MAN AND OTHER MAMMALS FROM TOALIAN SITES IN SOUTH-WESTERN CELEBES

BY

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TWEEDE SECTIE, DEEL XLVI, No. 2

WITH PLS. I—III

1950
NORTH-HOLLAND PUBLISHING COMPANY
(N.V. Noord-Hollandsche Uitgevers Mij.)
AMSTERDAM

Kon. Ned. Ak. Wet., Verh. Afd. Nat. (Tweede Sectie), Dl. XLVI, No. 2, p. 1—164, 1950

Doch jene Grösse schwand wie Rauch.
Zeit gabs genug — und Zahlen auch.

CHRISTIAN MORGENSTERN,
Anto-logie.

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INTRODUCTION

During the months March to July, 1947, Mr. H. R. VAN HEEKEREN, prehistorian to the Archaeological Survey of the Dutch East Indies, carried out an excavation in the Bola Batoe cave near Badjo, Barebo district, ca. 20 km S.W. of Watampone in Central Bone, and ca. 100 km N.E. of Macassar in the South-western peninsula of the island of Celebes. Cultural remains were unearthed which belong to the Toalian complex, a culture first found by the cousins SARASIN in the beginning of the present century around Lamontjong, not far from the site selected by Mr. VAN HEEKEREN, and named after the primitive inhabitants of that region, the Toala, which I have to say some words about below.

VAN HEEKEREN (1949) distinguished two horizons in the Bola Batoe cave a lower (Early Toalian) with convex-based stone arrow heads, leaf-shaped points or "Pirri", discoid scrapers, and pedunculated stone implements, and an upper horizon (Late Toalian) containing serrated stone arrow heads, shell artifacts, and bone points or "Muduk" [1]). Originally only the upper phase of the Toalian culture was found by the SARASINS, the older phase came to light at various excavations undertaken since 1930 by Dr. P. V. VAN STEIN CALLENFELS, Mr. H. R. VAN HEEKEREN, Mr. F. D. MCCARTHY, Mr. H. D. NOONE, and Dr. W. J. A. WILLEMS.

As well as on previous occasions, subfossil teeth and bones of animals and Man were found mingled with the cultural remains in the Bola Batoe cave, and these remains were offered to me for study by the courtesy of the Head of the Archaeological Survey of the Dutch East Indies, Prof. Dr. A. J. BERNET KEMPERS. The SARASINs found a great number of animal remains in the Lamontjong caves, which were well described (SARASIN, 1905). Vertebrates are represented by the anoa, a species of deer, the babirusa, a pig, a macaque, two marsupials, a palm civet, a rat, two species of "*Mus*", a squirrel, bats (including a flying fox), as well as (undetermined) birds, and the reticulated python. Domestic animals present are a dog, the water buffalo, and a hen. The human remains received most attention and were ascribed to ancestors of the present day Toala population.

On my request Mr. A. C. V. VAN BEMMEL, of the Zoological Museum at Buitenzorg (Java), sent me the animal remains of the Toalian sites explored by Dr. P. V. VAN STEIN CALLENFELS and his collaborators in the years 1933 to 1937, reported upon already by DAMMERMAN (1939). These caves are the following:

a. the Tomatoa Katjitjang cave and the Sebong cave, N. of Tjani,

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[1]) Pirri and Muduk are Australian terms (cf. MCCARTHY, 1940).

Lamontjong, ca. 60 km E.N.E. of Macassar, excavated by Dr. P. V. VAN STEIN CALLENFELS and Mr. H. D. NOONE during the months November and December, 1933 (VAN STEIN CALLENFELS, 1945, p. 193). The material of these two caves has not been kept apart, and is referred to below as originating from "a cave N. of Tjani".

b. the Panisi Ta'boettoe (panisi means rock-shelter), ca. 11 km W.S.W. of Palaka near Watampone, Central Bone, ca. 120 km N.E. of Macassar, examined by Dr. P. V. VAN STEIN CALLENFELS and Dr. W. J. A. WILLEMS in July, 1937 (VAN STEIN CALLENFELS, 1938, p. 139; WILLEMS, 1939, p. 185).

c. the Panganrejang Toedeja cave, and the Batoe Edjaja cave, situated at the S. coast of the South-western peninsula of Celebes near Bonthain. These caves were explored by Dr. P. V. VAN STEIN CALLENFELS and Dr. W. J. A. WILLEMS in 1937, and the only informations about these sites we owe to a report by VAN DER HOOP (1938, pp. 581—584). The archaeological finds were listed by VAN DER HOOP (1941, p. 165 (neolithic stone implements), p. 176/77 (Toalian artifacts), p. 259 (a bronze fishhook, coins, and bronze fragments), and p. 271 (a glass bead)).

Prof. Dr. W. A. MIJSBERG, Utrecht, Netherlands, has been so kind as to entrust to me the animal remains found in the Tjadang cave near Tjita, about 35 km W.N.W. of Watampone, which was excavated by Mr. F. D. MCCARTHY and Dr. W. J. A. WILLEMS in 1937 too. The trial trench dug at this site produced a human jaw (VAN STEIN CALLENFELS, 1938, p. 139), and in the course of the excavation more than two thousand human teeth were found, on which Prof. MIJSBERG will probably publish later. All specimens were numbered, animal teeth too, and the latter specimens will be referred to below under the numbers they bear. The shell artifacts of the Tjadang cave were described by WILLEMS (1939).

In March, 1949, I received from Dr. C. FRANSSEN, Macassar, a collection of subfossil teeth and bones from the Lompoa rock-shelter, between Maros and Bantimoeroeng. Maros is ca. 25 km N.E. of Macassar. Two nearby caves, the Karrassa cave and the Saripa cave, were reported upon by VAN HEEKEREN (1937, 1939), but the animal remains found at these latter sites I have not seen. According to preliminary identifications by Dr. G. H. R. VON KOENIGSWALD (in VAN HEEKEREN, 1937, p. 267) the Karrassa cave fauna comprises *Sus celebensis*, babirusa, a monkey, a large marsupial and (another) cuscus, as well as a species of sheep or goat. There is nothing peculiar in this association. But the Saripa cave contained remains, besides of *Sus celebensis*, of "*Cynopithecus niger*" and of three species of marsupials (VON KOENIGSWALD in VAN HEEKEREN, 1939, p. 114). *Cynopithecus niger* is the name for the Northern Celebes macaque, an animal distinguished by external, cranial and dental characters from the Southern Celebes form, *Macaca maura*, which is a true macaque. *Cynopithecus* is absent in Southern Celebes, also in the subfossil state (below, pp. 37—58), and I have some doubts as to the correctness of this identification. In previous literature there are mentioned but two marsupial species in Celebes, both living and subfossil, viz., *Phalanger ursinus* and *Phalanger celebensis* (below, pp. 13—29). The discovery of a third species of marsupial in the subfossil S. Celebean fauna would certainly be a remarkable thing. In a later paper VAN HEEKEREN (1941, p. 234) also records three marsupials in the Toalian fauna, basing his remark on VON KOENIGSWALD's informations. It is desirable to have more data on this material, and it is especially to be hoped that later on more material will become available.

With the advance of our knowledge it has become certain that the Toalian culture runs upward very high in the geological time-scale, the upper limit is well within historical times. The SARASINs regarded the Toalian as late palaeolithic, though with neolithic elements (the serrated point!), but VAN STEIN CALLENFELS (1934, p. 94) found glass bracelet fragments during his 1930 excavations at Lamontjong, and concluded that the Toalian must have lasted almost until the beginning of the Christian era. Some years afterwards, while excavating the Batoe Edjaja cave, VAN STEIN CALLENFELS (in VAN DER HOOP, 1938, p. 582) reports the finding of bronze together with Toalian stone implements in a compact layer of earthenware-fragments, and the deposit is regarded as being not older than 300 B.C. In the Panganrejang Toedeja cave the whole stratigraphy of the Toalian could be established (VAN DER HOOP, l.c., p. 582/83), the Proto-Toalian with pedunculated arrow heads below (layer C—D), and the true Toalian with the serrated point above (layer A—B). The upper layer is dated Bronze Age or younger, between 300 B.C. and 1300 of our era, while of the older layer no age determination is given. VAN STEIN CALLENFELS (1934, p. 94) and also VAN DER HOOP (1948, p. 19) now class the Toalian with the anomalously neolithic cultures.

In the Bola Batoe cave Mr. H. R. VAN HEEKEREN found datable Chinese potsherds proving that at this site at least the Toalian must have existed even up to the 17th century. There are no indications as to the age of the lower limit of the Toalian [1]).

The Early or Proto-Toalian cultural and animal remains found, e.g., in layer C—D of the Panganrejang Toedeja cave are, of course, older than the Toalian of layer A—B of the latter cave, but very little can be said about the relative chronological positions of the various Toalian cave-contents. From the absence of the babirusa in the Saripa cave fauna VAN HEEKEREN (1939, p. 114) infers that the latter cave is probably younger than the nearby Karrassa cave. In most of the Toalian sites the fauna of which I have studied the babirusa is present, while at this day the babirusa has vanished from the whole of the South-western peninsula of Celebes

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[1]) It may be mentioned here that according to another estimation (BEYER, 1948, p. 80) the Toalian culture is "Middle to Late Post-Pleistocene (about 12.000 to 8.000 B.C., more or less)".

where the Toalian exclusively occurs. I have found the babirusa, as well as the anoa, in the fossil state from Beroe and Sompoh, near Tjabengè (Sopeng district), between the Walanae river and the Singkang depression, about 100 km N.E. of Macassar. The babirusa is but one element to an interesting Pleistocene Vertebrate fauna which is now already known to contain extinct forms like a gigantic land tortoise, *Testudo margae* Hooijer (1948c), a pigmy archidiskodont elephant, *Archidiskodon celebensis* Hooijer (1949a), and a peculiar giant pig, *Celebochoerus heekereni* Hooijer (1948b). The specimens on which my descriptions are based were collected by Mr. H. R. VAN HEEKEREN in recent years, and, incidentally, formed the first Pleistocene Vertebrates ever to be made known from the island of Celebes.

The Pleistocene babirusa, then, is larger than the living races of babirusa from Celebes, Taliaboe, and Boeroe, and was baptized *Babyrousa babyrussa beruensis* Hooijer (1948d). This was the very first example I found for the island of Celebes of a living form averaging larger in former times than it does now. During my studies on fossil, prehistoric, and recent Mammals I have repeatedly found fossil or subfossil remains of recent species to average larger than their recent homologues. In Java and Sumatra this rule holds for the orang-utan (HOOIJER, 1948a), the tiger (HOOIJER, 1947a), porcupines (HOOIJER, 1946c), rhinoceroses (HOOIJER, 1946a and 1946b), and the tapir (HOOIJER, 1947b). There was a gradual diminution in size during the course of the Quaternary in all of these forms, and this process is more advanced in Java than it is in Sumatra (for a summary of the evidence, see HOOIJER, 1949b).

These are only local examples of an evolutionary change which has gone on all over the world in the Quaternary. Various students of fossil and recent European, N. American, African, and Asiatic Mammals observed the same fact (see, e.g., references in HOOIJER, 1947a, p. 4, and also DEGERBØL, 1933, p. 640; TEILHARD DE CHARDIN and PEI, 1941, p. 74; COLBERT, 1949, p. 128; SIMPSON, 1949, p. 14). It is tempting to attribute this decrease in size, a reversal of the trend toward large size generally shown in the Tertiary Mammals, to changing environmental conditions; DEGERBØL (l.c.) and COLBERT (l.c.) believe to see BERGMANN's principle at work. While this interpretation is apparently correct for the examples given by DEGERBØL and COLBERT who worked on Pleistocene and recent Mammals from Denmark and China respectively, I do not believe that it holds good for the decrease in size of the Quaternary Mammals in Java, Sumatra, and Celebes, where the climatic change since the Pleistocene was certainly less marked than that at more Northern latitudes (cf. ROMER, 1949, p. 111/112). I shall return to the size problem at the end of the present paper.

The rule of progressive diminution in size during the Quaternary will be shown in the present paper to apply to most of the elements in the Toalian cave fauna, including Man. There is one species, viz., *Sus celeben-*

sis Müller et Schlegel, in which there has been an increase in size instead of a size decrease after the cave deposits were formed, and this species obviously presents an exception to the rule. The differences in average size between the subfossil and the corresponding recent forms never are of great magnitude, however, The amount of time which has elapsed since the deposition of the teeth and bones in the Toalian caves was evidently insufficiently long for marked differentiations to have taken place. Most of the teeth of the prehistoric orang-utan from caves in Central Sumatra, *Pongo pygmaeus palaeosumatrensis* Hooijer (1948a, p. 187/188) average larger than those of recent *Pongo pygmaeus pygmaeus* (Hoppius), and the difference stands the statistical test for all of the elements of its dentition except for the I^1, the P_4, and the M^3. The variation ranges of the teeth of *Tapirus indicus intermedius* Hooijer (1947b, p. 288, see the table on p. 291) from prehistoric Central Sumatra are almost invariably above the corresponding recent ranges. It is known that a few thousand years suffice for a subspecific advance (SIMPSON, 1944, p. 19; MAYR, 1944, p. 222; HUXLEY, 1945, p. 194), and in neozoological practice it is accepted (MAYR, 1944, p. 107) that a subspecific difference exists when 75 per cent of the material is really distinguishable.

Of some sets of measurements I give the number of variates n, the means M, standard deviations $\sigma = \sqrt{\frac{\Sigma e^2}{n-1}}$, and variation coefficients $C = \frac{\sigma \times 100}{M}$. The standard deviation is a measure of the variability about the mean; 95 per cent of the variates will be within the limits $M \pm 2\sigma$, and this range, giving one exception in twenty, is considered to be sufficiently accurate in the given problems of subspecific differentiation. The figures representing the variation coefficients furnish a criterion for the relative variability which takes into account every single variate. To determine whether a difference in size between the subfossil and the recent material has statistical significance one has to compute the standard error $E_M = \frac{\sigma}{\sqrt{n}}$. Differences from the mean M as great as two times the standard error E_M are considered to have statistical significance. If two sets of measurements are to be compared, viz., those of the recent and those of the subfossil material, the difference between the means is statistically significant if it is two times greater than the standard error of this difference

$$E_{\text{diff.}} = \sqrt{E^2_{M\text{rec.}} + E^2_{M\text{subf.}}}$$

In the various lists of recent material examined the following abbreviations have been used: A.M. for Zoological Museum at Amsterdam, B.M. for British Museum (Natural History) at London, and L. M. for Rijksmuseum van Natuurlijke Historie at Leiden. I am greatly indebted to Dr. T. C. S. MORRISON-SCOTT (London) and Prof. Dr. L. F. DE BEAUFORT (Amsterdam) for permission to examine recent skulls in the

collections under their charge. Prof. Dr. J. DANKMEYER and Prof. Dr. W. A. MIJSBERG kindly permitted me to study human skulls from Southwestern Celebes in the collections of the Anatomical Institutions at Leiden and Utrecht respectively. Moreover I had the good fortune to examine various specimens of rats from Celebes in the collection of Mr. H. J. V. SODY at Amsterdam.

As acknowledged already above I owe the opportunity to examine the Toalian cave material to Prof. Dr. A. J. BERNET KEMPERS at Batavia, Mr. A. C. V. VAN BEMMEL at Buitenzorg (Java), Prof. Dr. W. A. MIJSBERG at Utrecht, and Dr. C. FRANSSEN at Macassar, to whom I tender my heartiest thanks.

All measurements recorded in the present work are in mm, unless otherwise stated. In the tables ap. stands for antero-posterior, tr. for transverse, atr. for antero-transverse, and ptr. for postero-transverse diameter.

SYSTEMATICAL PART

Class MAMMALIA Linnaeus
Order MARSUPIALIA Illiger
Family PHALANGERIDAE Thomas
Genus **Phalanger** Storr

Of the present genus there are two species in Celebes, viz., *Phalanger ursinus* (Temminck) and *Phalanger celebensis* (Gray).

The various subspecies of the Bear Cuscus, *Phalanger ursinus* (Temminck), are distinguished by external as well as by dental characters. The most recent review is that by TATE (1945).

Phalanger ursinus ursinus (Temminck)

Material examined:

1. Mounted skin and skull of young female (M3 not yet erupted). Gorontalo, N. Celebes, coll. VON ROSENBERG, July 1, 1864. L. M., cat. syst. e, cat. ost. d.
2. Mounted skin and skeleton of adult male (cotype). N. Celebes, coll. REINWARDT. L. M., cat. syst. a, cat. ost. a.
3. Mounted skin of adult male (skull inside). Menado, N. Celebes, coll. VON FABER, 1883. L. M., cat. syst. d.
4. Stuffed skin and skull of adult male. From the Rotterdam Zoo, 24—4—1930. L. M., reg. no. 1837.
5. Mounted skin of adult female (skull inside) (cotype). N. Celebes, coll. REINWARDT. L. M., cat. syst. b.
6. Mounted skin of adult female (cotype). N. Celebes, coll. REINWARDT. L. M., cat. syst. c.
7. Stuffed skin of adult (skull inside). Celebes. L. M., cat. syst. i.
8. Stuffed skin of adult (skull inside). Celebes. L. M., cat. syst. j.
9. Stuffed skin of adult (skull inside). Celebes. L. M., cat. syst. k.
10. Skeleton of adult (cotype). From the Groningen Museum. L. M., cat. ost. b [1]).
11. Skull of adult (cotype). N. Celebes, coll. REINWARDT. L. M. cat. ost. c.

Phalanger ursinus ursinus (Temminck), the cotypes of which are in the Leiden Museum, is typically from Northern Celebes, but there are also representatives in the South-western peninsula (MEYER, 1896, p. 34, 1899, p. 31; SARASIN, 1905, p. 44; TATE and ARCHBOLD, 1937, p. 380). TATE and ARCHBOLD (1937, p. 380) state that it is impossible to find characters for separation of the specimens from the Lompobatang Mt. (= Peak of Bonthain) at the extreme Southern part of the island from those of the typical locality.

A form from Central Celebes, of the high mountains East of Lake

[1]) The mandible associated with the calvarium does not belong to it.

Lindoe and North of Lake Poso, described by MILLER and HOLLISTER (1922) as *Phalanger furvus*, is regarded by TATE and ARCHBOLD (1937, p. 380) as a nigrescent mountain race of *P. ursinus*. In his final treatment of the genus *Phalanger*, however, TATE (1945, p. 28) refers the Southern specimens to *Phalanger ursinus furvus* Miller et Hollister, which latter should differ from the typical Northern race by having black instead of brown ears, little or no brown on the face, and, above all, a greater crown length of I^3 (3.6—4.0 mm against 2.7—3.2 mm).

In the Togean Islands race, in the Gulf of Tomini in Northern Celebes, the crown of I^3 is long too (3.4—4.1 mm), but the crown of I^3 is divided into a larger anterior cusp and a smaller posterior one, while a pronounced groove confluent with the depression between the two cusps appears on the outer surface of the tooth (TATE, 1945, p. 27). The divided crown of I^3 is present in 10 out of the 12 males and in 5 out of the 11 females of the series of *Phalanger ursinus togianus* Tate (1945, p. 4), and no sign of such division of I^3 is discernable in the mainland specimens.

The fourth race of *Phalanger ursinus* (Temminck), *P. ursinus melanotis* Thomas (1898a, p. 2) from the Talaud Is., agrees with the Southern mainland of Celebes race in the black colour of the ears, while the crown length of I^3 (3.3 mm) is intermediate between that in *P. ursinus ursinus* and *P. ursinus furvus* (TATE, 1945, p. 28). In the lighter colour of the skin, however, the Talaud Islands race is quite distinct from those of the Celebean mainland and of the Togean Islands. Specimens from the Peleng Island, off the East coast of Central Celebes, are described by TATE (1945, p. 27/28) as identical with the Northern race *P. ursinus ursinus.*

I can attach no value to the length of the crown of I^3 as affording means of distinction between the mainland races of *Phalanger ursinus.* One of the cotypes of *P. ursinus* from Northern Celebes (no. 5 of the above list) has the skull still inside the skin, and the length of I^3 is certainly not less than 4.0 mm, the maximum length recorded for the crown of I^3 in the Southern race *P. ursinus furvus*! In another cotype of *P. ursinus ursinus* (no. 3) the length of I^3 is 3.5 mm, which is also above the range for typical *ursinus* given by TATE (1945, p. 40). In two other Northern Celebes specimens in the Leiden Museum (nos. 1 and 10) the length of I^3 is 3.0 and 3.1 mm respectively. Unfortunately the length of I^3 cannot be measured in the two remaining cotypes (nos. 2 and 11) because the crown of this tooth is so abraded. But with the fact that TATE's observations for the Southern Celebes specimens (I^3 length 3.6 and 4.0 mm) fall within the range of typical *P. ursinus ursinus* this distinguishing character breaks down.

The remaining character, the colour of the ears, is difficult to check because I have no specimens which originate with certainty from the South. One, unlocalized, skin (with the skull) received from the Rotterdam Zoo in 1930 (no. 4) has the brown of the ears less distinctly shown than the typical Northern examples; this specimen may perhaps belong to

P. ursinus furvus. The length of I^3 in this specimen is 3.7 mm. Three, likewise unlocalized skins with the skulls inside (nos. 7—9) have crown lengths of I^3 of about 3.0 mm each and agree with the cotypes of *P. ursinus ursinus* in their external characters. None of my above listed specimens has the crown of I^3 subdivided in the way TATE describes it as typical of most of the Togean Islands skulls.

In my series of skulls I noticed one important dental variation. In skull no. 11, one of the cotypes of *Phalanger ursinus ursinus* (Temminck), there are no M4's except in the left ramus horizontalis in which latter it is dwarfed. In the right horizontal ramus a small M_4 may be still buried in the bone, but in the upper jaw M^4 is certainly congenitally absent. Neither JENTINK (1885, p. 118/19) nor TATE (1945, pp. 27 and 40) who have had this specimen in their hands make any special notice as to this anomaly, which is certainly remarkable because the numerical variations in the teeth of *Phalanger* known until now are confined to the incisors and premolars (JENTINK, 1885, pp. 89—91; COLYER, 1936, pp. 162—164). The small mandibular teeth between the long incisor and the large P_4 are usually referred to as "intermediate teeth" since their homologies are uncertain; their normal number for the species of *Phalanger* in question is two on each side, but in skull no. 10 of *P. ursinus ursinus*, as rightly observed by JENTINK (1885, p. 91), there is but one intermediate tooth on each side in the mandible. I have no doubt that the absence of M^4 in a specimen of *Phalanger* must be looked upon as a progressive character.

There is no conspicuous difference in size between the two sexes; skulls with the molar series completed, however, are not necessarily fully grown out (cf. TATE, 1945, p. 28) and this accounts for MILLER and HOLLISTER's original statement that *P. ursinus furvus* is larger than *P. ursinus ursinus*. The largest specimen of my series is one of the cotypes (no. 2) of the typical race.

The subfossil teeth and bones of *Phalanger ursinus* collected by P. and F. SARASIN in the Lamontjong caves present no differences from those of the recent form (SARASIN, 1905, p. 44). DAMMERMAN (1939, p. 67) noticed "noteworthy differences" between the subfossil and the recent *Phalanger ursinus*. The subfossil molars would be much heavier, broader, and more rectangular in shape than their homologues in recent *Phalanger ursinus*, while the jugal would be placed on a higher level in the subfossil Cuscus too. In the mandible the second intermediate tooth would be placed more on the inner side of the P_4 in the subfossil than in the recent form, and the height of the subfossil mandible would be higher.

These are noteworthy differences indeed, but upon examination of the specimen of the maxillary from the Panisi Ta'boettoe on which Dr. DAMMERMAN's remarks are based I found it to belong to a macaque, viz., *Macaca maura* (Geoffr. et F. Cuvier) subsp. The specimen is dealt with on p. 52 of the present work and is represented on pl. II figs. 4—5. The "loose third lower molar" from the Panganrejang Toedeja cave (layer A—B), referred by DAMMERMAN (1939, p. 67) to the present Cuscus too, also belongs to the Moor Macaque, and is in reality a left M_1 (this paper, p. 55).

The mandibles from the Panisi Ta'boettoe, the Batoe Edjaja cave, and the Panganrejang Toedeja cave listed under the head *Phalanger ursinus* by DAMMERMAN (l.c.) are correctly assigned to the present species, but I cannot find the differential character stressed by the latter author. It is true that Dr. DAMMERMAN had other recent skulls at his disposal than I have, but the mandibles of skulls nos. 2, 4, and 11 have the posterior intermediate tooth in exactly the same position relative to P_4, viz., immediately antero-lingually of the latter, as those in the subfossil mandibles. In skull no. 10 there is but one intermediate tooth on each side in the mandible, and this tooth is placed midway between the long incisor and P_4 and consequently more forward relative to P_4, but this specimen is anomalous (cf. above, p. 15), two being the normal number of the lower intermediate teeth.

The subfossil mandibles are not higher than the recent either. One of the cotypes of *P. ursinus ursinus* (no. 2) has a height at P_4 of 19.0 mm, which is more than that in any of the subfossil examples. The measurements of the recent and of the subfossil molars are given in table 1. From this table the only real difference existing between the subfossil and the recent *Phalanger ursinus* will be evident, viz., the tendency for the cave specimens to present greater dimensions than the recent ones do.

Phalanger ursinus (Temminck) subsp.

(pl. I figs. 4 and 6)

The only specimens of upper molars from Toalian sites seen by me are a right M^3 and M^4 in a maxillary fragment from the Bola Batoe cave collected by Mr. VAN HEEKEREN. The fragment is represented in pl. I fig. 6. The serial position of the molars is rendered certain by the typical subtriangular outline of the posterior element and by the inward curve of the maxillary behind. From lower molars these specimens are distinguished by their relatively greater width. No structural differences from their recent homologues appear, and as can be seen from table 1 the dimensions are within the range of variation of the corresponding recent elements with the exception of the width of M^4 that is a little greater (5.0 mm against 4.0—4.6 in the recent M^4). TATE (1945, p. 40/41), however, gives 4.2—4.9 mm as the range of the width of M^4 in *P. ursinus ursinus* and even 5.2—5.4 mm as the range in *P. ursinus furvus*. These are differences without any real significance, but which may perhaps indicate a greater tendency toward fourth molar reduction in the Northern than in the Southern race of *P. ursinus*. As I have already noted above (p. 15) there is even an instance of congenital absence of M^4 among the specimens of *Phalanger ursinus ursinus*.

I can now pass on to the mandibular teeth. These are very rare in the Bola Batoe cave, one specimen of M_1 being the only representative. It is of the left side and its serial position is easily seen from the almost unicuspid anterior half. Its length is the only remarkable point, being 8.1 mm against 6.9—7.4 in its recent homologues.

TABLE 1.

Phalanger ursinus.

No.	1	2	4	10	11	Bola Batoe	Panisi Ta'boettoe	Batoe Edjaja	Panganrejang Toedeja	
P^4 ap.	—	5.6	5.9	6.0	5.6	—				
tr.	—	4.4	5.3	5.1	4.6	—				
M^1 ap.	7.5	7.0	7.2	7.2	7.3	—				
tr.	5.7	5.6	5.7	5.6	5.4	—				
M^2 ap.	7.6	—	7.3	6.9	6.7	—				
tr.	5.7	5.9	5.8	5.8	5.5	—				
M^3 ap.	—	6.9	6.7	6.6	6.4	6.8				
tr.	—	5.9	5.5	5.4	5.0	5.5				
M^4 ap.	—	—	5.9	5.5	—	5.5				
tr.	—	—	4.6	4.0	—	5.0				
P_4 ap.	—	5.8	6.0	5.9	6.0	—	6.1	6.4	6.4	6.5
tr.	—	3.9	4.8	4.0	3.7	—	4.8	4.9	4.6	4.5
M_1 ap.	7.4	—	7.2	7.4	6.9	8.1	7.3	7.7	—	8.3
tr.	4.6	4.1	4.9	4.4	4.1	4.9	—	4.8	—	4.9
M_2 ap.	7.6	—	7.3	7.0	6.7	—	7.0	7.7	—	—
tr.	5.0	4.6	5.0	5.0	4.4	—	—	5.2	—	—
M_3 ap.	—	6.7	6.7	6.9	6.6	—	6.5	7.0	—	—
tr.	—	4.8	5.2	5.1	4.6	—	5.2	5.4	—	—
M_4 ap.	—	—	6.6	6.8	5.6	—	6.3	6.2	—	—
tr.	—	—	4.8	4.6	3.7	—	4.8	4.7	—	—
Height at P_4	—	19.0	16.6	15.0	13.9	—	18.5	18.0	18.8	—
Length P_4–M_4	—	—	34.0	33.8	31.8	—	33.8	34.5	—	—

The Panisi Ta'boettoe specimen of the mandible consists of a right horizontal ramus, broken off obliquely below M_4, with the greater part of the long central incisor, the P_4, all four molars of which M_2 and M_3 incomplete internally, and even the second intermediate tooth intact. The first intermediate tooth has broken off. There is nothing to remark about this specimen; the second intermediate tooth is in its common position at the antero-internal angle of P_4. The length of the latter tooth is only 0.1 mm above the range of its recent homologues. DAMMERMAN (1939, p. 67) refers this specimen to the present form "with some hesitation" but it can be identified without any reservation.

The best specimen in the VAN STEIN CALLENFELS collection is a right ramus horizontalis from the Batoe Edjaja cave, represented on pl. I fig. 4 of the present paper. The incisor is broken off, the alveoli of both intermediate teeth are shown, and P_4—M_4 are in an excellent state of preservation; the hypoconid of M_3 only is injured. M_4 is perhaps a little small relative to the other elements; it is the only tooth that is within the range of variation of the dimensions of the recent specimens, the others being larger. The difference in size, however, is not great and my series of recent skulls is very small, hence I do not believe that upon extending the recent series of skulls the differences would stand the statistical test. About this specimen DAMMERMAN (1939, p. 67) remarks that P_4 is set a little obliquely outwards, and this tooth is indeed rotated, but not to a greater extent than that in skulls nos. 4 and 10.

From the Panganrejang Toedeja cave DAMMERMAN (l.c.) recorded several specimens, viz., a fragment of the right horizontal ramus with P_4, an isolated M_3, and a piece of the left ramus with P_4 and M_1 from layer A—B, as well as a (posterior) toothless fragment of the left horizontal ramus from layer C—D. The latter specimen is not particularly robust, as might be expected from a geologically older specimen. The molars are stated by DAMMERMAN to be heavier, etc., than the recent, but this evidently refers only to the supposed M_3 which in reality belongs to *Macaca maura* (above, p. 16). Like the Bola Batoe cave, Panisi Ta'boettoe, and Batoe Edjaja cave specimens the teeth occasionally present greater dimensions than the recent do, as shown by the measurements recorded in table 1.

The Grey Celebes Cuscus, *Phalanger celebensis* (Gray), based on a specimen sent by WALLACE from Macassar in 1857, is known both from Northern Celebes and from the whole of the South-western peninsula (WEBER, 1890, p. 114; MEYER, 1896, p. 33; SARASIN, 1905, p. 44; TATE and ARCHBOLD, 1937, p. 379). MATSCHIE (1901, p. 293) states that it is very probable that upon a careful comparison of the Southern specimens with those from the Minahassa subspecific differences will appear, but TATE (1945, p. 18) did not find such differences, and WEBER's specimen from Goa in S. Celebes (no. 8 of my list, below) is indistinguishable from the Northern animals.

Phalanger celebensis celebensis (Gray)

Material examined:

1. Mounted skin and skull of young female (M3 not yet erupted). Amoerang, N. Celebes, coll. VON FABER, 1883. L. M., cat. syst. d, cat. ost. d.
2. Mounted skin and skull of subadult male (M4 erupting). Menado, N. Celebes, coll. VAN MUSSCHENBROEK, 1878. L. M., cat. syst. e, cat. ost. c.
3. Mounted skin of subadult male (skull inside). Menado, N. Celebes, coll. VAN MUSSCHENBROEK, 1878. L. M., cat. syst. f.

4. Mounted skin of adult male (skull inside). Amoerang, N. Celebes, coll. VON FABER, 1883. L. M., cat. syst. a.
5. Mounted skin and skull of adult male. Amoerang, N. Celebes, coll. VON FABER, 1883. L. M., cat. syst. b, cat. ost. a.
6. Stuffed skin and skeleton of adult male. Celebes, from the Rotterdam Zoo, 12–8–1908. L. M., reg. no. 126.
7. Mounted skin and skull of adult female. Amoerang, N. Celebes, coll. VON FABER, 1883, L. M., cat. syst. c, cat. ost. b.
8. Adult female, and young, in alcohol. Goa, S. Celebes, coll. WEBER, 1888. A. M., nos. 327 and 328.
9. Stuffed skin and skull of adult female. Amoerang, N. Celebes, leg. Dr. A. REYNE, 1932. L. M., reg. no. 2802.

Phalanger celebensis sangirensis Meyer (1896, p. 34) from the Sangi Is. to the N. of Celebes, perhaps identical with *Phalanger celebensis rothschildi* Thomas (1898b, p. 433) from the Obi Is. in the Moluccas, differs mainly in the presence of a more or less distinct dorsal stripe, which is absent in the Celebean animals. TATE (1945, p. 3) describes the Peleng Is. form, off the E. coast of Central Celebes, as *Phalanger celebensis pelengensis;* it differs from the Celebean race also by a skull character: the mastoid region is pointed instead of rounded.

The acknowledged subspeciation of the present Cuscus differs markedly from that of its larger congener in Celebes and the surrounding islands: one race for the whole of the island of Celebes in *P. celebensis* against two in *P. ursinus,* and a separate race for the Peleng Is. in *P. celebensis* while the Peleng Is. form of *P. ursinus* is considered to be identical with the Northern Celebes race of the latter species. TATE (1944, p. 8) records *P. celebensis* from Celebes as well as from Boeroe Is., but the latter locality is certainly mistaken; it is the *Phalanger orientalis* group that lives on Boeroe (cf. TATE, 1945, map on p. 26). *P. celebensis* is at once distinguishable from *P. orientalis* (Pallas) by the smallness of the upper C, the presence of a diastema between I^3 and C, and the absence of P^3 (TATE and ARCHBOLD, 1937, pp. 364 and 379). In a later paper TATE (1945, p. 17) mentions that in *P. orientalis* (except *ornatus)* I^3 and C are separated by an appreciable gap, but this is a slip of the pen of this author since in all the skulls of *P. orientalis* I have seen I^3 and C are in contact with one another.

There is, again, no difference in size between the male and the female sex, not even in the canines. Dental anomalies have not been found by me.

SARASIN (1905, p. 44) noticed no differences between the subfossil Lamontjong caves specimens and the recent of *P. celebensis;* DAMMERMAN (1939, p. 67) states one Batoe Edjaja cave maxillary to have teeth which are slightly smaller than their recent homologues. This is not correct; the specimen is within the range of recent *Phalanger celebensis celebensis* as far as its tooth dimensions are concerned, and in the dimensions of the skull it even shows an excess in size over the recent specimens, as I shall show below.

Phalanger celebensis (Gray) subsp.

(pl. I figs. 1—3, 5 and 15)

In the Bola Batoe cave collection there is a portion of the left maxillary with P^4 and M^1 in situ. Part of the zygomatic process is preserved, and the infraorbital foramen is (indistinctly) shown. The alveoli of the C and of the small premolar between the latter and P^4 are preserved, that of the canine, however, only in part. Careful comparison with the corresponding portion of recent skulls of *P. celebensis celebensis* does not show any difference. M^1 only is 0.2 mm wider than the largest M^1 in six recent specimens (table 2) but there is nothing peculiar in this.

The skull fragment from the Batoe Edjaja cave recorded by DAMMERMAN (1939, p. 67) as having a slightly shorter toothrow and smaller teeth than in recent *P. celebensis celebensis* is much more complete, and is remarkable in several respects, worth while a detailed description.

The Batoe Edjaja skull fragment comprises the left maxillary to above the infraorbital foramen, excellently preserved, with the anterior zygomatic root, and, fortunately, the almost complete premaxillary bone. In front the premaxillary is broken off about in the median line, but the medial boundary of the incisive foramen is missing, and the left palate is but partly present, as shown in the photograph of the specimen (pl. I fig. 5). The only teeth in situ are P^4—M^3; of M^4 the alveolus is seen. The posterior border of the zygomatic process, entire, with part of the jugal still attached to it, is on a level with the posterior moiety of M^2; in my recent skulls of *P. celebensis celebensis* with the molar series completed the posterior border of the zygomatic process is in the same position, or (no. 9) stands more posteriorly, beside the junction of M^2 and M^3. The remaining alveoli in front of P^4 are empty.

To begin anteriorly, the premaxillary forms a point just below the anterior nares and extending anteriorly beyond the nasal notch [1]). The first alveolus to be seen is at least 3 mm separated from the median line and 4 mm behind the anterior tip of the premaxillary, exactly below the nasal notch. The alveolus is rounded and 2.4 mm in diameter. There is another alveolus directly behind the first mentioned, and only very slightly smaller, behind which follows a diastema of 1.5 mm.

The next alveolus is rather large and is just behind the premaxillary-maxillary suture. It is inclined forward and measures 4.5 mm antero-posteriorly in the horizontal plane of the palate. In the space between this alveolus, which, beyond any doubt, contained the C, and the P^4 there is one alveolus, slightly nearer to the C than to the P^4, and just below the infraorbital foramen. Diameter ca. 2.5 mm. This alveolus is evidently that of the P^1 (or P^2) normally present in *P. celebensis*. The alveoli would

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[1]) The anterior incurvation of the premaxillary which forms the lateral boundary of the anterior narial orifice.

seem to be comparatively large, but not very markedly so, and this is just what one should expect.

What makes this subfossil specimen so peculiar is the presence of but two incisor alveoli, close together, and which must have been separated from the corresponding ones on the right side of the skull by a distance of at least 6 mm. In normal skulls of *P. celebensis celebensis* the central incisor, the largest of the incisor series, is placed in front of the nasal notch and very near to the median line, at the most 2 mm distant from the corresponding tooth at the other side. In the present cave specimen the anterior portion of the premaxillary is well preserved, but nothing is seen of the alveolus of the central incisor. The two incisor alveoli present are exactly in the position of I^2 and I^3 in the recent skulls, and the diastema between the hindmost incisor and the canine is just in front of the premaxillary-maxillary suture, exactly like that in recent *P. celebensis celebensis*. There can be no doubt about the homologies of the two incisor alveoli in the Batoe Edjaja specimen: they contained the I^2 and the I^3.

The present specimen offers an instance of congenital absence of the I^1. The perfect and unpitted condition of the bone points to the tooth having been absent completely. Numerical variations of the incisors are known in the genus *Phalanger*, viz., in *P. maculatus* (Geoffr.) and in *P. orientalis* (Pallas) (JENTINK, 1885, p. 90/91; COLYER, 1936, p. 162/163), but in these specimens it is the small I^3 that is absent. This diminutive tooth is absent in the left premaxillary of *P. orientalis*, L.M., cat. ost. gg (JENTINK, cat. no. 48, not noticed by JENTINK, 1885, p. 89), in the right premaxillary of *P. maculatus*, L.M., cat. ost. h (JENTINK, cat. no. 6, not noticed either), and on both sides in *P. maculatus*, L.M., cat. ost. g (JENTINK, cat. no. 5, noticed by JENTINK, 1885, p. 90). In a skull of the latter species collected in Amboina by Dr. KOPSTEIN in 1923 (belonging to skin no. 61 of the KOPSTEIN collection) both the right and the left I^3 are absent too. Of one of the skulls of *P. maculatus* (L.M., cat. ost. o, JENTINK, cat. no. 14) JENTINK (1885, p. 91) states five of the upper incisors to be missing, and indeed only I^3 sin. is preserved, but the loss of the front teeth is certainly due to a diseased condition in this case.

In one case (*P. orientalis*, L.M., cat. ost. s3, Boeroe) the left upper incisor series is complete but on the right side there is a diastema between I^1 and I^3, and this is consequently an instance of a missing I^2. There is another case (*P. maculatus*, L.M., cat. ost. tt, Schouten Is.) in which I^1 and I^3 are separated by a gap, but this instance is not free from suspicion for the premaxillary is pitted and rough, even partly necrotic.

It would seem that the anomaly found in the incisor dentition of the subfossil specimen of *P. celebensis* is unique for the genus *Phalanger*. There are a right and left horizontal ramus of the mandible found in the Batoe Edjaja cave in association with the calvarium fragment and considered to belong probably to the same specimen (DAMMERMAN, 1939,

p. 67). I shall discuss the mandibles below. Numerical variations in the incisor dentition are unknown until now in *P. celebensis celebensis.*

The Batoe Edjaja cave calvarium fragment permits of certain measurements to be taken, and these show the specimen to be not inconsiderably larger than the recent ones at my disposal. The I^3—C diastema is present in, and even characteristic of, recent *P. celebensis celebensis*, but the space between I^3 and P^4 is longer in the cave specimen than in the recent, and the distance from the nasal notch to the posterior borders of the infraorbital foramen and of the anterior zygomatic root respectively is greater too, as follows from the inspection of table 2. The dimensions of the teeth and the length P^4—M^3 of the cave specimen are within the limits of those in the recent skulls, and thus are certainly not less than those in recent *P. celebensis* as stated by DAMMERMAN (1939, p. 67); M^1 and M^2 even are to the higher side of the recent range of variation.

TABLE 2.

Phalanger celebensis.

No.	1	2	5	6	7	9	Batoe Edjaja	Bola Batoe
P^4 tr.	—	3.3	3.1	3.5	3.5	3.5	3.1	3.3
M^1 tr.	3.0	3.5	3.2	3.4	3.4	3.5	3.5	3.7
M^2 tr.	3.0	3.6	3.4	3.4	3.5	3.7	3.5	—
M^3 tr.	—	3.4	3.2	3.3	3.4	3.6	3.2	—
M^4 tr.	—	—	3.0	3.1	2.8	3.0	—	—
Length P^4–M^3	—	15.6	14.8	15.7	15.6	15.8	15.2	—
From nasal notch to posterior border of infraorbital foramen	—	11.7	12.5	12.6	12.4	12.4	14.0	
From nasal notch to posterior border of anterior zygomatic root	—	22.4	24.4	24.1	23.9	24.6	26.4	
Diastema I^3–P^4	—	7.8	9.0	9.5	8.7	8.8	10.5	

There is no reason to suppose that the Batoe Edjaja calvarium fragment belonged to a particularly large individual for its time of living, and it bears, again, evidence of the diminution in size in the course of time of which there are numerous other instances in the present collection.

The collections from the Toalian sites are especially rich in fragments of the mandible of the present smaller Cuscus, in contradistinction to the larger *P. ursinus,* and these smaller animals must have been captured in much greater quantities than the larger. In the VAN STEIN CALLENFELS collection there are twenty-seven horizontal rami, and in the VAN HEEKEREN collection there are six, besides seven isolated anterior lower incisors. The study of the incisors, which do not differ in structure from the recent, shows that most of the cave specimens are thicker transversely than the recent. Whether the former have a greater antero-posterior diameter too cannot be made out. The I^1 attains its greatest antero-posterior diameter inside its alveolus and I have not extracted the teeth because this cannot be done without demolishing the bone of the symphysis.

In table 3 I give the diameters of the recent I_1 (of skulls nos. 2, 5, 6, 7, and 9), and of four right (nos. 1—4) and three left (nos. 5—7) Bola Batoe cave specimens. No. 8 in this table is the incisor in a left horizontal

TABLE 3.

Phalanger celebensis.

No.	*Phalanger celebensis celebensis*					1	2	3	4	5	6	7	8	9	10	11
I_1 tr.	2.0	2.1	2.4	2.0	2.3	2.2	2.5	2.4	2.5	2.3	2.8	2.5	2.5	2.4	2.2	2.5
ap.	—	—	—	—	—	4.3	4.5	4.5	4.0	4.1	4.3	4.5	4.5	—	—	—

ramus from the Bola Batoe cave (no. 4 in table 4 below); no. 9 is a right I_1 from layer C—D of the Panganrejang Toedeja cave (not recorded by DAMMERMAN, 1939, p. 68), and nos. 10 and 11 are the incisors of two right rami from the same C—D layer of the Panganrejang Toedeja cave (nos. 21 and 22 of table 4 below). Rami nos. 4 and 22 are figured on pl. I figs. 1—3. The latter specimen is above the range of five recent I_1, as well as five out of the eight Bola Batoe cave specimens. Tooth no. 6 is particularly strong (transverse diameter 2.8 mm against 2.2 mm $\pm$ 0.2 mm in the recent) but the other cave specimens are not above the expected range in recent *P. celebensis celebensis.*

The study of the mandibles of *Phalanger celebensis* offered an example of microevolution in situ in the Panganrejang Toedeja cave. In this cave, Dr. VAN STEIN CALLENFELS kept the material from the lower layer (C—D) separate from that of the upper (A—B), and it is due to his accurate sampling that the study led to this result.

Table 4, besides the measurements of the six recent horizontal rami (of skulls nos. 1, 2, 5, 6, 7, and 9), contains those of three right (nos. 1—3) and three left rami (nos. 4—6) of the Bola Batoe cave, and of the specimens already recorded but not measured by DAMMERMAN (1939, p. 67/68). The latter consist of a right (no. 7) and a left (no. 8) ramus of the Batoe Edjaja cave, five right (no. 9—13) and seven left rami (nos. 14—20) of layer A—B of the Panganrejang Toedeja cave, and seven right (nos. 21—27) and six left rami (nos. 28—33) of layer C—D in the latter cave, the older layer.

In all of these specimens, nos. 4, 21, and 22 excepted, the incisor is not preserved, and little or nothing of the postdental part is present except in the two Batoe Edjaja cave specimens (nos. 7 and 8). In the latter the coronoid processes have broken off but the condyles are present. No differences from the recent mandibles appear, however, beyond the superior size: the length from the anterior border of P_4 to the posterior

TABLE 4.

Measurements of recent and subfossil lower teeth and horizontal rami of *Phalanger celebensis*.

No.	*P. celebensis celebensis*						1	2	3	4	5	6	7
P_4 ap.	—	3.8	3.7	3.9	3.9	4.0	3.8	3.8	—	3.8	4.1	3.7	3.9
tr.	—	2.9	2.9	3.0	2.9	3.0	2.8	2.9	—	2.9	2.7	2.9	3.0
M_1 tr.	2.5	2.7	2.4	2.5	2.6	2.6	2.6	2.6	—	2.5	2.8	2.5	2.7
M_2 tr.	2.9	2.9	3.0	2.8	2.9	2.9	3.0	2.7	—	3.0	3.0	2.8	2.8
M_3 tr.	—	3.2	3.1	2.9	3.0	3.1	3.1	2.9	3.2	3.1	3.3	2.9	3.1
M_4 tr.	—	3.0	3.0	2.9	2.7	2.9	—	—	2.9	2.8	—	—	—
P_4–M_3	—	15.8	14.8	15.5	15.5	15.8	14.9	14.9	—	15.2	15.8	15.4	15.7
Height at P_4	—	9.3	10.6	9.6	9.5	10.6	11.4	11.0	—	10.2	10.1	9.4	10.1
Id. at M_3	—	7.4	8.7	7.7	7.6	8.2	10.4	9.4	9.7	8.5	9.7	7.6	8.2
Width at M_2	—	4.0	4.2	4.5	4.0	4.8	4.6	4.4	4.7	4.7	5.2	4.1	4.4
No.	8	9	10	11	12	13	14	15	16	17	18	19	20
P_4 ap.	4.0	4.1	3.8	4.3	—	—	4.0	3.8	4.1	4.2	4.1	—	—
tr.	2.9	—	2.8	2.8	—	—	3.1	2.8	2.8	3.0	2.8	—	—
M_1 tr.	2.7	2.6	2.7	2.5	—	—	2.8	2.6	2.5	2.6	2.6	—	—
M_2 tr.	—	2.8	2.8	—	—	—	3.0	2.8	2.8	3.0	—	—	—
M_3 tr.	3.1	2.9	—	—	—	—	3.2	3.1	—	—	—	—	—
M_4 tr.	—	—	—	—	—	—	—	2.9	—	—	—	—	—
P_4–M_3	15.6	14.7	—	—	—	—	15.9	15.1	15.2	—	—	—	—
Height at P_4	10.8	—	10.6	9.5	10.0	10.0	10.3	—	10.3	10.8	10.7	—	—
Id. at M_3	9.3	—	—	9.0	8.5	8.4	8.6	—	8.4	9.0	8.9	—	8.5
Width at M_2	5.2	4.9	—	4.6	4.4	4.8	4.5	4.8	4.3	4.8	4.5	4.9	4.8
No.	21	22	23	24	25	26	27	28	29	30	31	32	33
P_4 ap.	4.3	4.0	4.4	4.0	—	4.0	—	4.4	3.9	—	4.0	—	—
tr.	2.9	3.1	3.4	2.8	—	3.0	—	3.0	2.8	—	2.9	—	—
M_1 tr.	2.7	2.8	2.8	2.7	—	—	—	2.6	2.5	—	—	—	—
M_2 tr.	3.0	3.3	3.1	—	3.1	—	—	3.1	2.8	—	—	—	—
M_3 tr.	3.1	3.4	—	3.2	3.3	—	—	3.3	—	3.2	—	3.0	—
M_4 tr.	—	—	—	—	—	—	—	3.1	—	3.0	—	—	—
P_4–M_3	15.4	16.0	—	15.7	—	—	—	15.8	—	—	—	—	—
Height at P_4	9.8	10.4	10.8	10.7	—	9.2	—	10.9	10.4	12.2	9.8	—	—
Id. at M_3	8.7	8.7	9.4	9.3	8.6	—	9.3	9.0	9.0	10.4	8.4	9.1	9.2
Width at M_2	4.4	4.9	5.0	5.0	4.4	4.6	4.6	5.0	4.7	5.5	4.0	4.7	4.8

border of the condyle is 37.7 mm in the right and 40.1 mm in the left ramus. The maximum value for this dimension in the recent material is 38.0 mm (in skull no. 9). DAMMERMAN (1939, p. 67) thinks the two rami in the Batoe Edjaja cave collection, together with the calvarium fragment recorded already above, to belong probably to one and the same individual. Now the occlusion of the left mandibular teeth with those of the left maxillary is not perfect, and the two rami (as rightly observed by Dr. DAMMERMAN) differ markedly in length. Asymmetrical development of the mandible or calvarium is not an unknown feature, but exceedingly scarce, and why should this sole specimen possess unequally long rami? The calvarium certainly is not of the same individual as the horizontal rami, and whether or not the two rami are of the same individual (the stage of wear and the state of preservation are not against this supposition) is not a matter of great moment.

Of many specimens (nos. 1, 4, 5, 7, 8, 11, 12, 14—23, 29, 30 and 33) enough is preserved in front of P_4 to show alveoli of intermediate teeth, if any. In all of these specimens mentioned there is the normal number of two alveoli for intermediate teeth between I_1 and P_4 except only in no. 4 (pl. I fig. 1) in which there is but one alveolus in front of P_4. This is a variation, though unknown in the recent *P. celebensis*, not uncommon in other species of *Phalanger*, and certainly not of systematic significance.

Teeth of which the measurements are not filled in in table 4 have either fallen out or are too much damaged for measurement. In all specimens the molar series is completed, no juvenile mandibles are present.

As said above, the material originates from different caves, and in one cave even from two different layers, an older and a younger one. In table 5 I give the variation ranges of the dimensions of the teeth and rami of the various caves as well as that of the recent ones, based on the data contained in table 4. The mean values are recorded in table 6. Though the variation ranges do overlap in part, and the differences in average size are not of great magnitude, these tables are certainly worthy of close consideration because they disclose a point of interest in the study of microevolution.

TABLE 5.

Variation ranges of dimensions of lower teeth and rami of *Phalanger celebensis.*

	Recent	Bola Batoe	Batoe Edjaja	Panganrejang A—B	Toedeja C—D
P_4 ap.	3.7—4.0	3.7—4.1	3.9—4.0	3.8—4.3	3.9—4.4
tr.	2.9—3.0	2.7—2.9	2.9—3.0	2.8—3.1	2.8—3.4
M_1 tr.	2.4—2.7	2.5—2.8	2.7	2.5—2.8	2.5—2.8
M_2 tr.	2.8—3.0	2.7—3.0	2.8	2.8—3.0	2.8—3.3
M_3 tr.	2.9—3.2	2.9—3.3	3.1	2.9—3.2	3.0—3.4
M_4 tr.	2.7—3.0	2.8—2.9	—	2.9	3.0—3.1
P_4–M_3	14.8—15.8	14.9—15.8	15.6—15.7	14.7—15.9	15.4—16.0
Height at P_4	9.3—10.6	9.4—11.4	10.1—10.8	9.5—10.8	9.2—12.2
Id. at M_3	7.4—8.7	7.6—10.4	8.2—9.3	8.4—9.0	8.4—10.4
Width at M_2	4.0—4.8	4.1—5.2	4.4—5.2	4.3—4.9	4.0—5.5

It is extremely improbable that it is due to chance that all the ten maxima are found in the specimens from the C—D layer, the older layer, of the Panganrejang Toedeja cave (last column of table 5). The maximum value for the width of M_1 (2.8 mm, in two specimens from layer C—D) is also that of the series of the A—B layer of the Panganrejang Toedeja cave as well as that of the Bola Batoe cave series (one specimen in each of the latter two series). And the maximum height at M_3 (10.4 mm) is equalled by that found in the Bola Batoe cave series (one instance in each of the two series). But in all of the remaining eight observations the maximum dimensions occur in the series of layer C—D of the Panganrejang Toedeja cave exclusively.

TABLE 6.

Average dimensions of lower teeth and rami of *Phalanger celebensis*.

	Recent	Bola Batoe	Panganrejang Toedeja A—B	Panganrejang Toedeja C—D
P_4 ap.	3.9	3.8	4.1	4.1
tr.	2.9	2.8	2.9	3.0
M_1 tr.	2.6	2.6	2.6	2.7
M_2 tr.	2.9	2.9	2.9	3.1
M_3 tr.	3.1	3.1	3.1	3.2
M_4 tr.	2.9	2.9	2.9	3.1
P_4–M_3	15.5	15.2	15.2	15.7
Height at P_4	9.9	10.4	10.3	10.5
Id. at M_3	7.9	9.2	8.7	9.1
Width at M_2	4.3	4.6	4.7	4.7

The latter material also averages higher than all other series except only in the height at M_3 in which measurement the Bola Batoe cave series stands first.

The distribution of the minima is of special interest too. Among the recent series we find six out of the ten minimum values, in the Bola Batoe cave series four (two of which, viz., the antero-posterior diameter of P_4, and the transverse diameter of M_3, are the same as those in the recent series), while in the Panganrejang Toedeja cave series we find only two minima both for layer A—B (transverse diameter of M_3, and length P_4—M_3) and for layer C—D (height at P_4, and width at M_2). These minima are also those of the recent series except that for the length P_4—M_3 and that for the height at P_4 which are both in one instance 0.1 mm less than in the smallest recent specimen.

The average dimensions listed in table 6 (the Batoe Edjaja cave is left out of consideration here) also show that the recent series is the smallest; the molars average as small as those from the Bola Batoe cave and from layer A—B of the Panganrejang Toedeja cave, but in the height and the width of the ramus the recent series averages smaller than all subfossil ones. The smallest average size of P_4 is found in the Bola Batoe cave series,which, like the series from layer A—B of the Panganrejang Toedeja cave, has also a shorter toothrow, on the average, than the recent individuals. It is unwise to lay too much stress on the latter point because with advancing age the toothrow shortens as a result of interproximal wear, and therefore, toothrows of old individuals are not strictly comparable with those of young adults. Similar measurements, which must be used with great reservations, are, however, still widely in use in taxonomic work. I try to make the least possible use of measurements of dental series. The transverse diameters of the teeth, being free from age variations for a much longer time, are the most reliable, and, added to that, easier to take.

To sum up, we have now found that the remains of *Phalanger celebensis* in the layer C—D of the Panganrejang Toedeja cave have the tendency to present greater dimensions than those from layer A—B, the upper layer, in the same cave. The differences in size of the teeth and the ramus horizontalis are not great, but all observations point in the same direction, and, taken together, leave no doubt that we have here before us a most beautiful instance of (micro)evolution in situ with diminution in size.

Recent *P. celebensis celebensis*, still spread over the whole of the island of Celebes today and which neozoologists have not succeeded in splitting, is smaller again than the form of the upper layer A—B of the Panganrejang Toedeja cave; the decrease in size has proceeded further, up to the present time. The bone of the mandible seems to be easier to affect by the process of decrease in size than the molars which stuck to their former average dimensions.

TABLE 7.

Phalanger celebensis.

	n	M	σ	C	$E_{\text{diff.}}$	$\frac{M_{\text{subf.}} - M_{\text{rec.}}}{E_{\text{diff.}}}$
Height at P_4, recent	5	9.9	0.6	6.4	0.4	1.5
Id., subfossil	9	10.5	0.9	8.1		
Height at M_3, recent	5	7.9	0.5	6.7	0.3	4.0
Id., subfossil	12	9.1	0.5	5.7		
Width at M_2, recent	5	4.3	0.3	8.1	0.2	2.0
Id., subfossil	13	4.7	0.4	7.9		

The difference in height and width between the horizontal rami of layer C—D of the Panganrejang Toedeja cave and the recent is even statistically significant, as appears from table 7. The subfossil teeth from layer C—D of the Panganrejang Toedeja cave, though averaging larger than those of the upper layer A—B of the same cave, those from the Bola Batoe cave, and the recent, are not really larger than the latter, however.

The *Phalanger celebensis* from the lower layer of the Panganrejang Toedeja cave, being the largest of the subfossil forms, is the lowest point we now have of a vertical cline leading to living *P. celebensis celebensis.* The form of the upper layer of the same cave is intermediate between the older form and the living, and represents only a point on the cline. When following this cline downward with the help of fossils (which are as yet wanting in this group) we shall certainly find more marked differences from the recent form, we shall find fossil Cuscuses which are really larger than the recent not only in their bony parts but also in their teeth. And here the difficult question as to the nomenclature of these intergrading forms comes in. In the present case of *P. celebensis* we have already at least three subfossil samples of different localities and/or ages, each representing a form but slightly differentiated from the others. Size is the only criterion, and greater size is connected with greater age, as we know also from other examples. I do not accept all of these cave forms as separate subspecies, but would like to baptize only the oldest Panganrejang Toedeja cave form, the only that is beyond the size range of living *P. celebensis celebensis*, as:

Phalanger celebensis callenfelsi nov. subsp.

Diagnosis: Teeth identical in specific characters to those of recent *Phalanger celebensis celebensis* (Gray) but of greater average size. The mandible is higher and wider than that of *P. celebensis celebensis* (Gray), and the difference in size is statistically significant.

Holotype: A right horizontal ramus of the mandible with all teeth except M_4 and the intermediate teeth (alveoli of which are present), represented on pl. I figs. 2—3 (no. 22 of table 4 of the present paper).

Paratypes: Six right and six left horizontal rami of the mandible, with teeth (nos. 21 and 23—33 of table 4).

Locality: Panganrejang Toedeja cave, layer C—D, near Bonthain, S. Celebes.

Age: Early Holocene.

Name: The name is given in honour to its discoverer, the late Dr. P. V. VAN STEIN CALLENFELS, who explored the Panganrejang Toedeja cave in 1937.

The Bola Batoe cave material of *P. celebensis*, like that of layer A—B of the Panganrejang Toedeja cave, has the same average molar dimensions as the living race of Celebes but a smaller P_4 and a higher ramus horizontalis. It is certain that the Bola Batoe cave material is geologically younger than that of layer C—D of the Panganrejang Toedeja cave, but whether or not it is more recent in age than the material from the upper layer A—B of the latter cave is impossible to make out on the base of this material.
I regard the Bola Batoe cave, Batoe Edjaja cave, and Panganrejang Toedeja (layer A—B) cave material as representing intergrades between *P. celebensis callenfelsi* nov. subsp. and *P. celebensis celebensis*, but nearer to the former than to the latter subspecies. Instead of using the name *Phalanger celebensis* (Gray) subsp. it is perhaps preferable to indicate these forms by a bifid racial terminal (cf. HARRISON, 1945), as follows:

$$\textit{Phalanger celebensis} \left\langle \begin{array}{l} \textit{P. c. callenfelsi}\ \text{Hooijer} \\ \textit{P. c. celebensis}\ \text{(Gray)} \end{array} \right.$$

thereby indicating that the cave material is nearest to *P. c. callenfelsi*.

There remain to be mentioned some limb bones. DAMMERMAN (1939, p. 68) records the lower part of a left humerus from the Panganrejang

Toedeja cave, layer A—B, as probably belonging to the present form, and also the lower parts of a right and a left humerus from layer C—D of the latter cave. The latter specimens are less complete than the former, the distal epiphyses being lost, but the comparison with the corresponding bone in the one skeleton (belonging to skull no. 6) in my possession shows that these specimens as well as that of the upper layer can be classed with *P. celebensis*. The older specimens are not yet adult, but the younger is, and the latter is of the same size as the recent humeri. The supinator ridge

TABLE 8.

Measurements of recent and subfossil humeri of *Phalanger celebensis*.

	P. celebensis		Panganrejang		Toedeja cave
	celebensis		A—B	C—D	C—D
	dext.	sin.	sin.	dext.	sin.
Height from upper incision in supinator ridge to articulation surface for radius	13.4	13.0	14.6	—	—
Least width of shaft	3.7	3.7	3.8	3.7	4.2
Greatest distal width	14.2	14.4	14.3	—	—
Greatest antero-posterior diameter at deltoid ridge	—	6.5	—	7.5	6.5
Antero-posterior diameter of articulation surface for radius	5.0	4.9	5.0	—	—

only is a little the higher in the subfossil specimen, but there is variation in this character even in one individual. The most prominent part of the deltoid ridge is broken off in the recent right bone and in the A—B layer specimen but complete in the older bones. On the basis of this meagre material no conclusions can be drawn as to the relative size of the races to which the bones belong, though some measurements of the subfossil examples do show an excess in size over the corresponding recent.

Order INSECTIVORA Bowdich

Family SORICIDAE Gray

Genus **Suncus** Ehrenberg

A singularly well preserved front part of a tiny calvarium, broken off behind the palate, is the only evidence I have of an insectivore in the Bola Batoe cave fauna. Two insectivore genera occur on the island of Celebes, viz., *Crocidura* and *Suncus*. That the subfossil calvarium belongs to the genus *Suncus* and not to *Crocidura* is evident from the presence of two instead of only one small tooth on each side between the third incisor and the enlarged hindmost premolar, thus making a total of three premolars instead of two (cf. CABRERA, 1925, pp. 142 and 147), or of two premolars instead of one if a canine is accepted (WEBER, 1928, p. 121). I shall denominate the four unicuspid teeth between the big anterior incisor and premolar as I^2, I^3, C, and P^1 respectively.

The generic position of the cave calvarium being certain, the species remains to be determined. The large Oriental house musk shrew, *Suncus murinus* (L.) (*Pachyura murina* s. *indica* auct.) is spread over the whole of the Malay Archipelago, and a number of species of this genus have been named in the course of time. As I shall show below subspecific differentiation is often really the most that can be recognized.

The Celebean race was described by REVILLIOD only in 1911, and was based on specimens collected by P. and F. SARASIN in Northern Central Celebes. This Celebes form is mentioned twice under different names not only by RAVEN (1935, p. 221: *Suncus indicus celebensis*, and *Suncus murina celebensis*, both as of REVILLIOD) but also by TATE (1944, p. 6/7: *Crocidura murina celebensis*, and *Suncus indicus celebensis*). KOLLER (1930) accepts only two subspecies, one wild and one commensal: *Suncus indicus indicus* and *Suncus indicus coerulus* respectively, for the whole of the Malay Archipelago, but distinguishes between a number of colour varieties. This is not accepted by SODY (1932a) who writes "*Suncus murina*"; LINNAEUS had applied the name *Sorex murinus* to the house shrew of Java, and the original description is apt (CHASEN, 1940, p. 19).

The Leiden Museum possesses a series of stuffed skins (made up from alcoholic specimens), with their skulls, from Java, Sumatra, and Borneo belonging to the typical subspecies *Suncus murinus murinus* (L.) (cf. CHASEN, 1940, p. 18), but we have unfortunately no specimens from Celebes. I have compared the Bola Batoe cave calvarium also with Philippines, Ternate, Batjan, Amboina, Banda Neira, and Timor specimens.

For the Philippines TAYLOR (1934) accepts three species of "*Pachyura*" (= *Suncus*, cf., l.c., p. 530), all supposedly distinct from *Suncus murinus*, viz., *S. occultidens*, *S. palawanensis*, and *S. luzoniensis*. Our Museum material is from Luzon and should, therefore, belong to *Suncus luzoniensis* (Peters). Of the Moluccan series in the Leiden Museum three specimens, from Ternate, Banda Neira, and Timor respectively, were made the holotypes of as many new species, viz, "*Pachyura unicolor*" (JENTINK, 1888a, p. 166), "*Pachyura semmelinki*" (JENTINK, 1889, p. 213), and "*Pachyura mülleri*" (JENTINK, 1888a, p. 166). The Batjan and Amboina specimens received no special names, and are listed in the Museum catalogues under the same name as the Greater Sunda Islands specimens, viz., "*Pachyura indica*" (see also JENTINK, 1888a, p. 163).

Critical colour comparison (except, of course, in very striking cases such as is the case with albinism displayed, e.g., in one of the Manila specimens) is impossible with these skins that were kept so long in alcohol (cf. SODY, 1932a, p. 40; CHASEN, 1940, p. XVIII [1]). Even skull measurements may be unreliable in view of the fact that skulls cleaned ex spirit have so often shrunk somewhat (MORRISON–SCOTT, 1948, p. 820).

The relative size of the upper I, C, and P has received a good deal of the attention of the various describers of new species or races of *Suncus*. The monocuspid I^2, I^3, C, and P^1, however, must differ individually, too, and the study of this variation is, therefore, strongly recommended. I have examined the Leiden Museum series for this purpose; the material is listed below:

Suncus murinus murinus (L.)

JAVA

1. Skeleton of adult. Coll. KUHL and VAN HASSELT. L. M., cat. ost. a.
2. Skeleton of adult. Coll. KUHL and VAN HASSELT. L. M., cat. ost. b.
3. Stuffed skin and skull of adult. L. M., cat. syst. e, cat. ost. l.
4. Stuffed skin and skull of adult. Coll. KUHL and VAN HASSELT. L. M., cat. syst. f, cat. ost. m.
5. Stuffed skin and skull of adult. Malang, coll. HILDEBRANDT, 1872. L. M., cat. syst. k, cat. ost. h^2, reg. no. 664a.
6. Stuffed skin and skull of adult. Malang, coll. HILDEBRANDT, 1872. L. M., cat. syst. l, cat. ost. i^2, reg. no. 664b.
7. Stuffed skin and skull of adult. Batavia, coll. SEMMELINK, received December, 1881. L. M., cat. syst. n, cat. ost. r, reg. no. 666.
8. Stuffed skin and skeleton of adult. Coll. GROEN. L. M., cat. syst. p, cat. ost. ij, reg. no. 668a.
9. Stuffed skin and skull of adult. Coll. GROEN, 1861. L. M., cat. syst. q, cat. ost. v, reg. no. 668b.
10. Stuffed skin and skull of adult. Coll. GROEN, 1861. L. M., cat. syst. r, cat. ost. w, reg. no. 668c.
11. Stuffed skin and skull of adult. Coll. GROEN, 1861. L. M., cat. syst. s, cat. ost. u, reg. no. 668d.
12. Stuffed skin and skull of adult. Coll. GROEN. L. M., cat. syst. t, cat. ost. x, reg. no. 668e.

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[1]) In his description of the new species *Suncus palawanensis* TAYLOR (1934, p. 78) records the "color in alcohol", and adds the colour he presumes the animal to have had during life!

13. Stuffed skin and skeleton of adult. Tjiomas, coll. SEMMELINK, received December, 1881. L. M., cat. syst. a^2, cat. ost. z, reg. no. 674a.
14. Stuffed skin and skull of adult. Tjibodas, coll. SEMMELINK, received December, 1881. L. M., cat. syst. b^2, cat. ost. s, reg. no. 674b.
15. Stuffed skin and skeleton of adult. Malang, coll. HILDEBRANDT, 1871. L. M., cat. syst. j^2, cat. ost. m, reg. no. 665.
16. Stuffed skin and skeleton of adult. Batavia, coll. SEMMELINK, 7–6–1882. L. M., reg. no. 1502a.
17. Stuffed skin and skull of adult. Batavia, coll. SEMMELINK, 7–6–1882. L. M., reg. no. 1502b.
18. Stuffed skin and skull of adult. Tosari, coll. KOHLBRUGGE. L. M., reg. no. 1427a.
19. Stuffed skin and skeleton of adult. Tosari, coll. KOHLBRUGGE. L. M., reg. no. 1427b.
20. Stuffed skin and skull of adult. Coll. DAMMERMAN, 29–3–1919. L. M., reg. no. 910.

SUMATRA

1. Stuffed skin and skull of young adult. Deli, coll. HAGEN, 18–7–1891. L. M., reg. no. 1411.

BORNEO

1. Stuffed skin and skull of adult male. Coll. SEMMELINK, 1865. L. M., cat. syst. u, cat. ost. o, reg. no. 669.
2. Stuffed skin and skull of adult. Coll. HAKBEYL, 1872. L. M., cat. syst. v, cat. ost. p, reg. no. 670.
3. Stuffed skin and skeleton of adult female. Pontianak, coll. BÜTTIKOFER, 7–12–1894. L. M., cat. syst. c^2, cat. ost. a^2, reg. no. 1284a.
4. Stuffed skin and skeleton of adult female. Pontianak, coll. BÜTTIKOFER, 8–1–1895. L. M., cat. syst. d^2, cat. ost. b^2, reg. no. 1284b.
5. Stuffed skin and skull of adult. Pontianak, coll. BÜTTIKOFER, 8–1–1895. L. M., cat. syst. e^2, cat. ost. t, reg. no. 1284c.
6. Stuffed skin and skull of adult. Pontianak, coll. SCHAEDLER, 1896. L. M., reg. no. 1362a.
7. Stuffed skin and skeleton of adult. Pontianak, coll. SCHAEDLER, 1896. L. M., reg. no. 1362b.
8. Stuffed skin and skull of adult. Pontianak, coll. SCHAEDLER, 1896. L. M., reg. no. 1362c.

Suncus murinus (L.) subsp.

PHILIPPINES

1. Stuffed skin and skeleton of adult female. Cagayan, Manila, coll. V. D. VALK, 27–12–1891. L. M., reg. no. 1352.
2. Stuffed skin and skull of adult. Cagayan, Manila, coll. V. D. VALK, 27–12–1891. L. M., reg. no. 1353a.
3. Stuffed skin and skeleton of adult. Coll. V. D. VALK, July, 1897. L. M., reg. no. 1357.

TERNATE

1. Stuffed skin and skull of adult female. Coll. VAN MUSSCHENBROEK, 11–1–1875. L. M., type of "*Pachyura unicolor*" Jentink, cat. syst. a, cat. ost. a.

BATJAN

1. Stuffed skin and skull of adult. Coll. BERNSTEIN, 1861. L. M., cat. syst. x, cat. ost. n, reg. no. 672a.
2. Stuffed skin and skeleton of adult. Coll. BERNSTEIN, 1861. L. M., cat. syst. ij, cat. ost. q, reg. no. 672b.
3. Stuffed skin and skull of adult. From H. ROLLE, 5–5–1899. L. M.
4. Stuffed skin and skull of adult. Coll. WATERSTRADT, from H. ROLLE, March, 1901. L. M.

AMBOINA

1. Stuffed skin and skull of adult. Coll. TEYSMANN, 1877. L. M., cat. syst. w, cat. ost. k^2, reg. no. 671.

BANDA NEIRA

1. Stuffed skin and skeleton of adult female. Coll. SEMMELINK, 1881. L. M., cat. syst. z, cat. ost. c^2, reg. no. 673.
2. Stuffed skin and skeleton of adult female. Coll. SEMMELINK, 1881. L. M., reg. no. 675, type of "*Pachyura semmelinki*" Jentink.

TIMOR

1. Stuffed skin and calvarium of adult. Coll. MÜLLER, 1828. L. M., type of "*Pachyura mülleri*" Jentink, cat. syst. a, cat. ost. a.

In the Javan series I found indeed several variations. The unicuspids, if arranged according to decreasing size, invariably form the succession I^2 — C — I^3 — P^1, but the relative size of the posterior cusp of I^1 is different. The latter cusp is most often about equal to the C as to size, but the C may be decidedly larger (nos. 13 and 19) and also decidedly smaller (nos. 4 and 11) than the posterior cusp of I^1. There is a similar variation in the relative height of the various cusps. That of I^2 is always the highest, and then follow the C, the posterior cusp of I^1, the I^3, and, finally, the P^1 in the most commonly found succession. But the I^3 may also exceed the posterior cusp of I^1 in height (nos. 5, 7, 10, 11, 14, and 20). Wear of the minute cusps often makes this latter observation difficult or unreliable.

Thus PETERS (1870, p. 593), in his description of the large Sumatran musk shrew *Suncus sumatranus*, writes that the posterior cusp of I^1 is low and blunt (in apparent contradistinction of the Luzon form he describes in the same paper), but my Sumatran specimen is a young adult and has a sharply pointed heel to the I^1. Nor can I agree with the diagnosis of the large Bornean form (*Suncus kroonii*) as given by KOHLBRUGGE (1895, p. 198/99), who writes that the posterior cusp of I^1 is slightly smaller than I^3 and C. The posterior cusp of I^1 is never smaller than I^3; it exceeds the I^3 in size in all of my eight Bornean examples as it does in the Javan material, too. The variations in the Bornean calvariums are the same as those in the Javan series, viz., the posterior cusp of I^1 is either higher or lower than I^3. In the Bornean skulls the I^3 has a greater tendency to be higher than the posterior cusp of I^1 than is the case in the Javan series, but the difference is not great.

The diagnosis of the Celebean form (REVILLIOD, 1911) unfortunately is not very elaborate on the teeth, but what is recorded (posterior cusp of I^1 about as high as I^3, and C higher than I^3) is nothing exceptional, and from the measurements given size differences from the other Greater Sunda Islands forms do not appear.

The Philippine calvariums do not all have the short and sharp posterior cusp of I^1 said to be typical of *Suncus luzoniensis* (Peters, 1870, p. 595), for no. 1 has a blunt posterior cusp of the I^1. The posterior cusp of I^1 is intermediate in size between the I^3 and the C, as usual. PETERS (l.c.) also records that I^2 is shorter than I^3 and C together, but this is the case in every skull of *Suncus murinus* I have seen. The diagnoses of *S. occultidens* (Hollister, 1913, p. 303) and of *S. palawanensis* (Taylor, 1934, p. 79) do not contain significant points of distinction as far as the teeth are concerned; my specimen no. 2 (reg. no. 1353a, from Luzon), e.g., has the high posterior cusp of I^1 supposedly typical of the Palawan form, and added to that P^1 is invisible from the outer side as should be characteristic of *S. occultidens* from Panay, Negros, and Mindanao.

The Ternate specimen in our Museum, holotype of *Suncus unicolor* (Jentink, 1888a p. 167), has I^3 and C not of the same size as noticed by its first describer. The C is decidedly larger than I^3, as is always the case in *Suncus murinus* (L.). The posterior cusp of I^1 is as big as the C, and the small ovoid P^1 is not to be seen from without. The external characters do not permit of a separation of the Ternate specimen from those of the Greater Sunda Islands. The recorded absence of elongated hairs on the tail can easily be accounted for by the bad state of preservation of the whole skin which has bald spots on the head, shoulders, and below (and I found still four or five long hairs on the tail).

The four specimens from Batjan Island are indistinguishable from *Suncus murinus murinus* (L.) and need not to be described. One interesting variation is shown in no. 1 (reg. no. 672a): P^1, always the smallest of the unicuspids, is decidedly larger on the left than on the right side. The posterior cusp of I^1 is sharp and pointed in nos. 1 and 3, but blunt in nos. 2 and 4.

The Amboina specimen has very much reduced P^1's, and P^2 is virtually in contact with the C. It needs, however, no further remarks.

Two Banda Neira specimens are in the Leiden Museum collection, one of which was made the holotype of *Suncus semmelinki* (Jentink, 1889, p. 213). Since the skull is now taken out of the skin the swollen muzzle is no longer apparent, and the maroon colour is unreliable in this formerly alcoholic specimen. This colour, moreover, is not shared by the topotype specimen of the same collector and date. Added to that the type colour occurs in Javan and Bornean skins too (see also KOLLER, 1930, p. 315).

As far as the skull characters are concerned, JENTINK (l.c.) is very accurate, stating that C is about 4/5 of the size of I^2, and that I^3 is about 2/3 of the size of the C. Comparison with the large Javan and Bornean series convincingly shows that these are no characters on which to base a new species.

There remain the Timor skin and skull (the mandible of which is lost), holotype of *Suncus mülleri* (Jentink, 1888a, p. 166). The external characters are irrelevant. The posterior cusp of I^1 is indeed small, but certainly not exceptionally so for a *Suncus murinus*. I^3 and C, in contradistinction to JENTINK's statement, are not of the same size but the C is decidedly the larger of the two. Neither in the relative size nor in the relative height of the unicuspids (painstakingly recorded in the diagnosis) there is the slightest justification for the separation of this specimen as a distinct species.

I am fully convinced, after the study of the type specimens, that *Suncus unicolor*, *S. semmelinki*, and *S. mülleri* can be rejected as species names, and I doubt whether they have any significance even as subspecies. It seems best, however, to leave these forms subspecifically unnamed as long as the material is so meagre, but the species undoubtedly is *Suncus murinus* (L.).

Suncus murinus (L.) subsp.

(pl. I fig. 9.)

In the subfossil calvarium from the Bola Batoe cave collected by Mr. VAN HEEKEREN the incisors and the canine are preserved on either side; the P^1 is lost on the left side but its alveolus is shown. At the right side there are both P^1 and P^2, but the molars are missing. Of the left cheek-teeth series only the anterior root of P^2 is present.

The posterior cusp of I^1 is smaller than the C and higher than I^3. I^2 is by far the biggest and highest of the four unicuspids, and is but slightly shorter antero-posteriorly than I^3 and C together. The C is the second largest unicuspid. I^3 is only very slightly larger than P^1, which latter is placed to the inner side of the antero-lateral projection of P^2, and which is, therefore, hardly visible from without. This all is well shown in the enlarged picture of the specimen represented on pl. I fig. 9.

The subfossil specimen represents a variation which is rare in the Javan musk shrew, viz., that in which the C is decidedly larger than the posterior cusp of I^1, shown only in two (nos. 13 and 19) out of the twenty Javan specimens, as noticed already above. Size differences do not exist either; in tabel 9 I give three skull measurements of the Bola Batoe cave specimen as well as the ranges found in the Javan, Bornean, Celebean (these latter after REVILLIOD, 1911), Philippines, Batjan, and Banda Neira skulls, and the observations of the Ternate, Amboina, and Timor specimens.

In the relevant part of the calvarium the subfossil Celebean form is indistinguishable from some of the Javan specimens of *Suncus murinus murinus* (L.). The recent Celebean form is perhaps subspecifically distinct from the Javan.The Sumatran, Bornean, and the various island forms East

TABLE 9.

Measurements of the skull of *Suncus murinus* (L.) subsp.

	Bola Batoe	Java	Borneo	Celebes
Median length of palate	12.9	11.8—15.0	12.7—14.2	12.5—13
Maxillary width (posterior)	9.2	8.3—11.0	9.0—10.5	—
Width of muzzle at I^3	4.0	3.5—5.0	3.8—4.9	—
	Philippines	**Ternate**	**Batjan**	**Amboina**
Median length of palate	11.8—12.7	11.5	12.6—12.8	12.6
Maxillary width (posterior)	8.0—9.0	8.6	8.8—9.2	8.5
Width of muzzle at I^3	3.1—4.1	3.7	3.8—3.9	3.8
	Banda Neira	**Timor**		
Median length of palate	11.4—12.2	12.2		
Maxillary width (posterior)	8.7—9.5	9.4		
Width of muzzle at I^3	3.5—3.9	4.0		

of WALLACE's Line do not, however, differ from the common large Javan musk shrew. It would seem evident that the three named Philippine Islands species can be merged with *Suncus murinus* (L.), too. The Leiden Museum skins and skulls are not different from Javan specimens.

My conclusions conform well, in part, with those of KOLLER (1930) who found the colours said to be typical of the Sumatran and Celebean races as well as those of *semmelinki* and *mülleri* (Banda Neira and Timor) in a series of skins from Java alone.

Neither SARASIN (1905) nor DAMMERMAN (1939) made mention of the presence of insectivores in the Toalian cave fauna. The presence of a musk shrew in the Bola Batoe cave is, however, not surprising since these animals seem to occur almost exclusively about houses and villages and, therefore, may be called domestic. The Celebean cave musk shrew is, perhaps, not subspecifically the same as the recent Javan form, and I identify the subfossil calvarium provisionally as *Suncus murinus* (L.) subsp.

Order PRIMATES Linnaeus

Family CERCOPITHECIDAE Gray

Genus **Macaca** Lacépède

The distinguishing external and cranial characters of the living Celebean macaques have been studied by various authors, among whom I may cite MURIE (1872), SCHLEGEL (1876), WEBER (1890), MEYER (1896, 1899), MATSCHIE (1901), ELLIOT (1913), BÜTTIKOFER (1917), POCOCK (1925), DE BEAUX (1929), MILLER (1931), and SCHWARZ (1934). The cave collections now at my disposal, however, necessitate a closer study of the teeth, which has been almost completely neglected in previous work. Measurements of toothrows (P3-M3, or C-M3) occasionally given in connection with a skull description are of little value; as a result of interproximal wear the toothrow becomes shorter with advancing age.

The recent material examined by me is almost completely recorded by BÜTTIKOFER (1917). In this work, like in most of the earlier papers, all forms are given full specific rank. In the material at hand I recognize two species, *Macaca maura* (Geoffr. et F. Cuvier), and *Cynopithecus niger* (Desmarest), each with three subspecies, as follows:

Macaca maura (Geoffr. et F. Cuvier) subsp.

Material examined:

Infant.

1. Stuffed skin and skull of ♂. From the Rotterdam Zoo, 16–12–1919. L. M., reg. no. 959.

Juveniles.

2. Mounted skin and skull of ♀. "Borneo", from the Rotterdam Zoo, 1–5–1875. L. M., cat. syst. c, cat. ost. f.
3. Mounted skin and skull of ♂. "Borneo", from the Rotterdam Zoo, 17–3–1863. L. M., cat. syst. d, cat. ost. e.
4. Mounted skin and skeleton of ♂. Celebes, from C. BLAZER, 11–6–1925. L. M., reg. no. 1395.
5. Flat skin and skull of ♂. From the Rotterdam Zoo, 13–3–1914 (imported 8–8–1913; no. 2412). L. M., reg. no. 751.
6. Skull of ♀. Maros, S. Celebes, coll. WEBER no. 314. A. M.
7. Skull of ♀. Maros, S. Celebes, coll. WEBER no. 332. A. M.
8. Skull of ♀. Celebes. A. M., no. S 113.

Subadults.

9. Mounted skin of ♂ (skull inside). From the Rotterdam Zoo, 2–2–1877. L. M. cat. syst. f.
10. Mounted skin of ♀. From the Amsterdam Zoo, 1844. L. M., cat. syst. i.
11. Mounted skin and skeleton of ♂. "Borneo", from FRANK, 9–2–1875. L. M., cat. syst. a, cat. ost. a.
12. Mounted skin and skeleton of ♂. "Borneo", from FRANK, 20–4–1875. L. M., cat. syst. b, cat. ost. b.

13. Mounted skin and skull of ♀. From the Amsterdam Zoo, 16–9–1882. L. M., cat. syst. e, cat. ost. d.
14. Mounted skin and skull of ♂. From the Rotterdam Zoo, 12–11–1874. L. M., cat. syst. h, *"Macacus ocreatus"*, cat. ost. b.
15. Mounted skin and skeleton of ♀. Celebes, from the Rotterdam Zoo, 9–9–1930. L. M., reg. no. 1877.
16. Mounted skin and skeleton of ♂. From the Rotterdam Zoo, 31–10–1930. L. M., reg. no. 1894.
17. Stuffed skin and skeleton of ♀. Macassar, S. Celebes, from the Rotterdam Zoo, 7–6–1918 (imported 8–8–1916). L. M., reg. no. 855.
18. Flat skin and skull of ♂. Celebes, from the Rotterdam Zoo, 6–12–1926. L. M., reg. no. 1547.
19. Stuffed skin and skull of ♂. From the Rotterdam Zoo, 30–6–1915 (imported 15–7–1912; no. 2335). L. M., reg. no. 751.
20. Stuffed skin and skull of ♂. Macassar, S. Celebes, from the Rotterdam Zoo, 24–8–1915 (imported 19–8–1914; no. 2484). L. M., reg. no. 751.
21. Skull of ♀. Kendari Bay, S.E. Celebes, coll. WEBER no. 116. A. M.
22. Skull of ♂. Boeton, coll. WEBER no. 115. A. M.
23. Skull. Celebes. A. M., no. S 114.
24. Skull of ♂. Celebes. A. M., no. S 118.

Adult males.

25. Mounted skin. From the Naturalists' Society, Batavia, 1848. L. M., cat. syst. g.
26. Stuffed skin and skeleton. From C. BLAZER, 5–4–1938. L. M., reg. no. 3398.
27. Stuffed skin and skull. Macassar, S. Celebes, from the Rotterdam Zoo, 18–8–1920 (imported March, 1920). L. M., reg. no. 1009.
28. Stuffed skin and skull. From the Rotterdam Zoo, 18–11–1916 (imported 6–2–1912; no. 2363). L. M., reg. no. 751.
29. Flat skin and skull. From the Rotterdam Zoo, 20–5–1914 (imported 6–5–1913; no. 2398 a). L. M., reg. no. 751.
30. Stuffed skin and skull. From the Rotterdam Zoo, 10–5–1917; no. 2202). L. M., reg. no. 751.
31. Stuffed skin and skull. Macassar, S. Celebes, from the Rotterdam Zoo, 16–4–1916 (imported 6–7–1915; no. 2529). L. M., reg. no. 751.
32. Stuffed skin and skull. From the Rotterdam Zoo, 21–10–1915 (imported 3–7–1914; no. 2472). L. M., reg. no. 751.
33. Skull. Celebes. A. M., no. S 120.
34. Skull. Celebes. A. M., no. S 117.
35. Skull. Celebes. A. M., no. S 119.

Adult females.

36. Mounted skin and skeleton. Macassar, S. Celebes, coll. REINWARDT, 1841. L. M., cat. syst. k, cat. ost. c.
37. Flat skin and skeleton. Macassar, S. Celebes, from the Rotterdam Zoo, 14–5–1927. L. M., reg. no. 1580.
38. Stuffed skin and skull. Macassar, S. Celebes, from the Rotterdam Zoo, 22–12–1917 (imported 15–7–1912). L. M.,reg. no. 810.
39. Stuffed skin and skull. From the Rotterdam Zoo, 31–1–1916 (imported 29–10–1910; no. 2201). L. M., reg. no. 751.
40. Skeleton. Macassar, S. Celebes, coll. REINWARDT. L. M., *"Macacus ocreatus"*, cat. ost. a.
41. Skull. Maros, S. Celebes, coll. WEBER no. 315. A. M.
42. Skull. Pare Pare, S. Celebes, coll. WEBER no. 334. A. M.
43. Skull. From the Amsterdam Zoo, 23–7–1937. A. M.

The bulk of the above mentioned specimens belong to the typical subspecies *Macaca maura maura* (Geoffr. et F. Cuvier) from the South-western peninsula of Celebes as far to the N. as Pare Pare (no. 42), and it is in this region of the island where the subfossil material to be dealt with below was found. Three specimens (nos. 9, 13, and 22) represent *Macaca maura brunnescens* (Matschie) from the islands of Boeton and Moena off the S. coast of the South-eastern peninsula, while six others (nos. 10, 14, 21, 25, 36, and 40) belong to *Macaca maura ochreata* (Ogilby) of the South-eastern peninsula (BÜTTIKOFER, 1917, pp. 44—57). The skulls of these specimens are indistinguishable from those of the typical Moor Macaque of the South-western peninsula.

Cynopithecus niger (Desmarest) subsp.

Material examined:

Infants.

1. Mounted skin. Menado, N. Celebes, coll. FORSTEN, 1842. L. M., cat. syst. e.
2. Mounted skin and skull of ♀. Gorontalo, N. Celebes, coll. VON ROSENBERG, April, 1864. L. M., cat. syst. i, cat. ost. i.

Juveniles.

3. Mounted skin of ♀ (skull inside). Menado, N. Celebes, coll. FORSTEN, 1842. L. M., cat. syst. d.
4. Mounted skin and skull of ♂. Celebes, from the Rotterdam Zoo, 20–3–1875. L. M., cat. syst. p, cat. ost. o.
5. Mounted skin and skull of ♂, Celebes, from the Rotterdam Zoo, 9–11–1874. L. M., cat. syst. q, cat. ost. p.
6. Mounted skin and skeleton of ♀. From the Rotterdam Zoo, 19–3–1876. L. M., cat. syst. s, cat. ost. c.
7. Skull of ♂. Coll. WETZEL, 1895. A. M., no. 342.

Subadults.

8. Mounted skin of ♀ (skull inside). Menado, N. Celebes, coll. FORSTEN, 1842. L. M., cat. syst. c.
9. Mounted skin and skull of ♂. Toelabollo, Gorontalo, N. Celebes, coll. VON ROSENBERG, 16–4–1864. L. M., cat. syst. g, cat. ost. g.
10. Mounted skin and skull of ♀. Gorontalo, N. Celebes, coll. VON ROSENBERG, 5–5–1864. L. M., cat. syst. h, cat. ost. h.
11. Mounted skin and skull of ♂. Batjan, coll. BERNSTEIN, February, 1861. L. M., cat. syst. m, cat. ost. l.
12. Mounted skin and skull of ♀. Batjan, coll. BERNSTEIN, February, 1861. L. M., cat. syst. n, cat. ost. m.
13. Mounted skin and skull of ♀. Batjan, coll. BERNSTEIN, 1864. L. M., cat. syst. o, cat. ost. n.
14. Flat skin and skull of ♂. N. Celebes, from the Rotterdam Zoo, 7–4–1915 (imported 16–9–1911; no. 2272). L. M., reg. no. 751.
15. Flat skin and skull of ♂. Menado, N. Celebes (?), from the Rotterdam Zoo, 12–5–1915 (imported 8–8–1913; no. 2411). L. M., reg. no. 751.
16. Skull of ♂. Menado, N. Celebes, coll. REINWARDT, 1822. L. M., cat. ost. e.

Adult males.

17. Mounted skin (skull inside). Menado, N. Celebes, coll. FORSTEN, 1842. L. M., cat. syst. a.
18. Mounted skin (skull inside). Menado, N. Celebes, coll. VAN MUSSCHENBROEK, 1878. L. M., cat. syst. t.
19. Mounted skin. Tomini, N. Celebes, coll. FORSTEN, 1842. L. M., cat. syst. j.
20. Mounted skin and skull. Gorontalo, N. Celebes, coll. FORSTEN, 1842. L. M., cat. syst. b, cat. ost. f.
21. Mounted skin and skull. Batjan, coll. BERNSTEIN, February, 1861. L. M., cat. syst. k, cat. ost. j.
22. Mounted skin and skull. Batjan, coll. BERNSTEIN, 1866. L. M., cat. syst. l, cat. ost. k.
23. Stuffed skin and skull. From the Rotterdam Zoo, 27–12–1938. L. M., reg. no. 3801.
24. Stuffed skin and skeleton. From the Rotterdam Zoo, 4–2–1937. L. M., reg. no. 2613.
25. Flat skin and skeleton. Goerospahi, Bolaäng Mongondow, N. Celebes, coll. W. KAUDERN, 26–4–1917. L. M., reg. no. 1343.
26. Flat skin and skeleton. Modajan, Bolaäng Mongondow, N. Celebes, coll. W. KAUDERN, 21–10–1917, L. M., reg. no. 1343.
27. Flat skin and skeleton. From the Rotterdam Zoo, 21–12–1933. L. M., reg. no. 2210.
28. Skeleton. Celebes, coll. FORSTEN. L. M., cat. ost. a.
29. Skull. Menado, N. Celebes, coll. VAN DELDEN, 1836. L. M., cat. ost. r.
30. Skull. Menado, N. Celebes, coll. VAN DELDEN, 1836. L. M., cat. ost. d.
31. Skull. A. M., no data.
32. Skull. Celebes, A. M., no. S 121.

Adult females.

33. Mounted skin. Gorontalo, N. Celebes, coll. FORSTEN, 1842. L. M., cat. syst. f.
34. Mounted skin (skull inside). From the Rotterdam Zoo, 24–12–1875. L. M., cat. syst. r.
35. Mounted skin and skull. N. Celebes, coll. FORSTEN, 1842. L. M., "*Macacus maurus*", cat. syst. j. Cf. BÜTTIKOFER, 1917, pp. 25/26 and 34.
36. Flat skin and skeleton. Goerospahi, Bolaäng Mongondow, N. Celebes, coll. W. KAUDERN, 16–4–1917. L. M., reg. no. 1343.
37. Skeleton. Batjan, coll. BERNSTEIN, May, 1863. L. M., cat. ost. b.
38. Skull. Menado, N. Celebes, coll. FORSTEN, 1842. L. M., cat. ost. q.

The present species is called the Black or Celebes Ape in recent literature (TATE, 1944, p. 8; CARTER, HILL, and TATE, 1946, p. 69). The name Ape, however, being reserved for the anthropoids (HOWELLS, 1947, p. 54) and *Cynopithecus* being no more of an Ape than the true macaques, I prefer the trivial name Crested Macaque (Schopfmakak: BÜTTIKOFER, 1917, p. 7, see also RAVEN, 1935, p. 194). The crest of long hair on the crown of the head is distinctive of the present form, no such crest being found in any species of *Macaca* (POCOCK, 1925, p. 1573).

The Crested Macaque, then, is confined to the Northern parts of the island of Celebes. The typical race, to which most above listed specimens belong, is known from the North-eastern portion of the Northern peninsula (Minahassa, and Bolaäng Mongondow), from some of the small nearby islands as well as from the island of Batjan in the Moluccas in which latter island it was most probably introduced by Man. We read in TATE (1944, p. 8) that the Batjan race is *Cynopithecus niger becki*, which is certainly a misprint for *Cynopithecus niger hecki* (Matschie). The latter race, however, is restricted to the Western part of the Northern peninsula of Celebes (BÜTTIKOFER, 1917, p. 35; my specimens nos. 15, 31, and 35), and the Batjan specimens are indistinguishable from *Cynopithecus niger niger* (Desmarest) proper. Three skins and skulls secured by the W. KAUDERN expedition in Bolaäng Mongondow (nos. 25, 26, and 36, not seen by BÜTTIKOFER) belong to the typical race too. The known range of *C. niger niger* consequently extends Eastward to about longitude 124°.

Seven of the above listed specimens (nos. 2, 6, 9, 10, 19, 20, and 33) represent *Cynopithecus niger nigrescens* (Temminck) which form occurs in the Southern parts of the Northern peninsula from Tomini to Malibagoe

TABLE 10.

Macaca maura.

	Males					Females				
	n	range	M	σ	C	n	range	M	σ	C
I^1 tr.	17	6.1—8.4	6.9	0.5	8.0	12	5.0—7.4	6.6	0.7	9.8
ap.	17	5.1—6.7	5.8	0.5	8.6	14	4.6—6.3	5.5	0.4	8.0
I^2 tr.	15	3.7—5.8	4.3	0.5	10.9	12	3.7—5.0	4.5	0.4	8.0
ap.	17	4.4—5.7	4.8	0.5	9.5	14	3.7—5.5	4.6	0.5	11.5
C ap.	11	9.2—10.9	10.2	0.6	6.0	9	6.0—7.6	6.8	0.5	7.5
tr.	11	6.4—7.8	7.0	0.5	7.4	9	4.9—5.7	5.3	0.3	5.0
P^3 ap.	16	4.7—5.8	5.2	0.3	5.0	10	4.5—5.2	4.9	0.2	4.6
tr.	16	5.1—6.0	5.6	0.3	5.0	11	5.1—5.9	5.5	0.3	5.5
P^4 ap.	16	4.9—5.8	5.3	0.2	4.6	11	4.8—5.7	5.3	0.3	5.3
tr.	16	5.5—6.6	6.1	0.3	5.2	12	5.7—6.8	6.1	0.4	6.8
M^1 ap.	19	6.7—8.4	7.3	0.4	6.1	11	6.5—7.5	7.0	0.3	4.7
tr.	21	6.4—7.9	6.9	0.4	5.2	16	6.3—7.3	6.7	0.3	4.3
M^2 ap.	17	7.1—10.3	8.2	0.7	8.2	12	7.0—8.5	7.8	0.5	6.2
tr.	17	7.2—9.2	7.9	0.4	5.6	13	7.0—8.5	7.6	0.4	4.7
M^3 ap.	10	7.8—8.7	8.2	0.3	3.4	8	7.0—8.6	7.6	0.6	7.6
tr.	10	7.4—8.2	7.7	0.2	3.1	8	6.7—8.5	7.3	0.6	7.7
I_1 tr.	17	3.7—5.3	4.6	0.4	8.5	12	3.5—5.5	4.5	0.5	11.7
ap.	17	4.8—6.3	5.4	0.4	7.7	13	4.5—6.0	5.0	0.4	7.3
I_2 tr.	16	3.4—4.8	3.9	0.4	9.2	12	3.1—4.6	3.9	0.5	11.7
ap.	16	4.5—5.9	5.1	0.4	8.1	13	4.2—5.5	4.8	0.3	6.7
C ap.	13	8.4—9.7	9.0	0.4	4.6	12	5.5—7.1	6.3	0.5	7.5
tr.	13	4.8—6.1	5.6	0.4	6.3	12	3.5—4.5	4.0	0.4	8.1
P_3 ap.	15	10.7—15.1	13.1	1.2	9.2	11	7.7—10.8	9.3	0.9	9.8
tr.	15	4.4—5.5	4.9	0.4	7.4	11	3.6—4.6	4.1	0.3	8.3
P_4 ap.	15	5.8—6.7	6.2	0.3	5.3	11	5.4—6.4	5.9	0.3	5.4
tr.	15	4.6—5.4	4.9	0.2	4.5	12	4.5—5.4	4.8	0.3	5.5
M_1 ap.	17	6.7—8.8	7.4	0.5	7.1	11	6.2—7.4	6.8	0.4	5.8
tr.	21	5.3—6.5	5.6	0.3	5.3	16	5.2—6.0	5.5	0.2	3.6
M_2 ap.	18	7.5—10.7	8.2	0.8	9.6	12	7.2—8.7	7.8	0.5	7.0
tr.	18	6.3—8.2	6.9	0.5	7.1	13	5.9—7.2	6.6	0.4	5.9
M_3 ap.	10	9.5—11.1	10.3	0.5	4.6	8	9.3—10.7	9.8	0.5	4.8
tr.	10	6.6—7.4	6.9	0.3	3.7	8	6.1—7.3	6.6	0.4	5.8

TABLE 11.

Cynopithecus niger.

	Males					Females				
	n	range	M	σ	C	n	range	M	σ	C
I^1 tr.	11	6.5—7.9	7.2	0.4	6.0	6	5.8—7.8	6.7	0.7	11.0
ap.	14	5.4—6.8	6.2	0.4	7.0	7	5.3—6.6	5.9	0.5	7.8
I^2 tr.	10	3.9—5.1	4.5	0.4	8.3	5	4.0—4.6	4.3	0.3	6.0
ap.	13	5.0—6.0	5.4	0.3	6.1	6	4.4—5.1	4.7	0.2	5.1
C ap.	13	9.8—12.4	11.1	0.9	8.5	5	6.2—7.4	6.6	0.5	7.6
tr.	13	7.2—9.0	8.2	0.5	6.6	5	5.0—5.7	5.3	0.3	4.7
P^3 ap.	16	4.9—6.7	5.5	0.5	9.3	4	4.5—5.0	4.7	0.2	5.1
tr.	18	5.4—6.7	6.1	0.4	5.9	4	4.9—5.9	5.5	0.5	8.6
P^4 ap.	15	5.0—6.1	5.4	0.3	5.4	4	4.8—5.1	5.0	0.1	2.8
tr.	17	5.8—6.8	6.3	0.3	4.9	4	5.5—6.4	6.0	0.4	6.3
M^1 ap.	17	6.9—8.3	7.6	0.4	4.7	6	6.7—8.0	7.2	0.5	6.9
tr.	21	6.4—7.8	7.0	0.4	5.7	6	6.4—6.9	6.7	0.2	3.0
M^2 ap.	18	7.4—9.4	8.5	0.5	6.3	7	7.8—8.6	8.2	0.3	3.8
tr.	18	7.5—9.3	8.2	0.5	5.7	7	7.2—8.4	7.8	0.4	5.3
M^3 ap.	13	7.6—9.5	8.5	0.6	7.0	5	7.2—8.0	7.7	0.3	4.4
tr.	13	7.4—9.0	8.1	0.5	5.9	5	6.8—7.8	7.4	0.4	5.0
I_1 tr.	12	4.2—5.5	5.0	0.4	7.0	6	4.3—5.2	4.7	0.4	8.7
ap.	15	4.8—7.0	5.9	0.6	9.8	6	4.9—5.9	5.5	0.4	8.0
I_2 tr.	11	3.5—4.4	4.1	0.3	6.2	6	3.7—5.2	4.2	0.6	14.3
ap.	14	5.1—6.5	5.7	0.5	8.3	5	4.4—5.5	4.8	0.4	9.4
C ap.	16	8.8—10.7	9.7	0.7	6.7	5	5.6—6.9	6.4	0.5	8.1
tr.	16	5.3—6.7	6.0	0.4	6.1	5	3.7—4.0	3.9	0.1	3.1
P_3 ap.	15	13.6—17.6	15.1	1.1	7.2	4	8.3—10.5	9.8	1.0	10.1
tr.	16	4.6—6.1	5.2	0.4	8.5	4	3.7—4.5	4.2	0.4	9.5
P_4 ap.	16	5.8—7.4	6.5	0.4	6.5	4	5.5—6.2	5.8	0.3	5.7
tr.	18	4.5—5.6	5.1	0.3	6.5	4	4.6—5.0	4.8	0.2	3.5
M_1 ap.	15	6.8—8.1	7.5	0.4	5.3	6	6.4—7.8	7.0	0.5	7.6
tr.	21	5.3—6.5	5.9	0.3	4.8	7	5.0—6.1	5.5	0.4	6.5
M_2 ap.	16	7.4—9.6	8.6	0.6	6.6	7	7.5—9.0	7.9	0.5	6.2
tr.	18	6.5—8.1	7.1	0.5	6.7	7	6.5—7.6	7.0	0.4	6.1
M_3 ap.	13	9.2—11.5	10.7	0.7	6.9	5	9.0—10.5	9.8	0.6	6.2
tr.	13	6.5—8.7	7.3	0.6	7.9	5	6.3—7.2	6.7	0.4	5.5

(at about longitude 124°). The skulls of *nigrescens* and *hecki* differ from those of typical *niger* mainly in the less or stronger development of the maxillary ridges. It is by this very character that the *Cynopithecus* skull (both sexes) is at once distinguished from that of the Southern Celebes form, *Macaca maura*, as well as from that of all other macaques. On this evidence *Cynopithecus* is sometimes associated with the African baboons, though in the structure of its feet it resembles the typical macaques (POCOCK, 1925, p. 1501).

In tables 10 and 11 the data on the teeth of both sexes in *Macaca maura* and *Cynopithecus niger* are presented.

The average variation coefficients given in table 12 permit at least of the broad conclusion that the mandibular teeth are more variable than the upper teeth. In its dimensions the mandible is also more liable to variation than the calvarium.

TABLE 12.

Average variation coefficients of dimensions of upper and lower teeth.

	Macaca maura		*Cynopithecus niger*	
	Males	Females	Males	Females
Upper teeth	6.4	6.7	6.5	5.8
Lower teeth	6.8	7.2	6.9	7.5

Among the dental variations in the series of skulls I notice especially the following:

a. *Macaca maura*, no. 27. The right P_3 is displaced outward because of the position of its anterior root to the lingual side of that of the C instead of to the labial side, as is normally the case. A similar anomaly I recorded previously in an orang-utan mandible (HOOIJER, 1948a, pp. 182 and 220). In the present case, too, the normal occlusion has been maintained. The P_3 dext., however, is decidedly smaller than that on the left side, the greatest diameter being only 11.0 mm as compared with 12.7 mm in P_3 sin. The right series of teeth is more forward in position than the left, both in the upper and in the lower jaw.

b. *Macaca maura*, no. 34. I_2 sin. is congenitally absent.

c. *Macaca maura*, no. 38. M_3 dext. is congenitally absent, while M^3 sin. is small and abnormally shaped.

d. *Cynopithecus niger*, no. 28. M_3 dext. has a very much reduced talonid, the "heel" being reduced to hardly more than a point. As isolated tooth this specimen would have been classed as an M_2. Its antero-posterior diameter is 8.6 against 9.2 in M_3 sin.

These anomalies are not only interesting in themselves, but also because they bear evidence of the variability just in the dental elements which are vanishing and present a high degree of variability in higher Primates like Man. The evident tendency to lateral incisor and third molar variability, the high variation coefficients sometimes shown by I_2 and M_3, would seem initial to their complete suppression.

The variability of the teeth is partly due to male or female sex, and partly individual. The male teeth average larger than those of the females. There are but two exceptions: in *Macaca maura* the transverse diameter of I^2 is 4.5 mm, in the average, in the ♀♀, against 4.3 mm in the ♂♂. And in *Cynopithecus niger* I_2 averages transversely 4.2 mm in the ♀♀ and 4.1 mm in the ♂♂. There is a tendency to greater variability in the female than in the male teeth.

The sexual difference in size is most pronounced in the canines, and added to that there is a difference in shape. The male upper C is a long pointed tooth with a deep longitudinal groove antero-internally, while the female upper C, though still projecting downward beyond the other elements, is very much less hypsodont and has the antero-internal groove but weakly developed. In the mandible the sexual difference in the degree of hypsodonty is as well marked as that in the maxillary canines. Besides in the canines, there is a marked sexual difference in structure in the anterior lower premolar too. The P_3, being adapted to the large upper C, has the crown protruded downward at the antero-external side so as to form an extended surface against which the upper C works during mastication. This antero-inferior enamel protrusion at the outer surface of P_3 is relatively more developed in the male than it is in the female specimens, which enables us to tell the sex of the individual to which it has belonged also from a P_3.

The differences between the teeth of *Macaca maura* and their homologues in *Cynopithecus* are much less conspicuous than those in outer body or skull. There is a greater tendency toward the development of small accessory cusps on the molars in *Cynopithecus* as compared with those of *Macaca maura*. These cusplets occur between the two lobes of the molars, at the inner base of the upper and at the outer base of the lower elements. These formations of the cingulum, which, when present, occur regularly throughout the whole molar series but which are most distinct in M 3, occur in one (no. 30) out of the nine adult male skulls of *Macaca maura* but in four (nos. 20, 28, 32, and 33) out of the thirteen adult male *Cynopithecus* skulls. No such cusplets were found in female teeth, except in M 2 of the juvenile skull no. 8 of *Macaca maura*. The standard error of the difference between the percentages [1]) of occurrence of accessory cusplets in *Macaca maura* (11.1 %) and in *Cynopithecus* (30.8 %) is 16.5 %. The difference between the percentages (19.7 %) is less than two times its standard error and consequently there is no real difference between the frequency of occurrence of accessory cusplets on the molars of *Cynopithecus* and *Macaca maura* respectively.

The sexual difference in size is more pronounced in *Cynopithecus* than it is in *Macaca maura*; while the teeth of ♂ *Cynopithecus* average invariably larger than those of ♂ *Macaca maura*, the teeth of ♀ *Cynopithecus* average larger than those of ♀ *Macaca maura* in 18 of the 32 measurements only. In not less than 7 measurements the ♀ teeth of *Macaca maura*, in the average, exceed those of ♀ *Cynopithecus* as to size, the average measurements being equal in the remaining 7 observations.

In the average, the male *Cynopithecus* dentition has a relatively larger I^2, upper C, I_2, and P_3 than has the male *Macaca maura* dentition. This difference in size is most evident in the transverse diameter of the upper C,

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1) The standard error of a percentage A is $E_A = \sqrt{\frac{A\,(100 - A)}{n}}$ in which n is the number of observations on which percentage A is based. The standard error of the difference between two percentages A and A' is

$$E_{\mathrm{diff.}} = \sqrt{E_A^2 + E_{A'}^2}$$

in the greater diameter of P_3, and in the antero-posterior diameters of I^2 and I_2. Both the relatively larger male upper C and P_3 and the comparatively less reduced I 2 stamp the *Cynopithecus* dentition as more primitively built than that of *Macaca maura*. Incidentally, these are exactly the evolutionary trends observed in the orang-utan dentition (HOOIJER, 1948a). *Pongo pygmaeus palaeosumatrensis* Hooijer from the Early Holocene of Central Sumatra differs from recent *Pongo pygmaeus pygmaeus* (Hoppius) in having a greater sexual difference in size of the canines (a relatively larger male canine), comparatively less reduced lateral incisors both above and below, and a relatively larger anterior lower premolar.

Both in *Macaca maura* and in *Cynopithecus* the female is more liable to third molar reduction than the male, and this is a sexual difference also displayed in other Primates. Of the upper molar series M^1 is decidedly the smallest in the Celebean monkeys. M^2 is the largest molar in five out of the ten adult male skulls and in five out of the seven adult female skulls of *Macaca maura*. In the remaining adult skulls M^3 is the largest upper molar. Thus there is a greater tendency toward predominance in size of the third molar over the other molars, a primitive condition still displayed in the lower jaw of *Macaca* and *Cynopithecus*, in the males than in the females. It is all the same in *Cynopithecus*, six out of the thirteen adult male, but none out of the five adult female skulls of which have M^3 as the largest upper molar.

This result is well in harmony with the observations in the orang-utan and in Man. In the orang-utan dentition (HOOIJER, 1948a, pp. 237 and 256) predominance in size of the third molar over the other molars is found more frequently in males than in females. In the female orang-utan dentition occasionally even M 1 is the largest molar, which is the advanced condition typical of recent Man. And in Man, as HELLMAN (1936, pp. 8 and 9) observes, the female skulls show a higher incidence of congenital absence of M 3's than the male, and consequently are in this connection more progressive than the males, too.

The collection of subfossil teeth at my disposal is dealt with below. To avoid endless repetition it may be stated here that the cave specimens do not differ in structure from those of recent *Macaca maura* (Geoffr. et F. Cuvier) subsp. While SARASIN (1905, p. 43) writes that teeth and bones of *Macaca maura* are of frequent occurrence in the caves explored, and that the subfossil specimens do not differ from the recent in any respect, DAMMERMAN (1939, p. 72) states that the shape of the canines found in the caves is nearer to that of *Cynopithecus* than to that of *Macaca maura*. I have found the dentition of the cave macaque to possess certain primitive traits as compared to that of the recent form, but the differences are not well-marked and are found in few of the elements only. No remains of the milk dentition were found, but every element of the permanent dentition is represented in the Bola Batoe cave collection.

Macaca maura (Geoffr. et F. Cuvier) subsp.
(pl. I figs. 7—8 and 10—14, pl. II figs. 1—5)

INCISORS

I^1 (pl. I figs. 10—11.)

There are nine specimens of I^1 in the VAN HEEKEREN collection from the Bola Batoe cave, three of the right (nos. 1—3) and six of the left side (nos. 4—9). The best specimen is represented on pl. I figs. 10—11. It shows a slightly developed lingual basal tubercle, that is exceptionally found in recent specimens of I^1 too. The measurements are given in table 13.

TABLE 13.

Measurements of subfossil I^1.

No.	1	2	3	4	5	6	7	8	9
tr.	7.7	6.8	—	6.8	7.0	7.0	6.9	7.4	7.4
ap.	5.9	5.3	5.8	5.2	5.5	5.8	6.0	5.6	5.5

All specimens are within the limits of the individual and sexual variation of recent *Macaca maura.*

I^2

Four specimens of I^2, two of the right and two of the left side (nos. 1—4), originate from the Bola Batoe cave, while one specimen (no. 5), an I^2 sin., marked CB, was found by me amongst the pig material from the Panisi Ta'boettoe in the VAN STEIN CALLENFELS collection. From the latter cave DAMMERMAN (1939, p. 72) recorded already a lower C as belonging to the present macaque. The measurements are given in table 14.

TABLE 14.

Measurements of subfossil I^2.

No.	1	2	3	4	5
tr.	ca. 4.5	—	4.1	4.3	3.9
ap.	5.1	5.7	—	4.9	4.8

None of the specimens, again, calls for special comment as to size.

I_1

Three specimens of the central lower incisor occur in the Bola Batoe cave collection, all probably of the left side. This tooth most often is so symmetrically built that it is impossible to determine what is the medial and what the lateral surface. Measurements (table 15) show the subfossil elements to be within the variation ranges of the female as well as the male recent I_1

TABLE 15.

Measurements of subfossil I_1.

No.	1	2	3
tr.	—	ca. 4.5	—
ap.	5.7	5.8	5.9

of *Macaca maura*, though there is but one recent ♀ I_1 (of skull no. 21) that is larger than the cave teeth, in all others the antero-posterior diameter being considerably smaller.

I_2

The only representative of this element in the Bola Batoe cave collection is of the left side. It measures 4.2 mm transversely and 6.0 mm antero-posteriorly. In the latter diameter it is a little above the variation range found by me in sixteen recent male I_2 of *Macaca maura* (4.5 mm—5.9 mm), but this is a difference of no importance.

CANINES

Male upper C (pl. I fig. 12).

Of the male upper C Mr. VAN HEEKEREN collected twelve specimens in the Bola Batoe cave, four right (nos. 1—4) and eight left specimens (nos. 5—12) (two of the latter consist of the tip of the crown only). The best specimen (no. 5) is figured on pl. I fig. 12. Next to this material I could examine, in the VAN STEIN CALLENFELS collection, two right and three left male upper canines (nos. 13—17) from layer A—B of the Panganrejang Toedeja cave, as well as one right male upper C (marked A) from the Batoe Edjaja cave (no. 18). The measurements are presented in table 16.

TABLE 16.

Measurements of subfossil male upper C.

No.	1	2	3	4	5	6	7	8	9	10
ap.	11.0	10.5	—	—	12.0	10.8	10.4	11.3	11.4	—
tr.	8.3	7.4	7.6	—	8.6	8.4	6.8	7.4	6.7	—
No.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**		
ap.	—	—	10.6	—	10.4	10.6	10.5	10:7		
tr.	—	—	7.7	—	7.8	7.4	7.8	7.6		

The canines from the Panganrejang Toedeja cave and the Batoe Edjaja cave, both situated in the extreme South of the South-western peninsula near Bonthain, are rather uniform in size and fall within the variation limits of the recent male upper C of *Macaca maura*, though they average slightly higher. The Bola Batoe cave specimens, on the other hand, are decidedly larger than their recent homologues in *Macaca maura*. Nevertheless they are not conformable to those of *Cynopithecus*; their antero-posterior diameter, in the average, is the same as that of the male upper C in *Cynopithecus* (11.1 mm), but the transverse diameter is less in the subfossil canines (7.7 mm against 8.2 mm in *Cynopithecus*). As I have already pointed out above the male *Cynopithecus* upper C is larger than that in *Macaca maura* especially in its transverse diameter, and the Bola Batoe cave specimens consequently differ from the male upper canines of *Cynopithecus* in the same point as those of recent *Macaca maura* do.

There is a real difference in size between the recent and the Bola Batoe cave male upper C of *Macaca maura*, in the antero-posterior as well as in the transverse diameter. As is evident from the inspection of table 17 the differences between the means are greater than two times their standard errors $E_{diff.}$ and consequently are of statistical significance.

TABLE 17.

Macaca maura.

Upper C ♂	n	M	σ	C	$E_{diff.}$	$\frac{M_{subf.} - M_{rec.}}{E_{diff.}}$
Ap. recent	11	10.2	0.6	6.0	0.3	3.0
Id. subfossil	7	11.1	0.6	5.1		
Tr. recent	11	7.0	0.5	7.4	0.3	2.3
Id. subfossil	8	7.7	0.7	9.4		

Female upper C

Four female upper C in the VAN HEEKEREN collection from the Bola Batoe cave, one of the right and three of the left side, in contradistinction to the male upper C, average smaller than their recent homologues. The

TABLE 18.

Measurements of subfossil female upper C.

No.	1	2	3	4
ap.	5.8	6.9	—	6.6
tr.	4.9	4.7	4.5	—

measurements are recorded in table 18, and from table 19 it will be seen that the difference in size between the recent and the subfossil specimens stands the statistical test, however, for the transverse diameter only.

TABLE 19.

Macaca maura.

Upper C ♀	n	M	σ	C	$E_{diff.}$	$\frac{M_{rec.} - M_{subf.}}{E_{diff.}}$
Ap. recent	9	6.8	0.5	7.5	0.4	1.0
Id. subfossil	3	6.4	0.6	9.0		
Tr. recent	9	5.3	0.3	5.0	0.2	3.0
Id. subfossil	3	4.7	0.2	4.3		

Male lower C

My material from the Bola Batoe cave comprises four right and one left male lower C (nos. 1—5), and there are four right and four left specimens from layer A—B of the Panganrejang Toedeja cave (nos. 6—13). One left lower canine from the Batoe Edjaja cave belongs to the present form but is too badly preserved for measurement.

TABLE 20.

Measurements of subfossil male lower C.

No.	1	2	3	4	5	6	7
ap.	8.4	9.5	10.1	8.7	9.5	10.4	9.0
tr.	5.6	6.0	6.0	5.5	6.2	6.2	5.3

No.	8	9	10	11	12	13
ap.	9.2	8.4	9.1	10.2	9.0	10.0
tr.	5.4	5.9	5.6	5.7	5.6	5.8

In the present case we find both in the Bola Batoe cave material and in that of the Panganrejang Toedeja cave a few specimens that present dimensions greater than those of their recent homologues. The difference in average size, however, is less than two times its standard error, and hence of no value. The male lower C of the Bola Batoe cave average slightly smaller than those of the more Southern cave in the antero-posterior diameter (9.2 mm against 9.4 mm), but average slightly larger in the transverse diameter (5.9 mm against 5.6 mm), differences that have no statistical significance, however.

Female lower C

Three right female lower C are in the VAN HEEKEREN collection (nos. 1—3), and there is one more female lower C, of the left side, from the Panisi Ta'boettoe (marked CB) (no. 4 of table 21).

TABLE 21.

Measurements of subfossil female lower C.

No.	1	2	3	4
ap.	6.6	6.7	6.9	6.7
tr.	4.4	4.3	4.1	4.2

These specimens, though all larger than the mean of the recent female lower C of *Macaca maura*, are well within their variation limits, and do not deserve of special comment.

PREMOLARS

P^3 (pl. II figs. 1—2).

The anterior upper premolar is bicuspid like the P^4 but differs from the latter in having the enamel border pushed rootward at the outer surface anteriorly, thereby making an oblique triangular fovea anterior for the reception of the fovea posterior of its antagonist, the P_3. The sexual difference in size is not so marked in P^3 as it is in P_3, however, though it is in turn more marked than that in P^4 which latter averages as large in the ♂♂ as it does in the ♀♀ of *Macaca maura*.

From the Bola Batoe cave I have a portion of the right maxillary with P^3—M^2 in a perfect state of preservation (pl. II figs. 1—2) (no. 1) as well as four isolated specimens of P^3, all of the left side (nos. 2—5). The sex of the individuals to which the isolated specimens of P^3 have belonged is impossible to determine; nos. 2—4 are larger than the ten recent female specimens of P^3 of *Macaca maura* available for comparison but are well within the range of male variation. The toothrow P^3—M^2 differs only

TABLE 22.

Measurements of subfossil P^3.

No.	1	2	3	4	5
ap.	5.1	5.3	5.4	5.3	5.1
tr.	5.5	5.6	6.0	5.7	5.3

0.1 mm from the mean found for the dimensions of all the teeth in recent male *Macaca maura* except in the length of M^1 (7.7 mm) which is 0.4 mm more than the mean length of the recent male M^1. In this measurement the subfossil specimen is above the variation range of the recent female M^1 and it would seem more probable that the toothrow belonged to a male than to a female individual. A definite conclusion cannot be arrived at.

P^4 (pl. II figs. 1—2 and 4—5).

Besides the specimen in the right toothrow P^3—M^2 (no. 1) I have six isolated specimens of P^4, three right (nos. 2—4) and three left (nos. 5—7), the measurements of which are within the limits of the recent female as well as male homologues in *Macaca maura*.

TABLE 23.

Measurements of subfossil P^4.

No.	1	2	3	4	5	6	7
ap.	5.4	—	—	—	5.5	5.5	5.6
tr.	6.0	5.8	6.0	—	6.3	6.2	—

P_3 (pl. I figs. 13—14).

Isolated specimens of the anterior lower premolar of *Macaca* can be sexed as well as the canines. I have taken the antero-posterior or greatest diameter from the inferior angle of the antero-external enamel protrusion to the posterior angle of the crown (not to the tip of the main cusp (protoconid) because this would exclude worn specimens from comparison), and found that this dimension varies from 10.7 to 15.1 mm in the male, and from 7.7 to 10.8 mm in the female of *Macaca maura*, giving an overlapping of 0.1 mm only.

In the VAN HEEKEREN collection from the Bola Batoe cave I found six specimens of P_3, while there is one, a right P_3, in the VAN STEIN CALLENFELS collection from the Panganrejang Toedeja cave (layer C—D), not recorded by DAMMERMAN (1939, p. 72). Six out of these seven specimens are of male individuals: two right (nos. 1—2) and three left (nos. 3—5) from the Bola Batoe cave, and one right (no. 6) of the Panganrejang Toedeja cave.

TABLE 24.

Measurements of subfossil male P_3.

No.	1	2	3	4	5	6
ap.	14.0	13.2	12.9	ca. 14.5	13.7	14.1
tr.	4.8	4.6	5.1	5.3	5.0	4.8

These specimens are well within the recent range of male variation.

The sole female (left) P_3 from the Bola Batoe cave has a greatest diameter of 10.6 mm, and measures 4.2 mm transversely. It does not exceed its recent homologue in size either. This specimen is figured beside a male P_3 on pl. I fig. 14.

P_4

P_4 is represented in the Bola Batoe cave collection by two specimens, both of the right side. One of them is one-fifth longer and broader than the other. This difference in size is most probably sexual; the smaller specimen is a little below the range of variation of fifteen recent male P_4, the larger a little above the range of variation of eleven recent female P_4. No. 3 is a right P_4 of the Tjadang cave (no. 153), intermediate in dimensions.

TABLE 25.

Measurements of subfossil P_4.

No.	1	2	3
ap.	6.6	5.5	6.2
tr.	5.4	4.5	4.7

MOLARS

Upper M (pl. II figs. 1—2 and 4—5).

Of the upper molar series, as said already above (p. 45), M^1 is always decidedly the smallest. M^3, which may be either larger or smaller than M^2, differs from M^2 in the posterior transverse contraction of the crown, a character that is more marked in some skulls than in others, but that suffices in most cases to tell an M^3 from an M^2. Added to that there is, of course, the absence of a posterior contact facet as distinctive of M^3, but this character appears only upon a certain stage of wear.

I have but one complete subfossil upper molar series of *Macaca maura*. This specimen, a portion of the left maxillary (marked CA) originates from the Panisi Ta'boettoe and was tentatively referred to *Phalanger ursinus* (Temminck) by DAMMERMAN (1939, p. 67), who did not fail to observe that the subfossil molars are much heavier, broader, and more rectangular in shape than those of the recent Bear Cuscus. These are exactly the points, however, in which the upper molars of *Macaca* differ from those of *Phalanger ursinus*. DAMMERMAN (l.c.) also remarks that the anterior zygomatic root is much higher in position in the subfossil specimen than it is in *Phalanger ursinus*, but it is of the same shape and is placed on the same level as that in recent *Macaca maura*.

The specimen is figured on pl. II figs. 4—5. M^2 is larger than M^3, and the dimensions of the molars (P^4 is too incomplete for measurement) fall below the variation range of recent male upper molars of *Macaca maura* with the exception of M^1, the transverse diameter of which (6.8 mm) is 0.3 mm less than that of M^3 (7.1 mm). In ten male calvariums of *Macaca maura* in which all upper molars could be measured the transverse diameter of M^1 is 1.2 mm to 0.6 mm less than that of M^3, while in eight adult female skulls of the same species the transverse diameter of M^1 varies from 1.2 mm less to 0.2 mm more than the transverse diameter of M^3. With a difference of only 0.3 mm between the transverse diameters of M^1 and M^3 the Panisi Ta'boettoe specimen belongs almost certainly to a female, which, as I said already above, is more liable to third molar reduction and consequently domination of M^2 than a male. This conclusion is also in harmony with the relatively small size of the teeth.

M^1

Next to the M^1 in the maxillary fragment with P^3—M^2 (no. 1) I have another fragment of the maxillary, also of the right side, containing M^1 and M^2, damaged lingually (no. 2), as well as five isolated specimens of the right (nos. 3—7) and one isolated specimen of the left side (no. 8), all from the Bola Batoe cave. As no. 9 in table 26 I give the measurement of the Panisi Ta'boettoe specimen just referred to above. Nos. 10 and 11 are a right and left M^1 from the Tjadang cave (nos. 239 and 318).

One specimen only (no. 4) has an accessory inner cusplet. Nos. 1 and 4

TABLE 26.

Measurements of subfossil M^1.

No.	1	2	3	4	5	6	7	8	9	10	11
ap.	7.7	7.5	7.5	7.6	6.7	7.1	—	—	—	—	7.4
tr.	7.0	6.8	7.0	—	6.9	6.9	6.6	7.2	6.8	7.1	6.7

are larger than the recent female M^1 of *Macaca maura*, but are within the limits of the recent male M^1.

M^2

Nos. 1 and 2 in table 27 refer to the specimens with the same serial number recorded under the head of M^1; nos. 3—6 are right and nos. 7—10 are left specimens of M^2 from the Bola Batoe cave. No. 11 is from the Panisi Ta'boettoe. There is again but one specimen (no. 10) with an inner accessory basal cusplet. No. 11, as said above, belongs almost certainly to a female individual. The largest specimens of my series (nos. 5, 9, and 10) exceed the recent female M^2 of *Macaca maura* in length, but are not larger than the recent male M^2 of that species.

TABLE 27.

Measurements of subfossil M^2.

No.	1	2	3	4	5	6	7	8	9	10	11
ap.	8.2	7.8	7.6	8.0	8.6	7.5	7.6	8.2	8.7	8.6	7.2
tr.	7.8	—	7.8	7.6	8.0	7.5	7.5	7.7	7.8	7.6	7.0

M^3

The ultimate upper molar is as fully represented in the Bola Batoe cave collection as are the anterior molars; there are nine specimens in the VAN HEEKEREN collection, nos. 1—6 of the right and nos. 7—9 of the left side. One, likewise isolated, right M^3 is in the collection from the Batoe Edjaja cave (recorded by DAMMERMAN, 1939, p. 72) and is no. 10 of table 28. No. 11 is the Panisi Ta'boettoe specimen dealt with already under the head of M^1 and M^2.

TABLE 28.

Measurements of subfossil M^3.

No.	1	2	3	4	5	6	7	8	9	10	11
ap.	7.0	8.0	8.1	8.2	8.7	—	6.6	7.8	8.1	8.5	6.8
tr.	7.1	7.2	7.6	7.8	7.9	7.5	7.0	7.7	7.7	8.0	7.1

Nos. 3 and 5 have inner accessory cusplets. The smallest specimen (no. 7) is below the female range of variation, the largest (no. 5) exceeds its female homologues in recent *Macaca maura* in size, but, as usual, is not larger than the male.

The low frequency of occurrence of molars with inner accessory cusplets (1 or 2 out of every 9 to 11 specimens) is well in accord with that found in recent *Macaca maura.*

Lower M (pl. I figs. 7—8, pl. II fig. 3).

There are several portions of the mandible in the Bola Batoe cave collection as well as in the VAN STEIN CALLENFELS collection. The specimens consist of the posterior part of the horizontal ramus with one or more molars in situ. The best specimen, from the Bola Batoe cave, possesses the complete molar series M_1—M_3. It is of the left side and represented on pl. II fig. 3. In its tooth dimensions it differs at the most 0.2 mm from the mean of the recent female molars of *Macaca maura.* The transverse diameter of M_1 (5.5 mm) is only 0.9 mm less than that of M_3 (6.4 mm). In ten male mandibles of *Macaca maura* the transverse diameter of M_1 is 1.1 to 1.8 mm less than that of M_3 (average 1.3 mm), while in eight female mandibles of that species M_1 is 0.9 to 1.8 mm narrower than M_3 (average 1.2 mm). Though the lower molars do not show the sexual difference in predominance in size of the last molar over the first as clearly as do the upper molars, the difference in width between M_1 and M_3 is more suggestive of a female than of a male specimen. Unfortunately the height of the ramus cannot be determined due to the specimen being somewhat crushed.

Two partial left rami of the Bola Batoe cave, one with M_2—M_3, and the other with M_3, differ markedly in the height of the ramus. At the middle of M_3 the ramus height is 15 mm in the first and 21 mm in the second specimen. Three ramus fragments in the VAN STEIN CALLENFELS collection, from a cave N. of Tjani (Lamontjong), from the Panganrejang Toedeja cave, and from the Batoe Edjaja cave respectively, measure in height at the middle of M_3 15 mm, 17.5 mm, and 19 mm. These figures are all within the recent range of variation of *Macaca maura,* as shown by table 29.

TABLE 29.

Macaca maura.

	n	range	M	σ	C	$E_{\text{diff.}}$	$\frac{M♂ - M♀}{E_{\text{diff.}}}$
Height of ramus horizontalis at							
M_3, male spec.	9	16—21	19	1.7	8.4	0.8	3.8
Id., female spec.	8	14—19	16	1.7	10.6		

The sexual difference in height of the horizontal ramus stands the statistical test. The larger of the Bola Batoe cave rami belongs almost certainly to a male, and the smaller to a female individual. The female specimens vary to a greater degree than the male, as is usually the case.

M_1

Of the anterior lower molar there are eight specimens in the Bola Batoe cave collection; three of the right (nos. 1—3) and five of the left side (nos. 4—8). No. 8 is of the left series M_1—M_3. No. 9 in table 30 is a left M_1 in a ramus fragment from a cave N. of Tjani. No. 10 is a left M_1 too, recorded as "one loose third lower molar" of *Phalanger ursinus* (Temminck) by DAMMERMAN (1939, p. 67), and originating from layer A—B of the Panganrejang Toedeja cave. Finally nos. 11 and 12, a right and a left M_1, are from the Tjadang cave (nos. 918 and 185).

TABLE 30.
Measurements of subfossil M_1.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	7.2	7.3	6.4	7.1	7.7	7.2	7.1	6.7	6.5	7.4	—	7.0
tr.	5.6	6.3	5.5	5.5	6.0	5.6	5.5	5.5	5.2	5.7	5.5	5.5

Outer accessory tubercles were not observed.

M_2

The lower second molar is represented in the Bola Batoe cave collection by three right (nos. 1—3) and eight left specimens (nos. 4—11; no. 8 is of the ramus with M_1—M_3, no. 7 of the ramus with M_2—M_3; the latter belongs apparently to a female). M_2 is also preserved in a right ramus fragment with M_2—M_3 from the Batoe Edjaja cave (no. 12) and in a left ramus with M_1—M_2 from a cave N. of Tjani (no. 13). Nos. 14—17 are two right and two left M_2's from the Tjadang cave (nos. 816, 261, 819, and 703).

TABLE 31.
Measurements of subfossil M_2.

No.	1	2	3	4	5	6	7	8	9	10	11
ap.	7.6	8.4	8.6	—	8.4	7.7	7.6	8.0	8.0	8.2	8.6
tr.	6.5	6.8	6.7	7.3	6.5	6.3	6.2	6.4	6.5	6.8	7.1
No.	12	13	14	15	16	17					
ap.	7.7	7.4	7.7	7.7	8.0	7.7					
tr.	7.0	6.5	6.5	6.4	6.4	6.4					

An outer accessory tubercle is shown in one specimen (no. 3) only.

M_3 (pl. I figs. 7—8, pl. II fig. 3).

The last lower molar is an element in the cercopithecoid dentition that has received much consideration, not the least by paleontologists who had mostly no first-hand knowledge of the amount of individual variation in the development of the talonid on which their attention was mostly focussed. In fact, even within the comparatively small series of Celebean macaque skulls at my disposal it is possible to find all intergrades in development of the hypoconulid between a simple point and a true "third lobe", longer antero-posteriorly even than the second lobe, with one central cusp, and mostly a smaller internal cusp too, which latter is occasionally subdivided by faint grooves.

In table 32 the measurements of four right and four left Bola Batoe cave specimens of M_3 in the VAN HEEKEREN collection (nos. 1—8) are given; no. 7 is of a ramus fragment with M_2—M_3, and no. 8 of the complete lower molar series recorded in tables 30 and 31 under no. 8 too. Nos. 9 and 10 are specimens from layer C—D of the Panganrejang Toedeja cave, and the Batoe Edjaja cave respectively. Under nos. 11 and 12 I give the measurements of two right M_3's originating from the Tjadang cave (nos. 525 and 816 bis). Outer accessory tubercles occur in two specimens (nos. 3 and 5) only.

TABLE 32.

Measurements of subfossil M_3.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	10.4	10.2	12.1	9.6	10.5	10.5	9.4	9.8	9.4	10.0	9.3	—
tr.	6.8	6.4	7.4	6.7	7.2	6.7	6.5	6.4	6.2	6.6	6.2	6.6

All specimens of M_3 but one (no. 3) fall within the limits of variation of their recent homologues in *Macaca maura*, as do the subfossil M_1 and M_2 too. The large specimen of M_3, which is figured on pl. I fig. 7 beside one of the smallest specimens of my series (no. 4, pl. I fig. 8), is decidedly larger than the recent M_3 of *Macaca maura*, but does not fall above the expected range of variation of M_3 in *Cynopithecus*. Unfortunately it is impossible to determine the means of the dimensions of the cave molars, since, with a few exceptions, it cannot be made out which of the specimens belonged to males and which to females. It is, however, very improbable that this single specimen would influence the mean in a way as to make its difference from the recent mean statistically significant. It bears evidence only that third molar reduction was less advanced in the subfossil *Macaca maura* than it is in the recent.

In the Bola Batoe cave collection there are moreover two halves of lower molars, 6.8 mm and ca. 7.0 mm in width respectively. Their size is suggestive of M_2 or M_3.

In summarizing the results obtained from the comparisons of each single element of the subfossil *Macaca maura* dentition with its recent homologue it can now be stated that there is a tendency for the subfossil teeth to average larger than the recent, but the size difference is of no real importance except in the case of the upper canines of the Bola Batoe cave. These elements, though indistinguishable in structure from those of recent *Macaca maura*, present a more stressed sexual difference in size than do those in the recent form, the male canines being larger and the female canines being smaller than the corresponding recent. As already stated above (p. 45) I have found the subfossil orang-utan from Sumatra to differ from the recent, among other points, in showing a greater sexual difference in size between the canines too.

It seems that a marked sexual difference in size of the canines may be looked upon as a primitive feature, at least in these Primates.

As another primitive trait in the cave *Macaca maura* the apparently less marked third molar reduction may be looked upon. As I have shown there is no difference in the relative frequency of occurrence of accessory tubercles on the molars between the cave and the recent *Macaca maura.*

The *Macaca maura* from the Toalian sites is not exactly the same as the present day subspecies of the same region, *Macaca maura maura* (Geoffr. et F. Cuvier), and the form from the Bola Batoe cave is highly interesting in its differing from the recent form by a more marked sexual dimorphism of the upper C. Whether the macaques from other sites have this apparently primitive feature too cannot be made out. In the Panganrejang Toedeja cave form (layer A—B) the male upper C is not so large as that of the Bola Batoe cave, which makes it probable that the size difference between the canines of the two sexes was not so marked either.

The Bola Batoe cave macaque is certainly different from the recent, and I propose to name it:

Macaca maura majuscula nov. subsp.

Diagnosis: Teeth identical in specific characters to those of recent subspecies of *Macaca maura* (Geoffr. et F. Cuvier), but of slightly greater size, except for the female upper C which is smaller than its recent homologue. The male upper C, like the other elements, shows an excess in size over its recent homologue. The difference in size between the upper C of the present form (both sexes) and those of the living is statistically significant. Thus sexual difference in size of the upper canines is more marked in *Macaca maura majuscula* than in the living races.

Holotype: A left male upper C, represented on pl. I fig. 12 (no. 5 of table 16 of the present work).

Paratypes: Four right and seven left male upper C (nos. 1—4 and 6—12 of table 16), as well as one right and three left female upper C (nos. 1—4 of table 18).

Locality: Bola Batoe cave, near Badjo (Barebo district), ca. 20 km S.W. of Watampone in Central Bone, S. Celebes.

Age: Holocene.

Name: Majusculus means rather large, also (TERENTIUS) somewhat older.

As follows from the study of the canines and the P_3, the only elements of the *Macaca* dentition that can be sexed with certainty, the male teeth are more numerous than the female. In the Bola Batoe cave collection I found twelve male against four female upper C, five male and three female lower C, and five male but only one female P_3. It seems that male macaques were captured by the Toalians in greater quantities than female, which is also the experience of modern hunters.

Family HOMINIDAE Gray

Genus **Homo** Linnaeus

The Boeginese and the Macassars are the two principal peoples of South-western Celebes. During their voyage in Celebes in the years 1902 and 1903 the SARASINS, however, discovered a small isolated tribe in the mountainous region W. of Watampone in Central Bone, the so-called Toala, still partly living in the caves which yielded the subfossil remains of Mammals and Man described in the present paper, as well as the primitive microlithic culture which latter received its name after the Toala, the Toalian. Struck by the resemblance of some Toala individuals to the Veddahs of Ceylon, the discovery of which latter tribe we owe to the SARASINS too, the SARASINS decided that the Toala (lit. bush-men) represented an impure Veddah relic in South-western Celebes (P. and F. SARASIN, 1903, 1905, pp. 258—305), and different from Boeginese or Macassars. The subfossil human remains studied by F. SARASIN (1905, pp. 58—61) were ascribed to pure ancestors of the present day Toala people.

It is against both of these conclusions that Dr. P. V. VAN STEIN CALLENFELS objected. Firstly the Toala should represent only the offspring of Boeginese banished to the forests of Lamontjong by the monarch of Bone, AROE PALAKA († 1696), and secondly it would not speak for itself that the cave culture should have belonged to a Toala population element (VAN STEIN CALLENFELS, 1945 (a letter dated November 21, 1933); SARASIN, 1935, p. 127/128; KLEIWEG DE ZWAAN, 1943, p. 91).

As a result of a careful anthropometrical comparison between the Toala on one hand and the Boeginese and Macassars on the other, the data for which were collected by Dr. VAN STEIN CALLENFELS, MIJSBERG (1937, p. 65; 1941) was able to show that the Toala and the Boeginese do not reliably differ from each other. With this Prof. MIJSBERG does not mean to say that the living Toala would have no Veddah-blood, but only that the Veddah element in the Toala is not more marked than it is in the Boeginese. It is still generally accepted that the Veddah element is widespread in the Malay Archipelago (KLEIWEG DE ZWAAN, 1934; MIJSBERG, 1937, p. 65; ARIËNS KAPPERS, 1939).

Miss W. C. KEERS, however, arrives at the conclusion that the Toala represent a mixture of Toradja and Boeginese, and finds no Veddah element in the Toala measured by herself (KEERS, 1941, p. 1820), though it is admitted that Veddah traits were undoubtedly present in the older generations seen by the SARASINS (KEERS, l.c., p. 1827).

Neither skulls nor teeth of the living Toala were ever collected, the characters of the outer body only being examined. Thus we are faced with the serious problem of identifying the cave material without having the proper recent material for comparison at hand.

Though the outlook was not hopeful, I decided to examine as great as possible a number of Boeginese, Macassars, and Toradja skulls for comparison with the subfossil human remains found by Mr. VAN HEEKEREN in the Bola Batoe cave. Human remains had been found already at various Toalian sites, viz., the Lamontjong caves of the SARASINS (SARASIN, 1905), the Tjadang cave near Tjita (VAN STEIN CALLENFELS, 1938, p. 139; and personal communication by Prof. Dr. W. A. MIJSBERG), the Batoe Edjaja cave (an upper milk premolar found by me among the babirusa material, see below, p. 68), the Panganrejang Toedeja cave (VAN DER HOOP, 1938, p. 583), and the Lompoa cave, human bones of which latter cave were sent to me for identification by Dr. C. FRANSSEN in 1949. I shall deal first with the Bola Batoe material collected by Mr. H. R. VAN HEEKEREN in 1947.

Homo sapiens L. subsp.

(pl. II figs. 6 and 10)

The calvarium remains in the Bola Batoe cave collection consist of the greater part of the frontal, fragments of the parietalia, and the left malar or jugal. Moreover there are a maxillary fragment with the right P^4 and M^1 in situ, and four isolated teeth.

The frontal (pl. II fig. 6) consists of seven fragments which could still be matched, though most of the fracture surfaces were covered with matrix when I received the specimens. Some breaks are fresh and undoubtedly originated during the excavation, but the skull must have been struck (or fallen?) into pieces before deposition in the cave. Three ancient fractures radiate about from a point, five cm above the inner angle of the left orbit, which point evidently received a heavy blow.

It is very unfortunate that the specimen is so incomplete that none of the measurements recommended by MARTIN (1928) can be given, except the least frontal width (no. 9 of MARTIN, l.c., p. 629). The nasion is not preserved, and neither is the bregma.

The frontal portion is broken off in the median line just below the glabella which is not markedly prominent; the contour is nearest to that of no. III of BROCA's classification (MARTIN, 1928, p. 873). The arcus superciliares are inconspicuous; there is no fossa supraglabellaris. The tubera frontalia can be felt, but hardly seen on the fragment. Posterior to these tubera the surface is evenly curved but does not reach to the coronal suture, though evidently not much less far, for the hindmost point preserved in the median line is ten cm above the upper margin of the orbit.

The lateral margins of the frontal are not preserved either. At the left side the frontal is broken off just laterally of the incisura supraorbitalis. At the right side the anterior part of the linea temporalis is, however, shown, and this enables us to locate the frontotemporale (MARTIN, 1928, p. 618), and thus, as the median line is clearly indicated by the crista frontalis on the inner side, the least frontal width, which is 98 mm.

In sixty-five Veddah skulls the least frontal width varies from 80 to 102 mm (OSMAN HILL, 1941, p. 108/115), average 90.7 or better 91 mm. The Bola Batoe cave skull, though within the Veddah range, is far above the average Veddah as far as its frontal width is concerned.

Frontal sinuses are not exposed, and cannot be extensive. The facies orbitalis is very incomplete and calls for no special comment. The cerebral surface presents a strong median crest, the crista frontalis, which flattens out some four cm above the nasal root.

It is impossible to make out whether the present frontal is of a male or of a female individual. The poor glabella and arcus superciliares suggest a female but the very slightly developed tubera frontalia a male. Neither of these characters is, however, decisive (MARTIN, 1928, p. 739).

Not much can be deduced from the remaining bony parts of the calvarium in the Bola Batoe cave collection; the parietal fragments cannot even be located with absolute certainty, though one shows an eminence that may represent the tuber parietale. The left malar is, again, incomplete at its edges but conforms well to the corresponding part of the skulls used for comparison in the shape of the infraorbital margin and the position of the foramen zygomaticofaciale. Of these latter specimens no measurements can be given.

I have moreover from the Bola Batoe cave a maxillary fragment with heavily worn teeth in situ, viz., P^4 and M^1 dext., an isolated P^3 sin. in the same stage of wear, a less worn right M^2 in a maxillary fragment containing also part of the roots of M^3 behind, and two isolated upper molars. Of the latter specimens, which for their conspicuous hypocones I take as M^1's, one is of the right side and in the germ stage, with undeveloped roots, while the other, a left M^1, is slightly worn. Milk elements are also present (see below, p. 67). The measurements of the premolars and molars will be found in table 34. Labio-lingual diameters are given only because the mesio-distal, as shown by the contact facets, are no more reliable. In Man as well as in other mammals interproximal wear, resulting from movements of the adjacent teeth during mastication, leads to loss of substance at the mesial and distal surfaces, and hence to a shortening of the mesio-distal diameters of the individual elements.

As already said above, our Bola Batoe cave skull is rather large for that of a Veddah. Does the skull show Veddah characteristics? OSMAN HILL (1941, p. 131) states that supraorbital ridges are present in most

Veddah skulls, but finds it difficult to decide what is their typical degree of development on account of the variations seen. "Occasional skulls have very prominent ridges like those of Australians on a very small scale, but these are not the rule. Generally the ridges are small to moderate and the tendency for them to be confluent across the glabella is about 50 per cent. Supraorbital notches are usual, but the conversion of the notch into a foramen on one or both sides is extremely frequent" (OSMAN HILL, l.c.). The Bola Batoe cave frontal has a supraorbital notch at the left side, and the right upper orbital margin does not show such a notch but this is certainly due to damage.

In the collections of the Anatomical Institute at Utrecht there are three Boeginese skulls which were kindly sent to me by Prof. Dr. W. A. MIJSBERG. Moreover I could examine fifteen Boeginese and seventeen Macassars skulls of the collection of the Leiden Anatomical Institute, for which I am indebted to Prof. Dr. J. DANKMEYER. The variations in the frontal regions of these skulls are so great that it is impossible to fix a standard type, and all peculiarities in the subfossil fragment can be matched with those in the recent skulls. The least frontal width varies in this series of skulls from 86 mm to 103 mm, average 93 mm. This range includes the value (98 mm) found for the subfossil frontal, which appears to be larger than the average recent Southern Celebes frontals, not an unexpected result.

The mandible from the Bola Batoe cave (pl. II fig. 10) was broken through at the symphysis before fossilization set in, but the two halves could be matched after removal of the matrix on the fracture surfaces. The two central incisors, the crowns of which are missing, are displaced to the outer side of the line of the arch, and I have not tried to bring the roots again in their normal position. Apart from this evident squeezing of the front part of the mandible the specimen does not seem to be much distorted for, as can be seen from the photograph, the dental series forms an even parabolic arch from side to side. The ascending rami are not preserved, however, the right mandibular body is broken off obliquely behind the last molar, and the left is broken off vertically immediately behind M_3.

The body of the mandible does not present any unusual feature; beneath the displaced upper median fragment containing the roots of both I_1 there is a distinct vertical median eminence, the tuber symphyseos, flanked by tubercula lateralia: the trigonum mentale. The chin is not prominent to a marked degree. The spina mentalis interna is present but incomplete due to its being traversed by the ancient fracture. The mental foramen is placed below the anterior moiety of M_1, slightly more forward on the left than on the right side. The mylohyoid ridge is quite distinct but the digastric fossa is only weakly defined.

The teeth are all in a much worn state, like the upper teeth in the right maxillary fragment and the left P^3. The incisors, canines, and premolars are worn flat, and the molars are hollowed by wear, especially the M_1. There is no evidence of caries, however. Of the right M_1 and the left M_3 the crown is completely gone. The approximal surfaces of the molars are worn by mutual friction, and labio-lingual dimensions are again the only that can be taken. The same holds for the front elements, these being worn down to below the level of the greatest mesio-distal diameter. Apart from tooth dimensions few measurements of the mandible can be given; I have chosen the greatest width of the body at the mental foramen (MARTIN 69 (3)), the height of the body at the same level (MARTIN 69 (1)), and the body width-height index which is $\frac{\text{width} \times 100}{\text{height}}$.

TABLE 33.

Dimensions of mandibular body at mental foramen.

	Bola Batoe	Boeginese	Macassars	Javanese males	Javanese females	Papuans	Australians
Width	11	11—14	11—16	10—15	9—13	9—18	11—17
Height	31	25—31	26—33	28—36	23—34	20—35	20—33
Index	35.5	38.7—50.0	37.5—57.7	31.8—48.9	29.7—50.6	30.6—81.8	—

MARTIN (1928, p. 979) gives figures for the mandibular body index in fossil and recent Man which range from 40.8 (Parisians) to 60.4 (Malarnaud). In our specimen the index only amounts to 35.5, and in 16 Boeginese and 15 Macassars mandibles measured by me (table 33) this index varies from 37.5 to 57.7, but in Javanese (both males and females, after SNELL, 1938, pp. 93—95) as well as in Papuans (KLEIWEG DE ZWAAN, 1932, p. 15) there are found indices even lower than 35.5, the value found for the Bola Batoe cave mandible. The data for Australians are after PÖCH (in MIJSBERG, 1940, p. 107). It will be observed that the width of the Bola Batoe cave mandibular body is to the lower side of the variation ranges in the Boeginese, Macassars, Javanese, Papuans, and the Australians, but that the height is on the contrary to the higher side of the range of that measurement in the latter. The Bola Batoe cave mandible is narrow in relation to its height, or high relative to its width, as the case may be, and this is responsible for its low index.

The Veddah mandible is rather small, the body height varying from 21 mm to 28 mm, average 25 mm (OSMAN HILL, 1941, p. 116/122). The Bola Batoe cave mandible, with a body height of 31 mm, thus falls above the Veddah range. The Veddah mandible is described as being small, delicately built, with little or no muscular markings, narrow body, short thick symphysis, and only a moderately developed chin (OSMAN HILL, l.c., p. 135). Thus neither in the mandible Veddah characteristics are apparent. The Boeginese and Macassars mandibles measured by me present variations in the degree of prominence of the chin, alveolar prognathism, position of the mental foramen (which ranges from beneath the junction of P_3 and P_4 to beneath M_1), and it is, again, impossible to find characters for a separation of the cave mandible, which is just within the recent range of variation of dimensions. Its rather low body width-height index does fall a little below the recent range, but this is a difference without real significance.

As isolated permanent lower teeth I have a left I_2, of greater size than that in the mandible, and a left M_1. The latter tooth was buried in a very small body fragment with a pd_4 in situ. The first lower molar could not be measured in the adult mandible, and thus forms a most welcome addition. It would seem to have belonged to a larger individual than that of the mandible above described. It is unworn, shows the "*Dryopithecus*-pattern" very clearly, and has an extra cusp posteriorly to the inner side of the median antero-posterior line, the so-called cusp 6. All of the Boeginese and Macassars mandibles with not too much worn M_1's have this molar with the five-cusped pattern; M_2 and M_3 may be four-cusped and of the cruciform pattern (cf. HELLMAN, 1928).

How many individuals are represented in the Bola Batoe cave collection? The heavily worn teeth of the mandible conform well with those of the right maxillary fragment and the left P^3; these remains may very probably represent one and the same individual, and there is nothing against the association of the calvarium remains (frontal, parietals, and malar) with the maxillary and mandible. A second individual is that to which the not much worn M^2 dext. belonged. The two specimens of M^1, differing in structure (though not markedly so) as well as in stage of wear are certainly of different individuals, and, of course, other than that to which the more worn M^2 belonged. One of the two former individuals, however, may be that of the milk dentition, for the M_1 associated with the left pd_4 is in the germ stage too. Since the lower teeth usually erupt earlier than the corresponding upper it is most probable that, if any of the two M^1's belongs to the individual of the milk dentition, it is the unworn right M^1 rather than the slightly worn left M^1 which latter indicates almost certainly an older individual than that of the unworn M_1. The I_2 sin., not much worn, is perhaps to be associated with the individual of the moderately worn M^2.

This makes for a total of at least four individuals that were buried in the Bola Batoe cave, and probably there even were six or seven.

Measurements are recorded in table 34. The data for the Boeginese and Macassars are original [1]), those for the Javanese after MIJSBERG (1932), of the Melanesians after SCHWARZ (1925), of the New Britains after JANZER (1927), and those of the Australians after CAMPBELL (1925). It will be observed that the Eastern peoples present the highest maxima,

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1) In parentheses the dimensions of the teeth of a rather big-toothed Boeginese male recorded by THE (1941) in so far as they exceed my maxima.

especially in the molar region. Some lower and upper Bola Batoe cave specimens are below the variation ranges of their homologues, and are smaller even than those of the recent Boeginese and Macassars. The isolated M^1's, I_2, and M_1 are within the range of variation of these elements in the recent natives of South-western Celebes, but the maxillary fragment with P^4 and M^1, and the C, M_2, and M_3 of the mandible fall below the minima of the corresponding recent series.

TABLE 34.

Variation ranges of labio-lingual dimensions of upper and lower teeth.

	Bola Batoe		Boeginese	Macassars	Javanese males	Javanese females	Melanesians	New Britains males	New Britains females	Australians
I^1			7.3—7.7 (8.7)	7.0—8.2	5.9—8.9	6.0—7.9	6.5—7.5	7.0—9.0	6.5—8.8	7—9
I^2			5.7—7.4 (8.4)	6.9—7.1	5.0—7.8	5.0—7.4	av. 7.1	6.1—8.0	6.0—8.3	6—8.5
C			7.8—9.8 (10.2)	7.7—9.6	6.8—10.4	6.8—9.0	8.8—10.4	7.5—10.1	7.0—10.0	7.5—11
P^3	8.6		7.8—11.4	8.4—10.8	8.3—11.6	8.1—10.1	10—10.7	9.0—12.0	9.0—11.2	8.5—12
P^4	7.8		8.9—11.4	8.2—11.2	8.4—11.3	8.1—10.7	9—10.8	9.0—12.0	8.5—11.2	8.5—12
M^1	10.4	10.8	10.7—13.2(13.5)	10.5—13.0	10.0—13.0	10.3—12.7	12—13.1	11.1—14.0	10.0—13.1	11.5—14.8
M^2	10.6		10.4—13.0(13.9)	10.3—12.7	10.1—13.8	9.0—12.3	11—13.5	10.2—14.5	9.2—14.0	11—16
M^3			9.7—13.6	9.8—13.5	7.0—14.5	9.5—12.7	10—13	9.0—13.5	9.2—14.5	10—15
I_1			5.9—6.8	5.7—7.0	5.0—7.0	4.9—6.6	5.5—6.8	5.2—7.2	5.0—6.8	5.5—7.5
I_2	5.8	6.4	5.7—7.1	6.5—7.0	5.0—7.4	4.6—6.9		6.0—7.5	5.7—7.2	6—7.5
C	7.0		7.6—8.7	7.5—8.9	6.5—9.6	6.6—8.1	—	6.5—9.5	6.9—9.1	7—10
P_3	7.4		7.3—9.5 (9.6)	7.8—10.0	6.6—9.9	6.8—8.6	7—9	7.5—9.8	6.9—9.0	7—10
P_4	7.7		7.4—9.5 (10.0)	7.5—9.5	7.1—10.1	6.9—9.1	7.5—9.7	8.0—10.3	7.0—10.0	7—10
M_1		11.2	10.2—11.8(13.2)	9.8—12.1	9.9—12.0	9.9—11.9	10.7—11.6	10.0—12.5	10.0—11.8	10—13.5
M_2	9.5		9.8—11.7(13.0)	9.7—11.6	9.0—12.0	8.8—11.1	9.5—11.4	9.5—12.0	9.0—11.8	10—13.5
M_3	8.4		9.4—11.5(12.0)	9.3—11.8	8.9—12.2	9.6—11.1	8.7—10.8	8.0—12.2	8.5—11.5	8—13

At first sight this result is highly remarkable, for what I am always finding is that subfossil (or fossil) remains of living forms average larger than their recent homologues. This is also the experience of anthropologists, as will become evident from the following digression:

The teeth of Wadjak Man, Res. Kediri, E. Java, late Pleistocene or early Holocene (VON HEINE-GELDERN, 1945, p. 154), are stated by DUBOIS (1920, p. 1027) to be on the whole large, though they are still surpassed in size by those of many Australians. Subfossil Man from Goewa Lawa, Sampoeng, and Bodjonegoro, Java, was found by MIJSBERG (1932) to possess very large teeth, often exceeding the maximum size of the recent Javanese series examined. MIJSBERG (l.c., p. 54) arrives at the conclusion that we are not justified to identify the subfossil human remains with the recent Javanese people, but that the prehistoric Java Man is allied to human races characterized by having large molars: the Papuans, Melanesians, and Australians (cf. also MIJSBERG, 1936, p. 169, and 1937, p. 74).

The human teeth from the Guak Kepah kitchen midden, Province Wellesley, Straits Settlements, were reported to be large by Prof. F. W. HUXLEY (quoted in VAN STEIN CALLENFELS, 1936a, p. 29), who states to be inclined to look among the Papuans for the nearest allies of the men to whom the shell mound once belonged. Prof. W. A. MIJSBERG (in VAN STEIN CALLENFELS, 1936a, p. 33) writes that an M^1 from the latter site is "markedly Melanesoid" and even larger than Sampoeng specimens. Other teeth (l.c., p. 34) also have dimensions greater than the maximum of modern Javanese teeth, and "thus" point to a Melanesoid origin. The molars are unusually large indeed (MIJSBERG, 1937, p. 74). A mandible is subjected to a careful study (MIJSBERG, 1940), and found to possess features described as characteristic of present day Melanesians. Some of them also recall features of Australian jaws. The large size of the teeth is its most conspicuous character again. In particular the labio-lingual diameters of I_2, C, P_3, and P_4 are extraordinarily large, equalling or even surpassing the maxima of their homologues in Australians, Neu-Pommerns, and New Caledonians (MIJSBERG, l.c., p. 116). "From these facts one is justified in concluding that Austromelanesian populations in earlier times have passed through the Malay Peninsula and through Java. The data however do not enable us to decide if these immigrants had already differentiated into real Australians and real Melanesians or if they represented common ancestors to both these racial groups which afterwards, perhaps only after settling in the regions they inhabit now, by divergent differentation have developed into the recent Australians and Melanesians" (MIJSBERG, l.c., p. 118).

While excavating a rock-shelter at Gunung Pondok, Malay Peninsula, EVANS (1922, p. 269) noticed that the human teeth are remarkably strong. DUCKWORTH (1934, p. 161) too remarks upon the large size of the human molar teeth, also of those from other rock-shelters and caves in Perak, Pahang, and Perlis, and from Selinsing (l.c., pp. 149 and 154).

TWEEDIE (1936, p. 22) states that the molars of one burial found at Bukit Chintamani, Pahang, Malay Peninsula, are extremely large and "of the characteristic Melanesoid type"; VAN STEIN CALLENFELS (1936b, p. 48) even writes that this burial, in the very large size of its molar teeth, shows "easily recognizable Melanesoid affinities".

It is, unfortunately perhaps, not so easy to tell the race of a human individual from the size of its teeth. A careful student like JANZER (1927) is against the use of tooth-size in establishing racial diagnoses, emphasizing that even European teeth may occasionally exceed their Australian homologues in size. TRATMAN (1938), after having studied the subfossil human teeth from Gua Bintong, Bukit Chuping, Perlis, Malay Peninsula, correctly concludes that there is nothing in the appearance or shape of the teeth to indicate any particular race.

The fact also must be accounted for that small teeth are sometimes found besides the larger ones. Some burials of the Guak Kepah kitchen midden have teeth of normal size, and even of smaller size than those of the existing inhabitants. Although Prof. MIJSBERG points out that this material not improbably originates from female skulls, he feels inclined provisionally to consider it as belonging partly to individuals of a non-Melanesoid race (VAN STEIN CALLENFELS, 1936a, p. 34). A second burial in the Bukit Chintamani has smaller teeth than the "characteristically Melanesoid" mentioned above (TWEEDIE, 1936, p. 22).

On the whole of the island of Sumatra, up to now, no particularly large subfossil human teeth have been found. SARASIN (1914, p. 104) states that the human remains from the Oeloe Tjanko cave in Upper Djambi, S. Sumatra, indicate a small, gracile people with small teeth, perhaps a Veddah form. WASTL (1939) examined the human remains from the Bindjai Tamiang kitchen midden, N. Sumatra. A small, obviously dolichocranial people is indicated; tooth measurements are not given though teeth were present (l.c., p. 241, fig. 36). Two human teeth, an I^1 dext., and a left upper M, were found by me among the orang-utan material in the Dubois collection from the Lida Ajer cave, Padang Highlands, Central Sumatra. These elements are not particularly large but fall within normal limits. A final racial determination cannot be arrived at, though the structure of the incisor is more suggestive of a Yellow-Brown than of a Negro or a White (HOOIJER, 1948a, pp. 182—197, pl. I figs. 1—5).

Migrations of Melanesoids and Australoids over the Malay Archipelago to their present habitat will certainly have taken place, but in my opinion it is entirely unjustified to use the large size of the subfossil teeth from the Malay Peninsula and Java in evidence. These teeth bear evidence only of the former existence of peoples with teeth bigger than those of the present natives, and do not necessarily belong to the Eastern peoples the living representatives of which happen to be characterized by large teeth. In fact, these large subfossil teeth are indicative of nothing but that Man, like the animals, has undergone a diminution in size in the course of the Quaternary.

The concept of evolution in situ with diminution in size, parallel to that of the animals of which I gave so many examples in the present and earlier papers, clarifies the whole problem.

But how, then, to account for the small subfossil teeth? The only logical explanation is that the size differences between the teeth from one and the same site (e.g., the above mentioned Guak Kepah kitchen midden, the Bukit Chintamani, and, also, the Bola Batoe cave) are due to a difference in sex of their former owners. Sexual differences in size do exist in the human dentition (MIJSBERG, 1931), and these size differences were formerly more stressed than they are now, probably in Man as well as in other Primates. WEIDENREICH (1936, pp. 113/14) has already found that sexual size differences were more pronounced in *Sinanthropus* than in recent Man, a conclusion that perfectly conforms with mine as far as the canines of the orang-utan and of the Celebes macaque are concerned (above, p. 57). Unfortunately sexual differences in the human mandible are manifest only in size (WEIDENREICH, l.c., p. 112), and thus it cannot be proven that the

Bola Batoe cave mandible is that of a woman, although it would seem to be extremely probable that it is.

It is practically certain that among my series of Boeginese and Macassars skulls there are no female skulls, but only those of men. A prince of Bone and three pirates are among the former owners of these skulls, and no conspiciuous size differences are found in the whole of the series. The teeth of the Bola Batoe cave maxillary fragment and mandible are well within the range of variation of dimensions of their homologues in Javanese women (MIJSBERG, 1932, p. 52/53, recorded in table 34) with the exception only of the P^4 and the M_3. The former element is 0.3 mm less wide than the minimum width of P^4 in Javanese females; M_3 presents a more considerable difference. However, with a view to the variability, dwarfing, and absence of this element which, e.g., in the bigger-toothed New Britain males may present dimensions smaller even than the Bola Batoe cave specimen, I do not attach any value to this difference. MIJSBERG (1931) found reliable sexual differences in the labio-lingual diameters of all the teeth except in the third lower molar, in which latter element the difference between the means is less than two times its standard error (l.c., p. 1114).

Whether the small subfossil Sumatran teeth are those of females exclusively cannot, of course, be made out. The association with small and slender bones points indeed to a pygmoid form, according to SARASIN a Veddoid, and I shall return to this problem later when discussing the human bones from the Lompoa rock-shelter.

As stated above, the Bola Batoe cave frontal is comparatively large for a Boeginese or Macassar. The least frontal width provides no clue for the sex of a skull, and even its value for racial discrimination is problematical (MARTIN, 1928, p. 817). In Javanese (SNELL, 1938, p. 50) the variation ranges of this measurement in the two sexes are practically the same (80—82 mm to 99 mm). Thus, whatever the sex of the former owner of the Bola Batoe cave frontal be, this specimen is more than average-sized for the living South-western Celebean peoples.

The comparatively small-toothed mandible and maxillary-fragment are in all probability a woman's. No characters can be found to separate the Bola Batoe cave human material from that of the living Boeginese and Macassars. Much and much more material is needed to establish the exact relationships of the Toalian cave dweller. There is evidence, even in these very slight materials, that the subfossil *Homo sapiens* of the Bola Batoe cave is probably a little larger than the living natives of that region.

I have a number of milk teeth in the Bola Batoe cave collection, without duplicates and occasional elements even of both sides. These teeth can safely be regarded as originating from one and the same child, which was not particularly small. The 11.2 mm wide M_1 which I removed from the jaw fragment holding the pd_4 is over the average widths of this element in recent Boeginese and Macassars (11.0 mm and 10.9 mm respectively). No milk dentitions of the latter peoples being available, I limit myself to the statement of the dimensions of the elements, as thorough comparison with a number of European milk dentitions does not reveal any character worthy of special notice except that some cave teeth are rather large, but this I am not surprised to find.

TABLE 35.

Measurements of deciduous teeth [1]).

	Bola Batoe			Bola Batoe	
id^1 md	7.6	6.0—6.8 (7.5)	id_1 md	—	3.5—4.8 (5.5)
ll	5.6	4.8—6.0	ll	—	3.6—4.0
id^2 md	6.2	4.2—5.8 (6.6)	id_2 md	—	4.0—5.0 (5.9)
ll	5.4	4.0—5.6	ll	—	3.4—5.3
cd md	6.7	5.9—7.6	cd md	—	4.9—7.0
ll	5.8	5.6—6.9	ll	—	5.0—6.0
pd^3 md	7.8	6.2—8.0	pd_3 md	9.1	5.7—9.3
ll	9.8	7.0—9.0	ll	7.8	5.5—7.8
pd^4 md	9.1	4.9—10.8	pd_4 md	11.2	8.0—12.0
ll	10.6	8.5—10.6	ll	9.5	7.7—10.0

Table 35 shows that the Bola Batoe cave pd^3 is above the maximum of the corresponding milk element as far as its labio-lingual diameter is concerned, and other teeth are at, or very near to, the maximum size. The variation ranges given are those of DE TERRA (in ADLOFF, 1908, p. 30) and comprise all races of Man. In a series of milk teeth measured by MÜHLREITER (in COHEN, 1920, pp. 180—191) I found occasional higher figures which are added in parentheses. The Bola Batoe cave-collection contains and id^1 sin., an id^2 dext., an upper cd dext., a right and a left pd^3, and a pd^4 sin., and of the mandibular dentition a right and a left pd_3, as well as a pd_4 sin. The Bola Batoe cave pd^3 is of the premolariform type, without a hypocone, but in the Tjadang cave collection I noticed a molariform pd^3 dext. with a distinct hypocone (no. 291), thus proving that the latter variation, which is (at least in Europeans) less common than the former (COHEN, 1920, p. 183/84), occurs in the Toalian cave dweller too.

In the VAN STEIN CALLENFELS collection from the Batoe Edjaja cave I found a human milk element among the babirusa teeth. It is a pd^4 sin., longer mesio-distally (9.7 mm against 9.1 mm) but slightly narrower (labio-lingual diameter 10.5 mm against 10.6 mm) than the corresponding tooth in the Bola Batoe cave collection. No human burials were reported thus far from the latter site, but they were found in the nearly Pangan-rejang Toedeja cave (VAN DER HOOP, 1938, p. 583). No description of these remains appears to have been published yet.

[1]) md is mesio-distal, and ll stands for labio-lingual.

In the collection from the Lompoa rock-shelter near Maros sent to me by Dr. C. FRANSSEN there is firstly a human frontal fragment. It comprises the region of the left frontal eminence, more pronounced than that in the Bola Batoe cave specimen described above, and with part of the left linea temporalis. As the median line is not preserved, nor any of the margins of the frontal, no measurements can be given.

Much more important are the post-cranial skeletal remains in the Lompoa rock-shelter, as these specimens permit of a comparison with the human remains of the Lamontjong caves discovered by the SARASINS [1]). The latter remains were described as belonging to a small people, a humerus fragment indicating a stature of ca. 156 cm. The gracile limb bones have but weak muscular markings, a supposedly primitive feature (SARASIN, 1905, pp. 56—62, pls. V and VI).

One of the best preserved bones of the skeleton in the FRANSSEN collection is a right humerus, two portions of which could easily be fitted to one another. The head is missing; the shaft is undamaged but for a 2.5 cm long superficial injury distally of the fracture and just medially of the musculo-spiral groove which must have been made during or after the excavation. At the distal end both the trochlea and the capitulum are damaged, as well as both epicondyles, the spongiosa of which are exposed. There was still sand in the coronoid fossa, which, upon cleaning of the bone, showed a perforation to the olecranon fossa, and hence a natural foramen inter-condyloideum s. supratrochleare.

The shaft is markedly smooth, the only roughened surface being that for the attachment of the tendon of the pectoralis major. The bicipital groove is weak. The deltoid tuberosity is incomplete due to the above mentioned injury. The brachialis anticus surface is bounded medially by a narrow longitudinal depression. The mid-shaft section represents an oval depressed at the medial surface.

TABLE 36.

Measurements and indices of humerus.

	Lompoa rock-shelter 1	Lompoa rock-shelter 2	Lompoa rock-shelter 3	Veddahs
Greatest length	ca. 270	—	—	247—339
Greatest diameter at middle of shaft	16.5	16	—	—
Smallest diameter at same level	11	11	—	—
Smallest circumference	43	44	55	44—60
Diaphysis section index	66.7	68.8	—	—
Robusticity index	ca. 15.9	—	—	17.4—20

There is also a shaft portion of a left humerus (no. 2 in table 36), very similar to the above mentioned right specimen and hardly differing in

[1]) Mr. VAN HEEKEREN writes me that he considers the human remains from the Lompoa rock-shelter to be too recent to have belonged to the Toalian culture bearers.

proportions. And finally I have a distal shaft fragment of another left humerus (no. 3), more robust than the foregoing ones as shown by the least circumference in table 36. The variation ranges of the Veddahs are after OSMAN HILL (1942, pp. 170—173 and 178—181).

The diaphysis section index classes the Toalian cave humeri 1 and 2 as platymeric (MARTIN, 1928, p. 1102), a result arrived at by SARASIN (1905, p. 59) too.

A perforated fossa olecrani is considered nowadays to be of doubtful morphological significance. The SARASINs regarded this feature as very markedly characteristic of Veddahs and their allies (SARASIN, 1905, p. 59), and not in the least on the strength of this evidence in a subfossil humerus from the Oeloe Tjanko cave in Upper Djambi, S. Sumatra (SARASIN, 1914, p. 105, fig. 22) the presence of a Veddah form in the latter cave is alluded to. OSMAN HILL (1942, p. 187) has shown that the presence of a perforated olecranon fossa is a character that cannot be regarded as of any significance for the Veddahs.

The greatest length of humerus no. 1 is a figure that I give only with some hesitation; comparison with European female humeri of various sizes leads to a most probable figure of about 270 mm for the greatest length. This is rather short, giving an estimated stature of its former owner of about 142 cm (MARTIN, 1928, p. 1069). The variation ranges in stature of living Toalian males is 145 cm to 173 cm (VAN STEIN CALLENFELS in MIJSBERG, 1941, p. 1285), but the females were, of course, smaller. The estimated stature of the Toalian cave Man is within the range of the Veddah (134—164 cm: OSMAN HILL, 1941, p. 43), but the variation ranges shown in table 36 indicate that the Veddah humerus is less slender than the subfossil Celebean one. In the absence of the relevant data of the recent South-western Celebes population the significance of this find cannot be judged. The least robusticity index of recent Man recorded by MARTIN (1928, p. 1100) is 16.6, for a Senoi woman.

The antebrachium is represented in the Lompoa rock-shelter collection by the proximal portions of a right radius and ulna, and the middle portion of the shaft of another right ulna. Damage to the capitulum radii and to the processus coronoideus and the olecranon (the lateral part of which latter is missing) of the ulna reduces the number of standard measurements to be taken to five, viz., the transverse width of the collum radii and the collo-diaphysis angle of the radius (MARTIN 4 (2), and 7), and the olecranon-coronoid distance, the dorso-volar diameter and the transverse diameter of the shaft of the ulna (MARTIN 7 (1), 11, and 12). The diaphysial section index $\left(\frac{(11) \times 100}{(12)}\right)$ is markedly different in the two ulnae due to the second and larger specimen having a stronger interosseous crest. There is nothing unusual to record of the present bones besides their comparatively small size and slender build. The radius, which is less complete than the left specimen from the Lamontjong caves figured by SARASIN (1905, pl. 5

TABLE 37.

Measurements of radius and ulna.

	Lompoa rock-shelter	
Radius		
Transverse width of collum	11.5	
Collo-diaphysis angle (°)	160	
Ulna		
Olecranon-coronoid distance	ca. 23	
Dorso-volar diameter of shaft	9.5	11
Transverse diameter of idem	12	17.5
Diaphysial section index	79.2	62.9

fig. 7), has the tuberosity placed on a slightly lower level only. The ulna is curved both in the antero-posterior plane and in the medio-lateral plane. The curvature in the antero-posterior plane is intermediate between that in the Australian and the Neu-Mecklenburger (FISCHER, 1906, fig. 8a, b and c). In its curvature the Lompoa rock-shelter specimen very closely matches the ulna from the Lamontjong caves figured by SARASIN (1905, pl. 5 fig. 6). The Veddah ulna is even more curved (OSMAN HILL, 1942, p. 188), and thus is nearer to the apes (cf. FISCHER, 1906, fig. 8b).

No bones of the hand are present in the Lompoa rock-shelter collection; SARASIN (1905, p. 60) mentions 31 specimens which are, however, not described.

Curiously enough there is not a single fragment of the femur in Dr. FRANSSEN's collection, but of the tibia I have distal portions of both sides. The left one comprises slightly more than the distal half; the right is only 9 cm long and lacks the malleolus medialis. The tibia is rather small, and falls to the lower side of the variation range in the Veddah (ranges given in table 38, after OSMAN HILL, 1942, pp. 174—181).

TABLE 38.

Measurements of tibia.

	Lompoa rock-shelter	Veddahs
Distal width	ca. 39	—
Distal antero-posterior diameter	30	26—46
Greatest diameter at middle	22.5	22—34
Transverse diameter at same level	15.5	15—24
"Index cnemicus"	68.9	57—79.3
Circumference at middle	60	52—81
Least diaphysial circumference	53	47—74

The index cnemicus ought to be based on the diameters of the shaft at the level of the nutrient foramen which is, however, not preserved. Judging by the greatest diameters at the middle of the height (approximately) our bone falls into the mesocnemic category (MARTIN, 1928, p. 1052), as does the average Veddah tibia too (OSMAN HILL, 1942, p. 212). The cross section at the middle conforms best with that of type V of HRDLIČKA's classification (MARTIN, 1928, p. 1158). SARASIN (1905, p. 60) had no tibiae from the Lamontjong caves.

Only the larger of the foot bones, astragalus and calcaneum, are preserved in Dr. FRANSSEN's collection from the Lompoa rock-shelter, both of the left side but belonging to different individuals, the astragalus being too large for the calcaneum. The posterior process of the astragalus and the articular surfaces are injured, while the caput tali is incomplete below and medially, but the length, width, height, and trochlear length (MARTIN 1—4) and the indices based thereon can be given (table 39). The bone is narrow and low relative to its length and has a short trochlea judged by European standards. The Veddah ranges, however, are wide, and both measurements and indices are within the Veddah range (table 39, after OSMAN HILL, 1942, pp. 216—217).

The tuber calcanei is damaged laterally and at the medial surface below; the borders of the articular facets are incomplete. The calcaneum is again narrow and low as compared with European specimens. The measurements (MARTIN 1, 1a, 2—5) and indices are shown in table 39. While the astragalus is to the higher side of the range in the Veddah, the calcaneum is to the lower side of the latter range.

TABLE 39.

Measurements and indices of astragalus and calcaneum.

	Lompoa rock-shelter	Veddahs
Astragalus		
Length	47.5	39—53
Width	38	30—39
Height	26	18—31
Length of trochlea	30	24—32
Width-length index	80.0	66—81
Height-length index	54.7	46.2—62
Trochlear length index	63.2	48—66
Calcaneum		
Greatest length	60	57—78
Total length	56.5	—
Middle width	34	34—46
Least width	18.5	18—31.5
Height	30	26—40
Length of corpus	41.5	41—53
Width-length index a	56.7	52.5—60.5
Width-length index b	30.8	30.2—40.5
Height-length index [1])	50.0	42—51.7
Corpus length index	69.2	63—75.7

[1]) This index is based on the height and the greatest length instead of the total length as recommended by MARTIN (1928, p. 1061). OSMAN HILL only gives the maximum length and bases his indices thereon. The correct height-length index of my subfossil specimen is 53.1.

Of the 20 tarsal bones in the Lamontjong caves collection, SARASIN (1905, p. 61) deals only with a metatarsal and a phalanx. The present bones thus are new for our knowledge of the osteology of the Toalian cave dweller, though they may have been present in the SARASIN collection too.

The left humerus (no. 2 of table 36), the proximal portions of a right radius and ulna, as well as the two tibiae and the calcaneum may have belonged to the small individual of the figured right humerus. A larger individual is indicated by the distal left humerus fragment (no. 3), the shaft portion of a right ulna, and the astragalus. This accounts for at least two burials in the Lompoa rock-shelter.

The results of the examination of the human remains in the Bola Batoe cave collection of Mr. VAN HEEKEREN and those in the Lompoa rock-shelter collected by Dr. FRANSSEN are the following:

1. The skulls shows no characters that are typically Veddah-like; the frontal bone is larger than the average in Boeginese and Macassars, and the mandible is high relative to its width and falls above the Veddah range in this respect.
2. The permanent teeth in situ are small when compared with those of Boeginese and Macassars, but this is most probably due to the subfossil teeth having belonged to a female, and the recent Celebean skulls used for comparison to male individuals. Some of the isolated teeth are not particularly small, however.
3. The milk dentition is large, some elements are at, or even over, the maximum size recorded for all living races of Man.
4. In the post-cranial skeleton, though primitive, no special Veddah characteristics are apparent either, and the structure of its ulna points to the subfossil Toalian cave Man as a form more advanced even than the living Veddah. The robusticity index of the humerus is very low. The tibia is now shown to be mesocnemic. The astragalus and the calcaneum exhibit primitive characters, judged by European standards, and conform well with the corresponding Veddah bones.
5. The remains in the Bola Batoe cave point to four to seven different individuals; those of the Lompoa rock-shelter have partly belonged to an individual the stature of which was probably only 142 cm, but one larger individual, at least, was present too.

These fragmentary remains prove nothing as to the racial identity of their former owners, whether they be Proto-Malays or Deutero-Malays, etc. It only seems improbable that they represented Veddahs. There is nothing against their ancestor-descendant relation to the living natives of this region of Celebes, whatever they may be now. No passing migrants are necessary to explain their occurrence.

It has also been shown that the occurrence of comparatively large subfossil teeth in the Malay Peninsula and in Java cannot be used in favour of migrations of Melanesoids or other big-toothed peoples to have taken place by way of these regions, though, of course, similar migrations must have happened once, or more than once, in the past. The Aitape skull of New Guinea (FENNER, 1941) and the Talgai and Keilor skulls of Australia bear evidence of this (WEIDENREICH, 1945, p. 31). Though the Pleistocene age of these fossilized specimens may be questionable, they show Man to have already begun immigrating New Guinea and Australia further back in the geological past than the time of the deposition of the human remains in the various caves and rock-shelters of the Malay Peninsula and Archipelago.

Order RODENTIA Bowdich

Family MURIDAE Gray

Genus **Lenomys** Thomas

Skull remains belonging to the present genus were found in Southern Celebes, both recent and in the subfossil state, by SARASIN (1905, p. 45/46); *Lenomys* was known, until then, only from Northern Celebes. The living Southern race was described by TATE and ARCHBOLD (1935b, p. 5) as *Lenomys meyeri lampo* from the Peak of Bonthain (= Lompobatang Mt.).

Besides *Lenomys meyeri* (Jentink, 1879, p. 12), SARASIN (1905, p. 46/47) distinguished in the Toalian cave fauna "*Mus neglectus*" (a Bornean species), and *Mus* spec. The latter should represent an unknown rat species to which the recent calvarium collected by Prof. WEBER at Pare Pare (S. W. Celebes) and figured by JENTINK (1890, pl. X figs. 4—6) belongs. The latter specimen, according to SARASIN, was wrongly referred by JENTINK (l.c., p. 120) to *Eropeplus callitrichus* (Jentink, 1879, p. 12) of Northern Celebes. According to TATE and ARCHBOLD (1935b, p. 6) and TATE (1936, p. 616) the Pare Pare calvarium belongs probably to *Lenomys meyeri lampo*. I have examined this specimen (L.M.), and it belongs to *Lenomys* indeed.

The genus *Lenomys* (Thomas, 1898c, p. 409 footnote (!)) is characterized by the complexity of its molars; it can be distinguished from all other large rats occurring in Celebes by its having three tubercles on the posterior loph of the upper molars (see THOMAS, l.c., pl. XXXVI fig. 1, and TATE, 1936, p. 613 fig. 28 C). In the very closely related genus *Eropeplus* (which also shows the narrow palate and the heavy supraorbital ridges typical of *Lenomys:* HOFFMANN, 1887, p. 21) to which JENTINK's *Mus callitrichus* belongs (TATE, 1940, p. 6/7), the posterior inner tubercle is absent. Now the Pare Pare calvarium agrees with the type of *Lenomys meyeri* (Jentink) in the structure of its molars; the critical postero-internal tubercle, incipient in the M^1 sin., is clearly developed in all other upper molars. The molar series of the Pare Pare specimen is only decidedly the shortest, being 10.5 mm as opposed to 12.1 mm (both at the crowns) in JENTINK's type specimen.

Consequently, if the "*Mus* spec." of SARASIN is really the same species as that of the Pare Pare calvarium it should be *Lenomys meyeri,* viz., the species already recorded by SARASIN in the same paper and from the same deposits.

DAMMERMAN (1939, p. 71/72) does not identify the Murid mandibles in the VAN STEIN CALLENFELS collection as to the species, identifying them as Murid species a, b, c, and d only. Species a is the largest rat represented, and DAMMERMAN (l.c.) states that in the structure of its molars it bears a great resemblance to *Lenomys meyeri*. The subfossil mandible is higher and longer, however.

Lenomys meyeri was originally described as being tawny on the upper parts (JENTINK, 1879, p. 12), but MEYER (1899, p. 27, pl. VIII) states that the colour varies between greyish and brownish, and gives a fine plate of a greyish specimen. Specimens 1 and 3 of the list below are greyish.

Lenomys meyeri meyeri (Jentink)

Material examined:

1. Stuffed skin and skull of subadult male (M3 not yet fully in place). Waroemboengan, Menado, N. Celebes, leg. Dr. A. REYNE, 1932. L. M., reg. no. 2797.
2. Stuffed skin and skull of adult (holotype). Menado-Langowan, N. Celebes, coll. VAN MUSSCHENBROEK, September, 1875. L. M., cat. syst. a, cat. ost. a.
3. Stuffed skin and skull of adult female. Menado, N. Celebes, coll. SODY, no. P 64.

N.B. The alcoholic specimen from Bone, collected by VON ROSENBERG as early as 1863 and listed as *Mus meyeri*, cat. syst. b, by JENTINK (1888b, p. 65) is an ordinary *Rattus*.

Lenomys meyeri lampo Tate et Archbold

Material examined:

1. Calvarium. Pare Pare, S.W. Celebes, coll. WEBER, 1888. L.M., cat. ost. b.

As already stated above the Pare Pare calvarium appeared in the literature already in 1890 but was correctly identified only in 1935. TATE and ARCHBOLD (1935b, p. 5) state that the race from S. W. Celebes is almost indistinguishable externally from the typical form, and the skull can be separated from that of *meyeri meyeri* only by its long palatal openings, which measure 8.6—8.8 mm against 7.1 in *meyeri meyeri* (TATE, 1936, p. 714/15). In one Amoerang (N. E. Celebes) specimen the length of the palatal foramina amounts to 8.1 mm (SODY, 1941, p. 318), however. The palatal foramina in the Pare Pare calvarium are not 9.9 mm long, as stated by TATE (1936, p. 716) and apparently measured from JENTINK's crude figure, but only 8.7 mm. Hence the difference in length of the palatal foramina is not so great as would appear from TATE's statements. In the Northern Celebean skulls of *Lenomys meyeri* examined by me the palatal foramina vary in length from 7.0 to 7.3 mm. I can find no other skull character to distinguish between the Northern and the Southern race. The shortness of the toothrow of the Pare Pare calvarium (10.5 mm against 11.0 in an adult ♀ and 12.0 mm in an adult ♂ of *Lenomys meyeri meyeri*: TATE and ARCHBOLD, 1935b, p. 6, and TATE, 1936, p. 715 respectively) is merely a result of prolonged interproximal wear. The transverse diameters of the teeth are those that count; as can be seen from table 40 in this respect there is no difference between the Southern and the Northern specimens.

Consequently, there is hardly any differentiation between *Lenomys meyeri meyeri* and *Lenomys meyeri lampo* to be admitted, not even in general size (cf. *Phalanger celebensis*, p. 19). The mandibles of the two races are indistinguishable from each other.

The lower molars of *Lenomys*, like the upper, are distinguishable from those of *Eropeplus* and *Rattus* by their more complicated structure; the median folds of the lophs in particular are very much more strongly marked in the present genus than in the others. In the cave collections at my disposal the following mandibles have molars the structure of which leaves no doubt as to their belonging to:

Lenomys meyeri (Jentink) subsp.

(pl. III fig. 11)

Batoe Edjaja cave (DAMMERMAN, 1939, p. 71, Murid species a): One recent-looking left mandible with the molar series and the alveolus of I intact. The condyle is also preserved, but the papery coronoid and angular processes are gone. Measurements of this and of the following specimens are given in table 40.

TABLE 40.

Measurements of upper and lower teeth of *Lenomys meyeri*.

No. of specimen	*L. meyeri meyeri* 1	2	3	*L.m. lampo*	Batoe Edjaja	Panganrejang Toedeja (layer A–B) a	b	d	e	f	Id. (layer C–D) a	b	c	Bola Batoe
M^1 tr.	3.3	3.4	3.3	3.4	—	—	—	—	—	—	—	—	—	—
M^2 tr.	3.0	3.2	3.2	3.2	—	—	—	—	—	—	—	—	—	—
M^3 tr.	—	2.5	2.6	2.5	—	—	—	—	—	—	—	—	—	—
M^1–M^3	—	12.1	11.2	10.5	—	—	—	—	—	—	—	—	—	—
Lower I ap.	—	2.8	—	—	—	—	2.7	2.6	—	—	2.8	—	—	2.9
id. tr.	—	1.9	—	—	—	—	1.7	1.8	—	—	2.0	—	—	1.8
M_1 tr.	3.0	3.4	3.0	—	3.0	3.0	3.1	—	3.2	3.1	2.9	3.0	3.4	—
M_2 tr.	2.9	3.4	3.1	—	3.1	2.9	3.1	2.9	3.0	3.1	2.9	—	3.1	—
M_3 tr.	—	3.0	2.6	—	2.9	2.7	—	2.6	—	2.8	—	—	2.8	—
M_1–M_3	—	11.4	10.9	—	10.8	11.3	—	—	10.9	11.6	—	—	11.9	—
Ramus height [1]	—	9.5	9.1	—	9.8	10.0	—	—	—	—	—	9.6	11.1	ca. 11
Length front to condyle		34.0	30.5	—	32.6	—	—	—	—	—	—	—	—	—
Length M_1 to condyle		26.2	22.9	—	24.3	24.8	—	—	—	—	—	—	—	—

Panganrejang Toedeja cave, layer A—B (DAMMERMAN, l.c.):

a. one recent right mandible with M_1—M_3, no incisor, coronoid or angular process;

[1]) From postero-inferior angle of symphysis to alveolar border of M_1.

b. idem, with M_1—M_2 and with the I preserved; coronoid process only lost;
c. a small fragment holding part of the I but no M;
d. a left mandible with I and M_2—M_3, broken off behind the molars;
e. idem, with M_1—M_3 and alveolus of I;
f. small fragment but with M_1—M_3 complete.

Panganrejang Toedeja cave, layer C—D (DAMMERMAN, l.c.):
a. a right mandible with I and M_1—M_2, postdental portion broken off;
b. idem, but with M_1 only;
c. a left mandible, I broken off, the molar series complete and rather large (pl. III fig. 11).

DAMMERMAN (1939, p. 71) feels that the last specimen in particular is rather large, too large to be classed with the same species as the remains from the other deposits. He adds that this specimen may represent another species. However, it is in accord with the observations in other species that the older the deposit the bigger the specimen therein. Layer C—D, the older layer of the Panganrejang Toedeja cave, contains also a cuscus bigger than that of the upper layer A—B (above, p. 27). In the present case the material is so very scanty that I do not venture to describe the C—D layer material of the Panganrejang Toedeja cave as a new subspecies though I feel pretty certain that it is. Structural differences from the recent specimens do not appear; size is, again, the only criterion. As will be seen from table 40 there is practically no size difference between the recent and the cave mandibles, all of the latter being within the recent range but for the last of the C—D layer mandibles, represented on pl. III fig. 11. The accessory tubercles on the outer side between lophs 2 and 3 of M_1 and between lophs 1 and 2 of M_2 are somewhat bigger than usual (cf. THOMAS, 1898c, pl. XXXVI, fig. 1, right fig.; not shown in the figure presented by HOFFMANN, 1887, fig. 2b).

No justification can be found for DAMMERMAN's statement that the subfossil mandibles are longer than the recent; the few length measurements that could be taken do not surpass those of JENTINK's type specimen.

The Bola Batoe cave collection, in which rats are but scantily represented, contains one comparatively large left horizontal ramus of a rat that is unfortunately toothless except for the I. As far as its size is concerned there is no objection against its reference to the present species with which it may be provisionally classed.

Genus **Rattus** Fischer

TATE (1936) has done a most valuable work in revising the recent Indo-Australian forms of *Rattus*, and it is not to be wondered at that both ELLERMAN (1941 (March 21), p. 215) and SODY (1941 (December), p. 313) named a new species of *Rattus* after this author. ELLERMAN's *tatei* belongs to the *concolor* group (or, better, *exulans* group: ELLERMAN, l.c., p. 645) of *Rattus* and is based on a specimen from Central Celebes, while

SODY's *tatei* belongs to the *xanthurus* group, and its type specimen is from Northern Celebes. SODY, however, proposed his name in the genus *Taeromys*, one of the twelve new generic names proposed by him (l.c., p. 260/61) for forms currently included in the genus *Rattus*. If *Taeromys* is valid as a genus (which I doubt) there is, of course, no preoccupation for the name *tatei* Sody; otherwise the latter name will have to be changed [1]).

I follow ELLERMAN (1941) who lists not less than 554 named forms of the genus *Rattus* but who does not see the possibility of a subdivision into smaller genera, mammary formulae, the number of roots of M^1, and other characters that have been used not having the slightest generic value (ELLERMAN, l.c., pp. 43 and 150—172).

Celebes, paradise of large rats (JENTINK, 1890, p. 119), is the habitat of *Rattus dominator* Thomas (1921, p. 244) to which I feel certain one of the Toalian caves rats belongs. It is the second largest rat species represented, the "Murid species b" of DAMMERMAN (1939, p. 71).

Rattus dominator represents a separate specific group of *Rattus*; it was formerly included in the *xanthurus* group of TATE (1936, pp. 522 and 557/58) but has several characters peculiar to itself like its wide and forwardly produced zygomatic plate, short palatal foramina, very small auditory bullae, and markedly opisthodont incisors (THOMAS, 1921, p. 245; TATE, 1936, p. 559; ELLERMAN, 1941, p. 217). Its molars, moderately large for an animal of this size (head and body about 240 mm, in the average; tail even longer) are of the ordinary *Rattus*-type, without the postero-internal tubercle on the upper molars and with the three tubercles on the first and second lophs with the tendency to assume a crescentic arrangement. TATE (1936, p. 509) feels that the teeth of *Rattus* represent the archaic murid tooth form, but ELLERMAN (1941, p. 44) holds the loss of cusps and tendency toward laminate dentition in *Rattus* to be specialization from complex-toothed forms such as *Lenomys*, etc., in which the cusps are well developed and angular. This problem can only be solved upon the discovery of fossil rats; the subfossil rats in my collection from Celebes do not differ in dental structure from the recent. In my opinion, however, ELLERMAN's hypothesis is probably nearer to the truth than that of TATE. The fact that the subfossil rat molars are occasionally provided with relatively bigger accessory tubercles than the recent is perhaps an indication that the more complex dental pattern is the primitive one. Progressive simplification of the molars is also what we observe in other rodents (WOOD, 1937, 1947).

Three races of *Rattus dominator* have been named. The Central Celebean race, *Rattus dominator camurus* Miller et Hollister (1921b, p. 96) only averages greyer than the typical race from N. E. Celebes, and the auditory bullae are smaller. TATE (1936, p. 562) reports upon specimens from all

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1) This was actually done a few months ago. ELLERMAN, in the Addenda to his publication of 1940/41 published in March, 1949, renamed SODY's *tatei* as *Rattus simpsoni*.

parts of Celebes, the "Lompobatang Mt." or Peak of Bonthain included. Specimens from the latter locality are stated to have the ears rather smaller than in either *dominator* or *camurus*, and the zygomatic plate runs slightly narrower. As a matter of fact the highland animals have the fur longer and denser than the lowland animals.

An adult male from Wawa Karaeng, Peak of Bonthain (2200 m) in the Buitenzorg Museum was compared with other specimens in this Museum and made the type of *Rattus dominator ursinus* (Sody, 1941, p. 312). Its tail is stated to be relatively longer (145 % of head + body length) than that in seven specimens from the lowland of Central and Southern (meant is, in all probability: Northern) Celebes (124 %). However, according to a table given by TATE (1936, p. 674, third column), in a Central Celebean specimen preserved in the Buitenzorg Museum the tail length is 150 % of head + body length. The skull of the Bonthain Peak animal is said by SODY to differ from that of the Northern race by "the anterior margin of the zygomatic plate sloping down steeply", which may conform with TATE's statement that the zygomatic plate is slightly narrower in the Southern skulls. The zygomatic plate in SODY's type is only 6.3 mm wide against 6.8—9.0 mm in five Northern Celebean specimens (SODY, 1941, p. 313). Since, however, a Central Celebean specimen has a zygomatic plate of 6.0 mm (TATE, 1936, p. 674, second column) this character is of no value, too. SODY does not remark upon the size of the ear in the Bonthain Peak animal, but as appears from his table the ear is indeed shorter (24.5 mm) than that in the Northern Celebean specimens in the Buitenzorg Museum (25—31 mm; SODY, l.c.). In the type of *dominator dominator* from the Minahassa the ear is only 21 mm in length (THOMAS, 1921, p. 245), however.

Consequently, neither in the relative tail length nor in the width of the zygomatic plate nor in the size of the ear the S. W. Celebean form of *Rattus dominator* is distinguishable from the Central Celebean form, *Rattus dominator camurus*, which is very much like the typical North-eastern Celebean form. The racial differentiation in the present species apparently is as weak as that in the foregoing (*Lenomys meyeri*).

Rattus dominator dominator Thomas

Material examined:

1. Stuffed skin and skull of adult ♀. Amoerang, N. Celebes, coll. SODY no. P 9.
2. Stuffed skin and skull of adult ♀. Tondano, N. Celebes, coll. SODY no. P 17.
3—13. Eleven stuffed skins and skulls of adults. Celebes, coll. SODY nos. P 52, 68—71, 73, 74, 83, 85, 86 and 88.
14. Stuffed skin and skull of adult ♂. Temboan, N. Celebes, coll. RAVEN, 27—7—1916. United States National Museum, no. 217684 [1]).
15. Stuffed skin and skull of adult ♀. Temboan, N. Celebes, coll. RAVEN, 1—8—1916. United States National Museum, no. 217696 [1]).

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[1]) These specimens were presented to Mr. H. J. V. SODY and are now in the Sody collection.

Not much attention was ever paid to the mandible of the Murinae for taxonomic purposes; the attention of the various students of this group was focused on skin and calvarium characters. Modern comprehensive works like those of TATE (1936), RÜMMLER (1938), and ELLERMAN (1941) only cursorily refer to the mandible. TATE and RÜMMLER figure calvariums only; TATE gives, in his tables, "length mandible" and "crowns, m_{1-3}" but the relevant figures are filled in only exceptionally. ELLERMAN (1941, p. 2) only states that one of the essential Muridae characters is that the angular portion of the mandible is not distorted outwards by the masseter muscle.

The identification of fragmentary rat mandibles seems to be a hopeless task, unless size is an important criterion, like it is in the present case. Moreover, *Rattus dominator* has a peculiarity, left unnoticed by earlier writers but observed by DAMMERMAN (1939, p. 71) in his "Murid species b", viz., that the incisors are relatively broader in antero-posterior direction than they are in other gigantic rats like *Lenomys*.

Rattus dominator Thomas subsp.

(pl. III fig. 10).

In the Bola Batoe collection of Mr. VAN HEEKEREN there are two mandible portions, with the incisors and with M_1 and M_2, one of the right and one of the left side. In addition there are two right lower I. In the VAN STEIN CALLENFELS collection the present species is well represented:

Batoe Edjaja cave (DAMMERMAN, 1939, p. 71, Murid species b): a left mandible with I, M_1 and M_3, and an isolated M_1 sin.

Panganrejang Toedeja cave, layer A—B (DAMMERMAN, l.c.):

a. a right mandible, broken off behind M_2;

b. idem, with M_2 only;

c. idem idem.

Panganrejang Toedeja cave, layer C—D (DAMMERMAN, l.c.):

a. a right mandible, I and M_1—M_3 but incomplete behind (pl. III fig. 10).

b. idem, but smaller;

c. a left mandible, well preserved but without M_3;

d. idem, with M_3 only, and with an incisor which may not belong to it;

e. idem, with incisor alveolus empty and with M_1—M_2.

The measurements of the recent and subfossil mandibles are given in table 41.

Though the subfossil mandibles are within the recent range of variation it will be seen that the former are often more than average-sized. The last molar of specimen b of the Panganrejang Toedeja cave, layer C—D, is rather small, and the toothrow M_1—M_3 extremely short, but recent no. 9 is very near in dimensions. The C—D layer material of the Panganrejang Toedeja cave is not larger than that of the upper layer of the same cave, as far as these few figures permit judgment.

TABLE 41.

Measurements of lower teeth of *Rattus dominator.*

No. of specimen	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
I ap.	—	2.9	2.6	2.5	3.2	3.2	3.0	2.9	2.8	2.6	3.0	2.8	2.8	3.1	3.0
id. tr.	—	1.6	1.4	1.4	1.6	1.7	1.5	1.6	1.6	1.6	1.5	1.5	1.5	1.7	1.4
M_1 tr.	2.5	2.5	2.3	2.4	2.6	2.7	2.6	2.4	2.4	2.6	2.4	2.6	2.7	2.7	2.7
M_2 tr.	2.5	2.6	2.5	2.5	2.7	2.8	2.7	2.5	2.5	2.7	2.4	2.8	2.7	2.7	2.8
M_3 tr.	2.2	2.1	2.1	2.1	2.4	2.6	2.5	2.3	2.1	2.4	2.1	2.4	2.3	2.4	2.3
M_1–M_3	9.0	9.2	9.0	9.0	9.6	9.7	9.4	9.6	8.6	9.8	9.1	9.9	9.8	9.7	9.5

	Average	Bola	Batoe	Batoe Edjaja	Panganrejang Toedeja (layer A–B)			Idem (layer C–D)				
					a	b	c	a	b	c	d	e
I ap.	2.9	3.3	2.9	2.8	3.4	3.4	3.3	3.2	3.1	3.4	3.2	—
id. tr.	1.5	1.6	1.5	1.4	1.7	1.6	1.5	1.7	1.5	1.7	1.6	—
M_1 tr.	2.5	2.4	2.5	2.4	2.6	—	—	2.5	2.4	2.5	—	2.5
M_2 tr.	2.6	2.5	2.5	—	2.7	2.6	—	2.6	2.4	2.6	—	2.5
M_3 tr.	2.3	—	—	2.3	—	—	2.4	2.5	2.0	—	2.2	—
M_1–M_3	9.4	—	—	9.4	—	—	—	9.8	8.7	—	—	—

Rattus spec. indet.

The medium-sized rat species c of DAMMERMAN (1939, p. 72) is represented in the VAN HEEKEREN collection of the Bola Batoe cave as well as in the VAN STEIN CALLENFELS collections of the Panisi Ta'boettoe and of the upper layer A—B of the Panganrejang Toedeja cave. The Panisi Ta'boettoe mandibles are undoubtedly recent, and one of them is almost completely preserved, but notwithstanding careful comparisons with series of various medium-sized Celebean rat mandibles I am unable to tell the species to which the cave material belongs. As said already above, in modern rat systematics the mandible is neglected, and it is my opinion, too, that a mandible is less serviceable to the identification of a given specimen than the calvarium or the skin.

However, it seems very probable that the present species belongs to the *xanthurus* group of *Rattus*, for the mandibles of *Rattus xanthurus xanthurus* (Gray), *Rattus xanthurus marmosurus* Thomas, *Rattus taerae* Sody, *Rattus tondanus* Sody, *Rattus celebensis* (Gray), and *Rattus bontanus* Thomas are very near in size to the medium-sized rat of the Toalian caves, and are indistinguishable structurally. I have seen and measured specimens of all of these species, and the material is listed below.

Rattus xanthurus xanthurus (Gray)

Material examined:

1. Stuffed skin and skull of adult. Menado-Langowan, N. Celebes, coll. VAN MUSSCHENBROEK, September, 1875. L. M., cat. syst. a, cat. ost. a.

2. Stuffed skin and skull of adult. Menado-Kakas, N. Celebes, coll. VAN MUSSCHENBROEK, September, 1875. L. M., cat. syst. b, cat. ost. b.
3. Stuffed skin and skull of adult male. Waroemboengan, Menado, N. Celebes, leg. Dr. A. REYNE, 1932. L. M., reg. no. 2799.
4. Stuffed skin and skull of adult male. Waroemboengan, Menado, N. Celebes, leg. Dr. A. REYNE, 1932. L. M., reg. no. 2819.
5. Stuffed skin and skull of adult female. Amoerang, N. Celebes, coll. SODY no. P 22.
6. Stuffed skin and skull of adult female. Amoerang, N. Celebes, coll. SODY no. P 23.

Rattus xanthurus marmosurus Thomas

Material examined:

1. Stuffed skin and skull of adult male. Amoerang, N. Celebes, coll. SODY no. P 2.
2. Stuffed skin and skull of adult male. Amoerang, N. Celebes, coll. SODY no. P 3.

Rattus taerae Sody

Material examined:

1. Stuffed skin and skull of adult male. Lembean, E. of Tondano, N. Celebes, coll. SODY no. P 72 (holotype).
2. Stuffed skin and skull of adult. Tondano, N. Celebes, coll. SODY no. P 87.
3. Stuffed skin and skull of adult. Tondano, N. Celebes, coll. SODY no. P 84.
4. Stuffed skin and skull of adult female. Lembean, E. of Tondano, N. Celebes, coll. SODY no. P 5.
5. Stuffed skin and skull of adult. Tondano, N. Celebes, coll. SODY no. P 67.

Rattus tondanus Sody

Material examined:

1. Stuffed skin and skull of adult male. Tondano, N. Celebes, coll. SODY no. P 89. (holotype).

Rattus celebensis (Gray)

Material examined:

1. Stuffed skin and skull of adult. Amoerang, N. Celebes, leg. Dr. A. REYNE, 1932. L. M., reg. no. 2798.
2. Stuffed skin and skull of adult female. Amoerang, N. Celebes, leg. Dr. A. REYNE, 1932. L. M., reg. no. 2801.
3. Stuffed skin and skull of adult. Tonsea, Minahassa, N. Celebes, leg. Dr. A. REYNE, 1932. L. M., reg. no. 2821.
4. Stuffed skin and skull of adult male. Temboan, N. Celebes, coll. RAVEN, 31—7—1916. United States National Museum, no. 217692 [1]).
5. Stuffed skin and skull of adult female. Temboan, N. Celebes, coll. RAVEN, 31—7—1916 United States National Museum, no. 217694 [1]).

Rattus bontanus Thomas

Material examined:

1. Stuffed skin and imperfect skull (front damaged, left ramus lost) of adult male. Indroelaman, Peak of Bonthain, S.W. Celebes, coll. EVERETT, 12—10—1895. B. M. no. 97. 1. 3. 10 (holotype).

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[1]) See footnote on p. 80.

The above mentioned species were described by GRAY (1867), THOMAS (1921), and SODY (1932b) from Northern Celebes with the exception of *Rattus bontanus* Thomas (1921, p. 245) the type of which is from the Peak of Bonthain, very near the Panganrejang Toedeja cave. The latter species as well as *Rattus xanthurus xanthurus* (Gray) and *Rattus taerae* Sody agree best in size with our subfossil and recent Toalian cave mandibles; *Rattus celebensis* (Gray) is rather too large, and *Rattus xanthurus marmosurus* Thomas and *Rattus tondanus* Sody are too small. This is apparent from table 42.

Of two Southern Celebean rats belonging to the same section as the above mentioned ones, viz., *Rattus foramineus foramineus* Sody and *Rattus toxi* Sody, I have seen no material, but from the length of the upper molar series (7.8—9.3 mm, SODY, 1941, p. 309) which is always about the same as the length M_1—M_3, it is evident that these species, too, might be the same as that of the Toalian cave rat now under discussion.

TABLE 42.

Measurements of lower teeth of various medium-sized *Rattus* species.

No. of specimen	*Rattus xanthurus xanthurus* 1	2	3	4	5	6	*R.x. marmosurus* 1	2	*Rattus taerae* 1	2	3	4	5
I ap.	2.2	2.3	2.5	2.1	2.6	1.6	1.9	1.7	2.2	1.8	2.1	2.3	2.3
id. tr.	1.5	1.4	1.4	1.3	1.6	1.2	1.1	1.2	1.2	1.3	1.3	1.4	1.4
M_1 tr.	2.2	2.4	2.3	2.2	2.4	2.3	1.8	1.8	2.3	2.2	2.0	2.3	2.0
M_2 tr.	2.2	2.4	2.3	2.4	2.5	2.4	1.9	1.9	2 4	2.3	2.3	2.4	2.3
M_3 tr.	2.0	2.1	1.9	1.8	2.1	2.1	1.7	1.7	1.9	2.0	1.9	2.0	1.8
M_1–M_3	7.8	7.7	7.8	7.9	8.3	8.5	7.3	7.0	8.6	8.7	8.5	8.8	8.6
Length front to condyle	31.0	30.5	31.7	27.8	31.9	23.8	24.3	24.0	29.4	26.2	27.8	29.6	29.0
Length M_1 to condyle	22.3	21.2	21.5	19.7	21.8	18.4	18.4	17.1	20.4	19.2	20.4	20.8	20.6

No. of specimen	*R. tondanus* 1	*Rattus celebensis* 1	2	3	4	5	*R. bontanus* 1	Bola Batoe a	b	c	Panisi Ta'boettoe a	b	Panganrejang Toedeja a	b
I ap.	1.6	2.4	2.2	2.2	2.4	2.6	—	2.4	2.6	2.4	2.1	—	2.4	—
id. tr.	1.3	1.4	1.4	1.5	1.5	1.7	—	1.5	1.6	1.5	1.2	—	1.5	—
M_1 tr.	1.9	2.5	2.5	2.4	2.5	2.4	2.3	2.4	2.4	2.4	2.2	2.4	2.4	2.5
M_2 tr.	1.9	2.6	2.5	2.6	2.5	2.5	2.4	2.4	2.5	2.5	2.4	2.4	—	2.5
M_3 tr.	1.7	2.4	2.3	2.1	2.0	2.2	2.0	—	2.0	2.1	—	2.0	2.1	—
M_1–M_3	7.3	9.1	8.9	8.6	8.8	8.6	8.3	—	9.1	8.7	—	8.0	8.4	—
Length front to condyle	25.1	32.9	29.0	30.5	29.8	30.5	—	—	—	—	28.4	—	—	—
Length M_1 to condyle	18.2	23.8	21.1	21.9	20.3	22.6	19.8	—	—	—	20.2	—	—	—

Rattus spec. (cf. *xanthurus* group)

Bola Batoe cave:

a. fragment of right mandible, I broken off, M_1 and M_2 present;
b. left mandible, broken off behind the complete molar series, I present;
c. idem, but I broken off, and an isolated left lower I.

Panisi Ta'boettoe (DAMMERMAN, 1939, p. 72, Murid species c):

a. a right mandible, complete except for M_3 and part of the angular process;
b. idem, but less complete behind; molar series intact.

Panganrejang Toedeja cave, layer A—B (DAMMERMAN, l.c.):

a. a right mandible with M_1 and M_3; I present;
b. a left mandible with M_1 and M_2; I lost.

Rattus spec. (cf. *rattus* group)

The smallest species of rat found by DAMMERMAN (1939, p. 72) in the VAN STEIN CALLENFELS collection is stated to be of the size of *Rattus rattus* but with stronger and broader molars resembling those of *Rattus hellwaldii* (Jentink). From the complete recent right mandible of the Panisi Ta'boettoe (a in table 43) and also from the fragmentary right mandible of the Batoe Edjaja cave (b in table 43) it is evident that the species is not *R. hellwaldii.* I have seen 17 specimens of this species, but in all of them the mandible is lower posteriorly than that of the Toalian cave though the teeth are of the same size indeed. DAMMERMAN states that the teeth of the Toalian cave rat are larger than those of *Rattus rattus* (L.), and this holds for the few specimens of this species from Celebes I have seen, but SODY (1941, p. 266) describes *Rattus rattus makassarius*, from Macassar, as being characterized by its large teeth; the upper toothrow of the type measures not less than 7.8 mm. *Rattus hoffmanni* (Matschie, 1901, p. 284) and *Rattus fratrorum* (Thomas, 1896, p. 246) are very near in general size of the mandible to the small Toalian cave rat but are too big-toothed. Added to that these species have not yet been found in South-western Celebes.

TABLE 43.

Measurements of lower teeth of a small *Rattus* (?*rattus*).

No. of specimen	a	b
I ap.	1.8	—
id. tr.	1.1	—
M_1 tr.	1.7	1.8
M_2 tr.	1.8	1.9
M_3 tr.	1.4	1.5
M_1–M_3	6.9	6.9
Length front to condyle	22.9	—
Length M_1 to condyle	16.3	—

If the small-sized Toalian cave rat species d of DAMMERMAN (1939, p. 72) is not *Rattus rattus* (L.) I can find no other species to which it might belong, and the possibility is not excluded that it represents a new species or race. The list of named forms of *Rattus* from South-western Celebes is notoriously short when compared with that of the Central, Northern, and South-Eastern parts of this island. We have *Rattus bontanus* Thomas (1921, p. 245), *Rattus penitus heinrichi* Tate et Archbold (1935a, p. 6), *Rattus foramineus foramineus* Sody (1941, p. 308), *Rattus toxi* Sody (l.c., p. 309), and *Rattus dominator ursinus* (Sody, l.c., p. 312) which are all too large for the present Toalian cave rat. On the other hand, *Rattus coelestis coelestis* (Thomas, 1896, p. 248) and *Rattus mollicomulus* Tate et Archbold (1935a, p. 4) are too small, as judged by the length of the upper molar series. To this list of living South-western Celebean *Rattus* forms only *Rattus rattus barussanoides* Sody (1941, p. 276), two ship's rats, viz., *Rattus rattus argentiventer* (Robinson et Kloss) and *Rattus norvegicus javanus* (Hermann) (fide SODY, 1941, pp. 268 and 285), and, finally, *Rattus concolor eurous* Miller et Hollister (1921a, p. 69), must be added to make it complete. The last mentioned rat was originally described from Northern Celebes, and it is SODY (1941, pp. 278 and 280) who uses this name for a series of rather small-sized rats from Macassar. Whether or not this identification is correct, there must be a very small *Rattus* (SODY, l.c., gives 4.7—5.5 mm, average 5.03 (!) mm, for the length of the upper toothrow) in South-western Celebes, smaller than either of the eleven above mentioned forms of *Rattus* from this region of the island.

Rattus spec. (cf. *coelestis* group)

In the Bola Batoe collection made by Mr. H. R. VAN HEEKEREN there is a left mandible fragment representing a form probably identical with *Rattus coelestis coelestis* (Thomas). Unfortunately M_1 is incomplete anteriorly, and M_3 is lost, but the tiny incisor is preserved. The postdental part is missing. In size the subfossil specimen is very near to the holotype of *Rattus coelestis coelestis* (Thomas) from the Peak of Bonthain which I had the opportunity to measure in the British Museum (Natural History) at London (table 44).

TABLE 44.

Measurements of teeth of *Rattus coelestis*.

	coelestis (recent)	Bola Batoe
Lower I ap.	1.4	1.2
Id. tr.	0.9	0.6
M_1 tr.	1.5	1.4
M_2 tr.	1.6	1.5
Upper I ap.	1.5	1.6
Id. tr.	1.0	0.9

A very small portion of the upper incisor, of the left side, from the Bola Batoe cave, seems to belong to the same form as the mandible does.

The Murid fauna of the Toalian caves comprises thus far five different forms, four of which were already recognized by DAMMERMAN (1939, p. 71/72), viz.,

DAMMERMAN (1939)	present author
Murid species a	*Lenomys meyeri* (Jentink) subsp.
Murid species b	*Rattus dominator* Thomas subsp.
Murid species c	*Rattus* spec. (cf. *xanthurus*)
Murid species d	*Rattus* spec. (cf. *rattus*)
	Rattus spec. (cf. *coelestis*)

Needless to say that the cave collections yield only a small part of the "micro-Mammalian" fauna. At present there are not less than seven named genera (*Lenomys, Eropeplus, Rattus, Haeromys, Mus, Echiothrix,* and *Melasmothrix*) of Murinae on the island of Celebes; thirty-six species with sixty subspecies in the genus *Rattus* alone. Nevertheless only two of these genera (*Lenomys* and *Rattus*) with twelve species and subspecies occur today in South-western Celebes, about one-half of which is apparently present in the Toalian caves. If this paucity of the South-western Celebean rat fauna is not due to the less intensive collecting in this region of the island as compared to that in Northern and Central Celebes, we are justified to speak of the South-western Celebean rat fauna as an impoverished one relative to that of other regions of the island. The impoverishment of the present South-western Celebean fauna is also evident from the absence of such relatively large forms like the babirusa and the Brown Palm Civet which were, however, still present at the time of the deposition of the animal remains in the Toalian caves. Further collecting in these caves might show that the rat fauna of South-western Celebes was not always as poor as it is today.

Order CARNIVORA Bowdich
Family VIVERRIDAE Gray
Genus **Macrogalidia** Schwarz

The big-toothed Brown Palm Civet with its banded tail and several skull characters peculiar to itself represents an endemic genus to Celebes, as SCHWARZ (1910) has so well seen. The species has never been found beyond the Minahassa, the extreme North-eastern portion of the island. Prof. WEBER and Prof. WICHMANN made a special search for this animal in Southern and Central Celebes, but nobody had ever heard of it in those regions (WEBER, 1890, p. 110). The SARASINS collected the species in the Minahassa exclusively (MEYER, 1899, p. 20). Our Museum possesses the cotype specimens of Mr. VAN MUSSCHENBROEK acquired in 1875, as well as topotypical specimens collected by Mr. VON FABER in 1883, as listed below:

Macrogalidia musschenbroekii musschenbroekii (Schlegel)

Material examined:

1. Young, in alcohol. Celebes, coll. VAN MUSSCHENBROEK, received February 16, 1877. L. M., cat. syst. f.
2. Mounted skin and skull of young male (cotype). Menado-Tanahwonko, N. Celebes, coll. VAN MUSSCHENBROEK, August 10, 1875. L. M., cat. syst. d, cat. ost. c.
3. Mounted skin and skull of young female (cotype). Menado-Tanahwonko, N. Celebes, coll. VAN MUSSCHENBROEK, August 10, 1875. L. M., cat. syst. c, cat. ost. d.
4. Mounted skin and skeleton of adult male (cotype). Menado-Kinilo, N, Celebes, coll. VAN MUSSCHENBROEK, September 2, 1875. L. M., cat. syst. a, cat. ost. a.
5. Mounted skin and skeleton of adult female (cotype). Menado-Kinilo, N. Celebes, coll. VAN MUSSCHENBROEK, September 2, 1875. L. M., cat. syst. b, cat. ost. b.
6. Mounted skin and skull of adult female. Menado, N. Celebes, coll. VON FABER, 1883. L. M., cat. syst c.
7. Stuffed skin and skull of adult male. Amoerang, N. Celebes, coll. VON FABER, 1883. L. M., cat. syst. g.
8. Stuffed skin and skull of adult female. Amoerang, N. Celebes, coll. VON FABER, 1883. L. M., cat. syst. h.

The reason why I have entitled the living form to a subspecific rank is that I have found in the collections from the Bola Batoe cave and the Tjadang cave the evidence of the former existence of *Macrogalidia* in South-western Celebes. There is no reason to accept more than a subspecific difference between the living and the subfossil form, and the new race I propose to name:

Macrogalidia musschenbroekii meridionalis nov. subsp.

Diagnosis: Teeth larger and relatively broader than those of the living North-eastern Celebean form, but identical in specific characters; P^4 with parastyle of the same length as metacone, posterior border convex, and with strong postero-internal cingulum.
Holotype: A right P^4 and M^1, represented on pl. II fig. 7.
Paratypes: A right P_4 and M_1 (pl. II fig. 8), and three isolated P^4's, one of which is that of pl. II fig. 9.
Locality: Bola Batoe cave, near Badjo (Barebo district), ca. 20 km S.W. of Watampono in Central Bone, S. Celebes.
Age: Holocene.

SARASIN (1905, p. 45) recorded some paradoxurine canines and milk teeth as well as a toothless ramus-fragment under the head *Paradoxurus hermaphroditus*, the common Indian Palm Civet also found in the Malay Peninsula and Archipelago. He states that *Macrogalidia musschenbroekii* is out of question because of its distinctly larger size. The cave remains are only stated to be slightly larger than *P. hermaphroditus;* measurements or figures are not given. DAMMERMAN (1939) found no paradoxurine remains in the VAN STEIN CALLENFELS collection, and this author even doubts whether *P. hermaphroditus* was present in prehistoric times in Celebes and is not, like the deer, an introduction of more recent times (l.c., p. 63/64). I did not find *Paradoxurus* in the Bola Batoe cave collection either.

A still smaller Civet from the Peak of Bonthain, *Paradoxurus celebensis* Schwarz (1911, p. 634), is represented by one specimen only. Its describer (in POCOCK, 1934, p. 660 footnote) is doubtful about the accuracy of the locality record of the type specimen, and, though this species is listed in all conscience by RAVEN (1935, p. 259), it is not recorded by TATE (1944, p. 7). The latter author, however, is certainly wrong in designating the Northern Palm Civet *musschenbroekii* as a subspecies of *Paradoxurus hermaphroditus* (l.c.).

That the Bola Batoe cave Palm Civet belongs to the genus *Macrogalidia* and not to *Paradoxurus* is evident from the structure of the upper carnassials, represented by not less than four specimens all of different individuals, two of which are figured on pl. II figs. 7 and 9. These subfossil specimens of P^4 have the anterior outer lobe or parastyle as long as the posterior one (metacone); their posterior border is convex, and there is a strong postero-internal cingulum. These are the characters already noticed in the first definition of the genus (SCHWARZ, 1910, p. 424). In *Paradoxurus* P^4 has a concave posterior border, no distinct posterior cingulum, and the parastyle, if any, is shorter than the metacone (see the figures in POCOCK, 1934, p. 660). Figures of the skull and teeth of *Macrogalidia* are to be found in JENTINK (1887, pls. 1—2, skull of cat.

a in L.M.), and in POCOCK (1933, p. 1014, fig. 4A—C, skull in B.M.), while MEYER (1896, pl. VI) figures a whole skeleton in the Dresden Museum. Skulls of *Macrogalidia* are scarce in European Museums, and apparently in American Museums too, for GREGORY and HELLMAN (1939), in their account of the phylogeny of the skull and dentition of the Viverridae, nowhere mention the genus *Macrogalidia*.

I have examined five adult skulls of *Macrogalidia*, viz., those of the specimens 4—8 of the list on p. 88 above. The female (nos. 5, 6, and 8), though being considerably smaller than the male skulls as a whole, have teeth that are but slightly smaller than those of the males. My subfossil material consists of the following specimens (measurements in table 45):

TABLE 45.

Measurements of teeth of *Macrogalidia musschenbroekii* subsp.

	Bola Batoe cave				recent (Minahassa)				
	b	c	d	e	4	5	6	7	8
P^4, length	10.7	9.5	11.2	11.3	9.6	9.7	9.4	9.7	9.1
ant. width	9.6	9.0	10.0	9.5	9.1	8.9	8.7	9.1	8.5
max. diameter	11.9	10.4	12.5	12.2	11.4	10.7	10.4	11.2	10.5
M^1, length	7.3				7.1	7.0	6.8	6.8	6.7
width	10.6				9.3	9.0	9.0	9.8	8.9
P_2, length	7.2				7.0	6.7	6.8	—	6.3
width	4.3				3.6	3.6	3.7	—	3.5
P_4, length	10.5				10.3	10.2	9.7	—	10.1
width	5.5	g		Tjadang cave	5.1	5.1	5.0	5.3	5.1
M_1, length	10.4	10.0		10.0	10.2	9.8	9.7	10.4	9.5
width	6.7	6.8		7.2	6.1	5.8	6.0	6.4	5.7

a. a P_2 sin., of slightly larger size than the corresponding tooth in the recent N. Celebean skulls; the width is especially greater;

b. a P^4 and M^1 dext. in a small maxillary fragment, indistinguishable from recent specimens but for their slightly superior size even when compared with male teeth. This specimen I select as the holotype, and it is shown on pl. II fig. 7;

c. an isolated P^4 dext. of comparatively small size (female?) but with the generic and specific features. It is still within the range of recent female upper carnassials;

d. a P^4 sin. with the parastyle even more distinctly marked off than that in specimen b, and of even larger size (pl. II fig. 9);

e. a P^4 sin., very similar to the last but less well preserved;

f. a P_4 and M_1 dext. in a ramus fragment (pl. II fig. 8), showing also the alveolus for the M_2. In the characteristically high protoconid of P_4 and in all structural characters of the M_1 there is no difference from recent specimens except that the subfossil specimen is larger; M_1 especially is broader;

g. an isolated M_1 sin. matches the foregoing specimen closely, being slightly shorter and wider only.

Specimens a—g are all from the VAN HEEKEREN collection of the Bola Batoe cave. In the Tjadang cave collection there is an M_1 sin. (no. 884) which presents an almost exact replica of specimen g of the Bola Batoe cave; it is only slightly wider relatively. This is certainly a find worthy of notice because the number of animal's teeth collected in the Tjadang cave is so very small, and the present form is undoubtedly a rare element to the Toalian cave fauna.

Like the babirusa, the Brown Palm Civet is now shown to be an animal species that in former times was spread over the whole of the island of Celebes but that has now vanished from the Southern regions.

Order ARTIODACTYLA Owen
Family SUIDAE Gray
Genus **Sus** Linnaeus

The species of *Sus* living in Celebes is regarded by MÜLLER and SCHLEGEL (1845, p. 177) as closely related to *Sus verrucosus* Müller et Schlegel from Java, from which latter species it differs, besides in its smaller size, in the less development of the heel to M_3 (see NEHRING, 1889, p. 13, pl. II figs. 7 and 8). It is customary to distinguish between two races, one of Northern, and the other of Southern Celebes, while the so-called *Sus weberi* of JENTINK (1905, p. 187) from Saleyer Island, South of Celebes is certainly not different specifically from the Celebean species and, therefore, is regarded here as a potential subspecies, too.

Sus celebensis celebensis Müller et Schlegel

Material examined:

Infants

1—3. Mounted skins. N. Celebes, coll. FORSTEN. L. M., cat. syst. f—h.

Juveniles

4. Mounted skin of ♀. Toelabollo, Gorontalo, N. Celebes, coll. VON ROSENBERG, April 16, 1864. L. M., cat. syst. d.
5. Mounted skin of ♀. Toelabollo, Gorontalo, N. Celebes, coll. VON ROSENBERG, April 21, 1864. L. M., cat. syst. e.

Subadults

6. Mounted skin (cotype). Menado, N. Celebes, coll. FORSTEN, 1841. L. M., cat. syst. a.
7. Mounted skin of ♂. Toelabollo, Gorontalo, N. Celebes, coll. VON ROSENBERG, May 7, 1864. L. M., cat. syst. b.
8. Skull of ♂. N. Celebes, coll. FORSTEN. L. M., cat. ost. b.
9. Mounted skin of ♀. Toelabollo, Gorontalo, N. Celebes, coll. VON ROSENBERG, April 21, 1864. L. M., cat. syst. c.

Adult males

10. Skull of old individual (cotype). N. Celebes, coll. FORSTEN, 1841. L. M., cat. ost. a.
11. Mounted skin and skeleton. Menado, N. Celebes, from the Rotterdam Zoo, 26—12—1881. L. M., *Sus scrofa*, cat. syst. d, cat. ost. c.

Adult females

12. Skull. N. Celebes, coll. FORSTEN. L. M., cat. ost. c.

Sus celebensis nehringii Jentink

Material examined:

Juveniles

1. Flat skin and skull of ♂. Macassar, S. Celebes, from the Rotterdam Zoo, 10—2—1914 (imported 8—8—1913). L. M., reg. no. 332.

Adult males

2. Calvarium. Pare Pare, S. Celebes, coll. WEBER no. 443, 1888. L. M., reg. no. 145.
3. Skull. Macassar, S. Celebes, coll. J. A. VAN DE WETERING DE ROOY, 1923. A. M.
4. Calvarium. From a cave near Birakeke, S. Celebes, coll. WEBER, 1888. A. M., no. 438.

Adult females

5. Skull (holotype). S. Celebes, coll. BERNSTEIN, 1866. L. M., *Sus celebensis*, cat. ost. d.
6. Skull. Loka, near Bonthain, S. Celebes, coll. WEBER no. 416, 1888. L.M., reg. no. 145.
7. Skull. From a cave near Birakeke, S. Celebes, coll. WEBER, 1888. A. M., no. 439.

Sus celebensis Müller et Schlegel subsp.

Material examined:

Adult males

1. Skull. Celebes, from the collection of E. DUBOIS, 1941. L. M.
2. Skull. Celebes, from the collection of E. DUBOIS, 1941. L. M.

Sus celebensis weberi Jentink

Material examined:

Adult males

1. Skull. Saleyer, coll. WEBER no. 533, 1889. L. M., reg. no. 147.
2. Skull. Saleyeı, from the collection of E. DUBOIS, 1941. L. M.

Adult females

3. Skull. Saleyer, from the collection of E. DUBOIS, 1941. L. M.

No important dental anomalies are to be recorded in this series of Celebean and Saleyer *Sus* skulls except for a malformed I^1 sin. in skull no. 11 of the typical race. The right P^2 in skull no. 1 of *Sus celebensis* subsp. is rotated for 90°, with its lingual surface facing forward. The smallish anterior premolars and third incisors are occasionally missing, but this variation is of no importance.

NEHRING (1889, p. 13) remarks that in the type skull of *Sus celebensis* as figured by MÜLLER and SCHLEGEL (1845, pl. 28 bis fig. 2—3) there are five premolars in the mandible. However, the skull which served as the base for this illustration (Leiden Museum, cat. ost. a; no. 10 of my list) is that of an old individual with many teeth lost but possessing the normal number of four premolars. In trying to reconstruct the dentition, the artist has figured a supernumerary lower premolar of which there is no evidence in the specimen itself. The calvarium is refigured, in lower view, by JENTINK (1905, pl. 10), who already stated that the original figure is not correct (l.c., p. 185).

Important numerical variations do occur, however, in the dentition of the present species; COLYER (1936, p. 126) records an instance of congenital absence of M^3 dext. in a subadult skull of *Sus celebensis*.

The mounted skin of a subadult individual figured by MÜLLER and SCHLEGEL (1845, pl. 28 bis fig. 1; it is no. 6 of my list above) cannot possibly have belonged to the same individual as the old skull mentioned above and figured on the same plate, though the text and the explanation of the plate (l.c., pp. 177 and 182) would suggest this to be the case. There must have been some mistake by which the old skull was assigned to the type skin, which latter, consequently, was regarded as that of an adult by its describers [1]).

The Southern Celebes skulls were separated from the Northern Celebes specimens by JENTINK (1905, p. 186) as *Sus nehringii*. The latter name should stand for a species that would differ from typical *Sus celebensis* "above all" by the absence of an anterior prolongation of the premaxillaries beyond the incisors, a feature that JENTINK considered to be highly characteristic of *Sus celebensis* proper. The difference in this respect between the adult *Sus* skulls of Northern and those of Southern Celebes, however, is of no value for taxonomic purposes. Two adult *Sus celebensis celebensis* skulls (nos. 11 and 12) have the premaxillaries extending 5—6 mm anteriorly to the I^1, which is within the variation limits in six adult *Sus celebensis nehringii* skulls (3—7 mm). Another, the very old type skull of *Sus celebensis celebensis*, has premaxillaries projecting about 14 mm, which is, indeed, somewhat unusual but which does not seem to be more than an individual aberration perhaps connected with the old age of the animal.

LYDEKKER (1915, p. 333) remarks that *Sus celebensis nehringii* is closely allied to the typical race but that the cheek-teeth, especially the molars, are decidedly smaller. As LYDEKKER had no specimens in the collection under his charge and, moreover, cites JENTINK only, it is pretty evident that LYDEKKER's statement is based on a misunderstanding of JENTINK's paper. In JENTINK (1905, p. 187) we only read that the teeth of skulls from Saleyer are smaller than those of some Southern Celebes skulls. There is no question at all of size comparison between the teeth of *Sus* skulls from the Southern and the Northern parts of Celebes proper. JENTINK's text, however, is likely to cause confusion, for JENTINK (1905, p. 187) lists the Saleyer skull under the head of his new species *Sus nehringii* only to separate the latter skull again, at the bottom of the same page, as a provisional species "*Sus weberi*"! The remark as to the relative smallness of the molars applies to the Saleyer skulls only.

There is no difference in size between the teeth of the Northern and the Southern *Sus celebensis* skulls at all. The Saleyer skull has indeed an upper toothrow that is a few mm shorter than that in the Celebes

[1]) Jhr. W. C. VAN HEURN, who has studied the suid material in the Leiden Museum, already made this observation a couple of years ago.

skulls used for comparison by JENTINK, but this is a difference too small to be of any value.

The reason why I have provisionally maintained the distinction between a Northern Celebes, a Southern Celebes, and a Saleyer Island race of *Sus celebensis* is only that I think it to be very probable that such a distinction can eventually be made, most likely so in external characters. This, however, I am not in a position to make out. Anyhow, it seems premature to drop the names *nehringii* and *weberi*, names that have found their way in the literature and which must remain available as long as we have insufficient material to decide whether they stand for distinct geographical forms or not. Two skulls from Celebes without a record for the exact locality cannot be referred to any of the two Celebean races in particular and, therefore, are left subspecifically unidentified.

Both SARASIN (1905, p. 37) and DAMMERMAN (1939, p. 70) have recorded *Sus celebensis* from the Toalian cave fauna. In these collections the babirusa is also represented, and there is not the least difficulty in distinguishing between the teeth of these two species as far as the incisors, canines, and premolars are concerned. The identification of the molars, however, is not always easy. STEHLIN (1899, p. 77) writes that in babirusa molars the main cusps are higher and consequently worn off at a later stage than those of *Sus*. He adds that the heel of the third molar is more simply built in the babirusa than it is in *Sus celebensis*. With a few notable exceptions the talon of M^3 is indeed narrower, lower, and more distinctly marked off in *Babyrousa* than it is in *Sus*. The distinction between the lower third molars is less clear, though the talonid in *Sus celebensis* often shows more cuspules than that in the babirusa.

In general the crowns of the molars of *Sus celebensis* have the main cusps less distinctly marked off than is the case in the babirusa molars because of the presence of more minor crests and wrinkles in the former. But the most important difference exists in the development of the cingulum. The cingula are usually better developed, especially toward the median line, in *Sus celebensis* molars as compared with those in the babirusa. This difference is most distinct in the lower molars which often appear to be longer relatively in *Sus celebensis* than in *Babyrousa* because of the greater prominence of the cingulum behind and in front. These characters are sufficient in most cases to distinguish between the molars of the two suids in the Toalian cave collections. The identification of fragmentary or much worn molars in which we miss the cingulum mark is always a matter of extreme difficulty, but even in these cases the comparison with the teeth in the series of recent skulls, which present all stages of wear, leads often to the desired end.

In the Bola Batoe cave collection as well as in the other Toalian cave collections *Sus celebensis* is represented by jaw fragments containing two or more teeth, and also by a great number of isolated teeth. The specimens with more than one tooth in situ will be dealt with first, and the loose teeth will be enumerated thereafter. There is nothing in the structure of the remains of the subfossil *Sus* that suggests a species different from the living Celebean form, but there is a difference in size between the subfossil and the recent pig, a difference that seems worthy of a subspecific distinction. The material to be discussed in the following pages tends to show that *Sus celebensis* was smaller in former times than it is now. *Sus celebensis* also seems to have gradually increased in size up to the present day. Thus it would seem to have evolved in a direction opposite to that in which most of the Toalian cave Mammals evolved which latter became smaller in the course of time. The material at hand is not as extensive as one could wish, however, and it is possible to prove only that the Bola Batoe cave boar is in reality smaller in size than the living one, the material from the remaining sites being too scanty to allow for such definite conclusions. I shall, therefore, refer to the Toalian caves *Sus* provisionally as *Sus celebensis* subsp., and return to the problem of its clinal variation and nomenclature at the end of the present chapter.

Sus celebensis Müller et Schlegel subsp.

(pl. III figs. 1—2, 4—5 and 8)

The present species occurs in all of the Toalian sites the fauna of which I have studied. It is, in fact, the most common species in the Toalian cave deposits.

My subfossil material of associated upper teeth consists of the following specimens:

Table 46, column	
	Bola Batoe cave
a	P^2—P^3 dext. (pl. III fig. 4), P^4—M^1 dext., M^2—M^3 dext.
b	P^2—P^4 dext., M^1—M^2 dext.
c	P^3—M^1 dext., M^1 (incomplete)—M^3 dext.
d	P^4—M^1 dext., M^1 (incomplete)—M^3 dext.
e	P^4—M^1 dext., M^2—M^3 sin.
f	P^4—M^1 dext., M^2—M^3 sin.
g	P^4—M^2 dext. (pl. III fig. 2)
h	P^2—P^3 sin., M^1—M^2 dext.
i	P^2—P^4 sin., M^1—M^3 sin.
j	M^2—M^3 sin. (pl. III fig. 8)
k	M^2—M^3 sin.
	Caves N. of Tjani
l	M^1—M^3 dext. (no. 109)
m	M^2 (half)—M^3 dext. (no. 227)

Table 46, column	
	Panganrejang Toedeja cave, layer A—B
n	P^2—P^3 sin.
	Coll. VAN STEIN CALLENFELS, exact locality unknown
o—q	P^4—M^1 dext. (3 specimens)
r	M^1 (half)—M^2 dext.
s	P^4—M^3 sin.
t	P^3—M^1 sin.
u	P^4—M^1 sin.
	Lompoa rock-shelter
v	P^4—M^2 sin.
w	M^1—M^3 dext.

TABLE 46.

Measurements of subfossil upper teeth of *Sus celebensis.*

	a	b	c	d	e	f	g	h	i	j	k
P^2 ap.	8.6	—	—	—	—	—	—	9.5	8.6	—	—
tr.	5.7	5.5	—	—	—	—	—	6.0	5.3	—	—
P^3 ap.	8.8	—	—	—	—	—	—	9.6	9.3	—	—
tr.	7.6	—	6.8	—	—	—	—	8.3	7.6	—	—
P^4 ap.	9.4	9.2	9.5	8.9	8.9	—	9.5	—	8.9	—	—
tr.	11.1	10.7	—	11.2	10.5	10.4	10.9	—	10.9	—	—
M^1 ap.	13.5	14.5	—	13.5	12.9	12.5	13.0	13.6	13.4	—	—
atr.	10.5	11.8	10.5	11.3	10.0	—	10.7	10.9	11.0	—	—
ptr.	10.5	11.3	10.6	10.7	10.0	—	10.7	10.8	10.7	—	—
M^2 ap.	17.6	17.8	17.8	16.5	17.0	18.4	17.0	17.0	16.8	17.6	17.4
atr.	14.5	14.8	13.9	14.0	—	15.7	13.8	13.6	—	13.5	—
ptr.	12.9	13.9	14.0	12.5	14.4	14.8	14.4	13.0	13.0	12.6	14.1
M^3 ap.	24.4	—	22.2	20.8	24.8	24.2	—	—	24.7	24.3	25.2
atr.	15.0	—	15.2	14.5	15.7	15.8	—	—	15.2	14.5	16.0
ptr.	12.8	—	13.1	11.6	13.4	12.5	—	—	13.2	12.6	13.4

	l	m	n	o	p	q	r	s	t	u	v	w
P^2 ap.	—	—	9.6	—	—	—	—	—	—	—	—	—
tr.	—	—	5.9	—	—	—	—	—	—	—	—	—
P^3 ap.	—	—	9.8	—	—	—	—	—	—	—	—	—
tr.	—	—	8.9	—	—	—	—	—	8.0	—	—	—
P^4 ap.	—	—	—	9.4	8.8	10.1	—	9.8	—	9.4	9.6	—
tr.	—	—	—	10.9	10.8	11.4	—	11.5	10.2	10.7	11.1	—
M^1 ap.	—	—	—	13.4	—	13.4	—	13.7	—	—	—	—
atr.	9.4	—	—	10.9	—	11.1	—	10.6	10.6	10.8	11.8	10.7
ptr.	—	—	—	11.3	10.9	11.0	10.7	10.7	10.2	10.3	11.5	—
M^2 ap.	17.2	—	—	—	—	—	17.2	16.7	—	—	—	—
atr.	13.2	—	—	—	—	—	13.9	13.5	—	—	14.6	13.3
ptr.	12.0	12.4	—	—	—	—	13.6	13.2	—	—	12.9	12.9
M^3 ap.	20.2	21.7	—	—	—	—	—	24.5	—	—	—	22.8
atr.	13.0	14.0	—	—	—	—	—	14.5	—	—	—	14.3
ptr.	11.4	11.9	—	—	—	—	—	12.4	—	—	—	12.0

The best specimens of the mandible occurring in the Toalian cave collections are the following:

Table 47, column	Bola Batoe cave
a	P_4—M_3 dext. (pl. III fig. 5)
b	P_3 (half)—M_1 dext., M_2—M_3 dext.
c	P_3—M_3 sin.
d	M_1—M_2 sin.
e	M_1—M_2 sin.
f	M_2—M_3 sin.

TABLE 47.

Measurements of subfossil lower teeth of *Sus celebensis.*

	a	b	c	d	e	f	g	h	i	j
P_2 ap.	—	—	—	—	—	—	9.0	8.4	—	—
tr.	—	—	—	—	—	—	3.9	4.3	—	—
P_3 ap.	—	—	9.5	—	—	—	11.0	9.5	9.5	10.0
tr.	—	5.7	6.6	—	—	—	5.8	5.8	5.5	6.0
P_4 ap.	10.7	11.0	10.2	—	—	—	12.2	—	10.5	—
tr.	7.4	7.6	8.4	—	—	—	7.5	7.4	7.4	—
M_1 ap.	12.3	12.8	12.7	13.2	12.9	—	13.1	—	—	—
atr.	8.4	8.4	9.3	8.0	8.0	—	8.4	—	8.4	—
ptr.	8.5	8.7	9.8	8.8	8.2	—	8.8	—	8.7	—
M_2 ap.	15.5	18.0	15.9	16.0	15.9	—	16.8	—	16.4	—
atr.	10.4	11.9	—	10.6	9.5	11.2	11.0	—	11.4	10.2
ptr.	10.8	11.8	12.0	10.8	9.3	11.3	11.3	10.7	11.3	10.5
M_3 ap.	21.5	25.6	25.4	—	—	23.5	—	23.7	—	—
atr.	12.3	13.4	13.3	—	—	12.6	—	12.6	—	—
ptr.	11.0	11.9	11.9	—	—	11.8	—	11.7	—	—

	k	l	m	n	o	p	q	r	s
P_2 ap.	—	—	—	—	—	—	—	—	—
tr.	—	—	—	—	—	—	—	—	4.5
P_3 ap.	—	—	—	—	—	9.5	—	—	—
tr.	—	—	—	—	—	5.4	—	—	5.9
P_4 ap.	—	—	—	—	—	10.2	—	—	10.4
tr.	6.9	—	—	—	—	7.5	—	—	8.0
M_1 ap.	—	—	13.6	—	13.3	13.0	—	—	—
atr.	8.4	—	9.4	8.5	8.8	8.6	—	—	9.0
ptr.	8.9	8.8	9.6	9.0	9.0	9.3	8.9	—	—
M_2 ap.	15.2	15.5	17.6	16.3	16.5	16.5	—	17.3	—
atr.	11.3	10.5	12.4	11.2	11.7	11.0	11.6	12.2	11.2
ptr.	11.1	10.7	12.8	11.5	10.8	10.9	11.8	11.7	11.3
M_3 ap.	—	21.7	26.5	24.7	—	—	24.9	24.6	24.7
atr.	11.1	11.4	14.3	12.5	—	—	12.2	13.2	13.0
ptr.	—	10.8	12.7	11.4	—	—	11.8	11.6	11.6

Table 47, column	
	Caves N. of Tjani
g	P_2—P_4 dext. (no. 220), M_1—M_2 dext. (no. 469)
h	P_2—P_4 dext. (no. 237), M_2—M_3 dext. (no. 139)
i	P_3—M_2 sin. (no. 223)
j	P_3—M_2 sin. (P_4 lost, M_1 damaged; no. 177)
k	P_4 (half)—M_3 sin. (no. 220)
l	M_1—M_3 sin. (no. 228)
	Batoe Edjaja cave
m	M_1—M_3 dext.
	Coll. VAN STEIN CALLENFELS, exact locality unknown
n	M_1—M_3 dext.
o	M_1—M_2 dext.
p	P_3—M_2 sin.
q	M_1—M_3 sin.
r	M_2—M_3 sin.
	Lompoa rock-shelter
s	P_2—M_1 sin., and P_3—M_3 dext., of one and the same individual.

Most of the material from caves N. of Tjani listed above has been referred by DAMMERMAN (1939, p. 69) to the babirusa, and only a small part to *Sus celebensis*. Without a shade of doubt, however, all the material found in these caves belongs to *Sus*. There is not a single tooth from these caves that represents the babirusa, and the latter consequently must be struck off the list of species occurring in the caves N. of Tjani as given by DAMMERMAN (l.c., p. 65/66). Many, but not all, of the specimens from the Panganrejang Toedeja cave recorded by DAMMERMAN (l.c., p. 69/70) as belonging to the babirusa, in reality belong to *Sus*, too.

The upper and lower teeth of which the measurements appear in tables 46 and 47 show a wide range of variations in dimensions. The total range of variation in the cave teeth can be given only after the whole of the material will have been dealt with.

INCISORS

Of the fifteen adult recent skulls of *Sus celebensis* only ten have measurable I^1's; the variation in size is not very great (table 48). The I^2 is a very variable tooth, the greatest crown length ranging from 9.9 mm to 14.0 mm. I^3 is absent in three skulls, while in a fourth (no. 7 of *Sus celebensis nehringii*) it is developed on the left side only.

In the Toalian cave collections there is one left premaxillary fragment from a cave N. of Tjani containing the three incisors (no. 177), while in the VAN STEIN CALLENFELS collection there is also a right premaxillary +

maxillary fragment, without a record for the exact locality, that holds the I^1, the empty alveolus for I^2, but no trace of I^3, showing that complete reduction of the lateral incisor occurred in the prehistoric *Sus*, too.

TABLE 48.

Measurements of upper I of recent *Sus celebensis*.

	celebensis			*nehringii*				*subsp.*		*weberi*	
	8	11	12	3	5	6	7	1	2	1	2
I^1 ap.	—	11.5	10.0	11.3	11.9	10.5	—	10.8	11.4	—	—
tr.	4.6	5.8	5.1	6.0	6.8	5.3	—	5.0	6.2	6.3	5.8
I^2 ap.	13.3	—	—	—	—	9.9	—	14.0	11.8	—	11.8
tr.	4.0	4.6	4.0	4.3	—	4.4	—	4.6	4.9	4.4	4.2
I^3 ap.	6.4	—	—	—	—	7.5	7.5	7.5	—	—	—
tr.	2.8	3.7	—	—	—	3.3	3.1	3.3	—	—	—

I^1

The central upper incisor is relatively abundant in the various Toalian cave collections; I have not less than 79 good specimens, while there are also a small number too much worn or damaged for measurement. The measurements are given in table 49; the antero-posterior diameter was taken perpendicular to the long axis of the tooth and at the posterior base of the crown. There are already 42 well-preserved specimens in the VAN HEEKEREN collection from the Bola Batoe cave, nos. 1—18 of the right, and nos. 19—42 of the left side. Nos. 43—45 are two right and one left I^1 originating from the Batoe Edjaja cave; no. 46 is the I^1 sin. of the premaxillary fragment from a cave N. of Tjani (no. 177 of the VAN STEIN CALLENFELS collection). We have also material both from the upper and from the lower layer of the Panganrejang Toedeja cave: nos. 47—55 are nine right, and nos. 56—66 eleven left I^1's from layer A—B, while nos. 67—69 are three right, and nos. 70—75 six left specimens from layer C—D. No. 76 is a right I^1 in a skull fragment of unknown origin in the VAN STEIN CALLENFELS collection, and, finally, nos. 77—79 are one right and two left I^1's from the Lompoa rock-shelter.

As is shown by table 50 the variation range in the cave teeth is practically the same as that found in the recent specimens though the former are seven times as frequent as the latter. As far as the transverse diameter is concerned, 75 cave specimens even vary between narrower limits than do 10 recent. The cave material is evidently much more homogeneous than the recent which originates from such remote regions as Northern Celebes, Southern Celebes, and Saleyer. There are only two among the ten recent specimens measured that belong to female individuals, and the minimum for the transverse diameter of the recent I^1 occurs in a boar (*Sus celebensis celebensis* no. 8). This material is far from representative for the recent form of *Sus celebensis*. However, it is the only material I have at my disposal, and as far as it goes it would seem to disclose a remarkable fact.

TABLE 49.

Measurements of subfossil I^1.

No.	1	2	3	4	5	6	7	8	9	10
ap.	10.8	12.1	10.9	11.0	10.7	11.8	10.9	10.0	11.4	10.4
tr.	5.4	6.2	5.6	5.4	5.5	5.4	5.5	5.4	5.3	5.4
No.	11	12	13	14	15	16	17	18	19	20
ap.	10.7	12.0	10.6	9.7	—	10.7	10.7	—	11.8	11.8
tr.	5.6	5.7	5.2	—	5.6	5.6	4.9	5.0	6.4	6.2
No.	21	22	23	24	25	26	27	28	29	30
ap.	10.3	10.5	9.9	10.5	11.5	11.2	11.0	10.5	11.1	—
tr.	5.3	5.4	4.9	5.9	—	5.9	6.3	5.7	6.3	5.2
No.	31	32	33	34	35	36	37	38	39	40
ap.	—	10.4	10.5	11.0	10.5	—	11.7	10.6	11.8	10.4
tr.	5.4	5.9	5.4	5.9	5.3	5.7	5.4	5.5	5.8	6.1
No.	41	42	43	44	45	46	47	48	49	50
ap.	11.2	—	10.8	10.4	10.7	10.5	10.3	11.8	10.0	10.3
tr.	—	5.6	6.0	5.6	—	5.2	5.1	5.5	5.3	5.2
No.	51	52	53	54	55	56	57	58	59	60
ap.	9.4	10.5	11.6	10.7	—	10.9	11.5	11.6	10.2	10.6
tr.	4.8	5.2	5.1	5.2	5.1	5.3	5.7	5.7	5.8	5.2
No.	61	62	63	64	65	66	67	68	69	70
ap.	12.2	10.6	10.6	10.2	—	—	10.7	10.2	10.6	10.2
tr.	—	5.6	5.4	5.0	5.9	5.5	5.6	5.0	5.0	5.5
No.	71	72	73	74	75	76	77	78	79	
ap.	10.7	10.4	10.5	9.4	10.9	11.9	10.7	10.7	—	
tr.	5.4	5.3	5.3	5.0	5.9	6.2	5.8	5.1	6.2	

The average dimensions of the cave teeth are less than those found for recent *Sus celebensis*, and hence it would seem that *Sus celebensis* was smaller in prehistoric times than it is now. Since this is exactly the opposite

TABLE 50.

Variation range and average of dimensions of recent and subfossil I^1 of *Sus celebensis*.

	recent		subfossil	
	range	mean	range	mean
ap.	10.0—11.5	11.1	9.4—12.2	10.9
tr.	4.6—6.8	5.7	4.8—6.4	5.4

of what is the rule in the species of Mammals dealt with thus far, it is especially unfortunate that in the present case the recent material for comparison is so inadequate. The preponderance of males in the recent series might have made the average dimensions higher than they would have been if the females had been equal in number to the males. I have no means to unravel the sexual heterogeneity in the cave material since sexual differences are displayed clearly in the canines only, and I shall, therefore, return to this problem when discussing the male canines.

The subfossil material is heterogeneous, too, in so far as it originates from different caves. The average dimensions of the Bola Batoe cave I^1's differ less from those of the recent than the average dimensions of the total collection of cave I^1's do, and consequently the material from the other Toalian caves averages smaller again and differs even more from the recent. There even is a small difference in average size between the I^1's from the upper and those from the lower layer of the Panganrejang Toedeja cave (table 51). Though the material at hand is insufficient to solve the problem definitely, everything seems to point to the prehistoric *Sus celebensis* as having been smaller than the recent races. The present species, therefore, seems to present an exception to the rule of micro-evolution with progressive diminution in size of which the other Mammals dealt with up to now in the present paper bear evidence.

TABLE 51.

Average dimensions of recent and subfossil I^1 of *Sus celebensis*.

	recent	Bola Batoe	Panganrejang Toedeja A—B	Panganrejang Toedeja C—D
ap.	11.1	10.9	10.8	10.4
tr.	5.7	5.6	5.3	5.3

I^2

Much less abundant than I^1; I have only nine Bola Batoe cave specimens. Nos. 1—4 in table 52 are four right, and nos. 5—9 five left I^2's of the Bola Batoe cave; no. 10 is the I^2 of the left premaxillary from a cave N. of Tjani mentioned above; nos. 11—12 are two right specimens from

TABLE 52.

Measurements of subfossil I^2.

No.	1	2	3	4	5	6	7	8	9	10
ap.	11.1	14.5	11.6	12.7	12.8	12.6	12.8	13.2	11.1	13.0
tr.	4.3	4.7	4.2	4.5	4.4	4.0	4.1	4.0	4.0	3.9
No.	11	12	13	14	15	16	17	18	Average	
ap.	13.0	11.5	12.9	12.0	12.2	13.1	12.4	12.0	12.5	
tr.	4.3	4.9	4.0	4.2	3.7	4.3	4.3	4.0	4.2	

layer A—B, nos. 13—18 two right and four left I^2's from layer C—D of the Panganrejang Toedeja cave. The antero-posterior diameter was taken over the anterior and posterior upper edges of the crown. No marked size differences between the recent (table 48) and the cave I^2's appear; the Bola Batoe incisors, however, are more often above the average size than those from layer C—D of the Panganrejang Toedeja cave, indicating that there is a trend toward increase in size in the present element, too. The difference is too small to be of real significance but nevertheless is worth mentioning.

The sole I^3 belonging to the present species found in the Toalian cave collections is that in the premaxillary fragment from a cave N. of Tjani in the VAN STEIN CALLENFELS collection (no. 177). In size (ap. 7.4 mm, tr. 2.7 mm) it is just below the variation limits found for five recent specimens of I^3 (table 48).

Lower I

TABLE 53.

Measurements of lower I of recent *Sus celebensis.*

	celebensis		*nehringii*				*subsp.*		*weberi*		
	8	12	3	5	6	7	1	2	1	2	3
I_1 tr.	5.6	5.7	6.0	7.4	5.9	5.6	5.5	7.0	7.2	6.4	6.8
I_2 tr.	6.7	6.8	6.4	8.4	—	6.8	6.1	6.4	6.7	6.4	7.1
I_3 tr.	5.7	—	6.3	—	—	—	7.3	—	—	5.7	—

The lower incisors of *Sus celebensis* do not display a sexual size difference; in *Sus celebensis celebensis* and in *Sus celebensis weberi* the sows even have bigger lower I than have the boars. In the former I_2 has the tendency to be larger relative to I_1 than is the case in the males. The transverse diameters of the lower incisors from the various Toalian sites are given in tables 54—56.

TABLE 54.

Measurements of subfossil I_1.

No.	1	2	3	4	5	6	7	8	9	10
tr.	5.5	5:9	5.8	6.0	5.6	5.5	5.8	5.6	5.6	5.5
No.	11	12	13	14	15	16	17	18	19	20
tr.	5.9	6.0	5.8	6.0	5.6	6.2	5.8	6.3	5.7	6.0
No.	21	22	23	24	25	26	27	28	29	30
tr.	5.6	5.0	5.2	6.2	6.3	4.8	5.1	4.9	5.6	6.4
No.	31	32	33	34	35	36	37	38	39	
tr.	5.6	5.2	4.6	4.6	5.5.	5.7	5.7	5.5	6.9	

In table 54 nos. 1—10 are right, and nos. 11—16 left I_1's from the Bola Batoe cave; no. 17 is an I_1 dext. from a cave N. of Tjani (no. 110 of the VAN STEIN CALLENFELS collection); nos. 18—19 are two left I_1's originating from the Panisi Ta'boettoe; nos. 20—25 are right, and nos. 26—30 left I_1's from layer A—B of the Panganrejang Toedeja cave; nos. 31—33 are right, and nos. 34—37 left I_1's from layer C—D of the latter cave; nos. 38 and 39 are an I_1 dext. and an I_1 sin. from the Lompoa rock-shelter.

TABLE 55.

Measurements of subfossil I_2.

No.	1	2	3	4	5	6	7	8	9	10
tr.	6.2	7.4	6.8	6.2	6.9	6.1	7.3	6.8	7.0	6.9
No.	11	12	13	14	15	16	17	18	19	20
tr.	6.6	5.6	6.0	5.8	6.9	7.2	6.8	6.9	5.6	6.9
No.	21	22	23	24	25	26	27	28	29	30
tr.	5.7	6.8	7.7	6.7	6.5	5.8	6.5	6.4	6.5	6.9
No.	31	32	33	34	35	36	37	38	39	40
tr.	6.3	6.7	6.4	6.7	7.0	6.1	6.2	6.1	6.7	5.6
No.	41	42								
tr.	6.5	6.3								

The specimens of I_2 of which the measurements are given in table 55 are the following: nos. 1—14 are right, nos. 15—21 left I_2's from the Bola Batoe cave; no. 22 is an I_2 sin. from the Panisi Ta'boettoe (marked CA); no. 23 is an I_2 sin. from the Batoe Edjaja cave; nos. 24—28 are right, nos. 29—36 left I_2's from layer A—B of the Panganrejang Toedeja cave; nos. 37—38 are right, nos. 39—40 left specimens from layer C—D of the latter cave, while nos. 41—42 are two left I_2's originating from the Lompoa rock-shelter.

TABLE 56.

Measurements of subfossil I_3.

No.	1	2	3	4	5	6	7	8	9	10	11	12
tr.	6.4	6.4	6.3	6.6	6.0	5.1	4.9	5.7	6.8	5.7	4.4	4.3

The I_3's recorded in table 56 are all of the Bola Batoe cave; nos. 1—7 of the right, and nos. 8—12 of the left side. In the Panganrejang Toedeja cave collection, layer C—D, there is also a specimen of I_3, but it is too much worn to permit of the transverse diameter to be taken.

Though the variation ranges overlap to a considerable extent, the cave material, as a whole, averages smaller than does the recent (table 57).

TABLE 57.

Variation range and average of dimensions of recent and subfossil lower I of *Sus celebensis*.

	recent		subfossil	
	range	mean	range	mean
I_1 tr.	5.5—7.4	6.3	4.6—6.9	5.7
I_2 tr.	6.1—8.4	6.8	5.6—7.7	6.5
I_3 tr.	5.7—7.3	6.3	4.3—6.8	5.7

There are, again, differences in average size between the teeth from different caves. The Panganrejang Toedeja cave material averages smaller than that of the Bola Batoe cave, and most clearly so that of the older layer C—D of the former cave. The differences are of the same kind and of the same small magnitude as those found in the case of I^1 (table 51). Thus the lower incisors of *Sus celebensis*, like the upper, have the evident tendency to become larger in the course of time (table 58).

TABLE 58.

Average dimensions of recent and subfossil lower I of *Sus celebensis*.

	recent	Bola Batoe	Panganrejang Toedeja	
			A—B	C—D
I_1 tr.	6.3	5.8	5.6	5.3
I_2 tr.	6.8	6.6	6.5	6.2

CANINES

Male upper C (pl. III fig. 1)

The Bola Batoe cave collection contains six measurable specimens of the male upper C, and a number of smaller fragments; nos. 1—4 are of the right, and nos. 5—6 of the left side. The most complete specimen (no. 1) is figured on pl. III fig. 1. I have moreover two fine right specimens from a cave N. of Tjani (nos. 7—8), one right and two left specimens of layer A—B of the Panganrejang Toedeja cave (nos. 9—11), and two right and one left specimen from layer C—D of the latter cave (nos. 12—14). Nos. 13 and 14 are in situ in maxillary fragments, but the ridge above the alveolus is damaged. There are seven fully grown out male upper canines available for comparison; the horizontal and vertical diameters of which are given beside those of the cave specimens in table 59.

The recent canines average larger than those from the Bola Batoe cave; the material from the remaining Toalian caves is too small to draw conclusions upon. It is certainly worthy of notice that the three specimens from layer A—B of the Panganrejang Toedeja cave are smaller than those from the older layer C—D of the same cave. In the average, however, the subfossil material is smaller than the recent, which is in harmony with what we found to be the case with the incisors of *Sus celebensis*. The fact that

TABLE 59.

Measurements of recent and subfossil male upper C of *Sus celebensis.*

	celebensis			*nehringii*		subsp.			*weberi*	
	10	11		3		1	2		1	2
hor.	18.0	18.9		19.8		16.7	16.7		19.8	15.7
vert.	13.0	14.5		15.4		12.6	12.2		12.7	11.5
No.	1	2	3	4	5	6	7	8	9	10
hor.	13.7	16.5	15.9	14.0	15.6	17.4	15.5	17.0	16.2	15.6
vert.	12.0	12.4	13.2	10.9	12.8	11.5	11.7	11.7	11.4	11.4
No.	11	12	13	14						
hor.	14.7	16.5	16.7	18.1						
vert.	12.8	12.3	12.8	12.8						

the older material of the Panganrejang Toedeja cave is larger than the younger material of the same cave evidently is due to chance only. The series from the Bola Batoe cave (there are also a few more specimens, but of these no measurements can be taken) shows the subfossil *Sus celebensis* to be definitely smaller than the recent. The difference in size stands the statistical test (table 60).

TABLE 60.

Male upper C of *Sus celebensis.*

	n	M	σ	C	$E_{diff.}$	$\frac{M_{rec.} - M_{subf.}}{E_{diff.}}$
Horizontal diameter, recent	7	17.9	1.6	9.1	0.8	3.0
Id., Bola Batoe	6	15.5	1.4	9.2		
Vertical diameter, recent	7	13.1	1.4	10.4	0.6	1.7
Id., Bola Batoe	6	12.1	0.7	6.0		

In its horizontal diameter, at least, the Bola Batoe cave *Sus celebensis* male upper C is really smaller than that of the recent races of the species, the difference between the means being three times as large as its standard error E_{diff}. This is a significant result as it affords proof of the distinctness of the form of *Sus celebensis* occurring in the Bola Batoe cave.

Female upper C

The female upper C is represented in the Bola Batoe cave collection by one specimen only. It is of the right side, and is no. 1 in table 61. No. 2 is a right specimen from the Batoe Edjaja cave; nos. 3 and 4 a right and a left canine from layer A—B of the Panganrejang Toedeja cave; nos. 5 and 6 are two left specimens from layer C—D of the latter cave. Three recent specimens are available for comparison, the measurements of which appear in table 61, too.

TABLE 61.

Measurements of recent and subfossil female upper C of *Sus celebensis*.

	celebensis	*nehringii*							
No.	12	6	7	1	2	3	4	5	6
ap.	—	9.5	8.8	9.0	8.8	8.3	7.7	8.4	8.1
tr.	5.3	6.0	4.9	5.0	5.1	4.2	5.0	5.4	4.3

One of the three recent specimens is distinctly larger than any of the six cave specimens.

Male lower C

Though there are many fragments of male lower C in the Bola Batoe cave collection only few belong to fully adult animals and are of an even thickness along their entire length. The latter specimens only have been measured. Three measurements are given: the width of the internal surface (int.), that of the external surface (ext.), and that of the posterior surface (post.).

Nos. 1—4 in table 62 are one right and three left male lower canines from the Bola Batoe cave, no. 5 is a left canine from a cave N. of Tjani, nos. 6—9 are one right and three left canines from layer A—B of the Panganrejang Toedeja cave, and no. 10 is a right canine from the Lompoa rock-shelter. There are no specimens of the male lower C from other cave deposits except for the tip of a right specimen (marked CA) in the Panisi Ta'boettoe collection.

The measurements of the seven recent male lower C are given in table 62 too. The two boars from Saleyer are seen to differ markedly in the size of the lower canine; that of *Sus celebensis weberi* no. 1 is larger than any of the ten subfossil specimens. Incidentally, it will be observed that the posterior surface is invariably narrower than the external, indicating that all specimens are typically verrucose.

TABLE 62.

Measurements of recent and subfossil male lower C of *Sus celebensis*.

	celebensis			*nehringii*		subsp.			*weberi*	
	10	11		3		1	2		1	2
int.	16.5	15.8		17.6		16.5	19.0		20.0	16.4
ext.	16.9	14.6		16.9		15.0	16.2		17.5	14.5
post.	11.2	10.4		13.4		11.2	12.4		14.5	11.0
No.	1	2	3	4	5	6	7	8	9	10
int.	15.0	17.6	16.7	16.3	14.0	15.0	13.4	17.4	15.4	15.5
ext.	12.6	17.4	16.6	15.2	12.5	13.7	13.6	15.6	14.5	15.0
post.	10.0	13.7	13.0	11.5	10.5	9.2	10.6	12.5	11.7	11.5

The difference in size between the recent and the subfossil specimens is not as marked as that in the case of the upper male canine, but the recent male lower C averages again larger than its subfossil homologue (table 63). Among the subfossil canines that of the Bola Batoe cave is a little larger, in the average, than that of layer A—B of the Panganrejang Toedeja cave; a difference that is too small to be of any significance, however.

TABLE 63.

Average dimensions of recent and subfossil male lower C of *Sus celebensis*.

	recent	Bola Batoe	Panganrejang Toedeja A—B
int.	17.4	16.4	15.3
ext.	15.9	15.5	14.4
post.	12.0	12.1	11.0

Female lower C

My subfossil material of female lower C comprises two right and four left specimens from the Bola Batoe cave (nos. 1—6 in table 64), one right specimen in a symphysis fragment from layer C—D of the Panganrejang Toedeja cave (no. 7), and one right and one left specimen from the Lompoa rock-shelter (nos. 8—9). The antero-posterior diameter was taken at the outer surface of the crown base. Two recent specimens are available for comparison; it will be seen from table 64 that both of these exceed their subfossil homologues in size.

TABLE 64.

Measurements of recent and subfossil female lower C of *Sus celebensis*.

No.	*celebensis* 12	*weberi* 3	1	2	3	4	5	6	7	8	9
ap.	8.0	7.5	7.4	7.7	7.6	7.0	7.3	7.7	6.7	7.3	—
tr.	5.4	5.8	5.4	5.5	5.4	5.3	5.2	5.4	4.6	4.7	5.3

I think that there can be little doubt that the female canines from the Toalian caves are smaller, in the average, than their recent homologues, but it was possible to prove the existence of a reliable size difference only in the case of the male upper C, viz., between that from the Bola Batoe cave and the recent. There is also some evidence that the material from the oldest cave deposit, viz., the layer C—D of the Panganrejang Toedeja cave, represents a form smaller still than the Bola Batoe cave form.

The premolars and molars which now remain to be discussed have the same disadvantage as the incisors, viz., that it is impossible to determine the sex of the individuals to which the teeth belonged. Even of the more complete specimens listed already in tables 46 and 47 a sex determination cannot be given unless, as is sometimes the case, part of the canine or of its alveolus is preserved. The premolars and molars of recent female skulls of *Sus celebensis* are not, or hardly, smaller than those of the males. Though all the maximum values for the premolar and molar dimensions taken in recent skulls occur in males, only half of the total number of minima were found in female dentitions. It seems evident that this is due to the very small number of female skulls in the recent collection at my disposal. There is a possibility that the variation ranges and averages of the various tooth dimensions of recent *Sus celebensis* given in following tables are a little too high, and that, consequently, the excess in average size over the cave teeth which the recent teeth undoubtedly show, is flattered.

PREMOLARS

Upper P (pl. III fig. 4)

In the Bola Batoe cave collection there are three right P^2's, one of which in a maxillary fragment also holding the stump of P^1 and the alveolus of a female canine. These specimens are nos. 1—3 in table 65. No. 4 is a left P^2 from the Batoe Edjaja cave; no. 5 is a left specimen from layer A—B of the Panganrejang Toedeja cave; no. 6 is the P^2 in a left maxillary fragment from layer C—D of the latter cave, with the roots of P^1 and a male canine (no. 14 in table 59).

TABLE 65.

Measurements of subfossil P^2.

No.	1	2	3	4	5	6
ap.	8.6	8.9	9.8	9.7	9.1	9.1
tr.	—	6.2	6.4	6.4	5.8	5.8

In table 66 the measurements are given of the following specimens: nos. 1—7 are right, nos. 8—12 left P^3's of the Bola Batoe cave; no. 13 is a right specimen from a cave N. of Tjani (no. 111 of the VAN STEIN CALLENFELS collection); no. 14 a left P^3 from layer A—B of the Panganrejang Toedeja cave, and no. 15 a right specimen, likewise from the VAN STEIN CALLENFELS collection but without a record for the exact locality.

TABLE 66.

Measurements of subfossil P^3.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ap.	9.6	9.6	9.8	9.0	9.8	9.4	—	10.0	9.4	10.4	10.3	10.2	10.9	10.0	9.2
tr.	8.2	8.6	8.7	7.7	8.5	8.6	8.5	9.0	9.2	9.0	8.2	7.8	9.1	8.1	9.0

The greater part of the P^4's is again from the Bola Batoe cave, viz., nos. 1—11 in table 67 which are five right and six left specimens. No. 12

in table 67 is a right specimen from a cave N. of Tjani (no. 113 of the VAN STEIN CALLENFELS collection); nos. 13—14 are a right and a left P^4 from layer A—B of the Panganrejang Toedeja cave, while no. 15 is a left specimen from layer C—D of the latter cave.

TABLE 67.

Measurements of subfossil P^4.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ap.	9.8	10.0	9.8	10.5	10.8	9.1	9.4	10.0	9.5	—	9.1	10.2	9.8	10.2	9.8
tr.	10.3	11.0	11.8	11.9	11.4	11.1	10.9	11.1	10.6	11.5	10.4	11.8	11.0	11.0	11.3

With the exception only of one P^4, viz., that from the Bola Batoe cave recorded as no. 5 in table 67, all subfossil specimens of upper premolars are smaller in size than the maximum found in recent specimens. The variation ranges of the recent upper P and their subfossil homologues overlap to a large extent, but the subfossil teeth average invariably smaller than their recent homologues, as is shown in table 68.

TABLE 68.

Variation range and average of dimensions of recent and subfossil upper P of *Sus celebensis*.

	recent		subfossil	
	range	mean	range	mean
P^2 ap.	9.1—11.8	9.7	8.6—9.8	9.2
tr.	5.7—7.5	6.3	5.3—6.4	5.9
P^3 ap.	9.1—11.6	10.0	8.8—10.9	9.7
tr.	8.3—9.9	9.1	6.8—9.2	8.3
P^4 ap.	9.0—10.5	9.9	8.8—10.8	9.6
tr.	10.5—12.9	11.9	10.2—11.9	11.0

Lower P (pl. III fig. 5)

There are no anterior lower premolars in the various cave collections except for part of the root of one in a mandible fragment with P_2—P_4 dext. from a cave N. of Tjani (no. 237 of the VAN STEIN CALLENFELS collection; measurements recorded in column h of table 47).

Of the P_2 there are two isolated specimens only; no. 1 is a P_2 dext. from the Panisi Ta'boettoe (marked CC); no. 2 is a P_2 sin. from layer A—B of the Panganrejang Toedeja cave. Measurements are given in table 69.

TABLE 69.

Measurements of subfossil P_2.

No.	1	2
ap.	9.4	9.2
tr.	4.4	4.5

There are four isolated P_3's in the cave collections; no. 1 is a left specimen of the Bola Batoe cave, nos. 2—3 are left P_3's from layer A—B of the Panganrejang Toedeja cave, and no. 4 is a right specimen from layer C—D of the latter cave (table 70).

TABLE 70.

Measurements of subfossil P_3.

No.	1	2	3	4
ap.	10.0	10.5	10.5	9.4
tr.	5.9	6.2	5.8	5.3

Of the P_4's recorded in table 71 nos. 1—3 are right, and nos. 4—5 left specimens from the Bola Batoe cave; no. 6 is a left specimen from layer A—B of the Panganrejang Toedeja cave, and no. 7 is a right P_4 from layer C—D of the latter cave.

TABLE 71.

Measurements of subfossil P_4

No.	1	2	3	4	5	6	7
ap.	11.8	11.1	10.2	12.4	11.0	11.6	10.8
tr.	—	7.6	7.5	8.5	7.7	7.4	8.1

There are, again, only very slight differences between the variation ranges of the recent premolars and of their subfossil homologues; the five specimens of P_2 (three of which were recorded already in table 47) even are all within the limits of the recent homologous teeth. Nevertheless, in all dimensions the subfossil lower P average smaller than the recent, as will appear from table 72.

TABLE 72.

Variation range and average of dimensions of recent and subfossil lower P of *Sus celebensis*.

	recent		subfossil	
	range	mean	range	mean
P_2 ap.	7.9—10.3	9.2	8.4—9.4	9.0
tr.	3.8—5.2	4.6	3.9—4.5	4.3
P_3 ap.	9.7—12.3	10.6	9.5—10.5	9.9
tr.	5.9—7.0	6.3	5.3—6.6	5.8
P_4 ap.	10.4—13.0	11.5	10.2—12.4	10.9
tr.	8.0—9.1	8.7	6.9—8.5	7.7

MOLARS

Upper M (pl. III figs. 2 and 8)

Far and away the best material of upper molars originates from the Bola Batoe cave collection; nos. 1—7 in table 73 are right M^1's, and nos.

8—19 left M¹'s collected by Mr. VAN HEEKEREN. No. 20 is a left specimen from a cave N. of Tjani, no. 21 is a right M^1 from layer A—B of the Panganrejang Toedeja cave, and nos. 22—24 are two right and one left specimens from layer C—D of the latter cave.

TABLE 73.

Measurements of subfossil M^1.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	14.0	13.5	13.7	13.9	13.0	13.8	13.7	14.6	14.5	13.8	13.9	13.7
atr.	11.5	10.8	12.1	10.7	10.5	11.1	11.9	10.8	11.8	12.0	10.5	11.4
ptr.	11.4	10.5	12.3	10.8	10.7	11.0	11.4	10.6	11.4	11.3	10.8	10.6
No.	13	14	15	16	17	18	19	20	21	22	23	24
ap.	14.3	15.0	14.4	14.7	—	13.8	—	15.1	13.6	—	12.6	13.6
atr.	11.6	12.0	11.6	12.0	11.1	—	12.0	11.8	—	11.0	10.8	11.3
ptr.	11.5	12.4	11.2	11.6	11.0	11.7	12.0	11.4	—	10.8	10.6	11.2

In table 74, nos. 1—13 are right, and nos. 14—32 left specimens of M^2 from the Bola Batoe cave; nos. 33 and 34 are two left specimens from a cave N. of Tjani (no. 33 is no. 113 of the VAN STEIN CALLENFELS collection). No. 35 is one right, and nos. 36—39 are four left M^2's from layer A—B of the Panganrejang Toedeja cave, nos. 40 and 41 are one right and one left M^2 from layer C—D of the latter cave, and no. 42 is a left specimen from the Lompoa rock-shelter.

TABLE 74.

Measurements of subfossil M^2.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ap.	17.7	17.4	16.6	18.0	18.0	20.7	18.0	17.1	16.9	18.4	17.9	—	17.8	17.7
atr.	13.9	15.4	14.4	14.0	14.7	15.9	15.4	14.9	12.9	15.4	12.8	15.5	14.5	13.2
ptr.	12.6	14.3	13.9	12.9	14.1	15.4	15.4	14.4	12.6	15.0	11.4	—	—	13.5
No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
ap.	20.5	18.4	18.6	17.4	16.6	16.8	—	16.8	17.6	18.2	17.6	19.2	17.7	17.2
atr.	15.8	14.9	14.6	14.3	13.4	14.3	13.7	15.2	14.5	14.0	—	15.9	15.1	14.6
ptr.	14.6	13.5	14.7	13.0	13.0	14.5	13.1	14.5	13.7	13.8	14.0	15.0	14.7	13.7
No.	29	30	31	32	33	34	35	36	37	38	39	40	41	42
ap.	—	16.3	—	—	18.7	18.7	16.9	17.6	17.6	17.2	17.0	15.3	17.0	19.6
art.	14.5	—	13.8	—	15.0	15.7	14.4	15.0	14.9	13.4	13.5	13.6	13.8	15.2
ptr.	13.4	12.3	13.0	14.3	14.5	14.9	13.7	14.5	14.9	12.7	13.4	13.0	13.4	14.3

In the Bola Batoe cave collection there are nineteen specimens of M^3; nos. 1—7 are of the right, and nos. 8—19 of the left side. Measurements are given in table 75. Nos. 20—22 are one right and two left M^3's from a cave N. of Tjani (VAN STEIN CALLENFELS collection nos. 237, 113, and

211 respectively). Nos. 23—25 are right, and nos. 26—29 left specimens from layer A—B of the Panganrejang Toedeja cave; nos. 30—32 are right, and nos. 33—35 left specimens from layer C—D of the latter cave. Nos. 36—38 are two right and one left specimen in the VAN STEIN CALLENFELS collection of which the exact locality is unknown.

TABLE 75.

Measurements of subfossil M^3.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
ap.	26.3	23.6	23.5	22.7	26.5	24.0	24.3	23.5	23.7	19.7	23.8	22.8	20.8
atr.	16.7	—	14.5	14.9	16.9	14.9	14.8	14.8	15.6	13.6	14.2	14.0	14.5
ptr.	13.1	12.9	12.1	13.4	14.6	13.0	12.1	13.8	12.8	12.1	12.6	10.9	12.0
No.	14	15	16	17	18	19	20	21	22	23	24	25	26
ap.	22.5	23.6	22.6	22.5	—	—	26.3	23.6	25.7	25.5	23.8	24.4	23.7
atr.	14.5	14.6	14.0	15.1	14.7	12.8	15.8	15.5	14.8	14.7	15.0	14.5	15.8
ptr.	12.4	12.4	12.4	12.8	12.4	10.6	12.7	12.9	12.8	13.2	11.5	13.2	14.9
No.	27	28	29	30	31	32	33	34	35	36	37	38	
ap.	27.3	21.9	23.7	20.4	23.5	21.6	24.4	23.3	25.0	23.8	23.7	—	
atr.	16.0	13.6	—	13.3	14.8	13.1	14.7	14.1	16.7	14.9	15.5	15.0	
ptr.	13.7	11.3	12.7	11.3	12.6	11.7	12.4	12.2	13.8	12.7	12.9	13.6	

Among all these subfossil specimens of upper molars there is one, viz., M^2 no. 6 in table 74, that is longer than the maximum found in the corresponding recent series; none of the remaining subfossil specimens is above the maximum size of its recent homologue. Consequently, there is a difference in average size between the subfossil and the recent upper M in favour of the recent (table 76).

TABLE 76

Variation range and average of dimensions of recent and subfossil upper M of *Sus celebensis*.

		recent		subfossil	
		range	mean	range	mean
M^1	ap.	12.8—15.5	13.9	12.5—15.1	13.8
	atr.	10.9—13.1	11.7	9.4—12.1	11.1
	ptr.	10.9—14.3	11.7	10.0—12.4	11.0
M^2	ap.	16.1—20.5	17.9	15.3—20.7	17.6
	atr.	13.8—17.5	15.2	12.8—15.9	14.4
	ptr.	13.5—18.0	14.5	12.0—15.4	13.7
M^3	ap.	23.0—ca. 29	25.3	20.2—27.3	23.6
	atr.	14.8—18.7	16.7	12.8—16.9	14.8
	ptr.	12.8—16.5	14.1	10.6—14.9	12.6

The last upper molar is a rather variable tooth, but it shows the tendency toward gradual increase in size again as well as was the case in I^1, I^2, I_1, and I_2; the M^3's from the older layer C—D of the Panganrejang Toedeja cave average smaller than those of layer A—B of the same cave (table 77). In the present case, the latter material averages larger than that of the Bola Batoe cave instead of smaller as was the case in I^1, I_1, I_2, and the male lower C.

TABLE 77.

Average dimensions of recent and subfossil M^3 of *Sus celebensis*.

	recent	Bola Batoe	Panganrejang Toedeja A—B	Panganrejang Toedeja C—D
ap.	25.3	23.5	24.3	23.0
atr.	16.7	14.9	14.9	14.5
ptr.	14.1	12.6	12.7	12.3

Lower M (pl. III fig. 5)

In addition to the lower molars in the mandible fragments enumerated in table 47 there is also a number of isolated specimens. Nos. 1—2 in table 78 are right, and nos. 3—4 left M_1's from the Bola Batoe cave, nos. 5—6 are left specimens from layer A—B of the Panganrejang Toedeja cave, no. 7 and no. 8 are a right and a left M_1 in the VAN STEIN CALLENFELS collection the locality of which is not given, and no. 9 is a left M_1 in the collection of Prof. MIJSBERG from the Tjadang cave (no. 53). In the latter collection there is also the posterior moiety of a right M_1 (no. 246, it is no. 10 in table 78), an imperfect specimen. These two latter teeth are the only evidence we have of the existence of the present species in the Tjadang cave fauna.

TABLE 78.

Measurements of subfossil M_1.

No.	1	2	3	4	5	6	7	8	9	10
ap.	13.4	14.0	14.0	13.4	12.9	—	13.9	13.9	14.5	—
atr.	8.0	9.4	9.3	9.7	8.3	10.1	8.5	8.4	8.7	—
ptr.	8.7	9.3	8.9	8.9	8.7	10.0	9.1	9.0	9.0	8.7

The measurements of the cave specimens of M_2 are given in table 79. Nos. 1—7 are right, and nos. 8—13 left specimens from the Bola Batoe cave; nos. 14—16 are right M_2's from a cave N. of Tjani, the first and second of which bear the numbers 135 and 230, no. 17 is a left M_2 from the latter cave (Coll. VAN STEIN CALLENFELS no. 147), nos. 18 and 19 are two left specimens from layer A—B of the Panganrejang Toedeja cave, and no. 20 is a left specimen, without a label, from the VAN STEIN CALLENFELS collection, too.

In table 80 nos. 1—5 are right, and nos. 6—12 left specimens of M_3 from the Bola Batoe cave; nos. 13—15 are right M_3's from a cave N. of Tjani (the first and second of which are numbered 460 and 161), nos.

TABLE 79.

Measurements of subfossil M_2.

No.	1	2	3	4	5	6	7	8	9	10
ap.	18.3	—	18.2	16.9	16.4	16.8	—	17.9	17.3	17.9
atr.	12.4	12.2	11.0	11.8	12.8	11.0	—	12.5	12.0	11.2
ptr.	12.3	11.5	11.0	11.7	11.7	11.6	12.1	12.0	12.4	11.7
No.	11	12	13	14	15	16	17	18	19	20
ap.	15.4	16.6	16.8	15.7	17.0	15.8	17.2	16.4	17.9	17.6
atr.	9.9	12.3	—	10.3	11.4	9.9	11.2	10.8	11.9	12.6
ptr.	10.2	11.7	11.9	10.7	11.1	10.3	10.9	10.8	12.2	11.9

16—17 are left specimens from the latter cave (the last bears no. 266 of the VAN STEIN CALLENFELS collection). No. 18 is a right, and nos. 19—21 are left specimens from layer A—B of the Panganrejang Toedeja cave, nos. 22—23 are right, and no. 24 is a left M_3 from layer C—D of the latter cave. No. 25 is a right, and no. 26 a left specimen from the VAN STEIN CALLENFELS collection, unlocalized.

TABLE 80.

Measurements of subfossil M_3.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
ap.	24.5	—	23.1	—	—	27.0	26.6	23.7	25.7	25.0	23.2	—	25.4
atr.	12.2	12.3	13.6	11.6	13.9	12.9	—	14.1	12.9	14.9	12.6	13.1	12.7
ptr.	11.6	11.0	11.8	—	12.7	11.8	12.6	12.3	12.3	12.9	11.4	11.8	11.9
No.	14	15	16	17	18	19	20	21	22	23	24	25	26
ap.	—	21.9	26.6	23.2	23.7	24.8	25.4	—	25.3	24.8	24.9	25.5	—
atr.	11.9	12.8	13.4	11.2	13.4	13.4	13.3	14.3	—	—	12.8	13.6	13.9
ptr.	11.1	11.0	12.2	10.8	12.2	11.9	12.6	12.7	12.3	12.0	11.4	12.3	12.1

Of the lower molars dealt with above, the subfossil M_1 averages slightly longer than the recent (table 81), but the mean of the recent is based on four observations only, most of the skulls examined being too old to permit of the total length of the first molar to be taken. The remainder of the lower molar dimensions average smaller in the subfossil than in the corresponding recent elements.

The various tables of measurements of the incisors, canines, premolars, and molars given above give accumulated evidence that *Sus celebensis* was smaller at the time of the formation of the Toalian cave deposits than it is now. Due allowance must be made, however, for the preponderance of male specimens in the recent series of skulls available for comparison. If there had been more female skulls in the recent collection it is quite imaginable that the difference in average size between the recent and the subfossil teeth would have been less pronounced than it is now. This does not

TABLE 81.

Variation range and average of dimensions of recent and subfossil lower M of *Sus celebensis*.

	recent		subfossil	
	range	mean	range	mean
M_1 ap.	12.0—14.5	13.2	12.3—14.5	13.3
atr.	9.0—10.1	9.4	8.0—10.1	8.7
ptr.	9.0—10.0	9.5	8.5—10.0	9.0
M_2 ap.	15.8—20.0	17.2	15.2—18.3	16.7
atr.	11.7—14.6	12.8	9.5—12.8	11.3
ptr.	11.7—14.8	12.8	9.3—12.8	11.3
M_3 ap.	24.4—31.0	26.8	21.5—27.0	24.6
atr.	13.5—15.8	14.8	11.1—14.9	12.9
ptr.	11.5—16.0	13.4	10.8—12.9	11.9

apply, of course, to the canines which can be sexed easily, and the male as well as the female canines also show that there has been an increase in size in the course of time in the present species. In the case of the male upper C the size difference between the Bola Batoe cave specimens and the corresponding recent stands the statistical test (table 60).

Though the material is insufficient to give actual proof, it seems evident that the pig from the basal layer of the Panganrejang Toedeja cave is smaller again than that of the Bola Batoe cave; the first and second upper and lower incisors as well as the last upper molar average smaller in layer C—D of the Panganrejang Toedeja cave than in the upper layer A—B of the latter cave and in the Bola Batoe cave.

The evident tendency toward large size shown in the present species contrasts with that found in the cuscuses, macaque, Man, and MEYER's rat from the very same deposits discussed earlier in the present paper. The Grey Celebes Cuscus (*Phalanger celebensis*) is represented in the collection from layer C—D of the Panganrejang Toedeja cave by enough specimens to prove (table 7) that it is really larger than the living form, and hence I have named it as a distinct subspecies, regarding the forms from the remaining and geologically younger deposits as intermediates. In the present case the not very well represented form from the basal layer of the Panganrejang Toedeja cave seems to be the smallest of all the cave forms. The Bola Batoe cave *Sus celebensis* is, however, the only Toalian cave form of this species of which the distinctness can be proven, and it is certainly worthy of subspecific distinction.

Sus celebensis sarasinorum nov. subsp.

Diagnosis: Teeth identical in specific characters to those of recent *Sus celebensis* Müller et Schlegel but of less average size. The difference in size between the male upper canines is significant statistically.

Holotype: The right male upper C represented on pl. III fig. 1 (no. 1 in table 59 of the present work).

Paratypes: The P^2—P^3 dext., P^4—M^2 dext., M^2—M^3 sin., and P_4—M_3 dext. figured in the present paper (pl. III figs. 2, 4, 5, and 8).
Locality: Bola Batoe cave, near Badjo (Barebo district), ca. 20 km S.W. of Watampone in Central Bone, S. Celebes.
Age: Holocene.
Name: I dedicate this subspecies to the memory of P. and F. SARASIN.

I see no reason to doubt that *Sus celebensis sarasinorum* nov. subsp. is a form ancestral to the pig which now lives in the same region of Celebes. The fact that in the oldest cave deposits the *Sus* remains tend to be even smaller than those of the Bola Batoe cave supports the view that *Sus celebensis* has gradually increased in size up to the present day. As noted already above this is an exceptional phenomenon because subfossil or fossil races of recent species are commonly larger than the living, swine included. The babirusa, a congener of *Sus celebensis* in the fauna of South-western Celebes until it became extinct in this region of the island while or shortly after the Toalian cave deposits were formed, was definitely larger in the Pleistocene than it is even now in Northern Celebes (HOOIJER, 1948d) and has decreased in size since that time. The present materials throw light only on the last few hundred or thousand years of the evolution of *Sus celebensis*, and as long as we possess no truly Pleistocene remains of the present species we cannot make out what the long-range trend in its evolution was. Speculations as to the nature of the tendency toward large size as shown in the present species during and after the formation of the Toalian cave deposits, therefore, can be better deferred until Pleistocene material becomes available.

Genus **Babyrousa** Perry

The presence of the babirusa in the Toalian cave fauna was considered by SARASIN (1905, p. 53) as one of the most striking points of difference between the subfossil fauna and the recent. At this day the babirusa does not occur in the South-western peninsula of Celebes. The type locality is Boeroe (STEHLIN, 1900, p. 511), and LESSON's description of 1827 is the first referring to Celebes specimens (DENINGER, 1909, p. 2). The Boeroe babirusa as well as that of Celebes are represented in the collections of the Leiden Museum and of the Amsterdam Museum by a fine series of skulls, while in the British Museum (Natural History) at London I could examine a series of eleven male skulls from Taliaboe, one of the Soela Islands East of Celebes. Two skulls from the Soela Islands (exact locality not specified) are in the Amsterdam Museum collection, too.

The peculiar recent distribution of the babirusa over Celebes, the Soela Islands (where it was known to exist already long before the first specimens reached any European Museum), and Boeroe was regarded by P. and F. SARASIN as evidence of the former existence of a land bridge, the Moluccas bridge, past which Celebes should have received part of its land fauna (P. and F. SARASIN, 1901, p. 108). DAMMERMAN (1929, p. 154), however, points out that it is more probable that the babirusa has been introduced in Boeroe by Man. How-ever this be, the babirusa shows today a clinal variation from Celebes over the Soela Islands to Boeroe, the Celebes animal having the largest teeth, the Boeroe animal the smallest, while the Soela Islands animal is intermediate in its molar dimensions, the premolars being, however, smaller, in the average, than those of the Boeroe race. This inferior premolar development in the Soela Islands babirusa contrasts with the development of supernumerary premolars. It is a characteristic of the babirusa to have but two premolars, but not less than seven out of the series of thirteen adult Soela Islands skulls possess one or more P 2's (or pd 2's), while this extra premolar occurs only in one out of the seventeen adult Boeroe skulls and only in two out of the fifteen adult Celebes skulls.

The babirusa skulls listed below show other interesting dental variations. There is a double upper left canine in mandible no. 8 of *Babyrousa babyrussa babyrussa*, and both teeth differ hardly in size from the single canine on the right side. A similar variation has never been recorded for the present species as far as I know. In skull no. 9 of *Babyrousa babyrussa alfurus* P_3 sin. is malformed; it has a small accessory inner root partly fused with the posterior one, and a distinct extra outer cusp supported by a root that is not smaller than the normal anterior and posterior roots. The right P_3 was normal as far as can be judged from its alveolus, but the first lower

Babyrousa babyrussa babyrussa (L.)

Material examined:

Subadults.

1. Skull of ♀. Boeroe, coll. BLUME. L.M., cat. ost. h.
2. Skull of ♀. Boeroe, coll. REINWARDT. L.M., cat. ost. i.
3. Skull of ♀. N.E. Boeroe, coll. KOPSTEIN, July, 1923. L.M.

Adult males.

4. Skeleton. Boeroe, coll. PEITSCH, ? 1836. L.M., cat. ost. a.
5. Skull of old individual. Boeroe, coll. REINWARDT. L.M., cat. ost. b.
6. Skull. Boeroe, coll. REINWARDT. L.M., cat. ost. c.
7. Skull. Boeroe, coll. REINWARDT. L.M., cat. ost. d.
8. Skull. Boeroe, coll. LÜDEKING, 1864. L.M., cat. ost. e.
9. Skull. Boeroe, coll. HOEDT, 1866. L.M., cat. ost. f.
10. Skull. Boeroe, coll. HOEDT, 1866. L.M., cat. ost. g.
11. Skull of old individual. Boeroe, coll. TOXOPEUS, September, 1921. A.M.
12. Skull. N.W. Boeroe, coll. TOXOPEUS, 1921. A.M.
13. Skull. S.E. Boeroe, coll. TOXOPEUS, 1921, A.M.
14. Skull. Boeroe, coll. KOPSTEIN, ca. 1923, L.M.
15. Skull. Boeroe, coll. KOPSTEIN, June, 1923. L.M.
16. Skull. Boeroe, coll. KOPSTEIN, ca. 1923, L.M.
17. Skull. Boeroe, coll. KOPSTEIN, June, 1923. L.M.

Adult females.

18. Skull. Boeroe, from M. C. J. LEYH, received August, 1904. L.M., cat. ost. p.
19. Skull. N. Boeroe, coll. KOPSTEIN, July, 1923. L.M.
20. Flat skin and skull. Boeroe, coll. TOXOPEUS, from the Amsterdam Zoo, 22–10–1924. A.M.

Babyrousa babyrussa alfurus (Lesson)

Material examined:

Infants.

1. Mounted skin and skull. N. Celebes, coll. FORSTEN, 1844. L.M., cat. syst. d, cat. ost. l.
2. Mounted skin and skull. N. Celebes, coll. FORSTEN, 1844. L.M., cat. syst. e, cat. ost. m.

Juveniles.

3. Mounted skin and skull of ♂. N. Celebes, coll. FORSTEN, 1844. L.M., cat. syst. c, cat. ost. k.

Adult males.

4. Mounted skin. N. Celebes, coll. FORSTEN. L.M., cat. syst. a.
5. Skull. Lumpias, N. Celebes, coll. DE BEAUFORT, 7—9—1903. A.M., no. S 916.
6. Skull. Celebes, coll. DE BEAUFORT. A.M., no. S 915.
7. Skull. Celebes, W. K. MORAUX don., 1—2—1907. L.M., cat. ost. q.
8. Calvarium. Celebes, coll. HORST, received May, 1913. L.M., reg. no. 301.
9. Mandible. Celebes, coll. HORST, received May, 1913. L.M., reg. no. 301.
10. Skull. Celebes, coll. HORST, received May, 1913. L.M., reg. no. 301.
11. Skull. Celebes, coll. HORST, received May, 1913. L.M., reg. no. 301.
12. Skull. Celebes, from H. D. VISKER, received 13—2—1915. L.M., reg. no. 388.
13. Mounted skin and skeleton. Menado, N. Celebes, from the Rotterdam Zoo, 7–6–1920 (imported 16–2–1914). L.M., reg. no. 992.
14. Skull. N. Celebes, ca. 1920, from W. C. VAN HEURN, L.M., reg. no. 1875.
15. Skull. Minahassa, N. Celebes, coll. HOLTHUIS, June, 1921. A.M.
16. Skull. Menado, N. Celebes, H. J. VINGERHOETS don. A.M., no. S 345.
17. Skull. Celebes, from the collection of E. DUBOIS, 1941. L.M.

Adult females

18. Mounted skin and skull. N. Celebes, coll. FORSTEN, 1844. L.M., cat. syst. b, cat. ost. j.
19. Skull. Celebes, W. K. MORAUX don., 1—2—1907. L.M., cat. ost. r.

Babyrousa babyrussa frosti (Thomas)

Material examined:

1—11. Male skulls, including the holotype, from Taliaboe, Soela Is., coll. FROST, recorded by THOMAS (1920). B.M., nos. 19.11.23.1 — 19.11.23.11.

12. Skull of adult ♂. Soela Is., C. L. J. PALMER VAN DEN BROEK don., from the Amsterdam Zoo. A.M.
13. Skull of adult ♀. Soela Is., C. L. J. PALMER VAN DEN BROEK don., from the Amsterdam Zoo, 10—12—1925 (imported 20—10—1915). A.M.

molar on the left side, likewise lost, had a small accessory outer root as well as an extra root in the centre. The latter is also shown in M_2 where it forms a projection of 6 mm between the four normal roots, which are about twice that long, and it has a separate alveolus. In skull no. 10 of *Babyrousa babyrussa alfurus* P_3 of the left side is duplicated; one of the teeth is slightly smaller, and the other slightly larger than P_3 dext. In skull no. 13 of the latter race the talon of both M^3's is hardly developed, and the length of these molars is only 0.4 mm greater than that of M^2 while in the other skulls from Celebes M^3 is 4.7 to 9.8 mm longer than M^2. The Soela Islands specimens do not show dental variations except for the high frequency of occurrence of supernumerary premolars already referred to above.

There is one babirusa skull in the Amsterdam Museum (no. S 804), unfortunately not localized, which possesses a supernumerary upper molar: behind the left M^3 there is another molar, which had only partly cut the gums, that has all elements of a normal M^3, the talon only being slightly less developed. COLYER (1936, p. 127) mentions a domestic pig mandible in which both M_4's are developed, but records no numerical variations in babirusa molars. This is apparently a dental variation unknown until now in the babirusa. It is of interest that this peculiar skull, too, has a small accessory premolar in front of the P^2 dext.

SARASIN (1905, pp. 37—39) found the babirusa to be about as frequent in the Toalian cave collection as *Sus celebensis*, and states that the cave babirusa is very similar to the recent. It is not clear with which of the three recent babirusa races the cave teeth were compared; the few measurements of recent upper and lower molars given for comparison are not characteristic. DAMMERMAN (1939, p. 69) records remains of the present species from caves N. of Tjani, the Batoe Edjaja cave, and the Panganrejang Toedeja cave (both layer A—B and layer C—D). The re-examination of the VAN STEIN CALLENFELS collection studied by Dr. DAMMERMAN made it evident to me, however, that most of the remains ascribed to the babirusa belong to *Sus* instead. From the material originating from caves N. of Tjani not a single specimen belongs to *Babyrousa*, and most of the specimens from the remaining sites are *Sus celebensis*, which latter species now appears to be decidedly more frequent in the collections than the babirusa. On the other hand the small collection of suid remains from the Panisi Ta'boettoe, identified as *Sus celebensis* by Dr. DAMMERMAN, contains a few specimens definitely belonging to the babirusa.

The Bola Batoe cave collection is particularly rich in specimens referable to the babirusa, which was certainly not less frequent than *Sus celebensis*. The large series of premolars and molars from this cave showed me that the subfossil babirusa is different from the living race of Central and Northern Celebes. The cave teeth average invariably smaller than those of the recent Celebean race and are about of the size of those of the babirusa races of the Soela Is. and Boeroe. If the babirusa could have persisted in

South-western Celebes up to the present day it would have been a smaller form than that now living in Central and Northern Celebes. The clinal variation in the South-western babirusa will be discussed at the end of the present chapter, and I propose to name the subfossil Toalian cave form:

Babyrousa babyrussa bolabatuensis nov. subsp.

Diagnosis: Teeth identical in specific characters to those of recent *Babyrousa babyrussa alfurus* (Lesson) of Northern and Central Celebes but of less average size, comparable to that found in *Babyrousa babyrussa babyrussa* (L.) of Boeroe and in *Babyrousa babyrussa frosti* (Thomas) of the Soela Is.

Holotype: The P^3—M^2 sin. represented on pl. III fig. 13 (column c in table 82 of the present work).

Paratypes: The M^2—M^3 sin., P_3—M_1 sin., and M_2—M_3 dext. figured in the present paper (pl. III figs. 6, 7 and 9).

Locality: Bola Batoe cave, near Badjo (Barebo district), ca. 20 km S.W. of Watampone in Central Bone, S. Celebes.

Age: Holocene.

It is a peculiar thing, again, that the number of female skulls in the recent collections from Celebes, the Soela Is., and Boeroe is so small relative to that of the males. The reason is, as Mr. FROST (in THOMAS, 1920, p. 188) states, that the boars put up such a plucky fight against the dogs used in hunting that it is impossible to get at the sows until such time as the male has been killed, thus enabling the females to get safely away. There is, however, no great sexual difference in tooth size apart from that in the canines, for some of the sow skulls (no. 19 from Boeroe, and no. 18 from Celebes) have rather large premolars and molars very near to, or even at, the maximum size found in their series.

In the Bola Batoe cave collection as well as in others there are a number of maxillary fragments with two or more teeth in situ. The measurements of these specimens are given first.

Table 82, column	
	Bola Batoe cave
a	P^3—M^1 dext., M^2—M^3 dext.
b	M^1—M^3 dext.
c	P^3—M^2 sin. (pl. III fig. 3)
d	P^3—P^4 sin., M^1—M^2 sin.
e	P^3—P^4 sin., M^2—M^3 sin. (pl. III fig. 9)
	Batoe Edjaja cave
f	M^1—M^2 sin.
g	M^2—M^3 sin. (marked B)

Table 82, column	
	Coll. VAN STEIN CALLENFELS, exact locality unknown
h	P^3—M^2 dext.
i	M^1—M^2 sin.
	Lompoa rock-shelter
j	M^1—M^2 sin.

TABLE 82.

Measurements of subfossil upper teeth of *Babyrousa babyrussa*.

	a	b	c	d	e	f	g	h	i	j
P^3 ap.	9.8	—	9.6	9.4	9.7	—	—	9.4	—	—
tr.	7.0	—	7.4	7.4	7.8	—	—	6.7	—	—
P^4 ap.	9.8	—	9.7	9.0	9.1	—	—	8.7	—	—
tr.	9.9	—	9.8	9.7	9.6	—	—	9.4	—	—
M^1 ap.	12.7	12.7	13.2	13.5	—	12.8	—	12.6	13.5	13.5
atr.	10.8	11.2	11.5	—	—	11.1	—	10.5	11.2	11.3
ptr.	10.9	12.0	11.7	10.9	—	11.0	—	10.4	11.3	11.6
M^2 ap.	17.7	15.7	17.0	16.8	16.1	16.0	16.5	16.7	17.5	17.4
atr.	14.8	14.5	14.2	14.4	14.5	14.2	14.4	13.9	14.6	14.3
ptr.	13.9	13.8	13.9	—	13.5	13.4	13.0	13.0	14.1	14.1
M^3 ap.	24.4	22.5	—	—	20.8	—	19.8	—	—	—
atr.	15.8	15.6	—	—	15.8	—	14.3	—	—	—
ptr.	13.6	13.0	—	—	12.6	—	11.4	—	—	—

INCISORS

Of the incisors only I^1 is well represented in the Bola Batoe cave; nos. 1—13 in table 83 are left, and nos. 14—18 right specimens from this cave. Nos. 19 and 20 are two left specimens from the Panisi Ta'boettoe (marked CA and CB respectively), nos. 21 and 22 are two right specimens from the Batoe Edjaja cave, nos. 23—25 are two right and one left I^1 from layer A—B of the Panganrejang Toedeja cave, nos 26—29 four left specimens from layer C—D of the latter cave, and no. 30 is a right I^1 originating from the Lompoa rock-shelter.

TABLE 83.

Measurements of subfossil I^1.

No.	1	2	3	4	5	6	7	8	9	10
ap.	10.5	10.4	10.9	10.3	9.3	10.2	10.6	9.1	8.4	8.9
tr.	5.9	5.6	6.0	5.8	5.5	6.0	5.8	5.3	5.5	5.0
No.	11	12	13	14	15	16	17	18	19	20
ap.	9.3	8.7	9.4	11.4	11.5	10.6	9.6	9.5	9.5	10.1
tr.	5.6	5.4	5.3	6.7	6.4	6.0	5.0	4.9	5.5	5.6
No.	21	22	23	24	25	26	27	28	29	30
ap.	10.5	10.9	10.4	10.5	9.8	12.4	12.7	11.7	11.4	11.7
tr.	5.9	6.2	5.5	6.5	5.8	6.8	6.8	7.5	6.7	6.4

It will be observed that one of the four specimens from layer C—D of the Panganrejang Toedeja cave, viz., no. 29, is as large as the largest of the series from the Bola Batoe cave (no. 14) while the three remaining specimens from layer C—D of the Panganrejang Toedeja cave, nos. 26—28, exceed all other cave specimens in size. The difference in average size between the recent I^1's from Boeroe and Celebes is only very small, and both average larger than the I^1's from the Bola Batoe cave, while the four specimens from layer C—D of the Panganrejang Toedeja cave average larger again than the recent (table 84).

TABLE 84.
Variation range and average of dimensions of recent and subfossil I^1 of *Babyrousa babyrussa.*

	recent		subfossil	
	Celebes	Boeroe	Panganrejang Toedeja C—D	Bola Batoe
ap.	10.0—12.3	10.3—13.3	11.4—12.7	8.4—11.5
tr.	6.4—7.7	6.3—8.5	6.7—7.5	4.9—6.7
	mean	mean	mean	mean
ap.	11.4	11.2	12.1	10.0
tr.	7.1	7.1	7.0	5.6

I have only two bad specimens of the I^2 from the Bola Batoe cave, and of the lower incisors there are only three specimens in this cave, and one in the Batoe Edjaja cave collection. Two left I_1's from the Bola Batoe cave measure 4.8 and 5.2 mm transversely, the Batoe Edjaja cave specimen 5.9 mm. An I_2 dext. from the Bola Batoe cave measures 7.8 mm transversely, dimensions which are within the limits of the recent. The apparent reason for the scarcity of lower I in the cave collections is that these teeth were used by the Toala for making the so-called bone points or "Muduk". In Mr. VAN HEEKEREN's collection from the Bola Batoe cave I saw a number of lower incisors of the babirusa which had been pointed at both ends.

CANINES

The babirusa canines are not very well represented in the cave collections either, but these teeth were also used by the Toala as ornaments or tools (SARASIN, 1905, p. 18/19, pl. III fig. 48; DAMMERMAN, 1939, pp. 65 and 69). In the Bola Batoe cave collection I found a few fragments both of upper and lower male canines. I have measured only the specimens which are of uniform thickness and hence fully grown out. In the Bola Batoe cave collection as well as in that from layer A—B of the Panganrejang Toedeja cave there are some tips of upper C, one similar specimen (marked I) is in the Panisi Ta'boettoe collection. The recent male skulls show an enormous amount of variation in dimensions of the canines, though I measured again only those that had attained their full size.

No. 1 in table 85 is a fragment of a right, and nos. 2—3 are two left male upper C in the Bola Batoe cave collection; nos 4—5 are two right specimens from layer A—B of the Panganrejang Toedeja cave. DAMMERMAN (1939, p. 69) records another specimen, 18 mm in diameter, which is now in the collection of the Archaeological Survey.

TABLE 85.

Measurements of subfossil male upper C.

No.	1	2	3	4	5
ap.	16.5	15.0	15.8	17.5	15.4
tr.	12.6	10.9	11.1	11.9	11.0

These subfossil specimens are well within the corresponding limits in the Boeroe babirusa, but some are below the size range found for the Celebes specimens (table 86).

TABLE 86.

Variation range and average of dimensions of recent and subfossil male upper C of *Babyrousa babyrussa.*

	Celebes		Boeroe		Bola Batoe	
	range	mean	range	mean	range	mean
ap.	16.7—20.4	18.7	13.8—20.6	15.4	15.0—16.5	15.8
tr.	10.9—13.4	12.5	10.0—14.0	11.0	10.9—12.6	11.5

Of the male lower C I have ten subfossil specimens; nos. 1—4 in table 87 are right, and nos. 5—6 left specimens from the Bola Batoe cave, nos. 7—8 are two left specimens from layer A—B of the Panganrejang Toedeja cave, no. 9 is a right male lower C from layer C—D of the latter cave, and no. 10 is a left specimen from the Lompoa rock-shelter.

TABLE 87.

Measurements of subfossil male lower C.

No.	1	2	3	4	5	6	7	8	9	10
ap.	18.6	17.4	18.2	14.7	17.5	17.8	18.3	16.6	18.9	18.7
tr.	12.0	11.6	11.9	10.0	11.4	11.4	12.0	10.3	12.0	12.8

The Celebes lower canines are larger again, in the average, than those from Boeroe, and the Bola Batoe cave material averages smaller than either of the two recent series (table 88).

TABLE 88.

Variation range and average of dimensions of recent and subfossil male lower C of *Babyrousa babyrussa.*

	Celebes		Boeroe		Bola Batoe	
	range	mean	range	mean	range	mean
ap.	18.1—24.0	20.4	15.0—23.0	17.8	14.7—18.6	17.4
tr.	11.9—15.5	14.0	11.1—17.3	12.8	10.0—12.0	11.6

PREMOLARS

Of the anterior upper premolar, P^3, there are 18 specimens in the Bola Batoe cave collection; nos. 1—12 of the right, and nos. 13—18 of the left side (table 89). Nos. 19 and 20 are a right and a left specimen from layer A—B of the Panganrejang Toedeja cave, and no. 21 is a left P^3 from layer C—D of the latter cave.

TABLE 89.

Measurements of subfossil P^3.

No.	1	2	3	4	5	6	7	8	9	10	11
ap.	9.9	9.5	9.4	10.3	9.8	10.5	9.6	10.3	10.6	9.6	9.6
tr.	7.8	7.5	8.2	7.7	7.6	8.5	7.7	8.2	8.8	7.8	7.9
No.	12	13	14	15	16	17	18	19	20	21	
ap.	10.5	10.9	9.8	10.5	10.9	9.4	9.3	9.3	9.9	10.5	
tr.	8.3	8.8	7.4	7.8	8.3	8.6	7.9	7.7	7.7	8.0	

Nos. 1—11 in table 90 are right, and nos. 12—23 left specimens of P^4 in the Bola Batoe cave collection; nos. 24—26 are two right and one left P^4 from layer A—B of the Panganrejang Toedeja cave, and no. 27 is a right specimen from layer C—D of the latter cave.

TABLE 90.

Measurements of subfossil P^4.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ap.	9.6	9.3	10.0	9.6	10.5	9.9	9.2	9.3	9.8	9.7	9.5	9.9	9.7	9.4
tr.	9.8	—	10.5	9.9	10.8	10.5	10.0	9.5	10.1	10.4	—	10.0	9.9	9.8
No.	15	16	17	18	19	20	21	22	23	24	25	26	27	
ap.	9.4	9.5	9.4	9.8	10.2	9.5	9.8	9.3	10.4	9.7	9.7	10.3	10.0	
tr.	9.8	10.7	10.0	10.5	10.4	10.5	10.4	9.7	10.0	9.5	9.9	9.8	10.8	

The lower premolars are fewer in number than the upper: nos. 1—4 in table 91 are right, and nos. 5—8 left specimens of P_3 in the Bola Batoe cave collection. There is also a fragment of a mandible containing the two left premolars as well as M_1, this specimen is figured on pl. III fig. 7. The measurements of its P_3 are given under no. 9 in table 91.

TABLE 91.

Measurements of subfossil P_3.

No.	1	2	3	4	5	6	7	8	9
ap.	10.7	10.1	10.9	9.9	10.4	11.2	10.3	10.0	10.8
tr.	5.8	5.0	5.7	4.9	5.1	5.4	5.0	5.7	5.5

The Bola Batoe cave contains 12 specimens of P_4; nos. 1—7 are of the right, and nos. 8—12 of the left side (table 92). No. 13 in table 92 is the P_4 in the mandible fragment already referred to. No. 14 is a right P_4 from layer A—B of the Panganrejang Toedeja cave, and no. 15 a left specimen from layer C—D of the latter cave.

TABLE 92.

Measurements of subfossil P_4.

No.	1	2	3	4	5	6	7	8
ap.	11.6	11.8	11.6	11.0	11.8	11.0	12.0	11.1
tr.	8.0	7.4	8.3	7.8	7.9	6.8	8.4	6.9
No.	9	10	11	12	13	14	15	
ap.	12.0	12.1	10.7	—	11.9	10.9	11.9	
tr.	8.1	7.7	6.7	8.2	7.7	6.9	7.5	

The variation ranges and averages brought together in table 93 show that the subfossil babirusa from the Bola Batoe cave is a smaller animal than the living Celebean form but about of the size of the Soela Is. and Boeroe races. Except for the width of P^3 the subfossil premolars average

TABLE 93.

Variation range and average of dimensions of recent and subfossil premolars of *Babyrousa babyrussa.*

	Celebes		Soela Is.		Boeroe		Bola Batoe	
	range	mean	range	mean	range	mean	range	mean
P^3 ap.	9.9—12.7	11.1	9.5—10.5	10.0	9.6—10.9	10.2	9.3—10.9	10.0
tr.	7.5—9.9	8.8	6.1—7.5	6.9	6.5—8.7	7.2	7.0—8.8	7.9
P^4 ap.	9.8—10.7	10.1	8.4—10.1	9.4	9.4—10.7	10.0	9.0—10.5	9.6
tr.	10.2—12.3	10.9	9.7—11.2	10.5	9.5—11.3	10.3	9.5—10.8	10.1
P_3 ap.	10.0—13.0	11.7	8.7—11.3	10.0	10.0—11.6	11.0	9.9—11.2	10.5
tr.	5.3—6.7	5.9	4.9—5.8	5.4	5.1—6.0	5.6	4.9—5.8	5.3
P_4 ap.	10.8—13.1	12.2	10.5—12.4	11.2	11.1—12.8	11.8	10.7—12.1	11.5
tr.	7.1—9.8	8.2	7.2—8.6	7.9	7.3—8.2	7.7	6.7—8.4	7.6

smaller than those of the Boeroe babirusa, and, again P^3 excepted, the Bola Batoe premolars average longer but slightly narrower than those of the Soela Islands form. The P^3, P^4, and P_4 from layer C—D of the Panganrejang Toedeja cave are above the average size of the Bola Batoe cave specimens.

MOLARS

Upper M (pl. III figs. 3 and 9).

The measurements of the upper molars are given in tables 94—96. Nos. 1—16 in table 94 are right, and nos. 17—28 are left M^1's from the Bola Batoe cave, no. 29 is a right specimen from layer A—B of the Panganrejang Toedeja cave, no. 30 is a right specimen from layer C—D of the latter cave, nos. 31 and 32 are a right and a left M^1 from the VAN STEIN CALLENFELS collection without a record for the exact locality, and no. 33 is a left M^1 originating from the Lompoa rock-shelter.

TABLE 94.

Measurements of subfossil M^1.

No.	1	2	3	4	5	6	7	8	9	10	11
ap.	13.3	12.6	13.5	—	13.0	13.0	13.2	13.6	12.8	13.3	—
atr.	11.0	10.9	11.3	11.3	11.2	10.7	11.2	11.4	10.8	11.7	12.4
ptr.	11.3	11.0	10.8	11.3	11.3	10.6	11.0	11.0	10.5	11.8	12.2
No.	12	13	14	15	16	17	18	19	20	21	22
ap.	13.9	13.8	14.1	—	13.2	13.6	13.6	—	13.3	13.7	14.8
atr.	11.6	12.1	12.2	10.8	11.4	11.1	11.4	11.4	11.3	—	12.6
ptr.	11.8	11.8	11.9	10.8	11.3	11.0	11.3	11.4	11.4	11.3	10.9
No.	23	24	25	26	27	28	29	30	31	32	33
ap.	14.0	—	12.7	12.8	13.1	12.9	13.4	13.6	13.8	—	13.4
atr.	11.0	12.3	11.0	11.7	11.8	11.5	11.7	11.3	12.0	—	11.2
ptr.	10.8	12.4	10.8	11.6	11.4	11.4	11.8	11.3	11.7	11.8	—

In table 95, nos. 1—18 are right, and nos. 19—33 left specimens of M^2 from the Bola Batoe cave, nos. 34 and 35 are a right and a left M^2 from layer A—B of the Panganrejang Toedeja cave, nos. 36 and 37 are likewise a right and a left specimen from layer C—D of the latter cave, and no. 38 is a left M^2 from the Lompoa rock-shelter, the only measurable tooth in a maxillary fragment which contains also the two premolars and parts of M^1—M^3.

TABLE 95.

Measurements of subfossil M^2.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
ap.	16.7	17.7	16.0	17.4	16.8	16.9	17.0	14.3	15.8	16.3	16.4	16.7	16.9
atr.	14.6	14.7	14.0	15.0	14.3	15.2	14.7	13.5	14.0	14.0	13.7	14.2	14.6
ptr.	13.7	14.3	12.7	14.2	13.0	13.4	13.0	12.5	13.1	13.6	12.8	13.7	13.4
No.	14	15	16	17	18	19	20	21	22	23	24	25	26
ap.	15.8	17.5	17.5	16.9	—	17.3	15.4	16.6	16.9	16.3	17.9	16.7	17.3
atr.	13.8	14.8	14.8	14.8	—	13.3	12.8	13.9	15.2	14.1	15.1	14.6	15.1
ptr.	13.0	13.8	13.9	13.6	14.3	13.2	12.4	13.8	13.1	13.4	13.6	13.6	12.9
No.	27	28	29	30	31	32	33	34	35	36	37	38	
ap.	16.8	17.4	16.9	16.4	16.7	16.8	16.2	16.7	16.3	17.8	17.4	16.4	
atr.	14.4	14.8	15.0	13.3	14.5	14.4	14.2	14.5	14.3	14.7	14.3	15.7	
ptr.	—	13.7	13.2	12.6	13.9	13.5	12.8	13.8	13.0	14.6	13.2	14.3	

M^3 is the best represented tooth; there are not less than 43 specimens in the Bola Batoe cave collection. Nos. 1—24 are of the right, and nos. 25—43 of the left side (table 96). Nos. 44—46 are one right and two left specimens from layer A—B of the Panganrejang Toedeja cave, and no. 47 is a left specimen from layer C—D of the latter cave. No. 48 is a right M^3 in the VAN STEIN CALLENFELS collection without a record for the exact locality.

TABLE 96.

Measurements of subfossil M^3.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	21.9	20.6	22.4	23.0	21.7	22.9	21.6	22.6	21.5	21.9	20.7	21.5
atr.	15.2	15.0	15.7	15.1	13.7	16.4	15.5	14.9	15.5	15.7	15.0	15.3
ptr.	12.5	—	13.0	12.4	11.8	13.4	12.7	13.0	12.5	11.7	13.0	12.3
No.	13	14	15	16	17	18	19	20	21	22	23	24
ap.	23.5	22.7	23.7	19.0	22.7	20.9	19.3	22.0	22.7	22.2	—	—
atr.	15.7	15.8	16.0	13.9	15.4	14.7	15.1	15.4	15.4	14.9	15.5	14.9
ptr.	12.7	13.7	13.5	13.0	12.1	12.6	12.5	12.5	13.0	12.6	—	12.6
No.	25	26	27	28	29	30	31	32	33	34	35	36
ap.	20.8	24.0	21.8	22.0	23.0	—	22.9	23.3	24.7	24.5	21.7	22.6
atr.	14.0	15.5	14.9	15.0	15.0	14.9	16.2	16.0	16.8	15.4	15.2	15.3
ptr.	12.5	13.4	12.3	12.1	12.5	12.0	14.0	14.9	13.4	13.4	12.4	—
No.	37	38	39	40	41	42	43	44	45	46	47	48
ap.	23.1	23.1	22.4	23.3	22.0	22.0	23.8	20.7	21.9	22.6	23.0	21.0
atr.	15.3	15.4	15.8	16.3	15.3	15.2	16.8	15.4	14.5	14.5	16.4	15.0
ptr.	12.9	13.4	13.1	13.4	13.1	13.8	14.0	11.9	12.0	12.5	13.0	12.2

The Bola Batoe cave upper molars, the isolated specimens as well as those recorded already in table 82, average smaller than the recent of Central and Northern Celebes, and larger than those from Boeroe, though there is hardly any difference in the size of M^2. The cave molars average smaller than those of the Soela Is. babirusa with the exception of M^3. The few molars from layer C—D of the Panganrejang Toedeja cave are invariably above the average size found for the Bola Batoe cave series.

TABLE 97.

Variation range and average of dimensions of recent and subfossil upper M of *Babyrousa babyrussa*.

	Celebes		Soela Is.		Boeroe		Bola Batoe	
	range	mean	range	mean	range	mean	range	mean
M^1 ap.	13.5—14.4	13.8	12.4—14.5	13.4	12.2—13.8	13.1	12.6—14.8	13.3
atr.	11.1—12.5	12.1	11.1—12.5	11.7	10.9—11.8	11.3	10.7—12.6	11.4
ptr.	10.8—13.5	12.2	10.5—12.2	11.4	10.5—11.8	11.2	10.5—12.4	11.3
M^2 ap.	16.2—19.4	17.6	15.4—18.2	16.9	14.7—17.7	16.6	14.3—17.9	16.7
atr.	15.0—16.4	15.5	13.5—15.6	14.6	13.6—16.1	14.5	12.8—15.2	14.4
ptr.	13.5—16.3	14.9	12.4—15.0	13.8	12.4—14.9	13.3	12.4—14.3	13.4
M^3 ap.	18.4—26.0	23.9	20.5—22.3	21.5	20.0—23.3	21.4	19.0—24.7	22.3
atr.	14.9—16.7	16.1	14.5—16.1	15.3	14.0—16.5	15.2	13.7—16.8	15.4
ptr.	11.8—14.4	13.4	11.7—13.9	12.7	11.5—12.9	12.3	11.4—14.9	12.9

Lower M (pl. III figs. 6—7)

In table 98 the measurements refer to the following specimens: nos. 1—3 are right, and nos. 4—9 left M_1's from the Bola Batoe cave, nos. 10—12 are right specimens from layer A—B of the Panganrejang Toedeja cave. No. 1 is not isolated but in a mandible fragment also holding M_2, while no. 9 is of the fragment with P_3 and P_4 represented on pl. III fig. 7.

TABLE 98.

Measurements of subfossil M_1.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	12.8	14.3	13.3	13.4	12.8	13.0	14.0	13.6	13.1	13.1	14.5	13.5
atr.	10.3	10.3	10.6	10.2	9.7	10.1	11.0	9.9	10.1	9.7	9.4	10.3
ptr.	9.5	9.8	10.0	9.9	9.5	9.8	10.1	9.7	9.8	9.4	10.1	9.7

Nos. 1—10 in table 99 are right, and nos. 11—17 left M_2's from the Bola Batoe cave; no. 1 is in the mandible fragment with M_1—M_2, and no. 2 is in a fragment also containing M_3 (pl. III fig. 6). No. 18 is a right specimen from the Batoe Edjaja cave, no. 19 is a left M_2 from layer A—B of the Panganrejang Toedeja cave, and no. 20 is a left specimen from the Lompoa rock-shelter.

TABLE 99.

Measurements of subfossil M_2.

No.	1	2	3	4	5	6	7	8	9	10
ap.	15.7	16.5	15.5	16.8	16.2	15.9	—	—	16.9	15.7
atr.	12.7	12.4	11.9	12.0	11.8	11.6	11.4	11.6	11.2	11.9
ptr.	11.8	11.7	11.4	11.8	11.2	10.9	11.6	12.0	11.2	11.0
No.	11	12	13	14	15	16	17	18	19	20
ap.	16.4	14.7	17.8	17.0	16.4	15.4	17.2	17.8	16.8	16.8
atr.	11.9	11.0	12.1	11.8	11.9	11.0	12.7	12.0	11.6	11.8
ptr.	11.4	10.8	11.9	11.4	—	10.5	12.1	12.5	11.8	11.9

The measurements of M_3 are given in table 100. Nos. 1—8 are right, and nos. 9—15 left M_3's from the Bola Batoe cave; no. 1 is a specimen in the mandible fragment also containing M_2 (pl. III fig. 6). Nos. 16 and 17 are a right and a left M_3 originating from layer A—B of the Panganrejang Toedeja cave.

TABLE 100.

Measurements of subfossil M_3.

No.	1	2	3	4	5	6	7	8	9	10
ap.	22.6	26.0	22.7	23.7	22.7	23.7	24.7	24.0	24.2	24.5
atr.	13.4	14.4	13.4	13.8	13.7	13.8	12.2	14.3	13.2	13.6
ptr.	11.7	12.4	11.7	11.8	11.9	12.0	11.8	12.0	12.1	12.0
No.	11	12	13	14	15	16	17			
ap.	22.4	24.5	25.5	23.0	22.8	23.5	22.9			
atr.	13.1	12.7	13.4	14.4	13.5	13.1	13.7			
ptr.	11.7	11.4	12.5	12.0	11.5	11.6	11.7			

The lower molars from the Bola Batoe cave average smaller again than those of the living Celebean form of babirusa; M_1 averages slightly larger, and M_2 and M_3 slightly smaller than the corresponding molars from the Soela Is. and Boeroe races (table 101).

TABLE 101.

Variation range and average of dimensions of recent and subfossil lower M of *Babyrousa babyrussa.*

	Celebes		Soela Is.		Boeroe		Bola Batoe	
	range	mean	range	mean	range	mean	range	mean
M_1 ap.	13.4—13.9	13.6	13.0—14.1	13.4	12.4—13.9	13.0	12.8—14.3	13.4
atr.	9.6—11.4	10.5	8.8—10.2	9.5	7.4—9.5	9.0	9.7—11.0	10.2
ptr.	9.8—11.0	10.4	9.2—10.8	9.9	7.6—9.9	9.3	9.5—10.1	9.8
M_2 ap.	15.8—17.6	17.1	16.0—17.8	16.7	15.5—17.7	16.6	14.7—17.8	16.3
atr.	12.0—13.4	12.7	11.1—13.3	12.4	11.4—12.7	11.9	11.0—12.7	11.8
ptr.	12.2—13.7	13.1	11.3—13.8	12.5	10.9—13.0	12.0	10.5—12.1	11.4
M_3 ap.	22.8—28.0	26.2	23.1—25.5	24.4	22.5—26.4	24.8	22.4—26.0	23.8
atr.	12.4—14.8	14.0	13.4—14.9	14.0	12.7—14.7	13.4	12.2—14.4	13.5
ptr.	11.9—14.6	13.2	11.7—13.9	12.6	11.5—14.1	12.5	11.4—12.5	11.9

There is a number of milk incisors and premolars in the collection from the Bola Batoe cave, but I am unable to determine whether they belong to *Babyrousa* or to *Sus;* the recent material for comparison is very scanty, too. The recent skeletons of the babirusa and that of *Sus celebensis* at my disposal are all of menagerie specimens, and do not show significant differences between the homologous bones of both forms. The specific identification of the subfossil post-cranial skeleton remains, therefore, cannot be given. Hence we have only the permanent teeth of the subfossil babirusa available for comparison with the recent material, and they show convincingly that the cave babirusa of South-western Celebes is nearer to that of Boeroe and the Soela Is. than to that today living in Central and Northern Celebes. The Toalian cave babirusa is smaller, in the average, than the living Celebean form. In layer C—D of the Panganrejang Toedeja cave there is unfortunately only a small number of teeth belonging to the babirusa, but they are always above the average, and sometimes even above the variation limits (1^1!), of the corresponding Bola Batoe cave specimens. The geologically oldest cave form, therefore, tends to be larger than that of the Bola Batoe cave. The Pleistocene babirusa of Beroe and Sompoh, near Tjabengè, about 100 km N. E. of Macassar, *Babyrousa babyrussa beruensis* Hooijer (1948d), is again much larger; the dimensions of the fossil teeth are above the variation limits of those in the living Celebean race.

Thus it is pretty evident that in South-western Celebes the babirusa has undergone a gradual diminution in size in the course of the Quaternary, thereby passing through the stage of size today represented by the Central and Northern Celebes babirusa, and this line came to an end while it was about of the size of the living insular races East of Celebes. We have here again a so-called chronocline extending down into the Pleistocene and showing a tendency toward small size in the babirusa, the tendency also found in the cuscuses, macaque, Man, and MEYER's rat discussed above. The babirusa became extinct in South-western Celebes at the time of the formation of the Toalian caves, but if the species would have been in existence today in South-western Celebes it would certainly have been regarded by neozoologists as a separate subspecies peculiar to this region. *Babyrousa babyrussa bolabatuensis* nov. subsp. is the terminal form of one of the longest continuous clines of which we have now evidence in the island of Celebes, and the future finds of subfossil and Pleistocene babirusa teeth in other regions of Celebes, in the Soela Islands, and in Boeroe will show us how long the various lines leading to the extinct Toalian cave form and to the three subspecies we distinguish today have already been separate.

Family BOVIDAE Gray

Genus **Anoa** Smith

The *Anoa* remains first discovered by the SARASINs in Toalian caves were remarkable in two respects, firstly because the anoa is now absent around Lamontjong where the subfossil remains were found, and secondly because of the smallness of the cave teeth and bones as compared with those of the living Northern Celebes *Anoa depressicornis* (Smith). The anoa, however, has not completely vanished from the South-western peninsula of Celebes like the babirusa, but still lives in the mountains N.E. of Macassar, and is also reported to occur on the Peak of Bonthain (SARASIN, 1905, p. 32). The SARASINs did not obtain actual recent material of the Southern Celebes anoa, and, therefore, they were not quite certain whether this form is really smaller than the Northern, though the small size of the cave remains would suggest this.

Two dwarf forms of the anoa have subsequently been described, one by LYDEKKER in 1905, and the other by OUWENS in 1910. *Anoa depressicornis fergusoni* (Lydekker), the type skin (B.M. 0.5.26.16; LYDEKKER, 1913, p. 50) of which is of unknown origin, differs from typical *depressicornis* by its smaller size, golden brown colour, and slightly shorter tail which does not reach nearly to the hocks. There are white markings on face and limbs, but these markings are variable; HELLER (1889, p. 10) had already pointed out that some specimens of the common *Anoa depressicornis* have white areas on the sides of the lower jaw only, while others are also white at the legs and frequently on the throat and hind part of the neck. LYDEKKER (1913, p. 49) states that, since the species was described on the evidence of a skull, the colour of the skin in the typical race is unknown, but that it is permissible to regard the ordinary black anoas as representing this race, and to take those devoid of white markings as typical. Most of the Museum specimens are without a record for the exact locality, and hence it is impossible to determine whether the two forms represent local races. There is a marked gap in the known distribution of *Anoa depressicornis* (cf. the map in MOHR, 1921, p. 212), and MOHR (l.c., p. 213) surmises that the form which possesses most markings is that of the Northern peninsula, while the animals from Lake Lindoe in Central Celebes to the middle of the South-eastern peninsula have white markings only on the cheeks and above the hoofs. Be that as it may, the difference in size between *Anoa depressicornis depressicornis* and *A. d. fergusoni* is not very great; LYDEKKER (1913, p. 49) is not certain whether some of the British Museum skulls belong to the former or to the latter race.

The form of *Anoa* described by OUWENS (1910) inhabits a region from which the common anoa is unknown; the types originate from the high forested mountains of the central region of Toradja, and the same small species is reported to occur in the high districts of Binoewang on the W. coast of Central Celebes at about lat. 3° 30′ S. The height at the shoulder (62.5 cm) is only three-fifths of that of the common anoa. Further characters that distinguish *Anoa quarlesi* Ouwens from the common anoa are the long, soft, and woolly hair, which is of a uniform light brown colour except only for small white spots above the hoofs, while the tail is short and reaches hardly more than halfway to the hocks. The horns are not depressed or triangular in cross-section but conical.

MOHR (1921, p. 209/210), who was unaware of Lydekker's description of *Anoa depressicornis fergusoni*, reports upon live anoas in the Zoological Gardens at Amsterdam and Rotterdam, originating from the Mandar Mts. in Western Central Celebes and from mountains in the hinterland of Macassar (2000 m) respectively, which, she has no doubt, belong to the pigmy species described by OUWENS. Consequently, it would be *Anoa quarlesi* that inhabited the whole of the South-western peninsula of Celebes before it retreated more and more into isolated mountainous places, and hence there can be little doubt that the small anoa remains reported from the Toalian caves by the SARASINS in reality belong to *A. quarlesi* (MOHR, 1921, p. 213).

HARPER (1945, p. 553), after having cited the type descriptions of *Anoa depressicornis fergusoni* and of *Anoa quarlesi*, states that these descriptions are in such close accord as to make it appear extremely probable that *quarlesi* is a synonym of *fergusoni*. This was adopted by me in the description of the Pleistocene *Anoa* remains from South-western Celebes (HOOIJER, 1948d).

Mr. A. C. V. VAN BEMMEL, of the Buitenzorg Museum, however, writes me that he considers the two forms to be distinct. *Anoa quarlesi* Ouwens, cotypes of which are in the Buitenzorg Museum, differs from *A. depressicornis* (including *A. d. fergusoni*) in having thick, woolly or long hair also in the adult, never any white markings except for a few light spots above the hoofs, a short tail, smaller dimensions, in the average, and horns which are round in cross-section. *Anoa quarlesi*, in contradistinction to *A. depressicornis*, is restricted to mountains. Mr. VAN BEMMEL thinks that there is more than one race in *Anoa quarlesi*, but as he intends to publish the evidence he has himself soon I shall not go into this matter now.

The Leiden Museum possesses the skins and skeletons of a pair of small anoa's originating from the hinterland of Macassar, at a height of 2000 m. Both are of adult individuals. The female has woolly dark brown hair, no white markings except above the hoofs (a few small white spots are seen on the cheeks and chin only); the tail reaches nearly to the hocks, and the horns are subtriangular in cross-section, though not so heavily ringed as is usual in the large form. This mountain animal is consequently not a pure *quarlesi*, for the tail is not short and the horns are not round in cross-section. The male differs from the female in its smaller size, in the colour of the woolly pelage which is reddish-brown, and in the length of the tail which can have reached scarcely more than halfway to the hocks. The horns are, again, depressed in cross-section. The male, therefore, is not a pure *quarlesi* either.

There is evidently a great deal of variation both in the length of the tail and in the shape of the horn, for in the Leiden Museum there is the skin and a partial skeleton of a small female (reg. no. 1559) indistinguishable externally from the female of the hinterland of Macassar but for its very short tail and the horns which are practically round in cross-section. This animal is unfortunately unlocalized, but it is nearest to OUWENS' description of *Anoa quarlesi*. It has also the smallest skull I have ever seen of an anoa.

The skins in the Amsterdam Museum labelled *Anoa quarlesi*, all of animals that have lived in the Amsterdam Zoo, have thick woolly hair of a uniform dark brown colour, no special white markings, and the tails are very short, only about 12 cm in length. The cross-section of the horns varies, but is never so distinctly flattened as that in the typical large anoa, the skins of which are distinguishable by having short hair (there often are bald spots), and a relatively longer tail. These latter characters, Mr. VAN BEMMEL holds, also apply to *Anoa depressicornis fergusoni*, which must be a form of the lowland woods and not a mountain animal like *Anoa quarlesi*.

In the British Museum (Natural History) at London I saw the skin that was labelled as the type of *Anoa depressicornis fergusoni* (B.M. 0.5.26.16); this skin possesses woolly hair, dark brown in colour, like those of *Anoa quarlesi*. However, there is also a calvarium labelled as the type of *A. d. fergusoni*, B.M. 8.12.23.1, loc. Zool. Gardens, Trivandrum, coll. H. S. FERGUSON, not recorded by LYDEKKER (1913, p. 49/50), and the (incomplete) skin bearing the latter no. has short hair of a lighter brown colour. Which of these two skins must be regarded as the type? If the skin B.M. 0.5.26.16 has been correctly labelled as such, there seems to be no objection to regard *quarlesi* as synonymous with *fergusoni*, as HARPER (1945, p. 553) has doen. In Celebes the anoas occur both in the lowlands and in mountainous regions, and the development of the coat seems to be purely phenotypical and to have no genetic basis. When brought into temperate climates even typical *A. depressicornis*, which has a woolly coat only while young, develops a denser coat (HELLER, 1889, p. 10); Mr. VAN BEMMEL reports that an old *depressicornis* male in the Amsterdam Zoo had a coat during winter not inferior to that of *A. quarlesi*.

Considering the uncertainty that exists as to the type of *A. d. fergusoni* it seems better to retain provisionally the name *Anoa quarlesi* Ouwens for the small woally-coated mountain anoas. The possibility exists that the material which goes under the name *A. quarlesi* comprises a group of mountain races of *A. depressicornis*, but this I am not in a position to make out. We need many more and better localized specimens to solve this problem.

I have arranged the series of adult *Anoa* skulls in the Leiden and Amsterdam Museums according to decreasing basal length, and found that there is complete intergradation between the largest and the smallest, without a gap at which the dividing line between *A. depressicornis* and *A. quarlesi* can be conveniently drawn. When the coat characters were taken into consideration it appeared that the two species overlap in size. The series is the following:

1. Skull of adult. Menado, N. Celebes, coll. VAN DELDEN, 1836. L.M., cat. ost. b.
2. Skull of adult. Celebes, A.M., no. 176.
3. Skeleton of adult female. Tondano, N. Celebes, coll. FORSTEN, May, 1840. L.M., cat. ost. a.
4. Skull of adult. Celebes, coll. REINWARDT. L.M., cat. ost. d.
5. Skull of adult male. Celebes, from the Amsterdam Zoo, 23—1—1936 (imported 3—6—1930). A.M.
6. Flat skin and skeleton of adult male. Celebes, from the Rotterdam Zoo, 24—7—1923. L.M., reg. no. 1246.
7. Skull of adult. Celebes, coll. REINWARDT. L.M., cat. ost. c.
8. Stuffed skin and skeleton of adult female. Mountains in the hinterland of Macassar, S. Celebes, 2000 m. From the Rotterdam Zoo, 30—9—1922 (imported 13—7—1920). L.M., reg. no. 1178.
9. Skull of adult male. Celebes, from the Amsterdam Zoo, 18—12—1925. A.M.
10. Flat skin and skeleton of adult male. Celebes, from the Rotterdam Zoo, 2—1—1939 (imported 3—7—1928). L.M., reg. no. 3871.
11. Skull of adult male. Celebes, from the Amsterdam Zoo, 8—2—1934. A.M.
12. Skull of adult female. Celebes, don. G. ALBERTS. From the Amsterdam Zoo, 30—1—1932. A.M.
13. Flat skin and skeleton of adult female. Celebes, from the Rotterdam Zoo, 21—10—1939, L.M., reg. no. 4102.
14. Flat skin and skull of adult female. Celebes, don. L. J. J. CARON, Macassar. From the Amsterdam Zoo, 12—9—1936 (imported 21—4—1932). A.M.
15. Flat skin and skeleton of adult male. Mountains in the hinterland of Macassar, S. Celebes, 2000 m. From the Rotterdam Zoo, 1—7—1925 (imported 13—7—1920). L.M., reg. no. 1402.
16. Flat skin, skull, and limb bones of adult female. Celebes, don. Jhr. F. C. VAN HEURN, 4—2—1927. L.M., reg. no. 1559.
17. Skull of adult male. Celebes, don. G. ALBERTS. From the Amsterdam Zoo, 5—12—1933. A.M.

The above listed skulls have the following dimensions (table 102):

TABLE 102.

Skull measurements of recent *Anoa* species.

No.	1	2	3	4	5	6	7	8	9	10
Basal length	291	289	288	285	274	271	263	260	258	250
Zygomatic width	141	138	134	134	129	132	124	115	126	121
No.	11	12	13	14	15	16	17			
Basal length	241	240	240	231	230	224	222			
Zygomatic width	111	118	118	111	107	104	114			

In the table of measurements of *Anoa* skulls given by HELLER (1889) the adult skulls vary in basal length from 260 to 290 mm, and the zygomatic width ranges from 120 to 141 mm. If we accept about this amount of variation for *Anoa depressicornis* proper the dividing line between this species and *Anoa quarlesi* has to be drawn somewhere between nos. 7 and 11. Specimen no. 8 as well as no. 10, however, have a woolly coat and, therefore, are no lowland animals. No. 8 and no. 15 are the pair from 2000 m height in the mountains of the hinterland of Macassar. On the other hand, the skin of no. 13 has short hair and a tail at least 20 cm long, and is certainly not a typical *quarlesi*.

It is now perfectly clear that the size difference between *Anoa depressicornis* and *Anoa quarlesi* is "average" rather than absolute. The only criterion available in the identification of the subfossil Toalian cave teeth and bones is size.

Mr. VAN BEMMEL has been so kind as to send me the tooth measurements of five adult skulls of *Anoa quarlesi* in the Buitenzorg Museum, including a cotype, and also those of four specimens of *Anoa depressicornis*. There is hardly any overlap in the variation ranges of the homologous teeth in both species. To *Anoa depressicornis* I refer the skulls nos. 1—7 of the above list, and to *Anoa quarlesi* skulls nos. 11, 12, and 14—17. The variation ranges of the tooth dimensions found in the eleven skulls of each of the two species will be given in following tables. It is a remarkable fact that the tooth dimensions of specimen no. 8, the female from the hinterland of Macassar with a woolly coat, are almost invariably within the limits found for *Anoa depressicornis* and above those found for *Anoa quarlesi*, while the tooth dimensions of the male from the same locality (no. 15) are within the limits of *Anoa quarlesi*. Mr. VAN BEMMEL, with whom I discussed this problem, stated that he has severe doubt whether the female specimen no. 8 has belonged to the same population as the male no. 15, if the former belongs to *Anoa quarlesi* at all. He suggests that the locality record of no. 8 is incorrect.

I have no special reason to doubt the correctness of the locality record of the female specimen from the mountains in the hinterland of Macassar.

In the subfossil fauna, too, there is evidence of the coexistence of large and small anoas. It is, moreover, certainly remarkable for a female to be so distinctly larger than the male with which it was captured. It seems best to leave this specimen out of consideration for the present, and to await Mr. VAN BEMMEL's paper on this subject.

The Bola Batoe cave collection contains the best material of the anoa, and, as will be seen below, the subfossil teeth from this cave are almost invariably within the variation limits of *Anoa quarlesi*. The teeth from layer C—D of the Panganrejang Toedeja cave have the tendency to be larger than the corresponding Bola Batoe cave specimens. So far so good. But in the caves N. of Tjani *Anoa* teeth have been found which are larger than those from the other sites, and one of them is even above the limits found for *Anoa depressicornis*. The bones tell the same story; those from the caves N. of Tjani are of the size of those in *Anoa depressicornis*, while rather large *Anoa* bones occur in the Panganrejang Toedeja cave, too.

It seems permissible to regard the smaller cave *Anoa* as representing *Anoa quarlesi*. The large teeth and bones of the caves N. of Tjani must have belonged to animals of the size of typical *Anoa depressicornis*, which thus seems to have been present in the subfossil South-western Celebean fauna beside the smaller form. I shall give the measurements of the cave specimens first, and return to the problem of the specific determination of this material later on.

Anoa quarlesi Ouwens subsp. and **Anoa depressicornis** (Smith) subsp.

There are a number of *Anoa* incisors in the Bola Batoe cave collection, but their serial position is often difficult to determine, and few recent skulls have the lower I sufficiently well preserved or not too much worn to be measurable. The width of the incisal edge of five unworn or hardly worn subfossil specimens which I take to represent I_1 varies from 9.5 to 11.4 mm. In three *Anoa quarlesi* skulls I found 9.3, 9.4 and 9.8 mm for the width of I_1, while three *Anoa depressicornis* skulls give 10.6, 11.3 and 11.7 mm for this measurement. In the Tjadang cave collection there is one *Anoa* incisor, presumably an I_2 sin., which is worn but worth mentioning since it is the only evidence we have of the presence of the anoa in this cave. The Batoe Edjaja cave collection contains also an I_2 or I_3 of the left side.

PREMOLARS

Two specimens of P^2 are in the Bola Batoe cave collection, one of the right and one of the left side. The measurements are given in table 106 below.

P^3 and P^4 are very much alike in *Anoa*, and I am unable to determine the serial position of the isolated cave specimens. In the Bola Batoe cave collection there are eleven specimens of P^3 and P^4; nos. 1—7 in table 103 are of the left, and nos. 8—11 of the right side. No. 12 in table 103 is a left P^3 or P^4 from a cave N. of Tjani (no. 237 of the VAN STEIN CALLENFELS collection).

TABLE 103.

Measurements of subfossil P^3 and P^4.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	10.8	10.9	10.3	9.6	10.1	9.5	10.2	9.8	8.7	9.5	—	11.6
tr.	10.9	9.9	10.6	9.8	9.6	10.4	10.0	9.7	9.6	9,0	12.1	11.7

In the Bola Batoe cave collection only I found specimens of P_3; nos. 1—4 in table 104 are right, and no. 5 in this table is a left specimen.

TABLE 104.

Measurements of subfossil P_3.

No.	1	2	3	4	5
ap.	10.6	10.7	10.2	10.3	9.7
tr.	6.8	5.7	6.0	5.8	5.8

The posterior lower premolar is very scarce, too. Nos. 1—3 in table 105 are three specimens of the right side in the Bola Batoe cave collection, and no. 4 in this table is a P_4 dext. originating from a cave N. of Tjani (no. 460 of the VAN STEIN CALLENFELS collection).

TABLE 105.

Measurements of subfossil P_4.

No.	1	2	3	4
ap.	13.0	12.0	11.8	14.0
tr.	6.7	6.7	6.4	7.8

It will be observed that the premolars from the caves N. of Tjani are relatively large. In table 106 I give the variation ranges of the premolars of both recent species as well as those of the Bola Batoe cave specimens.

TABLE 106.

Variation ranges of dimensions of recent and subfossil premolars of *Anoa depressicornis* and *Anoa quarlesi*.

	Anoa depressicornis		*Anoa quarlesi*	
	recent	Caves N. of Tjani	recent	Bola Batoe
P^2 ap.	9.0—11.5		7.4—10.0	8.5 8.6
tr.	7.3—8.7		6.3—9.0	6.8 7.4
P^3 ap.	10.4—12.7	11.6	8.4—11.0	8.7—10.9
P^4 ap.	11.4—13.6		8.5—10.5	
P^3 tr.	10.1—12.7	11.7	8.0—10.8	9.0—12.1
P^4 tr.	11.0—14.5		8.0—12.0	
P_3 ap.	11.0—13.5		9.7—11.5	9.7—10.7
tr.	6.4—8.6		5.2—7.0	5.7—6.8
P_4 ap.	12.6—15.2	14.0	9.3—14.2	11.8—13.0
tr.	7.9—10.0	7.8	5.7—7.8	6.4—6.7

The specimens from caves N. of Tjani are listed separately. While the Bola Batoe cave premolars are within the limits of those of *Anoa quarlesi* with the exception only of specimen no. 11 of P^3 and P^4 which is 0.1 mm wider than the largest of the recent specimens of P^4, the sole P^3 or P^4 from a cave N. of Tjani is longer than the recent P^3's and P^4's of *Anoa quarlesi*, but well within the limits of *Anoa depressicornis*. The P_4 from a cave N. of Tjani is larger than the Bola Batoe cave specimens too, but is still just within the limits of *Anoa quarlesi* (table 106).

MOLARS

Upper M

Of the upper molars of *Anoa* only M^3 can be identified with certainty because it differs from M^1 and M^2 by its being decidedly wider transversely in front than behind, and by the prominence of its metastyle. It is impossible to distinguish between isolated M^1's and M^2's.

M^1 and M^2 are represented in the Bola Batoe cave collection by 27 specimens; nos. 1—13 in table 107 are of the right, and nos. 14—27 of the left side. Nos. 28 and 29 are a right and a left M^1 or M^2 from a cave N. of Tjani (nos. 119 and 120 of the VAN STEIN CALLENFELS collection). No. 30 is a right specimen from layer A—B of the Panganrejang Toedeja cave; nos. 31—34 are two right and two left specimens from layer C—D of the latter cave. There is also a specimen in the Batoe Edjaja cave collection, too incomplete for measurement.

TABLE 107.

Measurements of subfossil M^1 and M^2.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	15.7	15.7	15.4	15.4	15.8	14.8	14.2	15.1	14.6	15.0	17.2	—
tr.	13.0	11.6	12.8	11.8	12.4	12.6	11.7	13.0	—	12.5	14.0	13,7
No.	13	14	15	16	17	18	19	20	21	22	23	24
ap.	16.6	14.4	15.0	14.9	13.1	14.9	14.1	—	16.1	14.8	16.2	15.4
tr.	13.4	11.3	12.3	12.5	10.7	11.4	12.1	12.2	13.0	11.8	13.2	12.3
No.	25	26	27	28	29	30	31	32	33	34		
ap.	—	—	—	19.4	17.9	—	16.9	17.3	15.2	16.9		
tr.	11.7	12.6	12.4	14.5	16.6	15.0	13.3	14.3	13.5	—		

The last upper molar is represented by 13 specimens in the Bola Batoe cave collection, nos. 1—8 in table 108 are of the right, and nos. 9—13 of the left side. No. 14 in table 108 is a left M^3 from a cave N. of Tjani (no. 211 of the VAN STEIN CALLENFELS collection), while nos. 15 and 16 are a right and a left M^3 from layer C—D of the Panganrejang Toedeja cave.

TABLE 108.
Measurements of subfossil M^3.

No.	1	2	3	4	5	6	7	8
ap.	14.5	14.7	15.7	15.4	16.9	14.9	13.9	15.3
tr.	12.6	12.5	12.8	12.5	14.0	12.6	12.8	12.9
No.	9	10	11	12	13	14	15	16
ap.	15.4	16.5	15.3	14.6	14.6	20.6	16.4	—
tr.	12.7	—	12.5	12.5	11.6	15.6	14.3	13.4

The upper molars from the Bola Batoe cave are within the limits of recent *Anoa quarlesi* with the exception only of one M^1 or M^2 (no. 11 in table 107) and one M^3 (no. 5) which are very slightly above the maximum found in the corresponding recent series. The upper molars from caves N. of Tjani are rather large; the M^3 (no. 14 in table 108) is decidedly above the limits of the M^3 of recent *Anoa quarlesi*, though still within those of *Anoa depressicornis*. No. 28 of the M^1's and M^2's, also a specimen from a cave N. of Tjani, is even above the variation limits found in *Anoa depressicornis* (table 109).

TABLE 109.
Variation ranges of dimensions of recent and subfossil upper molars of *Anoa depressicornis* and *Anoa quarlesi*.

	Anoa depressicornis			*Anoa quarlesi*	
	recent	Caves N. of Tjani		recent	Bola Batoe
M^1 ap.	14.8—17.9	17.9	19.4	13.4—15.5	13.1—17.2
M^2 ap.	17.3—19.3			14.4—16.9	
M^1 tr.	13.4—14.7	14.5	16.6	11.3—14.6	10.7—14.0
M^2 tr.	13.5—17.0			11.4—14.8	
M^3 ap.	16.0—22.0	20.6		14.7—16.9	13.9—16.9
tr.	13.4—17.2	15.6		11.0—13.8	11.6—14.0

As far as the upper molars from layer C—D of the Panganrejang Toedeja cave are concerned, it will be seen that both the specimens of M^1 and M^2 and those of M^3 are to the higher side of the variation range found in the Bola Batoe cave specimens. One of the M^1's or M^2's from layer C—D, viz., no. 32 in table 107, is even above the range of the Bola Batoe cave specimens and also above that of recent *Anoa quarlesi*, though the difference is not great.

Lower M

The lower molars are fewer in number than the upper, but they show the same differences in size between the specimens from the various caves. It is, again, impossible to distinguish between the first and second molars. Nos. 1—8 in table 110 are right, and nos. 9—13 are left M_1's and M_2's from the Bola Batoe cave, while nos. 14 and 15 are a right and a left specimen from caves N. of Tjani (nos. 119 and 477 of the VAN STEIN

CALLENFELS collection). Nos. 16 and 17 are two right specimens of M_1 or M_2 from layer A—B of the Panganrejang Toedeja cave, and nos. 18—24 are five right and two left specimens from layer C—D of the latter cave.

TABLE 110.

Measurements of subfossil M_1 and M_2.

No.	1	2	3	4	5	6	7	8	9	10	11	12
ap.	14.0	14.7	17.2	16.8	15.7	17.3	15.2	15.8	15.4	13.7	15.4	17.5
tr.	7.4	8.5	8.7	8.0	8.5	9.5	8.7	9.0	8.4	7.8	8.4	8.8
No.	13	14	15	16	17	18	19	20	21	22	23	24
ap.	16.8	18.3	16.7	16.2	16.6	18.6	17.5	16.7	18.4	15.9	18.4	16.6
tr.	9.5	10.2	9.4	8.6	8.1	10.4	9.6	9.1	9.9	9.0	10.3	9.1

The measurements of M_3 are given in table 111. Nos. 1—6 are right, and nos. 7—9 left M_3's from the Bola Batoe cave; no. 10 is a left M_3 from layer A—B of the Panganrejang Toedeja cave, and no. 11 is a right M_3 from layer C—D of the latter cave. In the collection from the Panisi Ta'boettoe there is an incomplete specimen, the posterior portion of an M_3 sin., that is the only evidence, besides a small upper molar fragment, of the presence of *Anoa* at this Toalian site. Both specimens are marked D.

TABLE 111.

Measurements of subfossil M_3.

No.	1	2	3	4	5	6	7	8	9	10	11
ap.	20.4	21.1	23.3	21.4	22.5	18.6	14.4	19.3	19.7	20.0	21.1
tr.	9.3	9.0	10.4	8.4	10.2	8.8	11.5	9.5	9.2	10.1	10.0

The variation ranges are given in table 112. Very few of the Bola Batoe cave lower molars fall outside the variation range in recent *Anoa quarlesi*: one of the M_1's or M_2's (no. 12 in table 110) and three of the M_3's (nos. 3, 5 and 7 in table 111) are slightly above the limits of the recent molars of *Anoa quarlesi*. Of the specimens from caves N. of Tjani one (no. 14 in table 110) is above the limits of M_2 in *Anoa quarlesi*; both of the upper molars from this site compare better with *Anoa depressicornis* (table 112).

TABLE 112.

Variation ranges of dimensions of recent and subfossil lower molars of *Anoa depressicornis* and *Anoa quarlesi*.

	Anoa depressicornis			*Anoa quarlesi*	
	recent	Caves N. of Tjani		recent	Bola Batoe
M_1 ap.	15.1—16.7	16.7	18.3	12.8—15.7	13.7—17.5
M_2 ap.	17.3—19.1			14.8—17.4	
M_1 tr.	9.5—11.6	9.4	10.2	7.8—10.5	7.4—9.5
M_2 tr.	10.0—12.9			8.5—11.3	
M_3 ap.	22.3—27.1			18.3—21.6	14.4—23.3
tr.	10.0—12.2			8.0—9.5	8.4—11.5

The lower molars from layer C—D of the Panganrejang Toedeja cave have again the tendency to be larger than those of the Bola Batoe cave; not less than four out of the seven C—D layer specimens of M_1 and M_2, viz., nos. 18, 19, 21, and 23 in table 110, are above the limits of the corresponding Bola Batoe cave specimens. The M_3's from layer C—D are to the higher side of the variation range of the Bola Batoe cave M_3's.

None of the cave specimens of M_3 is as large as that from the Pleistocene of Sompoh in South-western Celebes described by me as *Anoa depressicornis* (Smith) subsp. (HOOIJER, 1948d). The length of the fossil M_3 is 25 mm, a dimension that is far above the limits found in recent *Anoa quarlesi* (18.3—21.6 mm, above, table 112) but well within the limits of recent *Anoa depressicornis* (22.3—27.1 mm). The fossil P_4 found in association with the M_3 measures only 13.5 mm antero-posteriorly, a dimension that is within the limits both of *Anoa depressicornis* and of *Anoa quarlesi* (vide table 106).

As far as these materials permit one to judge, it would seem that in *Anoa* we find the same tendency toward decrease in size as that in most of the Toalian cave Mammals: some of the Bola Batoe cave *Anoa* teeth are slightly above the limits found in recent *Anoa quarlesi* but the bulk of them is well within these limits, and the *Anoa* teeth from the oldest cave deposit, the C—D layer of the Panganrejang Toedeja cave, have the tendency to be larger than the Bola Batoe cave specimens. The Pleistocene M_3 is larger than any of the subfossil Toalian cave M_3's.

The anoa is unfortunately very scarce in the Pleistocene collections from South-western Celebes, but the few scraps of *Anoa* molars from the Pleistocene of Beroe and Sompoh that have come to light after the description of the first found remains (HOOIJER, 1948d) are also of a size more suggestive of *Anoa depressicornis* than of *Anoa quarlesi.*

Do these Pleistocene remains represent *Anoa depressicornis* or are they to be regarded as having belonged to a large Pleistocene forerunner of *Anoa quarlesi*? I am inclined to accept the latter view. If this view is correct, *Anoa quarlesi* was as large in the Pleistocene as *Anoa depressicornis* is today. Even *Anoa depressicornis* of today ranks as a "pigmy buffalo", and it is extremely probable that it has undergone a diminution in size in the course of time and that the two *Anoa* species were consequently different in size in the Pleistocene as well as at the present day. As long as Pleistocene materials of *Anoa* are so poor it is not possible to give more than this suggestion, however.

The subfossil teeth from caves N. of Tjani are so large that they are mostly above the limits of their subfossil homologues in other Toalian caves, and well within the limits of their homologues in recent *Anoa depressicornis*. Some of the cave teeth even are to the higher side of the variation range found in the teeth of the latter species. To which of the two species do these teeth belong? The fauna of the caves N. of Tjani does not suggest any great age; on the contrary the absence of the babirusa and the presence of the water buffalo point even to a younger age than that of the other Toalian sites. I do not believe, therefore, that the relatively large *Anoa* teeth found in these caves have belonged to large forerunners of the present *Anoa quarlesi*, but rather take these teeth as evidence of the presence of *Anoa depressicornis* in prehistoric South-western Celebes. There is nothing peculiar in this supposition; there are other species of Mammals that are present in the subfossil fauna of South-western Celebes and that have gone now from this region, viz., the Brown Palm Civet and the babirusa.

There remains a number of bones referable to the anoa and originating from the caves N. of Tjani as well as from both layers of the Panganrejang Toedeja cave. These bones show that in the caves N. of Tjani, beside *Anoa depressicornis*, *Anoa quarlesi* was present, too. And some bones both from layer A—B and from layer C—D of the Panganrejang Toedeja cave also indicate animals of the size of the recent *Anoa depressicornis*. The measurements are given in table 113. I have compared the cave bones with

TABLE 113.

Measurements of recent and subfossil bones of *Anoa depressicornis* and *Anoa quarlesi*.

	Recent				Subfossil		
	no. 3	no. 8	no. 15	no. 16			
Humerus					N. of Tjani		layer C–D
Width of trochlea	48	41.5	37.5	37	35		44
Lateral ap. diameter	33.5	29	25.5	26	24.5		32.5
Radius						N. of Tjani	
Length	190	183	165	166		164.5	
Proximal width	48	43.5	38	37		32.5	
Middle width	29.5	23	21	20		21.5	
Distal width	43	38	35.5	33.5		29	
Distal ap. diameter (medially)	29.5	25.5	21.5	20.5		21	
Metacarpal						N. of Tjani	
Proximal width	38.5	34	30	28	36	37	38.5
Proximal ap. diameter	23	20.5	17.5	17	21.5	23.5	23.5
Astragalus					N. of Tjani	layer A—B	layer C—D
Medial length	40	38	34	32	34	35	38
Lateral length	44	41	37.5	35.5	37.5	—	42
Lateral ap. diameter	24	21.5	19.5	19	19	—	22.5
Distal width	27.5	25.5	24	22	22	23	26
Calcaneum						layer C—D	
Length of corpus	58	52	47	48		51	
Sustentaculum width	25	24	21	20		25	
Metatarsal						layer C—D	
Distal width	36.5	33.5	30	27.5		34.5	
Phalanges I—III						layer A—B	
Outer length of phalanx I	43	34	32	—		40.5	
Id. of phalanx II	26	23	21	—		25.5	
Id. of phalanx III (dorsally)	40	31	33	—		35	

those of a skeleton of *Anoa depressicornis* (no. 3 of the list on p. 134), with those of the skeletons of the large female and the smaller male from the mountains in the hinterland of Macassar (nos. 8 and 15), and also with those of the small anoa skeleton no. 16. It will be observed that the measurements of the skeleton of the female from the hinterland of Macassar are intermediate between those of skeleton no. 3 on one hand, and those of skeletons nos. 15 and 16 on the other.

The subfossil humeri from a cave N. of Tjani and from layer C—D of the Panganrejang Toedeja cave respectively are distal portions of the right side; they show a considerable difference in size. The specimen from a cave N. of Tjani is even slightly smaller than the corresponding part of skeletons nos. 15 and 16 which belong to *Anoa quarlesi*, while the bone from layer C—D of the Panganrejang Toedeja cave is almost as large as that of skeleton no. 3 which belongs to *Anoa depressicornis*.

The radius is represented only by a complete specimen from a cave N. of Tjani (marked S), and this bone is again slightly smaller than that in two recent skeletons of *Anoa quarlesi*.

Of the metacarpal we have three proximal portions, all of the right side, from caves N. of Tjani, bearing the numbers 120, 242, and 247 respectively. The dimensions in table 113 show these bones to be definitely larger than their homologue in *Anoa quarlesi* and about of the size of the metacarpal in *Anoa depressicornis*.

One left astragalus from a cave N. of Tjani (marked S) agrees well in size with that of *Anoa quarlesi*, and from layer A—B of the Panganrejang Toedeja cave we have another left astragalus, damaged laterally, that is of the same small size. A right astragalus from layer C—D of the latter cave, however, is a larger specimen, very slightly smaller only than that of the skeleton of *Anoa depressicornis* no. 3 and very near in size to that of the skeleton of the large female from the hinterland of Macassar no. 8. SARASIN (1905, p. 30) observed the same difference in size between the recent astragali (of *Anoa depressicornis*, (lateral) length given as 44 and 44.5 mm) and those from Toalian caves (varying in lateral length from 34—39 mm).

A calcaneum, of the right side, from layer C—D of the Panganrejang Toedeja cave, lacks the distal extremity, but the length of the corpus from the processus cochlearis and the greatest width over the sustentaculum show it to be larger than that of the two skeletons of *Anoa quarlesi* nos. 15 and 16 and very nearly of the same size as that of the female from the hinterland of Macassar no. 8.

The distal portion of a metatarsal (not a metacarpal as shown by the extension of the median dorsal groove down to the distal sagittal notch), also from layer C—D of the Panganrejang Toedeja cave, is of intermediate size, too, though nearer to *Anoa depressicornis* than to *Anoa quarlesi*.

A few phalanges are in the collection from layer A—B of the Panganrejang Toedeja cave. They belong either to the manus or to the pes, but the dimensions of the phalanges in the fore foot and hind foot of *Anoa* are very nearly the same. Table 113 shows that the subfossil phalanges are about as large as those of skeleton no. 3 of *Anoa depressicornis*. In the collection from layer C—D of the latter cave there is a second phalanx with an outer length of 24 mm.

The humerus, radius, and astragalus from the caves N. of Tjani must be referred to *Anoa quarlesi*; the proximal metacarpal portions together with the teeth already mentioned above indicate the presence of *Anoa depressicornis* at these sites.

Anoa depressicornis seems to be represented also by the comparatively large humerus, astragalus, calcaneum, and metatarsal from layer C—D of the Panganrejang Toedeja cave as well as by the phalanges from layer A—B of the latter cave. The astragalus, metatarsal, and calcaneum, however, hardly differ in size from those of the female specimen from the hinterland of Macassar. If the latter specimen, notwithstanding its woolly coat, does not belong to *Anoa quarlesi* because it is too large, as Mr. VAN BEMMEL suggests, these bones are nearest in size to *Anoa depressicornis*. Whether they actually belong to this species I am unable to make out at present. Mr. VAN BEMMEL writes me that there is a lowlands race in South Celebes (*fergusoni?*) which is larger than topotypical *quarlesi*, and it is perhaps to this form that the Panganrejang Toedeja cave bones should be referred.

SPECIES NOT BELONGING TO THE TOALIAN CAVE FAUNA PROPER

The fauna of the caves N. of Tjani differs from that of the other sites explored by Dr. VAN STEIN CALLENFELS in the absence of the babirusa (above, p. 120). On the other hand it yields some species not or questionably represented in other caves which give the fauna of the caves N. of Tjani a more recent character than that of the remaining sites. These species are the domestic dog, a relatively large pig, and the water buffalo which certainly do not belong to the typical Toalian cave fauna. Nor does the deer either.

The deer remains found by the SARASINS, two incisors, came from a cave that was then only a very short time ago still inhabited by Man, and they were associated with a piece of iron and modern China cup fragments (SARASIN, 1905, p. 33). There is nothing of the deer in the Bola Batoe cave collection. As SARASIN (l.c., pp. 33—37) points out, it seems certain that the deer has been introduced into Celebes by Man during the last few centuries; if it had been present in prehistoric Celebes its worked antlers would have been found in the Toalian caves. In South Celebes, where it is now a common animal, it seems to have been introduced by the Boeginese.

In the Bola Batoe cave collection there is one lower canine that is indistinguishable from that of a medium-sized domestic dog. This specimen is evidently from a recent animal. SARASIN (1905, p. 51) found one premolar of the dog in a Toalian cave, and state that it is rather fresh in appearance. DAMMERMAN (1939, p. 72) found three canines of the domestic dog in the top layer of a cave N. of Tjani, and has no doubt that this species is a late introduction. Two of these specimens are recent in appearance, and the third is but slightly altered.

There is an incomplete molar of a *Sus* species in the collection from caves N. of Tjani, an M_3 of the right side with the talonid broken off, that points to a pig of larger size than the recent Celebean wild pig. The antero-transverse diameter is 15.7 mm, but the width over entoconid and hypoconid is 16.6 mm. This tooth matches exactly some M_3's of *Sus cristatus vittatus* Boie which is widely spread over the Malay Archipelago as a domestic animal, and may hence have belonged to an introduced individual.

The teeth and bones of the water buffalo (*Bubalus bubalis* (L.)) from caves N. of Tjani (DAMMERMAN, 1939, p. 68) are the only evidence of the presence of this species in the VAN STEIN CALLENFELS collection. It is not represented in the Bola Batoe cave collection. SARASIN (1905, p. 51) found remains of the water buffalo too, but only in the cave which also contained the piece of iron, China cup fragments, and the deer teeth. Since even the Toala of today do not keep water buffaloes (SARASIN, l.c.) this must have been an importation of the Boeginese.

DISTRIBUTION OF THE SPECIES OVER THE TOALIAN SITES

	Sarasin, 1905	Caves N. of Tjani	Panisi Ta'boettoe	Panganrejang Toedeja cave layer A—B	Panganrejang Toedeja cave layer C—D	Batoe Edjaja cave	Tjadang cave	Lompoa rock-shelter	Bola Batoe cave
Phalanger ursinus (Temminck)	×		×	×	×	×			×
Phalanger celebensis (Gray)	×			×	×	×			×
Suncus murinus (L.)									×
Macaca maura (Geoffr. et F. Cuvier)	×	×	×	×	×	×	×		×
Homo sapiens L.	×			×	×	×	×	×	×
Lenomys meyeri (Jentink)	×			×	×	×			×
Rattus dominator Thomas				×	×	×			×
Rattus cf. *xanthurus* (Gray)			×	×					×
Rattus cf. *rattus* (L.)			×			×			×
Rattus cf. *coelestis* Thomas									×
Macrogalidia musschenbroekii (Schlegel)							×		×
Sus celebensis Müller et Schlegel	×	×	×	×	×	×	×	×	×
Babyrousa babyrussa (L.)	×		×	×	×	×		×	×
Anoa quarlesi Ouwens	×	×	×	×	×	×	×		×
Anoa depressicornis (Smith)		×		?	?				

THE EVOLUTION OF THE MAMMALIAN FAUNA IN SOUTH-WESTERN CELEBES

There are no species in the Toalian cave fauna that are no longer living in the island of Celebes. Even the subfossil rat mandibles, the specific identification of which is a very dubious matter as far as the genus *Rattus* is concerned, could be assigned to living Celebean forms.

Though the Toalian cave fauna evidently comprises but a fraction of the total fauna of its time it contains already three species which are gone now from South-western Celebes, viz., the Brown Palm Civet, the babirusa, and the larger anoa. The first of these species is represented in the subfossil South-western Celebes fauna by a race, *Macrogalidia musschenbroekii meridionalis* nov. subsp., that is larger than the living Minahassa race. The babirusa was smaller in the Toalian caves than it is nowadays in Northern Celebes, but in the Pleistocene of South-western Celebes it was definitely larger. *Anoa depressicornis* is not very well represented in the Toalian cave collections, and was certainly less common than the smaller *Anoa quarlesi*.

The remaining Toalian cave Mammals described in the present paper are conspecific with forms living today in the very same region, and the only difference between the subfossil and the corresponding recent animals is a difference in average size.

In many of these species the course of change has been similar: we find a tendency to decrease in size, most markedly so in *Phalanger celebensis* and *Macaca maura*, in which the process is carried to a stage at which the size difference is significant statistically. I found one notable exception, viz., in *Sus celebensis*, which shows a steady increase in size up to the present time. This deviation from the general trend is difficult to understand.

The phenomenon of decrease in size of animal species since the Pleistocene has been observed all over the world (above, p. 10), and suids do not form exceptions as far as I know. There is one more instance of size increase in a Mammal species since the Pleistocene, viz., the badger from the Holocene of Denmark. The case is as follows:

After a comparative study of subfossil and recent carnivores from Denmark DEGERBØL (1933, p. 640) found that in most cases the subfossil remains are larger than the corresponding recent, the opposite trend being shown only in the badger. DEGERBØL attributes the general size decrease to the working of BERGMANN's principle, and thinks that the badger evolved differently because "it digs holes in the ground where it can hibernate more or less the winter through and thus avoid the influence of the cold" (l.c., p. 640/41).

In the Middle Pleistocene Yenchingkou fauna of China, many Mammals of which are larger than the corresponding recent from the same region, the badger does not form an exception to the rule, however (COLBERT, 1949, p. 128).

COLBERT (l.c., p. 129/130) explains the decrease in size of many Mammals in the Chinese fauna as the working of BERGMANN's principle, too. As stated already earlier I cannot accept this interpretation, for the phenomenon of progressive size decrease during the Quaternary does not occur in temperate and cold regions of the earth exclusively.

Has there been any climatic change during the Holocene of Sumatra or Celebes comparable in importance to that in regions near the retreating glaciers and ice caps? More subtle factors are apparently involved in the evolution of the animals in Sumatra and Celebes.

If this uniform post-Pleistocene size decrease, by no means confined to islands, is merely a response to changing environmental conditions, it is difficult to understand why *Sus celebensis* has not followed the general trend. This animal once lived in the same region, was of the same size and as common as the babirusa, and both forms most probably were even feeding on identical food. Nevertheless *Sus celebensis* increased steadily in size and still lives all over the island of Celebes, while the babirusa became smaller in the course of time and finally became extinct in South-western Celebes. These are two definite evolutionary trends, brought about apparently by internal factors rather than by a change in environment.

SUMMARY

The material dealt with in the present paper consists of subfossil Mammalian teeth and bones originating from various caves and rock-shelters in South-western Celebes. These sites also yield cultural remains ascribed to ancestors of the primitive Toala tribe living today in the region of Lamontjong, and first discovered by P. and F. SARASIN in 1902. F. SARASIN (1905) published a report on the cave fauna.

The largest collection examined is that made by Mr. H. R. VAN HEEKEREN in the Bola Batoe cave in 1947, while the material collected by Dr. P. V. VAN STEIN CALLENFELS and his collaborators in the years 1933 to 1937 reported upon by DAMMERMAN (1939) has been reexamined.

The distribution of the various species of Mammals over the Toalian sites is shown in the table on p. 146. The results of the systematic study of the material are as follows:

Phalanger ursinus (Temminck), the Bear Cuscus of Celebes, is represented in the Toalian caves by some mandibles and teeth which occasionally present greater dimensions than the recent do.

The Grey Celebes Cuscus, *Phalanger celebensis* (Gray), is more abundantly represented in the cave collections. The subfossil mandibles have again the tendency to be larger than the recent. The material from the basal layer of the Panganrejang Toedeja cave, the oldest cave deposit, averages larger than that of the upper layer of the same cave and that from the remaining sites, and the size difference from the recent material even stands the statistical test. This large subfossil form has been described as a new subspecies: *Phalanger celebensis callenfelsi* nov. subsp.

An insectivore, the first of which we have any evidence in the Toalian cave fauna, is represented by a partial calvarium from the Bola Batoe cave. The examination of recent material of the genus *Suncus* from the Malay Archipelago leads to the conclusion that the forms described from Ternate, Banda Neira, and Timor as new species can be merged with the common Oriental house musk shrew *Suncus murinus* (L.), to which the subfossil calvarium from Celebes also belongs.

Remains of the Moor Macaque, *Macaca maura* (Geoffr. et F. Cuvier), are rather frequently found in the Toalian caves. Dental differences between this species and the Northern Celebean *Cynopithecus niger* (Desmarest) are given; the dentition of the latter species is shown to be the more primitive of the two. The macaque from the Bola Batoe cave differs from the recent Moor Macaque in its larger size and more stressed sexual difference in size of the canines. This form has been described as *Macaca maura majuscula* nov. subsp.

The living Toala were regarded by the SARASINs as an impure Veddah relic in the population of the Malay Archipelago, but this opinion is not shared by later investigators. The human remains found in the Bola Batoe cave, calvarium fragments, a mandible, and isolated teeth, do not show characters that are typically Veddah-like. Some of the teeth, in particular the milk elements, are rather large.

A survey of the literature is given which shows that it is common for subfossil human teeth to be larger than the recent. Since this is a common phenomenon in animals, too, there is no reason to ascribe the large subfossil teeth from the Malay Peninsula and Archipelago to Melanesians or Australians on their way to their present habitat, though such migrations must have taken place.

The human bones from the Lompoa rock-shelter exhibit some primitive characters, but these are no special Veddah characteristics. The stature of one of the people was probably only 142 cm.

The rat mandibles found in the Toalian caves belong at least to five different species. One of these is *Lenomys meyeri* (Jentink), with the tendency toward larger size and more complex tooth structure than the living form. Four species of the genus *Rattus* are representatives of the *dominator, xanthurus, rattus,* and *coelestis* groups respectively.

The carnivore in the Toalian cave fauna is *Macrogalidia musschenbroekii* (Schlegel). Until now this species was known to exist only in the Minahassa in the extreme North-eastern portion of Celebes. The cave remains indicate a form of larger size than the living, and have been described as *Macrogalidia musschenbroekii meridionalis* nov. subsp.

The remains of *Sus* found in the Toalian caves are small when compared with those of the living Celebes wild pig *Sus celebensis* Müller et Schlegel. We have to accept that in this species there was a gradual increase in size instead of a decrease as is commonly found; the oldest cave remains have the tendency to be smaller than that of the other sites. This animal is the most common species to the Toalian cave fauna, being represented at all the sites. The Bola Batoe cave form could be shown to present a real difference in size from the living, and has been named *Sus celebensis sarasinorum* nov. subsp.

The babirusa, now vanished from the South-western peninsula, occurs at most of the Toalian sites but is less common than the Celebes pig. The subfossil babirusa is smaller than the living from Central and Northern Celebes but about of the size of the babirusa races now found on the islands of Boeroe and Taliaboe, to the East of Celebes. It is evident that in South-western Celebes the babirusa has undergone a diminution in size in the course of time, for the oldest cave remains tend to be larger than those from the other sites, and the Pleistocene babirusa of this region even is larger than the living Celebean race. If the babirusa were still living today in South-western Celebes it would have been described as a separate race, as was done with other Mammals which are still living all over the island. I have named the subfossil cave form *Babyrousa babyrussa bolabatuensis* nov. subsp.

The anoa is practically extinct now in South-western Celebes, and is probably the small *Anoa quarlesi* Ouwens described from Western Central Celebes. Most of the cave teeth are within the limits of those of this species, and the oldest cave remains have again the tendency to be larger. The Pleistocene *Anoa* from South-western Celebes recently described is of the size of the large *Anoa depressicornis* (Smith), typically from the Northern region of Celebes, but the Pleistocene fossil may represent a large forerunner of *Anoa quarlesi* Ouwens. This is, however, an inference by analogy only. There is also evidence of the existence of a large anoa at some of the Toalian sites, apparently *Anoa depressicornis* (Smith) which does not occur in this region today.

Some remains of deer and domestic animals have been found in the caves, too, but these do not belong to the Toalian cave fauna proper.

The most interesting phenomenon observed is the diminution in size of most of the members of the fauna, *Sus celebensis* being a notable exception. The same evolutionary trend toward small size has gone on all over the world in the Quaternary, and is difficult to explain just because it is so universal. For regions near retreating ice caps and glaciers this phenomenon can perhaps be interpreted in terms of BERGMANN's principle, but other factors are certainly involved, too.

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EXPLANATION OF THE PLATES

PLATE I

Fig. 1, *Phalanger celebensis* (Gray) subsp.; left horizontal ramus with I and P_4—M_4 (no. 4 in table 4), Bola Batoe cave, lateral view.

Figs. 2—3, *Phalanger celebensis callenfelsi* nov. subsp.; right horizontal ramus with I and P_4—M_3 (holotype; no. 22 in table 4), Panganrejang Toedeja cave, layer C—D; fig. 2, upper view; fig. 3, lateral view.

Fig. 4, *Phalanger ursinus* (Temminck) subsp.; right horizontal ramus with P_4—M_4, Batoe Edjaja cave, upper view.

Fig. 5, *Phalanger celebensis* (Gray) subsp.; calvarium fragment with P^4—M^3 sin., Batoe Edjaja cave, crown view.

Fig. 6, *Phalanger ursinus* (Temminck) subsp.; M^3—M^4 dext., Bola Batoe cave, crown view.

Figs. 7—8, *Macaca maura majuscula* nov. subsp.; M_3 dext. (nos. 3 and 4 in table 32), Bola Batoe cave, crown view.

Fig. 9, *Suncus murinus* (L.) subsp.; front part of calvarium, Bola Batoe cave, lower view.

Figs. 10—14, *Macaca maura majuscula* nov. subsp.; figs. 10—11, I^1 dext. (no. 1 in table 13), Bola Batoe cave, labial and lingual view; fig. 12, male upper C sin. (holotype; no. 5 in table 16), Bola Batoe cave, lingual view; figs. 13—14, P_3 sin. (male and female specimen), Bola Batoe cave, outer view.

Fig. 15, *Phalanger celebensis* (Gray) subsp.; left horizontal ramus with I and P_4—M_4 (same specimen as that of fig. 1), Bola Batoe cave, lateral view.

Figs. 1—4, 6—8, 10, 11, and 13—15, twice natural size; fig. 5 $1^2/_3$ natural size; fig. 9, 4 × natural size; fig. 12, $1\frac{1}{2}$ natural size.

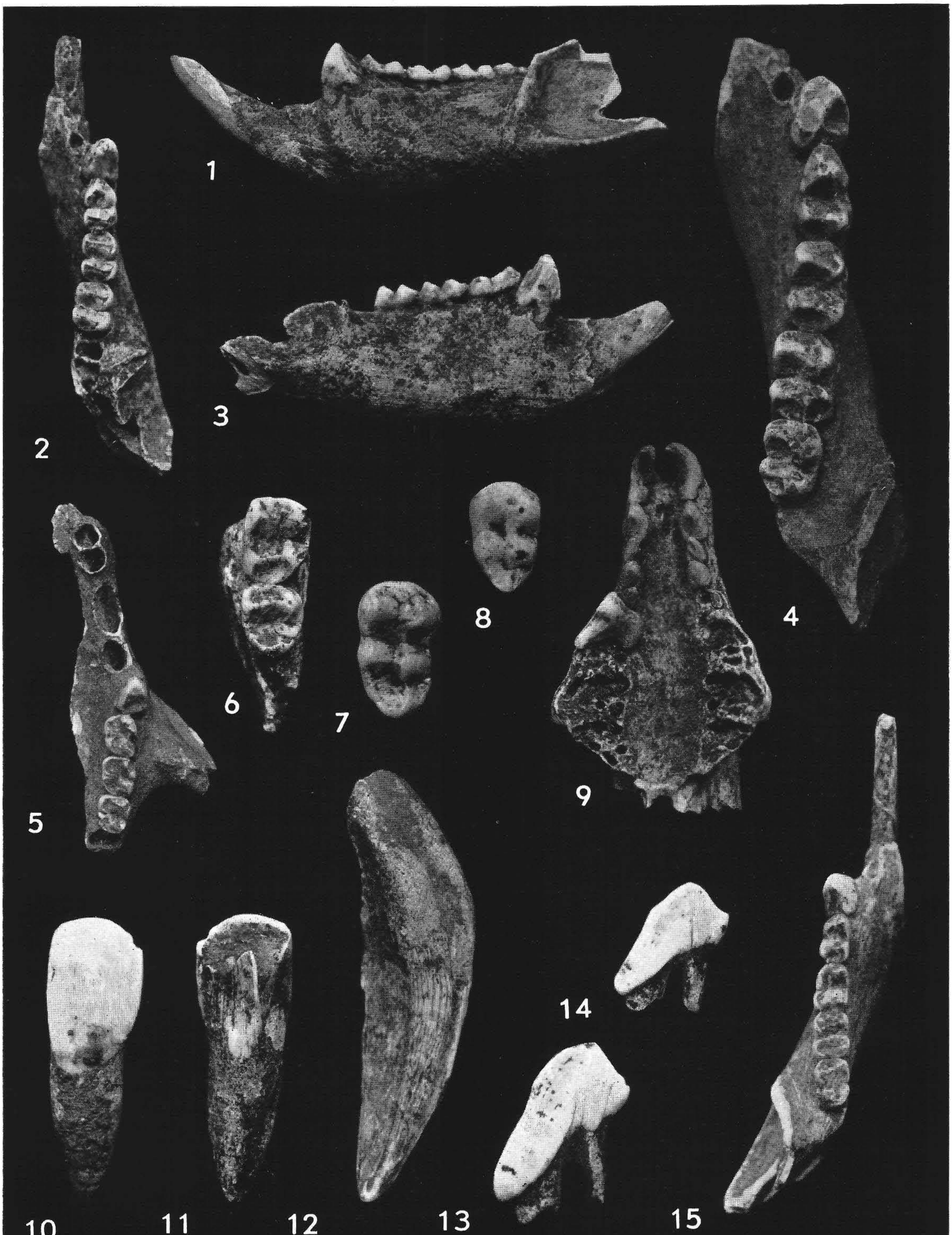
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PLATE II

Figs. 1—3, *Macaca maura majuscula* nov. subsp.; figs. 1—2, P^3—M^2 dext., Bola Batoe cave; fig. 1, crown view; fig. 2, lateral view; fig. 3, M_1—M_3 sin., Bola Batoe cave, crown view.

Figs. 4—5, *Macaca maura* (Geoffr. et F. Cuvier) subsp.; P^4—M^3 sin., Panisi Ta'boettoe; fig. 4, lateral view; fig. 5, crown view.

Fig. 6, *Homo sapiens* L. subsp.; frontal bone, Bola Batoe cave, anterior view.

Figs. 7—9, *Macrogalidia musschenbroekii meridionalis* nov. subsp.; fig. 7, P^4—M^1 dext. (holotype), Bola Batoe cave, crown view; fig. 8, P_4—M_1 dext., Bola Batoe cave, crown view; fig. 9, P^4 sin., Bola Batoe cave, crown view.

Fig. 10, *Homo sapiens* L. subsp.; mandibula, Bola Batoe cave, upper view.

Figs. 1, 2, 4, 5, 1¾ natural size; figs. 3 and 7—9, twice natural size; figs. 6 and 10, natural size.

PLATE II.

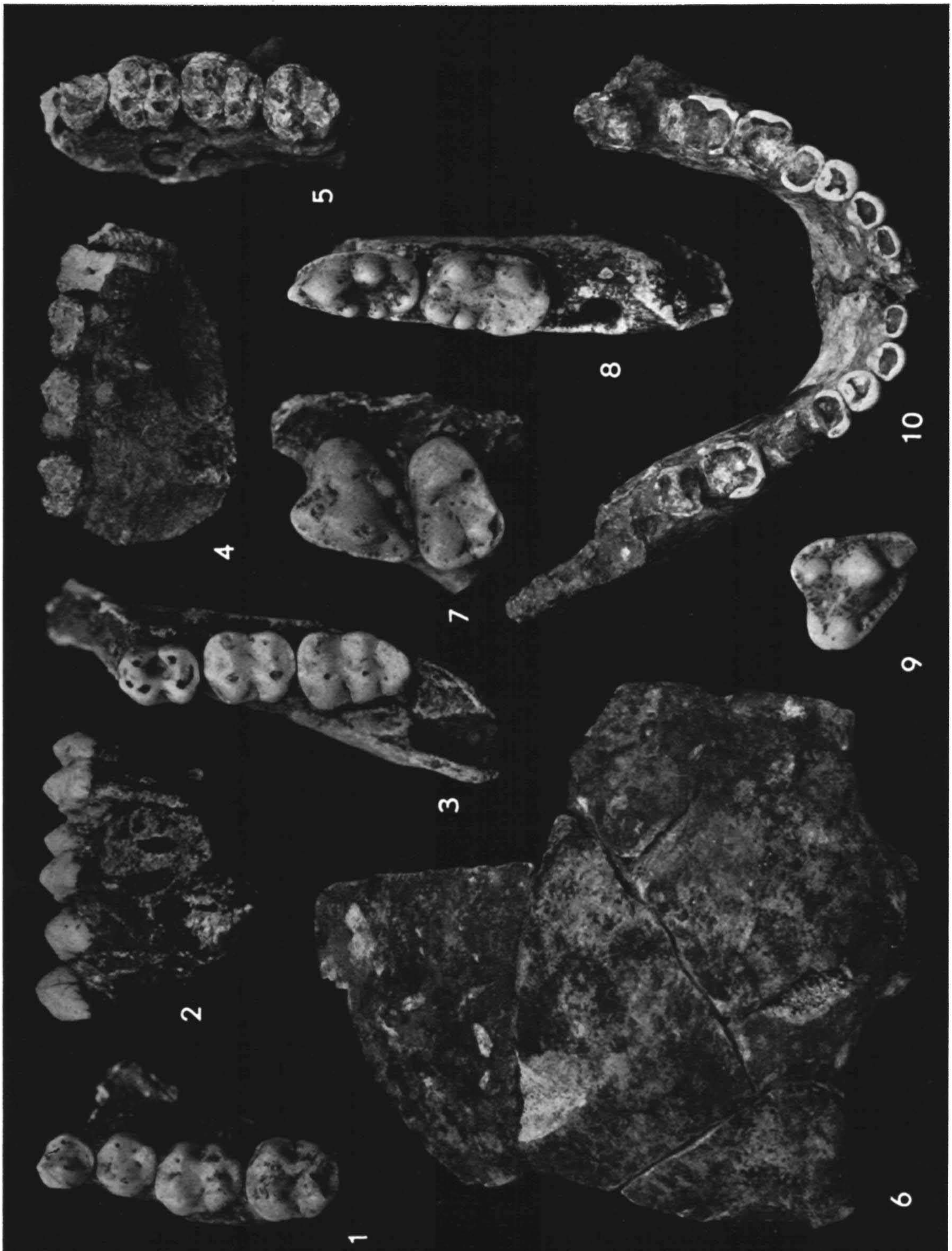


PLATE III

Figs. 1—2, *Sus celebensis sarasinorum* nov. subsp.; fig. 1, male upper C dext. (holotype), Bola Batoe cave, anterior view; fig. 2, P^4—M^2 dext., Bola Batoe cave, crown view.

Fig. 3, *Babyrousa babyrussa bolabatuensis* nov. subsp.; P^3—M^2 sin. (holotype), Bola Batoe cave, crown view.

Figs. 4—5, *Sus celebensis sarasinorum* nov. subsp.; fig. 4, P^2—P^3 dext., Bola Batoe cave, crown view; fig. 5, P_4—M_3 dext., Bola Batoe cave, crown view.

Figs. 6—7, *Babyrousa babyrussa bolabatuensis* nov. subsp.; fig. 6, M_2—M_3 dext., Bola Batoe cave, crown view; fig. 7, P_3—M_1 sin., Bola Batoe cave, crown view.

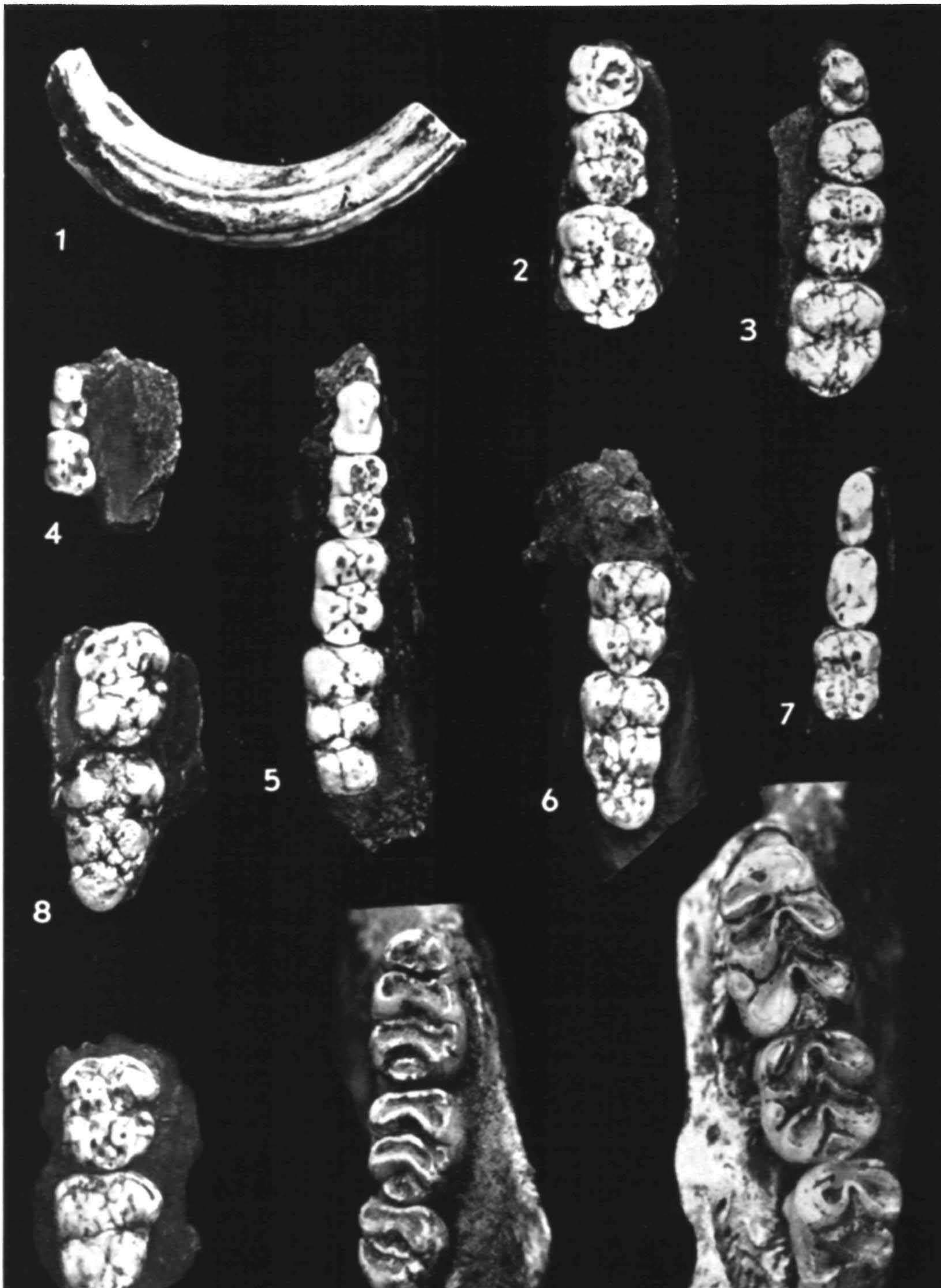
Fig. 8, *Sus celebensis sarasinorum* nov. subsp.; M^2—M^3 sin., Bola Batoe cave, crown view.

Fig. 9, *Babyrousa babyrussa bolabatuensis* nov. subsp.; M^2—M^3 sin., Bola Batoe cave, crown view.

Fig. 10, *Rattus dominator* Thomas subsp., M_1—M_3 dext., Panganrejang Toedeja cave, layer C—D, crown view.

Fig. 11, *Lenomys meyeri* (Jentink) subsp., M_1—M_3 sin., Panganrejang Toedeja cave, layer C—D, crown view.

Figs. 1—9, natural size; figs. 10 and 11, 5½ natural size.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