.8	12.0	14.5	12.8	11.8
Transverse	12.1	13.0	13.4	12.5	14.8	13.2	12.8	15.4	13.7	12.7
Vertical				7.9					9.8	
Height index				158					131	
No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	12.8	13.0	12.4	13.7	13.1	13.4	14.0	11.5	13.0	12.3
Transverse	12.8	13.0	14.7	13.6	14.4	14.4	14.5	12.0	13.4	13.0
No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	12.6	13.7	13.6	11.5	13.3	13.1	12.6	12.1	13.7	13.6
Transverse	13.3	15.8	14.1	12.1	14.2	14.5	13.1	11.7	14.7	15.7
No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	12.6	12.4	13.7	12.8	12.6	12.0	14.3	12.6	12.7	13.0
Transverse	14.0	13.0	14.9	14.2	13.2	14.3	15.0	13.4	13.2	13.3

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	11.3	11.8	12.6	15.6	12.3	12.5	11.7	12.6	12.8	13.7
Transverse	11.9	12.4	13.5	14.3	12.6	13.7	12.2	14.0	13.1	14.1

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	12.2	13.6	13.5	12.3	13.0	14.3	12.0	14.5	11.8	12.5
Transverse	12.7	15.2	13.8	13.2	14.4	15.0	12.7	15.0	13.2	14.1

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	14.5	13.9	14.7	14.7	12.3	12.0	12.1	12.0	11.8	12.6
Transverse	15.0	14.1	15.0	14.9	14.1	12.4	13.0	12.4	12.4	14.4

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	12.5	12.8	12.8	11.4	12.1	12.9	12.8	11.5	13.0	12.3
Transverse	12.2	14.1	13.0	12.0	13.1	14.0	13.0	12.7	12.4	13.7

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	14.3	10.8	11.2	10.8	15.3	12.5	12.8	12.3	12.8	12.0
Transverse	15.2	12.8	12.0	14.0	14.2	13.4	14.7	13.4	13.4	12.3

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	12.5	13.8	12.8	13.0	12.0	12.6	12.3	12.3	14.1	11.9
Transverse	13.7	15.0	14.0	13.1	13.0	13.8	14.2	14.3	14.4	12.1

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	13.3	13.7	11.8	13.8	12.5	14.5	12.9	12.5	13.3	12.1
Transverse	14.2	13.6	12.1	15.4	15.0	15.0	12.8	12.4	12.6	13.2

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	12.0	11.7	10.7	11.5	12.4	12.3	12.3	11.7	11.5	10.7
Transverse	13.5	12.1	12.0	13.0	13.5	13.0	12.6	12.8	13.5	11.8

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	12.5	13.0	12.3	13.5	12.3	14.4	13.1	14.0	12.1	13.6
Transverse	13.5	13.3	12.3	15.0	13.2	15.0	13.6	14.8	13.6	14.0

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	11.4	12.5	14.2	13.4	12.2	14.0	12.3	12.0	15.4	12.3
Transverse	12.9	14.0	14.6	14.6	12.8	14.7	13.1	12.3	15.5	14.2

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	14.0	13.6	12.2	13.4	12.2	12.6	11.3	12.2	13.0	11.0
Transverse	14.6	13.8	13.1	14.4	12.7	13.5	12.0	12.4	14.1	11.9

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	13.2	12.3	12.4	12.0	12.5	14.0	12.0	13.3	12.3	14.3
Transverse	12.4	12.0	12.9	12.7	13.4	13.6	12.8	13.4	12.3	15.1
Vertical		7.8								
Height index		158								

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	12.2	11.5	12.8	13.0	12.1	14.5	13.3	11.6	13.1	13.3
Transverse	12.3	12.7	13.2	14.0	13.7	15.1	14.5	12.8	13.9	12.9

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	12.9	14.6	12.7	12.0	11.7	12.4	14.0	14.0	12.6	12.4
Transverse	14.4	15.2	14.3	12.3	12.3	13.5	14.8	14.3	14.3	12.8

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	12.0	11.8	11.8	11.9	13.1	14.0	12.9	12.1	12.6	14.8
Transverse	13.2	13.8	13.6	12.4	13.9	14.1	13.0	12.8	12.9	15.3
Vertical					8.7		7.8			
Height index					151		165			

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	12.7	13.5	13.3	11.7	12.7	11.7	11.4	12.3	11.1	13.7
Transverse	14.3	14.1	13.2	12.7	13.5	12.8	12.3	12.5	13.0	15.4

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	12.8	12.0	13.2	13.7	13.4	12.2	12.3	11.0	13.5	13.0
Transverse	13.6	12.6	14.0	13.5	14.8	13.9	12.4	12.2	15.2	13.8

No. of specimen	221	222	223	224	225	226	227	228	229	230
Antero-posterior	13.9	12.9	13.2	13.0	12.9	12.3	13.1	12.3	12.3	12.0
Transverse	14.8	13.6	13.5	14.8	—	13.0	13.5	12.8	14.1	13.1

No. of specimen	231	232	233	234	235	236	237	238	239	240
Antero-posterior	13.5	14.2	14.4	14.0	12.0	13.2	13.5	12.2	14.0	13.6
Transverse	15.0	15.1	15.0	14.9	13.5	14.6	14.7	13.3	14.5	15.2

No. of specimen	241	242	243	244	245	246	247	248	249	250
Antero-posterior	14.6	11.7	11.9	14.5	12.3	13.0	12.2	12.8	12.0	11.7
Transverse	16.5	12.7	12.5	13.9	12.8	13.1	13.0	13.7	12.3	12.8

No. of specimen	251	252	253	254	255	256	257	258	259	260
Antero-posterior	12.3	12.8	13.7	13.2	12.0	13.3	12.1	12.3	12.2	12.7
Transverse	13.3	14.7	14.5	14.0	12.2	14.2	13.7	13.5	12.9	13.4

No. of specimen	261	262	263	264	265	266	267	268	269	270
Antero-posterior	12.8	13.0	11.7	11.8	12.3	14.3	11.5	12.5	11.5	13.0
Transverse	14.5	14.3	12.0	13.1	12.8	14.3	12.8	13.0	13.4	14.0

No. of specimen	271	272	273	274	275	276	277	278	279	280
Antero-posterior	12.3	12.5	11.5	11.7	11.6	—	12.0	12.7	12.6	13.0
Transverse	13.5	12.3	12.9	11.8	12.0	13.2	13.0	12.9	12.5	13.0

No. of specimen	281	282	283	284	285	286	287	288	289	290
Antero-posterior	11.1	13.0	14.0	12.9	13.5	13.9	12.5	12.7	11.0	13.0
Transverse	12.5	15.0	14.4	12.8	14.2	14.0	12.2	14.5	12.1	14.1

No. of specimen	291	292	293	294	295	296	297	298	299	300
Antero-posterior	11.5	13.0	12.0	13.8	12.5	12.4	12.0	12.2	12.3	11.2
Transverse	12.8	13.5	13.4	13.5	13.0	12.9	12.9	12.4	12.6	13.3

No. of specimen	301	302	303	304	305	306	307	308	309	310
Antero-posterior	13.0	11.4	11.8	12.2	12.3	12.2	14.0	13.1	14.3	11.1
Transverse	13.8	12.3	13.2	12.0	13.0	13.5	13.7	13.8	13.5	12.5

No. of specimen	311	312	313	314	315	316	317	318	319	320
Antero-posterior	11.5	11.3	11.2	12.2	12.0	12.0	13.7	12.8	12.8	13.2
Transverse	12.3	12.0	12.0	14.0	13.1	14.2	13.8	13.5	13.4	13.4

No. of specimen	321	322	323	324	325	326	327	328	329	330
Antero-posterior	12.4	11.2	13.8	11.7	11.7	12.1	12.4	11.4	13.0	12.6
Transverse	13.0	12.4	15.0	12.3	12.1	12.9	12.6	12.3	12.4	13.0

No. of specimen	331
Antero-posterior	12.4
Transverse	13.4

The M^1 of *Pongo pygmaeus palaeosumatrensis* nov. subsp. differs statistically from the M^1 of *Pongo pygmaeus pygmaeus* (Hoppius) in its greater antero-posterior and transverse diameters, and the variability in either of the subspecies is not great; as is evident from the inspection of table 30.

TABLE 30

M^1	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	59	12.2	1.07	8.77	0.15	3.3
Id. subfossil	330	12.7	0.92	7.24		
Transverse recent	64	13.1	0.95	7.25	0.13	3.1
Id. subfossil	330	13.5	0.95	7.04		
Vertical recent	6	8.0	0.70	8.75	0.37	1.4
Id. subfossil	8	8.5	0.68	8.00		
Height index recent	6	162	17.1	10.6	8.1	1.0
Id. subfossil	8	154	11.7	7.6		

M^2 (pl. VI figs. 12-19)

The M^2 is represented in the Sumatran cave collection by 353 specimens; nos. 1-173 are of the right side. Nos. 1-22 and 174-193 are unworn. Specification:

71 M^2 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11574/1-13, 116-173.
85 M^2 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11575/174-182, 273-348.
72 M^2 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11576/14-17, 43-110.
65 M^2 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11577/183-188, 212-224, 227-272.
24 M^2 dext., paratypes, Djamboe cave, Coll. Dub. no. 11578/19-42.
23 M^2 sin., paratypes, Djamboe cave, Coll. Dub. no. 11579/189-211.
6 M^2 dext., paratypes, cave not specified, Coll. Dub. no. 11580/18, 111-115.
5 M^2 sin., paratypes, cave not specified, Coll. Dub. no. 11581/349-353.
1 M^1 and M^2 sin., paratype, Lida Ajer cave, Coll. Dub. no. 11572/225.
1 M^1 and M^2 sin., paratype, Lida Ajer cave, Coll. Dub. no. 11573/226.

The roots are preserved in 23 specimens. The teeth are all isolated, except nos. 225 and 226 which were found together with nos. 225 and 226 of the M^1 in situ in maxillary fragments (Coll. Dub. nos. 11572/225 and 11573/226).

M^2 usually is the largest of the upper molar series; this is the case in 28 (14 ♂♂ and 14 ♀♀) of the 38 recent skulls in which the three upper molars could be measured. Of the remaining 10 skulls, 5 ♀ skulls have M^1 as the largest upper molar, whilst M^3 is the largest in the remaining 3 ♂ and 2 ♀ skulls. Just as Selenka (1898, p. 82) I found the preponderance of M^1 over the other upper molars to occur more frequently in female skulls than in the males. Remane (1921, p. 27) got less different percentages for the two sexes (table 31). The number of specimens on which the percentages are based is too small, however (5 out of 21 means 24 ± 9 %!), to allow any conclusion in this respect.

TABLE 31

Percentage of occurrence of M^1, M^2 and M^3 as largest molar

	♂♂			♀♀		
	Selenka	Remane	present author	Selenka	Remane	present author
M^1	30	36	0	59	37	24
M^2	58	44	82	41	48	67
M^3	12	20	18	0	15	9

As stated above, the M^2 differs from M^1 in its smaller and more posteriorly set hypocone. The width over the posterior cusps almost invariably is decidedly less than the anterior width. The metacone even may be displaced inward and reduced to an extent as to give the crown the typical triangular shape often found in M^3 (pl. VI fig. 12). The reduction of the posterior part of the crown, however, rarely has gone so far as in this recent specimen of M^2; it is the only recent M^2 of this form I could find. Miller (1923, fig. 14 a and e) figures two specimens of M^2 of a corresponding type.

Pl. VI fig. 14 represents a large subfossil M^2 (no. 143) with a low but little reduced metacone, and not much narrower behind than in front.

The variation in the distinctiveness of the cusps and the fineness of the enamel wrinkles is well shown by the three specimens of pl. VI figs. 13, 16 and 17. They are all unworn and of the right side. In no. 22 (fig. 13) the cusps are pointed and the wrinkles are coarse. The oblique ridge from the tip of the metacone to a point on the posterior slope of the protocone is well seen; in the middle of the tooth it is cut into by a groove. There is a distinct protoconule. On the posterior marginal ridge of the crown we observe both an inner and an outer accessory tubercle, of which the former is the larger. In no. 2 (pl. VI fig. 17) the whole surface of the crown is flat and covered with the fine wrinkles. The oblique ridge is not more prominent than any other of the wrinkles, and only the paracone is marked by a slight marginal prominence. No. 10 (pl. VI fig. 16) is intermediate in structure between the specimens figured on either side; the cusps are distinct but rounded, and the crista obliqua, though finely crenated, is still seen as the main cross ridge. A distinct protoconule is present, I found this accessory tubercle to be absent only in 4 of the 42 unworn specimens. In this material I noticed moreover 9 accessory inner, and 5 accessory outer tubercles on the posterior marginal ridge. The percentages of occurrence of these accessory tubercles in 42 subfossil and in 8 unworn recent specimens of M^2, together with those recorded by Selenka (1898, p. 68) are given in table 32.

TABLE 32

M^2	subfossil	recent	recent (Selenka) ♂	recent (Selenka) ♀
protoconule	90	100	100	94
tub. access. post. extern.	12	25	12	27
tub. access. post. intern.	21	13	3	0

I have one specimen of M^2 in the cave collection (no. 41, pl. VI fig. 18) that presents two large accessory cusps, one of which does not fit into the scheme given by Selenka. In addition there has been a protoconule, as is evident from a small vertical fold at the anterior inner angle of the crown. Between the protocone, the hypocone and the paracone the crown surface is touched by wear, but the metacone is intact. The enamel in the unworn part of the crown surface is seen to be moderately wrinkled, and the buccal portion of the crista obliqua is clearly defined. It runs from the tip of the metacone inward at right angles to the outer margin of the crown, instead of inward and forward, as usual. The lingual portion of the oblique ridge is worn away, and there is only seen to be a ridge running from the tip of the hypocone outward and forward, which joins the transverse ridge from the metacone about in the middle of the tooth. The hypocone is rather strong, and has decidedly been displaced outward relative to the protocone. It is flanked by two large and pointed accessory cusps, one on its lingual side and set low on the posterior inner margin of the crown, and the other on its postero-buccal side, forming a posterior protuberance to the crown. Each of these accessory cusps has three fine enamel ridges descending from the tip toward the centre of the crown.

The metacone is rather small (though more distinct than that in the flat-surfaced no. 2 of fig. 17), and presents a point on its posterior slope, evidently a tuberculum accessorium superius posterius externum. The large posterior accessory cusp is an elevation of the posterior marginal ridge of the crown and is nearer to the hypocone than to the metacone, and thus can be determined as a tuberculum accessorium superius posterius internum of extraordinary dimensions.

The extra cusp on the inner side of the hypocone, however, is a basal outgrowth of the crown, and its tip projects freely inward. Similar outgrowths on the crown of the upper molars are known to occur occasionally in man and in the anthropoids (Adloff, 1908, fig. 78 a and b; Remane, 1921, p. 58; Weidenreich, 1937, figs. 334-337; Adloff, 1938, p. 506 fig. 3), but are typically found at the lingual surface of the protocone, and not at the lingual surface of the hypocone as in the present specimen. Weidenreich, however, regards this so-called tuberculum Carabellii as an accidental formation of the cingulum "common to all Primates", and if we accept this view it is not surprising to find such cusp-like formations also beside the hypocone. Weidenreich (1937, fig. 337) figures an M^3 of *Cebus* with a large and high accessory cusp on the lingual surface between protocone and hypocone. According to Adloff (1938, pp. 507-509) a true Carabelli cusp occurs only in recent man (exceptionally in the gibbon too) and represents the remnant of a still more developed cusp in his remote ancestors. Similar occurrences in the apes are to be considered as derivations from the lingual cingulum which is lacking in man. Be this as it may, the accessory cusp lingually of the hypocone in our subfossil molar is too much posterior in position to deserve the name Carabelli cusp, and whether or not its presence has any value for systematic questions I dare not decide.

A clear indication of a buccal cingulum is found occasionally in the form of a short horizontal ledge about at one-half of the height of the crown and just below the vertical depression separating paracone and metacone. Its occurrence is cited by Remane (1921, pp. 58 and 84), and Selenka (1898, p. 80 fig. 104) gives figures of an M^1 and an M^2 in which it is clearly shown. I found a remnant of the buccal cingulum in one cave molar (no. 64, pl. VI fig. 19). Traces of an inner cingulum were not found by me, unless the large accessory cusp beside the hypocone of no. 41 must be regarded as a manifestation of the cingulum.

Caries has affected 8 specimens, viz., nos. 37, 92 and 223 (anterior surface) nos. 114 and 239 (centre of the crown), no. 248 (posterior surface), no. 321 (metacone), and no. 259, in which the protocone is completely lost and the pulp cavity lays bare (pl. VI fig. 15). This figure illustrates at the same time about the maximum angle of divergence between the buccal and the lingual root.

As in the case of M¹, there are only few unworn specimens of M² of which the lower border of the enamel is undamaged. The vertical diameter has been measured at the buccal side, over the tips of paracone and metacone.

TABLE 33

Measurements of M² of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	14.8	14.2	14.0	12.2	13.5	13.0	16.4	13.0	13.1	14.0
Transverse	16.7	15.2	15.8	—	—	—	17.4	14.8	14.8	15.2
No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	13.7	13.7	13.3	15.1	13.4	12.5	13.2	14.9	14.2	15.2
Transverse	14.9	14.8	16.6	17.3	15.2	13.3	14.7	16.8	16.3	15.3
Vertical		9.2					7.8		9.9	
Height index		149					169		143	
No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	13.1	13.6	13.8	12.4	14.0	14.2	15.0	14.1	14.5	13.9
Transverse	14.4	15.7	15.4	13.3	15.4	14.7	16.3	—	15.4	15.5
No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	14.0	12.8	14.1	14.0	13.0	13.3	—	11.8	12.2	13.6
Transverse	15.7	15.3	16.0	16.6	13.4	15.1	15.9	12.1	14.1	15.5
No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	14.8	14.5	14.8	12.5	15.3	15.6	15.8	14.9	14.8	14.3
Transverse	15.6	15.5	16.7	13.9	15.3	17.1	16.1	16.4	17.6	14.4
No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	14.1	12.1	12.1	13.1	15.5	12.3	16.0	14.4	15.6	16.2
Transverse	16.0	14.4	14.3	13.4	16.3	14.0	16.8	16.0	17.4	16.3
No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	13.3	13.6	13.5	13.6	14.6	14.7	15.1	15.1	16.3	14.3
Transverse	14.7	15.4	15.7	16.0	16.3	16.2	17.8	16.7	17.2	15.5
No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	13.8	13.2	15.7	15.8	14.4	13.1	12.2	12.7	14.9	12.8
Transverse	16.4	14.5	16.8	18.7	15.4	13.4	13.6	14.8	15.4	13.8
No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	13.0	12.8	16.0	15.0	12.7	14.3	15.8	14.1	13.4	12.3
Transverse	14.9	13.7	17.0	15.8	14.6	15.0	17.0	13.8	15.0	14.4
No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	14.3	14.6	14.4	14.3	13.4	14.4	12.0	14.3	13.5	14.0
Transverse	15.9	16.4	15.8	17.0	14.3	15.7	13.3	16.1	14.6	15.6
No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	14.0	13.5	12.4	13.0	13.4	13.0	13.0	12.3	14.0	12.4
Transverse	16.0	14.7	—	13.8	14.4	14.7	13.4	12.8	—	13.9

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	16.1	15.6	13.8	15.2	13.8	13.8	14.3	13.9	14.4	15.2
Transverse	16.8	17.1	17.0	18.0	14.7	14.7	15.8	15.0	15.0	15.4

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	12.5	12.3	12.5	13.2	11.7	13.7	12.0	11.5	12.7	12.0
Transverse	13.7	13.4	14.9	14.3	13.8	14.8	13.4	13.2	14.8	13.3

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	12.7	13.4	12.4	15.5	14.1	13.2	15.5	15.6	12.0	12.3
Transverse	14.2	14.7	13.5	17.7	15.0	14.3	16.7	16.5	13.9	13.8

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	12.5	13.0	17.7	15.0	13.4	14.1	13.2	13.7	12.4	14.7
Transverse	13.7	15.2	19.0	16.5	15.5	16.2	15.5	14.8	14.8	15.1

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	15.1	15.5	14.3	12.2	12.6	14.8	14.0	13.2	14.8	13.4
Transverse	16.2	18.1	14.6	12.8	14.9	15.7	15.4	14.0	15.9	15.1

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	13.4	13.1	14.7	14.4	13.5	15.3	13.0	13.1	12.8	13.0
Transverse	13.7	15.4	17.7	15.6	15.2	16.7	14.5	14.1	13.2	14.6

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	16.9	14.7	13.8	15.5	16.5	14.5	12.6	12.8	14.6	12.8
Transverse	17.1	16.3	15.4	17.2	17.8	15.3	14.3	13.1	16.1	14.8

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	13.6	13.9	12.5	14.9	14.3	12.4	15.0	14.6	12.0	11.8
Transverse	15.5	15.4	15.0	15.2	18.7	13.7	15.6	17.2	14.0	13.1
Vertical					11.0	7.5		9.0	8.5	6.8
Height index					130	165		162	141	174

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	13.8	13.7	14.6	14.2	13.7	15.8	—	12.8	13.2	14.0
Transverse	15.2	14.1	14.3	14.9	15.4	17.6	15.2	15.0	15.1	15.2

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	14.4	14.4	13.7	13.4	13.0	13.2	13.8	13.2	14.9	12.4
Transverse	14.8	16.8	14.9	14.2	14.7	15.8	16.3	14.8	15.5	13.7

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	13.8	13.1	12.5	13.7	—	13.4	13.1	14.7	12.5	12.2
Transverse	15.5	15.5	14.6	14.2	14.5	14.6	16.1	17.3	14.0	—

No. of specimen	221	222	223	224	225	226	227	228	229	230
Antero-posterior	11.7	13.8	14.3	12.7	12.5	11.9	12.7	14.5	13.3	16.1
Transverse	14.8	14.2	15.6	14.6	14.8	14.6	13.6	15.2	16.2	16.2

No. of specimen	231	232	233	234	235	236	237	238	239	240
Antero-posterior	14.9	15.8	12.3	15.5	13.5	13.1	15.6	13.0	14.2	14.5
Transverse	16.7	17.0	12.6	17.7	15.4	15.2	16.5	14.3	16.2	15.2

No. of specimen	241	242	243	244	245	246	247	248	249	250
Antero-posterior	15.4	14.0	13.4	12.3	12.7	14.7	17.2	11.6	14.0	14.4
Transverse	15.7	16.1	16.3	12.5	14.5	16.0	17.6	15.0	16.7	15.5

No. of specimen	251	252	253	254	255	256	257	258	259	260
Antero-posterior	12.7	14.9	12.5	14.5	14.2	13.4	14.6	14.5	—	13.2
Transverse	14.0	16.4	14.8	15.0	15.1	16.5	15.8	16.3	—	14.6

No. of specimen	261	262	263	264	265	266	267	268	269	270
Antero-posterior	15.7	14.0	13.9	14.3	13.6	12.7	12.3	13.6	14.0	13.1
Transverse	18.2	15.2	15.0	14.2	15.3	14.3	15.2	15.8	16.8	15.0

No. of specimen	271	272	273	274	275	276	277	278	279	280
Antero-posterior	13.5	13.4	12.7	13.5	13.0	12.8	12.4	13.0	14.0	14.6
Transverse	16.2	14.7	13.6	—	13.5	13.2	13.5	—	16.4	14.3

No. of specimen	281	282	283	284	285	286	287	288	289	290
Antero-posterior	14.5	12.4	14.2	15.5	14.4	13.1	14.5	14.3	14.0	12.5
Transverse	15.0	14.6	15.6	16.1	16.6	14.2	15.0	14.8	16.3	13.1

No. of specimen	291	292	293	294	295	296	297	298	299	300
Antero-posterior	12.6	13.0	12.5	12.7	11.6	11.4	14.0	14.0	13.6	14.2
Transverse	14.3	—	13.6	13.9	13.7	14.2	15.1	16.0	14.7	16.1

No. of specimen	301	302	303	304	305	306	307	308	309	310
Antero-posterior	14.1	14.5	14.7	14.9	14.0	14.2	15.3	14.1	14.9	15.3
Transverse	14.5	14.6	17.1	16.8	14.6	14.2	17.7	15.8	17.0	16.9

No. of specimen	311	312	313	314	315	316	317	318	319	320
Antero-posterior	15.8	15.0	15.3	14.2	11.1	14.5	11.7	13.0	12.5	14.3
Transverse	18.0	16.0	17.0	15.0	14.8	17.3	13.4	15.1	14.0	—

No. of specimen	321	322	323	324	325	326	327	328	329	330
Antero-posterior	14.8	14.4	13.7	13.3	16.4	13.5	13.5	14.4	13.5	14.5
Transverse	16.5	15.2	15.3	14.9	17.0	14.9	14.2	—	16.0	15.9

No. of specimen	331	332	333	334	335	336	337	338	339	340
Antero-posterior	14.0	10.6	13.3	14.6	11.4	13.0	14.0	14.7	12.3	12.5
Transverse	16.0	12.4	13.5	15.0	14.5	13.5	15.8	16.1	14.0	15.0

No. of specimen	341	342	343	344	345	346	347	348	349	350
Antero-posterior	12.5	12.7	12.5	12.4	12.8	12.3	12.7	13.0	14.4	14.0
Transverse	14.1	13.8	13.5	16.0	16.4	13.4	14.2	14.4	17.3	15.2

No. of specimen	351	352	353
Antero-posterior	13.1	14.1	15.8
Transverse	14.9	15.6	17.1

The second upper molar is a little more variable than the first. The subfossil specimens average very much larger relative to the recent than do the subfossil M^1. M^2 even has undergone a greater diminution in size than has I^2. The height indices offer no differences of statistical significance.

TABLE 34

M^2	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	46	12.2	1.27	10.41	0.20	8.0
Id. subfossil	349	13.8	1.16	8.41		
Transverse recent	51	13.9	1.27	9.14	0.10	7.4
Id. subfossil	340	15.3	1.36	8.89		
Vertical recent	4	8.7	0.43	4.94	0.50	0.0
Id. subfossil	8	8.7	1.27	14.60		
Height index recent	4	149	5.0	3.4	5.7	0.9
Id. subfossil	8	154	14.6	9.5		

M^3 and M^4 (pl. VII figs. 1-14).

There remain 240 specimens of upper molars; nos. 1-122 are of the right side. Nos. 1-22 and 123-142 are unworn. The specimens are specified below:

61 M^3 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11582/1-10, 12, 63-112.
61 M^3 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11583/133-143, 145-177, 179-195.
42 M^3 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11584/19-22, 24-31, 33-62.
42 M^3 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11585/127-129, 201-212, 214-240.
14 M^3 dext., paratypes, Djamboe cave, Coll. Dub. no. 11586/13-16, 113-122.
8 M^3 sin., paratypes, Djamboe cave, Coll. Dub. no. 11587/123-125, 196-200.
1 M^4 (?) dext., paratype, Sibrambang cave, Coll. Dub. no. 11588/11.
5 M^4 (?) sin., paratypes, Sibrambang cave, Coll. Dub. no. 11589/130-132, 144, 178.
4 M^4 (?) dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11590/17, 18, 23, 32.
2 M^4 (?) sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11591/126, 213.

The possibility exists that a few M^2 have been mixed up with this material, since in two adult skulls (nos. 62 and 73) the right M^3 has not developed. Colyer (1936, p. 20) records the absence of one to three M^3 in five skulls. That this absence is an indication that there is a trend in the orang-utan evolution to suppress the third molar, as is so evident in man, is very probable. A certain percentage of orang-utan skulls possesses one to four M4 while in man M4 is only very exceptionally met with. Even M5 has been recorded as occurring in the orang-utan (Selenka, 1898, p. 90; Hrdlička, 1907, p. 559; Schultz, 1941, p. 85). If we are justified to attach phylogenetical value to the occurrence of supernumerary molars (i.e., beyond the number of 3 for placental mammals), the latter facts are in accord with the view that the orang-utan undergoes the same process of reducing the number of its molars by elimination of the hindmost as does man, and that this process is not so advanced in the former as it is in the latter.

What is the percentage of occurrence of M4 in the recent orang-utan?

Selenka's find of 20 per cent of the adult skulls having at least one M4 is well known and often cited. From the paleontologist's point of view, however, the ratio of the number of M4 to the total number of last molars is more interesting. Every adult skull has four last molars, and these may be M4 for 0, 25, 50, 75 or 100 per cent. The tables 35 and 36 have been compiled from the data given by Selenka (1898), Hrdlička (1907), Colyer (1936) and those of the present author's collection. As the material of Hrdlička is incorporated in that of Colyer (1936, p. 18), the observations of the latter author on Hrdlička's collection have been left out of account. The upper and lower molars have been kept separate, for obvious reasons.

TABLE 35

	Upper last molars	M^4 (total)	M^4 with antagonist
Selenka	388	26	11
Hrdlička	44	2	1
Colyer	414	9	2
present author	90	3	0
Total	936	40	14

TABLE 36

	Lower last molars	M_4 (total)	M_4 with antagonist
Selenka	388	46	13
Hrdlička	44	6	0
Colyer	470	11	2
present author	88	6	0
Total	990	69	15

Thus 40 out of 936 upper last molars, or 4.3 ± 0.7 per cent represent the fourth molar, while the fourth lower molar is found as 69 out of 990 lower last molars, or 7.0 ± 0.8 per cent. There is a greater tendency toward the development of a fourth molar in the mandible than in the upper jaw. The difference between the percentages is almost three times its standard error (± 1.0 per cent) and consequently practically has statistical significance.

The percentage of M4 having an antagonist is 1.5 ± 0.4 per cent, both in the upper and in the lower jaw. This percentage, however, indicates the maximum number of specimens that might have been touched by wear. In reality the percentage of worn M4 must be lower, since a number of M4 is either impacted, or might not have been in place long enough to show signs of wear.

The shape of crown most often met with in M^3 is that which occurs only exceptionally in M^2 (recent skull no. 27, pl. VI fig. 12). The diminutive hypocone is distinctly behind the still smaller metacone, which has been placed inward relative to the paracone. The postero-lingual angle is acute and passes by a gentle curve into the antero-buccal angle, the angle occupied by the metacone being only slightly produced. The crown thus presents a subtriangular outline; the smaller the metacone, the nearer to the triangular form. This outline has been carried almost to the extreme in a subfossil right specimen (no. 78, pl. VII fig. 1). The metacone is placed in the antero-posterior midline between the anterior cusps, and about as far in advance of the hypocone as it is behind the protocone. The outer surface of the crown between hypocone and paracone even is pinched in at the place of the metacone. A recent left M^3 (skull no. 29, pl. VII fig. 2), fortunately unworn as the tooth is not yet fully in place, presents the same deformity. It is remarkable that in this deformed specimen the crista obliqua runs directly from the tip of the protocone to that of the metacone. In normal specimens the oblique ridge begins somewhere on the posterior slope of the protocone. The right M^3 of the same skull (pl. VII fig. 3) presents almost the other extreme condition: of the two posterior cusps the metacone is the larger, and, though its position is more advanced than that of the hypocone, there is a distinct postero-buccal angle to the crown. This outline resembles a normal M^2 much more than that of a normal M^3. The same contrast in form of the two M^3 is found in another skull (no. 50).

It is a well known fact that vanishing elements present a great variability. The orang-utan M^3 shows variations not only to the minus side, but also to the plus side, as is evident from some recent specimens (skulls nos. 29, 36, 37 and 59) in which M^3 does not follow the trend shown in M^1 and M^2 toward diminution in size of the posterior cusps and toward regression of the postero-buccal angle, but on the contrary has a more prominent postero-buccal angle than its neighbour. In these cases the antero-posterior diameter taken across paracone and metacone exceeds that measured over the lingual cusps. This is an approach to the shape of M^2 and M^3 normally found in man (below, p. 274), in which the hypocone undergoes the same regression as the metacone in the orang-utan upper molar. Nos. 7 and 12 (pl. VII figs. 4 and 11) give examples of right M^3 being longer antero-posteriorly at the buccal side than at the lingual side.

Being both unworn, nos. 7 and 12 illustrate at the same time the enormous variation in the degree of development of the accessory wrinkles and in the distinctiveness of the cusps, examples of which I have given already above at various occasions. In the coarsely wrinkled specimen of pl. VII fig. 11 we find the major grooves indicated with much greater clarity than the accessory wrinkles. The major grooves are the limits between the cusps, viz., the longitudinal groove between paracone and protocone, the buccal transverse groove between paracone and metacone, the groove (sulcus obliquus) isolating the postero-lingual angle with the hypocone and some accessory cusps, and the groove crossing the oblique ridge between protocone and metacone and connecting the centres of the trigon fossa anteriorly with the hypocone fossa posteriorly. The additional lines all meet these major grooves approximately at right angles and consist of the limits between ridges descending from the cusps.

When we compare the latter specimen with no. 7 of pl. VII fig. 4 we find the major features still somewhat more clearly shown than the accessory wrinkles and grooves in the latter, but in the right M^3 of skull no. 29 (pl. VII fig. 3) the wrinkling of the enamel has almost obliterated the fundamental pattern except the crista obliqua and the sulcus obliquus.

Two specimens (nos. 46 and 93, pl. VII figs. 12 and 13) of which the cusps are entirely worn away still show a number of fine lines on their smoothly worn occlusal surface, indicating that they were not of the coarsely wrinkled type. They show at the same time the normal outline of crown of M^3, viz., with the metacone angle regressed but still of the four-cusped type.

Recent specimens of the same coarsely wrinkled type as that of pl. VII fig. 11 I have not been able to find, but on the other hand the crown pattern of the subfossil specimens nos. 4 and 64 (pl. VII figs. 5 and 6), though larger in dimensions, is not inferior in complexity to that of the recent tooth. They have the typical triangular outline figured by Miller (1923, pl. 14 l, m and o) which is but rarely shown in M^3. Three cave specimens (nos. 32, 126 and 18, pl. VII figs. 7-9) of the same type are of smaller dimensions. Nos. 126 and 18 agree so completely in the formation of their roots, of which the lingual is fused both with the anterior and with the posterior buccal root over their entire length, that I have little doubt as to their belonging to one and the same dentition. Their crown pattern is comparatively coarse, but in their typical outline and small size they agree very well with the M^4 in skull no. 40 (pl. VII fig. 14).

There are not many specimens of last upper molars in the cave collection in which the metacone is so reduced and the triangular shape of crown is so perfectly shown. Apart from the five specimens (nos. 4, 66, 32, 126 and 18) figured on pl. VII figs. 5-9, there are only twelve, three of which (nos. 10, 127 and 143) are rather large, though smaller than the two large specimens figured, while the remaining nine (nos. 11, 17, 23, 130-132, 144, 178 and 213) are approximately of the same small size as the three of pl. VII figs. 7-9.

Why should not these upper molars represent the fourth molar? This is practically certain for the twelve small specimens, three of which have been figured. The M^4, however, is not always so diminutive as that in skull no. 40. Berwerth (1914, pp. 155-160) describes twelve cases of M^4 (from the Selenka collection), in one of which M^4 is but little smaller than M^3, while in another (no. 78) M^4 is stated to be larger than M^3. The five large triangular cave molars thus might represent M^4 as well as the small specimens do. Since all specimens are isolated, it cannot be proven that the seventeen molars of the triangular type are M^4. This determination only can be made more or less probable, and the more so for the twelve small examples which have a counterpart in the recent material. 12 out of 240 (the total number of upper last molars) is 5.0 ± 1.4 per cent. In recent orang-utan 4.3 ± 0.7 per cent of the number of upper last molars consists of M^4, a percentage that is not different statistically from that found for the subfossil material.

Since a diminutive triangular crown as that of nos. 11, 17, 18, 23, 32, 126, 130-132, 144, 178 and 213 is a great exception for recent M^3, in my opinion it can hardly be doubted at that these specimens represent M^4. It is extremely probable that these specimens even are not the only examples. We know now from the study of the other teeth, that the orang-utan's dentition is on its way toward reduction. This is particularly evident in I2 and M2. It would be only logical to assume the prehistoric orang-utan to have had more and larger M4 than has the recent. With only isolated teeth at hand, however, no convincing proof can be given.

The protoconule is shown in all but five of the 42 unworn crowns. Added to that I saw 24 accessory outer and 17 accessory inner tubercles on the posterior marginal ridge. The percentages of occurrence of these accessory tubercles in the subfossil and in 13 recent unworn last molars are given in table 37.

TABLE 37

M^3	subfossil	recent	recent (Selenka) ♂	♀
protoconule	88	85	100	93
tub. access. post. extern.	57	46	54	63
tub. access. post. intern.	40	31	21	31

Like the recent, the subfossil orang-utan more frequently has accessory cusps on the posterior marginal ridge of the hindmost molar than on the anterior molars. In two skulls (nos. 35 and 80) M^3 of one side has a large posterior inner accessory tubercle, while in that of the other side there are no posterior accessory tubercles.

The roots, for the greater part preserved in 36 teeth, often show a tendency to fusion, especially the lingual with the anterior buccal root. Somewhat less frequently the lingual root is fused with the posterior buccal root. Fusion of the two buccal elements came under notice only four times (nos. 47, 70, 150 and 217), and in three of them the lingual root is fused with one or both of the buccal roots. In many examples the roots are distinctly curved backward.

Caries has not been found in the subfossil last upper molars.

Table 38 contains the measurements. For the computation of the means, etc., the twelve small triangular crowns have been left out of account. Their average antero-posterior diameter is 9.3 mm, transverse 12.4 mm. The M^4 of skull no. 40 measures 9.4 mm antero-posteriorly, and 13.7 mm transversely.

TABLE 38

Measurements of M^3 and M^4 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	11.3	10.6	10.4	14.4	10.5	11.6	12.2	11.6	11.4	11.5
Transverse	15.8	12.1	12.6	18.7	12.6	14.3	13.7	13.8	13.1	16.0
Vertical			6.8							
Height index			153							
No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	9.6	12.4	11.4	11.6	11.8	10.3	10.4	8.7	12.4	12.3
Transverse	13.2	14.4	13.8	14.7	12.7	12.5	13.0	12.5	16.1	14.0
Vertical			6.6	8.4					9.0	
Height index			173	138					138	
No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	13.5	11.7	10.7	12.2	13.0	12.5	12.2	11.2	11.5	11.4
Transverse	16.8	14.2	12.5	14.1	14.0	14.0	13.2	13.1	13.6	13.1
No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	11.3	9.6	11.8	11.4	10.8	13.6	13.1	12.2	11.7	11.8
Transverse	13.6	13.8	14.0	12.4	11.4	16.2	15.7	15.5	13.3	13.5
No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	14.8	13.0	10.9	13.0	13.2	11.3	9.8	13.1	10.4	12.3
Transverse	17.5	15.2	13.0	16.1	15.6	13.2	12.2	15.1	13.0	13.4
No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	12.4	14.5	10.5	11.2	11.5	10.7	11.5	12.1	10.5	10.0
Transverse	15.1	16.4	12.3	12.2	13.4	12.8	15.0	15.0	13.2	11.4

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	12.6	14.0	11.9	15.5	11.8	14.1	11.0	10.9	11.8	11.4
Transverse	15.4	16.9	14.3	20.4	12.2	16.2	11.5	12.9	15.4	13.4

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	12.4	12.4	11.2	13.4	12.3	11.2	14.3	14.1	10.2	10.4
Transverse	13.3	15.0	13.5	15.8	13.5	14.0	14.6	14.3	11.7	11.0

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	11.8	12.4	13.4	12.7	10.4	10.0	10.6	11.0	12.1	11.2
Transverse	12.7	14.0	15.0	14.8	12.1	11.7	12.4	13.1	13.5	13.8

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	12.8	11.2	11.0	10.8	11.5	10.3	11.8	10.5	11.9	11.8
Transverse	13.4	13.4	13.2	13.0	13.5	11.4	13.4	13.2	13.2	14.1

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	11.8	12.0	11.4	11.0	—	11.9	11.2	12.0	11.4	10.5
Transverse	13.5	13.1	12.5	12.4	11.1	12.5	13.8	13.1	12.4	12.7

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	11.5	9.5	11.6	11.8	13.6	11.8	11.3	12.6	13.5	13.4
Transverse	12.5	12.5	12.8	13.5	14.2	13.0	13.7	15.2	14.9	14.6

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	10.0	13.0	15.8	11.3	11.8	8.7	12.3	10.4	11.5	8.5
Transverse	11.5	15.0	15.9	11.8	14.0	12.7	16.1	11.7	14.3	11.4
Vertical							8.3		7.8	
Height index							148		147	

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	8.7	9.8	11.7	12.5	12.0	13.7	10.4	11.6	11.2	11.7
Transverse	9.5	13.2	13.3	13.8	12.6	14.8	12.2	13.4	14.4	13.4
Vertical				8.3				6.4	7.0	
Height index				151				181	160	

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	14.1	14.0	11.8	8.9	12.0	11.3	11.8	10.8	9.7	9.8
Transverse	14.5	15.1	15.7	11.7	12.8	14.0	14.5	12.7	11.5	10.6

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	10.4	11.2	12.0	12.7	12.4	9.8	10.8	12.0	12.2	11.9
Transverse	11.3	13.1	13.2	15.5	12.5	11.0	13.5	14.0	13.8	12.2

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	11.7	12.7	10.0	13.0	13.2	11.7	10.4	10.5	10.8	11.6
Transverse	12.3	12.1	12.7	14.6	15.3	12.0	12.2	12.2	13.1	12.8

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	10.4	14.1	10.4	11.1	12.0	11.0	12.4	9.9	12.3	14.0
Transverse	13.3	14.2	12.4	13.4	13.6	12.1	14.4	12.1	14.3	14.6

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	11.6	11.0	13.4	11.0	11.5	11.7	11.5	12.8	10.4	11.8
Transverse	13.4	13.0	13.9	12.7	13.3	12.8	12.0	14.3	12.2	13.5

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	14.7	10.0	11.3	11.3	10.5	11.0	13.0	9.8	10.8	12.8
Transverse	16.8	11.1	13.6	13.0	12.0	12.6	15.5	11.5	12.3	15.0

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	12.5	14.0	11.0	12.0	10.8	11.4	11.9	13.7	10.4	13.7
Transverse	14.0	17.4	13.5	13.5	13.8	13.9	13.6	15.8	—	14.4

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	12.0	11.3	9.1	14.5	13.0	13.4	12.5	12.0	12.5	13.3
Transverse	14.8	14.3	13.1	16.7	16.0	14.8	13.7	13.0	13.4	14.6

No. of specimen	221	222	223	224	225	226	227	228	229	230
Antero-posterior	11.0	12.2	11.8	13.5	10.3	11.4	12.5	12.4	10.7	11.3
Transverse	12.7	13.9	13.4	15.3	12.8	14.3	13.7	15.0	11.6	12.5

No. of specimen	231	232	233	234	236	236	237	238	239	240
Antero-posterior	10.4	12.5	15.3	11.2	12.7	12.6	11.8	11.0	12.7	12.5
Transverse	12.2	14.2	16.0	13.4	13.5	14.0	13.5	13.0	15.7	13.4

TABLE 39

M^3	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	43	11.6	1.48	12.76	0.24	1.3
Id. subfossil	227	11.9	1.19	10.00		
Transverse recent	45	13.2	1.30	9.85	0.22	2.3
Id. subfossil	227	13.7	1.45	10.58		
Vertical recent	4	8.4	0.39	4.64	0.35	2.3
Id. subfossil	9	7.6	0.89	11.71		
Height index recent	4	155	9.3	6.0	6.6	0.2
Id. subfossil	9	154	13.8	9.0		

M^3 is again more variable than M^2, but has reduced in size even less than has M^1. The recent M^1 has diminished in size to an extent as to be just statistically distinct from its subfossil homologue; the differentiation of M^3 has not proceeded to the level of statistical significance.

Lower M

The lower molars of the orang-utan are built on the same general plan, which may be described as follows:

There are five cusps, three on the buccal and two on the lingual side. The latter are higher and more pointed than the former. The anterior buccal cusp (protoconid) and the anterior lingual cusp (metaconid) form a transverse pair. The cusp behind the protoconid on the buccal side, the hypoconid, is opposed to the interval between the metaconid and the posterior lingual cusp, or entoconid. The fifth cusp in situated behind the hypoconid and is more or less median in position. It is slightly posterior to the entoconid and is called hypoconulid in the present paper. Remane (1921), followed, e.g., by Eckardt (1929) and Weidenreich (1937), uses the name mesoconid for the hypoconulid (cf. Remane, l.c., p. 5 fig. 2) with one exception (l.c., p. 73 line 2 form top) where it is called hypoconulid, the name applied to this cusp by Osborn and Gregory.

The five cusps are separated by grooves. The grooves on the anterior and posterior side of the hypoconid form together with the lingual transverse groove a Y. Added to that there is an anterior central groove between protoconid and metaconid, and a posterior central groove between entoconid and hypoconulid. The metaconid meets the hypoconid at the base. This is the basic pattern of the lower molars of the anthropoid apes and man, the *Dryopithecus* pattern of Gregory.

Supernumerary cusps may develop on the posterior marginal ridge between hypoconulid and entoconid, and on the lingual marginal ridge between metaconid and entoconid. The frequency of their occurrence will be mentioned in the sections dealing with M_1, M_2 and M_3 (M_4) separately.

The ridges and fossae are of the same type in all lower molars. Between protoconid and metaconid there is a narrow transverse valley, the remnant of the trigonid fossa. The central part of the crown is basin-shaped and represents the talonid fossa. Accessory ridges are found at protoconid and metaconid; from the latter they run to the centre of the crown. The three posterior cusps likewise have accessory ridges toward the centre of the crown. A ridge between entoconid and hypoconulid separates the central fossa from the posterior fossa, an obliquely transverse valley on a higher level than the talonid basin. While the ridge connecting protoconid and metaconid is most often distinct, that between entoconid and hypoconulid is frequently reduced or absent.

The wrinkles all begin approximately at right angles to the marginal ridge around the whole crown, and run toward the central valley. A longitudinal groove with the accessory grooves as side branches, anastomosing near the buccal and lingual margin is occasionally seen.

M_2 in most cases is the largest of the lower molars (for details see below). This character, however, is not so important to distinguish between M_1, M_2 and M_3 as isolated teeth as are the following:

The angle between the anterior and the lingual surface decreases as we pass from M_1 to M_2. In the first lower molar this angle always is a blunt angle; the anterior surface of the crown slopes backward from buccal to lingual. The anterior protuberance of the antero-buccal or protoconid corner also makes the fovea anterior definitely oblique in its course. The antero-lingual or metaconid corner of the crown of M_1 thus is regressed; the metaconid itself, however, is by far the highest cusp, and in unworn specimens its tip is seen to be recurved toward the centre.

The M_2 differs from M_1 of the same mandible by its more produced antero-lingual corner, which presents approximately a right angle. Added to that the tip of the metaconid of M_2 is less high and not recurved outward to the extent as is true in M_1. In M_2 the marginal slopes of the cusps are more steep, and consequently their tips are less centrally located than those in M_1. The anterior surface in M_2 is at right angles to the long axis of the crown, or, if oblique, always less so than that of M_1, protoconid and metaconid being more nearly on a transverse line.

In M_3 this gradation is not continued. On the contrary in some cases M_3 in a mandible is seen to have a more retracted antero-lingual corner than its M_2 (skulls nos. 29, 35, 41, 46 and 76). In M_3 the apices of the cusps are again lower and more marginal in position than those in M_2.

In the postero-lingual corner of the crown the protuberance of the entoconid diminishes as we pass from M_1 to M_3. M_1 most often (52 out of 59 examples) resembles the pd_4 in being wider transversely behind than in front. In M_3 the transverse diameters of the crown invariably diminish as we pass posteriorly from the convexity of the anterior third of the tooth (trigonid width). M_2 is intermediate; only in 3 out of the 48 recent specimens examined the greatest width is that over entoconid and hypoconid (talonid width), while in 44 out of the 48 the greatest width lies in the anterior portion of the tooth (in one specimen the trigonid width being equal to the talonid width).

Even in the exceptional specimens of M_1 in which the trigonid width exceeds the talonid width, the first molar is distinguishable from M_2 by its prominent entoconid corner and the obliqueness of the anterior surface, the diminishing of the transverse diameters from front to back being due to the displacement inward of the hypoconid. And if M_2 is wider transversely over entoconid and hypoconid than in its anterior moiety, its postero-buccal corner is more rounded off and its metaconid is nearer to the margin of the crown than in M_1.

In M_3 the hypoconid as well as the entoconid are less prominent on the sides than are the protoconid and metaconid, and the posterior moiety of the crown is gradually rounded off from side to side behind. This molar is more liable to deformities than are the other molars.

The lower molars have two roots, one anterior and one posterior, of which the latter is the larger. Both roots are flattened in antero-posterior direction and have longitudinal grooves, most distinct on the approximal surfaces of the roots. The anterior root extends vertically downward and its lower half tends to be recurved posteriorly. The posterior deviates posteriorly from the vertical to a somewhat little extent.

Though the lower molars are identifiable more easily than the upper, it is impossible, a few small and definitely anomalous specimens excepted, to determine a special tooth as being M_4. Thus I shall deal first with M_1 and M_2, and finally with the ultimate lower molar, M_3 together with a certain number of M_4. The descriptions and special characters of these three types having been given already above, the lower molars do not need to be dealt with at the same length as the upper.

M_1 (pl. VIII figs. 1-5)

There are 209 specimens of M_1; nos. 1-96 are of the right side. Nos. 1-12 and 97-115 are unworn. The specimens are specified as follows:

58 M_1 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11592/1-7, 35-85.
73 M_1 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11593/106-178.
25 M_1 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11594/10-34.
23 M_1 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11595/100-105, 193-209.
13 M_1 dext., paratypes, Djamboe cave, Coll. Dub. no. 11596/8, 9, 86-96.
15 M_1 sin., paratypes, Djamboe cave, Coll. Dub. no. 11597/97-99, 179-190.
2 M_1 sin., paratypes, cave not specified, Coll. Dub. no. 11598/191, 192.

The roots are for the greater part preserved in 12 specimens only.

In many specimens the transverse ridge between protoconid and metaconid is seen to be double (no. 11, pl. VIII fig. 1), but this ridge may also be totally absent (no. 9, pl. VIII fig. 2). In the latter specimen the cusps are more distinct than those in the former. Both have the typical number of cusps, viz., five. A sixth cusp may develop on the posterior marginal ridge, between entoconid and hypoconulid. It is the tuberculum accessorium inferius posterius internum of Selenka (1898, p. 69). It is shown in 17 out of the 88 first lower cave molars that are either unworn or not too much worn to show accessory cusps, if any. Pl. VIII fig. 3 represents an example (no. 181) of a six-cusped tooth. A little more frequent even is a cusp that occurs as an elevation of the marginal ridge between metaconid and entoconid. Often it is hardly separated from the metaconid. In no. 112 (pl. VIII fig. 4) it is bordered in front and behind by a distinct groove, and is opposed to the hypoconid. In this case the six cusps are arranged in three transverse pairs. The tuberculum accessorium inferius mediale internum (Selenka, 1898, p. 70) occurs in 22 of the 88 cave specimens. In table 40 my percentages of occurrence of the accessory tubercles, for the subfossil and for 15 recent specimens of M_1 are given beside those recorded by Selenka (1898, p. 69).

TABLE 40

M_1	subfossil	recent	recent (Selenka)	
			♂	♀
tub. access. post. intern.	19	13	6	18
tub. access. post. extern.	0	0	0	0
tub. access. med. intern.	25	20	12	6

The buccal cingulum manifests itself in some specimens as a weak ledge ascending from the buccal groove between protoconid and hypoconid to the antero-buccal angle of the crown. In four specimens (nos. 8, 49, 52 and 80) it also makes an incipient ledge at the postero-buccal angle, between hypoconid and hypoconulid. The hypoconid itself thus appears to arise from the cingulum, when seen in buccal view (no. 8, pl. VIII fig. 5).

Caries came under my notice not less than 9 times, and the cavities are invariably on the buccal side. Most often the hypoconid is affected (nos. 33, 70, 84, 94 and 186), the hypoconulid alone in nos. 119 and 166, whilst the protoconid is lost in nos. 19 and 165.

The measurements of the specimens are given here. The vertical diameter has been measured on the buccal side, over the tips of the protoconid and hypoconid, and the height index is $\frac{\text{antero-posterior diameter} \times 100}{\text{vertical diameter}}$.

TABLE 41

Measurements of M_1 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	14.9	15.4	13.8	13.6	13.5	13.7	12.6	15.6	13.7	13.2
Transverse	12.3	13.3	11.5	11.6	—	12.4	11.5	13.2	12.7	11.6
Vertical										9.2
Height index										143

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	15.0	14.1	14.8	13.2	16.0	14.5	14.8	14.5	14.7	14.2
Transverse	12.6	11.7	13.2	11.7	14.3	12.1	13.0	13.7	—	12.8
Vertical		9.3								
Height index		152								

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	14.6	13.0	14.0	14.5	15.6	15.0	15.8	14.4	15.3	15.0
Transverse	13.8	—	12.3	13.5	14.2	12.8	13.2	13.1	12.8	13.6

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	15.4	15.2	13.4	12.9	13.7	14.3	13.0	12.8	13.2	13.9
Transverse	13.6	13.5	12.3	11.7	12.4	—	11.2	11.4	—	12.5

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	15.1	14.5	12.7	14.6	14.8	14.5	13.7	13.0	13.9	14.8
Transverse	13.2	12.3	11.2	12.6	13.6	12.2	11.6	11.3	11.8	12.3

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	13.2	14.7	12.6	12.3	14.1	—	16.0	12.2	14.3	13.3
Transverse	12.0	13.8	11.2	10.9	12.3	13.3	—	11.3	13.2	12.6

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	12.9	12.5	13.4	12.6	14.1	14.9	12.8	14.6	14.0	15.3
Transverse	12.4	10.8	11.3	11.1	12.7	12.3	11.5	12.8	12.5	—

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	14.4	16.2	15.0	13.2	14.0	14.1	14.3	13.4	14.2	15.6
Transverse	11.8	14.5	12.9	—	12.4	12.6	12.2	12.0	12.0	13.4

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	14.1	13.4	14.0	14.8	14.4	15.4	14.5	15.2	15.1	14.6
Transverse	12.0	12.3	12.8	12.8	13.0	13.3	12.0	12.8	12.8	12.5

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	13.4	13.0	13.9	12.3	15.4	13.3	14.9	14.0	15.4	12.7
Transverse	11.4	10.6	12.2	—	13.5	12.1	12.8	12.2	13.2	11.8

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	15.1	14.9	14.3	15.6	13.9	15.0	13.6	15.0	13.7	14.2
Transverse	13.1	12.7	12.4	14.0	12.0	12.4	11.6	13.4	11.4	12.3
Vertical	9.3	9.6			9.4					
Height index	162	155			148					

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	14.2	13.5	13.0	13.6	14.4	14.7	12.4	14.6	14.7	14.4
Transverse	12.0	11.3	11.1	11.2	13.0	12.8	11.4	12.5	12.3	13.1

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	13.3	14.7	14.3	15.4	12.7	15.6	13.8	13.9	13.0	14.8
Transverse	11.0	12.2	12.4	13.8	11.3	13.2	12.2	11.4	11.6	12.9

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	13.2	14.4	14.1	14.1	12.6	13.3	14.5	13.1	13.0	13.1
Transverse	11.4	12.3	12.7	12.3	11.7	11.0	12.7	11.7	10.6	11.4

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	13.3	13.0	13.7	12.5	12.8	14.4	14.5	13.4	15.9	14.9
Transverse	—	12.3	12.0	10.4	11.2	12.0	13.6	12.2	13.0	13.0

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	15.6	12.5	13.9	15.7	14.9	12.9	12.6	12.7	14.8	15.0
Transverse	13.7	11.2	12.2	13.3	12.2	10.8	11.7	11.8	12.7	12.2

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	14.0	14.2	13.4	14.2	—	—	15.4	14.0	13.0	15.8
Transverse	11.5	11.9	11.3	11.5	11.9	12.7	12.8	11.6	12.0	14.5

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	16.0	15.0	14.0	14.3	13.9	13.5	12.9	15.1	16.1	12.8
Transverse	14.1	12.8	12.1	12.0	12.0	11.5	11.4	13.3	13.2	—

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	15.5	13.2	13.6	15.0	14.0	15.6	13.0	13.1	13.5	14.3
Transverse	13.4	11.5	11.1	12.9	12.5	—	11.9	10.5	11.3	12.9

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	14.0	13.0	14.4	15.7	13.0	—	—	15.4	13.6	14.0
Transverse	12.3	—	12.2	13.5	11.8	12.6	13.4	14.0	11.5	12.3

No. of specimen	201	202	203	204	205	206	207	208	209
Antero-posterior	16.2	14.7	14.0	15.3	15.4	14.6	15.5	13.6	16.2
Transverse	13.8	12.5	11.8	13.7	12.8	12.2	13.6	11.7	—

TABLE 42

M_1	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	51	13.1	1.05	8.02	0.16	6.9
Id. subfossil	204	14.2	0.98	6.90		
Transverse recent	59	11.6	0.92	7.93	0.13	5.4
Id. subfossil	195	12.3	0.86	6.99		
Vertical recent	3	9.1	1.07	11.76	0.62	0.5
Id. subfossil	5	9.4	0.14	1.49		
Height index recent	3	153	8.6	5.6	5.72	0.2
Id. subfossil	5	152	6.4	4.2		

The difference between the recent and the subfossil M_1 in the antero-posterior and transverse diameters stand the statistical test, and the variability in these dimensions is not unusually great.

M_2 (pl. VIII figs. 6-10 and 12)

M_2 is represented by 230 specimens; nos. 1-109 are of the right side. Nos. 1-10 and 110-120 are unworn. The specification is given here:

49 M_2 dext., paratype, Sibrambang cave, Coll. Dub. no. 11599/1-7, 68-109.
61 M_2 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11600/110-117, 178-230.
40 M_2 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11601/10-49.
41 M_2 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11602/120-160.
19 M_2 dext., paratypes, Djamboe cave, Coll. Dub. no. 11603/8, 9, 50-66.
15 M_2 sin., paratypes, Djamboe cave, Coll. Dub. no. 11604/119, 164-177.
1 M_2 dext., paratype, cave not specified, Coll. Dub. no. 11605/67.
4 M_2 sin., paratypes, cave not specified, Coll. Dub. no. 11606/118, 161-163.

The roots are for the greater part preserved in 14 specimens.

Like the upper, the lower second molar most often is the largest of its series. Of the 32 (16 ♂♂ and 16 ♀♀) mandibles in which the three molars can be measured, M_2 is the largest molar in 22 specimens (11 ♂♂ and 11 ♀♀). M_3 is the largest in 5 ♂♂ and in 3 ♀♀, while in the remaining 2 ♀ mandibles M_1 is the largest of the series. In the material of Selenka

(1898, p. 82), of 33 ♂ mandibles only one had M_1 as the largest molar. In that of Remane (1921, p. 27) M_1 never was found to be the largest molar (table 43).

TABLE 43

Percentage of occurrence of M_1, M_2 and M_3 as largest molar

	♂♂			♀♀		
	Selenka	Remane	present author	Selenka	Remane	present author
M_1	3	0	0	0	0	12
M_2	88	71	69	99	81	69
M_3	9	29	31	1	19	19

A double accessory inner tubercle was found in a specimen (no. 11, pl. VIII fig. 6), that is the longest of my series. Its antero-posterior diameter is not less than 20.9 mm. This is even more than the maximum length of M_2 in the gorilla (19.7 mm according to Remane, 1921, p. 24) and slightly less than the length of the type lower molar of *Gigantopithecus* (22 mm; Von Koenigswald, 1935, p. 874). The wrinkle system has moderately developed, and a few wrinkles are seen on the buccal surface of the protoconid.

A tuberculum accessorium inferius mediale internum occurs in 21 out of the 93 specimens in which accessory tubercles, if any, are not obliterated by wear. In the same material I found 9 posterior inner accessory tubercles. In no. 12 (pl. VIII fig. 7) this tubercle betrays its presence by the apex of its dentine core, which has been reached by the grinding surface just as those of the three buccal cusps. Two examples of molars with the posterior inner tubercle well developed and forming a kind of heel to the crown (nos. 106 and 121) are presented on pl. VIII figs. 8 and 9. In one specimen (no. 9) there is a very small point on the marginal ridge directly behind the hypoconulid that may represent a tuberculum accessorium inferius posterius externum (Selenka, 1898, p. 70). The percentages of occurrence of these accessory cusps in the subfossil and in 22 recent specimens of M_2 are given in table 44.

TABLE 44

M_2	subfossil	recent	recent (Selenka)	
			♂	♀
tub. access. post. intern.	10	18	6	15
tub. access. post. extern.	1	0	3	0
tub. access. med. intern.	23	32	36	30

As in every molar, there is a great amount of variation in the development of the wrinkles. No. 106 (pl. VIII fig. 8) is covered with an abundance of fine wrinkles, while nos. 120 and 202 (pl. VIII figs. 10 and 12) are of the coarsely wrinkled type. In the former of the two the hypoconulid is almost median in position. The measurements will be found in table 45.

TABLE 45

Measurements of M_2 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	16.7	13.5	16.7	13.7	15.6	15.6	15.7	15.8	15.6	15.3
Transverse	14.8	12.4	14.5	13.0	14.6	15.6	13.4	14.3	14.1	13.5
Vertical								8.5		
Height index								186		

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	20.9	17.8	16.7	15.3	17.5	14.7	—	15.5	15.4	—
Transverse	16.7	16.8	15.9	13.0	14.8	14.0	13.8	14.8	15.2	13.2

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	15.4	17.6	16.4	16.4	16.2	14.3	13.9	18.2	15.1	15.8
Transverse	14.8	15.1	15.2	14.5	16.7	12.6	12.8	16.3	—	14.9

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	16.5	17.0	15.4	16.7	14.5	13.3	15.5	15.3	16.0	17.7
Transverse	14.0	14.5	13.0	15.6	13.7	13.1	13.6	14.1	15.1	15.0

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	—	16.8	16.4	14.8	15.2	14.0	13.1	16.0	13.4	17.0
Transverse	14.0	15.4	15.0	13.8	13.5	12.7	12.3	14.2	12.7	14.0

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	14.3	14.5	15.4	15.5	14.9	14.6	—	15.7	15.1	16.6
Transverse	11.7	12.8	13.8	14.0	14.5	13.2	16.1	14.9	14.8	15.5

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	16.5	16.4	14.1	—	15.3	16.1	—	17.0	13.9	—
Transverse	15.8	15.0	13.3	12.2	13.2	14.2	14.3	15.0	12.2	15.1

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	15.7	14.2	14.6	16.8	15.5	14.2	14.6	16.1	14.1	16.2
Transverse	14.6	13.7	12.5	14.2	14.4	12.4	—	14.7	—	14.4

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	—	14.7	14.4	15.4	16.8	14.7	14.1	14.4	14.8	15.1
Transverse	12.5	13.5	13.3	14.8	13.5	13.6	13.0	13.2	13.0	13.9

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	15.5	15.1	16.0	15.0	15.8	16.0	14.9	—	14.8	13.1
Transverse	13.4	14.0	14.2	13.5	12.9	14.6	13.8	13.5	13.0	12.3

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	15.8	15.5	15.4	18.7	16.3	17.0	18.4	13.8	14.6	14.8
Transverse	14.2	14.0	14.3	15.4	14.2	15.8	17.0	12.7	13.7	12.8

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	14.5	16.1	16.2	16.7	17.3	16.2	15.0	17.2	15.8	15.1
Transverse	13.4	15.4	14.8	14.1	15.6	14.9	13.9	15.4	15.1	13.7
Vertical								10.9		
Height index								158		

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	18.2	14.4	13.5	13.2	15.1	14.0	15.5	13.0	15.1	15.8
Transverse	15.9	13.2	11.9	13.1	13.8	13.0	14.3	12.5	13.5	14.6

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	17.0	14.4	15.0	15.8	15.0	16.4	16.8	13.9	14.7	15.0
Transverse	14.5	12.7	14.1	14.0	12.4	14.3	16.1	13.4	13.5	13.6

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	—	14.7	14.6	14.2	15.5	14.4	—	15.7	16.9	17.4
Transverse	11.4	13.5	13.5	13.3	14.0	13.4	14.3	14.6	—	14.7

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	14.2	14.5	14.3	16.6	13.1	14.3	17.5	—	14.4	15.7
Transverse	—	13.5	14.2	14.5	11.8	13.9	15.7	14.5	14.0	14.8

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	15.8	16.2	16.7	14.9	16.1	16.5	13.8	14.7	16.0	15.1
Transverse	14.5	14.7	14.4	13.5	15.0	13.4	12.8	13.3	14.1	12.8

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	16.1	16.6	16.3	15.2	16.2	15.0	16.9	13.0	13.7	16.4
Transverse	13.9	14.7	14.5	13.1	14.4	12.5	14.5	12.0	12.7	14.1

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	15.4	14.7	16.4	15.1	16.5	14.3	14.6	16.4	14.9	16.5
Transverse	—	14.0	13.8	13.9	15.2	12.5	14.1	13.3	13.6	14.3

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	14.6	15.7	14.4	13.6	16.9	13.9	16.2	16.8	18.0	15.4
Transverse	13.4	14.1	—	12.7	14.0	12.4	14.0	16.1	16.9	14.4

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	13.7	14.8	14.4	13.7	14.6	16.3	14.2	17.1	15.7	15.3
Transverse	12.4	13.3	13.5	12.3	12.7	14.5	13.8	15.4	14.2	13.8

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	14.1	16.5	16.4	16.0	17.0	16.5	16.7	15.4	15.5	13.4
Transverse	12.8	15.7	15.5	13.9	14.4	14.7	15.4	14.3	13.6	12.3

No. of specimen	221	222	223	224	225	226	227	228	229	230
Antero-posterior	15.1	13.7	13.7	16.3	14.4	13.5	14.1	—	16.4	15.7
Transverse	14.1	—	12.8	14.4	13.4	12.0	12.4	14.3	14.7	15.1

Of these specimens five are carious, viz., nos. 41, 70 and 147 (posterior surface) and nos. 77 (antero-internal angle) and 151 (antero-external angle). Traces of a buccal cingulum, both between protoconid and hypoconid and at the postero-buccal corner, are seen in five specimens (nos. 90, 95, 118, 133 and 207).

TABLE 46

M_2	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	47	13.6	1.42	10.44	0.22	8.2
Id. subfossil	217	15.4	1.24	8.05		
Transverse recent	48	12.7	1.18	9.29	0.18	7.2
Id. subfossil	222	14.0	1.08	7.71		
Vertical recent	4	8.9	1.53	17.19	1.14	0.7
Id. subfossil	2	9.7	1.20	12.37		
Height index recent	4	164	16.3	9.9	12.83	0.6
Id. subfossil	2	172	14.0	8.2		

The subfossil and recent M_2 are more variable than M_1, and the former are relatively larger when compared to the latter than is true in M_1. As usually the vertical diameter and the index offer no differences of statistical significance, their means being based on too few observations.

M_3 and M_4 (pl. VIII figs. 11, 13; pl. IX figs. 1-4, 6-8)

Of the lower last molar I have 225 specimens in the Sumatran cave collection. Nos. 1-113 are of the right side. Nos. 1-11 and 144-127 are unworn. The specification of the specimens runs as follows:

1 M_3 sin., holotype, Sibrambang cave, Coll. Dub. no. 11473/152.
70 M_3 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11607/1-10, 53-65, 67-113.
64 M_3 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11608/114-118, 120, 121, 153-165, 167-170, 172-177, 179-211, 213-215.
23 M_3 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11609/11-30, 32-34.
28 M_3 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11610/122, 123, 125-150.
16 M_3 dext., paratypes, Djamboe cave, Coll. Dub. no. 11611/37-52.
9 M_3 sin., paratypes, Djamboe cave, Coll. Dub. no. 11612/216-220, 222-225.
2 M_3 dext., paratypes, cave not specified, Coll. Dub. no. 11613/35, 36.
1 M_3 sin., paratype, cave not specified, Coll. Dub. no. 11614/151.
1 M_4 (?) dext., paratype, Sibrambang cave, Coll. Dub. no. 11615/66.
5 M_4 (?) sin., paratypes, Sibrambang cave, Coll. Dub. no. 11616/119, 166, 171, 178, 212.
1 M_4 (?) dext., paratype, Lida Ajer cave, Coll. Dub. no. 11617/31.
1 M_4 (?) sin., paratype, Lida Ajer cave, Coll. Dub. no. 11618/124.
1 M_4 (?) sin., paratype, Djamboe cave, Coll. Dub. no. 11619/221.

Of these specimens, 21 have the roots for the greater part preserved.

A typical form of M_3 is that in which the transverse diameters diminish appreciably from before backward, giving a triangular outline to the crown with the anterior surface as the base, and the hypoconulid or even the posterior inner accessory cusp at the top (nos. 152 and 1, pl. VIII fig. 11 and pl. IX fig. 1). The talonid, however, usually is less pointed behind than in the examples figured, though it tapers more distinctly than in M_2. The variety of form is greater than in the other molars. The right M_3 of skull no. 29 (pl. IX fig. 2) presents the normal shape, while the left (pl. IX fig. 3) is distorted and rotated for about 90°. It is not yet fully in place, but there is enough room for this molar to erupt. The anterior surface is convex from side to side instead of straight, and the buccal surface is concave outward instead of convex as in the right M_3. The protoconid is by far the highest cusp (which is never the case in normal shaped molars, in which the lingual cusps are the higher, at least the metaconid), and the metaconid is absent unless it is represented by the elevation in the middle of the lingual marginal ridge. The posterior portion of the tooth is much reduced. It is remarkable that the antagonist of this molar is deformed in the same way (pl. VII fig. 2). A similar deformation in presented by no. 43 (pl. IX fig. 4).

A normal-shaped M_3 with a well-developed fovea anterior and no ridge between entoconid and hypoconulid (no. 115, pl. IX fig. 6) is of the coarsely wrinkled type. The other extreme condition is shown on pl. IX fig. 7 (no. 114). The wrinkles in the latter specimen are more numerous and finer, the posterior cusps are lower and less distinct than those in the foregoing specimen. Extreme reduction of the talonid is shown in no. 124 (pl. IX fig. 8). The hypoconulid is only a point on the posterior inner side of the hypoconid, and the entoconid also is practically absent. A similar M_3 has been recorded by Remane (1921, p. 62), but he does not mention whether the tooth is also much reduced in size, as is the present specimen. A tooth of the same shape and size as that of pl. IX fig. 8 occurs as M_4 dext. in skull no. 72. The M_4 in skull no. 53 are likewise reduced posteriorly. In skull no. 75 M_4 has the same length as, but is a little narrower than M_3, and its talonid has not less developed than that in the ordinary molars.

The M_4, if present, most often is smaller than M_3 (this is true in 14 of the 18 cases recorded by Berwerth, 1914, pp. 155-160) and presents only three or four cusps. I have nine rather small specimens among the 225 lower last molars (nos. 31, 66, 119, 124, 166, 171, 178, 212 and 221). Even a greater number of specimens of M_4 might be expected, for from the 108 lower last molars in the cave collection that are worn to a degree sufficient to show the posterior contact facet, if any, not less than twelve (nos. 20, 33, 48, 88, 89, 131, 162, 197, 200, 206, 215 and 220) have a contact facet on the posterior surface. This indicates the presence of 11.1 ± 3.0 per cent of M_4 among the lower last molars, a percentage that tends to be higher, but that is not different statistically from the percentage of M_4 among the recent lower last molars (7.0 ± 0.8 per cent; above, p. 244).

The accessory cusps (no. 152, pl. VIII fig. 11 has not only a posterior inner accessory cusp but also two cusplets on the lingual marginal ridge between metaconid and entoconid) were counted in 86 not too much worn specimens from the caves, and in 13 recent M_3. My percentages of occurrence of the various accessory cusps, as well as those recorded by Selenka (1898, p. 69) will be found in table 47.

TABLE 47

M_3	subfossil	recent	recent (Selenka) ♂	♀
tub. access. post. intern.	19	23	27	13
tub. access. post. extern.	2	0	3	10
tub. access. med. intern.	27	31	18	26

Traces of a buccal cingulum were observed in various specimens, both in front and behind the hypoconid. Ten specimens are affected by caries, most often on the talonid (nos. 18, 19, 28, 131, 151, 204, and 213). The antero-external corner of the tooth is lost in nos. 12 and 97, while in no. 57 there is a large carious cavity between protoconid and metaconid.

The measurements are recorded in table 48. For the computation of the means, etc., the nine small specimens have been left out of account. Their average antero-posterior diameter is 11.4 mm, transverse 10.7 mm.

TABLE 48

Measurements of M_3 and M_4 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	13.7	15.8	13.3	16.5	16.0	12.7	13.0	13.7	14.8	15.2
Transverse	11.4	13.5	12.4	13.2	15.5	11.4	11.6	13.0	—	14.8
Vertical				7.0						
Height index				236						

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	13.7	15.6	13.4	13.3	14.6	15.4	14.8	—	—	14.6
Transverse	12.0	—	13.1	12.4	13.0	13.1	13.6	14.1	12.2	—

No. of specimen	21	22	23	24	25	26	27	28	29	30
Antero-posterior	15.8	12.7	15.5	13.6	15.0	13.4	18.2	—	13.0	17.8
Transverse	14.5	11.8	14.1	11.7	13.1	12.1	15.8	12.2	12.0	15.7

No. of specimen	31	32	33	34	35	36	37	38	39	40
Antero-posterior	11.1	16.4	18.4	17.8	16.2	13.3	13.7	14.4	14.3	13.7
Transverse	11.1	14.0	17.2	14.8	—	11.5	12.8	13.0	11.9	12.4

No. of specimen	41	42	43	44	45	46	47	48	49	50
Antero-posterior	14.9	13.8	14.0	15.7	13.5	15.3	16.7	12.0	15.9	14.0
Transverse	13.7	13.4	13.7	13.4	11.2	14.3	14.3	11.0	14.5	11.8

No. of specimen	51	52	53	54	55	56	57	58	59	60
Antero-posterior	—	15.5	14.6	18.2	14.3	13.0	—	15.7	15.5	14.3
Transverse	13.4	13.6	12.8	13.9	12.6	12.4	13.0	13.2	15.1	11.5

No. of specimen	61	62	63	64	65	66	67	68	69	70
Antero-posterior	13.3	13.7	15.0	13.5	14.0	11.3	13.8	13.5	15.0	15.0
Transverse	12.5	12.6	13.3	12.2	11.8	10.1	12.9	12.3	—	12.2

No. of specimen	71	72	73	74	75	76	77	78	79	80
Antero-posterior	14.3	15.0	13.0	14.1	13.2	12.8	12.6	13.8	13.2	12.6
Transverse	13.8	13.7	11.4	12.6	13.0	12.3	11.5	12.9	11.6	10.4

No. of specimen	81	82	83	84	85	86	87	88	89	90
Antero-posterior	12.3	13.2	15.5	12.7	12.8	13.8	13.5	12.6	14.2	13.0
Transverse	11.6	10.7	12.5	11.4	12.4	13.2	12.4	11.7	12.9	12.1

No. of specimen	91	92	93	94	95	96	97	98	99	100
Antero-posterior	12.5	14.8	16.7	13.9	14.6	14.0	13.8	13.5	15.4	14.1
Transverse	12.5	12.5	14.3	13.5	12.7	14.0	—	12.3	14.8	12.5

No. of specimen	101	102	103	104	105	106	107	108	109	110
Antero-posterior	16.5	13.6	12.7	13.2	13.2	15.5	15.8	14.5	12.3	11.9
Transverse	13.6	12.2	11.3	12.4	11.4	12.8	13.1	12.5	10.9	11.0

No. of specimen	111	112	113	114	115	116	117	118	119	120
Antero-posterior	15.1	15.8	13.7	13.4	16.0	15.0	16.7	13.6	10.9	15.0
Transverse	—	13.0	11.4	14.4	14.9	13.2	14.4	12.5	9.8	13.5
Vertical							9.5			
Height index							176			

No. of specimen	121	122	123	124	125	126	127	128	129	130
Antero-posterior	15.4	15.5	13.2	9.5	15.4	16.6	13.3	13.7	14.0	14.8
Transverse	12.9	13.4	13.0	10.5	13.4	15.0	11.0	11.4	12.9	12.8
Vertical						10.2				
Height index						163				

No. of specimen	131	132	133	134	135	136	137	138	139	140
Antero-posterior	13.0	13.3	14.8	17.0	16.6	16.1	16.2	18.4	17.1	13.5
Transverse	11.5	11.6	12.5	14.4	14.5	13.6	14.8	15.2	15.5	12.1

No. of specimen	141	142	143	144	145	146	147	148	149	150
Antero-posterior	15.5	15.1	13.6	12.7	14.4	14.4	13.3	14.6	12.3	15.3
Transverse	14.4	13.2	13.0	11.8	13.2	12.5	10.8	11.1	11.3	13.8

No. of specimen	151	152	153	154	155	156	157	158	159	160
Antero-posterior	—	19.4	14.9	13.6	14.2	13.5	13.4	13.5	14.4	15.0
Transverse	11.9	17.7	12.7	12.3	11.4	12.5	11.4	12.6	12.8	14.5

No. of specimen	161	162	163	164	165	166	167	168	169	170
Antero-posterior	—	12.4	13.9	15.4	14.1	12.0	14.1	12.7	13.0	13.5
Transverse	11.0	12.3	12.5	12.0	12.6	10.4	13.5	12.5	11.3	12.2

No. of specimen	171	172	173	174	175	176	177	178	179	180
Antero-posterior	12.0	14.8	15.5	12.7	16.2	14.7	15.7	12.1	15.0	16.0
Transverse	11.4	11.5	13.9	11.7	—	13.7	15.0	10.7	12.3	14.0

No. of specimen	181	182	183	184	185	186	187	188	189	190
Antero-posterior	15.2	14.0	14.6	13.2	14.1	14.1	13.0	15.5	15.4	16.8
Transverse	12.8	12.0	13.2	12.0	11.6	13.3	11.8	14.9	—	13.4

No. of specimen	191	192	193	194	195	196	197	198	199	200
Antero-posterior	12.5	12.4	12.6	15.8	13.0	13.5	14.4	12.3	14.5	13.5
Transverse	12.0	11.0	10.8	12.6	12.6	12.1	13.2	11.8	12.6	12.8

No. of specimen	201	202	203	204	205	206	207	208	209	210
Antero-posterior	13.6	15.0	14.7	—	13.3	16.8	13.4	16.3	12.9	13.0
Transverse	12.2	13.9	14.1	14.4	12.1	15.5	12.8	14.4	10.9	10.8

No. of specimen	211	212	213	214	215	216	217	218	219	220
Antero-posterior	14.4	12.0	15.0	14.3	13.5	17.1	15.3	14.9	14.6	12.6
Transverse	12.5	11.0	12.7	12.6	12.8	14.0	14.4	13.3	13.0	11.2

No. of specimen	221	222	223	224	225
Antero-posterior	11.5	15.0	16.3	17.2	15.4
Transverse	11.4	12.3	14.8	15.1	15.0

TABLE 49

M_3	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Antero-posterior recent	39	13.6	1.71	12.57	0.29	3.1
Id. subfossil	208	14.5	1.42	9.79		
Transverse recent	44	12.3	1.29	10.49	0.21	2.9
Id. subfossil	207	12.9	1.25	9.69		
Vertical recent	5	8.4	1.18	14.05	1.03	0.1
Id. subfossil	2	8.3	1.25	15.06		
Height index recent	5	163	21.5	13.2	23.29	1.8
Id. subfossil	2	206	30.0	14.6		

The subfossil M_3 can be separated from the recent only in its antero-posterior diameter, and is again more variable than M_2. This is well in harmony with the established transformation in the upper molar series. Both M^2 and M_2 in former times were much larger relative to the first and third molars than they are at the present day. M3 has reduced in size less than M1, but the variability increases as we pass from M1 to M3, the latter having the highest variation coefficients.

MILK DENTITION

(pl. IX figs. 5, 9-18)

There are but very few milk teeth of the orang-utan in the Sumatran cave collection, only six of the ten types are represented. These are the id^1, the upper cd, pd^3, pd^4, pd$_3$ and pd$_4$. The teeth are described below.

A left id¹ (Coll. Dub. no. 11622) originates from the Lida Ajer cave (pl. IX figs. 10 and 14). The tooth is rather worn, but the root is completely preserved. The outline of the crown surface is three-sided. The labial surface is slightly convex and is depressed in the middle just above the root. The angle between the labial and the lateral surface is more acute than between the labial and the medial surface. Lateral and medial surface pass into one another at the lingual side by a gentle curve, the point of the greatest labio-lingual or antero-posterior diameter, which is distinctly to the medial side of the axis of the crown. The enamel is worn off except for two patches, representing the depressions on either side of the basal lingual tubercle, which is present in this milk element as well as in its successor.

The root is single. Three-sided above, it gradually diminishes in antero-posterior diameter toward the apex. The transverse diameter, however, remains the same almost along the entire length, and at the apex the root consequently presents a transverse edge. The dimensions of the present and those of the following specimens are given in table 52 (p. 268).

Three specimens of the upper cd are in the collection, all from the Lida Ajer cave. No. 1 (Coll. Dub. no. 11623/1) (pl. IX figs. 9 and 13) is of the left side, the others (Coll. Dub. no. 11624/2, 3) (no. 2, pl. IX fig. 5) are of the right side. The latter have the roots completely preserved.

The crowns are conical and slightly elongated antero-posteriorly in cross section. The figured specimens present a wear facet on the posterior-inner side of the tip; the third is worn on a lower level. The labial surface is strongly convex before backward, the tip is slightly recurved inward. The lingual surface is more flattened than the outer and has a cingulum along the base which forms a prominent ledge with an anterior and posterior prominence. The anterior is less marked and on a higher level than the posterior. The prominences are surmounted by vertical edges which run to the tip.

The crown bulges out beyond the level of the root on all sides except the labial. The root is strong and single. It tends to recurve posteriorly. The figured specimen has a longitudinal median groove on its inner root surface. In structural characters these specimens are indistinguishable from recent upper cd of the orang-utan. The roots, which could be examined only in few specimens, are of the same type as in the subfossil teeth, and differ only in their smaller size.

The pd³ is represented by three specimens, all of the left side. Nos. 1 and 2 (Coll. Dub. no. 11625/1, 2) are from the Sibrambang cave, while no. 3 (Coll. Dub. no. 11626/3) originates from the Lida Ajer cave. No. 1 (pl. IX fig. 12) has the roots almost completely preserved.

The crown is much longer antero-posteriorly on the buccal side than on the lingual, due to the presence of an anterior protrusion of the crown in front of the main buccal cusp or paracone. On the posterior slope of the paracone an incipient metacone is to be seen. The lingual surface is well convex to the inside. There is but one lingual cusp, the protocone, the lingual surface of which slopes to the margin of the crown much less steeply than the outer surface of the paracone. The teeth are slightly worn, but in the figured tooth two fine transverse ridges are seen to descend from the paracone into the main antero-posterior valley.

The crown bulges well out beyond the level of the roots, of which there are three, viz., two buccal and one lingual. The lingual diverges much from the vertical line, while the two buccal also diverge from one another, but in the same vertical plane.

The strongly marked divergence of the roots is likewise characteristic of the pd^4, of which I have 20 specimens. Nos. 1-11 are of the right side. Nos. 1-4 and 12 are unworn. The specification is as follows:

7 pd^4 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11627/1-3, 8-11.
6 pd^4 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11628/12-17.
4 pd^4 dext., paratypes, Lida Ajer cave, Coll. Dub. no. 11629/4-7.
2 pd^4 sin., paratypes, Lida Ajer cave, Coll. Dub. no. 11630/18, 19.
1 pd^4 sin., paratype, Djamboe cave, Coll. Dub. no. 11631/20.

The present deciduous tooth has a great resemblance to the first upper molar, from which it is distinguished by its smaller size, relatively larger hypocone (the limiting groove between protocone and hypocone may be situated distinctly in the front half of the lingual surface as shown in no. 14 of pl. IX fig. 17), the greater tendency toward the development of an anterior protrusion buccally, and, above all, the widely divergent roots. In no. 2 (pl. IX fig. 18) the wrinkle system is not inferior in development to that in M^1, and the lingual surface shows some very fine ridges which may be regarded as remains of a cingulum. The specimen, like most of the others, has a protoconule fold at the antero-internal corner. Posterior accessory cusps were not observed by me. The measurements of the twenty specimens of pd^4 are recorded in table 50.

TABLE 50

Measurements of pd^4 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	11.4	10.4	9.5	11.0	11.2	10.3	11.4	11.8	11.5	11.0
Transverse	12.2	10.7	10.0	11.9	10.6	11.5	12.0	11.3	11.7	10.4

No. of specimen	11	12	13	14	15	16	17	18	19	20
Antero-posterior	10.0	11.4	11.2	11.4	9.4	10.9	11.7	11.4	10.7	10.4
Transverse	9.8	11.4	11.6	11.3	10.3	11.0	11.4	11.5	12.5	10.3

Of the anterior lower milk premolar we have but two specimens, one of the left and one of the right side (Coll. Dub. nos. 11632/1, 11633/2). Both specimens are incomplete posteriorly. The former originates from the Sibrambang cave; the locality where the latter specimen is from, is not known. The crown is a long oval in shape, and has a main buccal cusp, the protoconid, just as P_3 but much lower. Like in the latter, there is a trigonid basin enclosed by an anterior and a transverse ridge from the protoconid tip, and by the cingulum anteriorly and at the lingual side. Behind the transverse ridge is the talonid fossa, a shelving area, slightly depressed, enclosed by the posterior ridge from the protoconid and by the cingulum lingually and to the posterior side (pl. IX fig. 11). The roots are preserved in the right tooth; there is one anteriorly and one posteriorly, the former being the larger. Both have a longitudinal median groove on the surface opposed to the other root. In the left specimen the roots seem to have been almost parallel, in the right they diverge much from each other.

The pd_4 is represented by 14 specimens; nos. 1-8 are of the left side. Nos. 9 and 10 are unworn. Specification:

7 pd_4 sin., paratypes, Sibrambang cave, Coll. Dub. no. 11634/1-7.
5 pd_4 dext., paratypes, Sibrambang cave, Coll. Dub. no. 11635/9-13.
1 pd_4 sin., paratype, Lida Ajer cave, Coll. Dub. no. 11636/8.
1 pd_4 dext., paratype, Djamboe cave, Coll. Dub. no. 11637/14.

Like the pd^4, the posterior lower milk premolar is completely molariform. The milk tooth differs from M_1 in the greater tendency to the development of a broad talonid portion, and consequently in its narrower trigonid which may be gradually rounded off anteriorly from side to side (no. 11, pl. IX fig. 15). In all specimens the ridge connecting protoconid and metaconid is distinctly double; this is well shown in the comparatively large specimen no. 1 (pl. IX fig. 16). As stated above, many specimens of M_1 likewise have both an anterior and a posterior trigonid ridge between the two anterior cusps. In M_2 the duplication of the ridge connecting protoconid and metaconid is much less frequently met with. The gradation of form observed as we pass from M_2 to M_1 is thus seen to be continued in pd_4; the latter differs from M_1 in the same points as M_1 differs from M_2. I stated moreover (above, p. 251) that, while in M_2 the antero-lingual corner presents approximately a right angle, in M_1 this angle is blunt. In pd_4, however, the anterior surface may slope distinctly backward from lingual to buccal, and the antero-lingual corner consequently presents an acute angle (no. 1, pl. IX fig. 16). The anterior protrusion of the crown in front of the metaconid can be interpreted as evidence of the former existence of the paraconid. A true cusp or point that would deserve this name, however, I have not found either in my subfossil or in my recent material of pd_4 of the orang-utan, and neither has Remane (1921, p. 115). The latter author (l.c., p. 114) as well as Adloff (1908, p. 82) records the presence of a paraconid in the pd_4 of the gorilla.

The roots are preserved only in two specimens, and are built on the same plan as those of the lower molars and the pd_3. The angle of divergence is not great, and the posterior root is evidently the larger.

TABLE 51

Measurements of pd_4 of *Pongo pygmaeus palaeosumatrensis* nov. subsp.

No. of specimen	1	2	3	4	5	6	7	8	9	10
Antero-posterior	13.0	12.6	12.2	12.3	12.7	11.3	11.4	11.4	12.3	12.5
Transverse	9.7	10.4	10.5	10.1	9.4	8.7	9.5	8.6	10.5	9.9

No. of specimen	11	12	13	14
Antero-posterior	10.8	11.5	12.7	12.2
Transverse	8.4	—	10.0	9.8

The dimensions of the recent deciduous teeth, as well as those of the recent permanent teeth are recorded in the tables I and II at the end of this paper. I gave also the dimensions of the recent id^2, id_1, id_2 and lower cd, subfossil homologues of which are not in my collection; they may be of use to others. In table 52 I give the measurements of the subfossil deciduous teeth, of pd^4 and pd_4 the means (M), as well as of the recent. The isolated subfossil types are distinctly larger than the recent if they differ from the mean of the recent type more than three times its standard error (E_M). The series of posterior milk premolars can be compared to each other in the same way as the permanent described above; the difference between the means must be more than three times greater than its standard error ($E_{diff.}$) to be statistically significant.

TABLE 52

Comparative measurements of recent and subfossil milk teeth

	subfossil			recent	
				M	E_M
id^1 antero-posterior		7.8		6.7	c.11
cd antero-posterior	9.9	10.2	10.8	9.1	0.16
transverse	7.6	7.9	7.6	7.1	0.13
pd^3 antero-posterior	9.5	9.6	8.2	8.2	0.13
transverse	10.0	10.3	10.2	9.1	0.14
pd_3 transverse	7.5	6.7		7.0	0.12

	$M_{subf.}$	$M_{rec.}$	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
pd^4 antero-posterior	10.9	10.1	0.23	3.5
transverse	11.2	10.6	0.22	2.7
pd_4 antero-posterior	12.1	11.2	0.25	3.6
transverse	9.7	9.0	0.25	2.8

It is evident from the inspection of the above table, that the id^1, cd, pd^3 and the larger of the two specimens of pd_3 are decidedly larger in the subfossil than in the recent orang-utan. The posterior milk premolars can be distinguished by the antero-posterior diameter, which averages distinctly larger in the prehistoric race. The transverse diameters are less different, and it would seem that the recent milk teeth have the tendency to develop less antero-posteriorly elongated crowns than the subfossil. More than this cannot be inferred from the scanty material that is available to me.

THE PREHISTORIC ORANG-UTAN POPULATION

Our knowledge of the prehistoric orang-utan from Sumatra is based on the thirty-one hundred and seventy teeth, the description of which has been given above. All teeth are isolated except one pair of upper premolars, and two pairs of upper molars (M^1 and M^2) that were found together in situ in small jaw fragments. We know nothing of the skull, nor of the post-cranial skeleton of *Pongo pygmaeus palaeosumatrensis* nov. subsp. The teeth originate from the Sibrambang cave (about one-half of the total number), from the Lida Ajer cave (approximately one-third of the collection). from the Djamboe cave (one-ninth of the total), while the remainder is from other caves in the Padang Highlands of Central Sumatra. The various types of teeth are distributed over the three caves mentioned above with a remarkable constancy in relative frequency of occurrence. All types of teeth are represented in the cave collection, except four types of the deciduous dentition, viz., id^2, id_1, id_2 and the lower cd. The milk teeth are very poorly represented in the collection; the apparent significance of this fact will be dealt with below. The results from the comparative studies of the various elements have been given above in the respective chapters, and are summarized in the concluding chapter of this work. Generally speaking, the dentition of the subfossil animal has been proven to be decidedly more heavily built than that of the recent. The various trends in the evolution of the dentition indicate that the dental apparatus of the orang-utan is on its way to reduction; this is especially evident in the I2 and M2. The more stressed dominance in size of I2 and M2 over the other teeth in the subfossil as compared to the recent no student of primate evolution will deny to represent primitive features. In the absence of any skeletal material of the prehistoric forerunner of the orang-utan, it is impossible to say more about the external appearance of the subfossil animal than that the body-size of the latter very probably, like its teeth, averaged larger than that of the recent animal. The robustness of the prehistoric teeth, in the average, is sixteen per cent greater than that of the recent, and the subfossil orang-utan may have presented approximately the same excess in average body-size over its recent representative. The individuals to which the largest teeth have belonged very probably were even larger than the gorilla, which is now the greatest of all apes. Since, however, it is not improbable that the recent gorilla is but a diminutive descendant of its forerunner in prehistoric and Pleistocene times, the orang-utan may have stood second in size to the gorilla in former times as well as at the present day.

As judged by the total numbers of male and female canines in the caves, the male individuals seem to have been somewhat more numerous than the females. The difference in number, however, is not statistically significant, and the males may have balanced the females in number. The same is true for my collection of recent skulls.

It would be interesting to have an idea of the number of individuals constituting the population of the orang-utan in prehistoric central Sumatra, a region in which the animal is now gone.

If we compare the number of measurable teeth in the subfossil to that in the recent orang-utan, we find the same number of I in the recent and in the cave collection, except the I_2 which is about three times as abundant in the caves as in the recent collection. Of the lower C there are as many specimens in the recent as in the cave collection; of the upper C we have twice the number of the recent specimens in the caves. The premolars and molars, both in the upper and in the lower jaw, are four to six times as abundant in the caves as in the recent skulls. In the latter I counted the teeth of one side only, instead of both the right and the left (except in a few cases in which the teeth differ appreciably on the two sides, as, e.g., in M3). Since, however, I could only very exceptionnally find a right and a left tooth in the cave collection agreeing so completely that there is no doubt as to their belonging to one and the same individual, I feel certain that the numbers of measurable teeth of the subfossil orang-utan are indicative of the number of individuals with the same degree of certainty as are those of the recent orang-utan. In the recent skulls the I and C, being in an exposed and vulnerable place, are often damaged and consequently not measurable. The P and M offer better means of comparison, and these teeth, with a remarkable constancy, indicate that the number of individuals is four to six times as great in the caves as that of which I had recent skulls.

We may thus safely assume that between three hundred and five hundred individual orang-utans left their teeth in the prehistoric central Sumatran caves.

So far the milk teeth have not been taken into account. The deciduous teeth in the cave collection number all together only forty-three specimens. This number is very small when compared to that of the permanent teeth; it is only 1.4 ± 0.2 per cent of the total. I do not think that the number of deciduous teeth is so small because they were not observed so easily by the collectors as the larger ones, or because of these more delicate teeth relatively less escaping complete destruction by the porcupines than of the larger permanent teeth. Teeth of gibbons and monkeys are well represented in the cave collection, and the small *Acanthion* molars and premolars are preserved by hundreds. The small number of deciduous orang-utan teeth seems me to indicate that there were also few remains of young individuals brought into the caves. One might remark that the jaws and bones, before being gnawed at by porcupines, possibly were brought into the caves by the porcupines themselves. The latter of course only took dried bones and jaws with them, and it is evident that these are more frequently and easily found from adults than from young.

In sharp contrast to what is true of the orang-utan, however, the remarkable fact holds that of other elements in the cave fauna milk teeth are decidedly more common. The cases are not strictly comparable, and due allowance must be made for the fact that milk teeth are shed at various ages. But of the upper dentition of the rhinoceroses from prehistoric Sumatra, viz., *Dicerorhinus sumatrensis* (Fischer) subsp., and *Rhinoceros sondaïcus* Desmarest subsp., the milk teeth number 80 out of 123, or 65.4 ± 4.3 per cent (Hooijer, 1946a). And in *Tapirus indicus intermedius* Hooijer of the Sumatran cave collection at least 26 out of the 123 teeth, that is 21.1 ± 3.7 per cent, are of the deciduous set (Hooijer, 1947). These animals, or rather their somewhat diminutive descendants, still live all over the island of Sumatra.

Of course we do not know to what extent the number of individuals of which the teeth are preserved in the caves, is indicative of that of the population living in the woods at that time. If there were really as few infants of the orang-utan as we can deduce from the percentage (1.4 ± 0.2 per cent) of milk teeth left in the caves, this would be well in harmony with the fact that this species is extinct now in central Sumatra; it is found at present in Sumatra only in Achin (Atjeh; Carpenter, 1938, p. 57). The occurrence of the teeth in the caves of the Padang Highlands thus is well beyond the present geographical distribution.

From the relative scarcity of milk teeth it would seem at least probable that at the time of the accumulation of the teeth in the central Sumatran caves, viz., in the early Holocene, the orang-utan in this region of the island was already rapidly reducing in number.

Fossil teeth of the orang-utan are not known as yet from Sumatra, but have been found in the lower and middle Pleistocene of Java, southern China, and Indo-China. The following chapters contain descriptions and a discussion of the material at present known.

PONGO PYGMAEUS (HOPPIUS) SUBSP. FROM THE PLEISTOCENE OF JAVA

Of the two upper molars from the middle Pleistocene at Trinil in Java attributed to *Pithecanthropus erectus* by Dubois, one (Coll. Dub. no. 11621; pl. VII fig. 15) is worn to a considerable extent, while the other (Coll. Dub. no. 11620; pl. VII fig. 10) is only very little worn. For convenience I refer to these specimens below as the worn Trinil molar, and the unworn Trinil molar respectively. The former is of the left side and the latter of the right. Since an elaborate description of these teeth has never been published by Dubois, though he gave excellent photographs of them in his study of 1924 (Dubois, 1924b), I deem it not unnecessary to give such a description here.

The crown of the worn Trinil molar is wider than long and its worn surface is flat antero-posteriorly and concave from buccal to lingual, especially due to the buccal margin being less worn down than the remainder of the crown. The outline is subtriangular with well-rounded angles.

There is a fine notch in the buccal margin, slightly behind the middle of the crown, indicating the limit between paracone and metacone. In front of this notch, which flattens out toward the base of the enamel, the buccal surface is convex, and behind it the buccal surface recedes toward the middle of the posterior border of the crown, where another notch indicates the limit between metacone and hypocone. The hypocone is again convex at the outside; it forms a quarter of a circle, the postero-lingual angle of the crown. On its posterior surface is a small transversely oval contact facet, just below the worn edge. The separation of the hypocone from the protocone is marked at the lingual surface by a third notch, which occurs at three-fifths of the antero-posterior diameter of the crown from its anterior border, and very slightly behind the level of the buccal groove. The lingual groove continues to the lower margin of the enamel and even is discernible along the whole length of the lingual root. The protocone bulges out at the lingual surface slightly more than the hypocone, and presents a distinct pit on the worn occlusal surface, the apex of its dentine core. The antero-lingual angle of the crown is as well rounded as the antero-buccal and shows a minute indentation, the remainder of the groove separating the protoconule from the protocone, and thus indicative of the presence of this most common accessory tubercle in the orang-utan upper molar. The anterior surface of the crown is almost flat transversely and exhibits a contact facet about half as broad as the crown and slightly nearer to the buccal than to the lingual border.

The limit between the anterior cusps cannot be seen on the anterior side of the tooth. A fine pit exactly in the antero-posterior midline of the occlusal surface, at one-third of the length from the anterior margin, however, represents the deepest point of the trigon fossa. Fine lines radiate from this point to all sides. They are shown in the crown view of the specimen represented on pl. VII fig. 15, and represent the longitudinal groove between protocone and paracone, and the borders of the ridges descending from the tips of these cusps toward the centre of the trigon fossa. The pit is connected by a sinuous groove, with a side-branch running in the direction of the buccal notch between paracone and metacone, with another pit one-fourth of the length of the crown in advance of, and in the same antero-posterior line with, the notch on the posterior border between metacone and hypocone. The latter pit represents the deepest point of the hypocone fossa, and a line running anteriorly and inward from it is a remnant of the sulcus obliquus.

In addition to these lines, the worn enamel surface shows some cracks. Like the former, the latter are represented in Dubois's crown view of the specimen (Dubois, 1924b, pl. X fig. 21) and in my figure; one runs all over the worn surface from the lingual notch to a point slightly in advance of the labial notch, while another crosses the hypocone.

The crown projects posteriorly well beyond the level of the roots, which are completely preserved. There is one inner root, compressed from buccal to lingual, that deviates much from the vertical, and two outer roots, both elongated transversely in cross section. The angle of divergence of the roots, seen in posterior aspect, however, is not greater than that in one orang-utan molar from the Sumatran cave collection (pl. VI fig. 15). The anterior of the buccal roots has the usual longitudinal depression and is fused buccally along its entire length with the posterior, which is the smaller.

Of the four cusps the present molar has possessed the protocone, the only cusp of which the dentine core is exposed by wear, evidently was the largest, occupying at the base three-fifths of the antero-posterior diameter, and certainly not less of the transverse diameter than the paracone. The largest cusp but one is the paracone, which is a little shorter antero-posteriorly than the protocone. Next comes the hypocone, while the metacone is the smallest cusp. The postero-buccal angle occupied by the metacone is not produced, as are those formed by the other cusps. The outer surface of the metacone is approximately straight between the middle of the buccal and that of the posterior surface, giving the crown a subtriangular outline. Though the present molar is not properly three-cusped, it shows the way in which the triangular outline of the crown is being accomplished, viz., by the elimination of the metacone, the smallest cusp. This outline is typical of the third, and occasionally of the second upper molar of the orang-utan. In man it is the hypocone rather than the metacone that shows a similar regression in the posterior molars, the hypocone being gradually absorbed, so to speak, by the protocone. The triangular shape found in M^2, and more frequently so in M^3 of man is thus the mirror image of that normally found in the orang-utan (for exceptions see p. 245). The base of the triangles is always formed by protocone and paracone, but in man the top is the metacone, while in the orang-utan it is the hypocone. Both the metacone in the former and the hypocone in the latter are displaced inward relative to the anterior cusp of the same side in three-cusped examples, but the greatest antero-posterior diameter remains buccally of the antero-posterior axis of the crown in man, and lingually of it in the orang-utan.

The unworn molar from Trinil shows its simian features still much clearer than does the worn one. One point must be especially emphasized, viz., that the root formation is the same as that found in the worn molar from Trinil. The divergence of the roots is only a little more strongly marked, and added to that the roots are more directed backward, but the buccal roots are formed and fused in exactly the same peculiar way.

The following notes concern especially the differences between the present and the foregoing specimen. The crown of the unworn molar is wider transversely but more shortened in antero-posterior direction than that of the worn molar. It presents the same well-rounded angles on the buccal and lingual side anteriorly. The buccal surface is strongly convex in all dimensions; the lingual is equally strongly convex from above downward but is lower than the buccal surface and more inclined toward the centre of the crown. Of the cusps only the paracone is a low but distinct elevation of the marginal ridge that surrounds the whole crown. The anterior surface is concave from side to side with a transverse depression but no contact facet. As in the foregoing specimen the lingual surface protrudes to the inside mostly anteriorly, but the groove indicating the limit between protocone and hypocone is situated more posteriorly, only about one-fourth (instead of two-fifths) of the antero-posterior diameter of the crown from its posterior margin.

The posterior surface of the crown is well convex to the lingual side, and recedes forward toward the buccal side. The posterior protrusion beyond the level of the roots is formed by the hypocone, which is decidedly larger than the metacone. The latter is bordered by two grooves crossing the posterior marginal ridge only 2 mm apart. The anterior of these grooves, which forms the posterior margin of the paracone, is placed at two-thirds of the convexity of the buccal surface from the anterior border. The metacone thus is only one-half as long (instead of nearly as long) antero-posteriorly as the paracone.

The pattern of the crown is almost completely preserved. The anterior marginal ridge, as usual, is first and most touched by wear. The wrinkles are comparatively coarse; both from the tip of the protocone as from that of the paracone a ridge is seen to descend toward the centre of the crown. The latter ridge appears to be bifurcated, and is the stronger of the two. The postero-lingual portion of the crown surface enclosed by the marginal ridge is occupied by an enamel nodule of irregular form. The ridges as well as the posterior marginal ridge are crenulated, and so is the anterior marginal ridge, which presents a small groove antero-lingually apparently representing the protoconule fold.

Compared to the foregoing molar the posterior cusps, especially the metacone, have undergone a diminution in size. The paracone is approximately of the same size in both molars, while the protocone has increased in size, evidently at the expense of the hypocone. In addition, all cusps except the metacone, have increased in their bucco-lingual dimension.

Though the two Trinil molars described above did not give rise to such an extensive literature as the skull cap and the femur, many pages are devoted to opposing views as to their affinities, either simian or human. Most worthy of citation is Keith, who stated early in the debate that the crenation of the posterior fringe of the unworn molar is practically diagnostic of its being an orang-utan's tooth (Dubois, 1896, p. 15). Dubois himself advocated the view that they are intermediate in structure between man and the apes, and that they belong to the same individual as that of the calvarium, the femur and the premolar. To support his first supposition he remarks that both specimens show the same retrogression of the postero-buccal angle, of the metacone, typically of the anthropoids (Dubois, 1896, p. 16). The large and strongly divergent roots are believed to have no counterpart in human molars, and the dimensions are stated to be rather large for human proportions. The alleged human affinity, on the other hand, is based on the supposition that the two molars are from one and the same individual. If further the worn molar is M^2, and the unworn M^3, the latter must have erupted very much later than M^2, indicating that the last molar is on its way to reduction, as is the case in man.

In my opinion it is extremely probable that the two molars from Trinil have belonged to one and the same individual. Their roots are built on exactly the same plan. Similar individual peculiarities, when present, occur regularly throughout the whole dentition, and added to that this special root formation is rarely met with. This conclusion drawn by Dubois (1924a, p. 277) from the teeth I would like to share. The Trinil premolar can be left out of consideration, since it does not reveal the typical sectorial type of the anthropoid P_3, though it is not very characteristically human either.

Gregory (1916, p. 320) figured the casts of the two Trinil molars side by side with various human and anthropoid types, and states that the contour of the former is certainly nearer to that of the orang-utan than to the human types. The comparison between the supposed *Pithecanthropus* molars and those of orang-utan has been carried through by Miller (1923). The latter author has shown, in my opinion absolutely convincingly, that the Trinil molars present no characters that would justify a generic separation from the recent orang-utan, nearly all individual peculiarities being present in M^2 and M^3 of the recent orang-utan.

In his final description of the supposed *Pithecanthropus* remains Dubois (1924a, p. 277) remarks that the rugosity of the crown of the unworn molar is much more stressed than that in the orang-utan, though in the shape of its crown, he admits, this molar presents a striking resemblance to some orang-utan teeth from his Sumatran cave collection. Besides, he continues: "a shape of crown as of m^2 is frequently met with in the Orang-utan". This is undoubtedly true, but the molar of the orang-utan frequently presenting the same shape as that of the worn Trinil molar is not M^2 but rather M^3. Examples of M^2 with the same contour as that of the latter are scarce, I figured a specimen (from recent skull no. 27) on pl. VI fig. 12. This recent tooth even is very near in dimensions to the fossil.

The characters that could be inferred from the worn crown surface of the Trinil molar, viz., the limits between the cusps, the presence of a protoconule fold, the location of the deepest points of trigon and hypocone fossa, and the location of the apex of the dentine core of the protocone (see above, p. 273) can be matched with those in specimens worn to the same degree from the Sumatran caves. One of these is represented on pl. VII fig. 13; its dimensions are only slightly inferior to those of the fossil tooth. Another specimen (pl. VII fig. 12) is more worn than the Trinil tooth and consequently shows not only the tip of the dentine core of the protocone, but also those of the other cusps. In this specimen the lines radiating from the centre of the trigon fossa, and the remnant of the sulcus obliquus can still be seen. These subfossil specimens have no posterior contact facet, and consequently have been determined above (p. 246) as representing either M^3 or M^4. They belong to the group of specimens to which the majority of the specimens of last upper molars belongs, viz., those which are not typically M^4, and most probably M^3. The fact that the worn Trinil molar has a (small) posterior contact facet indeed does not exclude the possibility of its being an M^3, the view expressed by Gregory already in 1916. On the contrary this view is the most probable one, as is evident from what has been written above.

The interpretation of the Trinil molars as those of a fossil orang-utan by Miller (1923), though still doubted at by Weinert (1928, p. 519), has been accepted since by Weidenreich (1937, p. 145), Von Koenigswald (1928, p. 190), and Gregory and Hellman (1939, p. 564). Dubois (1938, p. 385), however, prefers to stick to his original opinion, and states that the character of the crown wrinkles of the Trinil molar is "entirely different" from that of the subfossil orang-utan molars from Sumatra. In an earlier paper Von Koenigswald (1936, p. 729/30) has already remarked that, if the Trinil molars are regarded as those of orang-utan, the worn molar might well be M^3, and the unworn M^4. In a subsequent paper (Von Koenigswald, 1940, pl. II fig. 16, pl. III figs. 9 and 10, pl. XIII figs. 9, 10 and 12) fossil orang-utan molars from the lower and middle Pleistocene of Java (recorded already in 1939 (Von Koenigswald, 1939, p. 37)) are figured, establishing the occurrence of this species in the same deposits that yielded *Pithecanthropus*. Von Koenigswald rightly remarks that the character of the enamel wrinkles on the crown is a very variable one, in the fossil specimens as well as in the recent.

From the few lines left on the crown of the worn Trinil molar, a drawing of which is given in his paper (1940, pl. XIII fig. 7a), Von Koenigswald infers that the crown was much more finely wrinkled than that of the unworn molar. In this, however, I cannot follow him. The lines found on the crown, which are not interpreted by Von Koenigswald, represent either the borders of the major ridges, viz., the paracone and the protocone ridges, or the limits between the cusps, viz., the central antero-posterior groove, the buccal groove, the groove connecting trigon and hypocone fossa (the pit of the trigon fossa is not represented in Von Koenigswald's figure), and finally the sulcus obliquus. I noted this already in the description of the specimen. These are the only elements required for the interpretation of the lines (Von Koenigswald rightly does not figure the cracks). In specimens from the Sumatran caves worn even to a greater extent, much more lines may still be seen, especially along the buccal marginal ridge (pl. VII figs. 12 and 13), indicating that the tooth was of the finely-wrinkled type. In the Trinil specimen no lines are visible that do not correspond to the grooves found in a comparatively coarsely wrinkled crown, as that presented on pl. VII fig. 11. In contradistinction to the statement of Von Koenigswald (l.c., p. 169) the worn molar thus cannot be said to have been more finely wrinkled than the unworn one.

There is no objection against the view, expressed above on the ground of the remarkable similarity in the root formation, that the two molars from Trinil belong to one and the same individual. Von Koenigswald, though regarding the Trinil molars as originating from different individuals (l.c., p. 167), stated that it is very probable that the unworn molar is an M^4 (l.c., p. 170), and this is indeed the only possible identification if we accept the two molars to be derived from one and the same dentition.

The dimensions of the Trinil M^3 are exactly those of the average M^3 from the Sumatran caves. In table 53 I give the measurements of the two Trinil teeth as well as the means (M) of the dimensions of subfossil and recent M^3 together with their standard errors (E_M):

TABLE 53

	Pleistocene (Trinil)		subfossil		recent	
	M^4	M^3	M^3		M^3	
			M	E_M	M	E_M
Antero-posterior	11.2	11.9	11.9	0.08	11.6	0.23
Transverse	15.4	13.7	13.7	0.10	13.2	0.19

As stated already above, M^4 differs from M^3 in its diminutive posterior cusps, especially the metacone. While the paracone has not changed in dimensions, the protocone has increased in size, at the expense of the hypocone. The crown as a whole is wider in M^4 than in M^3, which has increased the transverse dimension of all cusps except the metacone. The crown of M^4 is much larger than that of the twelve small specimens from the Sumatran caves which I feel quite certain to represent M^4. A similar triangular outline, however, is presented by some other cave specimens, two of which are decidedly larger than the Trinil tooth (pl. VII figs. 5 and 6).

The only characters shown by the casts of the Trinil molars that appeared to Miller (1923) to be outside the limits of individual variation in recent orang-utan are the tendency for the posterior side of the crown to bulge out beyond the level of the roots, the absence of this tendency to bulge outward along the anterior margin in the worn molar, and the wide angle of divergence of the roots in the unworn molar. The second and third of these characters can be matched with those shown by some cave specimens. The anterior margin of the Trinil M^3 agrees completely in the lack of protrusion with nos. 93 and 46 of the ultimate upper molars from Sumatra (pl. VII figs. 12 and 13), and the angle of divergence between the roots in no. 259 (pl. VI fig. 15) is the same as that in the Trinil M^4 (Dubois, 1924b, pl. XI fig. 29). I have no subfossil or recent orang-utan molars in which the crown bulges out posteriorly to the same extent as that in the fossil specimens. Would this justify a subspecific distinction from *Pongo pygmaeus palaeosumatrensis* nov. subsp.? In my opinion the examination of more material might very well prove the subspecific distinctness of the Pleistocene orang-utan from Java, but the material in the Dubois collection is too scanty for the creation of a new subspecies. In the lower and middle Pleistocene of Sangiran and Patjitan in Java Von Koenigswald (1940, pl. II fig. 16, pl. III figs. 9 and 10) provisionally distinguishes a large and a small form. As far as can be judged from the figures, even the "large form" does not fall outside the variation limits of the recent orang-utan. It is very probable that the Pleistocene orang-utan from Java, in the average, is smaller than *Pongo pygmaeus palaeosumatrensis* nov. subsp., and thus less different in size, or not different at all, from the recent form. This would be in accord with the results arrived at in my studies on the porcupines (Hooijer, 1946c) and on the tapir (Hooijer, 1947) from the Pleistocene of Java and the prehistoric Sumatran cave deposits.

I stated earlier (p. 244) that in recent orang-utan only 1.5 ± 0.4 per cent of the number of ultimate molars consist of M4 that have a change to be worn. In skull no. 40 (pl. VII fig. 14) the M^4 is unworn. M^3 is heavily worn, like the fossil M^3 from Trinil. In the skull to which the two Trinil molars have belonged there were at least three M4, viz., the right and left M^4, and the right M_4, as is evident from the posterior contact facet on the left M^3 and the signs of wear on the crown of the right M^4. Recent skulls with the same dental formula number only 6 out of 467 specimens, that is 1.3 ± 0.5 per cent.

If the two molars collected at Trinil by Dubois are not regarded as belonging to one and the same individual, but their identification as M^3 sin. and M^4 dext. is accepted, as advocated by Von Koenigswald, Dubois would not once, but even two subsequent times have made a find which according to the calculus of probabilities takes place only one time out of fifty or of a hundred! No one can possibly deny that Dubois was a very lucky collector indeed (*Manis palaeojavanica* Dubois, *Rhinoceros kendengindicus* Dubois, practically nothing of which species has been discovered since Dubois unearthed portions of a skeleton of the former, and of a skull, mandibles, forty separate teeth and some odd bones of the latter). As I have shown there is not a single reason, however, to put a greater strain on our imaginative faculty than to consider that Dubois twice came across a tooth of one and the same peculiar orang-utan dentition.

PONGO PYGMAEUS WEIDENREICHI NOV. SUBSP. FROM THE PLEISTOCENE OF S. CHINA

Diagnosis: Teeth identical in specific characters to those of recent *Pongo pygmaeus pygmaeus* (Hoppius) and *P. p. palaeosumatrensis* Hooijer, but most often distinctly larger. The lower C tends to be less hypsodont than that in the subfossil, and consequently than that in the recent form. The difference in size between *Pongo pygmaeus weidenreichi* and the younger races is statistically significant.

Holotype: The right lower female C figured by Weidenreich (1937, figs. 61 and 258).

Locality: Typically from the Hoshangtung cave, province of Yunnan, S. China. Similar teeth from other caves in Yunnan, Kwangsi, and from Indo-China.

Age: Lower or middle Pleistocene.

Like in Java, the fossil orang-utan made its first appearance in S. China in disguise. Young (1932, p. 387 fig. 4a) figured a right P_3 collected in 1930 by Wang in the Hoshangtung cave, Yunnan, as "?*Aeluropus* sp.". *Ailuropoda* is a characteristic element to the fauna from the lower or middle Pleistocene yellow cave and fissure deposits of southern China. This fauna has been described first by Matthew and Granger (1923) from pits at Yen Ching Kao, Wanhsien, Szechuan province. The teeth found in these deposits belong to *Stegodon*, rhinoceros, tapir, *Sus*, *Cervus*, bear, hyaena, etc., and are usually gnawed at by porcupines. They can be bought in Chinese drug stores wheresoever they are. The first truly recognized orang-utan teeth (thirteen molars and premolars) were bought associated with the *Stegodon-Ailuropoda* fauna in a shop at Yungning in the Kwangsi province by Teilhard de Chardin, Young, Pei, and Chang (1935, p. 195 footnote). These authors also corrected the earlier identification of Young (1932). The material has been briefly described by Pei (1935, p. 422/23, fig. 6 a-j), who gives also measurements. They will be referred to below. Pei rightly observed that some of the teeth are distinctly larger than those of recent orang-utan, but that the fossil does not seem to show any special character to justify the creation of a new species.

In the same year Von Koenigswald (1935, p. 873/74, figs. 1-13) published a note on fossil teeth of the orang-utan bought in Chinese drug stores in Manila and Hong Kong. From the state of preservation and the character of the associated fauna they are supposed to originate from the Pleistocene southern China caves too. The teeth are again stated to be in general larger than the recent specimens, but apparently not different specifically from the latter. Except for the length of a lower molar (19 mm) no measurements are given. As far as the figures permit judgment, the wrinkle system is not inferior in complexity to that on their recent homologues.

In his work on the *Sinanthropus* dentition Weidenreich (1937, p. 30/31, figs. 61 and 258) figures and discusses an unworn right lower C of a female orang-utan from the Pleistocene Hoshangtung cave in the Yunnan province, the same cave where Young's material was found. Broom (1946, p. 66) thinks the tooth to belong to *Gigantopithecus*, but I cannot see why it should not belong to the orang-utan. It has exactly the shape and size which one could expect to find for a Pleistocene lower female canine of this species. Weidenreich (l.c. p. 31) states that it is not easy to determine whether this orang-utan canine belongs to the upper or to the lower dentition, but fortunately he gives six good figures of the specimen, and the presence of a deep upward curvature of the lower enamel border on the medial side characterizes it as belonging to the lower dentition. The relatively low tip leaves no doubt as to the sex of the individual to which it has belonged. The high position of the apex of the antero-internal triangular prominence (about one-third of the height of the crown below the tip) and the antero-posteriorly elongated base also are characteristic of a female lower C.

In the fossil Chinese canine figured by Weidenreich all characters are well-marked: the antero-internal edge, the posterior edge and the prominence at its base, the posterior groove, the lingual ridge, and the cingulum, not only medially but surrounding the whole crown. The dimensions are given in table 54.

TABLE 54

	Weidenreich, 1937, p. 31, fig. 61	subfossil		recent	
Lower C ♀		M	E_M	M	E_M
Antero-posterior	14.2	13.3	0.17	12.3	0.23
Transverse	11.0	9.9	0.13	9.1	0.22
Vertical	18.0	16.9	0.32	15.7	0.59
Height index	78.9	77.0	2.03	74.0	1.87

In the table I give also the means of the various dimensions and of the index in the subfossil and in the recent specimens, with their standard errors ($E_M = \frac{\sigma}{\sqrt{n}}$). As I have the measurements only of one Pleistocene specimen and not those of a series we cannot compute the means and standard errors of the differences between them and the means found for the subfossil or the recent teeth. To determine whether the fossil canine is really different in size from the subfossil and the recent we have to see whether its dimensions deviate from the means of the subfossil and the recent series more than three times their standard errors (above, p. 179). And indeed the difference in the antero-posterior diameter and that in the transverse diameter stands this statistical test, for 14.2 is more than 13.3 + 3 × 0.17 or 13.8 and 11.0 is more than 9.9 + 3 × 0.13 or 10.3. The difference even holds for the vertical diameter too; in the latter respect the subfossil canines do not differ statistically from the recent.

The Pleistocene lower female canine from the Hoshangtung cave in Yunnan figured by Weidenreich (1937, fig. 61 and 258) 1) differs statistically from those of *Pongo pygmaeus palaeosumatrensis* nov. subsp. in its greater dimensions and deviates still more in this respect from the recent female lower canines. It certainly deserves a new subspecific name, and I dedicate this subspecies to Prof. Dr. F. Weidenreich for his outstanding work on fossil man and his nearest relatives.

Weidenreich moreover figures and briefly discusses a fossil P3 (l.c., p. 47, fig. 88), some upper molars (l.c., p. 66, figs. 126, 282, 332 and 336) and lower molars (l.c., p. 85, figs 179 and 243a), and even a cd (l.c., p. 111, fig. 192) originating from Kwangsi (Pei's material) and Yunnan. The fossil orang-utan from China is stated to have higher and more pointed cusps, and a coarser wrinkle system on its molars than the recent. As I have repeatedly shown above the wrinkle system is very variable in

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1 In a popular booklet Weidenreich (1946, p. 13, p. 14 fig. 14 Ab) refers again to the fossil Chinese orang canine which he states to resemble the form of the human canine more than that of the modern orang-utan or chimpanzee. This statement, of course, must be taken cum grano salis; Weidenreich evidently refers only to the relative height of the crown.

development, and finely wrinkled crowns are always found beside coarsely wrinkled ones. For the Chinese Pleistocene this contrast between the two types is well shown by the figures given by Von Koenigswald (1940, pl. XIII figs. 4 and 6). In his note on the fossil orang-utan molars from the Hoshangtung cave collected during 1934-35 by Yin, Weidenreich (in: Bien and Chia, 1938, p. 343) moreover remarks that some molars show an extraordinary abundance of fine wrinkles, whereas in other cases the wrinkles are coarse and sparse. Only the molars of the latter type, prevailing in the Kwangsi material previously figured by Pei, have been figured by Weidenreich, and not the molars with fine wrinkles.

Of more importance than the degree of development of the wrinkles is the question of size. We have seen above that the Hoshangtung cave canine differs statistically from its subfossil and recent homologues in its larger size. And it is not the only tooth displaying the subspecific distinctness of the Pleistocene orang-utan from China. In table 55 the dimensions of the teeth figured by Pei (1935) are given beside the means (M) and standard errors (E_M) of the corresponding subfossil and recent elements:

TABLE 55

		Pei, 1935, p. 422/23	subfossil		recent	
			M	E_M	M	E_M
P^3 antero-posterior		10.0	10.6	0.07	10.1	0.14
transverse		12.3	13.7	0.11	13.0	0.19
P^4 antero-posterior		11.0	10.0	0.05	9.4	0.13
transverse		15.0	13.7	0.08	12.7	0.17
P_3 antero-posterior		17.0	15.9	0.12	15.0	0.28
transverse		11.0	10.6	0.08	9.8	0.15
M^1 antero-posterior		14.0	12.7	0.05	12.2	0.14
transverse		14.0	13.5	0.05	13.1	0.12
M^2 antero-posterior		15.5	13.8	0.06	12.2	0.18
transverse		15.2	15.3	0.07	13.9	0.18
	(small)					
M^3 antero-posterior	11.2	12.2	11.9	0.08	11.6	0.23
transverse	12.5	15.5	13.7	0.10	13.2	0.19
M_3 antero-posterior		17.2	14.5	0.10	13.6	0.27
transverse		14.0	12.9	0.09	12.3	0.20

It will be seen, that while the P^3 and the small M^3 even remain below the recent average dimensions, and the transverse diameter of M^2 is less than that in the subfossil, the fossil P^4, P_3, the upper M and M_3 are larger than their subfossil, and consequently than their recent homologues, and that the differences stand the statistical test. These teeth, like the C, witness that the reduction in size of the teeth of the orang-utan is evident already since the Pleistocene.

In the following chapter the probable relationships between the Chinese fossil orang-utan and that from prehistoric Sumatra will be discussed in the light of the evidence obtained from the study of other mammalian species occurring in the same deposits.

SUMMARY; THE EVOLUTION OF THE DENTITION OF PONGO PYGMAEUS (HOPPIUS)

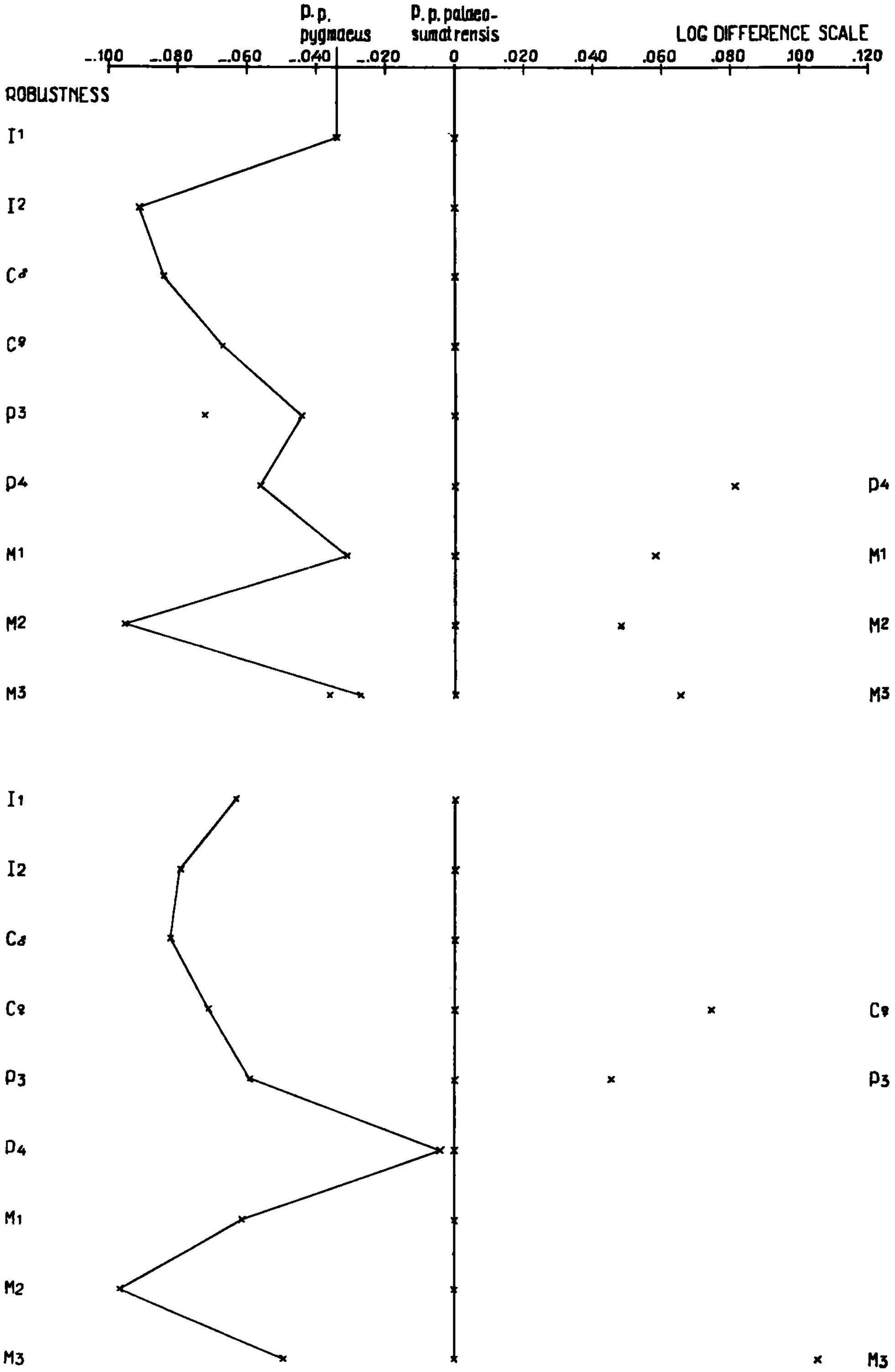
The following diagrams contain the results obtained by the measurements. I have followed Simpson (1941) in constructing these diagrams, and I have used this method already at an earlier occasion (Hooijer, 1946b).

In diagram I the robustness (antero-posterior diameter multiplied by transverse diameter of the crown) of the subfossil I, C, P and M can be directly compared with the corresponding values found in the recent and in the fossil orang-utan. The figures have been converted to their logarithms, and the differences have been calculated from those found in *Pongo pygmaeus palaeosumatrensis* nov. subsp. which I have chosen as the standard. The latter are set in a straight vertical line; the larger observations (*Pongo pygmaeus weidenreichi* nov. subsp.) fall to the right of this line, and the smaller (*Pongo pygmaeus pygmaeus* (Hoppius)) to the left. The observations of the recent race have been connected by a line, which is necessarily broken since the teeth are not similar in proportions throughout the series. The observations of the large Pleistocene orang-utan are represented as isolated crosses. As $\log a - \log b = \log \frac{a}{b}$ the crosses represent the logarithms of the ratio's, and it can be seen at a glance which of the teeth has undergone the greatest transformation in the course of time.

The I^2, M^2 and M_2 have reduced in size to a greater extent than any of the other teeth since the time of the deposition of the teeth in the prehistoric Sumatran caves. Next follow the male upper and lower C, and the I_2.

It is evident that the lateral incisors, both in the upper and in the lower jaw, have undergone a greater reduction in size than the central incisors. The I^1 from the caves even cannot be separated statistically from the recent. We have to do with a tendency in the orang-utan dentition completely parallel to that in the human dentition, to suppress the I2. In the upper jaw I2 is further on its way to reduction than in the lower.

The male C have diminished in size to a somewhat greater extent than the female C; the sexual difference in the dimensions of the canines consequently tends to be a little greater in prehistoric times than it is now. Unfortunately having the dimensions only of one Pleistocene female



Ratio diagram I comparing robustness of recent, prehistoric, and fossil teeth of *Pongo pygmaeus* (Hoppius). The means of the proportions found in the subfossil teeth are taken as the standard of comparison and are set in a straight vertical line. The broken line connects the observations of the recent teeth; isolated crosses represent the Pleistocene teeth from China.

lower C, makes it impossible to check this sexual difference in the Pleistocene. The fossil Chinese C only witnesses that the reduction in size has set in already in the Pleistocene. It is probable, however, that in the Pleistocene the male C were still bigger relative to the female than in prehistoric times.

In man there is no conspicuous difference in size between the canines of the males and those of the females. However, the sexual difference in the size of the C, so characteristic of the anthropoids, is still to be found in man. Mijsberg and Mijsberg (1932) have shown that in the Javanese males and females the difference in size of the C, both in mesio-distal and in bucco-lingual dimension, and both in the upper and in the lower dentition, stands the statistical test. It would seem that in this respect man is again more progressive than his less-brained relatives.

The other teeth of *Pongo pygmaeus weidenreichi* nov. subsp. agree with the C in being decidedly larger than the corresponding teeth of *P. p. palaeosumatrensis* nov. subsp., except for the P^3 and the small specimen of M^3 which fall to the left of the standard line. Of the relative decrease in size of the various teeth nothing can be said on the ground of single specimens.

The P^4 tends to reduce in size to a greater extent than does the P^3, but in the lower jaw the difference in size between P_3 and P_4 is very much greater in the subfossil orang-utan than in the recent. P_4 even has so little reduced in size that the subfossil cannot be separated statistically from the recent. In the subfossil orang-utan P_3 is much larger when compared to P_4 than in the recent race. As stated above (p. 229) the preponderance of P_3 over P_4 is regarded as indicative of the pre-existence of a bigger upper C. Now, as shown in the diagram, the upper C have undergone a greater reduction in size and consequently in former times were relatively larger than the premolars. We may thus further assume that the ancestor of the subfossil Sumatran race had relatively still larger upper canines.

The upper as well as the lower M1 and M3 have reduced in dimensions to a much smaller extent than have M^2 and M_2. The latter have undergone a diminution in size even greater than has I^2, and the reduction relative to the first and third molars again has proceeded further in the upper jaw than in the lower.

The dominance of M2 in the molar series is a typically simian feature, which thus now has been proven to be even much more stressed in the subfossil orang-utan than in the recent. As follows from the inspection of tables 31 and 43 on pp. 237 and 257, in the recent orang-utan the reduction in size of M2 may even have gone so far, that M1 is the largest molar. This occurs more frequently in the upper jaw than in the lower, perfectly in harmony with the relative reduction of M^2 and M_2 mentioned above.

In recent man M1 usually is the largest of the molar series, but the dominance of M2 occasionally is found in individuals of every race. It is significant that both in *Sinanthropus* and in Neanderthal Man M_2 is larger than M_1 and M_3 (Weidenreich, 1937, diagram 4). Weidenreich does not emphasize this point, but I would like to do so, since this fact, viz., that in early stages of the evolution of the hominid dentition M_2 predominated in size over the other molars, indicates that in this respect as well as in others man's dentition evolved parallel to that of the apes. Man is now beyond this stage, but the anthropoids are less advanced and still show the predominance in size of M2 in the majority of the cases (see table X in Remane, 1921, p. 27). Though a single case is not of great importance, and we have to compare the average robustness of large series of molars in order to get a sound base for our deductions, I call the attention to the fact that in *Pithecanthropus robustus* Weidenreich (1945, p. 29) M^2 is by far the largest of the three molars.

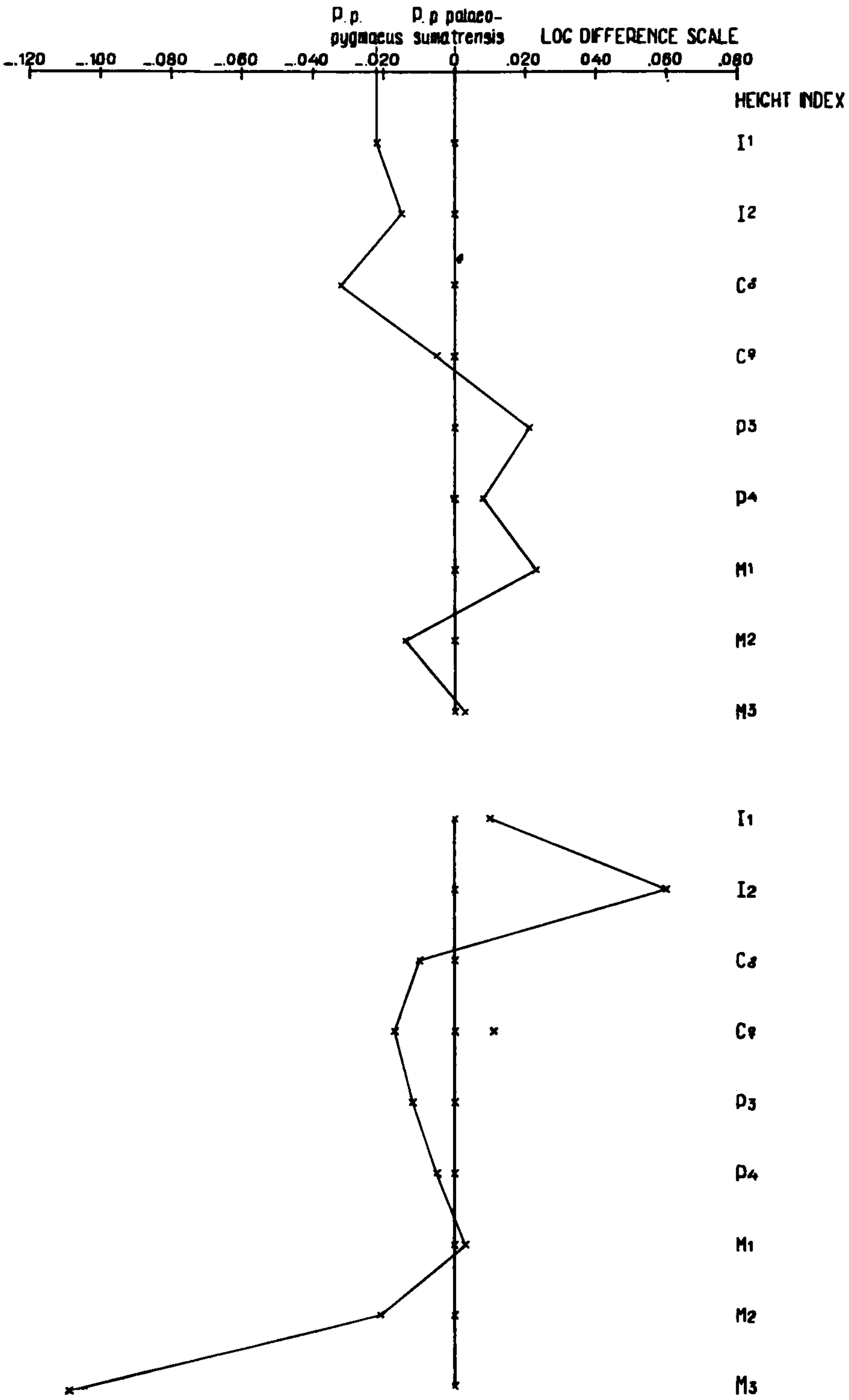
Without emphasizing the point, Weidenreich (1937, diagram 3) gives the curve of the robustness of the Australian aboriginal upper teeth with a peak in the M^2. This is not correct; as judged by the average figures given by Campbell (1925, p. 17) the robustness of M^2 is 142.79, and consequently lower than that of M^1 (145.92). There is, however, another race of recent man in which the average dimensions of M^2 exceed those of M^1, viz., the Bantu (Middleton Shaw, 1931, p. 24). The average robustness of M^1 is 113.30, against 115.00 in M^2. It would seem evident that in this respect the Bantu is even more primitive than the Australian.

Returning now to the discussion of the ratio diagrams presented above, we observe that M^3 and M_3 have reduced less in size than M^1 and M_1; the subfossil M^3 cannot be separated from the recent, and the subfossil M_3 is distinguished statistically from its recent homologue in the anteroposterior dimension only. The variation coefficients, however, increase passing from M1 to M3 (table 56).

TABLE 56

Variation coefficients of molars of subfossil and recent orang-utan

	Pongo pygmaeus palaeosumatrensis nov. subsp.		*Pongo pygmaeus pygmaeus* (Hoppius)	
	antero-posterior	transverse	antero-posterior	transverse
M^1	7.24	7.04	8.77	7.25
M^2	8.41	8.89	10.41	9.14
M^3	10.00	10.58	12.76	9.85
M_1	6.90	6.99	8.02	7.93
M_2	8.05	7.71	10.44	9.29
M_3	9.79	9.69	12.57	10.49



Ratio diagram II comparing height indices of recent, prehistoric, and fossil teeth of *Pongo pygmaeus* (Hoppius). The means found for the subfossil teeth form the standard line. The more hypsodont observations fall to the left of this line, the less hypsodont to the right. Isolated cross at C ♀ represents type canine of *Pongo pygmaeus weidenreichi* nov. subsp.

Though the present study gives no evidence that M3 reduces to a greater extent than the other molars do, the evident tendency to third molar variability would seem initial to its complete suppression, occasionally shown in the recent orang-utan. In the upper jaw M3 is further on its way to reduction than in the lower; M^3 is smaller, in the average, than M^1, whilst M_3 averages larger than M_1. This holds both for *Pongo pygmaeus palaeosumatrensis* nov. subsp. and for *Pongo pygmaeus pygmaeus* (Hoppius).

The height indices are represented in diagram II, which has been constructed in the same way as diagram I. As the index decreases with increasing relative height, a low index (to the left of the standard line) means a high-crowned tooth. It will be seen that the recent upper I, upper and lower C, and lower P fall to the left of the vertical line of *Pongo pygmaeus palaeosumatrensis* nov. subsp., and consequently show the tendency to become more hypsodont. The male upper C even has become really higher-crowned at the present day than it was in prehistoric Sumatra; the difference in the height index stands the statistical test (see p. 200). From the Pleistocene orang-utan from China we have the height index only of the female lower C, which shows the fossil tooth to be less hypsodont than its subfossil, and, consequently, its recent homologue. The tendency of the C to become more hypsodont thus is evident already since the Pleistocene.

The lower I and upper P have evolved in a direction opposite to that observed in the other teeth. They are becoming less hypsodont, and the differentiation has proceeded further in the I_2 than in any other element. The I_2 of *Pongo pygmaeus palaeosumatrensis* nov. subsp. can be distinguished statistically from the corresponding recent element by its lower height index and consequently higher crown (p. 198).

The molars are either more or less hypsodont in the subfossil as compared to the recent orang-utan. The average indices, however, are based on very few specimens, and the difference never has statistical significance. No value, therefore, must be attached to the greater or lesser degree of hypsodonty in the molars. The indices were computed only for the sake of completeness.

As stated earlier, the orang-utan has now been recognized as a typical element to the *Stegodon-Ailuropoda* fauna from the lower or middle Pleistocene caves of southern China, where it is represented by a large race, *Pongo pygmaeus weidenreichi* nov. subsp. The Malayan affinities of the *Stegodon-Ailuropoda* fauna have been stressed by various authors (Teilhard de Chardin, Young, Pei and Chang, 1935, p. 195; Pei, 1935, p. 424; Von Koenigswald, 1935, p. 873). The latter author found the same assemblage of mammals, *Ailuropoda* excepted, in the lower and middle Pleistocene of Java (Djetis and Trinil deposits). There can be no doubt that these animals, constituting the Sino-Malayan fauna of Von Koenigswald, migrated to Java via the Sunda Shelf, past Sumatra or Borneo. Von Koenigswald (1938-39, p. 296, 1940, p. 69) suggested a route past Formosa, Luzon, and Borneo, but it is more likely that the migrations took place via Malaya and Sumatra.

The fauna of the Mogok caves in Upper Burma, though still imperfectly known, is apparently closely related to the cave fauna of southern China, and may be considered as an element in this faunal complex (Colbert, 1943, p. 425). The orang-utan is so far lacking in Burma 1), but this species has been found to the south of China in the Tam-Hang and Tam-P'a-Loi caves in Indo-China, supposed to be early Pleistocene in age (Fromaget and Saurin, 1936, pp. 11, 12, fig. 3). During a short visit to the Leiden Museum in November 1946 Dr. Fromaget showed me his collection of fossil orang-utan teeth from Indo-China. Though time failed to make a thorough study of the specimens, they did not seem to be specifically different from the recent teeth, being only a little larger than the latter, just as the fossil Chinese and subfossil Sumatran specimens are. The figured P^4 and M^3 (l.c., fig. 3 a and b) are of the same size as those of *Pongo pygmaeus weidenreichi* nov. subsp., and consequently are distinguishable statistically from the prehistoric and the recent teeth. It is not impossible that the Indo-Chinese form, after careful study, will prove to form a linkage between the fossil Chinese and the subfossil Sumatran race.

It is a curious fact that truly Pleistocene or late Tertiary vertebrates have not been found as yet in Sumatra. Of course this is no reason to exclude Sumatra from the possible migration routes of the Pleistocene mammals from the continent to Java. The deposits of the Sibrambang, Lida Ajer, Djamboe, and other caves in the Padang Highlands in Central Sumatra do not yield extinct species, and they cannot be regarded as older than early Holocene. The fauna has a number of species in common with that of the Pleistocene of Java, and it is very remarkable that the species are represented in the prehistoric Sumatran caves by specimens that average

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1) The alleged occurrence of "*Simia* cf. *satyrus*" in the Upper Siwaliks of the Siwalik Hills, which has found its way in literature (Pilgrim, 1910, p. 198, 1913, p. 325, 1915, p. 2, 1927, p. 21/22; Matthew, 1929, p. 443 (dropped the cf. sign); Colbert, 1935, p. 59; De Terra, 1943, p. 459) rests upon the upper C described by Falconer (1868 I, p. 304, II, p. 578). The specimen is unfortunately lost, but, as rightly remarked by Dubois (1897, p. 83) and by Branco (1898, p. 6) the specimen would be insufficient even for a generic determination. In the absence of any convincing proof of its presence in the Siwalik fauna, even in its eastern extension in Burma, the orang-utan must be struck off the faunal list of the Upper Siwaliks.

larger than those of the same species in the Pleistocene of Java. This has already been established by me for the porcupine and the tapir, two elements to the Sino-Malayan fauna. The former is represented in the prehistoric Sumatran cave fauna by a race of *Acanthion brachyurus* (L.) that is larger than the living Sumatran *A. b. longicaudum* (Marsden). In the Pleistocene of Java we find, beside small porcupine teeth that may represent *Thecurus sumatrae* Lyon now confined to Sumatra, also teeth that fall within the variation limits of *Acanthion brachyurus longicaudum* (Marsden), larger than those of the living *A. b. javanicum* Cuvier but smaller than the prehistoric teeth from Sumatra (Hooijer, 1946c). The tapir is represented in the Sumatran caves by a race (*Tapirus indicus intermedius* Hooijer) that is decidedly larger than recent *Tapirus indicus indicus* Desmarest from Sumatra. And the Pleistocene *Tapirus* teeth from Java again are not different in size from the recent (Hooijer, 1947). If the tapir could have subsisted in Java up to the present day, it certainly would have been smaller in dimensions than that of Sumatra and would have been subspecifically distinct.

Both the tapir and the porcupine are represented in the Pleistocene caves of southern China and Indo-China (the latter also in the Pleistocene Mogok cave of Upper Burma) by teeth that are larger than those from the Sumatran caves. The big "*Hystrix* sp." (Mansuy, 1916, p. 24, pl. VII figs. 5-7; Young, 1932, p. 388; Pei, 1935, p. 419; Bien and Chia, 1938, p. 334; Colbert, 1943, p. 419) has received little attention. The dimensions of the teeth recorded are decidedly above the size of the Sumatran cave teeth. Whether this large from is the ancestor of *Acanthion brachyurus* (L.) cannot be established on the teeth alone.

Tapirus augustus Matthew et Granger from the Pleistocene of China and Indo-China (see Hooijer, 1947, pp. 290-293) is distinguished from *T. indicus intermedius* Hooijer from prehistoric Sumatra and *T. indicus indicus* Desmarest by its larger size, broader upper M, and more molarized premolars. The latter character removes it definitely from the ancestral line of the living Malay tapir.

In his latest contribution to the Pleistocene fauna of Java Von Koenigswald (1940, pp. 56 and 61) records teeth of a large porcupine and a molar probably referable to *Tapirus augustus* Matthew et. Granger. These finds reinforce the similarity between the Javan and the southern Chinese, Burmese, and Indo-Chinese Pleistocene faunal assemblage.

Recently Weidenreich (1945) has proclaimed *Gigantopithecus blacki* Von Koenigswald, evidently a member of the *Stegodon-Ailuropoda* fauna of southern China, to be probably the ancestor of the lower Pleistocene *Pithe-*

canthropus robustus Weidenreich and of *Meganthropus palaeojavanicus* Von Koenigswald from Java. The large size of the *Gigantopithecus* molars certainly is no objection against this view, as some of Weidenreich's critics (e.g., Vallois, 1946, p. 369; Mydlarski, 1947, p. 131) hold. The evidence of three isolated teeth, however, is too scanty. Not until the complete dentition of the giant Chinese hominid will be known, we might make out whether the latter is the ancestor of the fossil Javan hominids or only a representative of an extinct side-branch.

The orang-utan presents a case parallel to those of the porcupine and the tapir referred to above. In the cave fauna of Sumatra it has now been shown to be decidedly larger than the recent form; the Pleistocene teeth from Java do not seem to be different in size from the recent, and the Pleistocene teeth from southern China and Indo-China are in part distinctly larger than those from the Sumatran caves, and consequently than the recent teeth. The lower C of *Pongo pygmaeus weidenreichi* nov. subsp. is structurally ancestral to that of *P. p. palaeosumatrensis* nov. subsp., but whether or not the fossil race is the direct ancestor of the younger races from Sumatra cannot be made out as yet.

From the study of the prehistoric orang-utan teeth from the Sumatran caves, which doubtless belong to a population ancestral to the living race, we know now several trends in the evolution of the dentition, viz.,

a. a general diminution in size,
b. a progressive reduction in size of I^2 and I_2,
c. in the upper I, upper and lower C, and lower P a tendency to become more hypsodont, distinctly so in the male upper C,
d. a tendency to become less hypsodont in the lower I and upper P, distinctly so in the I_2,
e. a tendency to decrease the sexual difference in the size of the C,
f. a tendency to reduction of P_3 relative to P_4, and
g. both in the upper and lower jaw a decreasing preponderance in size of M2 over M1 and M3.

After the study of a large number of teeth of *Pongo pygmaeus weidenreichi* nov. subsp. one of the two following conclusions will be arrived at. Either this fossil race has already specialized in another direction than the Sumatran cave race, and consequently the former cannot have given rise to the latter. Or the dentition of the fossil Chinese orang-utan as a whole presents an initial stage of development of the distinguishing characters of the Sumatran cave race. Would this prove to be true, there would be a sound base for the view that *Pongo pygmaeus weidenreichi* nov. subsp. is the ancestral form of *Pongo pygmaeus palaeosumatrensis* nov. subsp., and thereby that of the living orang-utan.

TABLE I A

Measurements of upper teeth of *Pongo pygmaeus pygmaeus* (Hoppius)

No. of skull	14	15	16	17	18	19	20	21	22	23
M^1 antero-posterior	13.7	11.4	12.3	11.4	12.8	13.5	11.6	13.2	13.5	11.8
transverse	13.6	12.3	13.7	12.3	14.3	12.6	12.7	14.0	14.5	12.3
vertical	—	—	8.9	—	9.0	7.3	—	7.5	8.0	7.4
height index	—	—	138	—	142	185	—	176	169	160

TABLE II A

Measurements of lower teeth of *Pongo pygmaeus pygmaeus* (Hoppius)

No. of skull	14	15	16	17	18	19	20	21	22	23
M_1 antero-posterior	14.7	—	14.2	12.6	14.4	13.3	12.9	14.5	14.8	12.9
transverse	11.9	—	12.1	10.7	12.7	11.5	11.1	11.8	13.2	11.0
vertical	10.3	—	9.3	7.7	—	—	—	—	—	—
height index	143	—	153	164	—	—	—	—	—	—

TABLE 1 B

Measurements of upper teeth of *Pongo pygmaeus pygmaeus* (Hoppius)

No. of skull	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
I^1 transverse	12.9	—	12.9	—	—	13.4	15.0	15.6	—	—	—	—	—	—	—	—	—	—	—
antero-posterior	11.6	—	11.4	11.3	10.4	10.9	12.1	11.2	—	14.3	13.8	13.5	14.0	—	—	—	—	13.4	—
vertical	18.0	—	—	16.0	—	16.0	17.1	16.0	—	—	—	—	—	—	—	—	—	—	—
height index	71.7	—	—	—	—	83.8	87.7	97.5	—	—	—	—	—	—	—	—	—	—	—
I^2 transverse	—	—	—	—	7.8	7.0	9.9	8.3	—	10.0	8.3	8.2	9.0	8.8	—	—	—	9.2	s. 9.5 d. 10.4
antero-posterior	—	—	—	—	7.5	7.5	10.0	7.4	—	10.2	9.0	8.5	10.4	9.6	—	—	—	10.2	s. 10.0 d. 9.5
vertical	—	—	—	—	10.7	10.0	—	10.5	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	72.9	70.0	—	79.5	—	—	—	—	—	—	—	—	—	—	—
C antero-posterior	—	—	—	—	12.3	11.9	—	13.3	—	20.0	18.2	—	20.1	16.4	18.5	15.4	18.0	16.9	18.8
transverse	—	—	—	—	9.0	9.0	—	9.8	—	14.5	14.0	—	15.4	13.4	14.5	11.5	14.8	14.3	14.1
vertical	—	—	—	—	15.0	13.7	—	16.0	—	29.0	27.8	—	30.0	—	—	—	—	—	—
height index	—	—	—	—	82.0	86.9	—	83.1	—	69.0	65.5	—	67.0	—	—	—	—	—	—
P^3 antero-posterior	—	—	—	—	9.5	8.2	—	9.1	10.3	11.7	9.5	10.0	11.3	10.5	10.3	8.9	—	10.8	10.8
transverse	—	—	—	—	10.3	11.0	—	12.0	11.6	13.2	13.1	12.8	14.8	14.5	13.6	11.4	13.5	14.6	14.0
vertical	—	—	—	—	9.5	8.3	—	11.4	12.0	—	11.0	—	14.4	—	—	—	—	—	—
height index	—	—	—	—	100.0	98.8	—	79.8	85.8	—	86.4	—	78.5	—	—	—	—	—	—
P^4 antero-posterior	—	—	—	—	8.5	7.6	—	8.6	10.0	10.5	9.0	9.1	10.2	10.0	10.0	—	—	10.0	10.0
transverse	—	—	—	—	11.7	9.8	—	12.0	13.2	13.2	13.6	12.3	14.2	13.7	13.5	11.0	13.6	14.0	12.0
vertical	—	—	—	—	8.1	—	—	9.6	9.9	—	9.8	—	11.7	—	—	—	—	—	—
height index	—	—	—	—	104.9	—	—	89.6	101.0	—	91.8	—	87.2	—	—	—	—	—	—
M^1 antero-posterior	11.2	12.5	10.1	12.4	10.6	11.0	12.6	12.4	12.4	14.0	13.7	13.5	14.3	12.5	—	12.8	12.3	12.3	13.2
transverse	12.8	13.9	12.3	13.2	11.5	11.6	14.4	12.8	12.8	14.8	13.8	14.3	14.7	13.5	—	12.3	14.3	13.7	13.5
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M^2 antero-posterior	—	—	—	11.7	10.3	11.3	13.7	12.3	12.7	12.8	12.5	13.7	14.4	13.3	—	13.0	13.2	13.2	13.3
transverse	—	—	—	13.9	12.3	12.4	14.8	12.9	14.3	15.1	13.9	14.7	16.4	14.4	—	13.8	16.2	15.0	13.5
vertical	—	—	—	—	—	—	9.1	—	8.0	9.0	8.8	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	151	—	159	142	142	—	—	—	—	—	—	—	—
M^3 antero-posterior	—	—	—	—	—	12.1	—	—	11.7	—	—	s. 11.4 d. 13.0	14.0	13.7	—	12.4	12.6	12.5	12.0
transverse	—	—	—	—	—	12.5	—	—	12.9	—	—	s. 13.0 d. 13.8	15.6	14.0	—	13.1	15.0	14.2	12.9
vertical	—	—	—	—	—	—	—	—	—	—	—	s. 8.0 d. 8.4	—	9.0	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	s. 143 d. 155	—	152	—	—	—	—	—

No. of skull	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
I^1 transverse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
antero-posterior	—	—	—	—	14.3	—	13.1	—	—	—	—	—	—	—	14.7	—	—	—	—
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
I^2 transverse	—	—	—	—	7.5	—	9.5	—	—	9.1	—	—	—	—	8.8	9.5	—	—	8.0
antero-posterior	—	8.7	—	8.3	8.8	—	11.0	—	8.0	—	—	—	—	—	9.4	9.5	—	—	7.7
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13.8	12.9	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	63.8	73.6	—	—	—
C antero-posterior	—	16.1	—	—	—	18.0	21.8	21.5	15.7	19.4	—	—	—	—	18.2	—	17.5	—	13.2
transverse	—	13.2	—	—	—	15.1	16.9	15.6	13.8	15.0	—	14.3	—	13.5	14.2	—	14.0	—	9.4
vertical	—	—	—	—	—	—	—	—	—	30.0	—	—	—	—	27.1	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	64.7	—	—	—	—	67.2	—	—	—	—
P^3 antero-posterior	—	10.5	—	10.5	10.1	10.0	11.2	12.2	10.0	11.6	—	—	—	—	10.5	12.0	9.8	—	8.8
transverse	—	13.8	14.5	12.5	13.5	13.3	16.0	15.1	12.0	13.9	12.0	—	14.5	14.6	14.7	13.4	12.6	—	11.0
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13.0	12.1	10.8	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80.8	99.2	90.7	—	—
P^4 antero-posterior	—	9.6	—	9.4	9.1	—	10.7	11.0	9.8	10.0	—	9.0	11.5	—	10.4	10.4	9.4	—	8.7
transverse	—	13.6	13.7	12.7	14.0	13.1	13.8	15.0	12.2	14.5	11.2	12.5	14.4	14.1	12.3	14.5	12.5	11.1	10.8
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0	11.3	8.4	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	104.0	92.0	111.9	—	—
M^1 antero-posterior	—	12.2	12.8	—	12.2	—	13.0	13.7	—	13.3	11.5	11.3	—	—	13.7	14.3	12.0	—	10.4
transverse	—	13.4	13.8	12.7	13.5	12.7	13.5	15.0	12.3	14.2	12.3	12.0	14.2	—	13.2	14.8	12.7	12.2	11.5
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M^2 antero-posterior	—	13.3	—	13.5	12.3	—	13.4	14.3	12.3	12.7	12.2	11.4	—	—	12.8	14.8	11.7	—	10.3
transverse	—	14.8	—	14.4	14.8	13.7	14.3	16.1	13.4	15.5	13.5	12.4	15.5	15.4	14.6	16.4	14.2	12.5	12.1
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M^3 antero-posterior	—	13.5	—	14.0	11.7	—	12.7	13.4	11.2	11.5	10.4	12.3	—	—	14.5	13.7	11.5	—	9.4
transverse	—	14.6	—	14.3	14.1	—	13.2	14.0	12.8	14.6	13.1	12.5	15.0	—	14.4	15.9	13.7	12.4	10.7
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8.1	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	169	—	—	—

No. of skull	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
I^1 transverse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
antero-posterior	—	11.4	—	—	—	—	—	13.8	11.4	12.9	—	—	11.7	11.6	—	12.3	—	—	12.2
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
I^2 transverse	8.3	8.0	8.6	—	—	—	—	—	7.4	8.4	—	—	9.1	—	8.1	8.5	—	—	7.8
antero-posterior	7.5	7.7	8.4	8.7	—	—	—	10.0	7.8	8.5	—	—	8.4	9.2	8.3	8.9	—	—	7.6
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.2
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	76.5
C antero-posterior	12.1	12.4	14.0	14.0	11.7	12.5	12.7	14.6	12.9	12.7	12.0	12.2	13.2	15.0	12.5	12.6	12.0	13.6	13.4
transverse	9.5	11.0	10.1	10.8	9.8	10.3	10.7	12.6	9.8	10.2	9.3	10.5	11.1	12.1	10.7	10.3	9.5	10.5	11.5
vertical	—	—	—	—	—	—	—	—	15.0	15.1	—	—	—	—	—	—	—	—	15.1
height index	—	—	—	—	—	—	—	—	86.0	84.1	—	—	—	—	—	—	—	—	88.7
P^3 antero-posterior	9.5	9.5	9.8	11.0	—	9.5	9.1	10.5	9.0	9.0	10.0	—	10.0	—	9.2	9.5	—	10.4	9.6
transverse	11.3	11.8	12.7	14.5	12.1	11.8	12.5	14.3	11.0	11.5	12.5	—	12.8	13.5	12.6	11.2	—	13.3	13.7
vertical	—	—	12.7	—	—	—	—	—	9.4	9.7	—	—	—	—	—	—	—	—	—
height index	—	—	77.2	—	—	—	—	—	95.7	92.8	—	—	—	—	—	—	—	—	—
P^4 antero-posterior	9.0	8.0	9.4	10.0	—	8.5	—	9.8	8.5	9.2	—	9.1	—	9.2	8.5	8.2	—	9.2	9.0
transverse	12.0	11.3	11.8	14.0	11.5	12.6	12.8	13.7	10.5	12.1	12.1	12.8	12.5	13.5	12.5	11.2	—	12.7	14.0
vertical	—	—	9.8	—	—	—	—	10.8	8.3	8.6	—	—	—	—	—	—	—	—	—
height index	—	—	95.9	—	—	—	—	90.7	102.4	107.0	—	—	—	—	—	—	—	—	—
M^1 antero-posterior	11.9	10.5	10.8	12.2	10.5	11.2	11.4	12.8	10.7	12.1	11.2	12.2	10.3	11.6	11.5	11.4	11.7	11.9	12.3
transverse	12.4	11.4	12.0	13.5	11.8	12.3	12.8	13.5	11.0	12.7	12.4	12.4	12.6	13.3	12.8	12.5	11.9	13.2	14.3
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M^2 antero-posterior	11.1	8.8	10.5	11.5	—	10.7	11.5	13.1	10.8	11.2	9.6	12.1	10.8	12.0	11.7	11.1	11.4	12.0	12.8
transverse	13.0	11.3	11.8	14.4	12.3	14.2	14.3	14.7	11.8	13.3	12.2	13.4	13.0	14.2	12.7	13.2	12.3	13.3	15.1
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M^3 antero-posterior	10.6	9.2	10.7	12.4	8.6	10.3	10.4	11.3	10.1	10.5	9.3	10.6	9.4	11.4	10.9	9.5	10.0	11.1	s. 13.0 d. 12.3
transverse	12.0	11.7	11.2	14.2	10.4	12.3	13.1	13.4	11.0	12.0	11.4	12.5	11.8	14.5	12.8	12.2	11.5	12.8	s. 14.6 d. 14.1
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE II B

Measurements of lower teeth of *Pongo pygmaeus pygmaeus* (Hoppius)

No. of skull	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
I_1 transverse	9.0	8.7	8.2	9.2	—	—	9.1	9.0	—	10.5	—	—	9.6	—	—	—	—	—	—
antero-posterior	9.5	9.7	8.6	9.2	8.0	8.2	9.5	9.1	—	11.4	9.9	9.6	11.0	10.9	9.8	8.9	9.7	10.9	9.2
vertical	15.5	15.8	14.0	13.8	—	—	15.8	13.9	—	—	—	—	—	—	—	—	—	—	—
height index	58.1	55.1	58.6	66.7	—	—	57.6	64.7	—	—	—	—	—	—	—	—	—	—	—
I_2 transverse	—	—	—	9.6	8.2	7.8	9.5	9.6	—	10.2	—	8.7	9.5	—	—	—	—	—	—
antero-posterior	—	—	—	9.8	8.1	8.6	10.3	9.5	11.0	11.7	10.3	10.3	11.4	10.6	10.7	10.0	9.9	11.0	10.0
vertical	—	—	—	14.3	—	—	16.1	14.1	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	67.1	—	—	59.0	68.1	—	—	—	—	—	—	—	—	—	—	—
C antero-posterior	—	—	—	—	10.4	11.2	—	12.4	13.6	16.7	14.8	—	16.2	14.5	16.0	13.7	—	16.0	15.0
transverse	—	—	—	—	7.1	8.9	—	8.5	9.5	12.8	13.1	—	14.0	11.5	13.1	11.0	12.8	13.0	13.3
vertical	—	—	—	—	15.8	14.1	—	16.5	18.6	24.8	27.4	—	28.1	—	—	—	—	—	—
height index	—	—	—	—	65.8	79.4	—	75.2	73.1	67.3	54.0	—	57.7	—	—	—	—	—	—
P_3 antero-posterior	—	—	—	—	13.0	11.4	—	13.0	14.9	18.0	15.7	16.5	17.2	16.2	16.8	—	14.6	17.8	16.5
transverse	—	—	—	—	8.0	8.1	—	8.8	10.0	10.8	9.0	9.6	11.0	10.9	10.5	8.3	10.0	11.1	9.7
vertical	—	—	—	—	13.0	9.6	—	12.5	15.0	18.0	14.1	15.0	17.5	—	—	—	—	—	—
height index	—	—	—	—	100.0	118.8	—	104.0	99.3	100.0	111.3	110.0	98.3	—	—	—	—	—	—
P_4 antero-posterior	—	—	—	—	11.5	9.7	—	12.3	13.2	14.2	12.8	13.8	13.5	14.0	14.9	11.7	13.5	15.1	—
transverse	—	—	—	—	9.8	8.2	—	10.4	10.5	11.5	10.8	10.8	11.5	10.3	—	9.1	10.7	11.4	10.6
vertical	—	—	—	—	9.3	—	—	9.8	10.5	10.7	9.9	13.0	—	—	—	—	—	—	—
height index	—	—	—	—	123.7	—	—	125.5	125.7	132.7	129.3	106.2	—	—	—	—	—	—	—
M_1 antero-posterior	12.5	14.0	12.0	13.4	11.3	12.6	13.7	13.2	13.4	15.5	14.6	—	14.8	13.0	—	12.8	—	12.8	13.0
transverse	10.9	12.4	10.7	11.3	10.1	10.1	12.6	11.7	11.4	13.4	12.5	11.4	13.3	12.2	—	11.5	12.0	12.5	11.8
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M_2 antero-posterior	—	—	—	14.1	11.9	12.8	16.0	13.6	14.2	16.3	15.2	14.4	15.5	14.5	15.4	12.9	—	14.4	13.8
transverse	—	—	—	12.0	10.8	10.9	13.5	12.8	12.5	14.2	13.4	13.6	15.1	13.2	14.3	12.4	14.2	14.3	13.2
vertical	—	—	—	9.8	6.4	—	10.4	—	—	—	8.8	—	—	—	—	—	—	—	—
height index	—	—	—	144	186	—	154	—	—	—	173	—	—	—	—	—	—	—	—
M_3 antero-posterior	—	—	—	—	—	14.8	—	—	—	—	—	13.3	16.4	14.2	—	—	14.4	15.1	13.8
transverse	—	—	—	—	—	12.4	—	—	—	—	—	12.0	15.0	12.4	—	11.9	14.5	13.9	13.0
vertical	—	—	—	—	—	7.8	—	—	—	—	—	9.8	—	—	—	—	—	—	—
height index	—	—	—	—	—	190	—	—	—	—	—	136	—	—	—	—	—	—	—

No. of skull	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	61
I_1 transverse	—	—	—	—	8.9	—	—	—	—	—	—	—	—	—	—	10.6	—	—
antero-posterior	—	9.6	9.9	8.7	9.2	9.3	11.2	11.7	9.9	11.0	8.6	—	—	8.4	10.3	10.0	8.5	8.4
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
I_2 transverse	—	—	—	—	8.5	—	—	9.7	—	9.3	—	—	—	—	9.2	9.3	—	—
antero-posterior	—	10.0	—	—	10.7	9.6	11.8	11.4	10.2	11.2	9.0	—	—	9.1	11.4	10.4	9.7	8.6
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C antero-posterior	—	—	16.7	—	15.4	—	18.6	16.5	—	15.3	—	—	—	—	15.0	15.1	15.5	12.1
transverse	—	11.8	13.6	—	11.8	—	15.1	15.0	12.4	13.3	—	12.0	—	11.8	13.0	13.3	13.5	8.0
vertical	—	—	—	—	22.9	—	—	—	—	23.5	—	—	—	—	25.5	—	—	—
height index	—	—	—	—	67.2	—	—	—	—	65.1	—	—	—	—	58.8	—	—	—
P_3 antero-posterior	—	15.2	15.5	13.9	15.5	16.8	19.1	19.0	14.1	18.3	13.0	—	—	15.6	15.5	16.3	14.6	12.3
transverse	10.3	10.0	—	9.8	9.6	11.0	12.6	11.0	9.8	12.6	8.7	9.7	—	9.9	10.1	10.8	9.0	8.6
vertical	—	14.3	—	—	—	—	—	—	—	18.0	—	—	—	—	14.8	17.0	—	—
height index	—	106.3	—	—	—	—	—	—	—	101.7	—	—	—	—	104.7	95.9	—	—
P_4 antero-posterior	—	14.0	13.8	13.4	13.0	13.7	15.7	15.8	13.0	15.3	11.5	13.0	—	—	12.7	13.7	11.8	10.9
transverse	—	10.8	10.8	10.5	10.6	10.8	11.8	12.5	10.0	11.6	9.8	10.2	—	—	11.3	12.0	9.7	9.2
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.2	11.1	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	124.5	123.4	—	—
M_1 antero-posterior	—	—	14.0	12.3	12.8	12.5	13.9	14.4	—	13.5	13.0	—	—	—	13.4	15.1	12.0	11.6
transverse	—	11.4	13.2	11.6	11.4	10.8	12.8	13.0	11.3	13.3	11.2	—	—	12.3	11.7	13.4	10.5	10.5
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M_2 antero-posterior	14.6	14.0	—	13.6	14.3	13.0	15.4	15.7	—	14.3	14.4	12.6	—	—	13.7	17.5	12.9	11.8
transverse	—	13.1	—	13.5	12.4	12.6	14.3	15.0	12.3	14.2	12.9	—	—	—	13.4	14.7	12.3	11.4
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M_3 antero-posterior	—	14.2	—	16.1	14.7	—	s. 14.7 d. 16.4	15.7	—	14.0	14.9	12.8	—	14.2	15.9	16.8	13.4	10.9
transverse	15.0	12.5	—	14.4	12.1	12.4	s. 12.9 d. 13.0	13.4	11.3	13.7	12.4	11.9	—	—	13.6	14.1	12.0	9.7
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

No. of skull	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	No. of skull
I_1 transverse	—	—	—	—	—	—	—	—	8.0	8.4	—	—	—	—	—	—	—	—	—	I_1 transverse
antero-posterior	8.5	8.8	8.7	9.5	8.4	9.6	9.6	10.8	8.5	9.5	9.7	—	9.1	9.8	8.8	9.3	8.1	10.0	8.9	antero-posterior
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	vertical
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	height index
I_2 transverse	—	—	—	—	—	—	—	—	7.7	8.4	—	—	—	—	—	8.3	—	—	8.5	I_2 transverse
antero-posterior	8.2	8.3	10.0	10.0	9.3	9.2	9.8	11.5	8.7	10.2	9.3	9.0	9.5	10.9	9.7	9.8	8.3	9.9	9.1	antero-posterior
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	vertical
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	height index
C antero-posterior	10.6	12.5	13.2	12.9	—	12.3	12.8	14.9	11.6	11.7	12.3	11.6	12.5	14.1	12.1	12.8	10.2	12.6	12.2	C antero-posterior
transverse	7.7	8.3	9.0	10.6	—	9.1	9.2	11.7	8.7	8.8	9.0	9.8	9.6	11.0	9.4	7.7	—	9.5	9.6	transverse
vertical	—	—	—	—	—	—	—	—	16.2	14.9	—	—	—	—	—	—	—	—	—	vertical
height index	—	—	—	—	—	—	—	—	71.6	78.5	—	—	—	—	—	—	—	—	—	height index
P_3 antero-posterior	12.0	14.0	14.8	15.4	13.5	13.2	13.2	18.1	12.6	13.7	13.5	13.9	14.5	15.0	14.6	—	11.8	15.4	13.4	P_3 antero-posterior
transverse	8.0	9.0	8.1	10.9	9.0	9.5	9.5	11.3	9.0	9.1	10.0	10.0	10.2	10.7	9.5	—	—	10.0	9.5	transverse
vertical	—	—	—	—	—	—	—	—	—	12.5	—	—	—	15.3	—	—	—	—	11.3	vertical
height index	—	—	—	—	—	—	—	—	—	109.6	—	—	—	98.0	—	—	—	—	118.6	height index
P_4 antero-posterior	11.4	12.3	12.0	14.0	12.0	12.4	12.0	14.1	11.3	12.5	11.7	13.0	12.5	13.8	12.1	10.7	—	13.1	11.4	P_4 antero-posterior
transverse	10.2	9.2	9.3	11.4	9.5	10.3	9.7	10.9	9.0	10.5	10.8	10.6	10.4	11.4	9.6	9.5	—	10.3	10.1	transverse
vertical	—	—	—	—	—	—	—	11.0	—	8.6	—	—	—	—	9.3	—	—	—	9.0	vertical
height index	—	—	—	—	—	—	—	128.2	—	145.3	—	—	—	—	130.1	—	—	—	126.7	height index
M_1 antero-posterior	12.5	11.2	12.0	13.4	—	11.8	—	13.3	11.4	13.0	12.2	—	11.5	12.8	12.3	11.8	—	—	12.7	M_1 antero-posterior
transverse	11.0	10.4	10.0	12.4	10.3	11.1	11.4	12.4	9.9	11.4	11.5	—	10.9	12.0	11.4	10.9	—	11.5	12.5	transverse
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	vertical
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	height index
M_2 antero-posterior	12.5	10.5	12.6	13.8	—	11.7	12.8	14.5	11.6	12.7	11.3	13.5	12.0	13.4	12.2	12.3	12.5	12.8	13.9	M_2 antero-posterior
transverse	11.3	10.7	11.0	13.3	10.7	12.0	12.7	13.3	11.0	11.9	11.6	12.4	11.7	13.5	11.8	12.3	11.4	12.1	13.0	transverse
vertical	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	vertical
height index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	height index
M_3 antero-posterior	12.3	s. 10.1 d. 9.5	12.5	14.3	—	12.0	12.7	13.9	11.8	13.1	11.2	—	11.4	13.3	12.4	12.2	—	13.4	s. 14.0 d. 13.3	M_3 antero-posterior
transverse	10.4	s. 10.8 d. 11.0	10.2	13.0	10.4	11.5	12.5	12.4	10.4	11.7	11.0	—	10.5	12.6	11.4	11.4	11.6	12.2	s. 13.1 d. 12.2	transverse
vertical	—	—	—	—	—	—	—	—	6.4	—	—	—	—	—	—	—	—	—	s. 8.8 d. 9.1	vertical
height index	—	—	—	—	—	—	—	—	184	—	—	—	—	—	—	—	—	—	s. 159 d. 146	height index

TABLE I C

Measurements of upper teeth of *Pongo pygmaeus pygmaeus* (Hoppius)

No. of skull	2	3	4	5	6	7	8	9	10	11	12	13	13a	14	15	16	17	18	19	20	21	22	23	24
id^1 transverse	8.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
antero-posterior	6.2	6.0	7.4	7.3	—	6.0	8.0	7.0	7.3	6.7	6.5	6.7	6.2	6.6	6.4	6.7	6.3	6.5	6.8	5.9	6.8	7.3	7.3	—
id^2 transverse	5.6	5.8	5.9	6.2	—	—	—	6.7	8.3	7.0	6.0	—	6.7	—	6.5	5.8	—	—	—	—	—	—	—	—
antero-posterior	4.9	4.7	4.9	5.4	—	4.5	6.2	5.5	6.4	5.6	5.4	5.6	5.1	5.0	4.8	4.7	4.8	—	—	4.6	5.4	5.0	4.8	—
cd antero-posterior	8.4	8.2	9.5	9.1	—	7.9	—	10.0	10.2	9.8	9.9	9.7	8.8	8.1	—	9.0	—	—	8.5	9.6	9.3	9.8	9.5	8.1
transverse	6.2	6.6	6.7	8.0	7.0	6.0	8.4	7.1	7.8	7.7	7.3	7.3	6.5	7.0	—	7.1	6.7	7.9	6.5	6.9	6.8	7.8	7.1	6.7
pd^3 antero-posterior	6.9	7.8	8.2	—	7.8	7.8	9.1	—	9.0	9.0	8.0	8.0	8.0	8.2	8.5	8.3	—	—	8.3	7.7	8.4	8.7	8.7	6.8
transverse	8.0	9.4	9.4	9.5	8.7	8.8	10.5	9.5	10.7	10.3	9.0	9.4	8.7	9.0	8.7	9.0	8.8	9.1	8.6	8.2	9.3	9.7	8.1	8.4
pd^4 antero-posterior	8.5	10.1	9.5	11.5	10.3	9.6	11.0	9.8	10.8	11.5	9.8	10.3	9.8	11.3	9.6	10.3	9.0	—	9.8	9.2	10.6	11.0	9.7	8.7
transverse	9.2	10.4	11.0	11.2	10.0	9.8	11.7	10.7	11.7	11.7	10.7	11.0	10.0	11.4	9.7	10.8	10.0	—	10.4	9.8	10.5	11.3	9.9	9.8

TABLE II C

Measurements of lower teeth of *Pongo pygmaeus pygmaeus* (Hoppius)

No. of skull	2	3	4	5	6	7	8	9	10	11	12	13	13a	14	15	16	17	18	19	20	21	22	23	24
id$_1$ transverse	5.5	—	—	6.0	—	—	—	—	—	6.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
antero-posterior	4.7	5.0	5.1	5.4	5.2	4.7	6.4	5.4	5.5	5.5	4.8	5.4	4.7	5.0	4.5	5.0	5.3	4.9	5.3	4.7	5.3	5.5	—	4.8
id$_2$ transverse	5.4	—	6.0	5.6	5.4	5.7	7.0	6.4	—	6.3	—	—	5.8	6.5	6.0	—	—	—	—	—	—	—	—	—
antero-posterior	5.0	5.4	5.4	5.6	5.6	5.0	6.8	6.0	6.6	5.9	5.6	5.6	5.2	5.5	5.4	5.5	5.4	5.4	6.2	5.0	5.5	5.8	5.6	5.4
cd antero-posterior	6.6	7.4	7.5	8.1	—	6.7	9.2	9.6	8.6	8.7	8.2	8.4	7.5	7.3	—	7.8	7.5	8.0	7.6	7.5	7.7	9.4	8.0	7.4
transverse	5.9	6.0	6.0	6.8	—	5.7	7.7	6.5	7.0	7.1	6.8	6.7	6.5	6.2	—	6.5	6.4	7.2	5.6	6.2	6.4	7.2	6.5	6.0
pd$_3$ antero-posterior	7.9	—	—	10.4	—	9.4	—	—	10.0	10.5	—	—	—	—	—	—	—	—	9.4	9.1	—	—	9.7	—
transverse	—	7.1	7.0	7.5	6.4	6.8	—	7.2	8.4	7.5	7.1	7.2	6.4	7.4	6.6	7.1	7.2	7.4	6.9	6.4	6.7	8.2	6.6	5.8
pd$_4$ antero-posterior	9.8	11.1	11.8	12.3	10.7	10.6	11.8	11.0	12.4	12.9	11.3	—	10.7	12.0	10.8	12.0	10.4	11.4	10.5	10.0	11.5	12.2	11.1	9.7
transverse	7.7	8.9	9.0	10.0	8.3	8.0	9.9	8.7	10.1	10.5	9.0	9.6	7.9	9.4	8.7	9.6	—	9.0	8.6	7.9	9.3	9.8	8.8	7.7

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EXPLANATION OF THE PLATES

Plate I

Figs. 1-5, *Homo sapiens* L. subsp.; figs. 1-3, I^1 dext., Coll. Dub. no. 11471, Lida Ajer cave; fig. 1, lingual view; fig. 2, labial view; fig. 3, crown view; figs. 4-5, M^2 (?) sin., Coll. Dub. no. 11472, Lida Ajer cave; fig. 4, crown view; fig. 5, lingual view.

Figs. 6-15, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 6, I^1 dext., Coll. Dub. no. 11474/1, Sibrambang cave, lingual view; fig. 7, I^1 dext., Coll. Dub. no. 11474/2, Sibrambang cave, lingual view; figs. 8-9, I^1 dext., Coll. Dub. no. 11476/3, Lida Ajer cave; fig. 8, lingual view; fig. 9, crown view; fig. 10, I^1 dext., Coll. Dub. no. 11474/4, Sibrambang cave, lingual view; fig. 11, I^1 dext., Coll. Dub. no. 11474/1, Sibrambang cave, crown view; figs. 12-13, I^1 dext., Coll. Dub. no. 11480/5; fig. 12, crown view; fig. 13, lingual view; figs. 14-15, I^1 sin., Coll. Dub. no. 11477/25, Lida Ajer cave; fig. 14, lingual view; fig. 15, crown view; fig. 16, I^2 sin., Coll. Dub. no. 11483/41, Sibrambang cave, lingual view.

Fig. 17, *Pongo pygmaeus pygmaeus* (Hoppius), I^2 dext., Sumatra (from skull no. 31), lingual view.

Figs. 18-21, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 18, I^2 sin., Coll. Dub. no. 11483/40, Sibrambang cave, lingual view; fig. 19, I^2 dext., Coll. Dub. no. 11487/1, lingual view; fig. 20, I^2 dext., Coll. Dub. no. 11484/2, Lida Ajer cave, lingual view; fig. 21, I^2 dext., Coll. Dub. no. 11484/9, Lida Ajer cave, lingual view.

All figures twice natural size.

Plate II

Figs. 1-4, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 1, I_1, Coll. Dub. no. 11489/2, Sibrambang cave, lingual view; fig. 2, I_1, Coll. Dub. no. 11490/3, Lida Ajer cave, lingual view; figs. 3-4, I_1, Coll. Dub. no. 11489/7, Sibrambang cave; fig. 3, lingual view; fig. 4, left view.

Fig. 5, *Pongo pygmaeus pygmaeus* (Hoppius), I_1 sin., Borneo (from skull no. 30), lingual view.

Figs. 6-11, *Pongo pygmaeus palaeosumatrensis* nov. subsp., figs. 6-7, I_1, Coll. Dub. no. 11492/8; fig. 6, lingual view; fig. 7, left view; fig. 8, I_2 dext., Coll. Dub. no. 11496/81, Lida Ajer cave, lingual view; fig. 9, I_2 dext., Coll. Dub. no. 11496/82, Lida Ajer cave, lingual view; fig. 10, I_2 sin., Coll. Dub. no. 11499/5, lingual view; fig. 11, I_2 sin., Coll. Dub. no. 11499/6, lingual view.

Figs. 12-18, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 12, female lower C dext., Coll. Dub. no. 11525/17, Lida Ajer cave, lateral view; fig. 13, female lower C sin., Coll. Dub. no. 11526/20, Lida Ajer cave, lingual view; fig. 14, female lower C dext., Coll. Dub. no. 11525/17, Lida Ajer cave, lingual view; figs. 15-18, female lower C dext., Coll. Dub. no. 11523/1, Sibrambang cave; fig. 15, anterior view; fig. 16, lingual view; fig. 17, lateral view; fig. 18, medial view.

All figures twice natural size.

Plate III

Figs. 1-4, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 1, male upper C dext., Coll. Dub. no. 11503/1, Lida Ajer cave, lingual view; fig. 2, male upper C dext., Coll. Dub. no. 11503/2, Lida Ajer cave, lingual view; fig. 3, male upper C sin., Coll. Dub. no. 11504/20, Lida Ajer cave, lingual view; fig. 4, male upper C sin., Coll. Dub. no. 11504/28, Lida Ajer cave, lingual view.

Figs. 5-9, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 5, female upper C dext., Coll. Dub. no. 11510/1, Lida Ajer cave, lingual view; fig. 6, female upper C sin., Coll. Dub. no. 11509/23, Sibrambang cave, lingual view; fig. 7, female upper C dext., Coll. Dub. no. 11508/3, Sibrambang cave, lingual view; fig. 8, female upper C sin., Coll. Dub. no. 11509/25, Sibrambang cave, lingual view; fig. 9, female upper C sin., Coll. Dub. no. 11511/34, Lida Ajer cave, lingual view.

Fig. 10, *Pongo pygmaeus pygmaeus* (Hoppius), male lower C sin., Borneo (from skull no. 33), lingual view.

Figs. 11-13, *Pongo pygmaeus palaeosumatrensis* nov. subsp., male lower C dext., Coll. Dub. no. 11515/1, Sibrambang cave; fig. 11, anterior view; fig. 12, lingual view; fig. 13, medial view.

All figures 1½ natural size.

Plate IV

Figs. 1-4, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 1, male lower C dext., Coll. Dub. no. 11515/1, Sibrambang cave, lateral view; fig. 2, male lower C dext., Coll. Dub. no. 11517/7, Lida Ajer cave, lingual view; fig. 3, male lower C sin., Coll. Dub. no. 11518/46, Lida Ajer cave, lingual view; fig. 4, male lower C dext., Coll. Dub. no. 11517/5, Lida Ajer cave, lingual view.

Figs. 5-14, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; figs. 5, 7, 9, 11 and 13, P^3 sin., Coll. Dub. no. 11534/123, Lida Ajer cave; figs. 6, 8, 10, 12 and 14, P^3 sin., Coll. Dub. no. 11534/122, Lida Ajer cave; figs. 5 and 6, buccal views; figs. 7 and 8, posterior views; figs. 9 and 10, lingual views; figs. 11 and 12, anterior views; figs. 13 and 14, crown views.

Figs. 15-16, *Pongo pygmaeus palaeosumatrensis* nov. subsp., P_3 dext., Coll. Dub. no. 11550/1, Lida Ajer cave; fig. 15, crown view; fig. 16, lingual view.

All figures 1½ natural size.

Plate V

Figs. 1-7, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 1, P_3 dext., Coll. Dub. no. 11550/2, Lida Ajer cave, lingual view; figs. 2-3, P_3 sin., Coll. Dub. no. 11551/127, Lida Ajer cave; fig. 2, lingual view; fig. 3, crown view; figs. 4-5, P_3 sin., Coll. Dub. no. 11551/128, Lida Ajer cave; fig. 4, lingual view; fig. 5, crown view; figs. 6-7, P_3 dext., Coll. Dub. no. 11548/25, Sibrambang cave; fig. 6, lingual view; fig. 7, crown view.

Figs. 8-12, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 8, P_4 sin., Coll. Dub. no. 11557/227, Sibrambang cave, buccal view; fig. 9, P_4 sin., Coll. Dub. no. 11557/147, Sibrambang cave, crown view; fig. 10, P_4 sin., Coll. Dub. no. 11559/148, Lida Ajer cave, crown view; fig. 11, P_4 sin., Coll. Dub. no. 11557/139, Sibrambang cave, crown view; fig. 12, P_4 sin., Coll. Dub. no. 11559/149, Lida Ajer cave, crown view.

Figs. 13-20, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 13, P^3 sin., Coll. Dub. no. 11532/98, Sibrambang cave, crown view; fig. 14, P^3 sin., Coll. Dub. no. 11532/99, Sibrambang cave, crown view; fig. 15, P^3 sin., Coll. Dub. no. 11534/117, Lida Ajer cave, crown view; fig. 16, P^3 dext., Coll. Dub. no. 11531/1, Sibrambang cave, crown view; fig. 17, P^3 dext., Coll. Dub. no. 11531/2, Sibrambang cave, crown view; figs. 18-19, P^3 dext., Coll. Dub. no. 11535/16, Djamboe cave; fig. 18, crown view; fig. 19, anterior view; fig. 20, P^3 sin., Coll. Dub. no. 11534/121, Lida Ajer cave, crown view.

All figures twice natural size.

Plate VI

Fig. 1, *Pongo pygmaeus palaeosumatrensis* nov. subsp., P^4 dext., Coll. Dub. no. 11540/1, Sibrambang cave, crown view.

Fig. 2, *Pongo pygmaeus pygmaeus* (Hoppius), P^4 dext., Sumatra (from skull no. 31), crown view.

Figs. 3-6, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 3, P^4 dext., Coll. Dub. no. 11544/13, Djamboe cave, crown view; fig. 4, P^4 dext., Coll. Dub. no. 11540/4, Sibrambang cave, crown view; fig. 5, P^4 dext., Coll. Dub. no. 11540/5, Sibrambang cave, crown view; fig. 6, P^4 sin., Coll. Dub. no. 11541/144, Sibrambang cave, crown view.

Figs. 7-11, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 7, M^1 dext., Coll. Dub. no. 11564/12, Sibrambang cave, crown view; fig. 8, M^1 dext., Coll. Dub. no. 11564/10, Sibrambang cave, crown view; fig. 9, M^1 sin., Coll. Dub. no. 11569/170, Djamboe cave, crown view; fig. 10, M^1 dext., Coll. Dub. no. 11564/3, Sibrambang cave, crown view; fig. 11, M^1 sin., Coll. Dub. no. 11565/161, Sibrambang cave, crown view.

Fig. 12, *Pongo pygmaeus pygmaeus* (Hoppius), M^2 dext., Borneo (from skull no. 27), crown view.

Figs. 13-19, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 13, M^2 dext., Coll. Dub. no. 11578/22, Djamboe cave, crown view; fig. 14, M^2 dext., Coll. Dub. no. 11574/143, Sibrambang cave, crown view; fig. 15, M^2 sin., Coll. Dub. no. 11577/259, Lida Ajer cave, anterior view; fig. 16, M^2 dext., Coll. Dub. no. 11574/10, Sibrambang cave, crown view; fig. 17, M^2 dext., Coll. Dub. no. 11574/2, Sibrambang cave, crown view; fig. 18, M^2 dext., Coll. Dub. no. 11578/41, Djamboe cave, crown view; fig. 19, M^2 dext., Coll. Dub. no. 11576/64, Lida Ajer cave, buccal view.

All figures twice natural size.

Plate VII

Fig. 1, *Pongo pygmaeus palaeosumatrensis* nov. subsp., M^3 dext., Coll. Dub. no. 11582/78, Sibrambang cave, crown view.

Figs. 2-3, *Pongo pygmaeus pygmaeus* (Hoppius) (from skull no. 29); fig. 2, M^3 sin., crown view; fig. 3, M^3 dext., crown view.

Figs. 4-9, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 4, M^3 dext., Coll. Dub. no. 11582/7, Sibrambang cave, crown view; fig. 5, M^3 (M^4?) dext., Coll. Dub. no. 11582/4, Sibrambang cave, crown view; fig. 6, M^3 (M^4?) dext., Coll. Dub. no. 11582/64, Sibrambang cave, crown view; fig. 7, M^4 (?) dext., Coll. Dub. no. 11590/32, Lida Ajer cave, crown view; fig. 8, M^4 (?) sin., Coll. Dub. no. 11591/126, Lida Ajer cave, crown view; fig. 9, M^4 (?) dext., Coll. Dub. no. 11590/18, Lida Ajer cave, crown view.

Fig. 10, *Pongo pygmaeus* (Hoppius) subsp., M^4 (?) dext., Coll. Dub. no.

11620, Trinil, Java, crown view (ascribed to *Pithecanthropus erectus* by Dubois).

Figs. 11-13, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 11, M^3 dext., Coll. Dub. no. 11582/12, Sibrambang cave, crown view; fig. 12, M^3 dext., Coll. Dub. no. 11582/93, Sibrambang cave, crown view; fig. 13, M^3 dext., Coll. Dub. no. 11584/46, Lida Ajer cave, crown view.

Fig. 14, *Pongo pygmaeus pygmaeus* (Hoppius), M^1-M^4 sin. (from skull no. 40), crown view.

Fig. 15, *Pongo pygmaeus* (Hoppius) subsp., M^3 sin., Coll. Dub. no. 11621, Trinil, Java, crown view (attributed to *Pithecanthropus erectus* by Dubois).

Figs. 1-13, twice natural size; fig. 14, 1 3/5 natural size; fig. 15, 4½ natural size.

Plate VIII

Figs. 1-5, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 1, M_1 dext., Coll. Dub. no. 11594/11, Lida Ajer cave, crown view; fig. 2, M_1 dext., Coll. Dub. no. 11596/9, Djamboe cave, crown view; fig. 3, M_1 sin., Coll. Dub. no. 11597/181, Djamboe cave, crown view; fig. 4, M_1 sin., Coll. Dub. no. 11593/112, Sibrambang cave, crown view; fig. 5, M_1 dext., Coll. Dub. no. 11596/8, Djamboe cave, buccal view.

Figs. 6-10, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 6, M_2 dext., Coll. Dub. no. 11601/11, Lida Ajer cave, crown view; fig. 7, M_2 dext., Coll. Dub. no. 11601/12, Lida Ajer cave, crown view; fig. 8, M_2 dext., Coll. Dub. no. 11599/106, Sibrambang cave, crown view; fig. 9, M_2 sin., Coll. Dub. no. 11602/121, Lida Ajer cave, crown view; fig. 10, M_2 sin., Coll. Dub. no. 11602/120, Lida Ajer cave, crown view.

Fig. 11, *Pongo pygmaeus palaeosumatrensis* nov. subsp., M_3 sin.; Coll. Dub. no. 11473/152, Sibrambang cave, crown view (holotype).

Figs. 12-13, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 12, M_2 sin., Coll. Dub. no. 11600/202, Sibrambang cave, crown view; fig. 13, M_3 dext., Coll. Dub. no. 11609/33, Lida Ajer cave, crown view.

All figures twice natural size.

Plate IX

Fig. 1, *Pongo pygmaeus palaeosumatrensis* nov. subsp., M_3 dext., Coll. Dub. no. 11607/1, Sibrambang cave, crown view.

Figs. 2-3, *Pongo pygmaeus pygmaeus* (Hoppius) (from skull no. 29); fig. 2, M_3 dext., crown view; fig. 3, M_3 sin., crown view.

Figs. 4-8, *Pongo pygmaeus* nov. subsp.; fig. 4, M_3 dext., Coll. Dub. no.

11611/43, Djamboe cave, crown view; fig. 5, upper cd dext., Coll. Dub. no. 11624/2, Lida Ajer cave, lingual view; fig. 6, M$_3$ sin., Coll. Dub. no. 11608/115, Sibrambang cave, crown view; fig. 7, M$_3$ sin., Coll. Dub. no. 11608/114, Sibrambang cave, crown view; fig. 8, M$_4$ (?) sin., Coll. Dub. no. 11618/124, Lida Ajer cave, crown view.

Figs. 9-18, *Pongo pygmaeus palaeosumatrensis* nov. subsp.; fig. 9, upper cd sin., Coll. Dub. no. 11623/1, Lida Ajer cave, crown view; fig. 10, id^1 sin., Coll. Dub. no. 11622, Lida Ajer cave, crown view; fig. 11, pd$_3$ dext., Coll. Dub. no. 11633/2, crown view; fig. 12, pd^3 sin., Coll. Dub. no. 11625/1, Sibrambang cave, crown view; fig. 13, upper cd sin., Coll. Dub. no. 11623/1, Lida Ajer cave, lingual view; fig. 14, id^1 sin., Coll. Dub. no. 11622, Lida Ajer cave, lingual view; fig. 15; pd$_4$ dext., Coll. Dub. no. 11635/11, Sibrambang cave, crown view; fig. 16, pd$_4$ sin., Coll. Dub. no. 11634/1, Sibrambang cave, crown view; fig. 17, pd^4 sin., Coll. Dub. no. 11628/14, Sibrambang cave, crown view; fig. 18, pd^4 dext., Coll. Dub. no. 11627/2, Sibrambang cave, crown view.

All figures twice natural size.

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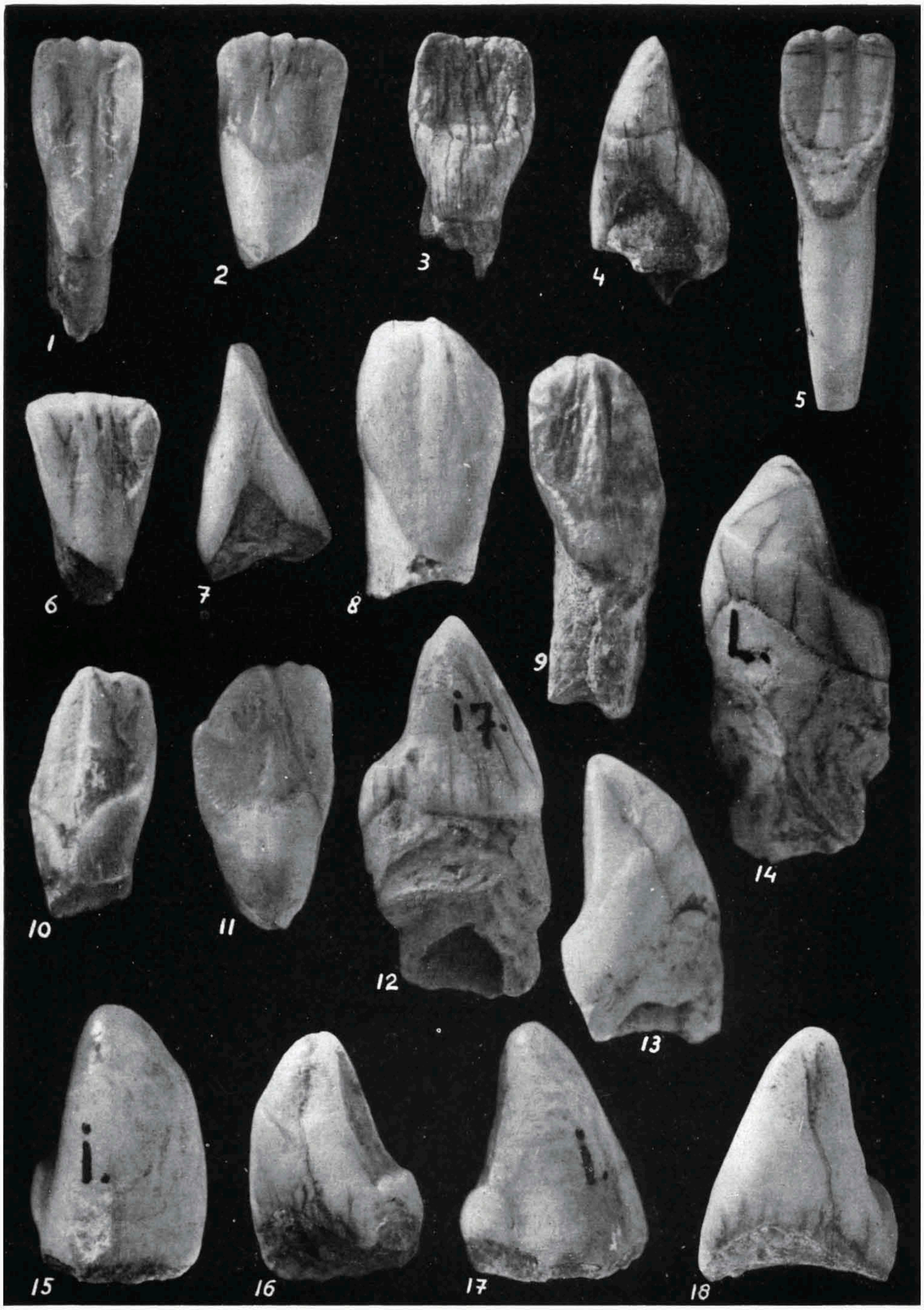

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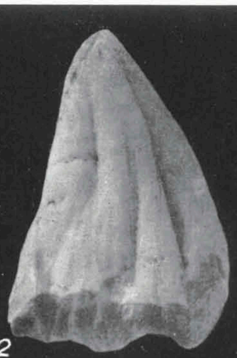
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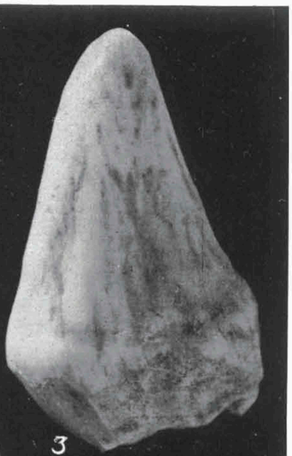
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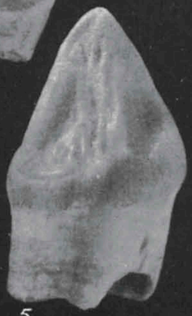
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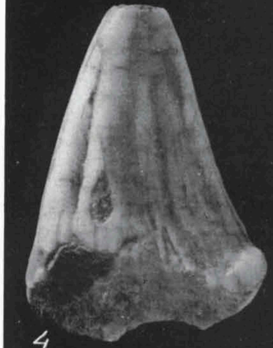
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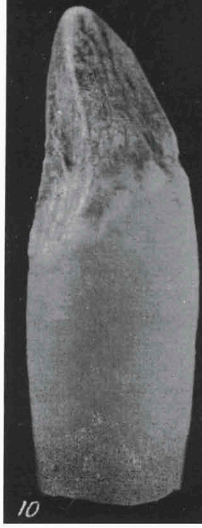
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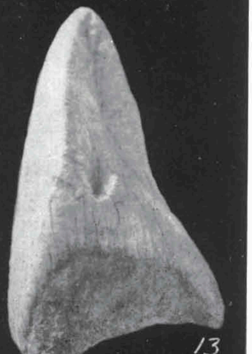
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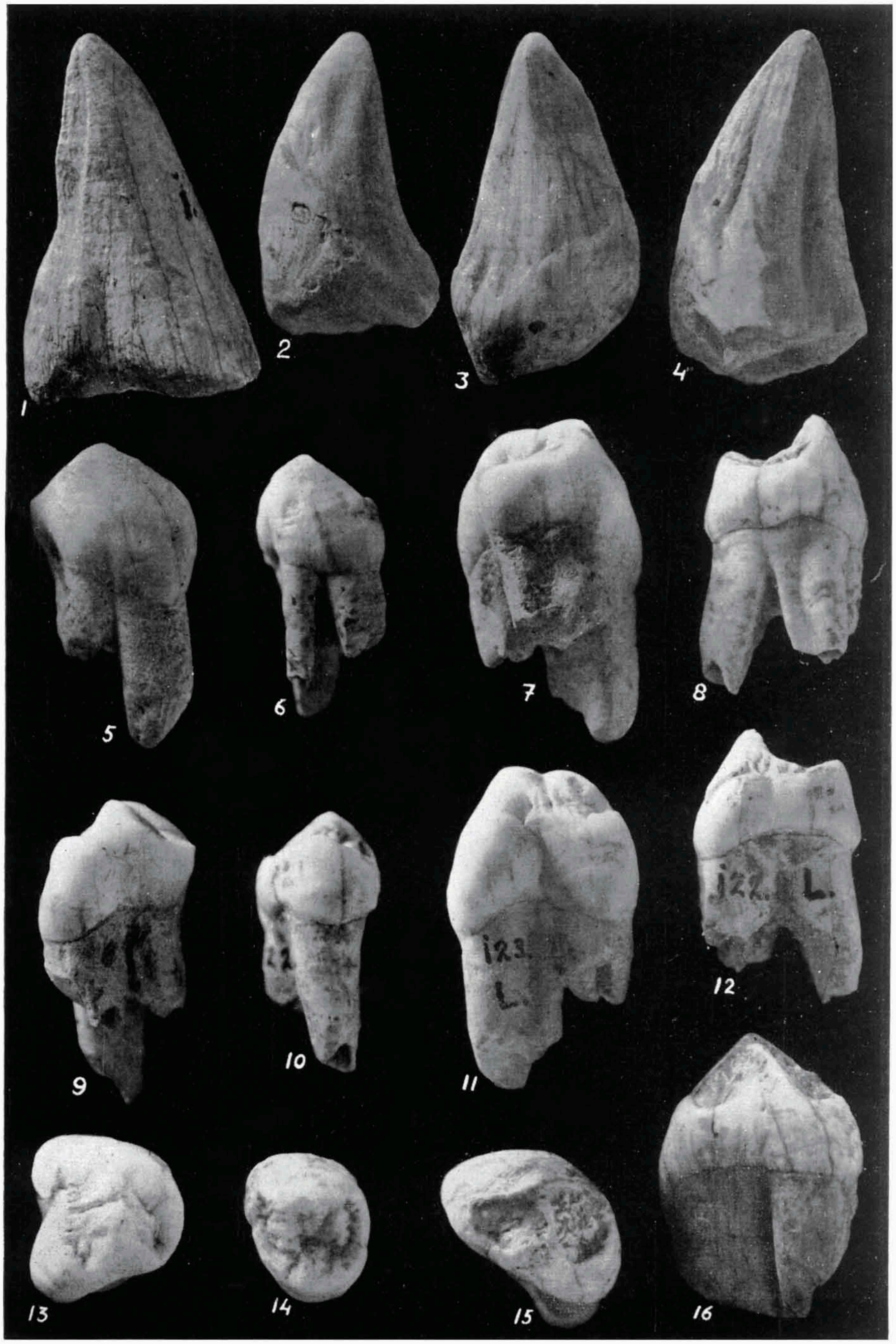

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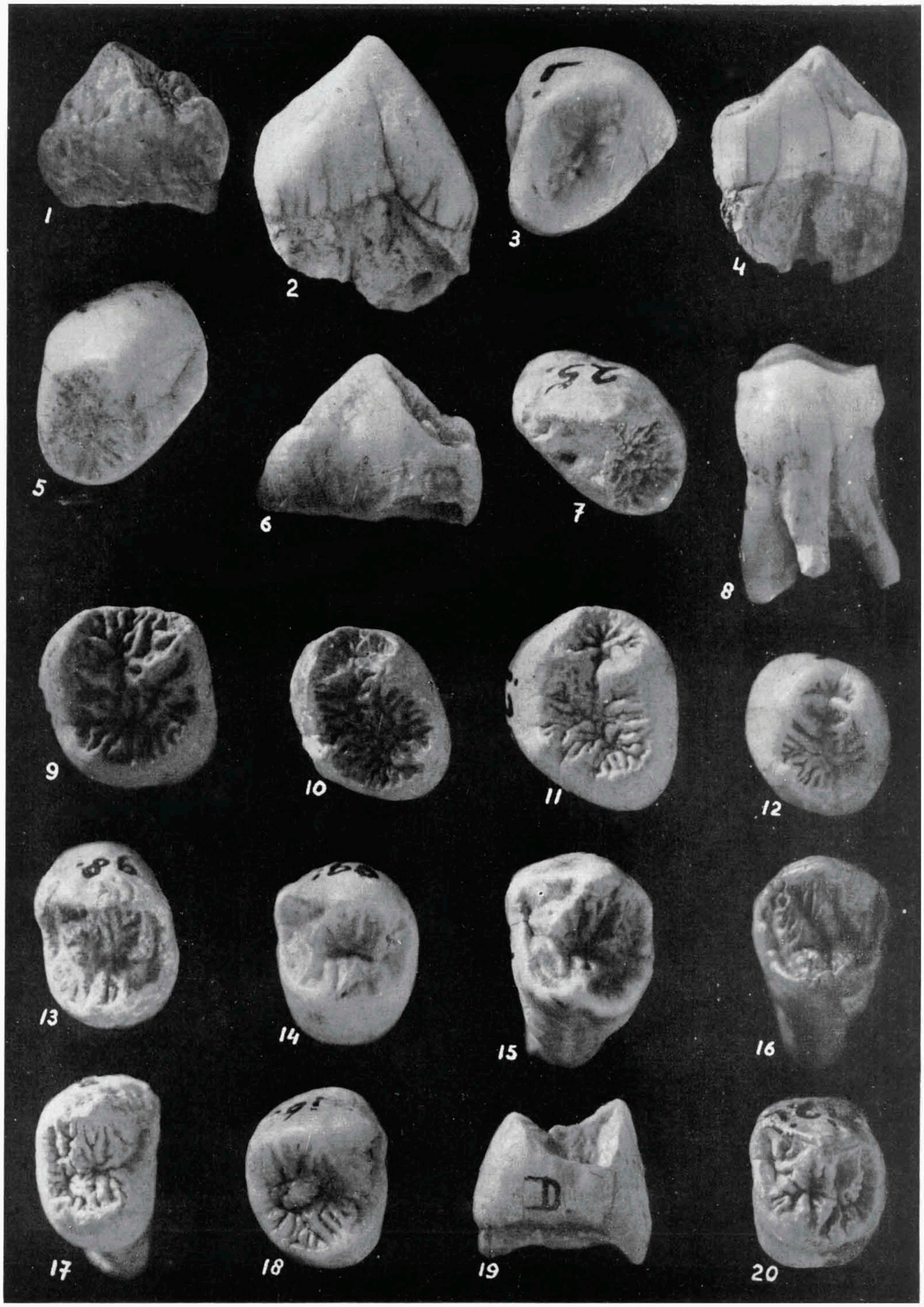

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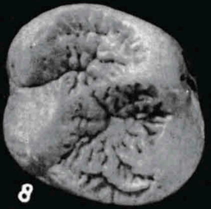
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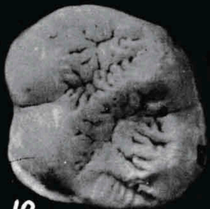
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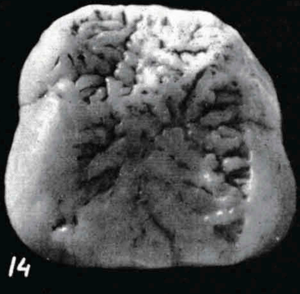
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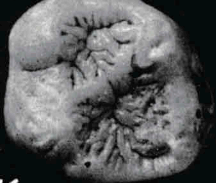
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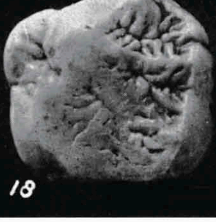
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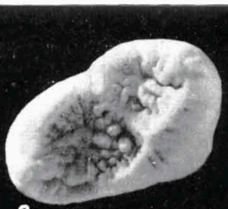

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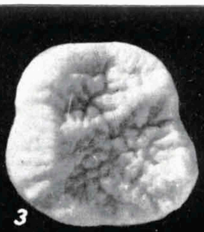

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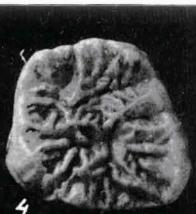

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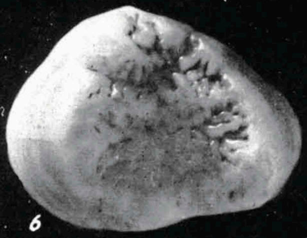

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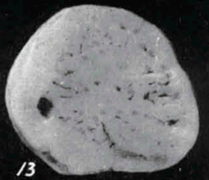

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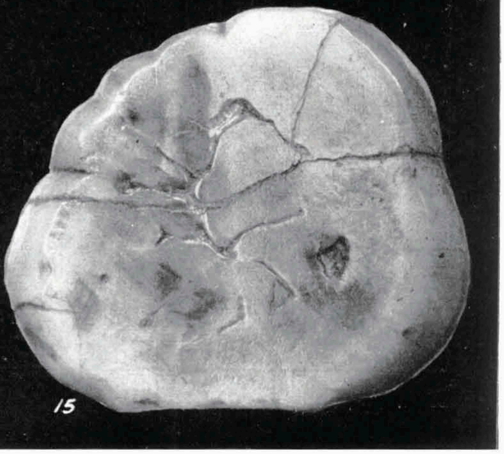

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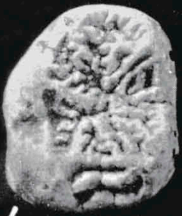
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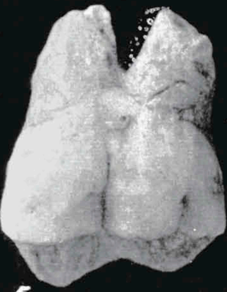
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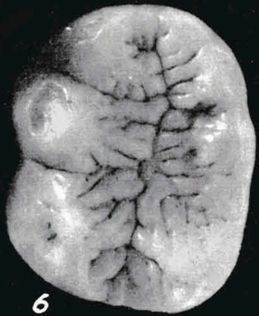
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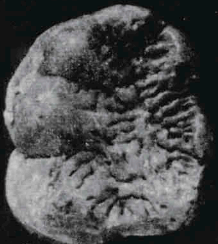
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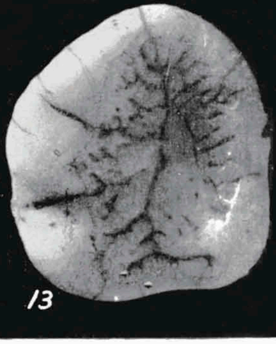
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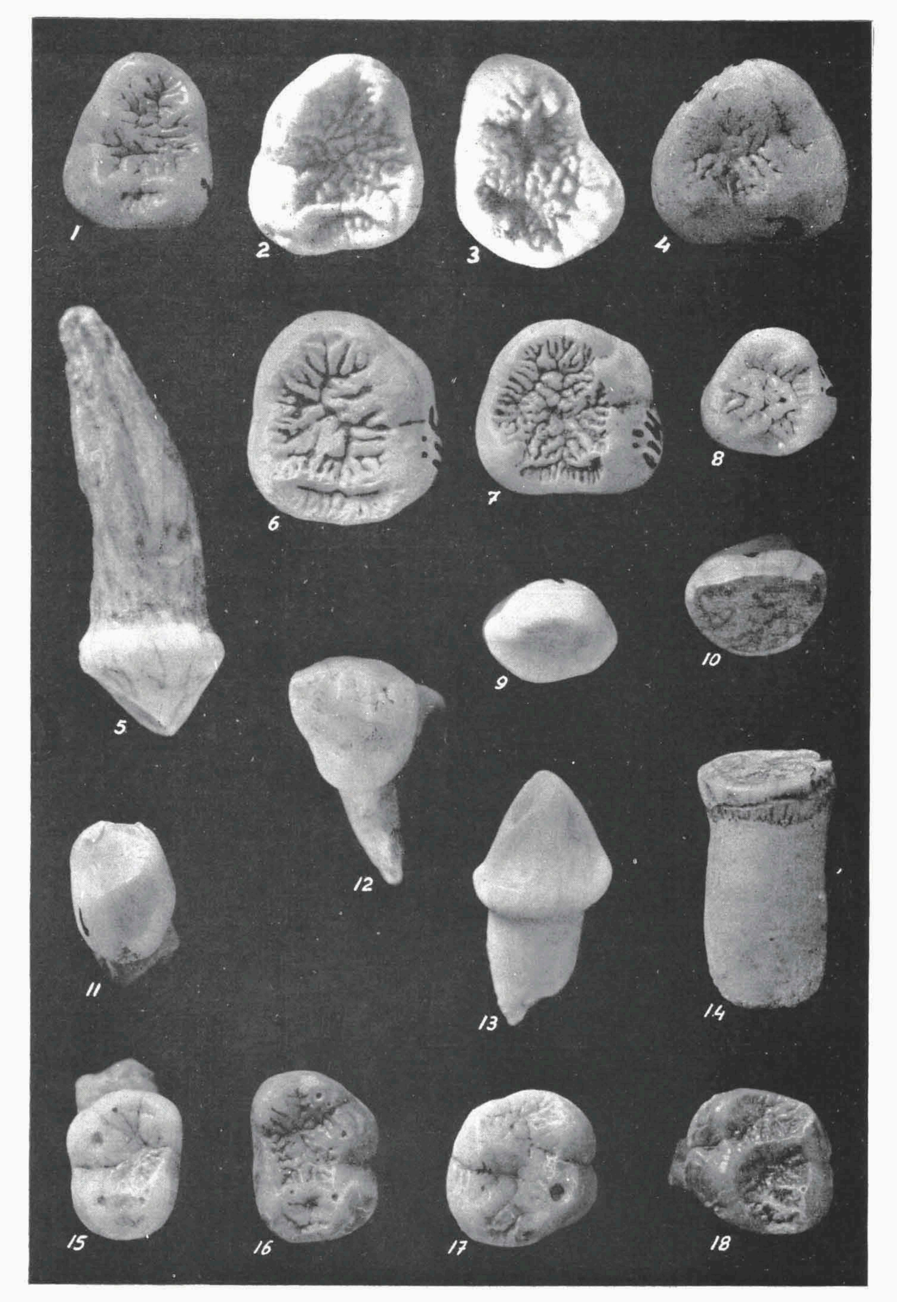

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