The evolutionary significance of the Wajak skulls

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Ever since their description by Dubois (1920, 1922) the Wajak skulls (Java) have played an important role in the discussions on the evolution of modern humans in Australasia. Because of the robust morphology of the skull, Wajak Man was seen as a link between Pleistocene hominids from Java (Solo) and Recent Australian Aborigines. However, for a long time hardly any attention has been paid to the contents of the other boxes with human, faunal and cultural remains, as collected by Dubois around 1890. Because a satisfactory description of the Wajak fossils has so far been lacking and the archaeological context of the Wajak site has so far been ignored, the evolutionary position of Wajak Man necessarily remained unclear.

The present study suggests that the evolutionary significance of the Wajak skulls can no longer be seen in terms of a Late Pleistocene transitional form between the Middle Pleistocene Solo skulls and Recent Australian Aborigines, nor can they be seen as proof of a gracile link between Chinese and Australian populations. Rather, the significance of these skulls is that they give some insight into microevolutionary processes that have taken place on Java itself. The most likely interpretation is to consider the Wajak skulls as Mesolithic robust representatives of the present inhabitants of Java.

According to the hypothesis presented at the end of this thesis there are two species within the genus *Homo* in Australasia: *Homo erectus* and *Homo sapiens*. Within *Homo sapiens* one can recognise in Australasia two main types: a Sunda type (Chinese and Javanese) with strong neotenic trends, and a Sahul type (Papuans and Australians) which is closer to a generalised *Homo sapiens* morphology. Wajak-1 (Java) and Liujiang (China) possibly represent the earliest clear examples of the Proto-Sunda type (proto meaning more robust). Hence, they are from this point of view, very important skulls when trying to understand the origin of the Sunda people.

Gracilisation of the human skull, as has occurred since the Late Pleistocene, has been reported from different parts of the world. Various explanations have been proposed for their occurrence, like the development of agriculture and climatic changes. To explain the worldwide decrease in size of the human body one could seek for a phenomenon that also has a global character. I propose the idea that because of population increase, technological innovations and rising temperatures, since the Late Pleistocene, various aspects of human life changed (like relaxation of predation, decrease of home range and mobility and increasing symbiosis with other organisms), which enabled an overall decrease in body size.

Contents

Introduction

The Wajak remains

On October 24, 1888, B.D. van Rietschoten discovered a fossilised human skull (Theunissen, 1989) close to Tjerme, near Tjampoer Darat (Fig. 1), in a mountain slope of the Gunung Lawa (Fig. 2). Later, C.Ph. Sluiter of the 'Koninklijke Natuurkundige

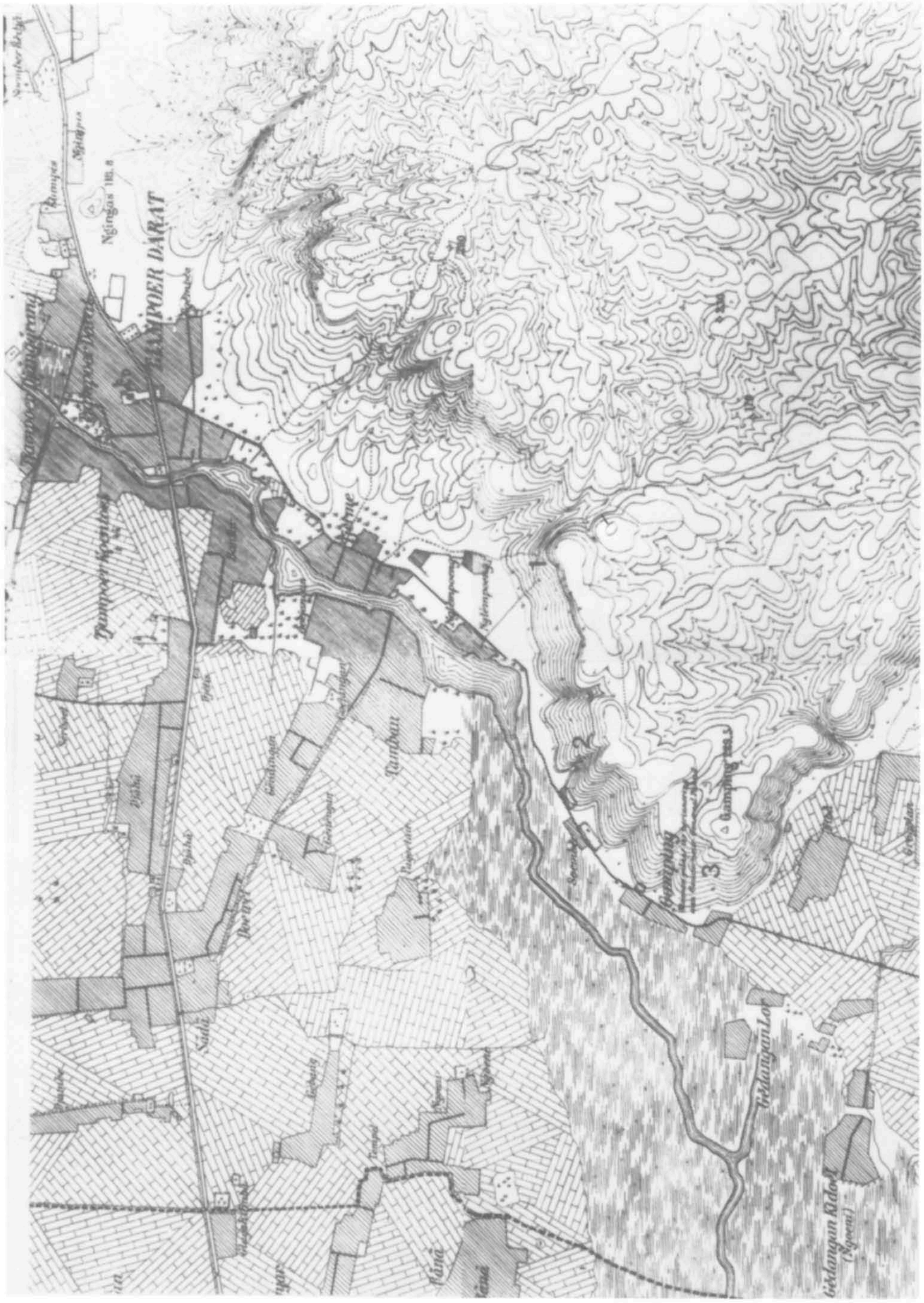


Fig. 1. The surrounding of Wajak (= Tjampoer Darat).
1 = Hoekgrot; 2 = Wajak; 3 = Kecil (see Fig. 2).

Vereniging' (Royal Society of Natural Sciences) received a letter from van Rietschoten dated October 31, 1888, with a drawing of the situation (Fig. 3). At the meeting of the Royal Society of Natural Sciences of December 13, 1888, Sluiter read out this letter of van Rietschoten (1889). According to van Rietschoten the Wajak skull was found during a mining exploration for 'marble' (indicated nowadays as limestone), although when pulled out the skull broke, four molars were still in the jaw. As van Rietschoten observed superficially, a low frontal bone and strong protruding zygomatic bones characterised the skull. Above the fossils there was about one metre of clay, and beneath a conglomerate of small 'marble' stones, united with a limestone like clay. It appeared to him as if it had been washed up and down by the sea. In this layer, that was so fixed that it was hard to loosen it with a crowbar, the bones were found.

On December 21, 1888 Sluiter (in litt.) wrote to Dubois, who was at that moment in Sumatra, that he had received the skull from van Rietschoten. Sluiter remarked that the skull was in a very sad state, broken in a number of pieces. With a small piece he had tried to remove the lime with hydrochloric acid, and it worked very well. Sluiter questioned, because of the condition of the bone and the situation of the site, if the skull could be seen as a fossil. Sluiter wrote that he would sent the complete collection to Dubois. At the meeting of the Royal Society of Natural Sciences of April 11, 1889, Sluiter read out the reaction of Dubois (1890a), in which he declared what Sluiter had written to him, viz. that the Wajak skull was in a very sad state. Dubois had worked a full week on the skull, with a chisel, glue and plaster, before he had the complete skull standing before him. Further, Dubois mentioned the presence of fragments of carpal bones and ribs, and a piece of a heel bone, a thigh bone and lower jaw. Dubois' first impression of Wajak Man was that it greatly deviated from the 'Malay type' and that it rather resembled the 'Papuan type'. Furthermore, Dubois remarked that it was better not to continue the excavation at the Wajak site by people who were no experts. Van Rietschoten said that, after the importance of his find appeared to him, he had instructed to stop the excavation.

Dubois, who went from Sumatra to Java, started his excavation at the Wajak site on June 9, 1890. In his notes Dubois (1890c) remarked that the Wajak-1 skull was found in a rock-fissure filled with breccia. In this rock-fissure no more human remains were found, but bones of animals, presumable deer, were found. However, as early as after a few days, the work at the site had to be delayed because of heavy rains. At the end of September 1890 the work at the Wajak site was resumed. Soon, a second specimen (Wajak-2) was found in the hard matrix with, according to Dubois (1890b), undeniable the same Australian (or Papuan) peculiarities as the first skull. The next month, October 1890, remains of a human skeleton were collected from the matrix that filled the above mentioned small rock-fissure, which presumably belong to the Wajak- 2 skull. Furthermore, fragments of various mammals were found, and a map of the site was made by Dubois' assistant de Winter (Fig. 4).

Dubois (1920a, 1922) described the exact position of the site: 'Tjampur Darat or Wadjak, the capital of the district of Wadjak, is a village (dessa), south-west of the town of Tulung Agung, and about in the meridian of the Wilis-summit. ..... On the slope of the part of the mountain that extends, almost rectilinearly, over a distance of 800 meters in W.S.W. direction, immediately on the south of Tjerme and at 2 kilome-

Fig. 2. The Gunung Lawa, two of Dubois' original photographs, (p. 6 and 7), taken in 1890. The arrows point to the three hominid-bearing sites, left to right: Hoekgrot, Wajak & Kecil (see Fig. 1).

tres distance S.S.W. of Tjampur Darat, fossil human bones were found in 1889 and 1890.'

Because van Stein Callenfels (1936: 49) noted that 'The sites have now been completely destroyed in the course of quarrying marble', until 1985 several other scientists probably assumed that this was the case. In 1985 the Wajak site was rediscovered by Aziz & de Vos (1989).

The Australian link

The first English scientific description of the human fossils from Wajak was given by Dubois in 1922 (Dutch version: Dubois, 1920), considering it a 'Proto Australian'. He based this interpretation on characteristics like the rooflike appearance of the cranial vault, vertical side walls, absence of a high cranium, a receding frontal bone with a pronounced glabella and superciliary arches, low orbits, prognathism with a rudimentary sulcus prenasalis, the nasal bones being slightly prominent, blunt sides of the nasal aperture, the well developed mandible, the large teeth, and the difference in breadth of the upper and lower dental arch. Interestingly, Dubois (1922) also noted differences between Wajak and Australians, such as the absence of a supraorbital torus and the supra- and lateral orbital borders. According to Dubois, the differences between Wajak Man and Australian Aborigines could be explained by the fact that the 'Australian natives', had for a long time, found a scanty subsistence and were in a state of decadence. The majority of the differences between the two could be attributed to a more vigorous development and greater perfection of the 'type'. For him '*Homo wadjakensis*' was an 'optimum' form.

Fig. 2 (continued).

The idea of a link between Wajak and the Australians was accepted by many scientists such as, for instance, Weidenreich (1945a-b), Jacob (1967) and Wolpoff et al. (1984). As far as the connection between Wajak and prehistoric Australians is concerned, the find of the Keilor skull in 1940 by James White in Southeast Australia is important. Weidenreich (1945a) made a direct link between these two skulls (from Java and Australia), the title of his paper permits no doubt: 'The Keilor skull: A Wadjak type from Southeast Australia'. According to Weidenreich (1945a: 22): 'the main measurements and the capacity agree so completely that the racial identity of the two skulls cannot be doubted'.

The first reaction against such a special link between Wajak Man and Australians came from Keith (1925), three years after the publication of Dubois. According to Keith, Wajak Man showed a mixture of characters, which he also noticed in other forms, i.e. Australians, Asians and 'Rhodesian Man'. He pointed to the fact that Wajak Man had unique characters which he could not find in other skulls. All this led Keith to the conclusion that Wajak Man was an extinct type. In 1936, however, Keith altered his view, and became convinced that Dubois (1922) was right. He considered Wajak as a 'Proto-Australian'.

Another scientist disagreeing with the idea of a Wajak-Australian connection was Pinkley (1936). On the basis of his comparative dental studies, he concluded that there are three possible affinities of Wajak Man. 1) Wajak became extinct; 2) Wajak was an early representative of, or akin to the ancestry of the Asians; 3) Wajak was the ancestor of the 'whites', (in particular the Mediterranean). He believed that the last hypothesis was the most likely one. According to Pinkley the close resemblance to the Australians was due to the primitiveness of the skull structure and the advanced

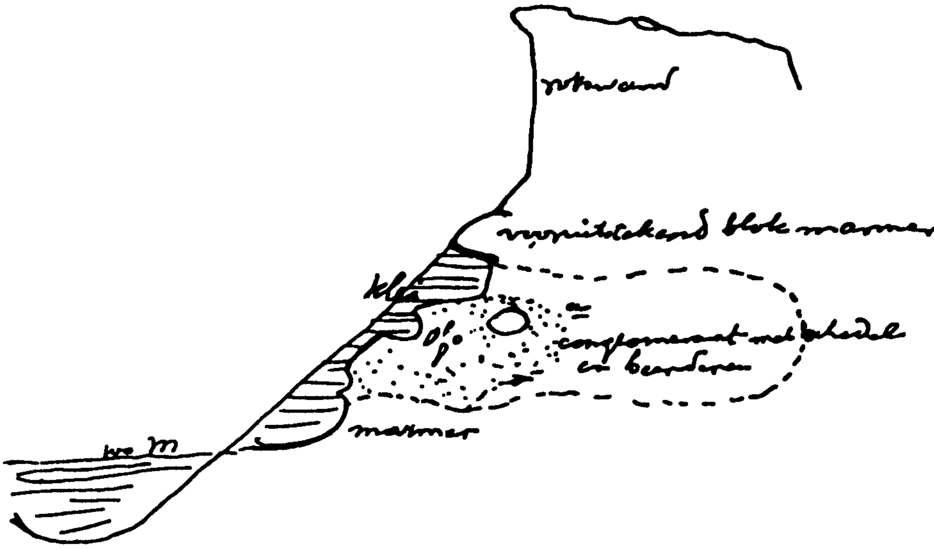
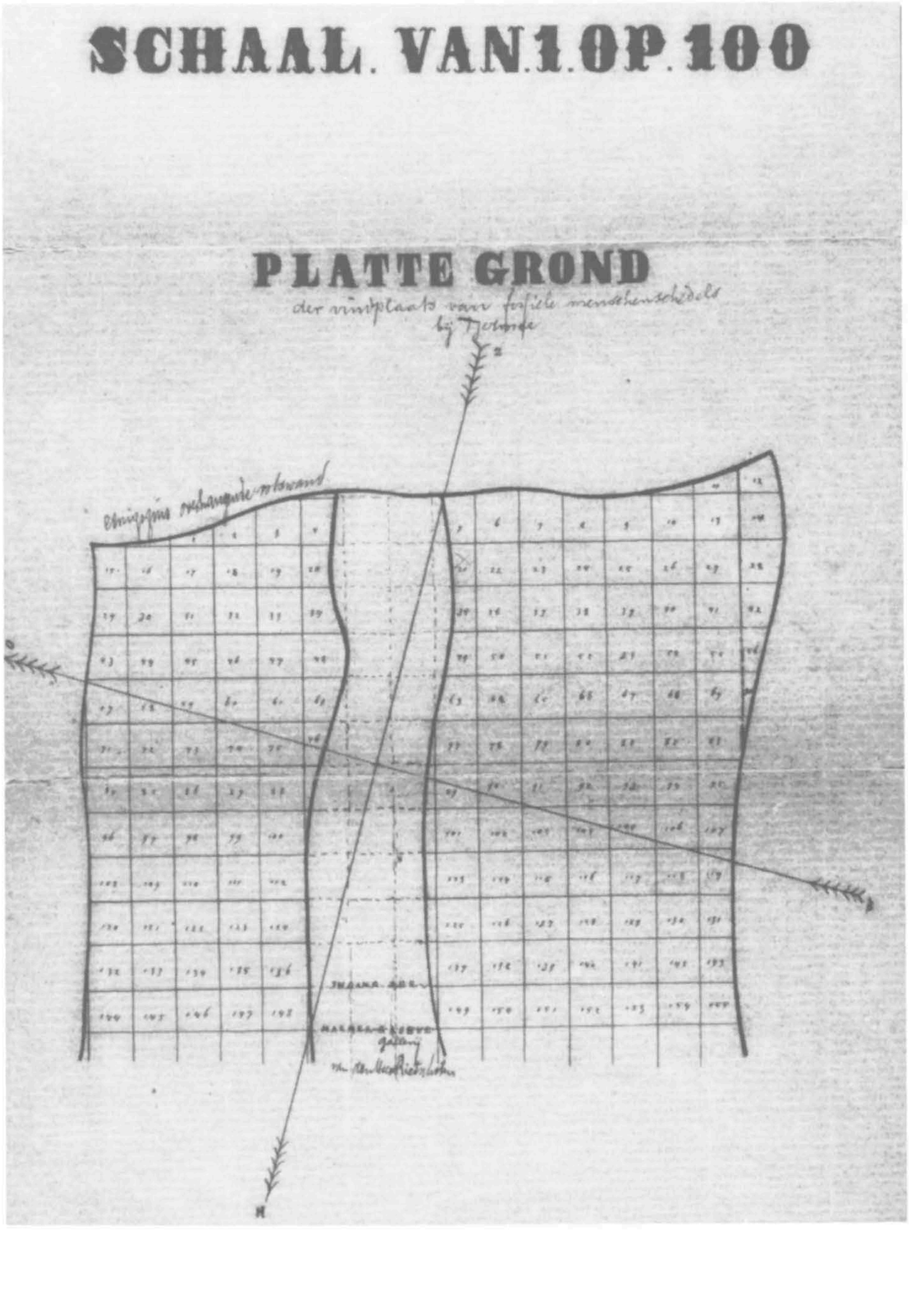


Fig. 3. Cross section of the Wajak site. This sketch is a copy made by Dubois after a sketch of the situation made by van Rietschoten. The original letter (with the sketch) was sent by van Rietschoten to the board of the Royal Society of Natural Sciences on October 31, 1888. Sluiter sent the letter of van Rietschoten to Dubois on December 21, 1888, and asked Dubois to send the letter back on occasion. Therefore, Dubois made a copy of the letter. The script in the figure reads, top to bottom: rotswand = rocky wall; vooruitstekend blok marmer = protruding block of ('marble') limestone; klei = clay; conglomeraat met schedel en beenderen = conglomerate with skull (Wajak-1) and bones; marmer = ('marble') limestone.

characters of Wajak could not have led to the more 'primitive' characters of the Australians.

Scientists such as Keith and Pinkley were absolute about their statements of connections, i.e. there were simply none. More recently scientists discussing these connections were less absolute and more cautiously. According to Jacob, Wajak Man had both 'Australoid' and 'Mongoloid' characters (Jacob, 1967, 1968), and traits that remind us of the 'Australoids' (Jacob, 1967) could be: its long shape with attendant sagittal keeling, slight occipital bulging with nuchal flattening and the superciliary arches. The cranial capacity would be too large and the dental characters too pro-

Fig. 4. Map of the Wajak site made by Dubois' assistant de Winter. The skull of Wajak-2 was found in square 21. The script in the figure reads, top to bottom: schaal van 1 op 100 = scale of 1:100; plattegrond = ground-plan; der vindplaats van fos/iele menschenschedels bij Tjermee = the site of the fossil human skulls at Tjerme; Z = S(outh); eenigszins overhangende rotswand = somewhat inclined rock-face; O = E(ast); ingang der marmer groeve = entrance of the ('marble') limestone quarry; gallerij van den Heer Rietschoten = gallery of Mr (van) Rietschoten; N = N(orth). The interpretation of the Wajak-abri is as follows. The unnumbered squares represent the activities of van Rietschoten in 1888 (possibly also 1889), Wajak-1 must have been found in this area. Dubois has extended the excavation in 1890, roughly east and west of the gallery of van Rietschoten. Wajak-2 was found at the west side near the gallery, and close to the somewhat inclined rock-face.


SCHAAL. VAN 1 OP 100
PLATTE GROND

gressive for an Australoid or Proto-Australoid (Jacob, 1968). Thus, Wajak Man seemed to be the ancestor of Austromelanesians and the Proto-Malays.

Weidenreich's (1945a) ideas about the connection between Wajak and Keilor were later 'borrowed' and expanded by others (Wolpoff et al., 1984; Wolpoff, 1989). According to these authors a considerable similarity exists between the Australian skull of Keilor and the Wajak specimens, particularly in size, proportions and facial flatness. Wolpoff et al. (1984) stated that the Wajak specimens resembled the Australian population in a number of features, but also reflected the effects of gene flow from the North. Following Jacob (1967) they noticed Mongoloid as well as Australoid characters in the Wajak skull. There would be a 'gracile link' between the North (China) and Australia, an evolutionary line between the skulls of Liujiang, Wajak and Keilor: Wolpoff et al. (1984); Thorne (1991, pers. comm.); Wolpoff (1992, pers. comm.).

The Middle Pleistocene Solo link

The interest in the Indonesian and particularly the Javanese Middle Pleistocene prehistory was initiated by Dubois who discovered in the years 1891 to 1892 the famous remains of *Pithecanthropus*-I (according to modern taxonomists: *Homo erectus*) near Trinil, which he described in 1894. Dubois' original find was initially the subject of much controversy, questioning the specimen's status as a hominid ancestor, and criticising the association of the femur with the skull- cap. The latter is not only an issue of the beginning of this century (Day & Molleson, 1973; de Vos, 1985). Many more finds of archaic-looking hominids followed, such as the Solo (Ngandong) hominids.

In 1931, the Dutch geologist ter Haar discovered a bone-bearing upper terrace of gravel and tuffaceous sand, some 20 m above the present Solo River near the village of Ngandong (Java). The skull remains of 12 individuals were found in the period between 1931 and 1933. This is the largest hominid collection coming from one site in the Indonesian region. The Ngandong hominids have been described by Oppenoorth (1932a-d, 1936, 1937), Weidenreich (1951), Jacob (1967), Santa Luca (1980), and Rightmire (1990).

Oppenoorth (1932a) was the first to suggest a direct link between *'Homo soloensis'* and *'Homo wadjakensis'*. However, one can hardly imagine a stronger association between Solo and Wajak than that defended by Dubois himself. Dubois (1940a-c) considered the Solo material as the remains of *'Homo wadjakensis'* (according to him synonymous with *'Homo soloensis'*). Dubois did not only consider the Solo material as *'Homo wadjakenis'*, but equally the Mojokerto infant skull, *Pithecanthropus*-II and -IV, all from Java; as well as the *Sinanthropus* material from China and Rhodesian Man from Africa. In this way he isolated his 'unique' *Pithecanthropus*-I skull, as the 'real missing link' between apes and humans.

One of the scientists criticising Dubois was Weidenreich (1951), in his admirable detailed description of the Solo skulls, under the heading of 'Eugène Dubois and Solo Man'. In his well known chart of the evolutionary phases of humans and their speciation, Weidenreich (1945b) suggested an 'Australian link' between *'Pithecanthropus soloensis'* and the 'Wajak group'. This idea is still alive: (Wolpoff et al., 1984;

Thorne & Wolpoff, 1992). The chart has been adopted, some terms have been changed. According to them the present Australians are the final result of 'local continuity' encompassing two 'main streams', a robust one (Sangiran, Solo, Kow Swamp) and a gracile one (Liujiang, Wajak, Keilor).

Several scientists noticed difficulties in the assumption of a direct evolutionary link between the Solo and the Wajak remains. According to Jacob (1967) many morphological characters of Solo are intermediate between *Pithecanthropus* and the Neandertals (but closer to the former) and Jacob (1967, 1976) used the name *Pithecanthropus* for the Solo specimens. Jacob (1967) noticed a morphological 'gap' between Solo and Wajak and consequently suggested an 'Asiatic Neanderthal stage' between the two. Santa Luca (1980) went further and believed that the characters, measurements, angles, and indices argued against a direct connection between Solo and Wajak; the connection would have been based only on one point of similarity, the 'supratoral plane'.

Local continuity

Dubois (1922) connected Wajak with the Australians, Oppenoorth (1932) connected *Pithecanthropus* and Solo with Wajak. Keith (1936) combined both ideas: a continuous line leading from *Pithecanthropus*, via Solo and Wajak to the recent Australians. This 'local continuity line' became well known after the publications of Weidenreich (1945a-b) and Coon (1963). It was discussed recently as a part of the 'Multiregional Evolution' model (Wolpoff et al., 1984; Stringer, 1990, 1992; Lahr, 1992; Thorne & Wolpoff, 1992). Ironically, as far as the possibilities of Wajak Man having affinities with recent living groups is concerned, the 'real local continuity' was largely ignored; probably because of the dominance of the idea of Dubois to see Wajak as a 'Proto-Australian', scientists did not take the logical step to compare the Wajak fossils with recent Javanese skulls.

Although the question of Wajak having an Asian connection is important, Dubois (1922) and Keith (1925) discussed only a few 'mongoloid' characteristics. Probably the first to consider the possibility of local evolution was Pinkly (1936), as expressed in his second hypothesis: Wajak would have been an early representative of, or akin to the ancestry of the Asians. He did not, however, accept the idea himself, and he rather preferred his first hypothesis of Wajak having Mediterranean affinities. According to Hooijer (1950, 1952) there had been a widespread progressive diminution in size of various Southeast Asian mammals during the Quaternary, including *Homo sapiens*. As stated before, Jacob saw both 'Australoid' and 'Mongoloid' characters in the Wajak skulls (Jacob, 1967, 1968). The 'Mongoloid' traits would be: alveolar prognathism, broad nasal root, broad face, high cheek bones and facial flatness. According to Jacob, Wajak was the ancestor of both the Austromelanesians and the Proto-Malayan. Bulbeck (1982) considered East Asian specimens, including Wajak, as 'Proto-Mongoloid'.

Conclusion and aim of this thesis

Ever since the description (Dubois, 1920, 1922) Wajak Man has played an important role in the discussions on the evolution of modern humans in Australasia. Because of the robust morphology of the skull, Wajak Man was seen as a link between Pleistocene hominids from Java (Solo) and recent Australian Aborigines. For a long time hardly any attention has been paid to the contents of the other boxes with human, fauna and cultural remains, as collected by Dubois around 1890. Because a satisfactory description of the Wajak fossils has so far been lacking and the archaeological context of the Wajak site had so far been ignored, the evolutionary position of Wajak Man necessarily remained unclear. Moreover, although the Wajak skulls have been found in Java, a comparison with recent skulls from this island has never been made.

The aim of this thesis is to describe the human fossils from the Wajak site, to provide the prehistoric background for their interpretation, and to compare the Wajak skulls with other recent and prehistoric skulls from China, Java, Papua New Guinea and Australia, in order to evaluate their morphology and to give them a place in the evolution of modern humans in Australasia. Furthermore, I will try to explain the possible underlying 'mechanisms and factors' which are responsible for the variation and evolutionary cranial changes in Australasia.

Material and methods

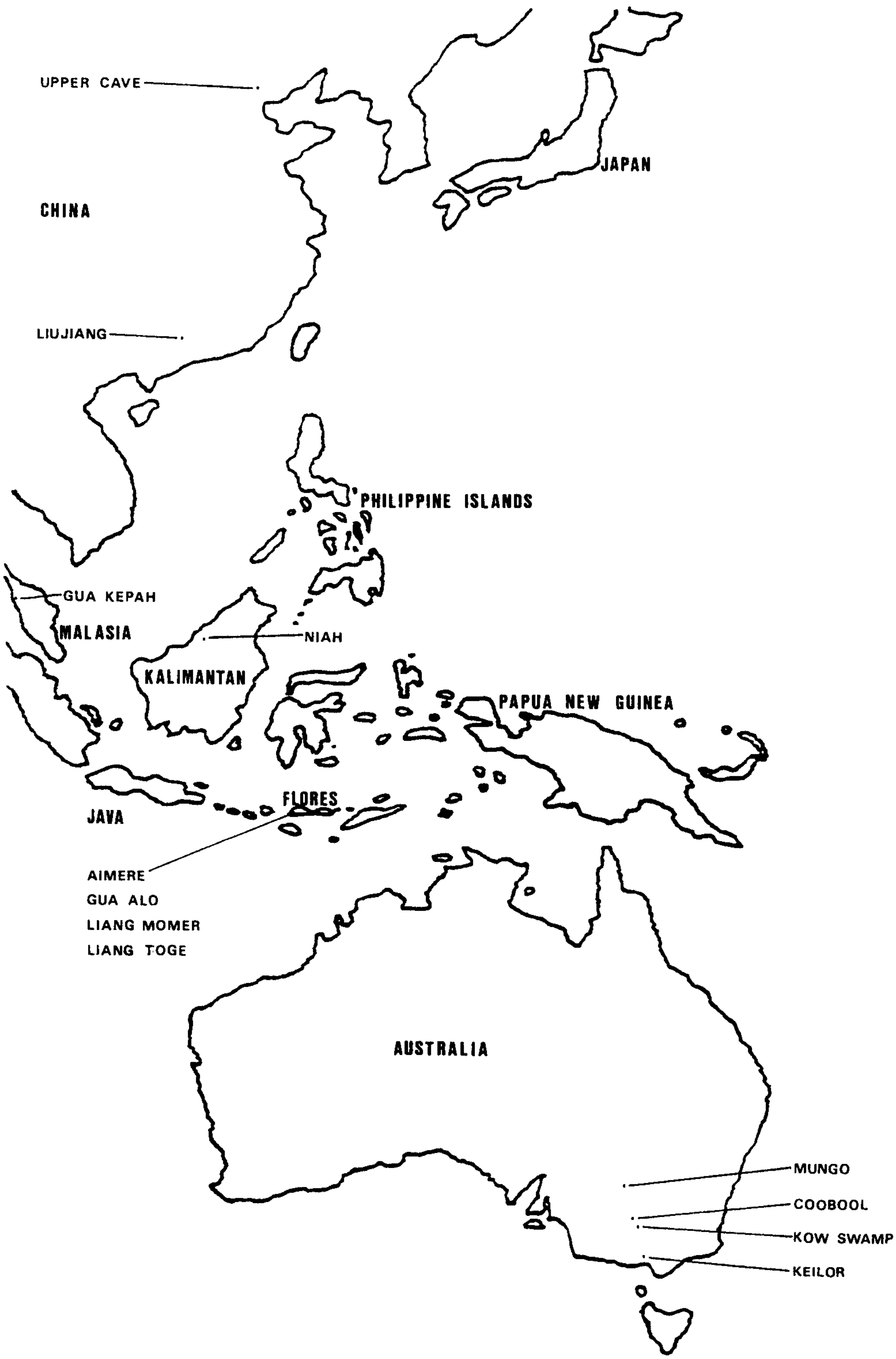
Introduction

In general the term 'recent' is used to refer to material dating from a hundred to a few hundred years old. The term 'subrecent' is used to refer to prehistoric material from the Holocene. In this thesis the modern Indonesian orthography has been adhered to. Original spellings such as: Goea, Wadjak, Ketjil, Sampoeng and Djimbe are written as: Gua, Wajak, Kecil, Sampung and Jimbe. Dutch names such as Hoekgrot remain the same.

Prehistoric skulls

Table 1 provides a view of the prehistoric skulls which have been studied and Fig. 5 the sites where they were found. The Solo skulls from Java and the skulls from China and Australia are all replicas, with one exception, the Kanalda skull from Australia. The skulls from Java, Malaysia and Flores are all original. The abbreviations used for some of the individual skulls and the Museums where the skulls are stored are given. The Javanese Middle Pleistocene Solo skulls selected were the more complete specimens. The prehistoric specimens from Java, Malaysia and Flores are usually all assumed to originate from the Holocene period. The more complete prehistoric Indonesian skulls considered and compared with the Wajak skulls stem from Java (Hoekgrot and Sampung- H) and Flores (Liang Momer-E and Liang Toge). For comparison, the skull fragments from the following regions are added in the Tables: Java (Gua Kecil and Gua Jimbe), Malaysia (Gua Kepah) and Flores (Aimere and Gua Alo).

Fig. 5A. Sites of the prehistoric skulls in Australasia studied/discussed. The four recent collections studied come from China, Java, Papua New Guinea, and Australia.


UPPER CAVE
JAPAN
CHINA
LIUJIANG
PHILIPPINE ISLANDS
GUA KEPAH
MALASIA
NIAH
KALIMANTAN
PAPUA NEW GUINEA
FLORES
JAVA
AIMERE
GUA ALO
LIANG MOMER
LIANG TOGE
AUSTRALIA
MUNGO
COOBOOL
KOW SWAMP
KEILOR

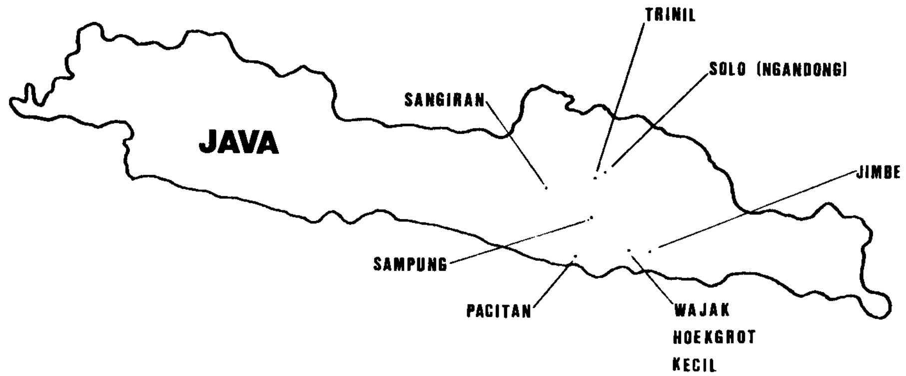


Fig. 5B. Sites of the prehistoric skulls in Australasia studied/discussed. The four recent collections studied come from China, Java, Papua New Guinea, and Australia.

To compare the Wajak skulls with prehistoric skulls from northern and southern regions, the following specimens are used: Liujiang, U.C.1, U.C.2, U.C.3 (from China); Kanalda, Keilor, K.S.1, K.S.5, K.S.15, Mungo-1, and Mungo-3 (from Australia).

Recent skulls

Most of the recent material from the reference collections (i.e. Java, Papua New Guinea and Australia) used for comparison probably originates from populations of the preceding century. The Chinese reference collection comes from a cemetery and is possibly older. Table 2 gives a view of the number of recent skulls which have been studied, the region of origin and the institutions where they are stored. In general, the skulls were selected with the following 'qualities'. They are from adults (synchondrosis sphenooccipitalis [nearly] closed), though not from very aged individuals (skulls with strong alveolar destruction were avoided). Skulls or parts of skulls showing distinct pathological, traumatic conditions and/or artificial deformation were excluded. Preferred were skulls with a mandible and complete dentition (molars). There was no selection on other morphological characteristics. Starting with the lowest catalogue number (if possible), every skull was selected that showed the above mentioned conditions.

The Chinese skulls — The sex of only six of the 63 Chinese skulls was recorded in the 'Catalogus der schedels uit het Rijksmuseum voor Volkenkunde', they were all recorded as male (Table 2). According to this catalogue the skulls are a gift from Dr B. Hagen, his name in fact being marked (on all skulls) next to the year '1885' and 'Zuid Chinese Koelie'. This last indication makes it probable that all skulls are male.

The Javanese skulls — Little is known about the Javanese skulls from C/S (Table 2). Much more is known about the 89 skulls kept in the AEM, which are coming from a mental hospital in Batavia (nowadays Jakarta), as collected by Dr Swaving. The years mentioned on these skulls range from 1856 to 1877. The sex of these skulls was recorded in the 'Katalogus der Ras schedels, bekkens en skeletten in het Anatomisch

Kabinet der Rijksuniversiteit te Leiden'. Because of this favourable situation of known sex, in the Tables under the head of 'males' (n = 80) and 'females' (n = 9) only the skulls of the AEM are used.

The Papua New Guinea skulls — Little is known of the 64 Papua New Guinea skulls from C/S (Table 2). The diagnosis of the sex was done in two steps. Firstly, the collection was divided in clearly male, clearly female and 'problematic indifferent skulls' by using the impression (inspired by Howells, 1973). Secondly, the mean scores were counted of the individual male and female skulls using the following characteristics: glabella; superciliary arches; inclinatio frontale; orbita (form + supraorbital margin); size and surface of zygomaticum bone; zygomatic process; frontal tubera; parietal tubera; mastoid process; supramastoid crest, occipital protuberance/torus; area of the nuchal lines and occipital crest (development ranges from -2 to +2; see Workshop, 1980). I obtained the following results and solution for problematic skulls:

	Average	Range	Problematic skulls
Males	+0.4	-0.2 - +1.3	female < -0.2 < male
Females	-0.8	-1.5 - -0.2	

After dividing the problematic skulls, the total number of female skulls is 34 (53%) and male ones is 30 (47%).

The Australian skulls — On only two of the 42 Australian Aborigines is a year written: 1879 and 1898. On the 3 replica skulls from the UMU the name of 'Klaatsch' is written. According to the catalogue of the NHM the skulls (35) come from Queensland, New South Wales, South Australia and Western Australia. For the diagnosis of the sex determination the same procedure was followed as with the Papuan skulls, with one difference: two impressions were used, that of the NHM catalogue, and mine. I obtained the following results and solution for problematic skulls:

	Average	Range	Problematic skulls
Males	+1.0	+0.4 - +1.8	female < 0.0 < male
Females	-0.5	-0.7 - -0.3	

After dividing the problematic skulls, the total number of female skulls is 8 (19%) and male skulls is 34 (81%).

Archaic characters

In order to obtain the cranial characters which are discussed for the morphology of *Homo erectus*, the works of Santa Luca (1980), Andrews (1984), Rightmire (1984), and Stringer (1984) were used. Results are given in the Tables 21-23.

1. Low skull: (length/height index ≤ 64.9).
2. Postorbital constriction: (index ≤ 74.9).
3. Supraorbital torus: clearly present as a thick/robust, and more or less straight

structure. The glabella, superciliary arches and zygomatic trigones all form part of this structure. Its development ranges from absent to present.

4. Superstructures: the superstructures judged include: metopic ridge, bregmatic eminence, coronal ridge, sagittal ridge and torus angularis (see for definitions Santa Luca, 1980). My classification ranges from absent (not present, slight or only one structure clearly present) via ambiguous (small or only two structures clearly present) to distinct presence (three or more structures clearly present).

5. Parietal bones converge: more or less immediately above the supramastoid crest. Range from absent to present.

6. Parietal margin os temporale: the parietal margin of the temporal squama has a low flat/straight superior border. The range is from absent to present.

7. Fissure between mastoid process and crista petrosa: a fissure of at least a few mm separates the mastoid process from the crista petrosa of the tympanic bone. They ranged from absent (not present or only one side around 1 mm) via ambiguous (trace or both sides around 1 mm) to distinct (clearly present on one or two sides).

8. Angle os occipitale: viewed from norma lateralis there is a clear, more or less sharp angle between the nuchal and the occipital planes, divided by a distinct occipital torus. The range is from absent to present.

9. Occipital torus: clearly present as a strongly developed structure which divides the occipital bone into a nuchal and an occipital plane (Opistocranion = Inion). The range is from absent to present.

Measurements

Table 3 gives an overview of the measurements, the abbreviations, the source of the definitions, and the instruments preferably used. The results are given in the Tables 24-58 (Tables 59-70 and 71-79 give the calculated indices and modules, respectively).

Definitions of the cranial landmarks

Alveolon: (alv) 'the middle of a transverse line connecting the posterior extremities of the maxillary alveolar border' (Brown, 1989, p. 10).

Basion: (bas) 'on the anterior border of the foramen magnum, in the midline, at the position pointed to by the apex of the triangular surface at the base of either condyle, i.e., the average position from the crests bordering this area' (Howells, 1973, p. 166.).

Bregma: (bre) 'the posterior border of the frontal bone in the median plane' (Howells, 1973, p. 167).

Ectomolare: (ect) 'the most lateral point on the outer surface of the alveolar margins' (Bass, 1987, p. 67).

Glabella: (gla) 'the most prominent point between the superciliary arches in the median sagittal plane' (Brothwell, 1981, p. 80).

Gnathion: (gna) 'middle point on the lower border of the mandible' (Brothwell, 1981, p. 80).

Infradentale: (inf) 'the most antero-superior point on the alveolar margin between the lower central incisors in the lower jaw' (Brothwell, 1981, p. 80).

Lambda: (lam) 'the apex of the occipital bone at its junction with the parietals, in the midline' (Howells, 1973, p. 168).
Nasion: (nas) 'the intersection of the fronto-nasal suture and the median plane' (Howells, 1973, p. 169).
Opisthion: (opi) 'the inferior edge of the posterior border of the foramen magnum in the midline' (Howells, 1973, p. 169).
Prosthion: (pro) 'the most anteriorly prominent point, in the midline, on the alveolar border, above the septum between the central incisors' (Howells, 1973, p. 169).

Definitions of the measurements

1. Glabella-occipital length: (GOL) 'greatest length, from the glabellar region, in the median sagittal plane' (Howells, 1973, p. 170).
2. Basion-bregma height: (BBH) 'distance from bregma to basion' (Howells, 1973, p. 172).
3. Maximum cranial breadth: (XCB) 'the maximum cranial breadth perpendicular to the median sagittal plane (above the supramastoid crests)' (Howells, 1973, p. 172).
4. Frontal chord: (FRC) 'direct distance from nasion to bregma, taken in the midplane and at the external surface' (Howells, 1973, p. 181).
5. Parietal chord: (PAC) 'direct distance from bregma to lambda, taken in the midplane and at the external surface' (Howells, 1973, p. 182).
6. Parietal arc: (S2) 'surface distance from bregma to lambda' (Brothwell, 1981, p. 83).
7. Occipital chord: (OCC) 'direct distance from lambda to opisthion, taken in the midplane and at the external surface' (Howells, 1973, p. 182).
8. Occipital arc: (S3) 'surface distance from lambda to opisthion' (Brothwell, 1981, p. 83).
9. Maximum supraorbital breadth: (MSB) 'maximum diameter of the frontal bone across the supraorbital ridges' (Larnach & Macintosh, 1970, p. 12).
10. Minimum postorbital diameter: (MPD) 'taken on the fronto-sphenoidal suture' (Larnach & Macintosh, 1970, p. 13).
11. Basion-nasion length: (BNL) 'direct length between nasion and basion' (Howells, 1973, p. 171).
12. Basion-prosthion length: (BPL) 'the facial length from prosthion to basion' (Howells, 1973, p. 174).
13. Nasion-prosthion height: (NPH) 'upper facial height from nasion to prosthion' (Howells, 1973, p. 174).
14. Bizygomatic breadth: (ZYB) 'the maximum breadth across the zygomatic arches, wherever found, perpendicular to the median plane' (Howells, 1973, p. 173).
15. Width fronto-nasal articulation: length of the sutura fronto-nasalis.
16. Nasal height: (NLH) 'the average height from nasion to the lowest point on the border of the nasal aperture on either side' (Howells, 1973, p. 175).
17. Nasal breadth: (NLB) 'the distance between the anterior edges of the nasal aperture at its widest extent' (Howells, 1973, p. 176).
18. Maxilloalveolar length: (MAL) from 'alveolon to prosthion' (Larnach & Macintosh, 1966, p. 73); 'place one end of the calliper on prosthion and the other on a

straight wire, knitting needle, or wooden rod placed across the posterior edges of the alveolar processes (alveolon) of the two sides' (Bass, 1987, p. 77).

19. Maxilloalveolar breadth: (MAB) palate breadth, external; 'between the two ectomolaria' (Larnach & Macintosh, 1966, p. 73); 'the greatest breadth across the alveolar border, wherever found, perpendicular to the median plane' (Howells, 1973, p. 176).
20. Cheek height: (WMH) 'the minimum distance, in any direction, from the lower border of the orbit to the lower margin of the maxilla, mesial to the masseter attachment'; on the right side, Howells (1973, p. 180) uses the left side.
21. Mandibular length: (ML) 'distance between the most posterior points on the condyles to the most anterior point of the chin' (Brothwell, 1981, p. 83).
22. Bi-condylar breadth: (W1) 'diameter between most external points of the mandibular condyles' (Brothwell, 1981, p. 83). For this measurement it is easy to use the broad flat ends of the sliding calliper.
23. Coronoid height: (CrH) 'mandible placed on board and held steady as for ML. Maximum height of the coronoid process from the base' (Brothwell, 1981, p. 83).
24. Corpus height: (Che) 'height of the mandibular corpus interproximally between M1-M2' (Brown, 1989, p. 10).
25. Corpus thickness: (CTh) 'maximum thickness of the mandibular corpus at the level of M1-M2' (Brown, 1989, p. 10). This measurement is taken at a right angle to the corpus height.
26. Symphysis height: (SHe) 'height of the mandibular symphysis measured from its lowest median point (gnathion) to the tip of the alveolar process between the medial incisors (infradentale)' (Brown, 1989, p. 11).
27. Symphysis thickness: (STh) 'the maximum anteroposterior dimension of the mandibular symphysis taken at a right angle to the symphysial height dimension' (Brown, 1989, p. 11).
28. Ramus breadth: (RB') 'minimum ramus breadth. Smallest distance between anterior and posterior borders of the ascending ramus' (Brothwell, 1981, p. 83).
29. Upper length P3-M3: from mesial point (in the middle) of the P3 to distal point (in the middle) of the M3.

30/32/34. Mesiodistal length of M1/M2/M3: maximum length in the middle.

31/33/35. Buccolingual breadth of M1/M2/M3: maximum breadth in the middle.

Non-metrical characters

In order to obtain non-metrical characters in Late Pleistocene and Holocene skulls the work of Larnach & Macintosh (1966, 1970, 1971, abbreviation used is L&M) to characterise Australian Aborigines and the work of the Workshop (1980) for sexual diagnosis were used. The results are given in the Tables 80- 110.

1. Inclinatio frontale: ranges from vertical to strongly inclined (Workshop, 1980).
2. Keeling of the vault: viewed from norma frontalis, ranges from absent to distinct presence (L&M, 1966).
3. Median frontal ridge: ranges from absent to distinct presence (L&M, 1966).
4. Glabella: ranges from absent (smooth surface) to massive prominent (Workshop, 1980; character also used by L&M, 1966).

5. Superciliary arches: ranges from absent (smooth surface) to very marked arches (Workshop, 1980; character also used by L&M, 1966).
6. Zygomatic trigones: (=arcus supraorbitalis) ranges from a triangular depressed field (absent) to an extremely prominent bulbous projection (large), (L&M, 1966).
7. Frontal tubera: ranges from missing to marked presence (Workshop, 1980).
8. Parietal tubera: ranges from missing to marked presence (Workshop, 1980; character also used by L&M, 1966).
9. Mastoid process: ranges from very small to very large (Workshop, 1980).
10. Supramastoid crest: ranges from a smooth surface to a strongly marked ridge.
11. Occipital torus: a clearly elongated mound of bone between the highest and superior nuchal line. A limited mound of bone in the centre of the occipital bone (external occipital protuberance) is not seen as a torus. Its presence ranges from absent to distinct (L&M, 1966).
12. External occipital protuberance: ranges from absent to distinct presence (L&M, 1966; character also used by the Workshop, 1980).
13. Nuchal lines and occipital crest: ranges from a smooth surface to a marked rough surface (Workshop, 1980).
14. Orbital form and supraorbital margin: the orbital form ranges from round to quadrangular; the supraorbital margin from a very sharp border to a very rounded border (Workshop, 1980).
15. Flattened lower orbital border: ranges from absent (sharp, slightly rounded) to distinct (flattened, with three distinct surfaces) (L&M, 1966).
16. Phaenozygy: denotes that the zygomatic arches are easily seen from norma verticalis. Ranges from absent (not visible, very small part visible) to distinct presence (clearly not attached to the skull) (L&M, 1966).
17. Os zygomaticum: ranges from very low with a smooth surface to very high with an irregular surface (Workshop, 1980).
18. Inferior border nasal aperture: ranges from a single more or less sharp border, via a situation whereby the margo infranasalis and crista prenasalis are close together, to a situation whereby the crista prenasalis runs forward (smooth border) (L&M, 1966).
19. Subnasal prognathism: ranges from absent to large (L&M, 1966).
20. Palatine torus: a clear mound of bone, following the course of sutura palatina mediana. Its presence ranges from absent to distinct (L&M, 1966).
21. Mental protuberance: (chin) ranges from small rounded to very prominent (Workshop, 1980).
22. Mental trigone: 'The prominence of the mental trigone is not necessarily proportional to the prominence of the chin, the degree of projection of the latter being dependent more on the development of the anterior mandibular incurvature' (L&M, 1971, p. 9). Its presence ranges from slight to marked (L&M, 1971, p. 30).
23. Anterior mandibular incurvature: ranges from slight to marked (L&M, 1971).
24. Projection of the chin: ranges from negative to positive (L&M, 1971)
25. Decline planum alveolare: ranges from vertical to greater decline (L&M, 1971).
26. Mylohyoid line: ranges from slight to marked presence (L&M, 1971).
27. Sulcus extramolaris: ranges from slight to marked presence (L&M, 1971).
28. Lateral prominence: ranges from slight to marked presence (L&M, 1971).

29. Fossa precoronoidea: ranges from shallow to deep (L&M, 1971).
30. Angulus mandibulae: ranges from a smooth surface to strongly marked eminences (Workshop, 1980).
31. Planum triangulare: size ranges from small to large (L&M, 1971).

Instruments and working-up the data

The instruments used were a sliding calliper (Helios), a dial calliper (Mitutoyo), a spreading calliper (GPM), an osteometric board(self made) and tape (synthetic). For one feature (recession of the frontal bone) the coordinate calliper (GPM) was used. Further requirements needed were a sonde, and a pillow for the skull. The data were processed by Lotus 123 computer programme. The following functions of Lotus were used: Number (@COUNT), Minimum value (@MIN), Average value (@AVG), Maximum value (@MAX) and Standard deviation (@SQRT[@COUNT[list]/ [@COUNT[list]-1] *@VAR[list]]). Before the construction of distributions of indices and modules, the round function (@ROUND[x,1]) was used for individual scores.

Sources of errors

Prehistoric skulls: some of the prehistoric skulls are fragile and hence measurements had to be taken with great care. Erosion, although slight, posed a problem. Sometimes the marks of previous measurements appeared to have been left on a skull. They can uncover differences between researchers' findings.

Reference material: the groups had different origins. Selection of the material cannot be excluded. For instance, all the Australian aborigine skulls in this study from collections in the Netherlands can be classified as 'robust males'. It is clear that many of the Papua New Guinea skulls originate from a 'ritual situation'. As far as can be checked, most (probably all) Javanese skulls originate from a dissecting-room.

Space and light: the various collections offered different situations. An ideal situation enabled the display of 60 to 70 skulls for comparison, but this was not always the case. Lighting conditions differed, and possibly this has had an effect on reading measurements and on scoring characters.

Sawing of the skull: 79 of the 89 Javanese skulls of the AEM had been sawed to lift up the calva; undoubtedly this affected some of the measurements (for instance BBH).

Possible pathology: One of the 80 Javanese male skulls showed an extremely low BBH (114 mm). In fact the skull looks different. It is included in the total series but excluded from the male series.

Different application of technique: although I tried to use for both measurements and non-metrical characteristics only those studies that use explicit definitions, it cannot be excluded that the execution differed, because workers do things differently (Howells, 1973).

Repeated measurements: remeasuring did sometimes produce (minor) differences (for instance, the teeth measurements).

Instrument errors: there is a difference between reading a sliding calliper and a dial calliper. The osteometric board was self-made and the tape made of synthetic material which could entail slight differences with other researchers using instruments made differently.

The MAL: remeasuring of the MAL showed that this measurement, because of the method, must rather be considered as an estimation.

Rounding off: part of some measurements (FRC, PAC, OCC, BPL, MAL and MAB) have been rounded off twice.

Reading and recording errors: cannot be excluded to have occurred.

To maximally avoid errors I performed all the morphological descriptions, measurements and scoring of the non-metrical characters myself (thus avoiding interworker error) similarly with the working up of the data (to recognise improbable figures). I remeasured several of the prehistoric skulls. In the recent skulls all high and low scores were verified for recording errors. In situations where any doubt arose about an error reaching a value more than insignificant, the material or method was abandoned.

The late prehistory of Indonesia

Sites

The Wajak site (Java) — This site was described in the Introduction.

The Hoekgrot site (Java) — In the period from October 1890 till December 1890 excavations were carried out at the Hoekgrot site (other names sometimes used are 'Hukgrot, 'Eastern [Corner] Cave', 'Gua Lawa', 'Kovher Cave', or 'Nieuwe Grot'; Figs. 2, 6, 7). At the Hoekgrot site not only red-painted human material was found, but also unpainted human bones, faunal remains, artefacts and tools (bone implements and pottery fragments), other signs of cultural acivities and remains of a domesticated dog. Dubois (1922) stated about the Hoekgrot site:

'At the eastern corner of the described rectilinear part of the mountain at a height of about 120 meters above the plain, in the same kind of breccia and clay and again on a small terrace-shaped projection (behind which was found the entrance of a cave forty meters long, running in the shape of a U, and almost entirely filled up with the same kind of clay, in which nothing of any importance was found), I dug up some parts of a human skeleton in the same year, which are in a very different state of fossilisation, and have a quite different anthropological character. It is also certain that these remains were worked as skeleton by human hand, for the outer surface of the cranial bones (not the inner surface), the teeth and also other bones were painted red with a firmly adhering ochre-layer. After this the bones must have been broken, for the fragments were encrusted and partly enclosed in breccia, in a similar way as those of the two Australoids. [Dubois means the two Wajak skulls]. They are however much less petrified and specifically lighter than these.'

There is a note from one of the assistants of Dubois, which is dated December 30 1890 and reported that two days before nothing more than a few human molars had been found and that the exit of the cave was 6.10 m deep. This could be an indication that the excavations were thoroughly done and everything found was collected. Another indication for this last mentioned statement is the fact that a map with a grid system of the excavations of the Hoekgrot site was made. In the boxes in which the fossils from the Hoekgrot site were stored, notes were found which, however, provided little information. Part of the fossil bones were found at a depth of 1.25 m below the surface, but another part was lying scattered through the site and probably a few bones have been collected from the surface. This would mean that there is some recent 'distortion' in the bone assemblage from the Hoekgrot site. According to Aziz & de Vos (1989) it seems still possible to excavate the Hoekgrot site, which certainly could give a solution for some of the problems.

Dubois (1922) mentioned only the human remains from the Hoekgrot site and made a remark about the morphology of the skull found at that site, which would be distinctly brachycephalic, in contrast to the Wajak skull. He gave no further description of these fossils. Some of the human fragments and the calotte were described by Nelson (1988, 1989). After Nelson's description of the human material, much more human material was found in the boxes in which the material is stored (NNM). A 'complete' description and discussion of this site, the fauna, cultural remains and human remains is given by Storm (1990a). One of the most striking aspects of the Hoekgrot material is the complete red painted skeleton, as described in the chapter 'The human material from Hoekgrot'.

The Gua Kecil site (Java) — The importance of the Kecil site is, just like the Hoekgrot site, its closeness to the Wajak site, in the mountain slope near Tulung Agung (Fig. 2). As far as can be deduced from a letter from De Winter to Dubois, excavations at the Kecil site (other name used: Western Cave) started around December 28, 1890 and ended around January 4, 1891. The fauna of this site has been described by Span (1993) and the fragmentary human remains by Nelson (1988). Because of the fragmentary state little can be said about the human material.

The Gua Jimbe site (Java) — The fossils from the Gua Jimbe site have also been collected by Dubois in 1890. It is situated near Redjobangan, c. 10 km west of Blitar in East Java (van den Brink, 1983). There are only a few notes about this site and it is not possible to give a reconstruction of the site and the excavation. In August 1890 Dubois stated about the Gua Jimbe site that c. 2 m beneath the surface a carafe, thurible, simple earthenware lamp and some copper ornaments had been found. He mentioned that at a depth of at least 3 m bones of pig, muntjak, small cat, porcupine, and monkeys had been found. Furthermore, human remains (mandible, maxilla and postcranial material) had also been found at this level. I think that the layer of 3 m (where bone tools, human and faunal remains have been found) belongs to an older period than the layer at a depth of 2 m. Data considering the fauna from this site have been published by Brongersma (1941), Hooijer (1946, 1962) and have been described by van den Brink (1983). Fragments of the human remains have been described by Nelson (1988, 1989). The bone tools have been preliminarily described

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Fig. 6. Map of the Hoekgrot site made by Dubois' assistant de Winter. The Hoekgrot site incorporates a cave (left side) and an abri (right side). The script in the figure reads, left to right (cave): uitgang = exit; Buitenkant rots = outside rock; Van ingang tot uitgang 40 meter = from entrance to exit 40 m; Plattegrond = ground-plan; Hoekgrot bij Tjermee waarvoor menschenschedel (ED 1920) = Hoekgrot at Tjerme for which a human skull (E[ugène] D[ubois] 1920); ingang = entrance. Top to bottom (Abri): Hier ergens menschenschedel foto ingang = somewhere here a human skull photograph entrance; schaal van 1 op 100 = scale of 1:100; Plattegrond = ground-plan; Hoekgrot Tjermee = Hoekgrot Tjerme. The red painted skull (skeleton) is found at the right side of the entrance (see Fig. 7).

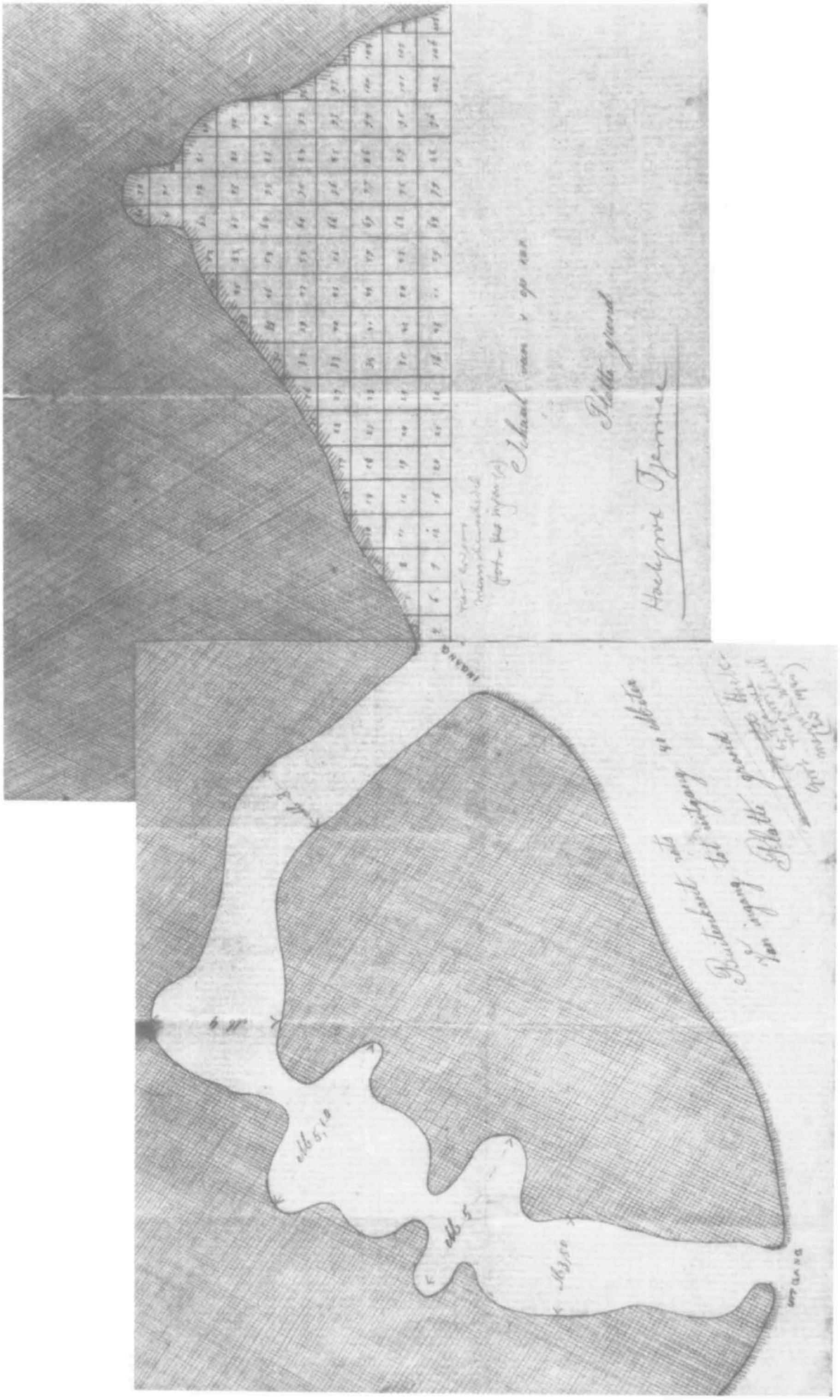

Fig. 7. The Hoekgrot site, photograph taken in 1890. The stick indicates where the red painted skull (skeleton) was found (see Fig.20). Notice the entrance of the cave at the left side (see map of Fig. 6).

by Burgers (1988). A more extensive description and discussion of these bone tools is given by Storm (1990b).

The Sampung site (Java) — The Mesolithic/Neolithic site Sampung is located 1.6 km south of Sampung, Ponorogo, East Java and is well known for its bone tools. The first publication of the Sampung site (also called the Guwo Lowo; Guwo = cave and Lowo = bat) was given by van Es in 1929 who discovered the site in 1926. A more extensive description was given by van Stein Callenfels in 1932, who worked on this site from 1928 till 1930. Information on the fauna was given by Dammerman (1932, 1934). The human remains have been described by Mijsberg (1932) and the skeleton of Sampung (H) by Jacob (1967).

The Liang Toge site (Flores) — The abri site Liang Toge (West Flores, near Warukia) was discovered by Th. Verhoeven in 1952, and in an exploring 'excavation' (with a pit of c. 50 cm x 50 cm and 80 cm deep) he found flakes (Verhoeven, 1974). In November 1954 he started to excavate the site and found a more or less complete skeleton, which is described by Jacob (1967). The remains of the mammals (*Dobsiona peroni, Macaca fascicularis, Rattus rattus, Papagomys armandvillei, Papagomys verhoeveni, Spelaeomys florensis, Acanthion brachyurus, Sus scrofa*) have been described by Hooijer (1967) and the cultural remains (flakes, blades, scrapers, ornaments made of mother-of- pearl, cores) by van Heekeren (1967). The date given by Jacob (1967) is 3550 ± 525 BP.

The Liang Momer site (Flores) — The site Liang Momer (West Flores, near Labuanbadjo) was discovered by Verhoeven in 1954, and named after Father Mommersteeg. As well as five human skeletons (which are known as Momer A, B, C, D and E), cultural remains have also been found of flakes, shell and bone implements, which have been interpreted as a Mesolithic assemblage (Jacob, 1967).

Taphonomy

The most striking phenomena of the material of the various Javanese sites, such as the composition of the fauna, marks of gnawing on bone material, the fragmentary state of the material and the production of pseudotools, will now be discussed.

Marks of gnawing on bone material — The bone fragments from the various sites, which have marks of gnawing on them, are mainly from the large rodent *Hystrix javanica*. These fragments are easily recognised because of the imprint of the porcupine incisors. Gnawing marks of little rodents (also the imprint of the incisors) are sometimes found. Marks that are possibly produced by carnivores are not clear. Bones have been found with both cutmarks and marks of gnawing, which means that after man had left the site a large rodent like *Hystrix javanica* visited the site and gnawed at the bones left by man.

Gnawing marks produced by porcupines are also known from South Africa; Brain (1981, p. 109) remarks: 'It is rather surprising that a vegetarian rodent like *Hystrix africaeaustralis* should prove to be an important collector of bones; yet I suspect porcupines carry more bones to African caves than does any other species'.

The fact that porcupines can be seen as 'collectors of bone' immediately raises the question as to what kind of role the porcupine has played in the bone accumulation of the Holocene sites excavated by Dubois. Probably the most important bone collector at these sites was not the porcupine because there are (relatively seen) not many bone fragments gnawed by *Hystrix javanica*. As far as gnawing is considered most of the bone fragments are undisturbed. In the examined collections of bones by Brain (1981, p. 117), gnawed percentages varied between 22% and 100%. Although the percentages of gnawed bones of the Javanese sites are not known, they are certainly not that high. In material from the sites of Sumatra and that of Punung (Java), and in the bone assemblages from Chinese drugstores the 'picture' is very different. In these bone collections often only the enamel of the teeth is present because the rest of the bone is completely absent due to gnawing by porcupines.

The fragmentary state of bone material — Characteristic of the bone assemblages of the Wajak, Kecil, Hoekgrot and Jimbe sites is the fragmentary state of the bone material. Brain (1981, p. 32) mentioned two factors which could be responsible for the fragmentary state of the bones at Pomongwe: 'The fragmentation of the bones at Pomongwe can be attributed largely to two factors: purposeful breakage by Stone Age people to extract marrow, and trampling by people walking around in the cave'.

In the case of the above mentioned Javanese Holocene sites, possibly trampling is the most important factor responsible for the fragmentary state of the bone assemblage. It is not necessarily (solely) caused by humans, it is possible that other animals (also) have been agents of trampling (personal communication Stringer, 1994). All parts of the bones show this fragmentary state and not only the diaphyses (which contained marrow). The red painted skeleton, which probably is the result of a ritual mortuary practice, was also found in many pieces. Breakage appeared to have occurred after painting of the skeleton because the broken edges show no red colour. The pattern of breakage can, in some instances, be demonstrated by single pieces of bone imbedded in hard matrix in which cracks are to be found. The process of trampling is also demonstrated by the wear and polishing of some of the bones.

The production of pseudotools — Not all bone fragments with marks of wear and polish on the broken edges can be interpreted as (real) bone tools. On this phenomenon Brain (1981, p. 15) remarked for Hottentot villages: 'While collecting bone fragments from the vicinity of the Hottentot villages, I was surprised to find many pieces that appeared to be bone tools. They tapered to points and showed wear and polish that had surely resulted from human use. In reply to my queries, the Hottentots denied that they made use of bone tools at all, and I had to find a different explanation for the remarkably suggestive appearance of these 'pseudotools'.

Part of the Javanese Holocene bone fragments were not interpreted as 'real bone tools'. They do not show the regular form of a tool. In most instances these fragments are less smooth and less shiny than those interpreted as 'real bone tools'. These signs of wear and polish occur also at the surfaces of the human material, for instance the cranium which is unlikely to have been used as a tool because of its shape and fragmentary character. A clear example is the cranium and mandible of the red painted skeleton from Hoekgrot. There are seventeen bone fragments (total weight 70 g) from this site with marks of wear and polish on the broken edges, which are not interpreted as bone tools. This means that the pseudotools from the Hoekgrot site can perhaps be interpreted as the effect of trampling and thus suggests that this site was regularly visited by humans and/or animals. Admittedly, one could question this explanation because of the differences in environmental circumstances between the villages of the Hottentots and the Hoekgrot site. However according to Brain (1981, p. 17): 'Pseudotool production is not restricted to arid environments like that of the Kuiseb River, and the mechanism should be born in mind when interpretation of a bone assemblage is undertaken'.

The composition of the faunal assemblage — Van den Brink (1982) provides three possibilities for the faunal composition of the Wajak site:
- The fossils were in situ, the animals died in the 'cave'.
- The bones were washed into the 'cave'.
- The presence of the bones in the 'cave' was due to human activities.

Analyzing these possibilities she stated that the in situ hypothesis is not very likely because of the fragmentary preservation and the presence of fossilised bones of animals of various habitats. The second possibility is equally unlikely because the bones are not abraded and do not show marks of transportation. The third possibility would hence be worth while considering and she wonders why so few human remains have been found at Wajak and why there is so little material of rhinoceros, tiger and tapir. Another (fourth) possibility is that animals brought parts into the abri Wajak (Stringer, pers. comm. 1994).

These questions and remarks are not only valid for the Wajak site but also for the Kecil, Hoekgrot and Jimbe sites. Most of the animals found at these sites are unlikely to have died there because, except for the domesticated dog from Hoekgrot and the muntjak from Jimbe, no (more or less) complete skeletons of animals have been found. In fact the various animals are frequently represented by only one or a few elements of the skeleton. The bones show no marks of transportation, thus the hypothesis of the bones washed into these abri's and caves is also very unlikely. The presence of humans is dominating at these sites (Tables 6-7), therefore the presence of the bones at these three sites is probably due to human activities. It is possible that *Hystrix javanica* did not only visit the sites and gnaw at bones but brought bones into these abri's and caves or took bones from these sites to their own lairs. This may be an explanation for the species that are sometimes only represented by a single tooth fragment (elephant, rhinoceros, tapir and tiger).

Faunas

Dubois (1922) only mentioned that at the Wajak site a few fragments of bones of mammals were found, which, as far as could be ascertained, appeared not to be different from species now extant in Java. All the bones were found in the same state of fossilisation as the Wajak skulls. Before van den Brink (1982) described the vertebrate fauna from the Wajak site, only a few data on the Wajak fauna had been published: i.e. on *Panthera tigris*, (Brongersma, 1937), on *Tapirus indicus*, (Hooijer, 1947) and on *Trachypithecus* (Hooijer, 1962). Not only land vertebrates have been found at the Wajak site, but also invertebrate remains from the sea (shell fragments of mollusca and six spines of echinodermata).

Before a discussion on the fauna from the various sites is given (Table 4) a few remarks have to be made about the formation of this table. The species lists of the sites Jimbe, Wajak and Sampung are taken from van den Brink (1983). All large Cervidae in this table are recorded as one large deer: *Rusa timorensis*, even though van den Brink (1983) gives three species of Cervidae: *Cervus eldi, C. timorensis* and *C. kuhlii.* The smaller mammals such as small rodents are not given in this table because they were not recorded for every site.

The subrecent fauna from Java — One of the interesting aspects of the Holocene subrecent fauna (Table 4) is that it gives a picture of the fauna of Java before the island became heavily populated by humans. Some of the animals which we find at prehistoric sites are extinct in Java nowadays, such as *Tapirus indicus, Elephas maximus, Capricornus sumatraensis,* and *Panthera tigris.* An animal like *Rhinoceros sondaicus* is restricted to a reserve in West Java. It can be expected that the transition from the Mesolithic to the Neolithic period in Java has had its effect on the wild animals because of the vanishing forests and the introduction of domesticated animals.

As far as can reasonably be judged (based on the C-14 dates and artefacts; Tables 7-8), the Wajak site can best be interpreted as Mesolithic, the Sampung site as Mesolithic-Neolithic and the sites Kecil, Hoekgrot and Jimbe as Neolithic. Animals that are represented abundantly (present in at least four sites) are: *Macaca fascicularis, Trachypithecus cristatus, Homo sapiens, Hystrix javanica, Rhinoceros sondaicus, Sus scrofa, Tragulus javanicus, Muntiacus muntjac, Rusa timorensis,* and as a group the Bovinae (*Bos sondaicus* and/or *Bubalus bubalus*). In other words, these animals are very characteristic for these subrecent Mesolithic/Neolithic faunal assemblages. If one removes the two 'meat/bone collectors', who are probably (partly) responsible for the assemblages, *Homo sapiens* and *Hystrix javanica,* a group of omnivores and herbivores is left. Animals that are represented scarcely (only occurring once at a site) are: *Lutrea cinera, Martes flavigula, Felis bengalensis, Arctogalidia trivirgata, Canis lupus familiaris, Felis silvestris catus,* and *Capricornis sumatraensis.* With the exception of *C. sumatraensis,* all are carnivores. A picture that one would expect from an ecological point of view: in a given ecosystem, herbivores and omnivores are much more abundant than carnivores (this makes the position of *C. sumatraensis* remarkable).

There is only one animal that occurs in the Mesolithic Wajak assemblage and not in the Neolithic assemblages Kecil, Hoekgrot and Jimbe (Sampung is interpreted as representing Mesolithic and Neolithic), namely: *Panthera tigris.* The tiger, however, adapts easily to different kinds of environment. Nevertheless, one would expect that this animal became less common with the introduction of domesticated animals and the enlarging human populations because humans increasingly began to hunt tigers. But this does not seem to really have been the case: the tiger survived the Neolithic period, and is known in Java from historical times. In other words, all species from the early Holocene are still alive in the Neolithic period. Thus, the idea that the last occurrence of *Tapirus indicus* is in the Wajak fauna (Leinders et al., 1985), and that it is possibly an indicator for the Mesolithic period (Storm, 1992a), is not confirmed by the data. *Tapirus indicus* is found at the Jimbe site dated 2650 BP.

The two domesticated animals *Canis lupus familiaris* (Hoekgrot) and *Felis silvestris catus* (Kecil) are found in a Neolithic assemblage. In the Mesolithic Wajak site no domesticated animals have been found. In general, because of the fragmentary state, it was not always possible to separate wild and domesticated animals; for instance, domesticated cattle (Bovinae) and pigs (Suidae) could have been present.

Remarkably, Dammerman (1934) found *Elephas maximus* remains at the Sampung site to be very scanty, i.e. similar to the Hoekgrot site. We know that the elephant was present in Pleistocene Java because it is also found in the older Punung fauna (c. 80 000 years B.P.). Assessing the status of elephants and their fate during the Mesolithic and later (pre)historic times is difficult because elephants have been possibly reintroduced in Java.

Ecological consequences — I propose to consider the wild species of the five faunal assemblages (Wajak, Sampung, Kecil, Hoekgrot, and Jimbe) as one subrecent fauna complex. In the absence of any convincing proof of major changes during this period in the wild species composition, this complex will be discussed in the light of two predated Javanese fauna complexes: Ngandong and Punung (Table 5). In the subrecent fauna complex typical Indonesian rain forest species, like *Pongo pygmaeus*, are absent. Rain forest species are absent in the recent fauna, whereas they are present in the Pleistocene Punung fauna. Therefore de Vos (1983) concluded that the Punung fauna is older than the Wajak fauna. According to him the Wajak fauna seems to represent an open woodland fauna probably during a glacial, whereas Punung resembles a humid forest fauna, probably during an interglacial. Thus de Vos (1983) assumed the climate to have become drier between the Punung fauna and Wajak fauna. Sondaar (1984) considered the Ngandong, Punung and Wajak faunas as probably mainland faunas. Although Ngandong and Wajak can be interpreted as open woodland faunas (de Vos, 1983, 1985) they clearly differ in the composition of species. Only two species appear to be present in both: *Panthera tigris* and *Tapirus indicus*. Archaic extinct mammals, like *Stegodon trigonecephalus*, *Hexaprotodon sivalensis* and *Sus macrognathus*, occur in the Ngandong fauna, but not in the subrecent fauna. Besides, between both faunas there probably existed a humid forest fauna, i.e. Punung.

Because of the obvious differences of the species composition between the Ngandong and Punung faunas, probably Punung represents a new migration wave from the mainland. To explain the differences between the Punung and the subrecent fauna two hypotheses can be brought forward. 1) The subrecent fauna represents a new migration wave from the mainland. Because of the close resemblances to the Punung fauna (which could be characterised as the 'extant Indonesian forest fauna') I favour the second hypothesis. 2) The subrecent fauna is an impoverished Punung fauna. Impoverished because of the disappearance of species that are more strictly adapted to the humid forest, like *Ursus malayanus* and *Pongo pygmaeus*. The rest of the fauna survived in a more open woodland and is represented as the subrecent fauna.

Archaeology

According to Dubois (1922) no artefacts were found at the Wajak site. However, recently, during a restudy of the fragmentary bone material, collected by Dubois in 1890 at the Wajak site and stored in the NNM in Leiden, several signs of human activities and artefacts were discovered and described (Storm, 1992a; Table 6; Figs. 7-8).

Artefacts from the Wajak site

Wajak artefact W-A-1 (Fig. 8) — A small blade, made from limestone. The distal end is broken and there is some damage at its proximal end. The shape of the body is elongated with parallel sides. Present are the bulb of percussion and the striking

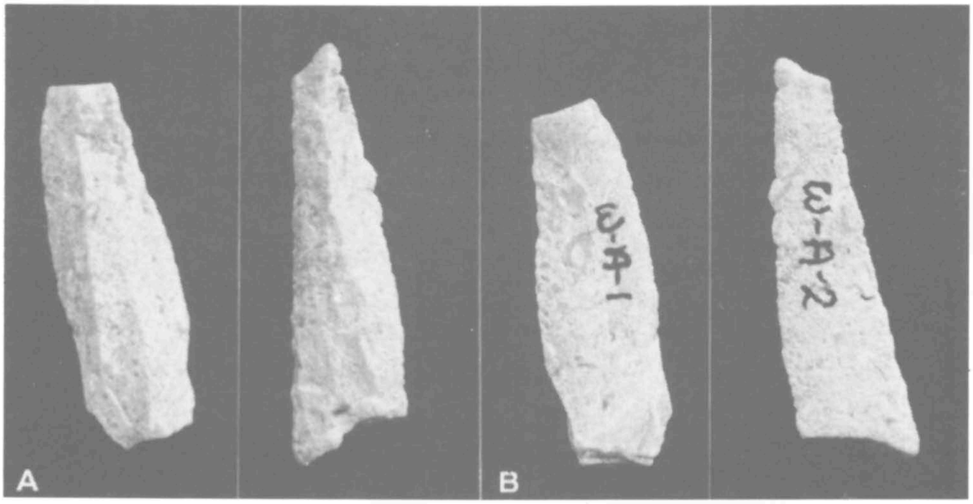

Fig. 8A. Wajak artefacts (dorsal side); from left to right: W-A-1 and W-A-2 (photograph by Ben Storm).
Fig. 8B. Wajak artefacts (ventral side); from left to right: W-A-1 and W-A-2 (photograph by Ben Storm).

platform. The dorsal side has two parallel ribs (three negatives) and there is erosion at this surface. The ventral side is flat, but also at this surface there is erosion. There is no retouch. Maximum length: 20.6 mm, maximum breadth: 6.9 mm, maximum thickness: 2.6 mm.

Wajak artefact W-A-2 (Fig. 8) — A small blade (possibly a point), made from limestone, which is in a bad condition. The proximal and distal ends are broken, maybe as the result of intentional breakage. The ventral side is flat. On the dorsal side one can recognise one rib, but possibly there were three ribs (parallel to the lateral sides). Ribs are difficult to recognise because there is edge damage (or retouch) on the dorsal side. Maximum length: 23.3 mm, maximum breadth: 6.5 mm, maximum thickness: 2.4 mm.

Wajak artefact W-A-3808-49 — Fragment of distal part of right metacarpus from a large deer (*Rusa timorensis* ?). Around the caput there are marks of gnawing, probably caused by a carnivore. On the lateral side there are cut marks which have a course in one direction (anterior/posterior). The total length of this fragment is 122.3 mm and the weight is 33 g.

Further signs — Marks of burning have been found on bone material from the Wajak site. No pottery sherds, neither bone implements nor charcoal remains have been found.

Signs of human activities — Before a discussion of the human activities (see Tables 8-9) is given, a few remarks have to be made about the formation of the tables. The excavation of Dubois in 1890 was not an archaeological enterprise in the sense of Van Stein Callenfels' excavation of the Sampung site (in the period 1928-1930). Because of the poorness of cultural remains, I was keen to find other signs of human activities in the boxes that contained the (fragmentary) material from Wajak and Hoekgrot. The

Jimbe site is the largest (in terms of numbers of bones) of the late prehistoric sites excavated by Dubois.

The hypothesis can be defended that, at these sites, people have been responsible for the assemblages (Tables 8-9). Several arguments could be brought forward to support this view. Firstly, the fact that at sites like Hoekgrot and Sampung complete human skeletons have been found. There is also indication that at the Wajak site more or less complete human bodies have originally been present because different parts of the body have been found (see next chapter). This is in contrast with the rest of the Wajak fauna, which is also more fragmented. Secondly, remains of domesticated animals have been found at the Hoekgrot and Kecil site. Thirdly, remains of marine Mollusca, and sea fishes have been found (the Wajak and Hoekgrot sites are at c. 9 km from the sea). Fourthly, obvious traces of human activities have been found. At the Wajak and Hoekgrot sites cut marks have been found on the bone material. Burnt bone fragments have been found at the sites Wajak, Hoekgrot and Kecil. Fifthly, last but not least, cultural remains have been found, at all five sites.

It is difficult to give an indication of the quantities of the burnt bone material from the Wajak, Kecil and Hoekgrot sites. In many instances this contact with fire was certainly not intense but rather superficial and hence may be interpreted as caused by scorching. The colours shown by the burnt fragments vary from black, via grey to white, which indicates different stages of burning (white means intensive burning). As far as can be deduced from the human remains, cremation of the dead did not take place. There is also no convincing evidence for a large hearth (although, at the Hoekgrot site some charcoal remains have been found). The best explanation for the state of burning of the bone material seems to be that people have used small fires.

Because the Holocene sites can be interpreted as having been influenced by humans (archaeological sites), the presence of the animal bones can partly be explained as the result of human hunting. The fauna assemblages need not be interpreted as a 'pure natural reflection' of the living fauna, as selection by humans has probably played a role in the bone accumulation. The Wajak, Hoekgrot, Kecil and Jimbe sites are less likely to be interpreted as 'hunting camps' because few indications for the hunting of animals (arrow points, abundant presence of artefacts and tools) have been found. Probably these sites must be interpreted as mainly being the result of the deposition of funeral rites in a rockshelter and some animal '-disturbance' (for instance *Hystrix javanica*).

Lithic and bone artefacts — There is a great variety of artefacts and tools found at the Sampung site (van Stein Callenfels, 1932). Erdbrink (1954) discussed the Mesolithic/Neolithic status of the site. Dammerman (1934) remarked that the exact place where each prehistoric implement or human material was found, had been ascertained with regard to depth as well as the horizontal position. The richness of the Sampung site is striking in comparison with the other four sites and cannot be explained merely by differences in excavation techniques. Particularly the findings of bronze objects at the Sampung site are surprising. These objects indicate possible distortion(s) from a later period, since they are not as numerous as the other artefacts (that are associated with the Mesolithic- Neolithic) and most of them are found in the upper layer (only one in the lower layer). The larger part of the remains from the

Sampung site consists of pottery fragments, artefacts made from animal remains, stone arrow points and stones for grinding. Most of the pottery fragments and artefacts made from animal remains have been found in the upper deposits, whereas most of the stone arrow points have been found in the lower deposits. Hence possibly the upper layers are Neolithic and the lower ones Mesolithic.

According to von Koenigswald (1956a) the 'bone culture' from Sampung has also been found at other Javanese sites, i.e. Bojonegro and Sitobondo (excavated by van Heekeren). In 1937 Erdbrink and Kerkhoven discovered an archaeological site in West Java, halfway between the Pasir (hill) Tjilawang and the hamlet of Tonjong, which Erdbrink (1943, 1954) attributed to the 'Mesolithic Sampung culture'. At this site, the 'Cave of Panoembangan', fossilised remains of animals were found in the northern part of the cave, together with five flint implements. One flint implement was found in the southern part. Erdbrink (1954) further remarked that, apart from the mentioned site, a small open air site nearby (also located on the Panoembangan tea estate) seems to be the only indication of the presence of remains of Mesolithic people in West Java. Erdbrink (1954) also reported a locality, discovered in 1936 by von Koenigswald, which could date from the Mesolithic period, a rockshelter, located on the eastern side of a hill, the Gunung Tjantelan, close to the village of Punung. They found a large number of flint flakes, some hammerstones, several arrowpoints (with a rounded bases), scrapers, bones, pierced shells of snails (used as components of necklaces) and a few isolated human teeth. Bartstra & Basoeki (1979) reported a new stone age site from East Java, which they thought dated from a post-Pleistocene period, either Mesolithic or Neolithic, although the dating was not certain. The site is located near a small village (Pucanganak), about 12 km west of the town of Trenggalek. They found a number of rectangular axe-like objects, scrapers and borers. Subagus (1979) reported on an 'Obsidian Industry in Leles', West Java. According to him the flake-blade tradition originated in the Palaeolithic period during the Pleistocene era (Ngandong, Pacitan, Sangiran) and continued to develop in the Epipalaeolithic period. Subagus remarked that this industry includes nuclei, blades and waste.

According to Kleiweg de Zwaan (1943) small artefacts have been found at several places in the area of Bandung. These sites can be found: 1) North of Bandung: Lembang, Cakidang, Pagermanuk, Pakar, Negla, Lebaksiu, Cilimoes, Ciharalang, Bojongkoning and Nagreg. 2) Southeast of Bandung: Paseh and Pacet. 3) South of Bandung: Kulalet and Pameumpeuk. 4) West of Bandung: Cililin and Cilalem. This could be an indication that groups of peoples, who produced microliths, were once widespread on the island of Java.

Linkage between Wajak and Pacitanian — On October 4, 1935, von Koenigswald (1936a/b) and Tweedie found primitive looking stone artefacts in the bed of the Baksoko, a small river near the South coast of Central Java. von Koenigswald called the culture Pacitanian after the nearby village of Pacitan. He considered *Homo erectus* as the maker of this culture, because at Punung, a village near Pacitan, fossil mammals were found in fissure fillings (for example *Stegodon*), which he assumed to be of the same age as the fossils from Trinil, where *Homo erectus* had been found. Following von Koenigswald, Movius (1948, p. 408) and van Heekeren (1972, p. 43) also attributed the Pacitanian to *Homo erectus*, and placed this culture in the Middle Pleistocene. However, Bartstra (1984a/b, 1987) placed the Pacitanian in the Late Pleistocene or

Holocene and he considered Wajak Man (*Homo sapiens*) as the maker of this culture.

That Wajak Man is the (possible) tool maker of the Pacitanian (Bartstra, 1984a/b, 1987; Sémah et al., 1990) is only a suggestion. The Wajak material and the Pacitanian artefacts do not appear to bear any relation to each other. The two microliths from the Wajak site are clearly different from the Pacitanian material. The Pacitanian belongs to a widespread group of 'chopper/chopping tool industries' (Bartstra, 1976, 1987; Bellwood, 1985) which is indeed very different from the two small artefacts from the Wajak site. Other problems are that some scientists view the Pacitanian as a local variant of the broadly defined Hoabinhian and that possibly many Pacitanian artefacts are in fact the result of natural processes (Tattersall et al., 1988).

Dating

The age suggested for the Wajak site ranges from Pleistocene (Dubois, 1922), the boundary Pleistocene/Holocene (Jacob, 1967; Bartstra, 1984b) to the Holocene (von Koenigswald, 1956b; Wolpoff et al., 1984; Habgood, 1989; Storm, 1992a). For the Sampung site most researchers agreed on a age within the Holocene.

Artefacts and tools found at the Sampung site have also been found at Wajak, Kecil, Hoekgrot, and Jimbe (Table 7). In addition, the same subrecent fauna has been found at all five sites (Table 4). This was the main reason for the assumption that the sites Wajak, Hoekgrot and Jimbe belong to the same period as the Sampung site, Mesolithic and/or Neolithic (Storm, 1990b, 1992a). Datings have become available (Shutler et al., in press; Table 8) confirming this hypothesis. The datings of the faunal and human remains of the Wajak site and the finds of microliths would place the Wajak site in the Mesolithic period, following van Heekeren (1975) in his ideas about the epipalaeolithic period, roughly between 10 000 and 5000 BP; the sites Kecil, Hoekgrot and Jimbe would be Neolithic, roughly between 5000 and 3000 BP. One has to realise that the boundaries suggested by van Heekeren (10 000, 5000, 3000) were very rough estimations. More research on subrecent faunal complexes (excavations are needed) and dating in the future will give more insight into the precise transitions from the Late Palaeolithic via the Mesolithic and Neolithic to the Metal period in Java (remember that bronze has been found in the Sampung site: hence possibly some layers/sites have to be dated in the Metal period: Sampung, Hoekgrot and Jimbe).

Because of the difference between the ages of the faunal and human remains of the Wajak site (if these data are correct) one can hardly maintain that humans were responsible for the (complete) faunal assemblage. On the other hand, it could be a support of the idea that the Wajak site is a burial site. The younger human remains from Wajak, dated 6560 BP, have been laid down in an older layer with fauna remains dated 10 560 BP.

Conclusion

Study of the faunal and cultural remains (and new dates) of the Wajak and other sites from Java (containing roughly the same fauna: Sampung, Kecil, Hoekgrot and Jimbe) help to place the Wajak fossils more securely in Southeast Asian prehistory.

The Wajak site can be dated in the Mesolithic period roughly between 10 000 and 5000 BP. The dominance of humans is clearly present at this site. Possibly, complete human bodies, dated 6560 BP, were once present and were buried in an older (fauna) layer, dated 10 560 BP. Further signs of human activities have been found in the form of cultural remains (two microliths) and remains from the sea, marks of burning and a bone fragment with cut marks. During this period there was probably a widespread use of microliths by humans and no — or limited — use of pottery. The fauna can be interpreted as an impoverished Southeast Asian extant mainland fauna, lacking typical rain forest species such as: *Ursus malayanus* and *Pongo pygmaeus*. This Mesolithic fauna is characterised by the absence of domesticated animals.

The human material from Wajak

Introduction

In this chapter the Wajak material is described, without comparison with other recent and prehistoric skulls from Australasia. These comparisons will be made and discussed later. Topics in this chapter include: the description of cranial and postcranial material, and a discussion of the number of individuals, sex, age, pathology, stature of Wajak Man and problems with measuring the Wajak skulls.

The cranium of Wajak-1 (W-H-24; Figs. 9-14)

Os frontale — The frontal bone (the left and right margin; posterior and lateral) does not fit with the parietal and sphenoidal bones. The frontal bone is intact, therefore the most probable explanation is that both the ossa parietalia and the greater wings of the os sphenoidale are pressed laterally. In the middle, the frontal bone does fit with the parietal bones on both sides, although on the left side there is, relatively seen, a lot of plaster.

The course of the external surface of the squama is oblique to posterior, not steep. This surface is eroded, like the rest of the cranium. There is no metopic suture. The frontal eminences are not well developed. In spite of the erosion the temporal line is visible, on the left side. At the right side this line is less clear. The parietal margin (coronal suture) is well preserved on the right side, over a distance of c. 53 mm. The left temporal surface shows a large hole (13 mm), however, there is no evidence for trepanation, as there are no signs of healing of the bone. It is probably caused by postmortem fracturing. The zygomatic process is well preserved on the left side, the right side is more damaged and there is some matrix.

Both the superciliary arches and the glabella are present. The region of the glabella is partly damaged, but as far as can be judged, this structure was well developed. It is not possible to exactly localise the landmark glabella. Although the region of the glabella and the superciliary arches is well developed there is no real supraorbital torus, as is present in many pleistocene hominids. A real supraorbital torus is here defined as a continuous beam above the orbits which consists of three regions: the glabella, the superciliary arches and the zygomatic trigones. The right supraorbital margin is damaged and the left side is relatively sharp, but this side is in fact difficult

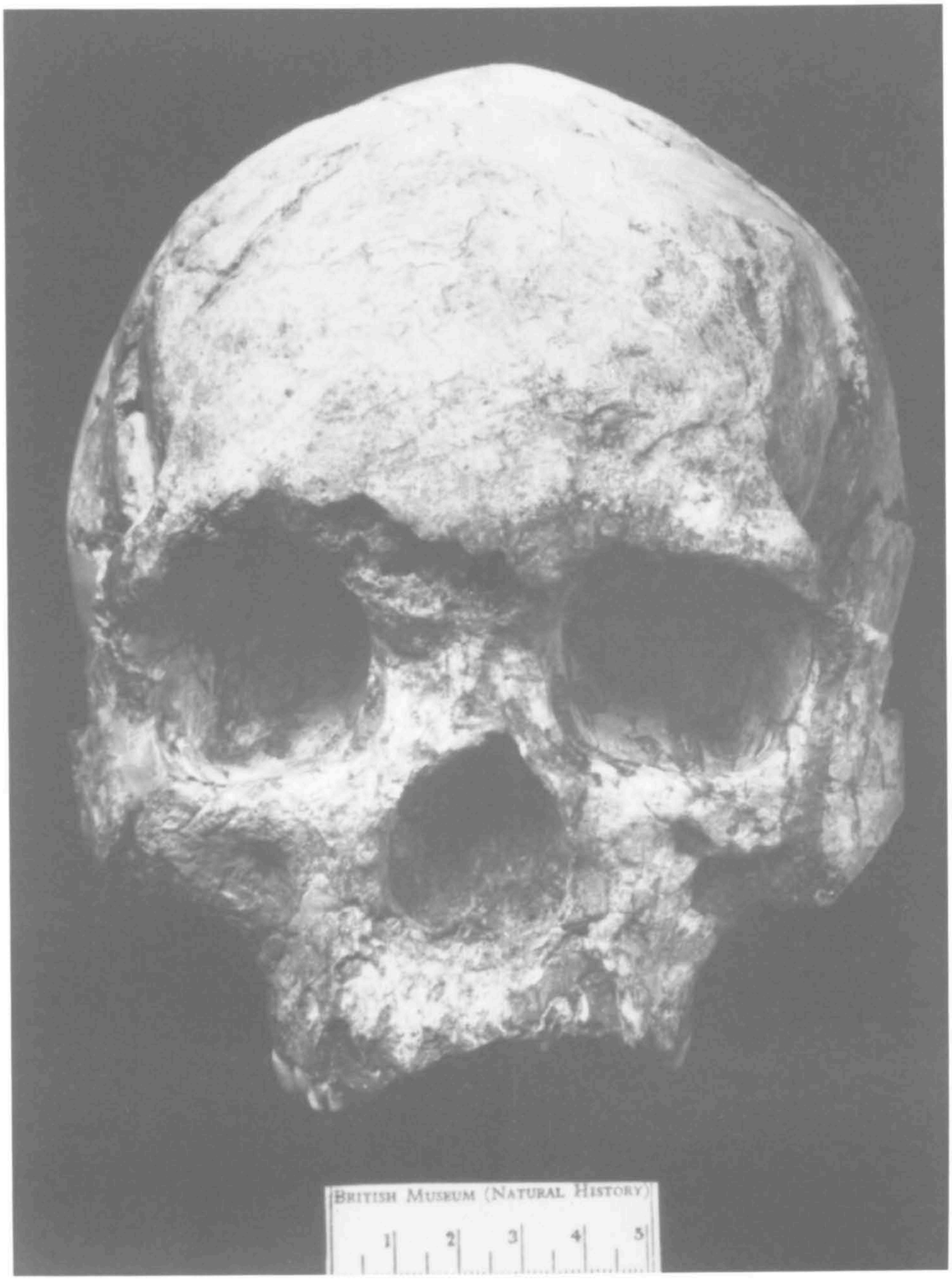

Fig. 9. Wajak-1 (norma frontalis), cranium W-H-24; photograph taken after the latest reconstruction (courtesy NHM, London).

to judge because of the presence of some erosion. The supraorbital foramen and the frontal foramen are not present; possibly they have been present, but have disappeared due to erosion.

The left orbital part appears to be well preserved; there is no cribra orbitalia. Unfortunately, the nasal part is damaged. Therefore it is not possible to localise exactly the landmark nasion. The anterior and posterior ethmoidal foramina are difficult to judge due to the presence of matrix. On the right side one can see a hole in the matrix. The lacrimal fossa is most intact on the left side.

Os parietale (right side of facies externa) — From lambda, one can follow the sagittal suture over a distance of c. 77 mm. Near bregma this suture is covered with plaster and there are cracks. From the lambdoid suture c. 25 mm of this structure is visible, the rest is covered with plaster. The squamosal suture is not visible. In the region of the frontal angle there is plaster; the occipital angle is in a good condition; in the region of the sphenoidal angle one can see a lot of cracks and erosion and the mastoid angle is not visible due to plaster. The parietal tuber is difficult to assess due to damage. The superior and inferior temporal line are invisible, probably due to erosion. The presence of the parietal foramen is uncertain due to damage in this region.

Os parietale (left side of facies externa) — The left bone is better preserved than the right one. Of the lambdoid suture c. 47 mm is visible (from lambda), the remaining part is covered with plaster. This suture (like other sutures) is clearly visible as it is filled with matrix. Between the squamous margin (squamosal suture) and the squamous part of the os temporale there is a thick layer of matrix. This is probably due to a well known postmortem process, namely, a situation in which the squamous part of the temporal bone turns laterally from the os parietale. Only a small part of the coronal suture is visible; this suture is partly covered with plaster. In the region of the frontal angle there is plaster. The occipital angle is visible; in this region there is a crack of c. 20 mm. In the region of the sphenoidal angle the os parietale has turned aside laterally. This has resulted in a thick crack filled with matrix. On the right side of the cranium there is more or less the same situation. Thus in this part of the skull (temporal surface) the connection of os frontale and os parietale is not in the original anatomical situation. In the area above this region the connection between os frontale and os parietale is correct. The region of the mastoid angle is covered by plaster. The parietal tuber appears to be better preserved than on the right side. The inferior and superior temporal lines are not clearly visible and it remains uncertain if the parietal foramen is present due to damage in this region.

Os occipitale — There is some erosion and damage at the margin of the occipital foramen. Nevertheless, it is possible to estimate the location of the landmarks basion and opisthion. The basilar part is not seriously damaged; as far as can be judged, the articulation with the os sphenoidale is in its original position. According to Jacob (1967) the skull possesses precondylar tubercles. Maybe it is due to later cleaning, but as far as I can judge, these tubercles are not present, though the pharyngeal tubercle may be. Both occipital condyles are anteriorly situated, close to one another. They differ in form, due to erosion and damage. Although there is matrix around its anterior part, the left condyle approaches the original morphology better than the right one. The right condylar fossa is invisible due to matrix; on the left side (-although there are remains of glue) the fossa is visible. Due to the matrix and glue,

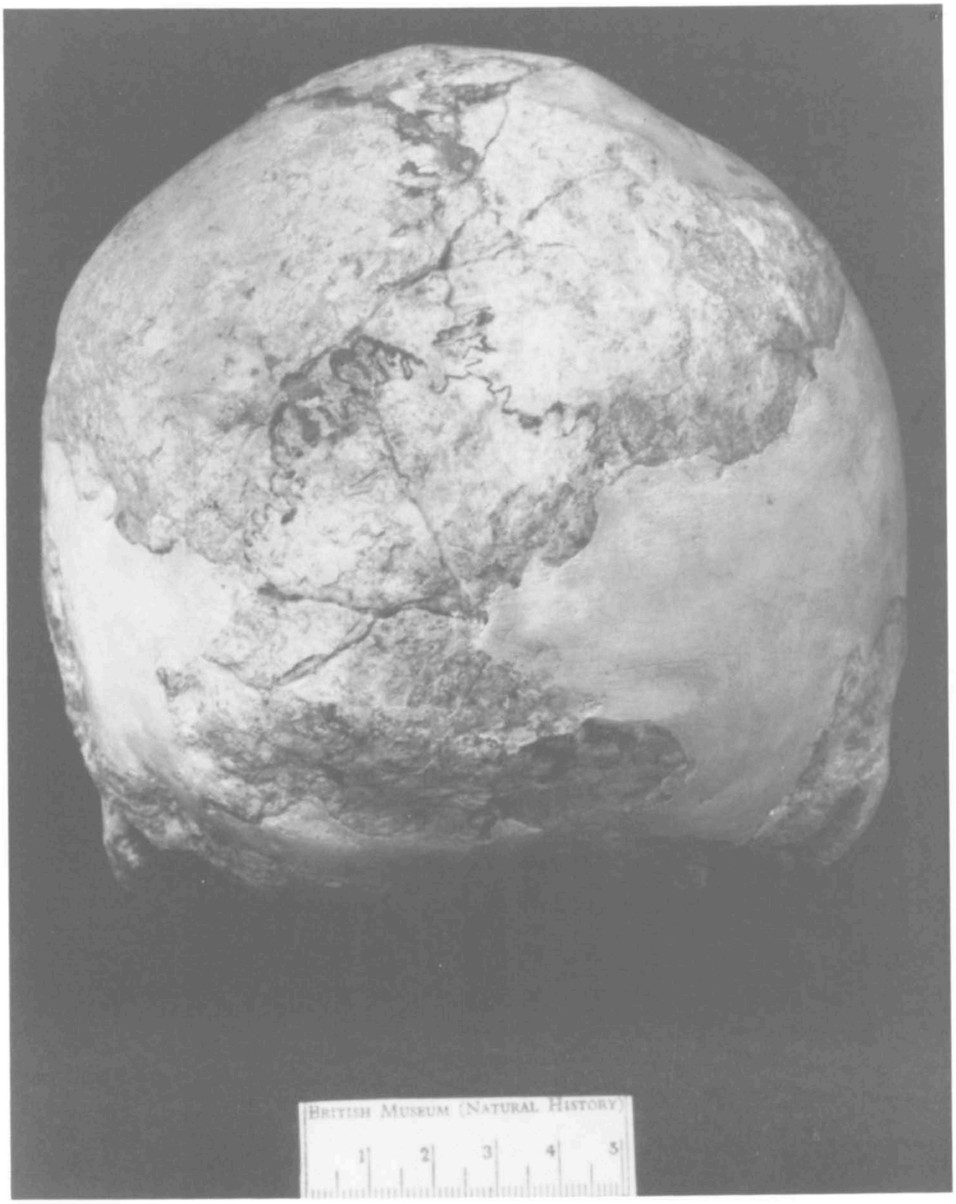

Fig. 10. Wajak-1 (norma occipitalis), cranium W-H-24; photograph taken after the latest reconstruction (courtesy NHM, London).

both the condylar canals are invisible. The hypoglossal canals are visible, both filled with matrix (seen from below and behind). Clearly recognizable is the right jugular process. The right mastoid margin (occipitomastoid suture) is clearly visible (filled with matrix) from below. Posterior/lateral from the right occipital condyle there is a rounded piece consisting mainly of matrix.

On the surface of the squama there are cracks and some erosion and it is partly covered with plaster. As far as can be judged, a clearly distinguishable external occipital protuberance is absent. Only a very (distorted) small part of the external occipital crest is visible; a large part of this crest is covered with plaster. None of the nuchal lines is marked present. There is no occipital torus. As a concluding remark it can be stated that the area of the attachment of the muscles of the neck is smooth, but it must be stressed that this view is limited by the presence of damage (plaster).

Os temporale (right side) — A major part of the squamous part is covered with plaster. The mandibular fossa is not visible as the condylar process of the mandible is fixed (with matrix) to the skull. An articular tubercle is present. Due to plaster, the sphenosquamosal suture is vaguely visible, only in the area of the mandibular fossa. The occipitomastoid suture is visible, and filled with matrix. The squamosal and parietomastoid sutures are not visible (plaster).

The small mastoid process shows a crack at the tip. The mastoid crest is present, just like the supramastoid crest (the latter is medium developed). In the area where one would expect the mastoid foramen there is some matrix. Therefore, it is hard to say with certainty anything about this foramen. The mastoid notch is visible and filled with matrix. The jugular fossa is also filled with matrix. The apex of the petrous part is clearly distinguishable from the surrounding matrix. Little structures like the petrosquamous, tympanomastoid and tympanosquamous fissures are not visible.

Considering the tympanic part, the area around the opening of the outer auditory canal appears to be smooth. The opening is oval in form, the canal is filled with matrix. The sheath of the styloid process is present, but eroded, the process itself is not present, around its base there is some matrix. Therefore the stylomastoid foramen is invisible.

Os temporale (left side) — The squamous part is visible, the zygomat process has disappeared. The lateral side of the mandibular fossa is eroded. The articular tubercle is partly broken (and glued); a thin layer of matrix is present on its surface. The sphenosquamosal suture is visible and can be traced over almost its whole length. Also the squamosal suture is clearly visible, whereas the parietomastoid suture is not. This suture is partly covered with plaster and a lump of matrix. Seen from norma basalis there is a thick layer of plastic between the os temporale (posterior part of the mastoid process) and the os occipitale (anterior part of basilar part). The total length of this striking plastic layer (band) is c. 10 cm.

The mastoid process is fractured, shifted laterally, and is therefore in a very bad condition. This probably explains the invisibility of the mastoid crest. In the region of the supramastoid crest there is extensive erosion. On comparing the right and left sides, it becomes clear that erosion can play a role in the disappearance of some structures. The mastoid foramen is invisible and the area concerned is partly damaged. The region of the mastoid notch is seriously damaged, consequently the groove for the occipital artery is also not visible. The apex of the petrous part is vis-

Fig. 11. Wajak-1 (norma verticalis), cranium W-H-24; photograph taken after the latest reconstruction (courtesy NHM, London).

ible. Not visible are small fissures such as the petrosquamous, the tympanomastoid and the tympanosquamous, due to damage.

The tympanic part is present with the external meatus which is filled with matrix. This part is in a worse condition than on the right side. The sheath of the styloid process is eroded, and the process itself is missing.

Os sphenoidale — Part of the vomer that covers the corpus of the os sphenoidale is not visible due to damage (in this region there is matrix and an 'offshoot' of plastic). The nasal cavities are filled with matrix (seen from norma frontalis and norma occipitalis). Both pterygoid processes are recognizable. More matrix is present around the right process than around the left one. Therefore the following structures are more clearly visible on the left than on the right side: the medial and lateral pterygoid plate, within between the pterygoid fossa. The left scaphoid fossae is visible. The pterygoid hamulus is broken. The oval foramen is visible on the left side, as a depression filled with matrix. The spinous foramen is bilaterally not clearly recognizable (matrix). The foramen lacerum appears on the right side to be covered by matrix and on the left side by plastic.

Bilaterally (from norma basalis) the greater wing of the sphenoid with the infratemporal crest is visible. Seen from norma lateralis dextra, little is visible of the right greater wing due to the presence of plaster. From norma lateralis sinistra, however, it is possible to follow the greater wing of this side. Visible are the sphenofrontal, sphenosquamous, and sphenoparietal sutures; however the picture is somewhat distorted by postmortem damage (cracks filled with matrix).

From norma frontalis, in both orbits, the greater wings are visible. Due to matrix it is not possible to see the lesser wings and hence also not the optic canals. In the region of the superior orbital fissure one finds a thick layer of matrix. The left inferior orbital fissure is visible. The right one is partly covered by plastic.

Os palatinum (seen from norma basalis) — The posterior side and central part of the horizontal plate are broken: therefore, the posterior nasal spine is missing. Both palatine crests are laterally visible, though an assessment of the medial side is difficult due to breakage and erosion. The greater palatine foramen is represented on both sides by a depression. The left one is filled with matrix and provides a clear indication of the position of this foramen. The right one is partly filled with matrix and gives a less clear indication of its position. The lesser palatine foramina are covered with matrix (on the right side there is also plastic). It is possible to observe a little part of the left pyramidal process (it is partly covered by matrix).

Maxilla — On the anterior side of the body there are some cracks and erosion. From norma lateralis the right surface of the body looks undamaged, the left side shows a hole filled with matrix (largest measurement c. 10 mm). From norma frontalis it is difficult to judge the exact connection of the maxilla to the os zygomaticum because, especially at the left side, there is damage. The left canine fossa is difficult to judge due to damage. On the right side there is hardly a real fossa. Although there is some erosion on the surface of the bone, there has probably never been a distinct (-depressed) canine fossa. The infratemporal surface is on both sides well preserved. On the left side there is a large hole filled with matrix (12 mm from norma verticalis to norma basalis). The alveolar foramina are not clearly recognizable. The transition of the tuberosity of the maxilla to the pterygoid process of the os sphenoidale is visible on the left side. On the right side there is a layer of plastic (c. 35 mm) between these two areas.

The infraorbital margin is almost intact on the left side. On the right side, laterally a small piece of the edge is missing and eroded (c. 5 mm). Both orbital surfaces are visible; on the left side there are cracks and this area is a little pressed to the underside. In both orbits it is possible to distinguish the zygomaticomaxillary, ethmoidomaxillary, and lacrimomaxillary sutures. Both infraorbital foramina are clearly visible, and the infraorbital canals are filled with matrix. The infraorbital sulci are difficult to judge because of the presence of matrix and there is damage on the left side. The anterior nasal spine is present but probably eroded. The crista prenasalis and margo infranasalis are not sharp and hence not clearly visible. The nasal surface is anteriorly visible on both sides, with a well preserved conchal crest on the left side. The lacrimal sulcus is not visible..

Bilaterally the frontal process is present. The region between the orbits can be

Fig. 12. Wajak-1 (norma basalis), cranium W-H-24; photograph taken after the latest reconstruction (courtesy NHM, London).

classified as broad. The course of the frontomaxillary and nasomaxillary sutures is not easy to follow because of the presence of matrix, erosion and 'scratches'. The anterior lacrimal crest is visible on both sides, probably a little eroded. The zygomatic process, appears to show some erosion on both sides. On the left side a piece is missing under the infraorbital foramen (damaged region around hole). It appears impossible to follow the course of both zygomaticomaxillary sutures. According to Jacob (1967) the malomaxillary junction is slightly angulated on the left, but not on the right side. It is clear that parts of both zygomatic bones are probably not situated in their exact original position. Jacob does not give any further explanation, but the explanation of this difference is differential damage on both sides. It cannot be seen as a proof of asymmetry, but must be seen as a result of postmortem processes.

When considering the palate from norma basalis, it is obvious that it is large and deep. The palatine process is completely intact. The incisive foramen and the incisive canal are filled with matrix. The palatine spines and palatine sulci can best be observed on the right side. The alveolar process is complete, although its anterior side is damaged (i.e. from the right canine teeth to the left second molar). In and around the dental alveoli on both sides, matrix is always more or less present. Considering the right side, the I1, I2 and C are missing. The right P3 is present but damaged. The right P4 and M1 are intact. The right M2 is present but heavily damaged. The right M3 is intact. Considering the left side, the I1 is missing. Of the left I2, C, P3, P4, and M1 only dentine is visible. Between the left P4 and M1 there is a crack and a piece of bone is missing. The left M2 is intact. The left M3 is present but heavily damaged. The interalveolar and interradicular septa are not clearly visible due to damage and matrix. Because of erosion and matrix one can question if it is possible to judge the alveolar juga reliably. The juga are clearly visible on the anterior side. Possibly, the juga of the canines were originally more pronounced.

Os zygomaticum (right side) — This bone shows several cracks and there is erosion. In the area of the frontal process there is plaster and on the medial side matrix. The lateral side of this bone is shifted and therefore does not represent the original spatial condition. The malar surface shows obvious cracks, this surface is a little eroded and there are remains of plastic. The temporal surface is covered with matrix, therefore it is not possible to see the zygomaticotemporal foramen. The orbital surface is eroded and some pieces are missing. Looking at the temporal process, the underside is broken. The frontal process is eroded and a piece is missing on the upper side (in the area where plaster is present, that also covers the area of the zygomatic process and temporal surface of the os frontale). Thus it is difficult to judge if the marginal tubercle is present. The zygomaticoorbital and zygomaticofacial foramina are not visible. The frontozygomatic, sphenozygomatic, and zygomaticomaxillary sutures are all three rather difficult to see in the orbits due to erosion and cracks.

Os zygomaticum (left side) — The malar surface, together with the frontal process, is broken and shifted laterally. This broken part is separated by an obvious thick crack filled with matrix (50 mm long and thickness between 2.5 and 5.5 mm) from the rest of os zygomaticum, os frontale and the maxilla. Nevertheless, this side is better preserved than the malar surface of the right side. The temporal surface is covered with matrix and therefore the zygomaticotemporal foramen is not visible. The orbital surface is better preserved than on the right side, this part is still in its original position. The temporal process is broken, and at the place of the fracture there is matrix. The marginal tubercle is perhaps discernable (assessment is difficult due to matrix). It is not possible to be certain about the zygomaticoorbital foramen, but it is possibly visible and filled with matrix. The zygomaticofacial foramen is not visible. The frontozygomatic, zygomaticomaxillary and sphenozygomatic sutures are visible (inside the orbit).

Os nasale — Both nasal bones are preserved but damaged. Due to erosion, the presence of matrix and damage, the exact course of the sutures is a little hard to distinguish in this area. The upper margin of the piriform aperture is broken. The nasal bones are somewhat pronounced. The region of nasion is damaged: as far as can be judged, Jacob (1967) could be right when stating that the region of nasion is not depressed.

Os ethmoidale — In both orbits, the orbital lamina is visible and it appears partly intact. In the right orbit, especially in its anterior part, the lamina is well preserved; behind it there is a small hole and matrix. In the left orbit, in the anterior part, there

Fig. 13. Wajak-1 (norma lateralis sinistra), cranium W-H-24; photograph taken after the latest reconstruction (courtesy NHM, London).

is some damage and matrix; also deep inside the orbit one can see matrix. The anterior part of the frontoethmoidal suture is visible most clearly in the right orbit. The left ethmoidomaxillary suture can largely be followed. At the right side, it is possible to follow its course over a shorter distance.

Os lacrimale — The os lacrimale with its posterior lacrimal crest is visible in both orbits. Both fossae of the lacrimal sac are filled with matrix (more on the right side than on the left). Bilaterally the lacrimal hamulus is intact and the course of the frontolacrimal sutures can be distinguished. In general, one can say that the sutures of the orbits are very well preserved. In norma frontalis there is a difference in the shape of the right and left orbit. Because the orbits are undamaged on the inside this asymmetry is due to damage and erosion of the margins of the orbits and shifting of the zygomatic bones.

The mandible of Wajak-1

The mandible of Wajak-1 consists of three parts:
1) A piece of the right condylar process fixed at the skull W-H-24 (this fragment has no separate number).
2) A piece of the right anterior part of the body of the mandible with the inferior margin (W-H-7).
3) A piece, from the right side, that consists of the body and a part of the ramus (W-H-25).

The mandible fragment W-H-25 (Fig. 14) — Almost the whole fossil is covered with a thin layer of matrix (especially its medial side). The matrix is covered with a transparent plastic layer. Because of the thin layer of matrix and plastic the colour of the mandible is dark and shiny in comparison with the skull of Wajak-1. Striking are the blue parts of plaster that cover damaged regions. At first sight, this fossil looks robust because of the broad ramus, the high and thick body and the three large molars.

Concentrating on the body, one notices that the alveolar part of the buccal side is hardly damaged; more damage can be noticed on the lingual side. The alveolar juga are not pronounced. The oblique line is present but is not 'sharp'; it is difficult to judge why this structure is not marked, because of matrix and the plastic layer. The sulcus extramolaris is slightly developed, the lateral prominence is medium developed. The region of the torus marginalis is damaged. It is also not possible to judge the torus lateralis superior. The posterior marginal tubercle is marked. The dental alveoli cannot be described because all three molars are present. Of the M1 the mesial side is broken and there is a little matrix around the neck. The M2 and M3 are intact. The mylohyoid line is medium developed. The submandibular fovea is not as deep as in W-H-23; its development could be classified as medium. It is not possible to judge the mylohyoid sulcus because the area is covered with matrix.

Seen from norma lateralis the last molar appears partly 'covered' by the anterior border of the ramus, thus there is no retromolar gap. The lateral side of the angle is damaged (in this region plaster) and its medial side is covered with matrix. The angle bends a little to the medial side. The development of the masseteric tuberosities and the pterygoid tuberosity is difficult to judge, but probably have not been pronounced. The fossa masseterica is more or less flattened. In the region of the eminentia lateralis ramus there is damage, but as far as can be judged, the development seems to be slight. Not visible are the lingula, mandibular foramen and the mandibular canal.

Mandible fragments W-H-7 and W-H-15 — Fragment W-H-7 fits more or less to W-H-25 (not perfectly due to damage and erosion). This would make the inferior margin of the right side more complete. Possibly fragment W-H-15 represents the angle of the mandible of the left side. This fragment fits more in the 'view' of Wajak-1 than Wajak-2 (curvature and thickness; Wajak-1 looks less robust than Wajak-2).

The teeth of Wajak-1

The teeth (W-H-24, W-H-25) — There is no evidence of antemortem loss of teeth. Presumably there was a normal number of teeth present. The degree of resorption of

Fig. 14. Wajak-1 (norma lateralis dextra), cranium W-H-24 and mandibula W- H-25; photograph taken after the latest reconstruction (courtesy NHM, London).

the alveolar bone is limited. It is not possible to judge the occlusion reliably because of the small number of teeth; the direction of the wear of the teeth is horizontal. There is no calculus nor abscesses. Caries can clearly be seen in the right upper M1 (occlusal, mesial/lingual). The wear of the molars (using the method of Brothwell, 1981) is as follows (/ = not possible to judge):

R	M3=2	M2=/	M1=2+	M1=/	M2=2	M3=/	Maxilla
							L
	M3=2	M2=2	M1=3-	M1=/	M2=/	M3=/	Mandibula

The cranial bones of Wajak-2

Os frontale (W-H-4, W-H-5) — Many parts of this frontal bone are missing or damaged and this fragment consists mainly of the supraorbital region. At some places there is matrix on the surface. The fossil is covered with a transparent plastic layer. The form of the orbits is angular (fragment W-H-16 [os zygomaticum/maxilla] fits with W-H-5; thus it is possible to see more than only the upper side of the left orbit).

The right side of the external surface of the squama is best preserved; it is oblique in its course. The glabella is prominent, but not extremely robust. The superciliary arches are pronounced, but neither extremely robust. According to Jacob (1967), there is a distinct supraorbital torus and a well marked supratoral groove. It is the same discussion as with W-H-24, there is no real supraorbital torus. However, there is a continuation of the glabellar region into the region of the superciliary arches; this may explain why Jacob named this a supraorbital torus. One could speak of a 'shallow depression' above the region of the glabella and superciliary arches before one meets the external surface of the squama, but this depression is not comparable with the 'real' supratoral groove as can be seen in Pleistocene hominids. The supraorbital margin is not sharp but rounded. It is difficult to judge structures like the supraorbital and frontal foramen due to the presence of matrix in the supraorbital region.

The temporal surface is bilaterally partly visible. There are clear angles between the external surface of the squama and the temporal surfaces, which can be seen as two sharp borders formed by the right and left temporal lines. Especially the left temporal line is visible as a real ridge. The orbital part is bilaterally partly present. The nasal part is broad, the nasal depression is faint. Considering the depressed region of the frontonasal suture: parts of the nasal bones are still in situ. Looked at through a stereo-microscope, beneath the transparent plastic layer, a little part of the suture is visible. Both the zygomatic processes are present; the right one is broken, the left one is still in its original position. There is a little left of the os zygomaticum to enable the frontozygomatic suture to be seen. The lacrimal fossa is preserved on both sides. The internal surface of the squama is partly visible around the orbits. The frontal crest is present, the cecal foramen is invisible due to damage.

Os occipitale (W-H-1, W-H-6) — This fragment does not only consist of parts of the occipital bone, but also of fragments of the parietal bone. The whole fragment consists of several glued parts. It is very difficult to assess this fragment because cleaning has not been performed very well. The sutures are not visible (the border between os occipitale and os parietale is not clear) and due to damage, there is no '-natural' (original) margin visible. In some areas the surface looks weathered. There is a lot of matrix on the surface. Visible structures are described below.

Especially the right side of the external surface is preserved. In some places there is no matrix and the original surface can be seen. The external occipital protuberance is present, and around this protuberance there is some matrix. There are no signs of serious erosion; thus probably the original shape of this protuberance has been well preserved. This structure is well developed, but not extremely so. There is no occipital torus. The external occipital crest is visible, but due to the presence of matrix it is difficult to say anything about its development. Due to damage and matrix it is impossible to judge the nuchal lines. One can observe asymmetry at the internal surface of the squama, which is a 'normal' situation. The cruciform eminence is asymmetrical. The groove for the superior sagittal sinus is well defined; this structure does not stand perpendicular to the internal occipital protuberance, but a little to the right side. The groove for the transverse sinus of the right side is a little higher than the opposite groove on the left side. The internal occipital protuberance is closer to the foramen magnum than the external occipital protuberance, thus both protuberances are not opposite to each other.

Os temporale (right side; W-H-3, W-H-20) — In some places there is some matrix, and this fragment is partly covered with a transparent plastic layer. The fragment consists of three glued parts. There is also a part of the os occipitale.

First concentrating on the petrosal bone. The occipital margin is broken and there is some matrix in this region. The mastoid process is strongly developed; on the anterior side there is a hole (2-7 mm), but generally speaking this process is well preserved. Further the tip of the mastoid process is broken and glued. There is a well developed mastoid crest. The supramastoid crest is more pronounced than in W-H-24, but not extremely strong. The mastoid notch is well developed. The groove for the sigmoid sinus is present, but not deep; there are no pronounced margins around this structure and there is some matrix in this depression. The mastoid foramen is invisible, from the inside as well as from the outside; there is matrix in this region. At the place where the stylomastoid foramen should have been present, there is a depression filled with matrix and a transparent layer. The apex of the petrous part cannot be seen in all its details due to erosion, matrix and remains of glue. The entrance of the carotid canal is clearly visible (from norma basalis); it is filled with matrix. In the region of the apex it is possible to see the exit of this canal. In the region of the musculotubal canal there is damage. Most of the anterior surface of the petrous part is covered with matrix. The roof of the tympanic cavity is partly covered with matrix and probably intact. The arcuate eminence is visible. The hiatus and groove for the lesser petrosal nerve and the hiatus of the facial canal and the groove for the greater petrosal nerve are not distinctly visible. In this region there is a hole (3-5 mm). The area of the trigeminal impression is damaged. The superior margin of the petrosal bone is present, but the groove for the superior petrosal sinus is not clearly visible. It has to be remarked that there can be an obvious difference of the development of the superior petrosal sinus between the left and right side within the same skull. The posterior surface of the pyramid is present, but the opening and the internal acoustic meatus itself is not visible, due to damage and matrix. Therefore, this area is difficult to describe. The region of the posterior margin of the petrous part is damaged. The jugular notch is present, there is some damage in this area. The jugular fossa is visible and within this fossa there are remains of matrix and a transparent layer; consequently it is not possible to see the mastoid canaliculus. The bony crest between the carotid canal and the jugular fossa is visible but a small structure like the tympanic canaliculus is not visible. The inferior surface of the pyramid is probably a little eroded. The styloid process is not present (it is broken off). One cannot see the petrotympanic, tympanomastoid, tympanosquamous, and petrosquamous fissures. In some regions there is matrix and a transparent layer. The whole area around the fissures looks smooth (possibly due to erosion).

Considering the tympanic part, the area around the opening of the outer auditory canal looks smooth and it is not possible to distinguish a structure such as the suprameatal spine, or the greater tympanic spine. According to Jacob (1967) the opening of the outer auditory canal is somewhat rounded. This is possibly due to postmortem damage (erosion). The same opening of W-H-24 is oval. The sheath of the styloid process is probably eroded and is covered with matrix and a transparent layer.

There is not much left of the squamous part. The edges are broken; hence one cannot see the parietal and sphenoidal margins. Also the zygomatic process and the articular tubercle are not present. There is something left of the posterior side of the mandibular fossa, but further analysis is hampered by remains of matrix and the transparent layer.

Os zygomaticum (right side; W-H-11) — There is much matrix attached to this fragment, which makes a lot of anatomical details invisible. This fragment can be recognised as a zygomatic bone (it contains also a part of the maxilla) because it fits more or less with the maxilla W-H-22 and the presence of the temporal surface.

Os zygomaticum (left side; W-H-16) — This fragment is smaller than W-H-11, but is in a much better condition enabling us to see some anatomical details. In fact, it also contains a part of the maxilla. The zygomatic part shows the malar, temporal and orbital surfaces, and the frontal process. The zygomatic part fits with fragment W-H-5 (os frontale). The maxilla part shows the infraorbital margin, the infraorbital foramen and the maxillary sinus (inside is filled with matrix).

Maxilla (W-H-22; Figs. 15-18) — This maxilla is well cleaned around its body, maxillary sinus and palatine process. Especially on the outside, traces of cleaning (surface damage and scratches) are visible. Within the palate there is still a lot of matrix. On both sides the alveolar process with the M2 and M3 are glued with the rest of the process. Because this repair has apparently not been done very accurately, the occlusion with the mandible is poor. Including the broken upper part, this maxilla consist of four glued parts. There is alveolar prognathism. The palate is deep (deeper than W-H-24) in accordance with the other rather large dimensions of the masticatory apparatus.

The body is present on the left and right side, but damaged. There is no depressed canine fossa. Because bilaterally the frontal process and the area around the orbits are missing the maxillary sinus is visible. The thin and fragile bone around the sinus is missing; the sinus 'bottom', above the alveolar process is left. Only on the right side is a little piece of the underside of the zygomatic process visible. Bilaterally, the posterior/lateral side of the palatine process is damaged.

The inferior border of the nasal aperture is smooth, the palatine process curves gradually into the anterior part of the alveolar process. The anterior nasal spine is present, though broken. Both the crista prenasalis and the margo infranasalis are not distinct and, like W-H-24, there is no real 'forma anthropina' as defined by Larnach & Macintosh (1966, 1970). On the right side there is only a little part of the nasal surface left; on the left side there is more of this surface present. In the area of the inferior nasal concha there is an 'outgrowth' which represents probably the remains of this concha, together with some matrix. The nasal crest is visible, but the conchal crest is not.

The incisive canal is, seen from norma basalis, not very clearly distinguishable. In this area there is a depression, indicating its entrance (incisive foramen). From norma verticalis the two entrances of this canal are present at both sides. The elevated region of the palatine spines are visible on the right side, but appear to be eroded. The left one is not visible. The palatine sulci are probably visible at both sides (diffi-

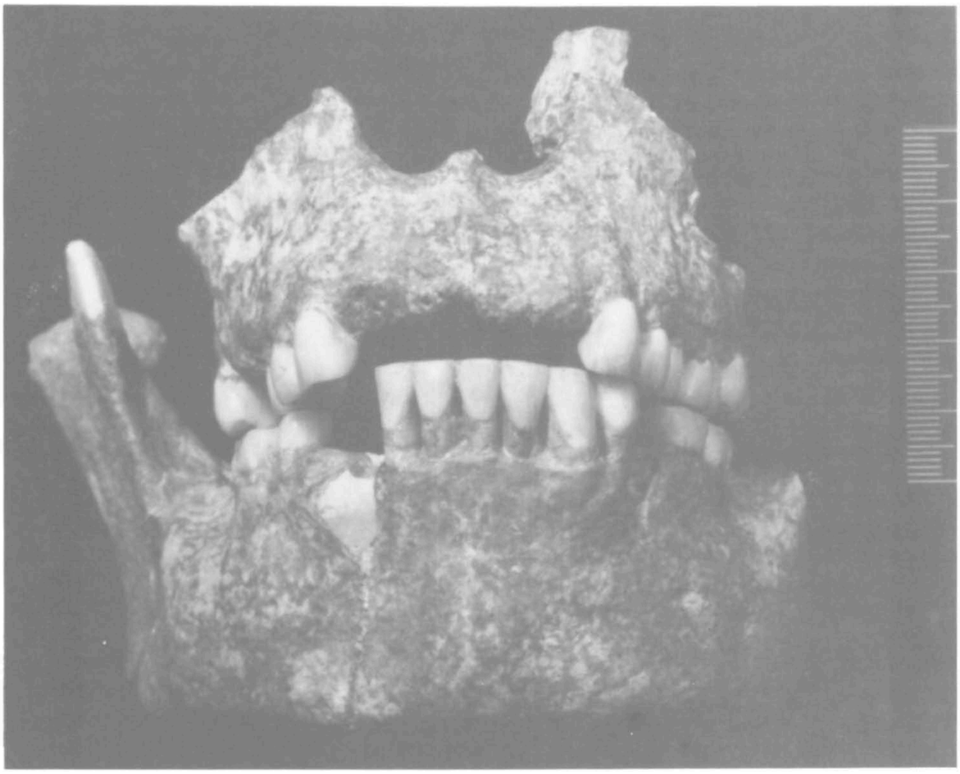

Fig. 15. Wajak-2 (norma frontalis), maxilla W-H-22 and mandibula W-H-23 (courtesy NHM, London).

cult to judge because of matrix). Besides the two previous mentioned cracks in the first paragraph, the alveolar process is eroded on the right posterior side.

Considering the dental alveoli on the right side, the crowns of the I1 and I2 are not present, therefore it is possible to see the roots. The right C, P3 and P4 are intact. The crown of the right M1 is not present therefore it is possible to see the root. The right M2 and M3 are intact. Considering the dental alveoli on the left side, the crowns of the I1 and I2 are not present, therefore it is possible to see the roots. The left C, P3, P4, M1, M2, and M3 are intact. The interalveolar septa are well visible around the teeth which are broken. In general the surfaces of the alveolar juga are smooth but possibly this is partly due to cleaning. The juga of the canines are slightly prominent (normal 'view').

The mandible of Wajak-2 (W-H-23; Figs. 15-16, 19)

At first sight this is a 'robust' mandible, showing a high and thick body, a very broad ramus, and large teeth. Looking at the base of the mandible, its thickness is striking. In general, the parts of the body have been cleaned better than those of the ramus. On the surface of the ramus a thin matrix layer can be seen, which covers the fine structures and makes several of them invisible.

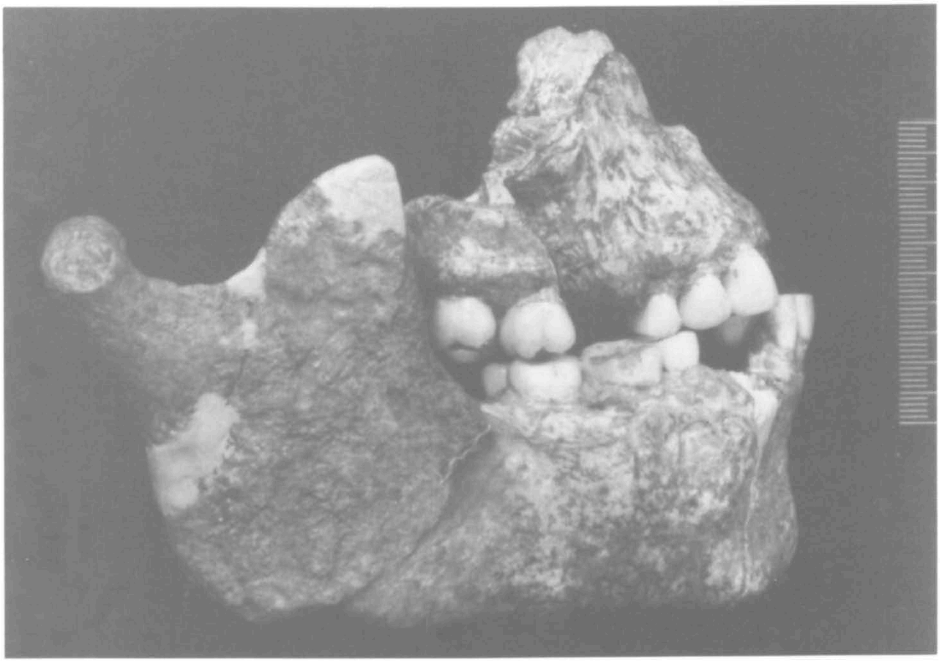

Fig. 16. Wajak-2 (norma lateralis dextra), maxilla W-H-22 and mandibula W-H- 23 (courtesy NHM, London).

Corpus mandibulae — The mental protuberance is clearly present (bilaterally the mental fossa is marked), but not very prominent (certainly not for such a 'robust' mandible). The most prominent part of this protuberance is highly situated. Another striking aspect is that the mental trigone is present, while the mental tubercles are not. Therefore, seen from norma frontalis, the chin looks triangular, and from norma basalis rather 'pointed'. The anterior mandibular incurvature is medium developed.

The mental foramen is bilaterally present. On the right side (it is more reliable to judge this side because on the left side there is more damage and matrix) its position is under the P4, and its size is 3.4 mm. The oblique line is discernable on both sides. Especially the left one is partly well preserved. The distance from the oblique line to the molars is large, thus the sulcus extramolaris is very marked. The lateral prominence is marked (especially at the right side). The anterior marginal tubercle is indistinct, whereas the posterior marginal tubercle is marked. The lateral prominence gradually passes over into the posterior marginal tubercle and can be seen as a distinct elevation of the body. The posterior marginal tubercle is more strongly developed in W- H-23 than it is in W-H-25. The sulcus intertoralis is only slightly developed; this could be 'expected', because both the torus lateralis superior and the torus marginalis are slightly developed (right side) or difficult to distinguish (left side).

Looking at the planum alveolare, there appears to be a slight decline. The development of the superior transverse torus is indistinct/slight. The torus mandibularis and the genial pit (the latter below the superior transverse torus and above the genial spines) are not present. The genial (mental) spines are present, on a large elevation as

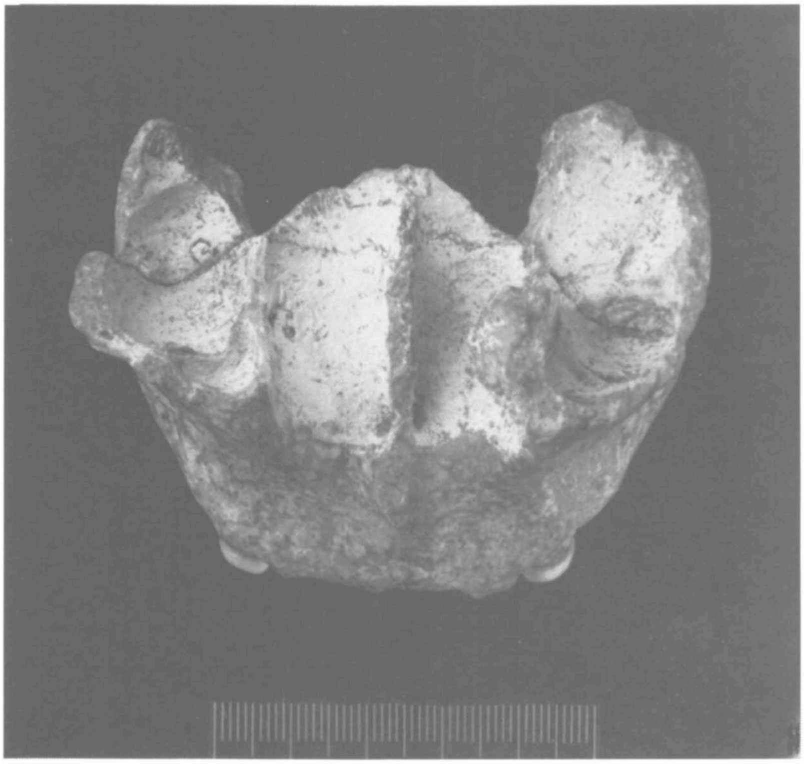

Fig. 17. Wajak-2 (norma verticalis), maxilla W-H-22 (courtesy NHM, London).

three smaller 'bumps', which are inter-connected. Maybe the spines were originally somewhat 'sharper' and have become flattened by erosion. There are no distinctly depressed digastric fossae. The spina interdigastrica and the sulcus praedigastricus are absent. The mylohyoid line is well pronounced on both sides. On both sides the sublingual fovea is not present as a depression but rather as a slight convex region. The submandibular fovea is present as a deep depression.

The alveolar part is almost completely present, though it is somewhat damaged. The right I1 and I2 are intact. The right C is not present, the alveolus is empty and partly filled with blue plaster. The crown of the right P3 is broken, therefore the root is visible. The right P4, M1 and M2 are present (the M2 is a little damaged at the lateral side). The crown of the right M3 is broken, accordingly, the root is visible; the medial side of alveolus is broken and reconstructed with blue plaster. The left I1, I2, C, and P3 are intact. The left P4 is not present, the area is damaged and remains of glue can be seen. The left M1, M2 and M3 are intact. In general there is little matrix between the teeth. The interalveolar septa are most clearly visible between the broken teeth. Most alveolar juga are smooth, the most prominent part can be found in the region of the canine (left side).

Ramus mandibulae (right side) — The condylar process is very well developed; the neck is intact; the head is broad (mesio/distal) and rounded (there are no signs of pathology). Laterally there is some erosion on the surface of this head, which means

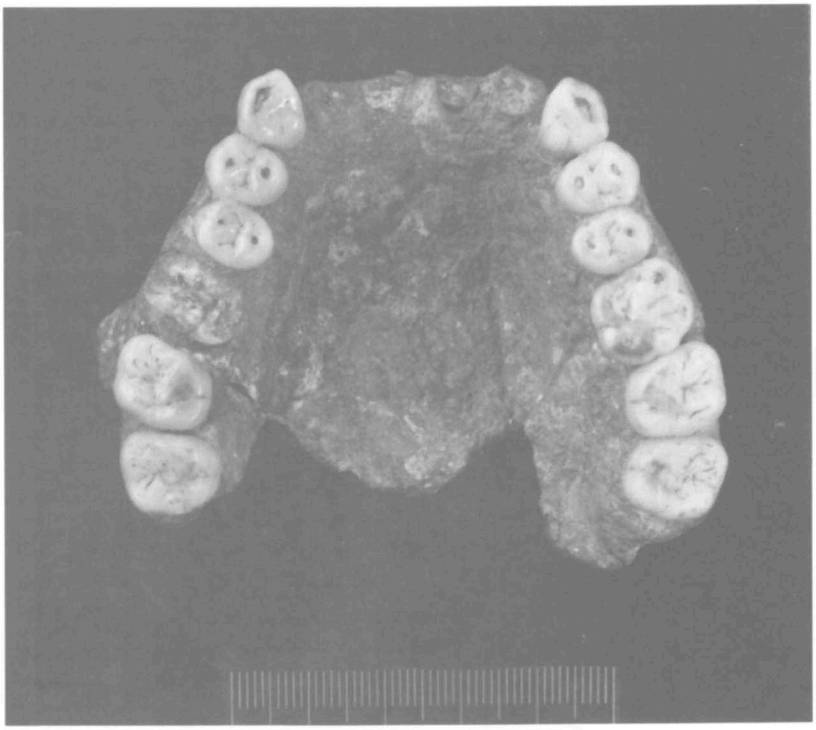

Fig. 18. Wajak-2 (norma basalis), maxilla W-H-22 (courtesy NHM, London).

that its breadth (buccolingual) was originally a little larger. The superior pterygoid tubercle is absent. The tip of coronoid process is broken and reconstructed with blue plaster; one has to be careful with assessing this reconstruction (for instance, taking measurements). In general, this process is low and broad. There is a little damage at the margin of the mandibular notch, but reconstruction of its original form is possible. The notch is, relatively seen, not deep (the mandible is large in all dimensions), but using the classification of Larnach & Macintosh (1971) it is deep, (this means that it is deeper than 13 mm). One must be careful in judging its depth because of the reconstruction of the coronoid process.

The angle of the mandible is incomplete, part of its underside is missing. This area bends somewhat laterally. Because the area is partly damaged it is impossible to describe the exact form of (the underside of) the angle. As far as can be judged (it is covered by a thin layer of matrix) the area of the masseteric tuberosities is smooth. The fossa masseterica is not present as an obvious depression, but rather as a flat, slightly convex, region. The eminentia lateralis rami, as well as the crista ectocondyloidea, are slightly developed.

The region of the pterygoid tuberosity appears smooth, but it must be remarked that a reliable judgement is hampered by the presence of matrix. Three structures are marked: the crista endocondyloidea, the crista endocoronoidea and the torus triangularis. The planum triangulare is large and its fossa is deep. The pterygoid fovea is

Fig. 19. Wajak-2 (norma verticalis), mandibula W-H-23 (courtesy NHM, London).

intact, it is rather small and shallow. As with the lingula and the mylohyoid sulcus, the mandibular foramen is invisible due to matrix. Although the above mentioned structures are invisible, it is possible to see the depression of the sulcus colli. The fossa precoronoidea is medium developed (the region of the fossa is large, but the fossa is not distinctly shallow nor deep) and the crista pharyngea is present, but this margin is not sharp.

The teeth of Wajak-2

The teeth (W-H-22, W-H-23) — There are no antemortem missing teeth. Presumably there was a normal number of teeth present. Caries is not clearly present, and there is no calculus, nor any sign of abscesses. Judging the extent of resorption of the alveolar bone is difficult due to the presence of matrix. The degree of resorption is normal around the molars (a little more resorption than in W-H-24/25). There is some resorption around the lower incisors. The occlusion can be judged as 'moderate' and the direction of wear of the teeth is horizontal and oblique. The wear of molars (using the method of Brothwell, 1981) (/ = not possible to judge) is:

	M3=2	M2=2	M1=/	M1=3+	M2=2	M3=2	Maxilla
R							L
	M3=/	M2=2	M1=4	M1=3+	M2=2	M3=2	Mandibula

Single teeth

In the collection there are three single human teeth, which will be described below.

Left lower canine (W-H-1457-12) — This canine is much smaller than the one from the mandible of W-H-23 (Wajak-2). Hence it is also unlikely that this canine belongs to the mandible of Wajak-1 because the latter is not much smaller than Wajak-2. This could indicate the presence of a third human individual in the Wajak bone assemblage (this canine gives the impression of being more recent).

Left upper premolar (P3) (W-H-1457-13) — This element looks older than the above described canine and there is some matrix around its root. This indicates that there is a third human individual in the Wajak assemblage because both Wajak-1 and Wajak-2 have a left P3. This premolar is much smaller than the premolar from W-H-22 or W-H-24.

Left lower premolar (P4) (W-H-1457-14) — This premolar is smaller than P4 from the mandible of W-H-23 (right side).

Postcranial human skeletal material

Humerus fragments — W-H-13584-7 is a fragment (with a total length of c. 143 mm) of the distal end of a left humerus. It is heavily weathered and in some places it is covered with red/brown matrix. It needs to be cleaned. Clearly present is the capitulum. At the place of the radial fossa there is matrix. Furthermore it is possible to observe the proximal part of the coronoid fossa and a part of the olecranon fossa.

W-H-13584-6 is a fragment (with a total length of c. 68 mm) of the diaphysis of the left humerus. It can be placed in line with W-H-13584-7; in this way they form the greater part of a left humerus. Also this fragment needs to be cleaned. As far as can be judged (this fragment is weathered) there was no pronounced crest of the greater tubercle, the picture appears therefore not robust.

Radius fragments — W-H-10021-44 is a fragment (with a total length of c. 40 mm) of the distal end of a left radius. It has some damage, but is not as weathered as the above mentioned two humerus fragments. Clearly present are the ulnar notch and the carpal articular surface; the styloid process is broken. In comparison with the radius of the red skeleton from Hoekgrot (HG-R-26) this fragment must have belonged to a bigger individual. The next two fragments of the diaphyses of the radius provide few details, there total length is a little less than 6 cm.

Femur fragments — W-H-13584-1 is a fragment (with a total length of a little more than 9 cm) of the proximal end of a left femur. The head is heavily weathered and incomplete; there is hardly compact bone left, and therefore it is possible to see the spongy bone. Of the neck only the medial part is present and the base of the lesser trochanter is present. Although this fossil is in a bad state, it is clear that this fragment stems from a bigger individual than the red skeleton of Hoekgrot.

W-H-13584-2 is a fragment (with a total length of c. 89 mm) of the diaphysis that, regarding the weathered state, is comparable with the humerus fragments W-H-13584-6 and W-H-13584-7.

W-H-13584-5 is a fragment (with a total length of c. 82 mm) of the diaphysis and appears to be much better conserved than the mentioned fragment W-H-13584-2. This fragment clearly originates from a more heavily built individual than the red skeleton of Hoekgrot.

W-H-27 is a fragment of the proximal end of a left femur with a total length of c. 147 mm. It shows a good preservation of the anterior part of the head; the posterior part is heavily damaged. The neck is almost intact (its proximal part is broken), just as the greater trochanter (it shows a crack that continues to the diaphysis). The lesser trochanter is broken and the trochanteric fossa is filled with some matrix. The intertrochanteric line is not distinctly present; possibly this is due to damage to the surface. The intertrochanteric crest is clearly visible in contrast to the pectineal line and the gluteal tuberosity, which can partly be caused by a combination of slight damage, presence of matrix, and the transparent layer. Beneath the lesser trochanter there is 3 cm of the diaphysis present. Fragment nr. W-H-27 is, in comparison with the fragments HG-R-31/32 of the red skeleton from Hoekgrot, big and robust. The subtrochanteric anterior/posterior diameter = 26.5 mm. The subtrochanteric medio/lateral diameter = 32.6 mm. The platymeric index = 81.3.

W-H-28 is a fragment (with a total length of 64 mm) of the distal end of a left femur. The condyli are not present and for the rest it is also damaged. Nevertheless the popliteal surface is clearly visible.

The next fragments are all from the diaphysis and the total lengths of these fragments are about: W-H-29: 83 mm; W-H-30: 47 mm; W-H-31: 57 mm. Fragment W-H-29 has been sawn; therefore, one has a very good view of the medullary cavity that appears to be filled with matrix. If one considers the total number of femur fragments the number of individuals is two.

Tibia fragments — W-H-32 is a fragment (with a total length of c. 131 mm) of the proximal end of a right tibia with, in the region of the condyli (posterior), three pieces of bone fragments fixed on its surface. It has been sawn in the region of the diaphysis, enabling a good view of the medullary cavity that is filled with matrix. Clearly visible are the superior articular surfaces of the medial and the lateral condyli. Around the condyli there is some erosion, enabling a view of the spongy bone. Above the tuberosity there is a depression (postmortem damage) filled with matrix between the trabeculae; anterior/medial there is a second depression. It is impossible to see the articular surface of the fibular head due to erosion of the compact bone. Clearly visible are the anterior and posterior intercondylar areas, and the intercondylar eminence (with both the medial and lateral intercondylar tubercles; showing a little erosion). Beneath the clearly pronounced tuberosity c. 5 cm of the diaphysis is left, enabling it possible to observe the anterior margin, the medial surface, the proximal part of the interosseous margin and the soleal line.

W-H-33 is a fragment of the proximal end of a left tibia, with a total length of c. 80 mm. Clearly visible are the superior articular surfaces of the medial and lateral condyli. The grade of erosion is comparable to fragment W-H-32. This fragment shows a depression (postmortem damage) in the region above the tuberosity, and anterior/medial there is a second one. Both depressions are filled with some matrix between the trabeculae. The (complete) smooth articular surface of the fibular head cannot be seen due to erosion, but it is possible to distinguish the eminence of this articular facet. Clearly visible are the anterior and posterior intercondylar areas, the intercondylar eminence (with both the medial and lateral intercondylar tubercles; there is a little erosion), and the proximal part (a large part) of the pronounced tuberosity.

Fibula fragments — W-H-34 is a fragment (with a total length of c. 31 mm) of the distal part of a right fibula, showing the lateral malleolus (there is a hole and a lot of matrix) and the malleolar articular surface. The following diaphyses fragments were found and their total lengths are about: W-H-10022-1: 59 mm; W-H-35: 67 mm; W-H-36: 54 mm; W-H-37: 40 mm.

Pelvic fragment — W-H-38 is a small fragment, with a total length of c. 40 mm, which fits in the view of an ileum fragment from the region of the greater sciatic notch.

Feet — W-H-39 is a fragment of the upper part of the right calcaneus, suffering from a lot of damage and presence of matrix. Its total length is c. 64 mm. Recognizable are the sustentaculum of the talus, the calcaneal sulcus (difficult because of erosion), the tarsal sinus (filled with matrix), the middle and posterior talar articular surfaces and the upper part of the articular surface for the cuboid bone.

W-H-40 is a complete talus of the right side, in a good state of preservation. The following measurements can be given: length: 58.7 mm; maximum length: 63.0 mm; height: 33.8 mm. The index of the talar height (height*100/length) = 57.6. It is not possible to give the exact breadth, because the lateral talar process is broken. Possibly the fragments W-H-39 and W-H-40 are from the same foot.

W-H-10021-25 is the proximal part of a left metatarsus-I; its total length is c. 44 mm (two parts have been shifted).

W-H-10021-33 is the proximal part of a left metatarsus-III; its total length is c. 45 mm.

W-H-41 is the proximal part of a left metatarsus-IV; its total length is c. 51 mm. This fragment is covered with a thick layer of matrix which hinders its determination.

W-H-1457-37 is a phalanx distalis-I, its total length is 27 mm.

Parts of the feet are in agreement with the 'picture' of a bigger person than the red painted skeleton of Hoekgrot (see next chapter), and possibly of a male.

Number of individuals

So far, it had generally been assumed that the human remains of the Wajak site represented two individuals. This assumption is not confirmed by this study, because (part of) three upper left premolars (P3) have been found: W-H-22 (complete in the maxilla of Wajak-2), W-H-24 (root in the maxilla of Wajak-1), W-H-1457-13 (complete single premolar). (The crown of the premolar (W-H-1457-13) is smaller than the left P3 of Wajak-2 and smaller than the right P3 of Wajak-1.) As the number of individuals is no longer two but three, one has to be very careful when ascribing certain fragments to certain individuals. There are nine fragments left, which are not described and need cleaning.

Jacob (1967) remarked in his description of the 'upper facial fragment' of Wajak-2 that the infraorbital foramen was distinct on the left zygomatic bone. This means that at that time, the zygomatic maxilla fragment W-H-16 was fixed with the frontal bone (W-H-4 and W-H-5). From a replica of Wajak-2 I could deduce that a part of W-H-5 has been lost. Consequently, fragment W-H-16 does not fit to the frontal bone (W-H-4 and W-H-5) as it once did. To summarise, it is highly probable that the following fragments are from the same person (Wajak-2): W-H-22 (maxilla), W-H-23 (mandibula), W-H-4/5 (os frontale), W-H-11 (os zygomaticum dextra/maxilla) and W-H-16 (os zygomaticum sinistra/maxilla). Also the other cranial fragments of Wajak-2 fit with the view of a (slightly) more robust skull than Wajak-1. Considering the fragments which fit, it must be possible to reconstruct the face of Wajak-2.

Sex of the Wajak skulls

In view of the relatively small size of the palate of Wajak-1 (as compared with that of Wajak-2) Dubois (1922) assumed that it belonged to a female and Wajak-2 to a male. Other female characters of Wajak-1, noticed by Dubois (1922) included: the more reduced form of the teeth, the smaller dimensions of the comparable parts of the skull, the less pronounced superciliary arches, the forehead that does not recede so much, the higher orbits, the somewhat slighter development of the muscle attachments, the more rounded form of the occiput, the somewhat slight lophocephaly and dolichocephaly, the smallness of Flowers 'gnathic index'.

According to Keith (1925), there were grounds for doubting this decision; possibly both Wajak-1 and Wajak-2 were remains of a male. Also Coon (1963) was not sure about Dubois' interpretation, but he gave no further explanation. So far, there has been no extensive discussion on the sex of the two skulls and therefore there is a lot of uncertainty.

On the basis of Table 9 both Wajak skulls can best be interpreted as males. Particularly Wajak-2 seems to be a robust looking male. Because of the differences between the two skulls one can understand why Dubois (1922) interpreted Wajak-1 as female. If one were to agree with Dubois' idea, one is confronted with the problem that one has to accept that the Wajak-1 skull comes from a population showing an extreme robust morphology. Many dimensions of Wajak-1 appear very large compared to both prehistoric and recent male skulls from Australasia (Tables 24-58 and 71-79). Both Wajak skulls can be interpreted as modern humans (*Homo sapiens*); therefore, the most likely interpretation is that both skulls are male, and the differences observed between the two are due to variability within the male skull range.

Uytterschaut (1983, 1986) uses the measurements of Howells (1973) for her sex

discriminant function. If we apply this sex discriminant function, the result for Wajak-1 is as follows:
Y = (GOL*0.35) + (ZYB*0.54) + (NLH *0.58) + (NLB *0.49)
Y = (200*0.35) + (144*0.54) + (51.7*0.58) + (30.7*0.49)
Y = 70.0 + 77.8 + 30.0 + 15.0 = 192.8.

Uytterschaut (1983, p. 65) renders the results of 13 populations, coming from East Asia and Australasia. Her lowest sectioning point is 159.3 (Andaman), her highest 182.0 (Moriori). Although the bizygomatic breadth of Wajak-1 is a rough estimate, using Uytterschaut's discriminant function the score of Wajak-1 is very high (192.8). Obviously, the dimensions of Wajak-1 are so large that it is very likely a male.

Admittedly, the characteristics used in Table 9 were originally proposed for the sex determination of European (Acsadi & Nemeskeri, 1970; Workshop, 1980) and Australian Aboriginal skulls (Larnach & Macintosh, 1966, 1970, 1971). Male skulls from Asians (for instance, Chinese and Javanese; Tables 80- 110) have in general some rather more feminine characteristics. Probably sexual dimorphism in these populations is not as pronounced as among Europeans and Australians. If one accepts its Javanese status, the morphology of Wajak-1 with its mix of robust and some gracile characters becomes understandable. Its feminine characters, like the small mastoid process, the absence of the external occipital protuberance, and the minor traces of the nuchal lines and occipital crest, frequently occur in recent Javanese male skulls.

Age of the Wajak skulls

The age determination of single adult skulls can be difficult and uncertain; dental attrition differs between populations and in addition there is individual variation. Exocranial suture closure provides only a crude impression, and even this method has been criticised (Brothwell, 1981). Therefore, only a very rough estimate of the Wajak specimens' age is possible (Table 10). The development of the dentition (method of Ubelaker, 1978) indicates that both Wajak skulls are adult, i.e. more than 21 years of age. On the basis of dental attrition (method of Brothwell, 1981; which was used for Neolithic to Medieval British skulls) both Wajak skulls should stem from young adults, aged between 17 and 25 years, Wajak-2 being probably closer to 25 years. As a check, the method of Montagu (1960) was used, i.e. assessing the exocranial suture closures: this results in an estimated age of Wajak-1 of around 22. Although both estimates are highly speculative it is clear that both skulls are from young adults and show no signs of degeneration due to aging.

Pathology of Wajak-1

In the Wajak-1 skull the region of the glabella is damaged, enabling the region of the frontal sinus to become visible. Remarkable, however, is the presence of spongy bone in (next to) this cavity. Possibly the sinus was small or not present at all. This could have been due to a pathological process having influenced the morphology of this region. If one accepts this idea (one could, for instance, think of an inflammation or tumour) it is more likely that it would extend into the direction of the 'softer' ethmoidal region than into that of the compact bone of the glabellar region. Furthermore, there is actually no indication of an abnormal situation. In addition there are two arguments against this idea. 1) The spongy bone of the frontal sinus appears to be normal. 2) The presence of spongy bone next to the sinus frequently occurs in recent humans, as is apparent in anatomical collections, and can be confirmed by clinical experience (pers. comm. Wind), just as in the case of Wajak, without any sign of abnormal growth. It could also be suggested that its presence can be explained by biomechanical stress factors. At this stage the only conclusion can be that there is no evidence of a serious pathological process which could have shaped the 'outside' morphology of Wajak-1.

Stature of Wajak man

According to Dubois (1922) Wajak Man was, judged from the preserved parts of the femur and tibia, rather slender, like the Australians, but taller. Therefore the bones of Wajak Man were, according to him, most certainly heavier (thicker). Unfortunately, the preserved parts of the postcranial skeleton are too fragmented to say anything reliable about the stature. The only thing that can be suggested is that the postcranial material is not in contradiction with the interpretation of the presence of two males at the Wajak site.

Measuring the Wajak skulls

Confronted with the frequent presence of erosion, matrix, and plaster, one may gain the impression that it is not possible to measure the Wajak skulls reliably. Although the state of preservation of the skulls is certainly not as good as, for instance, that of the Kanalda skull (see chapter 'The Kanalda skull'), to omit measuring these skulls would be something like 'throwing a beautiful baby away with the bath water'. Nevertheless, because of the presence of the above- mentioned disturbing circumstances, it is certainly not always possible to give exact measurements.

Measuring Wajak-1 (W-H-24) — In general, the preservation of the skull is such that quite a lot of measurements can be made. One must be careful with measurements of the zygomatic bones because of distortion and with short measurements because of erosion. Craniometric points are not always distinct. Here follows a summary of some of the cranial landmarks of Wajak-1.

Asterion: bilaterally this landmark cannot be assessed due to plaster in this area.

Basion: this point is not present due to erosion, but it is possible to estimate its position.

Bregma: there is some damage in this region, but it is possible to localise its position.

Dacryon: present on both sides.

Ectoconchion: it is difficult to give its precise position due to damage (on both sides, and on the left side there is also matrix). Because the interior of the orbits is very well preserved it is possible to estimate the position of ectoconchion.

Frontomalare anterior: see ectoconchion.

Glabella: one can only give an estimate of this craniometric point because of damage in the region of the glabella.

Lambda: is present.

Nasion: it is not possible to use this point in case of short measurements because it is impossible to give its precise position. One must be careful with using the subtense. It is, however, possible to use nasion in case of large measurements.
Opisthion: see basion.
Prosthion: due to damage one cannot use this point in case of short measurements.
Stephanion: it is best to estimate the position of this point on the right side; following this, it is easier to estimate the position of this point on the left side.
Subspinale: due to erosion of the spina nasalis anterior one must be careful when using this point.
Zygomaxillare anterior: only a rough estimate of this landmark is possible. Measurements taken from this point remain estimates and one must be careful with using these.
Zygoorbitale: it is impossible to give its position.

Remeasuring — If one compares the measurements of Wajak-1 as taken by different authors one finds differences (Table 11). Due to the presence of (slight) surface distortion it is not surprising to find differences of ca. 1 mm (for instance; cranial length, basion-nasion length, orbital breadth, nasal breadth). Also, in my experience, it is not always easy to find the same data after remeasuring, because some cranial landmarks are not present and have to be estimated (for instance: glabella, nasion, basion, opisthion and prosthion). Various explanations can be given for the difference in outcome.

a) Usage of different definitions is likely to produce slight differences.
b) Different interpretations of the position of cranial landmarks in case of surface damage are likely to produce slight differences.
c) Wajak-1 has undergone several restorations (Dubois, 1920; Jacob, 1967; in the 70's by C.B. Stringer and R. Parsons). This can cause minor as well as major differences.
d) Unfortunately (reading) errors cannot be excluded. They may produce substantial differences.

The cranial breadth as measured by Dubois (145 mm) differs, in fact, from later measurements (151 mm) (Table 11). This is possibly due to later reconstructions. It is, however, not always possible to explain differences in this way. Jacob and Santa Luca found the same lambda-opisthion chord (107 mm), but their arc differed (resp. 135 mm and 127 mm). This difference cannot easily be explained by the use of different definitions. The landmark opisthion is not present and has to be estimated. To explain this difference there is a possibility that the same researcher estimated the position of opisthion differently.

Do these differences affect the opinion about the Wajak skulls? By using the measurements given in Table 11 the following calculations can be given, providing information about form (cranial index) and about size (cranial module).

	Dubois, 1920	Jacob, 1967	Santa Luca, 1980	This study
Cranial index	72.5	75.5	75.1	75.5
Cranial module	161.7	162.7	-	162.7

In Australasia the cranial index ranges between 63.1 and 93.6 (Table 59). Using the measurements of Dubois, Wajak-1 would have to be classified as dolichocranic; using the other measurements, however, Wajak-1 would be classified as mesocranic. In Australasia the cranial module ranges between 133.3 and 161.3 (Table 71). It makes no difference which measurements one uses, Wajak-1 remains an extremely large skull. These examples are given to stress two aspects:

A) One is often confronted with the fact that using different measurements does not change one's opinion about the Wajak skulls (in this example the size of the neurocranium).

B) The use of some different measurements could influence one's opinion (in this example cranial index). Due to the presence of distortion we will probably never know exactly some of the measurements. In other words, do not lay to much weight on slight differences, do not base the opinion on only a few aspects of the skull, and try to take into account only undamaged regions. Therefore, in this thesis I have tried to include data from different regions of the skull (including non-metrical characters).

Wajak-1 and Wajak-2

If one compares the dimensions of Wajak-1 with those of Wajak-2 (Table 12), of the neurocranium, viscerocranium and mandible, it is obvious that, as far as I have been able to check Wajak-2 is larger in all its dimensions. Interestingly, this is, however, not the case with dental dimensions (Table 13). The dimensions of the skull of Wajak-2 are not only larger, but in comparison with Wajak-1, Wajak-2 is for a few characters more masculine (mastoid process, supramastoid crest, external occipital protuberance). The morphology of the frontal bone of the two skulls is remarkably similar (Table 9). Although the taphonomical circumstances remain obscure, based on the morphology of the skull there is no reason to believe that Wajak-1 and Wajak-2 represent different groups (species, subspecies). Both skulls represent robust *Homo sapiens* skulls. In general, Wajak-2 is more robust (often larger and more masculine) than Wajak-1.

Conclusion

Although the postcranial material of the Wajak site is fragmented, the presence of different parts of the body indicates that complete human bodies have been present. No reliable estimate of the stature can be made from these fragments. Based on the upper left premolars (P3) the number of individuals of the human material is three. The Wajak-1 skull is represented by a cranium and part of a mandible, the Wajak-2 skull by various fragments (frontal bone, right and left malar bones, maxilla and mandible; and probably by a temporal and occipital bone). Detailed study of the Wajak skulls shows that they represent the remains of 'fully modern' humans (*Homo sapiens*). Different characteristics (metrical and non-metrical) have been used to assess the sex of the Wajak skulls. Both skulls can best be considered as coming from males. Further, it is obvious that both Wajak skulls are from young adult individuals, with a highly speculative estimated ages, for Wajak-1 of 22 years, and for Wajak-2 of

24 years. The skulls show no evidence of pathology, trauma, or premortal artificial deformation.

The human material from Hoekgrot

Introduction

Human remains have not only been found at Wajak, but also at other sites in Indonesia. More or less complete human skeletons, now stored in the NNM in Leiden, have been found at the Javanese sites of Hoekgrot (Fig. 20) and of Sampung, and at the Flores sites Liang Momer and Liang Toge. These skeletons also contain well preserved skulls, which makes them valuable for a comparison with the Wajak skulls. In this chapter the human material of the Hoekgrot site will be described. Comparisons with other recent and prehistoric skulls from Australasia will be given and discussed in the next chapters.

The red-painted skeleton (Fig. 20)

The skull

HG-R-1: calva with a part of the maxilla (maxilla part is the frontal process).
HG-R-2: fragment of os frontale (right side, from the region of the zygomatic process).
HG-R-3: right os zygomaticum.
HG-R-4: left os zygomaticum.
HG-R-5: left os temporale.
HG-R-6: right os temporale.
HG-R-7: maxilla (left side with 3 molars).
HG-R-8: maxilla (right side with 3 molars and frontal process).
HG-R-9: fragment of the left ramus of the mandible with its condylar process.
HG-R-10: larger part of the right mandible, consisting of a nearly complete ramus and a large part of the body with the M1.

There are 24 unnumbered fragments (probably most of them from the cranium) and two fragments of the mandible (from the region of the symphysis).

The postcranial material

Os coxae (right side)

HG-R-11: fragment of os ileum with its auricular surface.
HG-R-12: fragment of os ischium with its acetabular notch and the lunate surface.
HG-R-13: fragment of os ischium with a part of the ischial tuberosity.

Os coxae (left side)

HG-R-14: fragment of os ischium with its acetabular notch, lunate surface and ischial tuberosity.
HG-R-15: fragment of the os ileum from the region of the greater sciatic notch.
There are also six unnumbered fragments of the os coxae.

Clavicula (right side)

HG-R-16: both extremities are broken off; it is possible to recognise the conoid tubercle and the impression of the costoclavicular ligament.

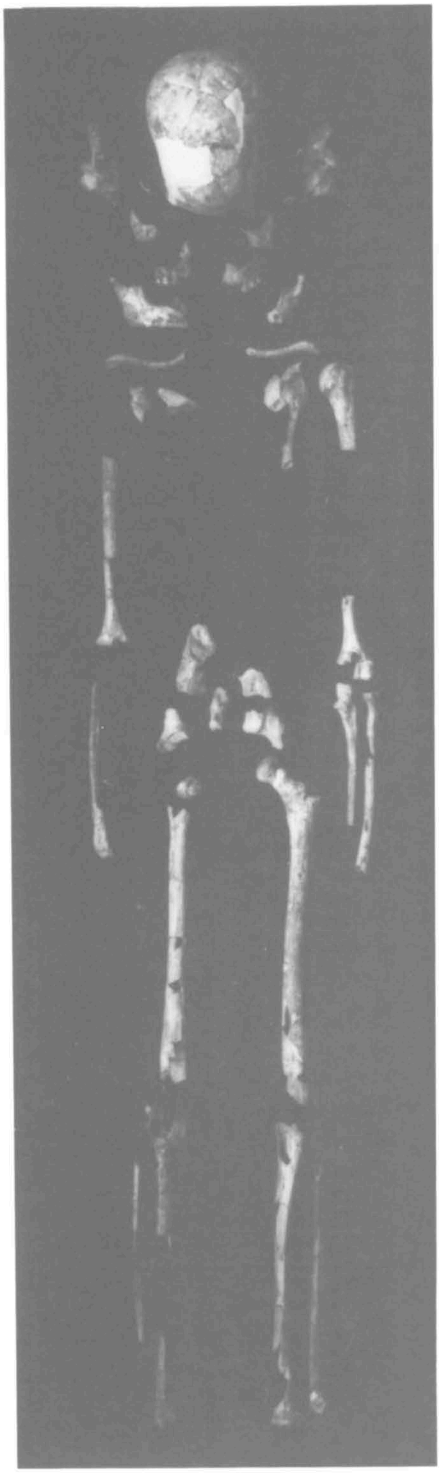

Fig. 20. Hoekgrot red painted skeleton (photograph by Jan Pauptit))

Clavicula (left side)

HG-R-17: both extremities are broken off; it is possible to recognise the conoid tubercle and a small part of the impression of the costoclavicular ligament.

Scapula (right side)

HG-R-18: fragment of upper part of the glenoid cavity and the coracoid process (tip is broken).

HG-R-19: fragment of medial part of spine.

Scapula (left side)

HG-R-20: relatively large fragment with an almost complete glenoid cavity, coracoid process (tip broken), lateral margin and the lateral part of the spine. Length of the glenoid cavity is approximately (damage) 35.5 mm.

Humerus (right side)

HG-R-21: proximal part of diaphysis without the head. The crest of the greater tubercle is visible.

HG-R-22: distal part of diaphysis with part of the coronoid fossa and part of the olecranon fossa.

Humerus (left side)

HG-R-23: proximal part of diaphysis with the head. Visible are the neck, the greater and lesser tubercles with their crests, and the intertubercular groove. The vertical diameter of the humeral head is approximately (damage) 43 mm.

HG-R-24: distal part of diaphysis with part of distal epiphyses. Visible are the lateral epicondyle and the capitulum.

Ulna (left side)

HG-R-25: greater part of the diaphysis, there is damage at proximal part and the distal part is missing. Visible are: olecranon, coronoid process, trochlear notch, radial notch (damage; spongy bone is visible), tuberosity, and the interosseous margin.

Radius (right side)

HG-R-26: nearly complete radius; the head is not present and the distal end is heavily damaged. Visible are: interosseous margin, ulnar notch, and the carpal articular surface.

Radius (left side)

HG-R-27: proximal part with: head (circumference is damaged, spongy bone is visible), neck, and the radial tuberosity.

HG-R-28: part of the diaphysis with the interosseous margin.

Femur (right side)

HG-R-29: greater part of diaphysis, with missing proximal and distal end. Visible are: gluteal tuberosity and linea aspera.

HG-R-30: fragment of the head with the fovea. Probably belongs to HG-R-29.

Femur (left side)

HG-R-31: greater part of diaphysis; missing are the distal part and the head. Visible are: neck, greater trochanter, lesser trochanter (heavily damaged), pectineal line, gluteal tuberosity, and the linea aspera.

HG-R-32: greater part of the head (with the fovea), which is eroded (spongy bone exposed). Probably belongs to HG-R-31.

There are three unnumbered fragments of the femur.

Tibia (right side)

HG-R-33: heavily damaged fragment of proximal part of tibia. Visible are: part of lateral condyle, distal part of tuberosity, anterior margin, interosseous margin, and the foramen nutricium.

HG-R-34: fragment of distal part of the lateral side. Visible are: part of inferior articular surface, fibular notch, and the interosseous margin.

Tibia (left side)

HG-R-35: nearly complete tibia, but both ends are heavily damaged. Visible are: distal part of tuberosity, anterior margin, interosseous margin, inferior articular surface, and the malleolar articular surface.

There are two unnumbered fragments of the tibia (from the region of the condylus).

Fibula (right side)

HG-R-36: diaphysis with both ends missing.

Fibula (left side)

HG-R-37: fragment of proximal part of diaphysis.

HG-R-38: fragment of the diaphysis with a distal broadening to the lateral malleolus (fragment nr. HG-R-39)

HG-R-39: fragment of lateral malleolus with visible the malleolar articular surface.

(Fragments nr. HG-R-37, 38 and 39 form the left fibula without the head).

Hand

HG-R-40: proximal part of metacarpus.

HG-R-41: proximal part of metacarpus.

HG-R-42: distal part of metacarpus.

HG-R-43: phalanx media.

Feet

HG-R-44: distal part of metatarsus I (right side).

HG-R-45: phalanx proximalis I (left side).

Unnumbered Fragments — Vertebra fragments: 26; costa fragments: 43; other fragments: 173; they vary in size between 4 and 53 mm.

The non-coloured human remains

Cranial fragments

HG-W-1: fragment of os occipitale with the internal occipital protuberance (greater part of cruciform eminence), the left groove for the transverse sinus and the internal occipital crest.

HG-W-3: fragment of right petrous part with the opening of the internal acoustic meatus.

HG-W-4: fragment of os zygomaticum (left side) with the frontal process, the temporal and orbital surface (latter has a lot of matrix).

HG-W-5: fragment of the body of the mandible (right side) of a young individual. Visible are: right half of mental protuberance (weakly developed), mentale foramen, anterior part of mylohyoid line, anterior part of submandibular fovea, sublingual fovea, mental spine, digastric fossa, I2 (not fully erupted), dental alveolus of the canine is partly empty and partly filled with matrix, m1 and the m2. The dental alveolus of the M1 is partly present (posterior/medial side is broken).

There is some damage and matrix in the area of the I2, the incisor has become slightly pushed to the medial side, probably due to postmortem damage. It is possible that it is not the I2 but the I1 (pushed to the lateral side), but probably it is the I2.

HG-W-6: fragment of left ramus with: condylar process, neck, head (damaged medially), pterygoid fovea, mandibular foramen and the lingula.

There are 30 fragments of the skull left unnumbered.

Incisors

HG-W-7: right I1 of the maxilla, point of the root is broken. There is wear on the occlusal side and this incisor is slightly shovel-shaped.

HG-W-8: right I1 of the maxilla, point of the root is broken.

HG-W-9: right I2 of the maxilla, although the point is broken, it is still possible to follow the direction of this root.

HG-W-10: left I2 of the maxilla.

HG-W-11: left I2 of the mandible. There is wear on the occlusal side.

HG-W-12: right I2 of the mandible. There is heavy wear.

Canines

HG-W-13: right C of the maxilla, point of the root is broken.

HG-W-14: C of the maxilla, there is heavy wear.

HG-W-15: left canine of the maxilla. This tooth is different from other teeth, i.e. it looks more recent. The crown is less weathered and the colour is lighter. Also there is no matrixon its surface.

HG-W-16: two teeth (held together by matrix): the C and P3 of the left maxilla. Half of their root is broken.

Premolars

HG-W-17: right P3 of the maxilla. Half of the root is broken.

HG-W-18: P of the maxilla, wear of the crown.

HG-W-19: P4 of the mandible, the root is covered with a thick layer of matrix.

HG-W-20: P of the mandible, wear of the crown.

HG-W-21: P of the mandible, wear of the crown.

Molars

HG-W-22/23: lower molars, wear of the crown.

Postcranial material

Os coxae (left)

HG-W-24: fragment of os ischium with the ischial tuberosity. This fragment appears masculine, at least when compared with the red painted skeleton (HG- R-14).

HG-W-25: fragment of os ileum from the region of the greater sciatic notch; due to damage it is not possible to give a reliable diagnosis of the sex of this fragment.

Os coxae (right)

HG-W-79: fragment with the acetabular fossa and the upper part of the ischial tuberosity being visible.

Clavicula (right)

HG-W-26: fragment of the diaphysis with the outlet to the sternal extremity.

Humerus (left)

HG-W-27: distal fragment of the humerus with the trochlea and the capitulum.

HG-W-28: proximal fragment of the diaphysis of the humerus with the crest of the lesser tubercle.

HG-W-29: distal fragment of the diaphysis of the humerus. This fragment is probably from a smaller person than HG-W-27/28.

Ulna (left)

HG-W-30: proximal part of the ulna with: olecranon, coronoid process, trochlear notch, radial notch, and the tuberosity.

HG-W-31: proximal part of the ulna of a young individual as far as can be judged from the size and 'robustness'. Visible are: part of trochlear notch, radial notch, tuberosity (not very well developed), and the interosseous margin.

Radius

HG-W-32: diaphysis fragment of the right radius with the interosseous margin.

HG-W-33/34: two fragments of proximal part of the radius, from the region of the radial tuberosity.

HG-W-35: fragment of distal part of the left radius.

There are three fragments left unnumbered.

Femur

HG-W-36: nearly complete diaphysis of the left femur, with linea aspera, foramen nutricium and the gluteal tuberosity.

HG-W-37: heavily eroded fragment from proximal part of the left femur, with much spongy bone exposed. Present are the anterior and medial part of the neck and part of the medial side of the diaphysis.

HG-W-38: fragment of proximal part of the right femur. Present are posterior and medial part of the neck, part of the lesser trochanter and proximal part of the gluteal tuberosity.

HG-W-39: fragment of proximal part of the diaphysis of the right femur. Present are the linea aspera and foramen nutricium.

HG-W-40: fragment of distal part of the diaphysis of the right femur, with distal part of the linea aspera.

Tibia

HG-W-41: fragment of the diaphysis from the left tibia, with the anterior, interosseous and medial margins, and foramen nutricium.

HG-W-42: fragment of distal part of the diaphysis from the left tibia, with the anterior, interosseous and medial margins.

HG-W-44: fragment of the diaphysis of the left side.

HG-W-45: fragment of the diaphysis, probably the right one. This fragment is partly burnt (i.e. in view of its black colour) and shows marks of gnawing made by a large rodent (probably *Hystrix javanica*).

Metacarpalia

HG-W-46: proximal part of metacarpus II of the right hand.

HG-W-47: proximal part of metacarpus II of the left hand.

HG-W-48: proximal part of metacarpus III of the left hand.

HG-W-47 and 48 are possibly from the same hand (they fit), HG-W-46 is larger, indicating the presence of a second individual.

Phalanx proximalis of the hand

HG-W-49, 50, 51: proximal part of phalanx proximalis.

HG-W-52, 53: distal part of phalanx proximalis.

Phalanx media of the hand

HG-W-54, 55, 56: complete or nearly complete.

HG-W-57, 58: proximal part of phalanx media.

HG-W-60: distal part of phalanx media.

Phalanx distalis of the hand

HG-W-59: proximal part of phalanx distalis I.

HG-W-61: complete phalanx distalis I.

It is possible that fragments HG-W-46, 52, 54 and 61 come from the same hand because they are darker and heavier (as a result of their containing more matrix) than the other parts of the hand.

Tarsalia

HG-W-62: complete calcaneus of the left side.

Metatarsalia

HG-W-63: proximal part of metatarsus I of the left side.

HG-W-64: proximal part of metatarsus I of the right side.

HG-W-65: proximal part of metatarsus I of the right side, damaged.

HG-W-66: proximal part (with also a large part of the corpus) of metatarsus II of the left side.

HG-W-67: proximal part of metatarsus III of the right side.

HG-W-68: proximal part of metatarsus IV of the right side.

HG-W-69: proximal part of metatarsus IV of the left side, which is burnt.

HG-W-70: distal part of metatarsus I of the right side.

HG-W-71: distal part of metatarsus I of the left side.

HG-W-72/73: distal parts of metatarsus IV of the right side; the caput is heavily eroded.

Probably HG-W-63 and 71 are from the same metatarsus I of the left side. This is also the case for HG-W-64 and 70.

Phalanx proximalis of the feet

HG-W-74: complete phalanx proximalis I of the right foot (upper side) and the distal part of the phalanx proximalis I of the left foot (underside) fixed to each other by matrix.

HG-W-75: complete phalanx proximalis (probably II or III).

Ossa sesamoidea of the feet

HG-W-76 and 77: two ossa sesamoidea from the region of the caput of metatarsus I.

It is possible that the following fragments are from the same individual because of their colour, size and state of preservation: metatarsalia: HG-W-63, 64, 70 and 71; phalanx proximalis: HG-W-74; ossa sesamoidea: HG-W-76 and 77.

Vertebra

HG-W-78: fragment of left side of cervical vertebra consisting of the vertebral body, transverse foramen, spinal nerve sulcus, posterior tubercle (anterior tubercle is broken), and the superior and inferior articular process. This fragment is burnt.

Costae

There are 19 unnumbered rib fragments.

Number of individuals

It is possible that HG-W-36, 39 and 40 are from the same individual if one considers their original position in the femur and their size. Fragment HG-W-37 (proximal part of left femur) and HG-W-38 (proximal part of right femur) are not from the same individual because HG-W-38 is much more robust than HG- W-37. Based on the femur fragments one could state that there are three individuals in the non-coloured human remains. If we add the red painted skeleton the number of individuals is four.

Sex of the red-painted skeleton

The most likely interpretation of the skull of the red painted skeleton is that of a female (Table 19). This interpretation agrees with the shape of the pelvis: possibly HG-R-15 belongs to a wide and greater sciatic notch, and the ischial tuberosity is gracile. In addition, the rest of the postcranial skeleton appears equally gracile. However, this interpretation is somewhat weakened by the rather masculine development of the glabella, superciliary arches, zygomatic process of the temporal bone, and the supramastoid crest. Moreover, although the feminine features dominate in the Hoekgrot skull (in contrast to Wajak-1 and Sampung), recent Javanese male skulls can equally have a very feminine appearance (Table 18). Also robust prehistoric males like Wajak-1 and Sampung have feminine characters. So, Neolithic Javanese male skulls may have possessed feminine characters. In this light, the presence of masculine developed characters in the Hoekgrot skull are 'suspect'. Although the diagnosis of the rest of the red painted skeleton confirms the determination of the Hoekgrot skull as female, the pelvis of this skeleton is fragmented, and in Javanese specimens the gracile appearance is not necessarily a strong indicator of the female sex. The diagnosis is therefore possibly much weaker than it appears.

Age of the red-painted skeleton

Unfortunately the postcranial material is too fragmentary for an assessment of the age, only the skull could be used. From the development of the dentition (-Ubelaker's, 1978 method) one can deduce that the individual must have been an adult: both upper M3 are present. Although it is unreliable to apply the classification of attrition of Brothwell (1981) to this skull, it nevertheless gives a rough impression of the age, according to which this skull would have belonged to an individual between 17 and 25 years of age, closer to 25. The exocranial closure of the skull sutures (method of Ashley Montagu, 1960) suggests that the individual must have been younger than 24 years. The endocranial closure of the skull sutures (method of Acsadi and Nemeskeri, 1970) suggests that the individual was possibly between 20 and 24 years old. Hence the very speculative estimated age is around 22/23 years. Anyway, the red painted skeleton can be interpreted as a young adult.

Age of the juvenile

The presence of the mandible HG-W-5 made it possible to estimate the age of the juvenile. Ubelaker's (1978) method of the development of the dentition was used. The m1 and m2 are present, indicating an age between 3 ± 1 years and 9 ± 2 years. Because of the well developed dental alveolus of the M1, and the presence of the I2, an age of 6 ± 2 years or lower is improbable. Because of the development of the I2 (not fully erupted), an age of 9 ± 2 years or higher is also improbable. An estimated age around 7/8 ± 2 years is likely.

Stature of the red-painted skeleton

The method of Trotter & Gleser (1952) was applied to estimate the stature of the red skeleton. I combined the Tables from 'White females' and 'Negro females'. Because of this and the fragmentary state of the bones, only a very rough estimate can be given. Probably the length of this individual was between 164 and 171 cm (* = original length of bone is estimated).

Number	Bone	Length	Original* length	Estimation stature
HG-R-31	Femur	42.0 cm	45 cm	164 ± 5 cm
HG-R-35	Tibia	35.7 cm	39 cm	171 ± 7 cm

Pathology of the red-painted skull

Although the skull from Hoekgrot can, in general, be regarded as gracile, its bones are thick. This could be the result of pathology. Because of 'the normal radiographic appearance' and 'the thickness measurements fall within most of the ranges of variation' (Nelson, 1988, pp. 16-17), the thickness of the skull can probably better not be interpreted as the result of a pathological process. The M1 of the mandible shows very extensive wear, much more pronounced than the opposite lying molars of the maxilla. This wear is somewhat oblique and down to the roots. Possibly this molar was heavily suffering from caries which led to the extensive and somewhat oblique wear.

Conclusion

Among the sites excavated by Dubois at the end of the previous century, Hoekgrot is one of the better known. Considering the human material, it is highly probable that complete bodies had been buried or laid down in the Hoekgrot site as many parts of the skeleton have been found. The amount of burnt material is too low to interpret this as the result of cremation. The number of individuals, based on femur fragments, is four. There are three adults and one juvenile. The age of the young individual was probably around seven or eight years. The most remarkable aspect of this site is the completely red painted human skeleton, which indicates secondary burial practices.

The uncertain interpretation of the skull of the red painted skeleton as female is not in contradiction with the gracile appearance of the postcranial skeleton. If various methods for the estimation of the age are combined, the picture emerges of an individual of an age of probably around 22-23 years. The stature is estimated between 164 and 171 cm. One can conclude that the skull bone thickness is probably not the result of pathology, but should rather be seen as a sign of individual variation. The wear of the right lower M1 is oblique and down to the roots.

The Kanalda skull (Australia)

Introduction

In February 1976 the Natural History Museum, London, received a skull (in exchange with Dr R.L. Casanova) that was said to originate from Australia, and was named Kanalda. The origin of this skull, however, is, just like its name, obscure. An Australian site whose name comes close, is spelled as 'Koonalda'. Later, in view of its state of preservation (and probably its morphology) Dr P. Brown, from Australia, was asked if this skull could possibly belong to one of the Australian collections (i.e. Coobool Creek), and this he confirmed. It was the only original (pre)historic skull (possibly) from Australia that could be examined, which makes it a valuable '-acquisition' for the interpretation of the Wajak specimens. In this chapter, the Kanalda skull is described, without comparison with other recent and prehistoric skulls from Australasia, which will be made and discussed in the next chapter.

State of preservation

The state of preservation of this skull is very good. However, there is some post-mortem damage and erosion in the following areas (this enumeration is not complete). Within the orbits, the os sphenoidale is partly broken, and the os ethmoidale and os lacrimale are broken. Within the nasal aperture, the vomer is broken and there is some breakage around the aperture, on the nasal bones, the maxilla (frontal process) and the anterior nasal spine. Some damage of the temporal process of the os zygomaticum, zygomatic process of the os temporale (around the temperozygomatic suture), and the marginal tubercle on the left side. The parietal margin of the left and right temporal squama are broken. One can see matrix between the temporal squama and parietal bones. Viewed from norma basalis, damage is apparent around the posterior part of the alveolar process, the lateral and medial pterygoid plates, occipital condyles, styloid process and the petrous part. Obvious damage of the mandible is its broken coronoid process (right side) and around the left side of the mylohyoid line (latter is 'fresh', possibly a sample for dating and/or chemical analysis).

Diagnosis of the sex

The first impression one gets from this skull is that it is obviously robust, i.e. both masculine (Tables 14, 19) and large (Table 17). The characteristics used for the determination of the sex (Acsadi & Nemeskeri, 1970; Workshop, 1980) show clearly that it is highly probable that this skull is from a male. Although this skull has some feminine characteristics, like the supramastoid crest, the nuchal lines and the mental protuberance (this last mentioned feature is generally small in Australian Aborigines) its masculine appearance clearly dominates.

The sex discriminant function (method of Uytterschaut, 1983, 1986; for the formula, see p. 58) for the Kanalda skull is 195.7. Although a further study has to be made of the precise discrimination points of the collections of (recent) Australian skulls, the score of the Kanalda skull is so extremely high that it can safely be classified as male.

Measurements of the mandible are: minimum ramus breadth: 37 mm; ramus height: 63 mm; bigonial breadth: 106 mm; total length: 116 mm; symphysis height: 36 mm. Except for the ramus height (which is medium), these measurements are high according to the standard of Larnach & Macintosh (1971), which indicates that this skull is male.

Estimation of the age

The closure of the synchondrosis sphenooccipitalis and the development of the teeth (method of Ubelaker, 1978) show that the skull is from an adult. Although it is, just as with Wajak and Hoekgrot, unreliable to apply the classification of dental attrition of Brothwell (1981) to Kanalda, it nevertheless gives a rough impression of the age, according to which this skull would have belonged to an individual between 25 and 45 years. So, the skull cannot be seen as juvenile nor as very old. This idea is more or less confirmed by the slight resorption of the alveolar bone. However, the obliteration of the sutures (Table 15) is slight, most parts are still open, possibly an indication for 'young adult'. The wear of the molars of the Kanalda skull was probably intense. This is also indicated by the anterior teeth which show clear signs of intense wear (edge to edge bite). One could therefore suggest that the skull seems to originate from an adult, with an highly speculative age of 25-35. Anyway, the skull is not from an old individual showing signs of degeneration.

Conclusion

Although there is some postmortem damage and erosion, the state of preservation of the Kanalda skull can be considered as excellent. The skull shows no clear signs of trauma, pathology or antemortem cultural deformation. Both non-metrical and metrical features of the cranium and mandible clearly indicate that this skull is that of a male. If one combines different indications for the estimation of the age; closure of the synchondrosis sphenooccipitalis, suture obliration, eruption and attrition of the teeth, and resorption of the alveolar bone, an highly speculative age of 25-35 can be suggested. Most important, this adult skull shows no signs of degeneration due to old age.

Cranial variation in *Homo sapiens*

Introduction

In this chapter, which deals with cranial variation in *Homo sapiens* in Australasia, two approaches are followed: from a methodological point of view, and from a regional point of view. Before the cranial morphology of both prehistoric and recent skulls from the various regions is discussed, sexual dimorphism will be considered. The abbreviation used for Papua New Guinea/Papuans is: N.G.

Measurements

Cranial measurements give information about absolute cranial dimensions. Two kinds of measurements were used:

1. Straight lines which connect two points (for instance, basion-bregma height) or connect one or two 'imaginary' points (for instance, mandibular length). Not only well defined cranial landmarks were used (for instance, nasion and opisthion), but also those measurements one had to seek (for instance, maximum cranial breadth). The instruments used were the sliding/dial calliper, spreading calliper, and osteometric board.
2. Lines which follow the course of the bone (for instance, parietal arc). The instrument used was tape.

Neurocranium

Glabella-occipital length (Table 24) — In the recent series, Javanese tend to have the shortest skulls. Prehistoric male skulls (Liujiang, U.C.1, Wajak-1, Sampung, Kanalda, Keilor, K.S.5) clearly surpass the average values of their own regional recent male series (China, Java, Australia).

Basion-bregma height (Table 25) — In the recent series, N.G. tend to have the lowest skulls, whereas Chinese tend to have the highest skulls. Wajak-1 is close to the average recent Javanese male series, whereas Kanalda surpasses the range of recent Australian male series.

Maximum cranial breadth (Table 26) — In the recent series, both Chinese and Javanese tend to have broader skulls, whereas N.G. and Australians tend to have narrower skulls. Prehistoric male skulls (Liujiang, U.C.1, Wajak-1, Kanalda, Keilor, K.S.5) clearly surpass the average values of their own regional recent male series (China, Java, Australia).

Frontal chord (Table 27) — Tendencies are not strong in the recent series: Australians tend to have the largest frontal chord, whereas N.G. tend to have the smallest. Considering the prehistoric skulls; Wajak-1 surpasses the recent Javanese male series, and Hoekgrot the recent Javanese female series. Both Kanalda and K.S.1 surpass the recent Australian male series, but Keilor does not.

Parietal chord (Table 28) — In the recent series, it is obvious that Javanese tend to have the shortest parietal chord. Prehistoric male skulls (Wajak-1, Kanalda, Keilor) surpass the average values of their own regional recent male series (Java, Australia).

Parietal arc (Table 29): for trends, see parietal chord.

Occipital chord (table 30) — In the recent series, N.G. and Australians tend to have the shortest occipital chord, whereas Chinese tend to have the longest. Wajak-1 is close to the recent Javanese male series. Kanalda and Keilor clearly surpass the recent Australian male series.

Occipital arc (Table 31) — In the recent series, Chinese tend to have the longest occipital arc. The three prehistoric males (Wajak-1, Kanalda, Keilor) surpass the average values of their own regional recent male series (Java, Australia).

Maximum supraorbital breadth (Table 32) — In the recent series, it is obvious that Australians tend to have the largest MSB. Prehistoric males (Liujiang, U.C.1, Wajak-1, Kanalda, Keilor, K.S.1) clearly surpass the average values of their own regional recent male series (Java, China, Australia).

Minimum postorbital diameter (Table 33) — In the recent series, N.G. tend to have the smallest MPD. Prehistoric males (Liujiang, Wajak-1, Kanalda) surpass the average values of their own regional recent male series (China, Java, Australia).

Basion-nasion length (Table 34) — Put roughly, this is the boundary line between the neurocranium and viscerocranium. Considering the recent series, Australians tend to have the largest BNL. Prehistoric males (Liujiang, U.C.1, Wajak-1, Kanalda) clearly surpass the average values of their own regional recent male series (China, Java, Australia).

Viscerocranium

Basion-prosthion length (Table 35) —In the recent series, Chinese tend to have the smallest BPL, whereas Australians tend to have the largest. Both Wajak-1 and Kanalda surpass their own recent male series, respectively Java and Australia.

Nasion-prosthion height (Table 36) — In the recent series, Chinese and Javanese tend to have the largest NPH, whereas N.G. and Australians tend to have the smallest. Interestingly Wajak-1 does not surpass the average value of the recent Javanese males. Kanalda surpasses the average value of the recent Australian males.

Bizygomatic breadth (Table 37) — In the recent series, it is obvious that N.G. tend to have the smallest ZYB. Prehistoric males (U.C.1, Wajak-1, Kanalda) clearly surpass the average values of their own regional recent male series (China, Java, Australia).

Width fronto-nasal articulation (Table 38) — In the recent series, only data of the Javanese and Australians have been collected. Considering the prehistoric skulls Keilor has the broadest FNA, just within the range of recent Australian males.

Nasal height (Table 39) — In the recent series, Chinese and Javanese tend to have the largest NLH, whereas N.G. and Australians tend to have the smallest. Liujiang and Wajak-1 do not surpass the average values of their own regional recent male series (China, Java). U.C.1, Kanalda, Keilor and K.S.1 surpass the average values of their own regional recent male series (China, Australia).

Nasal breadth (Table 40) — In the recent series, Chinese tend to have the smallest NLB, whereas Australians tend to have the largest. Both Liujiang and U.C.1 surpass the average value of the recent Chinese male series, U.C.1 has an extremely broad nasal aperture. Wajak-1 surpasses the average value of the recent Javanese, approaching the maximum value. Some of the prehistoric Australian male crania (Kanalda, K.S.5) surpass and others (Keilor, K.S.15) do not surpass the average value of recent Australian males.

Maxillo-alveolar length (Table 41) — In the recent male series one can observe a geographical trend from China, via Java and N.G. to Australia of the MAL becoming larger. The recent Chinese and Javanese tend to have the smallest MAL, whereas N.G. and Australians tend to have the largest. Prehistoric males (Wajak-1, Wajak-2, Kanalda) surpass the average values of their own regional recent male series (Java, Australia).

Maxillo-alveolar breadth (Table 42) — In the recent series, Australians tend to have the largest MAB. Except for Liujiang, the prehistoric males (U.C.1, Wajak-1, Wajak-2, Kanalda, Keilor, K.S.15) clearly surpass the average values of their own regional recent male series (Java, China, Australia). Wajak-2 and Kanalda have an extremely broad maxilla surpassing every examined maxilla, both recent and prehistoric.

Cheek height (Table 43) — In the recent series one can clearly recognise two groups: Chinese and Javanese tend to have the largest WMH, whereas N.G. and Australians tend to have the smallest. Wajak-1, Kanalda and Keilor surpass the average values of their own recent males series (Java, Australia), Sampung does not. Hoekgrot does not surpass the average value of the recent Javanese females.

Mandible

Most of the skulls from N.G. lacked a mandible, consequently data cannot be given on these skulls.

Mandibular length (Table 44) — In the recent series, Chinese tend to have the shortest mandible. As far as can be seen (the ML of Wajak-2 is an estimation and the sex of Mungo-3 is uncertain) prehistoric males (Wajak-2, Kanalda, K.S.5, Mungo-3) surpass the average value of their own regional recent male series (Java, Australia).

Bi-condylar breadth (Table 45) — In the recent series, Australians tend to show the most narrowest bi-condylar breadth. Kanalda and K.S.5 have an extremely broad bi-condylar breadth, surpassing every examined recent skull.

Coronoid height (Table 46) — In the recent male series, one can observe a geographical trend from China, via Java to Australia of the CrH becoming smaller. Wajak-2 and Sampung-H surpass the average value of the recent Javanese males. Kanalda and K.S.5 surpass the maximum value of the recent Australian males.

Corpus height (Table 47) — In the recent series, Chinese tend to have the largest CHe, whereas Australians tend to have the smallest (the trend is not really strong). Both Wajak-1 and Wajak-2 have a very high corpus, Wajak-2 surpasses all examined mandibles. Both Kanalda and K.S.1 surpass the maximum value of the recent Australian males. If one does not take into account the Wajak-2 mandible, Kanalda surpasses every examined mandible.

Corpus thickness (Table 48) — In the recent series, Australians tend to have the smallest CTh. Both Wajak-1 and Wajak-2 posses a very thick corpus, Wajak-2 surpassing every examined mandible. Sampung-H (male) and Hoekgrot (female) surpass the average values of the Javanese series of the corresponding sexes. Kanalda surpasses the average value of the recent Australian males.

Symphysis height (Table 49) — In the recent series, Chinese tend to have the largest SHe. Interestingly, U.C.1 has no high symphysis. Sampung-H is close (under) to the average value of the recent Javanese males. The other prehistoric males (Wajak-2, Kanalda, K.S.5) surpass the average values of their own regional recent male series (Java, Australia). The SHe of Wajak-2 is very high, but does not surpass the maximum value of the recent Javanese male series.

Symphysis thickness (Table 50) — In the recent series, Javanese tend to have the largest STh, whereas Australians tend to have the smallest. Prehistoric males (Wajak-2, Sampung-H, Kanalda, K.S.1, K.S.5, Mungo-3) surpass the average values of their own regional recent male series (Java, Australia).

Ramus breadth (Table 51) — With the exception of Mungo-3, prehistoric males

(U.C.1, Wajak-1, Wajak-2, Sampung-H, Kanalda, K.S.1, K.S.5) surpass the average values of their own regional recent male series (China, Java, Australia). Hoekgrot surpasses the maximum value of the recent Javanese female series. Both Wajak-1 and Wajak-2 have a very broad ramus, Wajak-2 has an extremely broad ramus, surpassing all examined mandibles.

(Pre)molars

Length upper P3-M3 (Table 52) — In the recent series, Chinese tend to have the shortest length, whereas Australians tend to have the longest length. Prehistoric males (Wajak-1, Wajak-2, Kanalda, K.S.15) surpass the average values of their own regional recent male series (Java, Australia).

Mesiodistal length upper M1 (Table 53) — For recent series see remark length upper P3-M3. Both Wajak-1 and Wajak-2 surpass the average value of the recent Javanese male series.

Buccolingual length upper M1 (Table 54) — For recent series see remark length upper P3-M3. Prehistoric males (Wajak-1, Wajak-2, Kanalda, K.S.15) surpass the average values of their own regional recent male series (Java, Australia). Both Wajak-1 and Wajak-2 surpass the maximum value of the recent Javanese male series and other Indonesian prehistoric specimens, but not the maximum value of the recent Australian male series.

Mesiodistal length upper M2 (Table 55) — In the recent series Australians tend to have the highest value. The prehistoric males (Wajak-1, Wajak-2, Kanalda, K.S.15) surpass the average values of their own regional recent male series (Java, Australia).

Buccolingual length upper M2 (Table 56) — For recent series see remark Mesiodistal length upper M2. Both Wajak-1 and Wajak-2 surpass the maximum value of the recent Javanese male series and other Indonesian prehistoric specimens, but not that of the recent Australian male series.

Mesiodistal length upper M3 (Table 57): recent series: see remark length upper P3-M3. Prehistoric males like Wajak-2, Kanalda and K.S.15 surpass the average values of their own regional recent male series (Java, Australia). Interestingly Wajak-1 does not surpass the average value of the recent Javanese male series.

Buccolingual length upper M3 (Table 58) — For recent series see remark Mesiodistal length upper M2. Prehistoric males (Wajak-1, Wajak-2, Kanalda, K.S.15) surpass the average values of their own regional recent male series (Java, Australia). The most striking measurement is that of Wajak-1: it shows an extremely large size, surpassing every prehistoric skull and the maximum values of China, Java and N.G., whereas the mesiodistal length is small.

Indices

In this case an index is derived from two measurements and gives information about a relative form aspect of the skull. The indices used have a very simple construction: (index = A*100/B). In other words, it indicates how large A is in comparison to B, as expressed in a percentage number.

Neurocranium

*Cranial index (XCB*100/GOL; Table 59)* — In the recent series, one can clearly distinguish two groups. Chinese and Javanese tend to have broader skulls, whereas N.G. and Australians tend to have narrower ones. Especially many Javanese have a brachycranic skull (69.6% of the males), whereas none of the examined Papua and Australian male skulls have a brachycranic skull. Interestingly, Liujiang, U.C.1 and Wajak-1 score under the average value of their own regional recent males series (China, Java), whereas Kanalda, Keilor and K.S.5 score above their own regional recent male series (Australia).

*Length-height index (BBH*100/GOL; Table 60)* — In the recent series, one can distinguish two groups. Chinese and Javanese tend to have higher skulls, whereas N.G. and Australians tend to have lower ones. None of the Chinese or Javanese male skulls has a low skull, whereas 20.8% of the Papua males and 20.7% of the Australian males do. Interestingly, Liujiang and Wajak-1 score again under the average value of their own regional recent males series (China, Java), whereas Kanalda scores above its own regional recent male series (Australia). The index of Wajak-1 is very low, i.e. under the minimum value of the recent Javanese males.

*Breadth-height index (BBH*100/XCB; Table 61)* — In the recent series, one can distinguish two groups. Chinese and, even more so, Javanese, tend to have low skulls, whereas N.G. and Australians tend to have higher ones. Considering the recent male series: 46.0% of the Chinese, 21.7% of the Javanese, 81.8% of the Papuans and 85.7% of the Australians have a high skull. Both Liujiang and Wajak-1 score below the average value of their own regional recent males series (China, Java). Kanalda, scores close to the regional recent Australian male series.

*Postorbital constriction (MPD*100/MSB; Table 62)* — In the recent series, one can distinguish two groups. Javanese and even more so the Chinese tend to have weaker postorbital constriction, whereas N.G. and especially Australians tend to have stronger postorbital constriction. Of the males series, none of the Chinese and only 2.6% of the Javanese shows a strong constriction. 32.1% of the Papuans and 50.0% of the Australians show a strong constriction. The few prehistoric males examined (Liujiang, Wajak-1, Kanalda) tend to have a stronger postorbital constriction than the average values of their own regional recent males series (China, Java, Australia).

*Parietal index (S2*100/PAC; Table 63)* — In the recent series, trends are too weak to distinguish (clear) groups. Javanese tend to have the most rounded parietals, whereas Australians tend to have the most flattened. But it is not possible to distinguish the two groups as in the foregoing indices because N.G. tend to have more rounded parietals, whereas Chinese tend to have more flattened ones. The variation of the recent Javanese is large, the score of Wajak-1 is close to the average score (lower) of the recent Javanese male series.

*Occipital index (S3*100/OCC; Table 64)* — In the recent series, there is one group that 'attracts the eye': Javanese tend to have a flat occipital bone as compared to the other three groups; Chinese, N.G. and Australians. Considering the male series: 14.5% of the Chinese, 0.0 % of the Papuans, 20.0% of the Australians and 50.0% of the Javanese have a flat occipital bone. In comparison with the average value of the recent Javanese males, Wajak-1 has a bulbous occipital bone, but does not surpass the maximum value of the Javanese males.

Viscerocranium

*Upper facial index (NPH*100/ZYB; Table 65)* — In the recent series, a broad face is most frequently found among Australians; the following percentages in the males series is found: Chinese (28.8%), Javanese (28.0%), N.G. (36.9%) and Australians (75%). Wajak-1 and Kanalda have a broad face compared to the average values of their own regional recent males series (Java, Australia).

*Prognathic index (BPL*100/BNL; Table 66)* — In the recent series, Chinese tend to have the most orthognathous faces, whereas N.G. tend to have the most prognathous faces. Both recent Javanese and Australians seem to represent the 'middle of the road'. Considering the male series, an index above 99.9 ([slightly]prognathous face) is found among the Chinese (16.7%), Javanese (45.3), Australians (56.3%) and Papuans (90.4%). Wajak-1 has a slightly orthognathous face and Kanalda has a slightly prognathous face.

*Nasal index (NLB*100/NLH; table 67)* — In the recent series, there seems to be a geographical trend of the nasal aperture to become broader. Considering the males series: from Chinese (17.5%), via Javanese (29.5%) to the Papuans (37.0%); here the trend stops. A 'jump takes over'; Australians tend frequently to have a broad nasal aperture (82.7%). Wajak-1 has a very broad nasal aper ture in comparison with the average value of the recent Javanese males (though it does not surpass the maximum value), but the same is true for Liujiang and U.C.1 in comparison with the average value of the recent Chinese males. Prehistoric Australian males score under the average value of the recent Australian males (Keilor, K.S.15) and above (Kanalda, K.S.5).

*Maxilloalveolar index (MAB*100/MAL; Table 68)* — In the recent series, many Chinese and Javanese have a broad maxilla: in the male series: Chinese (78.4%), Javanese (81.4%), Papuans (13.3%), Australians (42.9%). Wajak-1 scores under the average value of the recent Javanese males, Wajak-2 scores above this value; both maxillae can be classified as broad. The score of the female skull Liang Toge is noticeable. It is the only skull with a score under 100, which means that the MAL is higher than the MAB. Also the score of Kanalda is striking because the score is outside the Australian range, the maxilla is, compared to recent Australians, very broad.

Mandible

*Mandibular index (W1*100/ML; Table 69)* — In the recent series one can observe a trend. Considering the male series, a broad mandible is found among the Chinese (38.7%), Javanese (22.6%) and Australians (7.1%); while a narrow mandible is found in the following percentages: Chinese (22.6%), Javanese (30.6%) and Australians (64.3%). Kanalda, and even more so K.S.5, have a (relatively) broad mandible compared with the average/maximum value of the recent Australian male series.

*Mandibular length-height index (CrH*100/ML; Table 70)* — In the recent series one can observe a trend. Considering the male series, a high mandible is found in the Chinese (20.7%), Javanese (10.7%) and Australians (0.0%); while a low mandible is found in the following percentages: Chinese (12.7%), Javanese (50.6%) and Australians (86.7%). The prehistoric male skulls Wajak-2, Kanalda and K.S.5 tend to have a relatively high mandible compared with the average values of their own recent male series (Java, Australia), but they can all three be classified as medium.

Modules

Modules are derived from different measurements in several ways (formulas are given below and with the Tables) and provide information about sizes. The advantage of using modules is that they give a quick and easy impression of the total aspect of the area involved (for instance, the neurocranium). As they do not indicate which particular measurement gives an important contribution to the size, they do not replace measurements.

Neurocranium

Cranial module ({GOL+XCB+BBH}/3; Table 71) — As could be expected from the three measurements involved, recent Chinese tend to have the largest neurocranium, whereas recent N.G. tend to have the smallest. In the male series, a large neurocranium is found among Chinese (84.2%), Javanese (47.4%), Papuans (27.3%) and Australians (57.1%). The three prehistoric male skulls, Liujiang, Wajak-1 and Kanalda clearly surpass the average values of their own regional recent males series (China, Java, Australia), and all three can be classified as very large.

Viscerocranium

Facial module ({BPL+NPH+ZYB}/3; Table 72) — In the recent series, Papuans tend to have the smallest faces. Considering the male series, a large face is found among the Chinese (44.1%), Javanese (53.3%), Papuans (23.5%) and Australians (53.4%). Wajak-1 and Kanalda clearly surpass the average values of their own regional recent males series (Java, Australia); both faces can be classified as very large. Interestingly, although Wajak-1 has an extremely large neurocranium, the viscerocranium does not surpass the maximum value of the recent Javanese males.

*Maxilloalveolar module (MAL*MAB/100; Table 73)* — In the recent male series, one can distinguish two groups. A large maxilla is more frequently found among Papuans (93.3%) and Australians (85.7%) than among Chinese (45.1%) and Javanese (55.7%). The three prehistoric male skulls, Wajak-1, Wajak-2 and Kanalda clearly surpass the average values of their own regional recent males series (Java, Australia). Both Wajak-2 and Kanalda have an extremely large maxilla, surpassing every other skull examined (the maxilla of Kanalda is the largest).

Mandible

Mandibula module ({ML+W1+CrH}/3; Table 74) — Compared with recent Chinese and Javanese, recent Australians tend to have the smallest mandible. Considering the male series, a large mandible is found among the Chinese (20.9%), Javanese (12.0%) and Australians (0.0%). Kanalda and K.S.5 have a very large mandible, surpassing the maximum value of the recent Australian male series.

Corpus mandibula module ({CHe+CTh+SHe+STh}/4; Table 75) — Considering the average values of the recent male series, one can observe a slight geographical trend from China, via Java to Australia of the corpus to become smaller. A small corpus is found among the Chinese (12.2%), Javanese (2.1%) and Australians (0.0%). The three prehistoric male skulls, Wajak-2, Sampung-H and Kanalda surpass the average values of their own regional recent males series (Java, Australia). Wajak-2 has an extremely large corpus mandibulae, surpassing every other examined mandible.

Molars

*Cross-sectional area upper M1 (MD*BL; Table 76)* — In the recent series, Chinese tend to have the smallest values, whereas Australians tend to have the largest. Considering a large area in the males series there is a clear trend: Chinese (21.3%), Javanese (55.0%), Papuans (63.7%) and Australians (95.2%). The four prehistoric male skulls Wajak-1, Wajak-2, Kanalda and K.S.15 surpass the average values of their own regional recent males series (Java, Australia). Although both Wajak skulls have a large cross-sectional area compared to the recent and other nine Indonesian prehistoric skulls, they do not surpass the maximum value of the recent Javanese male series.

*Cross-sectional area upper M2 (MD*BL; Table 77)* — In the recent series, Australians tend to have the highest value. Considering the male series, a very large area could only be found among Australians (12.0%). Compared with recent Chinese, Javanese, N.G. and prehistoric Indonesian skulls, Wajak-1 and Wajak-2 have a large cross-sectional area. The ones of Kanalda and K.S.15 can be classified as very large, although they do not surpass the maximum value of the recent Australians.

*Cross-sectional area upper M3 (MD*BL; Table 78)* — In the recent series, Chinese tend to have the smallest cross-sectional area, whereas Australians tend to have the largest. Considering a large area in the males series: Chinese (2.6%), Javanese (11.8%), Papuans (9.1%) and Australians (29.4%), it is obvious that the M3 is often smaller than the M1. The four prehistoric male skulls Wajak-1, Wajak-2, Kanalda and K.S.15 surpass the average values of their own regional recent males series (Java, Australia).

Total cross-sectional area upper molars (M1+M2+M3; Table 79) — In the recent male series, Australians tend to have the highest value; a large cross- sectional area is found among the Chinese (13.8%), Javanese (29.8%), Papuans (16.7%) and Australians (86.7%). Wajak-1, Wajak-2, Kanalda and K.S.15 surpass the average values of their own regional recent males series (Java, Australia). Wajak-2 surpasses the maximum value of the recent Javanese males, but not that of the recent Australian males and the score of Kanalda.

Non-metrical characters

The non-metrical characters examined can be divided in continuous (for instance, mastoid process) and discontinuous (for instance, palatine torus) characters. Many of the characters examined are continuous. Possibly, discontinuous characters have a simpler genetic basis (Larnach & Macintosh, 1966), and their use for the study of relationships (like accessory sutural bones, variation in the number of foramina) can be recommended (see, for instance, Pardoe, 1991). For the choice of the characters, there was a preference for characters that were present in at least one of the Wajak skulls, and it was tried to cover various regions of the skull.

Neurocranium

Inclinatio frontale (Table 80) — In the recent male series, Australians show most frequently a strong inclination: 71.4%. A vertical development of the frontal bone is found among recent Chinese (23.8%) and Javanese males (15.2%), but seems rare among N.G. (3.3%) and Australian males (0.0%). None of the examined prehistoric skulls (n = 13) has any vertical development of the frontal bone.

Keeling of the vault (Table 81) — In the recent male series, one can distinguish two groups. N.G. and Australians with a frequent occurrence of keeling (resp. 55.2%, 50.0%), and Chinese and Javanese with a rare occurrence of keeling (resp. 6.3%, 1.3%). Considering the prehistoric skulls: none of the Chinese (n = 3) and Indonesian (n = 5) ones shows keeling, whereas three of the six examined Australian prehistoric skulls do show this character (all male skulls, i.e. Kanalda, K.S.5, and in Mungo-3 it is not distinct).

Median frontal ridge (Table 82) — In the recent male series, the distinct occurrence of this ridge seems to be a typically Australian situation (27.3%; in the other three groups its distinct occurrence is 0.0%). The absence of this ridge is typical among Chinese and Javanese (resp. 93.7%, 94.9%). Considering the prehistoric skulls, one of the Chinese (n = 4) shows a trace (female skull U.C.2) and none of the Indonesian skulls (n = 5) shows this character. Kanalda shows this character distinctly, K.S.1 shows only a trace, and in Keilor it is absent.

Glabella (Table 83) — In the recent male series, one can distinguish two groups. N.G. and Australians can be characterised by the frequent occurrence of a marked or massive developed glabella (83.4%, 88.3%, respectively). A marked or massive glabella is less frequently found among Chinese and Javanese (3.2%, 7.6%, respectively). With the exception of Keilor, the four examined prehistoric Australian male skulls all possess a massive glabella. Three non-Australian prehistoric male skulls U.C.1, Wajak-1 and Wajak-2, equally possess a massive glabella.

Superciliary arches (Table 84) — In the recent male series, one can distinguish two groups. N.G. and Australians appear to be characterised by the frequent occurrence of very marked superciliary arches (resp. 55.2%, 67.6%). These are less frequently found among Chinese (1.6%) and Javanese (3.8%). All the five examined prehistoric Australian male skulls possess very marked superciliary arches. So do two non-Australian prehistoric male skulls, U.C.1 and Sampung- H.

Zygomatic trigones (Table 85) — A limited number of recent skulls have been examined, only Javanese (n = 50) and Australians (n = 41). In the recent male series, medium to large zygomatic trigones appear to occur in Australian males, but not in Javanese males. Large zygomatic trigones are probably rare in recent Australian males (3.0%), and the occurrence of the medium development was not very frequently found (24.2%). Therefore, it strikes that five of the seven examined prehistoric Australian skulls possess medium to large zygomatic trigones (the male skulls K.S.1 and K.S.15 have large zygomatic trigones). Large zygomatic trigones have not been found among the six examined prehistoric Indonesian skulls (including the male skulls Wajak-1 and Wajak-2), and of the four prehistoric Chinese skulls, only the male U.C.1 possesses them.

Frontal tubera (Table 86) — In the recent male series, one can distinguish two groups. Chinese and Javanese are characterised by the frequent occurrence of medium to marked developed frontal tubera (resp. 47.6%, 43.0%), which are, however, less frequently found among N.G. (3.4%) and Australians (0.0%). Especially in recent Australians there is a very frequent occurrence of missing to indistinct developed frontal tubera (97.1%). This situation is also present in the six examined prehistoric Australian male skulls.

Parietal tubera (Table 87) — In the recent male series, different trends between the groups are less clear than those in the development of the frontal tubera. It is more likely that well developed parietal tubera will be found in Chinese (46.0%) and Javanese (48.1%) than in N.G. (33.3%) and Australians (35.3%).

Mastoid process (Table 88) — In the recent male series, differences between the groups are not clear. A very small mastoid process is most frequently found among recent N.G. (40.0%).

Supramastoid crest (Table 89) — In the recent male series, differences between the groups are not clear. Marked to strongly developed crests are most frequently found among Javanese (50.6%) and Australians (55.9%), and less frequently found among Chinese (34.9%) and N.G. (34.5%).

Occipital torus (Table 90) — In the recent male series, one can distinguish two groups. N.G. and Australians are characterised by the frequent occurrence of a distinct torus (resp. 57.1%, 66.7%), which, however, occurs less frequently in Chinese (23.8%) and Javanese (8.9%). The four examined prehistoric Australian male skulls possess a trace of or a distinct occipital torus. None of the three examined prehistoric Javanese male skulls (Wajak-1, Wajak-2, Sampung-H) have a torus.

External occipital protuberance (Table 91) — A limited number of recent skulls have been examined, only Javanese (n = 49) and Australians (n = 39). A distinct protuberance is more frequently found among Javanese males (30.0%), and less frequently among Australian males (6.3%). The only prehistoric (male) skull with a distinct protuberance is Wajak-2 (as far as can be seen: one has to be careful in assessing this region because of the presence of matrix). The male skulls Kanalda and Mungo-3 have a trace of the protuberance.

Nuchal lines and occipital crest (Table 92) — In the recent male series, one can distinguish two groups. N.G. and Australians are characterised by a more frequent occurrence of marked nuchal lines and occipital crest (resp. 69.2% and 69.7%), which is less frequently found among Chinese (34.9%) and Javanese (19.0%). In the prehistoric male skulls a large variation can be observed: from slight (U.C.1, Wajak-1, Kanalda), via evident (Liujiang), and marked (Keilor), to very marked (K.S.5).

Viscerocranium

Orbital form and supraorbital margin (Table 93) — In the recent male series, one can distinguish two groups. N.G. and Australians are characterised by a more frequent occurrence of masculine developed orbits (resp. 72.4% and 82.3%), which is less frequently found among Chinese (4.8%) and Javanese (21.5%). Interestingly, all examined prehistoric male skulls from China (Liujiang, U.C.1), Java (Wajak-1, Wajak-2, Sampung-H) and Australia (Kanalda, Keilor, K.S.5, K.S.15) have masculine developed orbits.

Flattened lower orbital border (Table 94) — In the recent male series, a distinct flattened lower orbital border is a typical Australian occurrence (44.1%), compared with Chinese (4.8%) and Javanese (1.3%), although this is certainly not rare among N.G. (13.3%). None of the examined prehistoric Javanese male skulls (Wajak-1, Wajak-2, Sampung-H) have a flattened lower orbital border, but this occurrence is found in the Chinese male skull U.C.1 and female skull U.C.2.

Phaenozygy (Table 95) — In the recent male series, one can distinguish two groups. N.G. and Australians are characterised by a frequent occurrence of distinct phaenozygy (resp. 92.9%, 91.2%), which is less frequently found among Chinese (34.9%) and Javanese (13.9%). With the exception of Liujiang, distinct phaenozygy is found in all the examined prehistoric skulls, both in the females (U.C.2, Liang Toge) and the males (U.C.1, Wajak-1, Liang Momer, Kanalda, Keilor, K.S.5).

Os zygomaticum (Table 96) — The development of the zygomatic bone needs some further explanation. According to the Workshop (1980) a high/irregular development indicates masculinity, a low/smooth development feminine. The impression is that Chinese and Javanese males can possibly best be characterised as high/smooth and N.G. and Australian males as low/irregular (development of the malar tuberosity), therefore many skulls scored around '2' (medium). In this case it would have been better to separate the height from the development of the surface (see Table 43). Nevertheless, looking at the recent male series one can still distinguish two groups. In comparison with N.G. and Australians, Chinese and Javanese tend to have more frequently a high/irregular os zygomaticum. Of the prehistoric skulls, Kanalda has a very high/irregular os zygomaticum, which is, however, rarely found among recent Australian males (2.9%).

Inferior border nasal aperture (Table 97) — In the recent male series, one can notice a few interesting aspects. The frequent occurrence of a single, more or less sharp border, common to Europeans (77.1% according to Sullivan, 1922; from Larnach and Macintosh, 1966) has not been found in the four examined groups. A sharp border is most frequently found among Chinese (38.1%) and less frequently among Australians (2.9%). Accordingly, a smooth border is most frequently found among Australians (61.8%) and less frequently among Chinese (12.7%). The ambiguous situation, whereby the margo infranasalis and crista prenasalis are close together, can often be found among Chinese (49.2%), Javanese (51.9%), and N.G. (56.7%). No sharp border is found among the twelve examined prehistoric skulls. Except for Liang Momer and Keilor, which have an ambiguous situation, all prehistoric skulls from China, Indonesia and Australia have a smooth border.

Subnasal prognathism (Table 98) — A limited number of recent skulls have been examined, only Javanese (n = 50) and Australians (n = 38). It is clear that among these a small to medium developed subnasal prognathism is most frequently found, as in prehistoric skulls from China, Indonesia and Australia. The presence of large (-extreme) subnasal prognathism was only found in 3.1% of the recent Australian males.

Palatine torus (Table 99) — In the recent series, the occurrence of a distinct palatine torus is a typical Australian character. In the two Wajak skulls the situation is difficult to assess; probably a distinct torus is absent in both. With the exception of K.S.5, the prehistoric Australian skulls (Kanalda, Keilor, K.S.15) all possess a distinct palatine torus. The prehistoric Chinese skull Liujiang also has it, and weaker developments can be seen in all three Upper Cave specimens.

Mandible

For many characters of the mandible a limited number of recent skulls have been examined, namely from Java and Australia. In the case of the development of the mental protuberance (Table 100) and angulus mandibulae (Table 109), recent Chinese skulls have also been examined.

Mental protuberance (Table 100) — Considering the recent male series, the occurrence of a prominent mental protuberance is frequently found among Chinese (61.9%) and Javanese (49.3%), but less frequently among Australians (10.6%). The prehistoric male skulls from Indonesia (Wajak-2, Sampung-H, Liang Momer) and Australia (Kanalda, K.S.1, K.S.5, Mungo-3) have no prominent mental protuberance. Three aspects of the mental protuberance are considered in the following three Tables.

Mental trigone (Table 101) — In the recent male series, as can be expected from the observation of the mental protuberance (Table 100), Australians frequently have a slight to medium developed trigone (100%), whereas Javanese often show a medium to marked developed trigone. A marked trigone is present in 31.7% of the Javanese and in 0.0% of the Australians. Wajak-2 has a medium developed trigone. Prehistoric Australian male skulls show, like the recent male series, a slight development (Kanalda, K.S.5) and a medium development (K.S.1, Mungo-3).

Anterior mandibular incurvature (Table 102) — In the recent male series, Javanese tend to have a medium to marked incurvature, whereas Australians tend to have a slight to medium developed one. Interestingly, although a marked mental trigone could not be found among recent Australians, in some skulls a marked incurvature is present (11.8%). The prehistoric male skulls from Java (Wajak-2, Sampung-H) and Australia (Kanalda, K.S.1, K.S.5) all show a medium development, a situation frequently found among recent males from Java (65.0%) and Australia (41.2%).

Projection of the chin (Table 103) — In the recent male series, Javanese tend to have a more positive projection (52.5%), whereas Australians tend to have a more negative projection (66.7%). Six of the seven examined prehistoric male skulls have a negative (Wajak-2, Kanalda, K.S.5, Mungo-3) or neutral (Sampung-H, K.S.1) projection. Liang Momer-E has a positive projection.

Planum alveolare (Table 104) — The recent male series show more or less the same trend (Javanese and Australians). Most mandibles possess a moderate to greater decline of the planum alveolare; Javanese (62.5%) and Australians (61.1%). A vertical development is less frequently found among Javanese (7.5%) and Australians (11.1%). The seven examined prehistoric male skulls from Indonesia (Wajak-2, Sampung-H, Liang Momer) and Australia (Kanalda, K.S.1, K.S.5, Mungo-3) follow this trend: they do not show a vertical development.

Mylohyoid line (Table 105) — In the recent male series, no obvious different trends between the Javanese and Australians could be found. In both series, most frequently found are a slight to medium development of the mylohyoid line, but a marked development is not rare: Javanese (19.5%) and Australians (22.2%). The variation observed in the recent series can also be found in the prehistoric series; Wajak-1 has a medium, and Wajak-2 a marked development of the mylohyoid line.

Sulcus extramolaris (Table 106) — In the recent series, one can observe a little trend. Among the males, it is more likely to find a slight development of the sulcus in Australians (41.2%) than in Javanese (17.1%). The variation observed in the recent series can also be observed in the prehistoric series; Wajak-1 has a slight, and Wajak-2 a marked development of the sulcus.

Lateral prominence (Table 107) — In the recent series, a trend can be observed. Javanese tend to have a medium to markedly developed lateral prominence, whereas Australians tend to have a slight to medium developed lateral prominence. A marked development has not been found in the examined 22 Australian mandibles. Among the prehistoric (male) skulls a marked development of this structure appeared present in Wajak-2, Sampung-H, and K.S.1.

Fossa precoronoidea (Table 108) — In the recent male series, no obvious differences between the Javanese and Australians can be found. In both series, a shallow to medium developed fossa is most frequently found. Of the Javanese 14.6% and of the Australians, 11.1% have a deep fossa precoronoidea. The seven examined prehistoric male skulls from Indonesia (Wajak-2, Sampung-H, Liang Momer) and from Australia (Kanalda, K.S.1, K.S.5, Mungo-3) follow this trend. Only K.S.1 has a deep fossa.

Angulus mandibulae (Table 109) — In the recent male series, no obvious differences between the Chinese, Javanese and Australians could be observed. A smooth to slight development of the angulus mandibulae was present in 25.4% of the Chinese, 17.3% of the Javanese, and 31.6% of the Australian skulls. A smooth to slight development of the angulus mandibulae was absent among the ten examined prehistoric skulls from Indonesia and Australia.

Planum triangulare (Table 110) — In both recent male series, a small planum triangulare is not frequently found; Javanese (9.8%) and Australians (5.9%). It is more likely to find a large planum triangulare in a Javanese series (65.9%) than in an Australian series (29.4%). Wajak-2, Kanalda and K.S.1 have a large planum triangulare.

Sexual dimorphism

Size of recent skulls — Fortunately the sex of the 89 recent Javanese skulls is known, eighty males and nine females. Therefore, it is possible to study measurement differences between the sexes of this group. Of the 35 measurements, in thirty cases the average scores of females are lower, in two cases the average scores between the sexes are equal, and in three cases the average scores of females are higher. This means that for most skull dimensions, females appear to be smaller than males.

There are two exceptions. The average values of the occipital chord and arc (-Tables 30-31) of the females (n = 9) are higher than those of the males (n = 74). In other words, the size of the occipital bone in the median-sagittal plane of females is larger than that of males. The second exception concerns some dimensions of the molars. The average value of the MD length of the upper M1 of the females (n = 9) is higher than that of the males (n = 71). The average values of the MD lengths of both the M2 and M3 of the females (n = 8/4) and those of the males (n = 72/51) are equal. Thus the average MD dimensions of the molars of Javanese females are not smaller than those of Javanese males, whereas most other average dimensions of the skull (-except for the median-sagittal dimension of the occipital), including BL dimensions of the molars, are smaller in the female. Due to a constant MD wear between the molars, this value decreases during life. Therefore, without knowing the age of individuals and wear pattern of the populations under study, BL dimensions probably give a more reliable picture of sizes which are under genetic control than MD dimensions.

Skull size differences between the sexes can also be observed in the modules (-Tables 71-79). Considering the cranial module: 47.4% of the males could be classified as large, whereas a large neurocranium was absent among the females. The same applies to the facial module: 53.3% of the males can be classified as large but a large face is not found among the females. These size differences can also be observed in the masticatory apparatus (Tables 74-76).

Indices of recent skulls — As relative form aspects (indices) were not included in the sexual diagnosis of the skulls an attempt was made to find some different trends among the sexes. As only a limited number of female skulls were studied (Java, Australia) only those trends will be mentioned that can be observed in all three groups (Java, N.G., Australia). Seen from norma occipitalis, female skulls seemingly possess a somewhat lower skull than males (Table 61), and postorbital constriction is somewhat weaker (Table 62). Prognathism is somewhat stronger in female series (Table 65). With the exception of prognathism in the recent Javanese series (45.3% of the males and 85.7% of the females has a prognathous face), the trends observed are not strong. The average MD dimensions of the molars of Javanese females were not smaller than those of Javanese males, but for most dimensions, female faces tend to be smaller than male faces. This agrees with the observation that Javanese females tend to be more prognathous than Javanese males. The overall impression of the cranial indices is that sexual dimorphism is not strong (with the possible exception of prognathism).

Recent Javanese and Australians — Though the sex of the recent Javanese was known and the sex determination of the Australians was implemented by using a combined method (Howells, 1973 and Workshop, 1980; see Fig. 21) which could exaggerate some of the tendencies observed, some of the trends are very strong and cannot be neglected (Table 18):

1) Sexual dimorphism is stronger in the Australian than in the Javanese series, because Javanese males are feminine like. Some characters in Javanese males have a striking feminine appearance, for instance the glabella and parietal tubera.
2) There are characters that can be used as indicators for both sex and affinity. According to Larnach and Macintosh (1966) the glabella is a strong indicator of an Australian affinity. According to the Workshop (1980), the glabella is, in a European context, a strong indicator of masculinity. It is more likely to find a marked glabella in an Australian male than in a Javanese (male or female) or a female Australian. This is more or less also true for characters such as the superciliary arches, inclinatio frontale and the orbita (form and supraorbital margin).
3) It seems that there are characters that are reliable indicators of sex, whereas it makes no difference if the skull is Javanese or Australian: for instance, the supramastoid crest, total aspect of the mandible and the angulus mandibulae.
4) In an European context, the frontal and parietal tubera can be used as an indicator of femininity, because females tend to retain these juvenile characters, whereas males tend to loose them (Workshop, 1980). Interestingly, Javanese males and females tend to retain the frontal and parietal tubera 'stronger' than Australian males and females.

Recent Chinese and Papuans — The trend of the frequent occurrence of feminine characters in recent male skulls also goes for Chinese male skulls, but not or less for Papua New Guinea male skulls. See inclinatio frontale (Table 80); glabella (Table 83); superciliary arches (Table 84); frontal tubera (Table 86); parietal tubera (Table 87); occipital torus (Table 90); nuchal lines and occipital crest (Table 92); orbital form and

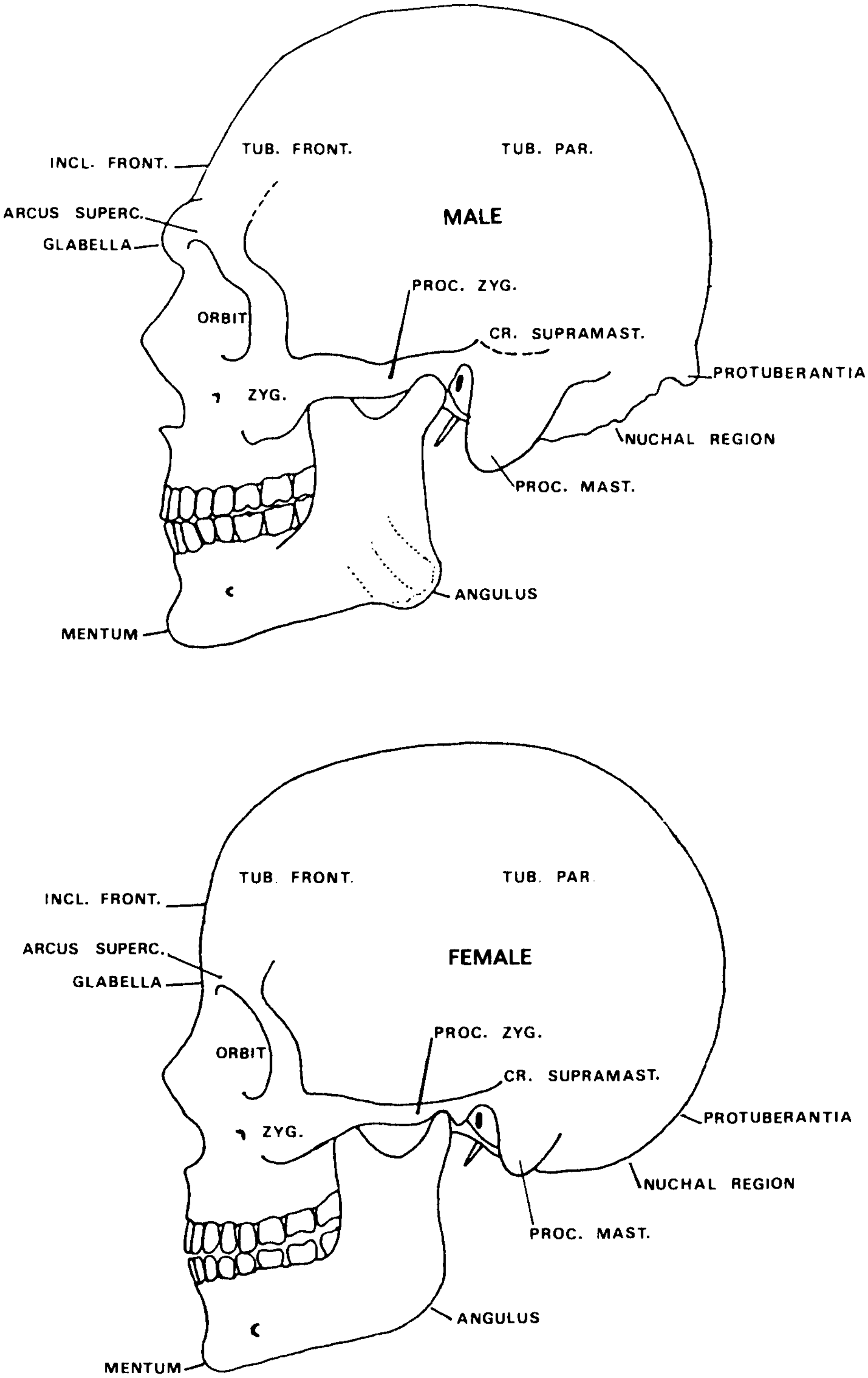

Fig. 21. Sexual dimorphism. Schematic representation of recent European male and female skull (Fig. by Paul Storm).

superior orbital border (Table 93). It seems that there are two groups. One group of males that can be characterised by the frequent occurrence of feminine (juvenile) characters, namely Chinese and Javanese skulls, and another male group where feminine (juvenile) characters are less frequently found, namely, Papua New Guinea and Australian skulls. Interestingly, the reverse seems to be true for the development of the chin. A small and rounded chin is not present in the Chinese series, and in Javanese mandibles its occurrence was 9.2%, but it was frequently found in the Australian series (Table 100: 54.2%).

Wajak and other Prehistoric skulls — Sexual dimorphism appears to vary among recent human populations (Table 18). It cannot be ruled out that this was also the case in prehistoric populations and that sexual dimorphism has changed through times. Therefore, sex determination of prehistoric skulls can be a hazardous task. Nevertheless, it is important to consider sexual dimorphism of prehistoric specimens before an attempt is made to evaluate their morphology. The sex of the Wajak and Hoekgrot skull has been discussed in the previous chapters. Before the discussion is continued, attention will be paid to the sex of three, relatively seen, well preserved prehistoric skulls from Indonesia: Sampung-H, Liang Toge and Liang Momer-E.

Sampung-H (Java) — Unfortunately, the skeleton (including the skull) has suffered from thorough cleaning. The Sampung-H skull can be interpreted as male (Table 19), as is confirmed by the morphology of the pelvis (the method of the Workshop [1980] has been followed). Although the iliac crest is flat (feminine-like) and both the sulcus praeauricularis and 'arc compose' can be classified as neutral, the other characters that I was able to examine are mascu line. As far as can be judged, the following characters show a masculine development. The greater sciatic notch is narrow (left side, reconstructed), the subpubic angle is acute (reconstructed), the view of the os coxae is high and narrow (left side), the body of the ischium is broad with a marked ischial tuberosity, and the iliac fossa is high and narrow (left side).

Liang Toge (Flores; Figs. 22-23) — The Liang Toge skull can be interpreted as female (Table 19). In many cases the presence of matrix did not disturb judgment of the characters strongly. The angulus mandibulae shows clear outward projection (which could be used as an indication for masculinity), but show no strong masseteric tuberosities (Table 109). The diagnosis of the skull is confirmed by the morphology of the pelvis (method of the Workshop [1980] has been followed). All characters of the pelvis that were able to be examined show a feminine development. Due to matrix and damage it is not possible to judge the greater sciatic notch, but as far as can be seen it is feminine developed. 'Arc compose' is very clearly double curved. Although the muscle marking of the os coxae is, due to damage, somewhat harder to judge, the form is clearly feminine developed i.e. low and broad. The body of the ischium is gracile (as far as can be judged: left side). The iliac crest is flat and the iliac fossa is low and broad.

Liang Momer-E (Flores; Figs. 24-25) — The best preserved skull from the site Liang Momer, is named Liang Momer-E, and has been (just like Sampung-H and Liang Toge) described by Jacob (1967). This skull, because of its relative completeness, will also be described and analyzed. The Liang Momer-E skull, as reconstructed by Jacob, was found in 1992 in a bad condition and reconstruction was needed. In agreement with the curator of the Dubois collection Dr J. de Vos, I tried to restore its

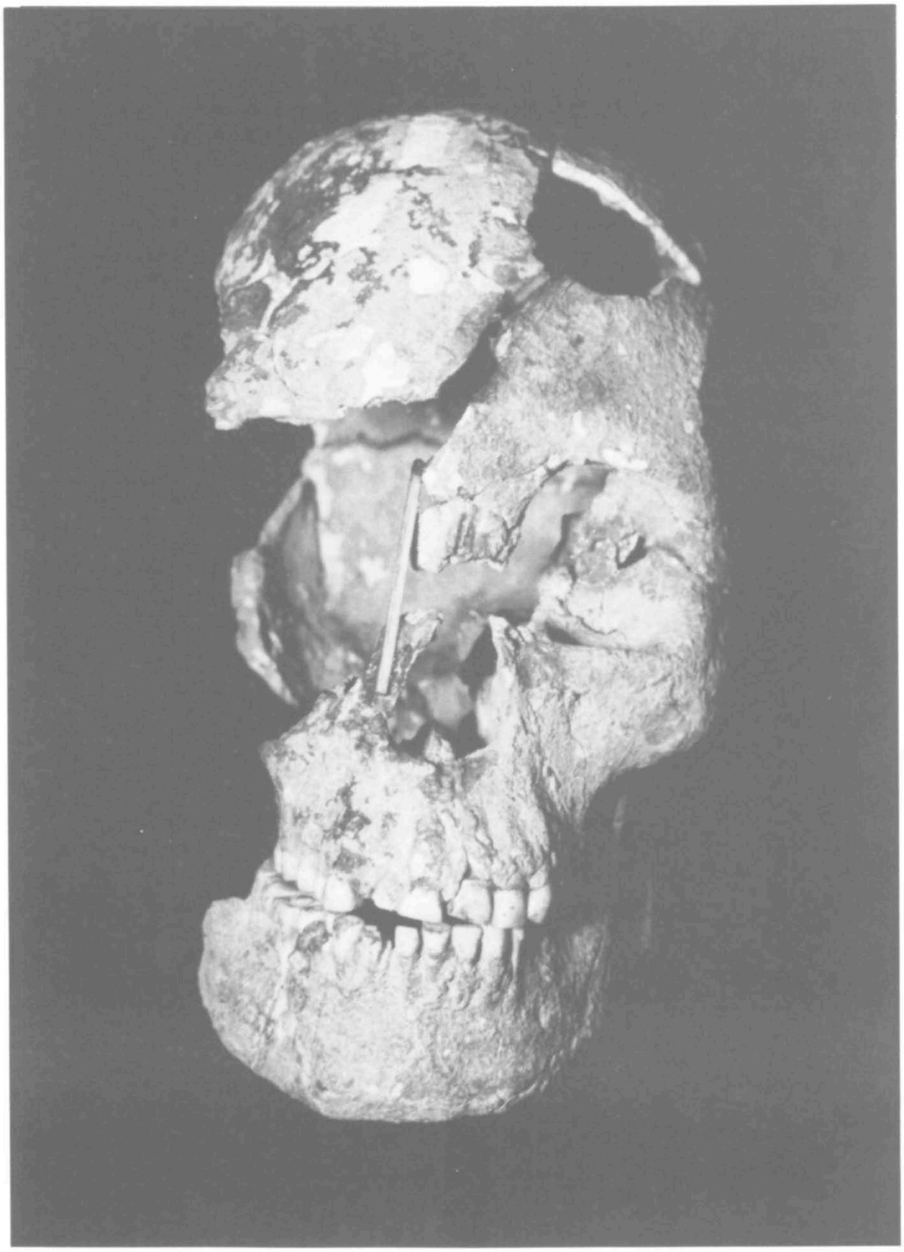

Fig. 22. Liang Toge (norma frontalis) (photograph by Paul Storm).

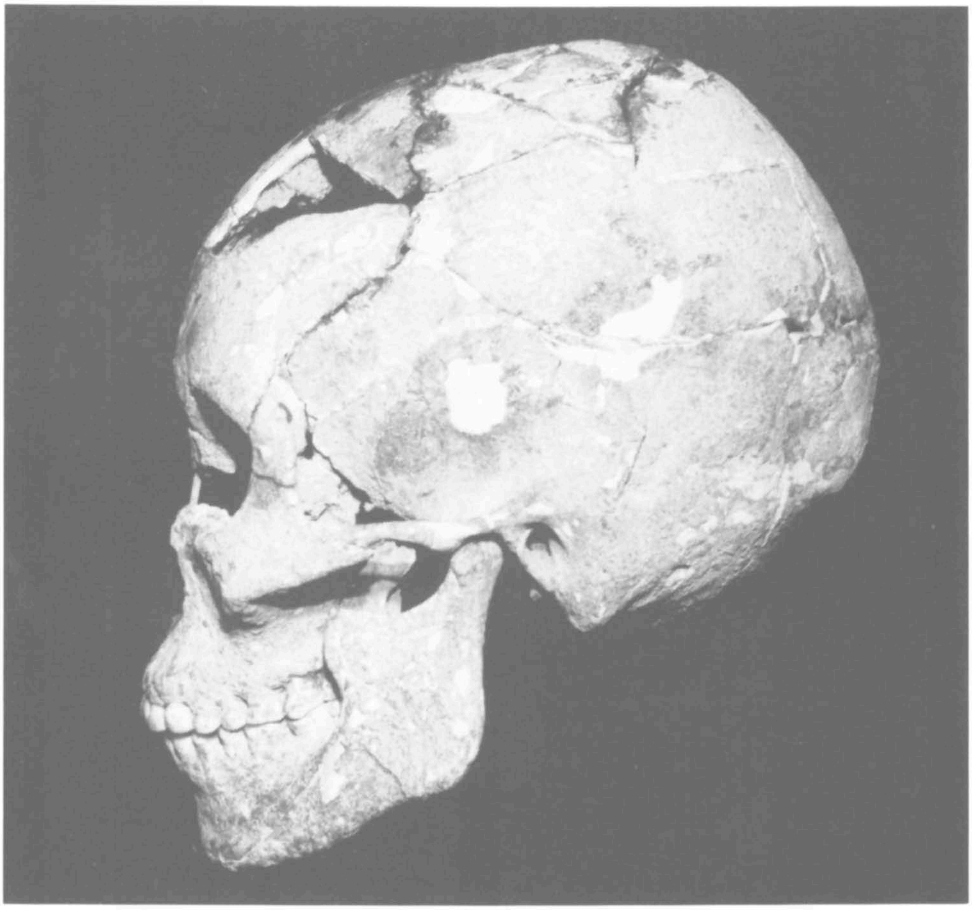

Fig. 23. Liang Toge (norma lateralis) (photograph by Paul Storm).

shapes as much as possible in the way Jacob had left it, even if I did not always agree with all of the details; the reason for this, was the fragile state of the skull. Exploring the rest of the well preserved Liang Momer-E skeleton, fragments of the left ramus of the mandible were found which have been used to complete the mandible. Considering the sex of the skull, the morphology is rather neutral with a very slight predominance towards masculinity (Table 19; the right and left frontal tubera are different; the right parietal tuber is undamaged and judged). The neurocranium (Table 71) is large and the mandible can be classified as medium (Table 74) and surpasses the average values of the male series. The total cross-sectional area of the molars can be classified as large (Table 79). The overall impression of the size of the skull is not in contradiction with its diagnosis as a male (Table 19). Unfortunately, not many characters of the pelvis could be judged, they indicate masculinity (the subpubic angle and the body of the ischium). Compared to Liang Toge, Liang Momer-E is male-like.

Recent Chinese and Javanese male skulls have many feminine characters in contrast with Australians (Table 18). It cannot be excluded that this was also the case in

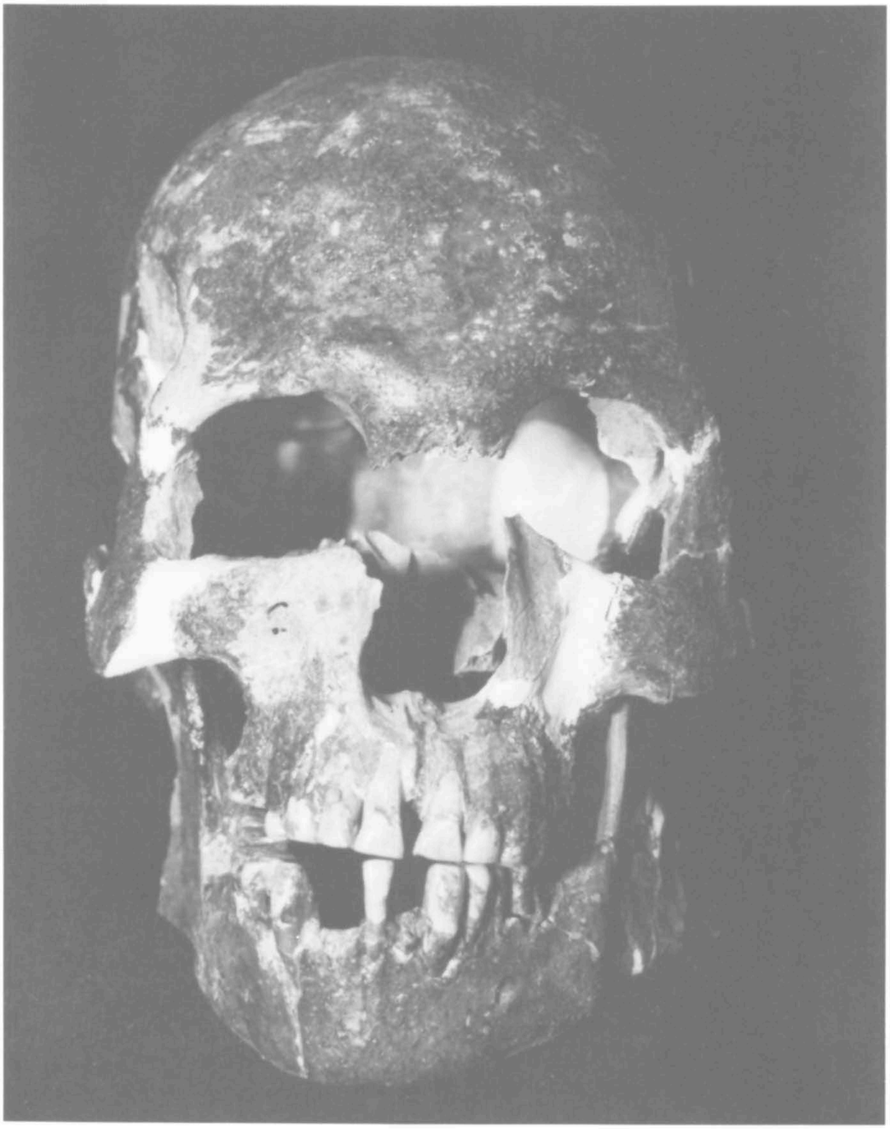

Fig. 24. Liang Momer-E (norma frontalis) (photograph by Paul Storm).

late prehistoric Chinese and Javanese populations. The region of the temporal bone and nuchal area shows a trend of a neutral/feminine development in Wajak-1 and Liujiang (Table 19). Although, in recent skulls from China and Java this trend is also present in the region of the glabella, superciliary arches and orbits, this is not the case in Wajak-1 and Liujiang. These two prehistoric skulls show an interesting mixture of robusticity and feminine characteristics.

Fortunately, complete skeletons are available from Sampung, Hoekgrot, Liang Toge and Liang Momer, and postcranial material has been found at the Wajak site. The likely sex, as presented in Table 19, is in accordance with the overall picture of

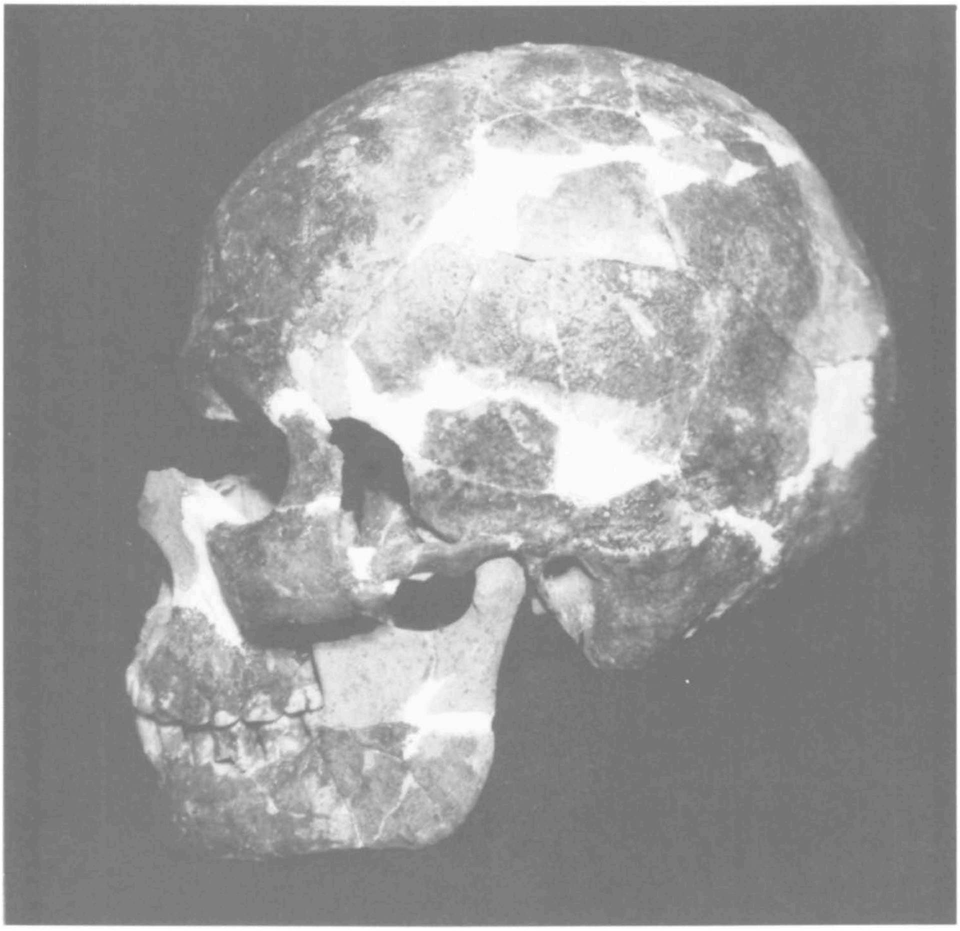

Fig. 25. Liang Momer-E (norma lateralis) (photograph by Paul Storm).

the postcranial material of these skulls (Sampung, Hoekgrot, Liang Toge and Liang Momer) or site (Wajak). Using the same characters as those suggested in Table 19, the sex diagnosis of other fossils from Australia can be added (characters Tables 80-110): Kow Swamp 15, Mungo 1 and Mungo 3. My opinion of the sex of prehistoric skeletons (skulls) can be given:

	Indonesia	China	Australia
Male	Wajak 1	Liujiang	Kanalda
	Wajak 2	Upper Cave 1	Keilor
	Sampung H		Kow Swamp 1
	Liang Momer E ?		Kow Swamp 5
			Kow Swamp 15
			Mungo 3 ?

Female	Hoekgrot ? Liang Toge	Upper Cave 2	Mungo 1

Upper Cave 3 appears to be indifferent (Table 19). Furthermore, the sex of three individuals appears to be somewhat uncertain. The sex of the red painted skeleton has been discussed in the chapter on the Hoekgrot material and that of Liang Momer E above. The sex of Mungo 3 is discussed by Brown (1987), concluding about this issue (p. 47): 'Although the sex of Lake Mungo 3 remains in some doubt, the innominate fragments combined with the discriminant analysis of the mandible suggest that it is a male, and it will be considered to be a male in this analysis.'

Recent Javanese and prehistoric Indonesian skulls

As the diagnosis of the Wajak skulls as males and the fact that of the Javanese series more male skulls have been studied than female ones the discussion of recent skulls will be concentrated on male skulls. The prehistoric skulls from Java that will be discussed include the males Wajak-1, Wajak-2 and Sampung-H and the female Hoekgrot. The prehistoric skulls from Flores that will be discussed include the male Liang Momer-E and the female Liang Toge. It must be stressed that the sex of Hoekgrot and Liang Momer are uncertain (Table 19).

Recent Javanese males

Neurocranium — One of the most characteristic features of the Javanese neurocrania is their shortness (Table 24) and broadness (Table 26), often resulting in a brachycranic form (Table 59; 69.6%). Furthermore, they are often hypsicranic (Table 60; 83.4%). Compared with the other three groups examined, tapeinocrany appears frequent (Table 61; 23.1%), although most skulls are metriocranic (55.1%). The frontal bone of the recent Javanese can be characterised as lacking the masculine features and being very rounded. Postorbital constriction (Table 62) is often small (44.8%) and a strong development is rare (2.6%). Even in males a robust development of structures, like the glabella (Table 83) and superciliary arches (Table 84), are not frequently found (resp. 2.5%, 3.8%). Features like the presence of the median frontal ridge (Table 82) or the bulbous development of the zygomatic trigones (Table 85) were absent. Characteristic of the Javanese skull is the presence of the frontal tubera (Table 86; 74.6%). The parietal of the Javanese appears to be short (Table 28-2) and the presence of the parietal tubera (Table 87) is typical (89.9%). The occipital index (Table 64) is often low (50.0%), indicating the presence of a flat occipital bone. Furthermore, the occipital bone often lacks marked structures (Table 92).

Viscerocranium — Considering the form of the face, a number of indices frequently show a medium development, like the upper facial index (Table 65; 54.7%), the prognathic index (Table 67; 84.0%) and the nasal index (Table 68; 47.4%). Furthermore, Javanese seem to have a characteristic face. They possess high and prominent cheek bones (Tables 43; 96). Because of the obviously rounded contour of the skull, distinct phaenozygy (Table 95) is not a typical characteristic of the Javanese skull (13.9%). The lower orbital border is sharp or rounded, rarely flat (Table 94; 1.3%). Another distinct feature of the Javanese face is that (viewed from norma lateralis) it is often flat and, especially when this is combined with subnasal prognathism (Table 98), it results in a highly characteristic facial expression. A single sharp lower border of the nasal aperture (frequently found in Europeans) is lacking in many Javanese skulls (Table 12.18; 85.7%). The length of the maxilla is on the small side (Table 41), but the breadth is on the large side (Table 42). The result is a maxilla with a broad form (brachyurany), which is found in 81.4% of the male skulls examined (Table 68).

Mandible — It is difficult to characterise the Javanese mandible for two reasons. It has moderate developments compared with Chinese and Australians, like its length (Table 44), coronoid height (Table 46), mandibular index (Table 69), and length-height index (Table 70). Or because it is difficult to see clear differences between the three groups at all, like the decline of planum alveolare (Table 104) or the development of the angulus mandibulae (Table 109). Nevertheless, when comparing the Javanese mandible with the Australian ones, some trends, especially in the region of the chin, can be observed. Javanese tend to have a larger mandible, as reflected by the mandible module (Table 74) and corpus dimensions (Table 75). Furthermore, Javanese have a more prominent mental protuberance (Table 100). This character is reflected by several others: a more marked mental trigone (Table 101), a stronger anterior mandibular incurvature (Table 102), and more often a positive projection of the chin (Table 103). Other trends include the more marked development of the sulcus extramolaris (Table 106) and of the lateral prominence (Table 107), and a larger planum triangulare (Table 110).

The upper (pre)molars — Compared with Chinese and Australians, the size of Javanese (pre)molars is moderate (Tables 52-58; 76-79).

Wajak-1

Neurocranium — The most characteristic feature of the Wajak-1 neurocranium is its extremely large size; it is the largest of the skulls that I examined, surpassing both recent and prehistoric skulls from Australasia (Table 71). This large size is due to its length (Table 24) and breadth (Table 26). Hence Wajak-1 lacks the highly characteristic brachycranic and hypsicranic form of the recent Javanese, but is mesocranic (close to dolichocrany, Table 59) and chamaecranic (Table 60). Of the recent Javanese males 25.3% are mesocranic, 5.1% are dolichocranic and none is chamaecranic. Seen from norma occipitalis, the Wajak-1 skull is tapeinocranic, a feature that is found in 23.1% of the recent Javanese males (Table 61). The overall impression is thus that Wajak-1 lacks the typical recent Javanese form. Considering the frontal bone, except for the development of the massive glabella (albeit damaged), Wajak-1 shows no strong deviation from the recent Javanese male series. Of the recent Javanese males, 2.5% has a massive glabella (Table 83). Furthermore, the skull matches the recent robust Javanese morphology. Of the Javanese males 17.7% have (very) marked superciliary arches (Table 84), and 25.3% show indistinct frontal tubera (Table 86). Wajak-1 resembles the Javanese skulls in the rounded contour, the absence of keeling (Table 81), medium postorbital constriction (Table 10.4), absence of the median frontal ridge (Table 82) and the flat zygomatic trigones (Table 85). As can be expected the parietal bone of Wajak-1 is not short, and surpasses the average recent Javanese (Tables 28-29). It cannot be classified as flat or bulbous but is medium developed (Table 63). The left tuber parietale (it is only possible to judge this side) is clearly present (Table 87), but moderately developed. The right mastoid process can be classified as small (Table 88) and the right supramastoid crest is medium developed (Table 89) (It is only possible to judge this side). These features are no exception among recent Javanese males. Wajak-1 has no flat occipital bone, but a protruding one (Table 64; this region has recently been reconstructed and as there is damage, one has to be careful with ones interpretation), not a typical Javanese situation. Furthermore, this part resembles the Javanese morphology in the nuchal area (Table 92) and in the absence of both the occipital torus (Table 90) and external occipital protuberance (Table 91). It attracts the attention that this robust male skull is so smooth (Javanese like) in this region.

Viscerocranium — The face (Table 72) and maxilla (Table 73) are very large, but do not surpass the maximum value of the recent Javanese series. Considering the orbital form and supraorbital margin, the orbits (based on the left side) can be classified as masculine (Table 93). The form of the orbit is quadrangular, but the supraorbital margin is thin, i.e. feminine developed. Thus, its classification as '3' has some uncertainty. Of the Javanese males, 21.5% have masculine orbits. The Wajak face is very Javanese-like. It possesses high and prominent cheek bones (Tables 43, 96) and it lacks a flat lower orbital border (this latter interpretation is based on the left side; Table 94). Although the os zygomaticum is high, it lacks the malar tuberosity. Moreover, viewed from norma lateralis, the face is flat (see Jacob, 1967) and there is distinct presence of subnasal prognathism (Table 98). There is no single sharp lower border of the nasal aperture (Table 97) and the maxilloalveolar index indicates a broad palate (Table 68). Of the Javanese males, 81.4% have a broad palate. As far as can be judged, there is no distinct palatine torus (Table 99). Of the Javanese males, 92.4% shows absence of this torus. The broad face (Table 65) is not particularly Javanese-like, but is no exception among Javanese males (28.0%). As with Wajak-1, many Javanese skulls show a slightly orthognathous face (Table 66; 46.7%). Wajak-1 has a very broad nasal aperture (Table 67), which is certainly not typical of the Javanese, 2.6% possess it. Wajak-1's distinct presence of phaenozygy (Table 95), is found in 13.9% of the Javanese males.

Mandible — Also the Wajak-1 mandible is (as far as can be assessed) very large. The corpus height (Table 47) exceeds the maximum value of the recent Javanese male series and its thickness (Table 48) is, like its ramus breadth (Table 49), very close to the maximum value of the Javanese series. (The ramus breadth must, however, be seen as an estimation, but it is obvious that this is large.)

Upper (pre)molars — Compared with recent Javanese Wajak-1 has large (pre)-molars (Tables 52-58, 76-79). The Javanese maximum values are surpassed by Wajak-1 in case of the buccolingual dimensions of the molars (Tables 54, 56, 58), and the cross-sectional area of the M2 (Table 77).

Wajak-2

A morphological description of Wajak-2 must inevitably remain less satisfactory than that of Wajak-1 because of the former's fragmentary state. The overall impression is that Wajak-2 must have been a really huge skull, in many dimensions surpassing the robust Wajak-1 skull. The most obvious feature of Wajak-2 is the extreme large size of the masticatory apparatus, which is best preserved and includes the maxilla, mandible and upper and lower teeth (Table 13). Although the MAL (Table 44) and MAB (Table 45) can be seen as estimations, undoubtedly the maxilla is very large, surpassing the maximum value of the recent Javanese (Table 73). In all its dimensions the mandible exceeds the average values of recent mandibles: i.e. in its length (Table 44), coronoid height (Table 46), symphysis height (Table 49) and symphysis thickness (Table 50). Because the roots of the incisors are clearly visible the measurement of the symphysis height (Table 49: 40.2 mm) must be seen as a minimum, atrophy or (and) erosion having possibly influenced the data. Its corpus dimensions in the region of M1/M2 are exceptionally large, surpassing every mandible, in both the recent and prehistoric series (Table 47-48), resulting in an extremely high module (Table 75). The large dimension also holds true for the ramus breadth (Table 51). The length-height index of the mandible can be classified as medium (Table 70). Looking at the (pre)molars of the Javanese, the maximum values are surpassed by the Wajak-2 skull for the P3-M3 length (Table 52), the buccolingual dimensions of the molars (Tables 54, 56, 58), the cross-sectional area of the M2 and M3 (-Tables 77-78), and the total cross-sectional area (Table 79).

As far as can be judged this large size is not limited to the masticatory apparatus but encompasses more parts of the skull, as indicated, for instance, by the minimum frontal breadth (Table 12). The Wajak-2 skull can be seen as representing the same group as Wajak-1 because the deviations can be explained by cranial variation within a group, and because there are a number of striking resemblances. Wajak-2 is, in general, more robust (larger and more masculine) than Wajak-1 (Table 12). Moreover, it was found at the same site, and there is no indication that the skulls might have originated from different groups. Deviations from the Wajak-1 morphology include a more robust development of the supramastoid crest (Table 89), the mastoid process (Table 88), the external occipital protuberance (Table 91), the mylohyoid line (Table 105), the sulcus extramolaris (Table 106) and the lateral prominence (Table 107). Besides the large size, resemblances between Wajak-1 and Wajak-2 encompass: a strong inclinatio frontale (Table 80), a massive glabella (Table 83), marked superciliary arches (Table 84), flat zygomatic trigones (Table 85), absence of the occipital torus (Table 90), the masculinity of the orbits (Table 93), absence of a flattened lower orbital border (Table 94), smooth inferior border of the nasal aperture (Table 97), and presence of subnasal prognathism (Table 98). As far as could be judged, there is no distinct palatine torus (Table 99).

Sampung-H

Due to thorough cleaning and to damage, some parts of the skull were difficult to analyse. These included the superciliary arches, zygomatic bones, inclinatio frontale, parietal tubera (only the right side was judged), temporal region (supramastoid crest), nuchal area, and the presence of superstructures (Tables 20, 22-23, 80-110).

The Sampung-H skull does not show the combination of characters frequently found in Australian males, like keeling (Table 81); median frontal ridge (Table 82); zygomatic trigones (Table 85); a distinct occipital torus (Table 90); flattened lower orbital border (Table 94) and a small rounded mental protuberance with a negative projection (Tables 100-103). The skull is more inclined to show some characters frequently found in recent Javanese males, like the delimited development of the glabella (Table 83); marked parietal tubera (Table 87); absence of the occipital torus

(Table 90); high and prominent zygomatic bones (Tables 43, 96); and a marked development of the lateral prominence (Table 107). The robust development of the superciliary arches (Table 84), as compared to recent Javanese male skulls, is striking (very marked superciliary arches are present in 3.8% of the Javanese males). The develop ment of the supraorbital region is in many prehistoric skulls more robust than in recent skulls from the same region. Because of its probable male status (Table 19), Sampung-H is an interesting skull for comparison with both Wajak skulls. Considering some of the dimensions of the skull (Tables 24, 43, 46-51), Sampung-H is smaller than the Wajak skulls, but compared with the recent Javanese males, Sampung-H is large. For instance, the following dimensions of the mandible are larger than the averages of recent Javanese males: coronoid height (Table 46), corpus module (Table 75), ramus breadth (this is an estimation due to damage; Table 51).

Although the Sampung remains have been interpreted by some authors, like Mijsberg, Coon and Jacob (from Jacob, 1967) as representing an 'Austromelanesian' morphology, there is no reason to assume that the Sampung-H skull represents anything other than a slightly robust prehistoric Javanese.

Hoekgrot

Compared with the Wajak skulls, the Hoekgrot skull is gracile, i.e. the dimensions of the cranium (Tables 24, 26, 27, 38, 43), mandible (Tables 4849) and molars (-Tables 76-79) are all smaller. The glabella (Table 83), temporal line, mastoid process (Table 88), os zygomaticum (Table 96) and the inferior border of the mandible show a more gracile development. Compared with recent Javanese males, the Hoekgrot skull is rather neutral or even (slightly) robust, for some of the dimensions of its cranium (Tables24, 38), mandible (Tables 48, 51) and molars (Tables 76-79). The development of the glabella (Table 83) and the superciliary arches (Table 84) are marked.

The Hoekgrot skull does not possess the characters frequently found in Australians, such as dolichocrany (Table 59), zygomatic trigones (Table 85), occipital torus (Table 90), and a flattened lower orbital border (Table 94). Moreover, this skull has characters frequently found in recent Javanese such as brachycrany (Table 59), as far as can be judged, no strong inclinatio frontale (Table 80), a distinct development of the frontal and parietal tubera (Tables 86-87), and a smooth development of the nuchal area (Tables 90-91). Undoubtedly, the skull has some characters that seem to negate a close resem blance to recent Javanese, such as the marked glabella (Table 83) and superci liary arches (Table 84). But these structures appear often more robust in prehistoric skulls than in recent skulls from the same region. The Hoekgrot skull morphology can therefore best be interpreted as an intermediate Neolithic Javanese, i.e. between the robust Mesolithic Wajak skulls and the recent, more gracile, Javanese. If the skull is from a female, it should be characterised as 'robust'.

Liang Momer-E

The uncertainty of the sex determination (as a male) makes a judgement about its affinity uncertain. Furthermore, the interpretation is somewhat hampered by the presence of distortion. The fit between the os sphenoidale and the os temporale is not satisfactory and there is slight damage at bregma. There is no correct fit between the face and the neurocranium. There are few characteristics which agree with a Mongoloid morphology. The skull is orthocranic (Table 60), and the frontal bone is rounded, i.e. no keeling (Table 81) nor a median frontal ridge (Table 82). There is damage in the facial region, but as far as can be judged, the skull lacks the typical flat face with high prominent cheek bones (Table 43). Besides a number of medium developed characters — such as the supraorbital region (Tables 83-84), frontal tubera (Table 86), and orbita (Table 93) — there are others that could indicate an Australian morphology, i.e. dolichocrany (Table 59), hyperacrocrany (Table 62), a narrow and low mandible (Tables 69-70), indistinct parietal tubera (right side; Table 87), distinct occipital torus (Table 90), trace of a flattened lower orbital border (left side; Table 94), phaenozygy (Table 95), and low cheek bones (Table 97).

Liang Toge

Because Liang Toge is the most complete prehistoric Indonesian skull with a more reliable diagnosis as a female (Table 19), it is interesting to compare this skull with the series of recent female skulls (Tables 24-110). However, there is damage and the following dimensions had to be estimated: XCB (Table 26), MSB (Table 32), NLB (Table 40), MAL (Table 41), ML (Table 44), and W1 (Table 45).

At first glance, this skull impresses as gracile, i.e. small with feminine non-metrical characters (Table 19). Its cranial breadth is remarkably small (Table 26), which, combined with its length, results in an obviously dolichocranic skull (it must be stressed that the cranial breadth is a very rough estimation, possibly exaggerating the effect). The lengths of the upper P3-M3 (Table 52) are rather small, like the cross-sectional area of the upper M1 (Table 76), M2 (Table 77) and M3 (Table 78). But this skull is not (extremely) small in all its dimensions, (Table 24). The dimensions of the frontal bone (Tables 27, 32) are large, the maximum supraorbital breadth (Table 32) surpassing the maximum values of the recent female series. As to the viscerocranium, Liang Toge has an obviously large nasion-prosthion height (Table 36), and its maxilla can be classified as large (Table 73). Both the mandibular length (Table 44) and bicondylar breadth (Table 45) are rough estimations, but they do not indicate a small mandible. Also the corpus dimensions (Tables 47-48), symphysis dimensions (-Tables 49-50), and ramus breadth (Table 51) do not indicate a small mandible. Therefore the overall impression is that, except for the dimensions of the cranial breadth and (pre)molars, this skull cannot, according to female standards, be classified as small, but rather as large. Considering the non-metrical characters (Tables 80-110) Liang Toge is in many of them feminine developed, which explains its gracile appearance.

According to Jacob (1967), Liang Toge has its closest affinity, like the other human remains from the Flores caves, with the 'Austromelanesians'. Trying to classify a single female skull is, because of its retaining of a juvenile appearance, probably a questionable undertaking. This is not to deny that Liang Toge shows a combination of some characters resembling the morphology often found in recent female Australian skulls. For instance it shows: hyperdolichocranic (Table 59), a low maxilloalveolar index (Table 68), an indistinct development of the frontal and parietal tubera (Tables 86-87), a trace of a occipital torus (Table 90), a trace of a flattened lower orbital border (Table 94), distinct phaenozygy (Table 95), and a smooth inferior nasal border (Table 97). However, not all characters support the idea of an 'Austromelanesian' affinity. For instance, the skull has a low nasal index (Table 67), a rounded contour (Table 81), no trace of a median frontal ridge (Table 82), and no palatine torus (Table 99).

Recent and prehistoric skulls from China

The present discussion will be concentrated on male skulls from China, including the prehistoric male skulls Liujiang and Upper Cave 1.

Recent Chinese males

Neurocranium — The neurocranium of the Chinese is often large (Table 71), due to their large cranial height (Table 25) and breadth (Table 26). The skull is relatively broad; yet, the average is not brachycranic, but mesocranic (Table 59). The crania are often, like the Javanese, hypsicranic (Table 60) and their average is at the border of acrocrany, close to metriocranic; Table 61). The frontal bone of the Chinese is very similar to the Javanese. What has been said on the Javanese also holds for the Chinese frontal bones. A strong postorbital constriction (Table 62) is in Chinese (0%) even less than in the Javanese (2.6%). In Chinese skulls a distinct presence of the parietal tubera (Table 87) is less frequently found than in Javanese (resp. 77.7%, 89.9%). In Chinese skulls the occipital bone is large (Tables 30-31), and is less smooth than in Javanese, the occipital torus (Table 90) and a marked nuchal area (Table 92) are more frequently found.

Viscerocranium — In general, the Chinese and Javanese facial skeleton are very similar: they have a flat face (known as the 'mongoloid face'; see, for instance, Bass, 1987) with high and prominent cheek bones (Tables 43, 96). Further resemblances to the Javanese skulls include: the frequent presence of brachyurany (Table 68), the feminine orbits (Table 93), and the absence of a flat inferior orbital border (Table 94). There are, however, also differences. Compared with the Javanese, Chinese have a less protruding face (Table 66), which is in accordance with the observation that the Chinese have a smaller maxilla (Table 73) and teeth (Tables 52, 79). Chinese have, in fact, the smallest maxilla and teeth of the four examined groups. Compared with the Javanese, distinct phaenozygy is more frequently found among the Chinese (Table 95), and a smooth lower border of the nasal aperture less frequently (Table 97).

Mandible — Because the length of the mandible is small (Table 44) and the coronoid height (Table 46) is large, recent Chinese have a relatively high mandible (Table 70). Seen from the lateral side, this obviously high appearance is exaggerated by the large corpus height (Table 47) and symphysis height (Table 49). Because the bicondylar breadth is not small this results in a relatively broad mandible (Table 69). Interestingly, in contrast with the Australians, the Chinese have (like the Javanese) a strongly developed chin (Table 100).

The upper (pre)molars — As could be expected, because of the small size of the maxilla (Table 73), the (pre)molars of the Chinese are often small (Tables 52- 58, 76-78).

Liujiang

Considering the cranial morphology of Liujiang in comparison with recent Chinese, one notices an interesting parallel with the Javanese situation. More or less the same combination of resemblances and deviations can be observed between the prehistoric and recent skulls. The prehistoric specimen can be seen as a robust representative of the present inhabitants.

Viewed from norma frontalis Liujiang resembles the recent Chinese skulls in its rounded contour (Table 81), its absence of a median frontal ridge (Table 82) and a flat development of the zygomatic trigones (Table 85). As with many recent Chinese skulls, Liujiang has a small postorbital constriction (Table 62). Furthermore, this skull lacks a: marked nuchal area (Table 92), external occipital protuberance (Table 91), and occipital torus (Table 90). Thus Liujiang resembles the frequently found Chinese/Javanese situation in being rather smooth in the nuchal area.

Like Wajak-1, Liujiang has a very large neurocranium (Table 71). The prehistoric specimens are relatively lower and less broad than the average recent skulls from the same region (Tables 59-61). Liujiang has a marked glabella (Table 83: though certainly not robust, close to being delimited) and superciliary arches (Table 84). The frontal bone shows a strong inclinatio (not very strong, Table 80) and the frontal tubera (Table 86) are indistinct. It has a relatively quadrangular orbital form with a rounded supraorbital margin, a situation that is rare among recent Chinese (Table 93). Liujiang has a high nasal index (Table 67) and a smooth development of the inferior border of the nasal aperture (Table 97).

Upper Cave 1

Compared with recent Chinese skulls, U.C.1 is clearly robust (large and showing many masculine developed characters). Moreover, in many morphological features it deviates from the present-day inhabitants. Though such differences are quite common for prehistoric skulls, here they are so pronounced that it is hard to consider U.C.1 as an early representative of the recent Chinese.

The neurocranium is large as indicated by measurements like the maximum cranial breadth (Table 26), basion-nasion length (Table 34), the glabella occipital length (Table 24) and maximum supraorbital breadth (Table 32), the last two surpassing the maximum value of the recent Chinese. Not only the neurocranium is large, but also the viscerocranium, as can be deduced from the bizygomatic breadth (Table 37) and maxilloalveolar breadth (Table 42). In China and Java it seems that prehistoric people tended to have a narrower skull than the recent inhabitants. This also holds for U.C.1. Compared with the average values of recent Chinese, U.C.1 has a very low cranial index (hyperdolichocranic; Table 59). The nasal height (Table 39) and especially the nasal breadth (Table 40) are very large. Prehistoric skulls from China have a higher nasal index than the average recent Chinese, U.C.1 surpasses the maximum value of the recent Chinese series (Table 67).

As to the non-metrical characters, U.C.1 is a typically robust male skull, lacking many of the feminine features, that frequently characterise the recent Chinese male skulls. U.C.1 possesses a strong inclinatio frontale (Table 80), but no keeling (Table 81) or a median frontal ridge (Table 82). The development of the supraorbital region is, compared to the recent Chinese, very robust. The massive glabella (Table 83) together with the very marked superciliary arches (Table 84) and large zygomatic trigones (Table 85) form an ambiguous supraorbital torus (ambiguous in the sense that it is not straight and is not strong at the lateral sides; Table 22). Juvenile characters, like the frontal and parietal tubera (Tables 86-87) are not clearly present. The mastoid process (Table 88) is, like the supramastoid crest (Table 89), medium developed. U.C.1 has no marked nuchal area (Table 92) or external occipital protuberance

(Table 91), although the occipital crest is clearly present. But there is a distinct occipital torus (Table 90). The presence of an occipital torus itself is not unique for recent Chinese, 23.8% of the examined Chinese shows it. But in U.C.1 this torus divides the occipital plane and nuchal plane in a sharper angle than is usual among recent Chinese (Table 22).

Considering the non-metrical characters of the facial skeleton of U.C.1, it shows some developments also frequently found in recent Chinese. These include the clear presence of phaenozygy (Table 95), and the masculine devel opment of the zygomatic bones (Table 96). Other characters that are less frequently found among recent Chinese include the masculine development of the orbits (Table 93), the flattened lower orbital border (Table 94), and the smooth inferior border of the nasal aperture (Table 12.18). Remarkably, the occurrence of a smooth inferior border of the nasal aperture is found in all prehistoric Chinese skulls examined (Table 97), like at least a trace of the palatine torus (Table 99)

Recent and prehistoric skulls from Australia

The discussion will be focused on male skulls from Australia. The prehistoric ones that will be discussed in more detail include: Kanalda, Keilor and Kow Swamp 5.

Recent Australian males

Neurocranium — The average Australian skull is long (Table 24) and its average breadth (Table 26) is not large, often resulting in dolichocrany (Table 59; 90.0%). In this series no skull was found with brachycrany. Seen from the lateral side, Australian skulls are often orthocranic (Table 60; 51.7%). Seen from norma occipitalis, they can be characterised by the frequent occurrence of acrocrany (Table 61; 85.7%). The frontal bone of the Australian is often large, as expressed by the frontal chord (Table 27) and maximum supraorbital breadth (Table 32). It often has a striking appearance: seen from norma verticalis, many show a strong postorbital constriction (Table 62; 50.0%) and distinct phaenozygy (Table 95; 91.2%). Other features commonly found in the Australians are robust male characteristics, like a strong inclinatio frontale (80; 82.4%), a marked glabella (Table 83; 88.3%) and superciliary arches (Table 84; 94.1%), and an indistinct development of the frontal tubera (Table 86; 97.1%). It has to be stated that in some skulls the development of the glabella was so much pronounced that it was far beyond the classification 'massive' (European standard was used to judge all skulls, Workshop, 1980). The presence of keeling (Table 81; 50.0%), the median frontal ridge (Table 82; 27.3%) and medium to bulbous zygomatic trigones (Table 85; 27.2%) are characteristic for this group. The occipital of the Australians can be characterised by a marked nuchal area (Table 92; 69.7%) with the presence of a occipital torus (Table 90; 66.7%). But in many skulls the external occipital protuberance (Table 91) is rarely distinct (6.3%).

Viscerocranium — Compared with recent Chinese and Javanese, Australians tend to have a broad face (Table 65; 75.0%). The form of the orbits are frequently masculine (Table 93; 82.3%). Characteristic of the Australian facial skeleton is the occurrence of a flattened lower orbital border (Table 94; 44.1%). Furthermore, the face can be characterised by low cheek bones (Table 9.20) and platyrrhiny (Table 67; 82.7%); the latter due to the regular occurrence of a small nasal height (Table 39) and large nasal breadth (Table 40). The maxillary region can often be characterised by the absence of a single sharp inferior border of the nasal aperture (Table 97; 97.1%), the presence of subnasal prognathism (Table 98; 93.7%), and a large maxilla (Table 73; 85.7%) as due to the large size of both the length (Table 41) and breadth (Table 42). Although not very frequently present, the presence of the palatal torus (Table 99; 24.2%) is characteristic for Australians.

Mandible — Although the maxilla is often large, the mandible is regularly small (Table 74; 42.9%). This small appearance is due to its bicondylar breadth (Table 45), coronoid height (Table 46) and corpus dimensions (Tables 47-50), but not its length (Table 44). This great mandibular length is understandable because of the large basion-prosthion distance (Table 35). To keep the teeth in occlusion the mandible has to be long. Interestingly, the mandible is in some cases so large that one can observe (from norma lateralis) a space between the last molar and the anterior border of the ascending ramus. This retromolar gap has also been observed in Neanderthals (Stringer & Gamble, 1993). Considering the total aspect, the Australian mandible's shape is often the opposite of the Chinese, i.e. by being narrow (Table 69; 64.3%) and low (Table 70; 86.7%). Many Australian male crania appear, except for the mastoid process, masculine. Therefore, it is a surprise to frequently find a small, feminine chin (Table 100; 73.7%). The chin can often be characterised by a slight development of the mental trigone (Table 101; 50.0%) and the anterior mandibular incurvature (Table 102; 47.1%), and a negative projection (Table 103; 66.7%). Also the sulcus extramolaris (Table 106) and lateral prominence (Table 107) are often slightly developed (41.2%, 61.1%, resp.).

Upper (pre)molars — In the four recent groups examined, Australians have the largest (pre)molars (Tables 52-58, 76-79).

Kanalda

General appearance — Kanalda can be classified as a very robust modern human skull because of its very large size and frequent presence of masculine structures. In general one could state that, compared with recent and prehistoric skulls from Australasia, its large size is exceptional. Kanalda exceeds every examined skull, both recent and prehistoric, in the dimensions of the viscerocranium (Table 72), maxilla (Table 73) and mandible (Table 74). Although the dimensions of the neurocranium (Table 71), body of the mandible (Table 75) and the upper (pre)molars (Tables 52, 76-79) do not surpass the maximum values of the other skulls, they can still be classified as (very) large.

Total aspect — Seen from norma verticalis, the skull is dolichocranic, close to mesocranic (Table 59). Seen from the lateral side, it is hypsicranic, close to orthocranic (Table 60). Seen from norma occipitalis, it is acrocranic (Table 61). For an Australian skull, Kanalda is high (Table 25) and broad (Table 26) (in both measurements it surpasses the maximum values of the Australian series). It has (both relatively and absolutely) a (very) broad face (Table 65), the bizygomatic breadth surpassing every other examined skull (Table 37). Kanalda has no orthognathous or prognathous face, the value is close to the average of recent Australians (Table 66). Considering its general shape, the deviations from the average Australian is not very pronounced and with its clear presence of keeling (Table 91) and its protruding zygomatic arches (phaenozygy, Table 95) the skull could fit in an Australian series.

Frontal region — In the frontal region Kanalda's aboriginal nature is obvious. It has a large supraorbital breadth (Table 32), strong post-orbital constriction (Table 62), massive development of the glabella (Table 83), very marked superciliary arches (Table 84) and indistinct frontal tubera (Table 86). It must be stressed, however, that Kanalda does not possess an extremely robust glabella and superciliary arches, as some recent Australian skulls do. The inclinatio frontale is ambiguously developed (Table 80), remarkable for a skull with such a masculine appearance. Although the zygomatic trigones are medium developed (Table 85), this region is not extremely robust, but some elevation is an aboriginal character. Furthermore, the frontal bone is flat (index < 23.5, Table 20) and the median frontal ridge (Table 82) is present, though not very marked. The region around bregma is swollen, yet there is no real bregmatic eminence in the sense that there is a real mound of bone. The glabella passes over gradually into the squama of the frontal bone: in other words, there is no distinct supraglabellar fossa. The ophryionic groove is present, but not very well developed.

Parietal and temporal region — In accordance with Kanalda's general large size, the parietal bone is large (Tables 28-29). Its contour is slightly rounded (Table 63). The parietal tubera are moderately developed (Table 87). The mastoid process is large, but not exceptionally (Table 88) and the supramastoid crest is small (Table 89). The zygomatic process is strongly developed, but not extreme (the left one being a little stronger).

Occipital region — Kanalda's occipital bone is large (Tables 30-31), its contour is slightly flat (Table 64). The whole occipital region is not as masculine as one would expect with such a robust skull. The nuchal area is slightly developed (Table 92). The external occipital protuberance (Table 91) is difficult to classify: it is small and somewhat damaged. An indistinct occipital protuberance is frequently found among Australian males (93.8%). Kanalda has no distinct occipital torus (Table 90), it is partly present and small. This torus is frequently found among Australian males (66.7%).

Facial region — The orbits have an obviously masculine appearance, i.e. quadrangular, with rounded supraorbital margins (Table 93). The left lower orbital border (Table 94) is flatter than the (more rounded) right one, but this difference is not marked. Both marginal tubercles are, like the canine fossa, well developed. Because the zygomatic bones are high (Table 43) and show a malar tuberosity (more pronounced on the right side) they can be classified as very masculine (Table 96). The nasal aperture is large, both in its height (Table 39) and breadth (Table 40). The nasal index (Table 67) indicates a broad nasal aperture, which is a frequently occurring feature among recent Australians (82.7%). There is no sharp inferior border of the nasal aperture, which can thus be classified as smooth (Table 97). Both the margo infranasalis and crista prenasalis are clearly present. The region of the anterior nasal spine is fractured. There is slight subnasal prognathism (Table 98). The large size of the maxilla (Table 73) is caused by its large maxilloalveolar length (Table 41) and, in particular, its very large maxilloalveolar breadth (Table 42) (only equalled by Wajak-2). Consequently, the form of the maxilla is broad (Table 68) exceeding the maximum value of recent Australians. In fact, a broad maxilla is not a typical Australian feature, but a clearly present palatal torus is (Table 99).

Total aspect of mandible — The large dimensions of the mandible (Tables 74- 75) are caused by its length (Table 44), bicondylar breadth (Table 45), coronoid height (Table 46), corpus height and thickness (Tables 47-48), and symphysis height and thickness (Tables 49-50). Compared with the average recent Australian, the mandible is not only larger, but also, relatively seen, broad (Table 69) and high (Table 70).

Region of the corpus — The chin as a whole is small and rounded (Table 100) with a negative projection (Table 103), a slightly developed mental trigone (Table 101), and a medium anterior mandibular incurvature (Table 102). The planum alveolare shows a distinct decline (Table 104). In other words, this region shows a morphology frequently found in Australian Aborigines. The anterior marginal tubercle gradually passes into the mental tubercle: above the latter one finds the mental fossa. It is somewhat difficult to judge the digastric fossa on the right side due to possible erosion, on the left side its development is not marked. The inferior margin of the mandible is thick. Focusing now on the outer surface of the body, the sulcus extramolaris is marked (Table 106) with a medium development of the lateral prominence (Table 107) (which is on the left side weaker than on the right). The right lateral prominence passes into the posterior marginal tubercle. On the left side the torus lateralis superior, torus marginalis and the intermediate sulcus intertoralis are clearly present. As to the inner surface of the body, the mylohyoid line is slightly developed (Table 105).

Region of the ramus — As to the outer surface of the (broad) ramus (Table 51): the crista ectocondyloidea and the eminentia lateralis ramus are present, though not marked. The fossa masseterica is not present, the area is not depressed but rather raised. The fossa precoronoidea is medium developed (Table 52). The region of the angulus mandibulae is moderately developed (Table 53). There are eminences, but the gonia have no strong outward projection. The head of the mandible is broad and thick, the depth of the mandibular notch, between the condylar and coronoid process, is medium developed. As to the inner surface of the ramus, on the left side the area of the planum triangulare is clearly present as a depressed area: this is caused by the well marked crista endocoronoidea and endocondyloidea. Furthermore, the planum triangulare can be classified as large (Table 54), and the mylohyoid sulcus is medium developed.

Interpretation at species level — The Kanalda skull is clearly that of a robust modern human (*Homo sapiens*) (Table 22). Two features that can be found in *Homo erectus*, the metopic ridge (median frontal ridge, Table 82) and the angular torus, are small, and this situation can also be found in other modern human skulls. Although the glabella and superciliary arches can be classified as robust, and there are medium developed zygomatic trigones, there is no supraorbital torus, in the sense of a continuous beam above the orbits (as can sometimes be found among recent humans). The postorbital constriction is not as pronounced as in *Homo erectus* skulls. Furthermore, Kanalda lacks characteristics found in Middle Pleistocene skulls, like a low skull, a strong parietal constriction, a sharp angle between the nuchal and occipital plane, a robust occipital torus, a flat and straight superior border of the temporal squama, and a well developed fissure between the mastoid process and crista petrosa (Table 22).

Interpretation at subspecies level — The combination of features that could be used as an argument to interpret the Kanalda skull as Australian Aborigine include: the cephalic index (dolichocephalic), the distinct keeling of the vault, the extreme grade of phaenozygy, the slope of the forehead, the large maximum supraorbital breadth with a marked postorbital constriction, the robust glabella and superciliary arches, the elevated zygomatic trigones and median frontal ridge, the large palate with a clear palatine torus; the subnasal prognathism (not strong), the sharpness of the inferior orbital border, the inferior border of the anterior nasal aperture which can be classified as smooth, the slight development of the mental trigone and a negative projection of the chin, and the moderate to greater decline of planum alveolare. It must be stressed that it is the combination of features that gives an indication, and that the indication is not always strong, as some of the features can also be found in other groups of Australasia. In comparison with recent Australian skulls, Kanalda is large in all its dimensions and clearly shows a number of features that are used to characterise recent Australian crania. In general, its morphology and large size, as is also present in other (prehistoric) Australian skulls, could be used as an argument that it belongs to this group.

Keilor

One of the most prominent features of Keilor is its large size (Tables 24, 26, 32) and its masculinity (Table 19). Furthermore, the skull is dolichocranic (Table 59) and has a flat parietal bone (Table 63). Although many Australians have a broad nasal aperture (Table 67; 82.7%) in Keilor it is medium. Some characters which one would expect in a recent Australian skull, are absent in Keilor. These include: keeling (Table 81), a median frontal ridge (Table 82), and a marked (massive) glabella (Table 83). The combination of characters that could be used as an argument to indicate its affinity with recent Australians are for instance, a strong inclinatio frontale (Table 80) (though not extreme), very marked superciliary arches (Table 84), absence of the frontal tubera (Table 86), distinct occipital torus (Table 90), absence of the external occipital protuberance (Table 91), very masculine development of the orbits (Table 93; the supraorbital margin is not very rounded, but the form of the orbits are clearly angled), distinct presence of phaenozygy (Table 95), subnasal prognathism (Table 98), and a distinct palatine torus (Table 99). As far as can be judged, Keilor has a distinct malar tuberosity. Australians show a large cranial variation, thus the absence of characteristic features is absolutely no exception among Australian skulls. Hence, the overall impression is that Keilor can best be seen as an early representative of the recent Australians.

Kow Swamp-5

This is clearly a masculine skull with a striking appearance. Its vault appears very high and it has an extreme flat frontal bone, probably due to artificial deformation (Brown, 1981). Because of this and postmortem damage (e.g. the distance between the condyli of the mandible is greater than that between both fossae mandibularis) one has to be careful when interpreting certain parts of the skull.

Although Kow Swamp 5 possesses some characters which are not particularly Australian, such as its broad mandible (Table 69) and the absence of a distinct palatine torus (Table 99; that is only slightly present posteriorly; 36.4% of the Australian males has no palatine torus), it seems to be one of those skulls which comes close to the 'idealised' Australian skull morphology. Those characters that are possibly strongly correlated with artificial deformation like the strong recession (Table 20) and inclinatio of the frontal bone (Table 80) will be left aside. However, it cannot be excluded that some other characters mentioned below are influenced by the practice of head binding (see Brown, 1981). The combination of characters that could be used as an argument to indicate its affinity with recent Australians seems overwhelming. These include:

1) dolichocranic form (Table 59);
2) very broad nasal aperture (Table 67);
3) as far as can be judged, distinct keeling (Table 81);
4) marked glabella (Table 83; considering the occurrence in Australians certainly not robust);
5) very marked superciliary arches (Table 84);
6) medium zygomatic trigones (Table 85);
7) slight presence of a supraorbital torus (Table 22);
8) absence of the frontal tubera (Table 86);
9) absence of the external occipital protuberance (Table 91);
10) as far as can be judged, very marked nuchal area (Table 92);
11) masculine orbits (Table 93);
12) distinct flattened lower orbital border (Table 94);
13) no obvious high os zygomaticum, combined with the presence of distinct 'malar tuberosity';
14) as far as can be judged, phaenozygy (Table 95);
15) smooth inferior border of the nasal aperture (Table 97);
16) subnasal prognathism (Table 98);
17) small and rounded mental protuberance (Table 100);
18) slight mental trigone (Table 101);
19) negative projection of the chin (Table 103);
20) greater decline of the planum alveolare (Table 104);
21) slight lateral prominence (Table 107).

There seems to be little doubt about the fact that Kow Swamp 5 can be interpreted as an early representative of the recent Australians.

Recent crania from Papua New Guinea

This is the only series with a reasonable number of female skulls. Nevertheless, again the discussion will be concentrated on male skulls because the Wajak skulls have been diagnosed as males and, in general, more male skulls have been studied than female skulls.

Recent Papua New Guinea males

Neurocranium — The average small size (Table 71) is caused by the common occurrence of a small height (Table 25) and breadth (Table 26). As far as the cranial shape is concerned, Papuans closely resemble Australians. Their neurocrania are often dolichocranic (Table 59; 81.4%), orthocranic (Table 60; 58.3%) and acrocranic (Table 61; 81.8%). In the frontal bone Papuans (except for size, see Table 27) often closely resemble Australians. These include features like a strong postorbital constriction (Table 62; 32.1%), keeling (Table 81; 55.2%), a marked glabella (Table 83; 83.4%) and superciliary arches (Table 84; 75.9%), and indistinct frontal tubera (Table 86; 69.0%). Also in the region of the occipital bone, Papuans often resemble Australians. These include features like a marked nuchal area (Table 92; 69.2%), and a distinct occipital torus (Table 90; 18.2%).

Viscerocranium — Although Papuans show the highest occurrence of a small face (Table 72; 17.6%), owing to a frequent occurrence of a small nasion-prosthion height (Table 9.13) and bizygomatic breadth (Table 37), the maxillas (Table 11.3) are often large (93.3%). As with the Australians, the basion-prosthion (Table 35) and the maxilloalveolar lengths (Table 41) are often great, which explains the frequently found (slightly) prognathous face in Papuans (Table 66; 90.4%). Compared with Chinese and Javanese, the overall impression is that the Papuan face bears resemblance to the Australian. Papuans show more or less the same trends in the following characters: short nasion-prosthion length (Table 36), short nasal height (Table 39), low cheek bones (Tables 43, 96), a narrow palate (Table 68; 60.0%), distinct phaenozygy (Table 95; 92.9%), a masculine appearance of the orbits (Table 93; 72.4%), and a flat lower orbital border (Table 94; 13.3%).

Upper (pre)molars — Their size is larger than that of the Chinese but smaller than the Australians (Tables 52-58; 76-79). Considering that the Papuan cranium is often small (Tables 71-72), this could be used as an argument that the Papuan tooth size follows the Australian trend of having relatively large teeth.

Conclusion

Recent skulls

Size — Considering the *measurements* and *modules* Papuans can be characterised as having a small cranium. Although their neurocranium and viscerocranium tend to be small, the maxilla and upper molars are not (data of the mandible are not available). The Chinese have a combination of a relatively large neurocranium, and small maxilla and upper molars. Although the face, maxilla and upper molars of the Australians tend to be large, their mandibles are often rather small.

Two morphological types — Considering the indices, one can clearly distinguish two groups. Chinese and Javanese can be characterised as having a more rounded neurocranium and broader maxilla, Papuans and Australians as having a less spherical neurocranium and a narrower maxilla. The distinction between these two groups is also apparent in other indices, i.e. comparing Chinese with Australians, whereas in Javanese and Papuans this trend is weaker, rather approaching a medium situation. Compared with Chinese, Australians are characterised by a broader face and nasal aperture, and a narrower and lower mandible. Moreover, the most obvious trend apparent in the non-metrical characters is also the distinction of these two groups. It seems that sexual dimorphism is weaker in Chinese and Javanese than in Australians and Papuans. Chinese and Javanese males resemble the female morphology closer than Australians and Papuans. As to the male skull morphology, on the one hand Chinese and Javanese can be characterised by a more rounded skull, rounded orbits with high zygomatic bones, a limited outgrowth of superstructures, and a more frequent retention of juvenile characters. On the other hand, Papuans and (often more clearly) Australians can be characterised by a less rounded skull, quadrangular orbits with lower zygomatic bones, a rather obvious outgrowth of the superstructures, and a less frequent retention of juvenile characters.

Prehistoric skulls

Size — In assessing the measurements and modules, the studied prehistoric male skulls from China, Java and Australia often tend to exceed the dimensions of the neurocranium, viscerocranium, mandible and molars of their own regional recent male series.

China — Both Liujiang and U.C.1 are more robust than the average recent Chinese males. Arguments can be brought forward favouring the interpretation of Liujiang as a robust representative of the present inhabitants of China. Because of its stronger deviations from the recent Chinese it is, however, difficult to see U.C.1 as portraying a robust Chinese.

Indonesia — The complete skull of Wajak-1 is large and, furthermore, it has a characteristically Javanese face. Wajak-2 is even more robust (a really huge skull), Sampung-H less so, and Hoekgrot is, compared with the above mentioned skulls, rather gracile. A possible interpretation would be to consider the Wajak, Sampung and Hoekgrot skulls as robust representatives of the present-day inhabitants of Java. Although both prehistoric skulls from Flores (Liang Toge and Liang Momer-E) are fairly complete, conclusions about their affinity remain problematic. As far as can be judged, they cannot convincingly be seen as Mongoloid, and although some characters found frequently among Austromelanesians are present in the Flores skulls (especially in Liang Toge), it is also not possible to see them as clear examples of Austromelanesians.

Australia — The overall impression of the recent Australian skulls is that they show a large variation; and prehistoric skulls from this region, (Kanalda, Keilor, and Kow Swamp 5, also the more meagre material from Kow Swamp, and Mungo) fit within this variation, and can therefore be seen as early representatives of the recent Australians. The prehistoric skulls tend to be larger than the recent average male Australian skulls, and can thus be characterised as being (slightly) more robust.

A Solo-Wajak-Australian connection?

Introduction

The Middle Pleistocene Javanese Solo skulls have been linked with later, more recent hominids, like Wajak and/or Late Pleistocene and Holocene Australian Aborigines (Weidenreich, 1946; Coon, 1963; Jacob, 1967; Thorne & Wolpoff, 1981, 1992; Wolpoff et al., 1984). One could divide the Solo-Wajak-Australian connection into three components:

a) the Solo-Wajak connection,
b) the Solo-Australian connection,
c) the Wajak-Australian connection.

The Solo connection

'Dated' in the Middle Pleistocene and found in association with an archaic fauna, the first question regarding the Solo skulls that one would like to have answered is whether they are really different from skulls of modern humans. More precisely formulated: does the Solo skull show more resemblance to *Homo erectus* (see: Santa Luca, 1980; Andrews, 1984; Rightmire, 1984; Stringer, 1984) or with *Homo sapiens*? Secondly, can prehistoric groups (Indonesia, Australia) be considered as being transitional forms between Solo and recent Australians?

Are the Solo skulls different from recent human skulls? — Characters of *Homo erectus* include: a low skull, recession of the frontal bone, a robust and straight supraorbital torus, a low and straight superior border of the temporal squama, and a sharp angle between the occipital and nuchal plane, divided by a distinct occipital torus. These could not be found among recent skulls (Chinese, Javanese, Papuans, and Australians; Tables 20-21). Some other characters of *Homo erectus*, such as a strong postorbital constriction, a strong convergence of the parietal bones above the supramastoid crest, can only rarely be found among recent Australians. Some *Homo erectus* characters are rarely found among recent humans, such as a clear development of the superstructures (Javanese and Australians) and a fissure between the mastoid process and the crista petrosa (Javanese, Papuans, and Australians). Thus, these archaic characters are not found - or rarely found - among recent humans. A combination of these characters is probably never present in recent humans.

However, that combination is shown by the Solo specimens (Tables 20, 22). Due to damage it was not possible to measure all the Solo specimens, but both the low skull and strong postorbital constriction are clearly present in the skulls which were not measured. Furthermore, the Solo skulls can be characterized as having a receding frontal bone, a robust and straight supraorbital torus, the parietal bones converge above the supramastoid crest, a low and straight superior border of the temporal squama, a distinct fissure between the mastoid process and the crista petrosa (which is broader than in recent humans, if present at all), and a sharp angle between the occipital and nuchal plane, divided by a distinct occipital torus. Tightly speaking, the opistocranion was not always at exactly the same point as inion (always close) and the superstructures did often not show a strong development, but this probably also goes for some other *Homo erectus* skulls.

The Solo skulls are clearly different from recent humans, and are most likely from *Homo erectus*. This is also suggested by others. Weidenreich (1951, p. 227) remarked:

'Earlier studies led me to the conviction that Ngandong man is not a true Neanderthal type but distinctly more primitive and very close to *Pithecanthropus* and *Sinanthropus*. For this reason I ranked Solo man with the same group of early hominids as the two latter forms and called the whole group Archanthropines.'

For his 'Archanthropines' we should now read: *Homo erectus*. Jacob (1967), in his study of the Solo skulls, followed Weidenreich and used the term: *Pithecanthropus soloensis*. Besides Weidenreich (1951), Santa Luca (1980) has also made an extensive study of the morphology of the Solo crania; and on their taxonomical status he remarked (op. cit., pp. 131-132):

'The entire set of Far Eastern *H. erectus* studied here presents a single morphological 'bauplan': each skull has the same basic shape, with group and individual variations overlaid on this plan. The Ngandong hominids share it with the Peking and Sangiran- Trinil 2 fossils. Absolutely no basis has been found for separating Ngandong as a different species from the latter groups. ..... In morphology, craniometry, and craniography, the Ngandong group agrees with the far Eastern *H. erectus* specimens studied here and is clearly differentiated from other major hominid groups.'

In accordance with earlier opinions (Weidenreich, 1951; Jacob, 1967; 1978; Santa Luca, 1980; Rightmire, 1990) the morphology of the Solo specimens is indeed close to that of the Chinese *Homo erectus* (formerly called *Sinanthropus*) and Javanese *Homo erectus* (formerly called *Pithecanthropus*) material. The Solo skulls can therefore best be interpreted as the remains of a late *Homo erectus* group.

A special link between Solo and Wajak? — Is there a special link between Solo (*Homo erectus*) and Wajak? The answer is no. The Wajak skulls show in all details a *Homo sapiens* morphology, without archaic characters that could point to any special connection between Solo and Wajak (Tables 20, 22). It is true that Solo and Wajak share some characters (Table 23), such as the obelion depression, the supramastoid sulcus and the mastoid crest. However, these are not limited to the Solo skulls, but can be found in modern *Homo sapiens* skulls in general.

A special link between Solo and Australians? — Claims have been made about a morphological continuity in Australasia between the Middle Pleistocene hominids from Java (Sangiran and Solo) and the Late Pleistocene humans from Australia, i.e. the more robust specimens. The latter include: Willandra Lakes 50 (WLH-50), Kow Swamp, Nitchie, Coobool Creek, and Cossack. This supposed continuity is used as a support for the 'Multiregional Evolution' model (Thorne & Wolpoff, 1981, 1992; Wolpoff et al., 1984; see Fig. 26).

The Tables 20-23 seemingly suggest this connection, but at a closer look this relationship cannot be confirmed. Both skulls from Kow Swamp (K.S.1 and 5; Table 20; fig. 26) show a strong recession of the frontal bone. This and the low position of maximum biparietal breadth seems to indicate a link between Sangiran and Solo with the robust Australian group (Kow Swamp, Coobool Creek). These characters of the Australian skulls, however, are probably the result of artificial deformation (Brown, 1981, 1987, 1989, 1992b), lowering their value as taxonomic indicators. Recently, WLH-50 has been described, using skull thickness, as a link between the Middle Pleistocene Javanese hominids and Australia (Thorne & Wolpoff, 1992; Wolpoff, 1992). Possibly the skull thickness of WLH-50 is the result of pathology (Brown, 1992b). The presence of some archaic characters, like a robust and straight supraorbital torus and a sharp angled os occipitale with an occipital torus, are not distinctly present in prehistoric Australians, and are, in this ambiguous form, also present in the prehistoric Chinese skull U.C.1.

This does not exclude the possibility of some characters more frequently being found among Australians than among other groups. This pertains to postorbital constriction, and to one of the superstructures, i.e. the median frontal ridge (Tables 21, 23, 62, and 82). Macintosh & Larnach (1976, p. 124) postulated an interesting explanation for the occurrence of archaic characters, which is certainly worthwhile considering:

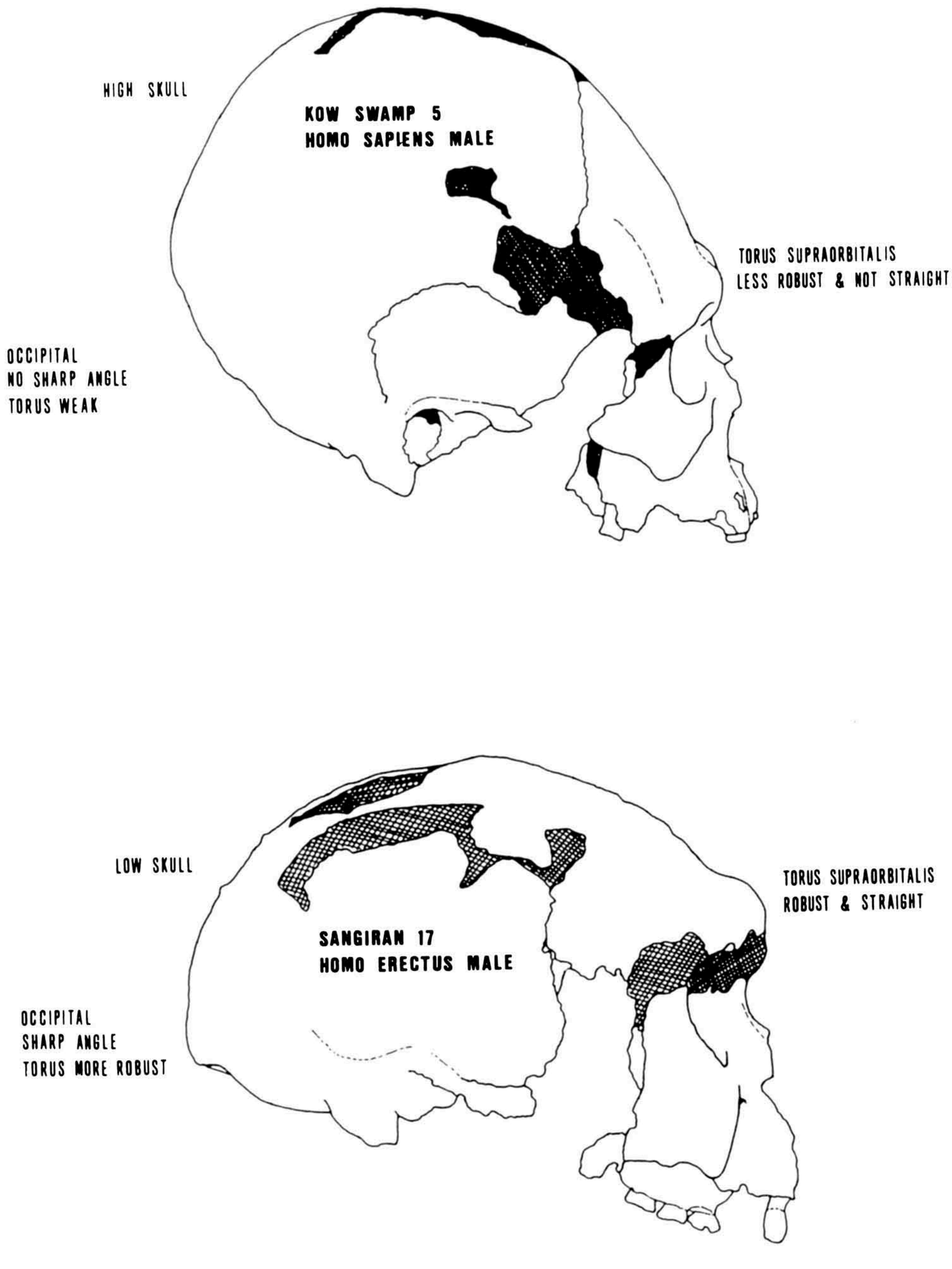

Fig. 26. Sangiran-17 and Kow Swamp-5 (Fig. by Paul Storm). Two species of the genus *Homo* in Australasia. Kow Swamp 5 is a Late Pleistocene/Early Holocene Australian skull, that can be characterized as a robust adult male *Homo sapiens* skull. There are characters in Kow Swamp 5 that are possibly correlated with cultural deformation, like the flat frontal bone. Sangiran 17 is the most complete *Homo erectus* skull from Java, probably male and can possibly be dated in the Middle Pleistocene.

'.....we could postulate the Aboriginal Australians as the earliest examples of evolving generalised modern *H. sapiens sapiens* to arrive in their ultimate area of migration. This hypothesis would also explain why Aboriginal Australians have retained a moderate to higher frequency of *Homo erectus* traits than other modern *sapiens* groups.'

The Wajak-Australian connection

Compared with the previous questions, that of a Wajak-Australian connection is harder to resolve, for we are not dealing with an interspecific connection (i.e. *Homo erectus* and *Homo sapiens*), but with an intraspecific one (i.e. *Homo sapiens*). Thus, as the discussion is on a subspecies level, comparing two single specimens has only a limited value. For instance, both Wajak and Kanalda can be interpreted as robust modern human male skulls which show a mixture of similarities and differences (Table 121). One can, of course, count the number of similarities and differences, but what does that mean in a consideration of a species that shows a large variation and when parallel processes cannot be ruled out? Before the suggested relationship between Wajak and (prehistoric) Australians can be discussed, two questions have to be answered. 1) Is it possible to recognize recent Australian skulls among other recent human skulls? 2) Can recent and prehistoric Australian skulls be considered as belonging to one group? As the Wajak skulls have been diagnosed as males, in the following discussion we will only deal with male skulls.

The recent Australian male skull morphology

Total aspect — The skull is neither particularly large nor small. A remarkable aspect of the masticatory apparatus is that the maxilla can often be classified as large, whereas the mandible is often rather small. The upper (pre)molars are often large.

Neurocranium — Australians appear to be characterized by dolichocrany, acrocrany and distinct phaenozygy. The frontal bone in many skulls is large with strong postorbital constriction, which, in some cases, is very strong. Masculine characters of the frontal bone are frequently found, these include: a strong inclinatio frontale, a marked glabella and superciliary arches, and indistinct frontal tubera. Although not always present, keeling of the vault, the median frontal ridge, and zygomatic trigones, are highly characteristic of Australians. In some skulls a distinct supraorbital torus is present, i.e. one finds a continuous development of the glabella, superciliary arches and zygomatic trigones, bordered by the ophryonic groove and supraglabella fossa before it meets the squama of the frontal bone and on the underside by a very rounded superior border of the orbits. Not only the median frontal ridge can be clearly present but also other superstructures, such as the bregmatic eminence, sagittal ridge, and torus angularis. The mastoid process is variably developed, i.e. ranging from very small to very large. The supramastoid crest is often medium to strongly developed. As to the occipital region, the nuchal lines and occipital crest are often markedly developed, a distinct occipital torus is regularly present, but the external occipital protuberance less so.

Viscerocranium — The Australian face often has quadrangular formed orbits, with a rounded superior border, which is present in many male skulls. Quite striking is the regular presence of a flattened inferior border of the orbits. The cheek bones are often low. The nasal aperture is relatively broad, often with a smooth inferior border. In most cases subnasal prognathism is small or medium developed. There is a rather frequent occurrence of the palatine torus.

Mandible — The mandible often seems to be small due to its small bicondylar breadth, coronoid height and corpus dimensions; yet, its length can frequently be classified as large (sometimes even a retromolar gap can be observed). Because of these dimensions, the mandible is often relatively narrow and low. The other characters of the mandible are in accordance with its small size, and the general appearance is in fact frequently gracile. In many cases there is a small rounded chin with a negative projection, a slightly developed mental trigone, and anterior mandibular incurvature. The lateral prominence is often slightly developed.

Discussion — Without doubt, the Australian male skulls appear to be remarkable. They can repeatedly be clearly distinguished from other recent groups. A few points must, however, be stressed. Australians show a wide cranial variation. In other words, not every skull clearly shows this obvious morphology. The 'idealized' Australian skull, i.e. one which combines all the characters attributed to this group, is rare. Some features are characteristic of this group, but that does not mean that they occur frequently. Many of the features are not exclusive for Australians, but can better be seen as general (robust) characters (see for instance: Klaatsch, 1908; Larnach & Macintosh, 1966, 1970; and the chapter on cranial variation). Obviously prehistoric Late Pleistocene and Holocene male skulls tend to harmonize frequently with the Australian morphology. Consequently, in its morphology any given Late Pleistocene or Holocene prehistoric male skull will probably partly resemble the average Australian male skull. To illustrate this, I applied the test of Larnach & Macintosh (1966) to the well known African Broken Hill specimen; this skull then appeared to be very Australian-like. Many prehistoric specimens from Africa, Europe and Asia will, in fact, score high on that test, simply because they are generally robust. The test works when applied to recent male skulls from Australasia but when used on prehistoric skulls, it has its limitations.

The prehistoric Australian male skull morphology

Neurocranium — Pleistocene Australian skulls show, like the recent Australian skulls, a large frontal bone, surpassing the average MSB of the recent series (Kanalda, Keilor and K.S.1). Furthermore, the striking appearance of the recent Australian frontal bones is also present in prehistoric Australian skulls, i.e.: strong postorbital constriction, distinct phaenozygy, strong inclinatio frontale, marked glabella and superciliary arches, indistinct development of the frontal tubera, keeling, median frontal ridge, and zygomatic trigones. The marked nuchal area with a torus and without the external occipital protuberance is present in Keilor and K.S.5, thus closely resembling the recent morphology.

Viscerocranium — A generally occurring feature in males, like the masculine form of the orbits, is clearly present in the four prehistoric skulls that were examined. There is no sharp inferior border of the nasal aperture, and subnasal prognathism, although small, is present. A reliable estimation of the maxilloalveolar module could only be made of Kanalda which has the largest maxilla of all the skulls examined, even surpassing Wajak-2. The occurrence of some features is variable, like the flattened lower orbital border (ranging from absent to distinct presence). The nasal index ranges, as in recent Australians, from medium to broad. Kanalda and Keilor, for instance, do not possess the characteristic low cheek bones, and Kanalda has a broad palate.

Mandible — Both Kanalda and K.S.5 possess a large mandible, larger than all the examined recent Australians. Neither mandibles are narrow, nor very low. Of the four prehistoric skulls examined, two had a marked sulcus extramolaris and large planum triangulare. A marked lateral prominence is present in K.S.1. Thus, so far, these prehistoric mandibles do not resemble the average recent Australian mandible closely. This is different for the region of the chin. A marked mental trigone or incurvatio mandibulae, or a positive projection of the chin could not be found. Many more prehistoric mandibles will have to be examined, but before this is done, it is interesting to note that such an obvious feature like the small rounded chin in robust males is present in the Late Pleistocene Australians.

Conclusion — The prehistoric skulls from Australia are, like the recent skulls, variable. The overall impression is that they largely resemble the recent skulls. From a morphological point of view, there would be no reason to separate recent and prehistoric Australian skulls.

Size of the Wajak skulls and the question of an Australian affinity

One of Dubois (1922) arguments in favour of a genealogical link between Wajak and Australians was based on size, e.g. the large tooth size and the 'strong' mandible. The large size of Wajak-1, however, is not limited to the masticatory apparatus, but also encompasses the rest of the skull. Wajak-1 has the largest neurocranium of all the skulls examined (Table 71). In this case, size has possibly a limited value in the affinity argument. Firstly, although Papuans and Australians can be classified in one group as based on the morphology of the skull (Tables 115-116), Papuan skulls are smaller with regard to many of the dimensions (Table 114). Compared with Chinese and Javanese, Papuan skulls can possibly be interpreted as small Australian skulls. Secondly, it is obvious that many Chinese, Javanese and Australian prehistoric skulls are larger than the recent skulls from the same regions (Table 118). As far as it was possible to check the modules; the neurocranium, viscerocranium, mandible and upper molars of prehistoric skulls always surpass the average and often the maximum values of recent series from the same region. It seems that, from the Late Pleistocene to modern times, there has been a decrease in skull size in Australasia. Therefore, it is not possible to fruitfully use size as an indication of a special relationship between Wajak and Australians.

Wajak and the Australian morphology

Wajak-1 shows both deviations from and resemblances to recent Australians (Table 111). Leaving aside the size of the masticatory apparatus, which is in this case a bad indicator for affinity, there are indeed a number of characters favouring a relationship of Wajak-1 and recent Australian Aborigines. These include: the low length-height index (Table 60), the protruding occipital bone (Table 64), the broad face (Table 65), the very broad nasal aperture (Table 67), the strong inclinatio frontale (Table 80), the massive glabella (Table 83), the indistinct frontal tubera (Table 86), and the distinct presence of phaenozygy (Table 95).

There are, however, a few problems when interpreting these characters as proof of a special relationship between Wajak and recent Australian Aborigines.

1) Part of these features can be seen as general robust characteristics, as one can expect in prehistoric male skulls from any region. These features include: a strong inclinatio frontale, a massive glabella, indistinct frontal tubera, and phaenozygy.
2) The less frequently occurring but highly characteristic Australian features cannot be found in the Wajak skulls, like the presence of keeling (Table 81), the median frontal ridge (82), the medium to bulbous development of the zygomatic trigones (Table 85), the occipital torus (Table 90), and the flat lower orbital border (Table 94).
3) Some characters present in the Wajak skulls and Australians probably occur generally in Australasia, that is in both prehistoric and recent groups. These characters include: the absence of a sharp inferior border of the nasal aperture (Table 97), the presence of subnasal prognathism (Table 98) and a decline of planum alveolare (Table 104).
4) There are also characters 'denying' a relationship between Wajak and Australians, such as tapeinocrany of Wajak-1 (Table 61), the distinct external occipital protuberance of Wajak-2 (Table 91), the slight development of the nuchal plane of Wajak-1 (Table 92), the high cheek bones of Wajak-1 (Table 43), and the marked lateral prominence of Wajak-2 (Table 107).
5) There are strong resemblances between Wajak and Javanese. The face of Wajak-1 is very Javanese (Mongoloid) like, and the neurocranium of Wajak-1 has a rounded appearance.

In conclusion, the Wajak skulls do show resemblances with the Australians, but these resemblances can hardly be seen as proof of any special genealogical linkage. In fact, there are also characters which are not typically Australian. The resemblances between Wajak and Australians encompass general robust male characteristics. The Wajak skulls have no typical Australian appearance at all, and because Wajak-1 shows strong resemblances with the recent Javanese there is a much more satisfactory explanation for their robust morphology (see next chapter).

The colonisation of Australia

Theories about the human colonisation of Australia can be classified under two groups (Tattersal et al., 1988): those that assume that the large (cranial) variation is explained by two or more migration waves, and those that assume one single migration wave. It seems to be a complicated and difficult task to discuss the origin of the Australian Aborigines within the context of a single thesis. According to Birdsell (1993, p. 23):

'It is pertinent to the issue that an international symposium convened in 1974 in Canberra by R.L. Kirk and A.G. Thorne to discuss 'The Origins of the Australians' (1976) made no real contribution to the topic in spite of the presence of 26 researchers of international stature using a wide variety of techniques and data.'

The Wajak skulls were interpreted as Proto-Australians by Dubois (1922) and have been used for a number of ideas on the origin of the Australians (Weidenreich, 1945a; Jacob, 1967; Wolpoff et al., 1984; Birdsell, 1993). Therefore, it is not possible to avoid the general discussion on the origins of the Australians. The question of the number of migration waves is extremely important for the discussion of the evolutionary significance of the Wajak skulls in relation to the recent cranial morphology of the Australian Aborigines. The first people to reach the Australian continent have been dated around 38 000-40 000 years BP. (Jones, 1992) or even as early as 50 000-60 000 years BP. (Roberts et al., 1990). The human Wajak material has been dated at 6560 ± 140 BP. (Shutler et al., in press). Consequently, those who interpret the Australian record as the result of one major migration wave, automatically exclude Wajak from any significant role regarding the question of the origin of the Australian Aborigines.

The 'Robust and Gracile' theory — According to the 'Robust and Gracile' theory of Thorne (1971, 1972, 1977) there have been two major migration waves into Australia: one population with a robust and another with a more gracile skull morphology. Skulls that would represent the robust group (as based on Wolpoff et al., 1984; Habgood, 1985, 1986) include: Coobool Creek, Cohuna, Cossack, Kow Swamp, Mossgiel, Nitchie, Talgai, and WLH-50. Skulls that would represent the gracile group include: Green Gully, Keilor, Mungo, and Tandou. According to Wolpoff et al. (1984) the present Australian Aborigines are the final result of a dominant migration wave of people from Indonesia (Sangiran, Solo) possessing a robust skull morphology, and a later influx of people from Asia and Southeast Asia (Liujiang and Wajak) possessing a gracile skull morphology.

The 'Trihybrid' theory — One of the best known theories on multiple migrations is the 'Trihybrid' theory of Birdsell (1967, 1993), according to which there have been three migration waves. The first, Negrito or Negritoid, is represented by prehistoric skulls such as Niah (Borneo) and Mungo (Australia). The second, that of the Murrayians, is represented by prehistoric skulls such as Liujiang (China) and Wajak (Java), and in Australia by Keilor and Kow Swamp. The third and last wave is named that of the Carpentarians.

The 'Single Wave' theory — According to this theory, the present Australian Aborigines are the descendants of one major migration wave (from one homeland) and have to be considered as forming a homogeneous population with a large variation (Macintosh & Larnach, 1976; Habgood, 1985, 1986; Brown, 1987, 1989).

Wajak and the 'Gracile Wave'

As we have seen in the foregoing chapter, Wajak and Liujiang can be regarded as prehistoric Asian males and Keilor as a prehistoric Australian male. According to Weidenreich (1945a) Wajak-1 and Keilor are very similar. Later authors (Wolpoff et al., 1984; Wolpoff, 1989) followed and expanded this suggestion by stating that there would be a 'gracile link' between Liujiang (China) via Wajak (Java) to Keilor (Australia), reflecting the effects of gene flow from the North.

The three skulls are indeed remarkably similar (Table 119). On the one hand, Liujiang and Wajak show some characters one could expect in Australians, such as a relatively broad nasal aperture, a strong inclinatio frontale, a marked supraorbital region, absence of the external occipital protuberance, phaenozygy (ambiguous in Liujiang), and a smooth inferior border of the nasal aperture. On the other hand, Keilor lacks some characters which one would expect in Australians, like keeling, a median frontal ridge and bulbous zygomatic trigones. Moreover, Keilor resembles the Asian morphology in having a flat face (Bulbeck, 1981; Wolpoff et al., 1984).

Though these skulls do show similarities, one cannot simply interpret this as proof of a (gracile) genealogical link between ancestral populations from China, Java and Australia. There are various reasons for this admonition.

1) There is some confusion about the robust/gracile status. According to Thorne (1977), Nitchie belongs to the robust group and according to Habgood (1986) to the gracile one.
2) One may question the robust/gracile distinction within Australia. Multivariate analyses have shown that Late Pleistocene and Early Holocene Australian crania can be seen as one group, distinguishable from crania from Asia and Southeast Asia (Habgood, 1985, 1986).
3) Both Liujiang and Wajak are (in their own context) not gracile at all. They can be interpreted as representing robust prehistoric Asian males (see foregoing chapter).
4) The similarity between Liujiang, Wajak and Keilor can partly be explained by the fact that all three can be interpreted as large prehistoric male skulls (see foregoing chapter).
5) Some characters which are said to be characteristic of recent Australian skulls are also frequently found among recent Javanese skulls, such as: the absence of the external occipital protuberance and the sharp inferior border of the nasal aperture and the presence of subnasal prognathism. These characters can therefore hardly be used to point at a special relationship between single prehistoric skulls. They rather show that Asians and Australians are generally related, sharing a common ancestor. If one goes back in time one can expect closer resemblances to be found between the two groups.
6) The recent Australian skulls of the series examined in this thesis show a very wide variation. The Australian skulls that show all the 'highly characteristic features' as, for instance, given by Larnach & Macintosh (1966, 1977) are in the minority. Thus, it is understandable that Keilor lacks some Australian characters.
7) Simply from the dating arrived at, Liujiang and Wajak cannot readily be seen as representing ancestral Asian skulls with a gracile morphology that would later emerge in Australia, as represented by Keilor. Wajak is dated at 6560 ± 140 BP (Shutler et al., in press), and Liujiang is 'probably Holocene in age, and possibly Neolithic age or even later' (Kamminga & Wright, 1988, p. 759), Keilor is dated at 12 000 ± 100 BP (Brown, 1992b).

Wajak and the 'Murrayian Wave'

Birdsell's (1993) second wave of migrants to Australia is represented by modern populations in Southeast Australia (Murray Valley) and in Asia, Japan (Ainu). As prehistoric representatives of his 'Murrayian Wave' Birdsell referred to skeletal remains from Australia (Kow Swamp and Keilor), and from Asia (Liujiang and Wajak).

A comparison of Liujiang, Wajak-1 and Keilor is given in Table 119 and has already been discussed in the preceding part of this chapter. A comparison of both

Wajak skulls with the three skulls from Kow Swamp (K.S.1, K.S.5 and K.S.15) is given in Table 120. Apart from the size, the most striking similarities of the Wajak skulls with the Kow Swamp specimens are: the strong inclinatio frontale, the massive glabella, the indistinct frontal tubera, distinct phaenozygy, and a smooth inferior border of the nasal aperture. Characters suggesting a resemblance to Kow Swamp with recent Australian Aborigines and being less markedly present in the Wajak skulls are (Table 120): the cranial index of K.S.5, the presence of keeling in K.S.5, a trace of the median frontal ridge in K.S.1, the more massively developed superciliary arches, the more marked development of the zygomatic trigones, a trace of an occipital torus in K.S.5, the masculine developed occipital area of K.S.5, the more masculine developed orbits of K.S.15, the distinct presence of a flattened lower orbital border in K.S.5, and a slight development of the chin in K.S.5. Moreover, the three Kow Swamp specimens have a supraorbital torus which is lacking in the Wajak specimens (Table 22). The overall impression is that the Kow Swamp specimens do not have the highly characteristic Javanese face, as found in Wajak-1. In conclusion one could state that the Kow Swamp skulls are much more Australian-like than the Wajak specimens. As many of the characters examined include general robust male characteristics, as were globally present in prehistoric skulls, the similarities that exist between Wajak and Kow Swamp (and Australian Aboriginal skulls in general) can best be attributed to the prehistoric status of the Wajak specimens.

In general it is very hard to interpret the morphology of the Wajak skulls and Liujiang as representing a (Proto) Australian (group), in this case the Murrayians. Besides, previously discussed problems on the use of general, robust, characters, and the wide Australian cranial variation, Keilor and Kow Swamp go back to a later date than Liujiang and Wajak. Furthermore, there is no consensus of opinion on the number of different groups to be found in the prehistoric Australian skulls. Birdsell (1993) places the Kow Swamp specimens in one group together with Keilor, Wajak and Liujiang. Wolpoff et al. (1984) place Kow Swamp in the 'robust group' and Keilor, Wajak and Liujiang in the 'gracile group'. Although the work of Birdsell (1993) is, without doubt, an impressive contribution to the knowledge of Australian Aborigines, he provides no arguments as to why he puts Liujiang, Wajak, Keilor, and Kow Swamp in one group. As far as skull morphology is concerned, it is difficult to find a sound prehistoric basis for his 'Murrayian Wave'.

Wajak and the 'Single Wave'

In general, one cannot easily avoid the impression that Australian Aborigines show a broad cranial variation and that it is difficult to detect well defined groups in Australia. This impression is confirmed by the work of Birdsell (1993, p. 434), who remarked: 'The composite gradients presented in the preceding parts have all revealed a great deal of regional differentiation that shows no particular cohesive patterns.'

Arguments can be brought forward to see the 64 Papuan and 42 recent Australian skulls that were examined as one group with a large variation (Tables 115-116). Notwithstanding the latter, this group shows a cranial morphology that can repeatedly be clearly distinguished from other recent groups, as that found in neighbouring Southeast Asia. This can probably best be interpreted as the result of one dominant wave of immigrants.

Probably from the moment that people for the first time arrived in Australia, more migrations have taken place. This can be deduced from the relatively late arrival of the dingo (Mount Burr: 3230 ± 100 BP; Madura Cave: 3450 ± 95 BP; Fromm's Landing: 3170 ± 90 BP; source: Flood, 1983). In comparison with the first immigrants who were confronted with an empty continent, later immigrants probably had only a very limited effect on the already established gene pool. Late Pleistocene Australian crania are significantly larger than Holocene crania (Brown, 1987, 1992b), which seems to agree with later immigrations. A better explanation, however, seems to be local microevolution, a reduction in the size and robusticity of the cranium and the masticatory apparatus since the Late Pleistocene (Brown, 1987, 1992a-b). This gracilisation trend has been observed in many parts of the world.

The interpretation of the Australian record as the result of one major migration wave, possibly taken place around 38 000-40 000 years BP (for dates see Jones, 1992), or even as early as 50 000-60 000 years BP (for dates see Roberts et al., 1990), automatically excludes the possibility of the Wajak skulls representing the remains of a population that had a significant contribution to the origin of the Australian Aborigines. This statement is not in contradiction with the view that the Wajak skulls lack a convincing prehistoric Australian morphology.

Conclusion

From the cranial morphology one could state that the Middle Pleistocene Solo skulls have to be considered as *Homo erectus*, and the prehistoric Late Pleistocene and Holocene skulls from Indonesia (including Wajak), China and Australia, as described in this thesis, as modern humans (*Homo sapiens*). The trend of the Australian skulls showing a morphology, somewhat closer to the Solo specimens, is too slight to assume a special genealogical linkage. It is more inclined to show that Australians are the descendants of an early generalised *Homo sapiens* group, in which isolation has preserved some of the ancestral characters. As far as this study is concerned: no real, transitional forms are known in Australasia, between the latest *Homo erectus* (Solo) and modern humans.

The relationship between Wajak and the studied (prehistoric) Australians is less clear because we are dealing with a discussion on a subspecies level, i.e. within the species *Homo sapiens*. Both recent and prehistoric Australian skulls can best be interpreted as representing one group, albeit one with a highly variable skull morphology. Although some cranial features are characteristic of this group they are not all exclusive to Australians; many should be seen as general (robust) characters. Therefore, any given Late Pleistocene or early Holocene modern human male skull can show resemblances to Australians, but this cannot be interpreted as proof of a genealogical special link. Also both Wajak skulls show some resemblances to the Australian morphology as they are robust, but they do not show the combination of highly characteristic Australian features. The Australian record can be interpreted as the result of one major Pleistocene migration wave. This excludes the possibility of the (Holocene) Wajak skulls to represent the remains of a population that significantly contributed to the origin of the Australians. As Wajak-1 shows strong resemblances with the recent Javanese, and Wajak-1 and Wajak-2 are interpreted as coming from one group, another explanation has to be found for their (robust) morphology (see next chapter).

Adaptation of the craniofacial complex

Introduction

Generally speaking there are two ways of explaining differences in a particular historical sequence of skulls: migration and local evolution (Howells, 1976). For the Indonesian region, various authors assumed that migration played an important role in the transition from the Mesolithic to the Neolithic period (see for a discussion: Bellwood, 1985). Others considered the possibility of local (micro)evolution (Hooijer, 1950, 1952; Bulbeck, 1981, 1982). Microevolutionary changes (reduction) of the human skull has been reported from many regions of the world (Table 113). Some give an extensive discussion on morphological changes (Carlson & van Gerven, 1979; Armelagos et al., 1984). Various explanations have been offered for their occurrence, such as the development of techno-cultural systems (Frayer, 1977); the development of agriculture (Carlson & van Gerven, 1979; Armelagos et al., 1984; Calcango, 1986); dietary adaptations to an isolated island environment (Spoor & Sondaar, 1986, 1988); and climatic factors (Hooijer, 1950, 1952; Brown, 1987, 1989, 1992). In an attempt to explain the size and morphology of the Wajak skulls, both dietary adaptations and climatic factors have some interesting implications.

The shift from Wajak to recent Javanese skull morphology

On first trying to 'portray' the Javanese cranium, the most characteristic feature of Javanese neurocrania is their rounded contour: hence the frequent occurrence of a brachycranic and hypsicranic form, a flat occipital bone and absence of a strong postorbital constriction. This rounded contour is also due to a frequent lack of superstructures and masculine features of the frontal, parietal and occipital bones. Moreover, Javanese skulls show a trend of retaining juvenile characters, such as the frontal and parietal tubera, which thus add to the impression of the rounded form. The overall form of the viscerocranium is in harmony with this rounded contour. Many Javanese have a very characteristic face, i.e. flat, with prominent high cheek bones, a broad palate, and the presence of subnasal prognathism.

One of the most obvious aspects of the Wajak skulls is their large size. However, if a large size is not really uncommon to prehistoric skulls, the inevitable question then is: what is the relation of Wajak to recent Javanese? Except for the L-H index of Wajak-1, which is outside the range of recent Javanese (Table 60), it is hard to find features of the Wajak skulls that are absent in the recent series (Table 111). Moreover, apart from size, the slight deviations of the Wajak skulls from the average Javanese morphology can possibly partly be explained by greater stress on the masticatory apparatus of the former. The Wajak skulls can be characterized as robust Javanese skulls (robust meaning: being larger and having a more marked supraorbital region; Fig. 27).

If one accepts the idea — based on the size and morphology of the skull, the

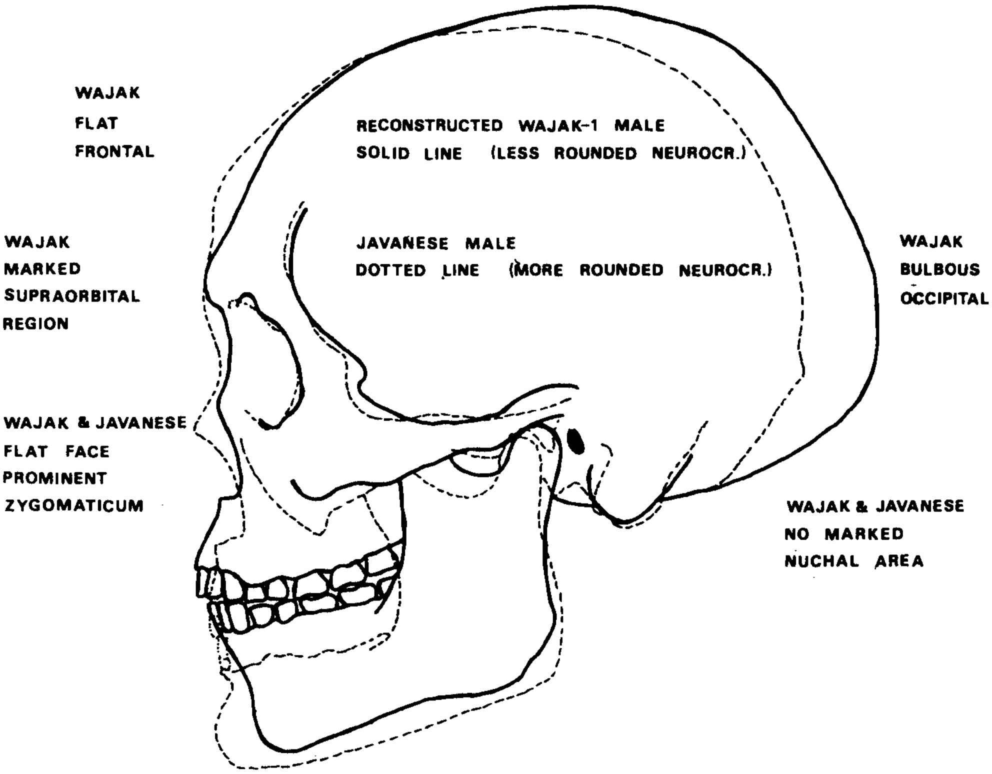

Fig. 27. From Wajak to the recent Javanese (Fig. by Paul Storm). Solid line = Wajak-1; dotted line = Javanese male. The recent Javanese male skull used to make the drawing comes from the AEM, Leiden, the Netherlands (see Fig. 29).

associated finds (fauna and cultural remains), and dates — that the Wajak remains represent an early robust Javanese type, the question arises, what is needed to change the Wajak skull morphology into that of an average Javanese male? One has to keep in mind that robust Javanese males are a recent reality, and can show (strong) resemblances to the Wajak skulls. Concentrating on the most marked deviations, I will attempt to reconstruct what evolutionary processes have taken place in the Javanese skulls in the course of the past 6500 years (Table 111 and Fig. 27).

If one would wish to change the Wajak-1 skull into that of an average Javanese male the most important change would be the decrease in size. The whole skull has to be involved in this reduction, not only the maxilla, mandible and teeth, but the complete neurocranium and viscerocranium (Table 111). The most important change in the shape of the neurocranium is the increase in the height and the occipital bone has to become flatter. Furthermore, the neurocranium has to become broader. The nasal aperture has to decrease in breadth and the glabella in size. Other less profound changes (they occur in recent Javanese males, 13.9%) include: the frontal bone has to become more rounded, the superciliary arches have to decrease in size, the orbits should be more feminine, and the zygomatic arches have to become less laterally projecting. It appears that some of the characteristics of the Javanese, such as the flat face with protruding zygomatic bones, the limited outgrowth of the superstructures, and the retention of juvenile characters were already well established in Wajak-1 (Fig. 27).

Comparing Wajak and the recent Javanese skulls, the observations point possibly to an adaptation by the former to endure more stress on the masticatory apparatus. The maxilla, mandible and teeth of both Wajak skulls are large as compared to recent Javanese. Wajak-1 shows distinct phaenozygy, which indicates a large temporal muscle. Its neurocranium is not as broad as the average recent Javanese. Narrow skulls have an advantage; the temporal muscle works more efficiently because of the larger attachment area and biomechanical advantage for the attachment on the mandible (Bulbeck, 1981). The high zygomatic bones (also present in recent Javanese) of Wajak-1 are possibly ideally built to cope with the stress caused by the masseter muscle. Possibly the morphology of the supraorbital region of the Wajak skulls (the combination of a massive glabella, marked superciliary arches and strong inclinatio frontale) can be explained by Russel's (1985) beam model of the supraorbital region. A more massive supraorbital region is to be expected in skulls with heavily developed masticatory muscles and a strong inclinatio frontale, i.e. to deal with the bending stresses exerted on the frontal bone during mastication.

Dietary adaptations

During the early 1960's archaeological excavations were started in Nubia. Greene et al. (1967) presented a concept that linked modes of food procurement with morphological observations of the teeth of a Mesolithic population from Wadi Halfa, Sudan. According to them the data suggested that these people were confronted with a large amount of grit in their diet. This would have been caused by the eating of vegetable food which was macerated on grinding stones. In the course of time this caused a selection pressure favouring large and/or morphologically complex teeth.

In 1973 van Gerven et al. discussed the diffusionist view on the racial history of Nubia. According to them, human populations were traditionally described as internally static units. Hence, studies normally began with the assumption that two basic types of people had occupied early prehistoric Africa. Deviations from these idealized types were explained by hybridisation. In this way cultural and biological changes in the society were seen as external forces, leaving no room for internal processes. Later on, researchers (Carlson & van Gerven, 1979; Armelagos et al., 1984) continued to stress the limits of this diffusionist view and issued another explanation: diachronic changes in the features of the skull, as observed in Sudanese Nubia, could be explained by local evolution caused by a biocultural adaptation instead of by migration.

According to Carlson & van Gerven (1977, 1979) and Armelagos et al. (1984) differences can be observed in the morphology of the human skull over a 12 000-year period, i.e. from the Mesolithic through the Christian periods in Nubia. The main trigger in their 'masticatory-functional hypothesis' is the cultural change from a Mesolithic, hunting-gathering, way of life with a 'gritty diet' to a Neolithic, agriculture subsistence pattern, with a more carbohydrate diet. Changes in the masticatory function thereby reduced the neuromuscular activity and caused a different pattern of craniofacial growth. This could have been the cause of an evolutionary shift to dental reduction and reorientation of the face and vault. In the course of time, the result was the development of a more 'globular', less robust and less prognathic craniofacial complex.

The parallel between the situations in Africa and Indonesia seems obvious, both for the associated historical concepts of replacement versus local evolution and the observed changes of the craniofacial complex. As in the Nubian case differences between the Indonesian skulls were explained in terms of a new migration wave. Mesolithic robust Austromelanesian populations, as represented by the Wajak skulls, were replaced by later Neolithic populations having a more gracile appearance. According to Bellwood (1985, p. 89) this idea 'has a respectable pedigree, and is still supported by most recent authors'. As a clear example of this opinion a conclusion of von Koenigswald (1952, p. 96) can be quoted:

'It was not before the late Neolithic — the period of the quadrangular axe — that the first Indonesians arrived at their present habitat in southeast Asia, where they replaced a mainly macrodont population of Australomelanesoid affinities, which is well established by skeletal remains (not the teeth alone). The older population then became extinct, viz., was pushed to the east. Dealing with two racially different populations no conclusions can be drawn about 'microevolution in situ with diminution in size' being responsible for the smaller teeth of the present inhabitants of this region, as suggested by Hooijer.'

An explanation in terms of local evolution may be just as satisfactory (Hooijer, 1950, 1952; Bulbeck, 1981, 1982; Storm, 1990b, 1992a/b, 1993). Accepting the local Javanese status of the Wajak skulls, deviations of these prehistoric skulls from the recent Javanese can possibly partly be explained by more stress on the masticatory apparatus. Unfortunately, the number of prehistoric Javanese skulls is limited, but it is interesting that when one compares the Mesolithic Wajak skulls with recent Javanese the emerging trends show resemblances with those observed in Nubia when comparing Mesolithic and historical populations (Table 112). On the one hand, the use of the masticatory-functional hypothesis of Carlson & van Gerven (1979) and Armelagos et al. (1984) is very attractive when one tries to explain the appearance of the Wajak skulls. It not only explains their large dimensions, but also, partly the morphology of these skulls, like the diachronic trend towards a more globular skull and towards a decrease of the glabellar region. On the other hand, we cannot avoid the observed diminution in size in the course of time of many other mammals in the Indonesian region as described by Hooijer (1947, 1948, 1950, 1952).

Climatic adaptations

In 1947 Hooijer remarked that in prehistoric times, in Sumatra, the tapir (*Tapirus*) was larger in size than the recent tapirs, but were indistinguishable in the structure of their teeth. According to him it was not surprising to find that the Pleistocene Chinese tapir jaws were larger than recent ones. A study of the teeth of the orang-utan (*Pongo pygmaeus*) by Hooijer (1948) showed that the prehistoric subspecies *P. p. palaeosumatrensis* and *P. p. weidenreichi* were larger than the recent subspecies *P. p. pygmaeus*. As the older *P. p. weidenreichi* was larger than *P. p. palaeosumatrensis* this agrees with a trend from a larger subspecies towards a smaller one in the course of time. Furthermore, he saw this decreasing trend in many other species like the bear, grey Celebes cuscus, moor macaque, siamang, Meyer's rat, common porcupine, brown palm civet, leopard, tiger, Javanese and Sumatran rhinoceros, babirusa, barking deer, anoa and the water buffalo. Thus, according to Hooijer (1950, 1952), there was a widespread progressive diminution in size in many different mammal species during the Quaternary. He thought therefore that it was not justified to use Wajak Man's large size teeth as evidence that Austromelanesians once came along Java while migrating to the East. His view (op. cit.) was that microevolution in situ with diminution in size of the teeth, parallel to those found in the other mammals, could also explain Wajak's large size teeth. As an explanation Hooijer (1950) remarked that some scientists shared the view that the decrease in size could also be correlated with the warming of the climate since the Pleistocene. In other words, we could see the working of Bergmann's rule in time rather than in space.

If Hooijer's (1950, 1952) suggestion is correct, other parts of the skull would also have to show this decrease in size. If this gracilisation of the human skull is due to dietary changes, then it is to be expected that the changes be limited to the masticatory apparatus and other parts of the skull associated with it; these changes would not be evident in the rest of the skull. From this point of view it seems reasonable to assume that the large size of the Wajak skulls can best be explained by climatic changes as the large size of the Wajak skulls is not limited to the masticatory apparatus but involves the complete skull. Actually, this is probably a very complex problem as changing biomechanical forces can affect more parts of the skull than only those which seem to be directly associated with the process of mastication (see for instance Russel, 1985). Because Hooijer (1950, 1952) uses Bergmann's rule, which encompasses the complete body, to explain differences in size, the best way to test the hypothesis of Hooijer is to include postcranial material. The picture one can reconstruct from the postcranial material of the Wajak site is that of confirming the idea of Hooijer, i.e. considering its local situation it can presumably be described as robust.

Worldwide gracilisation of the modern human skull

Assuming food processing to be a cause for gracilisation, some difficulties arise when applying it on a broad scale. Brown (1987) remarked that reduction in size and in robusticity of the cranial vault and masticatory apparatus occurred in the Australian Aborigines over the last 10 000 years and parallels with that in other parts of the world. He thinks that cultural change and gene flow are unlikely to explain these phenomena because of the geographic isolation of Australia and the relative cultural conservatism since the initial occupation of that continent. Garn (1971) remarked that the human crown teeth size is largest in Australian Aborigines, New Guinea natives, and Pima Indians and smallest in Lapps, African Bushmen, Cochin (India) and Yemenite Jews. In other words, we can find both large and small teeth in populations that have a subsistence pattern based on hunting-gathering. In addition, one may wonder if the change from a hunting-gathering way of life to one based on agriculture could have had a worldwide effect of gracilisation, as if this change is always a one-way direction to softer food, demanding less stress on the masticatory apparatus.

The worldwide gracilisation trend during the Late Pleistocene and the Holocene is probably not limited to the teeth, masticatory apparatus or skull, but encompasses the complete body (Foley, 1991; Brown, 1992a). In other words, diachronic trends of tooth size decrease are possibly linked to an overall reduction of the skeleton. To explain the latter, one could search for a phenomenon that also has a global character. It can for instance be suggested that the stress caused by population increase was the main factor of the worldwide decrease in body size (Stringer, pers. comm. 1994).

What are the advantages and disadvantages for a large mammal to decrease in size, and under what circumstances can reduction be observed? Its advantage is less energy demand for body maintenance. However, there are also disadvantages, such as the increasing vulnerability to predators and a decrease of thermoregulatory efficiency (see Foley, 1991, for an extensive discussion). Due to the high absolute metabolic costs of maintaining a large body, one can say that large mammals decrease in size once they are able to cope with the disadvantages of being smaller. Good examples of this are large mammals, like elephants in an island environment (in the absence of predators) which become much smaller than the elephants on the mainland.

It can be hypothesised (Fig. 28) that because of a population increase, technological innovations, and rising temperatures since the Late Pleistocene different aspects of human life changed, which 'permitted' an overall decrease in body size. For instance, a relaxation of predation generated by a better defence system, decrease of the home range and mobility (this resulted in many cases in settlements), and a more stable food procurement (resulting recurrently in the domestication of plants and animals). Both diffusion and gene flow caused most populations to be affected, including those who were less involved in these changes. The result was that in many parts of the world the average body size of humans decreased.

Conclusion

Besides resemblances between the skulls of Wajak and those of recent Javanese males, there are also differences. Part of these, including the large size of the masticatory apparatus and morphological aspects of the skull, can possibly be attributed to more stress on the masticatory apparatus of the Wajak skulls. Reduction (gracilisation) of the teeth, (parts of) the human skull, since the Late Pleistocene, have been reported from various parts of the world: Europe, Africa, and Australia. Hence, there seems to be nothing special about the Wajak skulls; they are simply large, robust, Mesolithic Javanese skulls. It is attractive to seek the explanation for the large size and morphology of the Wajak skulls in dietary adaptations. As the large size is not limited to the teeth and masticatory apparatus, but also encompasses the complete skull, and possibly even the postcranial skeleton as well, another explanation, like rising global temperatures, may be just as satisfactory. Because of the metabolic costs of maintaining a large body, in general mammals conceivably decrease in size under ecological conditions where they are able to cope with the disadvantages of a smaller size. Technological innovations and rising global temperatures, since the Late Pleistocene, possibly caused such conditions. Both diffusion and gene flow may explain why most populations were affected by this decrease in size of the human body.

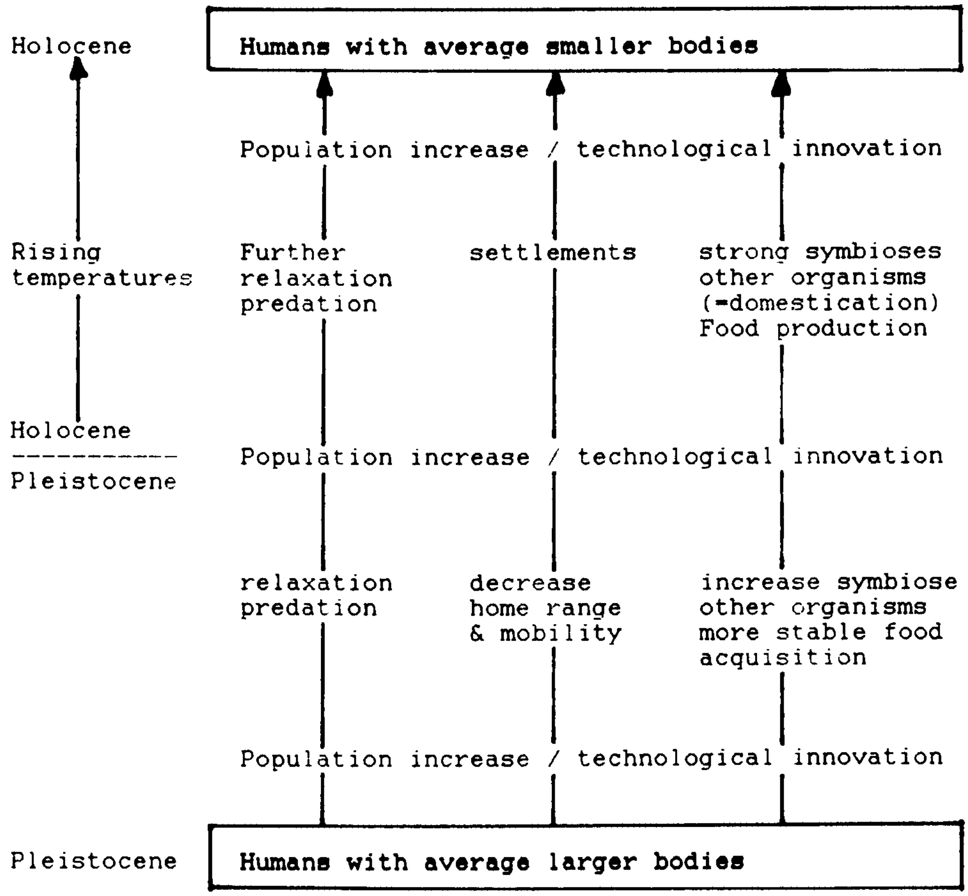

Fig. 28. The Relaxation Hypothesis.

Evolution of hominids in Australasia

Introduction

In Australasia cranial variation within the genus *Homo* can readily be observed. Studies attempting to explain this variation are, however, hampered by the history of the region (Jacob, 1967). This is probably typified by both migrations and local (micro)evolution which are often interwoven and difficult to disentangle. To complicate the problem, genetic changes can become dispersed by gene flow, without people actually migrating. Nevertheless, in this chapter I will try to assess the place of Wajak Man in the evolution of modern humans (*Homo sapiens*) in Australasia.

The emergence of the genus *Homo*

Recently, claims have been made for the presence of hominids (Mojokerto and

Sangiran) in Java as early as 1.81 ± 0.04 and 1.66 ± 0.04 Ma BP (Swisher et al., 1994). As long as there is confusion about the correlation between the fossils and the pumice dated (de Vos, in press) there is no firm basis on which to assume that *Homo erectus* was present in Java before 1.2 Ma BP. *Homo erectus* emerged in Indonesia (Table 5: Trinil H.K.) probably after 1.2 Ma BP as an element of the archaic mainland fauna (Sondaar, 1984) which is interpreted as having been an open woodland fauna (de Vos, 1983, 1985). An earlier date for its presence is less likely because the preceding fauna complexes were typical island faunas and accordingly poor in species diversification. *Homo erectus* can be found (roughly during a period of some 1 Ma) only on the Sunda side, never having reached the Sahul side. Because of its long presence in the region, one can expect evolutionary trends to have occurred within the species. The later Solo (Ngandong) form (*Homo erectus soloensis*) probably evolved from the earlier (Trinil, Sangiran) form (*Homo erectus erectus*). Although the critical period, roughly between 200 000 and 60 000 BP, remains obscure, two arguments can be brought forward for the break between this species and the new migrant *Homo sapiens*. The morphology of the two types of skulls is very different (Tables 20-23) and this agrees with the information of the fauna complexes. Many of the archaic Ngandong mammalian species disappeared and were replaced by modern species (de Vos et al., 1993).

An early form of *Homo sapiens* possibly emerged in Indonesia between 100 000 and 60 000 BP., as an element of the modern mainland fauna of Punung, which is interpreted as a humid forest fauna (de Vos, 1983, 1985; Table 5). The human material is, however, very poor ('two upper incisors, an upper canine and a lower canine' and possibly an upper molar; Badoux, 1959, p. 124), and the date of this fauna remains uncertain, but it is probably older than the Wajak and younger than the Ngandong fauna (de Vos, 1983, 1985). This date would not contradict an early date of human settlement in Australia (based on archaeological finds: Roberts et al., 1990; Jones, 1992), that is, if the early humans entered Australia via the Indonesian archipelago. It is, however, possible that early humans entered Australia via the Philippines and, combined with the uncertainty about the Punung fauna, this leaves the possibility open that there has been a tropical rainforest phase in Indonesia without hominids. A hominoid scenario in Java would thus have been as follows:

Open woodland ———>	Humid forest ———>	Open woodland
Archaic Ngandong	Modern Punung	Modern Wajak
Homo erectus	*Pongo pygmaeus*	*Homo sapiens*

Homo erectus, evolved and adapted to more open environments in the African grasslands was only present in Java (in the period between 1 000 000 and 200 000 BP) in open woodland faunas (Trinil H.K., Kedung Brubus and Ngandong, respectively). Between 200 000 and 60 000 BP the complete open woodland fauna was replaced by a humid forest fauna, and *Homo erectus*, like many other mammals, became extinct, and rain forest species such as *Pongo pygmaeus* moved in. Later on, in the Late Pleistocene period, when the climate in Java became drier, the Punung fauna was not replaced, but typical highly adapted rain forest species like *Pongo pygmaeus* found their niche being reduced. From this point of view the Wajak fauna can be seen as an impoverished Punung fauna. The ecological situation became more attractive for *Homo sapiens* and this species entered the region very 'delayed' in the Late Pleistocene.

Two morphological types of *Homo sapiens*

Neoteny — Considering cranial morphology in recent *Homo sapiens*, it seems that there are two main groups in Australasia (Tables 115-116; Fig. 29): looking at the geographical map of the region, one group west of the Wallace line (one could refer to this group as the *Sunda type*; Chinese and Javanese) and one east of the Weber line (one could refer to this group as the *Sahul type*; Papuans and Australians). The process of neoteny may have been an important determinant of the skull morphology of the Sunda type (Tables 115-117; Fig. 29). Compared with the Sahul type, the Sunda type has a: 1) more rounded skull; 2) flat face with high zygomatic bones; 3) limited outgrowth of superstructures; 4) stronger retention of juvenile characters. Therefore, it is not surprising that Larnach & Macintosh (1966, p. 82) remarked on the most characteristic traits of the New South Wales coastal Aboriginal crania: 'The most characteristic features of the skull are usually more marked in the male than in the female, and it is the male which is used here for comparison with other racial groups.'

From a worldwide point of view, human female skulls show less variability than males, as females tend to retain juvenile characters more. Because of the stronger differences between male skulls, one can more readily distinguish male than female skulls. Sunda male skulls resemble female skulls more closely than Sahul males do. The irony is that from the point of view of neoteny, Dubois was partly right in his interpretation that Wajak-1 resembled a female Australian; he only missed the point that most Javanese males do so too (Table 18).

Difficulties in distinguishing the two types — At what geographical location can one expect difficulties in distinguishing the two types? Firstly, the most likely one would be near the Wallace and Weber line, because even though gene exchange between Sunda and Sahul has probably been limited, it has most likely occurred among populations in this area. Secondly, within groups that have been isolated from the rest of the populations for some time. The morphology of the Papua skull can possibly be explained by these two factors. It is a Sahul type skull, but the features used to characterize this type are less pronounced in Papuans than in Australians (Table 116), such as the glabella and superciliary arches, the indistinct development of the frontal and parietal tubera, the occipital torus, the angular form of the orbits, and the palatine torus. In Papuan skulls superstructures are less markedly developed and they retain juvenile characters more strongly than Australians. In other words, compared with Australian skulls, Papuan skulls are not only smaller (Table 114), but they are also more similar to the Sunda type. This can be explained by ecological pressures, i.e. adaptations to the local situation, and the fact that Papuans have been more affected by gene flow from Sunda than Australians have been. According to Jacob (1967), Liang Momer-E has its closest affinity with the 'Austromelanesians'. This skull is difficult to classify, probably because of its geographical situation, i.e. between the Wallace and Weber line.

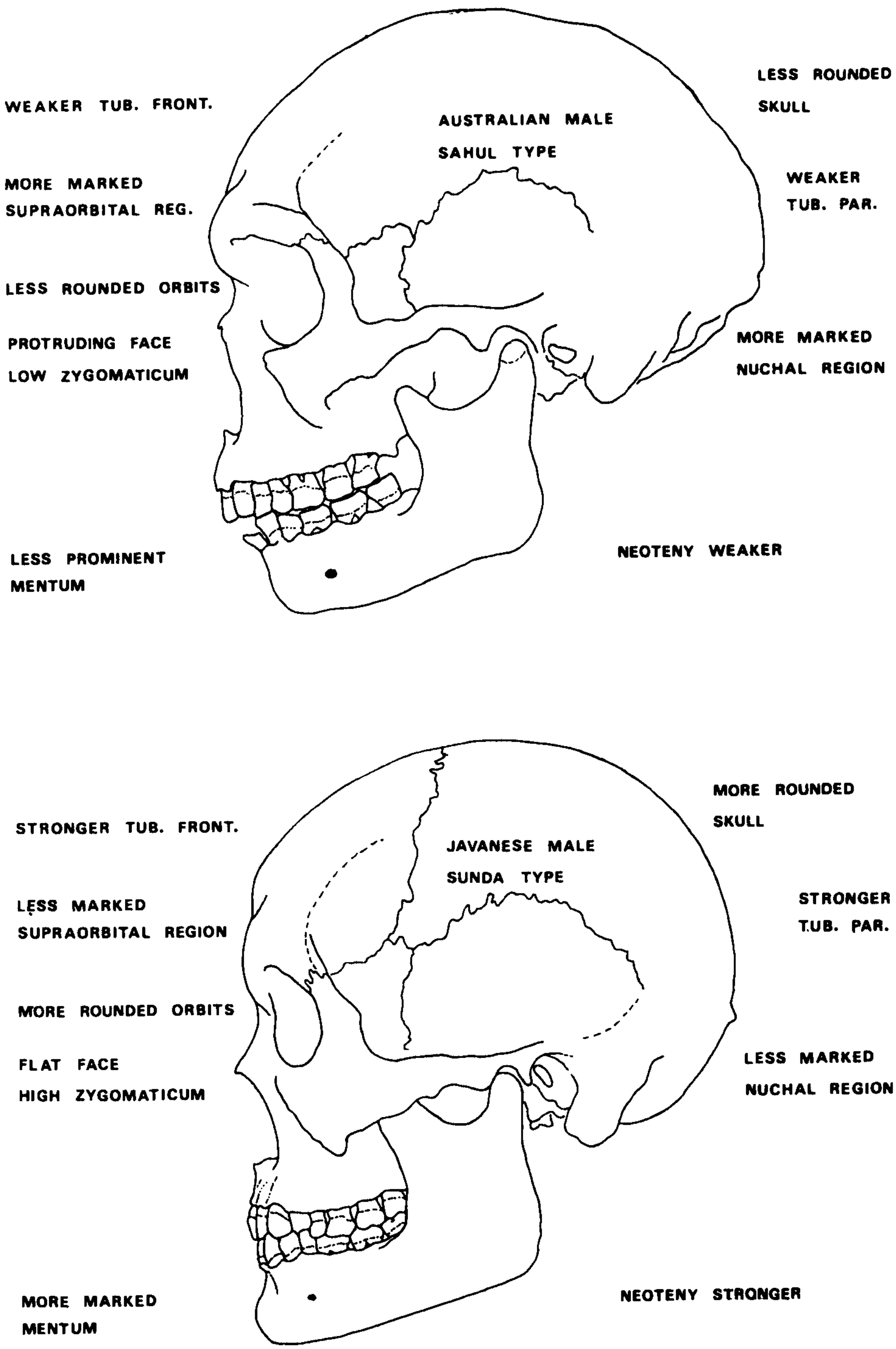

Fig. 29. Two morphological types of *Homo sapiens* (Fig. by Paul Storm). Both skulls used to make the drawing come from the AEM, Leiden, the Netherlands (see also Tables 115-117).

The evolution of *Homo sapiens* in Australasia

Generalised early Homo sapiens — The knowledge about early *Homo sapiens* in Australasia, i.e. those dated between 100 000 and 30 000, is extremely limited (Fig. 30). Because of the presence of human remains in the Javanese Punung fauna (Badoux, 1959; de Vos, 1983); dated around 80 000 BP (Table 5), and archaeological remains in Australia, dated between 60 000 and 38 000 BP) (Roberts et al., 1990; Jones, 1992), we may assume that humans have been present since about 70 000 BP. Unfortunately, their cranial morphology is unknown. Probably it was not very different from that found in the early *Homo sapiens* remains from the Middle East sites, like Skhûl and Quafzeh. Skhûl is dated at 101 000 and Quafzeh at 100 000 years BP (Stringer & Gamble, 1993). A male skull like Skhûl-5, can easily be thought to have evolved via the male skull Predmosti-3 (showing a generalised European morphology) into the recent male Europeans (Predmosti is dated about 26 000 years ago; Stringer & Gamble, 1993). Similarly, the morphology of U.C.1 (with a probable date between 24 000 and 34 000 BP; source, Hedges et al., 1992) can be interpreted as generalised *Homo sapiens*. In other words, roughly between 100 000 and 20 000 BP we find *Homo sapiens* populations with a generalised morphology scattered throughout the world, i.e. in areas such as the Middle East, Europe and Asia. It is quite possible that these populations were also present c. 70 000 BP in Southeast Asia because of their presence in Australia c. 30 000 BP.

From early Homo sapiens to the Sahul type — In view of the low sea levels about 50 000 BP. (Chappell, 1976) it is likely that the first migrants reached Australia at about that time (Fig. 30). The cranial morphology of prehistoric and recent Australians and recent Papuans can be interpreted as reflecting one group possessing a large variation; especially continental Australians show a generalised morphology (see chapter on Solo-Wajak-Australian connection?). This means that many Australians show cranial traits that are also found in Pleistocene early generalised *Homo sapiens* skulls. This retention of cranial traits has also been noticed by others (Macintosh & Larnach, 1976; Lahr, 1992; Stringer, 1992a). Lahr (1992, p. 255) for instance remarks: 'The Australian differences relate almost completely to the retention of primitive features, associated to the maintenance of a large dentition, prognathic faces and small cranium.'

I think that prehistoric Australians, like the skulls examined in this thesis (Mungo, Keilor, Kow Swamp) and others can be considered as having belonged to a population with a generalised *Homo sapiens* cranial morphology that gradually evolved into the recent Australian populations, with limited alteration (in Fig. 30 referred to as the Sahul type). This does not mean that generalised *Homo sapiens* is identical to the Sahul type; one may assume that changes have occurred. For instance, a decrease in size has occurred in Australia (Brown, 1987, 1992a/b). As the sea levels rose regions like Papua New Guinea became isolated from Australia. Probably because of a combination of local adaptation and a stronger influence from the Indonesian region the (smaller) population of Papua New Guinea started to deviate from the Aborigines of Australia. Similarly, one may expect that Tasmanians have adapted to local environments, though they can still be considered as Australians (for a discussion on this, see Pardoe, 1991).

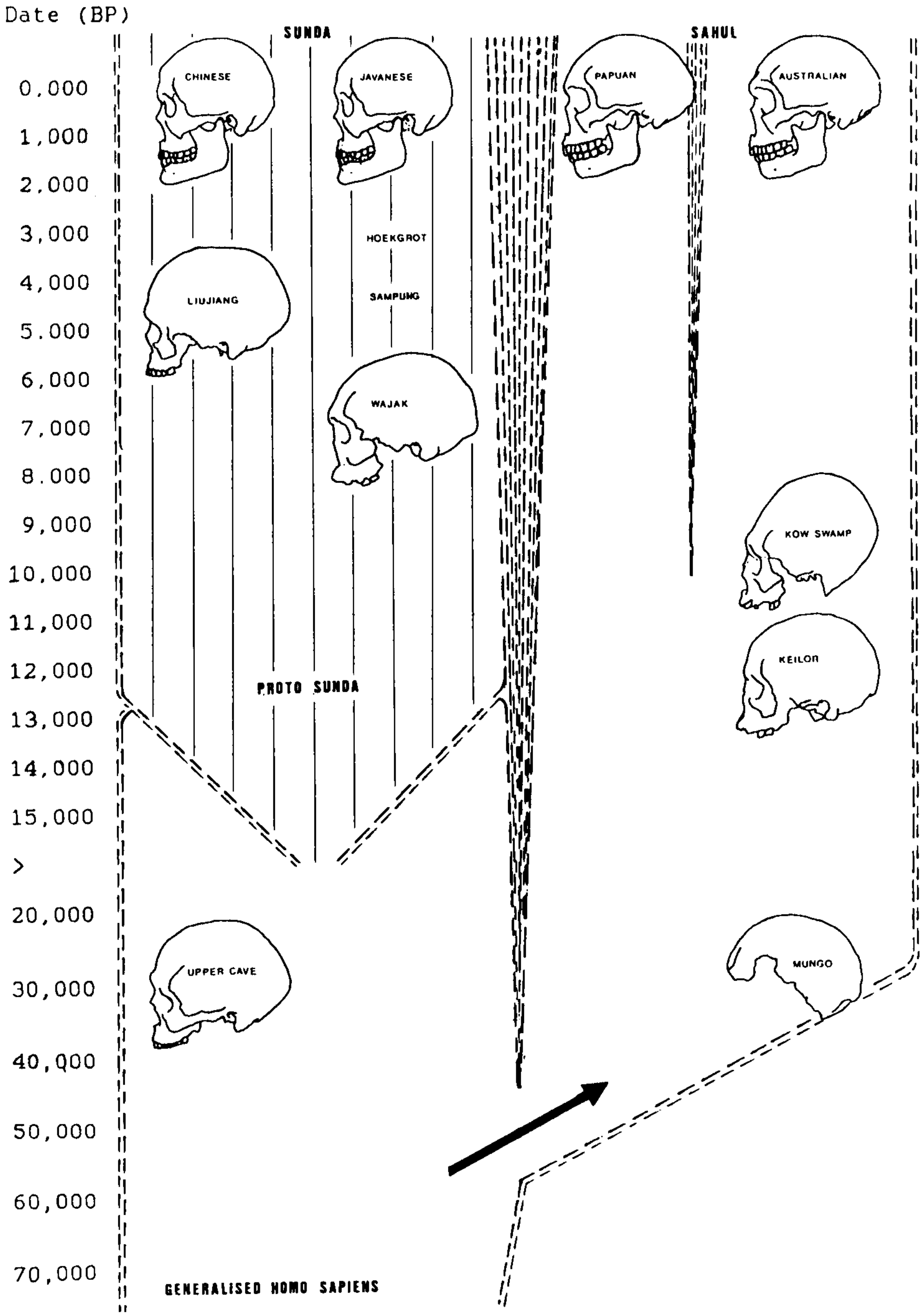

Fig. 30. The evolution of *Homo sapiens* in Australasia (Fig. by Paul Storm).

From early Homo sapiens to the Sunda type — Our knowledge of the early humans in Indonesia from the period between 70 000 and 10 000 BP is very scanty (Fig. 30). Apart from the Wajak remains, the only hominid remains which have been claimed as having originated from this period are the Niah skull remains from Borneo. The Wajak remains are probably much younger (Table 8), and the 40 000 years claimed for Niah (Brothwell, 1960) is uncertain (Tattersal et al., 1988). Besides, the Niah skull has been interpreted as having belonged to a young individual, with unknown sex and it shows postmortem damage (Brothwell, 1960), which makes studies of its affinity very difficult.

According to this study, and in agreement with Kamminga & Wright (1988), Stringer (1990) and Wright (1992), Upper Cave 1, although found in Asia, cannot be interpreted as a Chinese (Mongoloid) type (in Fig. 30 this type is named: Sunda). The Upper Cave remains are probably between 24 000 and 34 000 BP (Hedges et al., 1992) and possibly represent one of the latest groups of humans in Asia showing a generalised *Homo sapiens* cranial morphology. Between about 20 000 and 12 000 BP this morphology disappeared in Asia and another type emerged. The cranium became more rounded, the face flatter with higher zygomatic bones, the superstructures became less marked and the retention of juvenile characters stronger. Sexual dimorphism reduced, i.e. males started to show more similarities in their skull morphology to the females. These skulls were still quite large, however, and maintained remnants of the superstructures, like the supraorbital region, which still provides them a robust appearance. They have therefore been named Proto-Sunda types. Wajak-1 and Liujiang possibly represent the earliest clear examples of this type.

In general there are two striking aspects in the emergence of this type. Firstly, as far as can be interpreted, its development has probably been relatively fast. Secondly, known as the 'Mongoloid' or 'Asian', this type shows at present a very wide distribution (according to Garn, 1971, encompassing continental Asia, Japan, Taiwan, Philippines, Indonesia, Sumatra, Borneo, and Java); in fact little is left in Asia of the generalised *Homo sapiens* morphology. It is therefore assumed that in Asia a bottleneck must have occurred some time during the Late Pleistocene or even later in the Early Holocene. Microevolution did not cease, but a continuing neotenic trend and decrease in size produced the recent Sunda populations, which closely resemble each other, like the Chinese and the Javanese. Considering male skulls, one can observe an example of such a gracilisation trend from Wajak via Sampung to the recent Javanese.

Conclusion

In this chapter I have proposed a hypothesis on the evolution of *Homo sapiens* in Australasia (Fig. 30). As far as the fossil record can be interpreted at this moment, there have been two species within the genus *Homo* in Australasia: *H. erectus* and *H. sapiens*. The cranial morphology of the hominid species and fauna complexes suggest that *H. sapiens* was a new migrant in this region; a common ancestor at around 70 000 BP., possessing a generalised *H. sapiens* cranial morphology. On the Sahul side this generalised cranial pattern seems to have been quite stable. Consequently, prehistoric (Keilor, Kow Swamp and Mungo) and recent Australians, and to a lesser extent recent Papuans, show resemblances to this generalized pattern. In Pleistocene Asia this generalised pattern is represented, for instance, by the U.C.1 skull. On the Sunda side, some time in the Late Pleistocene or the Early Holocene, this generalized cranial pattern disappeared and became replaced by the Proto-Sunda type. ('Proto' in this context meaning more robust than in the recent Sunda type). Wajak-1 and Liujiang possibly represent the earliest, clear examples of this Proto-Sunda type. Because of its relatively fast emergence and its recent broad distribution, while there is little left of the generalised pattern, the Proto-Sunda type may be the result of a so-called bottleneck. Continuation of neoteny and gracilisation trends (for instance, in Java, from Wajak via Sampung to the recent Javanese) produced the recent Sunda type. As a result of these different courses of evolution in Sunda and Sahul, one can today clearly recognize two main types in *H. sapiens*: a Sunda type (in China and Java) and a Sahul type (in Papua New Guinea and Australia). Deviations from these two main types can be explained by an increase of gene flow (entering the Wallace and Weber line) and/or by local adaptation (isolated islands).

Concluding remarks

The questions surrounding the origin of *Homo sapiens* have recently raised renewed interest. Since 1984, several volumes have been dedicated to the topic (e.g., Smith & Spencer, 1984; Mellars & Stringer, 1989; Trinkaus, 1989; Bräuer & Smith, 1992; Lewin, 1993). The discussions on our origin as a species largely focus on the question: continuity or replacement? Accordingly, hypotheses appear to fall into two competing groups. 1) Those emphasizing replacement, defended by scientists from two scientific quarters, i.e. palaeoanthropology (Bräuer, 1984, 1989, 1992; Stringer & Andrews, 1988; Stringer, 1992b) and genetics (Rouhani, 1989; Cann, 1992). 2) Those emphasizing continuity (Wolpoff et al., 1984; Frayer, 1992; Smith, 1992; Thorne & Wolpoff, 1992; Wolpoff, 1989, 1992). In its extreme interpretation, the first model proposes that all modern humans derived from a single common ancestral population that replaced all other archaic hominid populations in other regions ('Single Origin Model' or 'Noah's Ark Model'). As scientists recently favour Africa as the cradle of our species it is also known as the 'Out of Africa Model'. The second model proposes that modern humans evolved locally in different parts of the world from dissimilar archaic ancestors ('Multiregional Evolution' or 'Local Continuity' model).

The two Javanese Wajak skulls have played an important role in the development of the 'Multiregional Evolution' model. According to some scientists there is a continuous lineage leading from *Pithecanthropus* via Solo and Wajak to the recent Australians (Weidenreich, 1945a/b; Coon, 1963). Other scientists suggested, later, a gracile link between Liujiang (China) via Wajak (Java) to Keilor (Australia), reflecting the effects of gene flow from the North (Wolpoff et al., 1984). The present study suggests that the evolutionary significance of the Wajak skulls can no longer be seen in terms of a Late Pleistocene transitional form between the Middle Pleistocene Solo skulls and recent Australian Aborigines, nor can they be seen as proof of a gracile link between Chinese and Australian populations. Rather, the significance of these skulls is that they give some insight into microevolutionary processes that have taken place on Java itself. The most likely interpretation is to consider the Wajak skulls as Mesolithic robust representatives of the present inhabitants of Java. This is no final conclusion but only a starting point from which much more future research should be initiated. Information on the Mesolithic/Neolithic biocultural context and prehistoric Javanese people is scarce, but this gap in our knowledge can be filled. It is still possible to further excavate the Wajak site (Aziz & de Vos, 1989) and it is highly probable that a lot more Late Pleistocene, Mesolithic and Neolithic Javanese sites are 'waiting' for excavation. Giving further thought to the origin and evolution of the Asian people, it would be very exciting to search for more (and older) Indonesian sites, than only Wajak, Hoekgrot, Kecil, Jimbe, Sampung, etc.

According to the hypothesis presented in the previous chapter there are two species within the genus *Homo* in Australasia: *Homo erectus* and *Homo sapiens*. Within *Homo sapiens* one can recognize in Australasia two main types: a Sunda type (Chinese and Javanese) with strong neotenic trends, and a Sahul type (Papuans and Australians) which is closer to a generalised *Homo sapiens* morphology. Wajak-1 and Liujiang possibly represent the earliest clear examples of the Proto-Sunda type (proto meaning more robust). Hence, they are from this point of view, very important skulls when trying to understand the origin of the Sunda (Asian) people. This hypothesis, which is constructed around the Wajak skulls, must be tested against many more recent and prehistoric skulls. For instance, the question of the origin and evolution of the Polynesians, Melanesians, Tasmanians, and Negritos needs further attention. Future research could also be concentrated on what is happening along the Wallace and Weber line and on what the effects would be on human populations in relatively isolated circumstances on small islands.

Considering van Vark's (1994) suggestion that: 'There are three major approaches to the study of hominid morphological affinities, viz., visual comparison, cladistic analysis, and mathematical multivariate statistical analyses, all of which have limitations of their own.', it is clear that, as far as skull morphology is concerned, the research reported in this thesis can be classified as belonging to van Vark's first category of 'visual comparison'. This is certainly not without reason, as besides providing a biocultural context, a morphological description and visual comparison of the Wajak remains were so far lacking. Every more or less complete prehistoric specimen primarily deserves an extensive description and visual comparison with recent and prehistoric skulls. When considering the phylogenetic position of a fossil skull, one needs a basis in the first place, one has to consider aspects such as postmortem damage, age, sexual dimorphism, pathology, and trauma. Moreover, it is possible that there are underlying factors and mechanisms affecting different regions of the skull, both metrical and non-metrical, such as gracilisation trends. Therefore, visual comparison is still a very strong and useful tool, and cannot be replaced by more 'sophisticated' approaches. In this thesis I have tried to provide a morphological basis of the Wajak remains as a fundamental work. It is hoped that in the future also other approaches will be applied to this and other material from Southeast Asia, like dental morphological comparisons (Turner, 1992), size-standardization techniques (Stringer, 1992), and multivariate statistical analyses. Furthermore, in order to have meaningful comparisons and discussions, a standardized notion of cranial traits is a basic need. From this point of view the morphological scoring procedures of Lahr (1992) are very useful, and it would be very interesting to include her methods in future research in order to expand regional comparisons.

Various explanations have been proposed for the worldwide occurrence of the gracilisation of the human skull, since the Late Pleistocene, like the development of agriculture (Carlson & van Gerven, 1979; Armelagos et al., 1984; Calcango, 1986) and climatic changes (Hooijer, 1950, 1952; Brown, 1987, 1989, 1992). It is attractive to seek an explanation for the robust morphology of the Wajak skulls in dietary adaptations, however, because their large size is not limited to the masticatory apparatus but encompasses the complete skull, and possibly even the whole skeleton, another explanation may work as well. To explain the worldwide decrease of the human body one could seek for a phenomenon that also has a global character. I hypothesise that because of population increase, technological innovations and rising temperatures, since the Late Pleistocene, various aspects of human life changed (like relaxation of predation, decrease of home range and mobility and increasing symbiosis with other organisms), which enabled an overall decrease in body size. Because of the marked cranial variation in Australasia this region is very attractive for research into the underlying mechanisms and factors responsible for such microevolutionary changes. The better we understand these mechanisms and factors, the better are we able to construct more reliable phylogenetic trees. The Holocene age for Wajak does not remove it from playing a role in Southeast Asian hominid evolution. I think they provide insight into the rate and kind of evolutionary changes of the Sunda (Asian) skull. An improved understanding of sexual dimorphism, cranial and postcranial adaptations and the role of neoteny in recent hominid evolution could be important in understanding the emergence of our species.

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While the origin of *Homo sapiens* was hotly debated in the eighties, the two Wajak skulls were safely stored in their safe: 'untouched'. During those days (1986) I was, as a student, looking for a palaeoanthropological subject, but in The Netherlands working on palaeoanthropology seemed to be impossible. At the same time, for Dr John de Vos (Nationaal Natuurhistorisch Museum, Leiden) the picture of Wajak Man appeared obscure, therefore he thought that something had to be done, not only with the Wajak skulls, but also with the other material excavated by Dubois in the previous century. Arno van Berge Henegouwen (Museon, The Hague) was so keen to bring John and me together. I am very grateful to John, that he gave me the opportunity to work on the 'Wajak problem', and for his constant generous support, help and advices during those years.

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Tables

Table 1. Prehistoric skulls studied.

		Abbreviation	Museum	N
INDONESIA				
Java Middle Pleistocene				
Solo-1,-3,-4,-5,-6	R		NNM	5
Solo-9,-10,-11	R		UMU	3
Java Holocene				
Wajak-1,-2	O		NNM	2
Hoekgrot	O		NNM	1
Gua Kecil	O	G. Kecil	NNM	1
Gua Jimbe	O	G. Jimbe	NNM	1
Sampung-H	O	Sampung	NNM	1
Malasia Holocene				
Gua Kepah B347,C77	O	G.K.B347,-C77	NNM	2
Flores Holocene				
Aimere	O		NNM	1
Gua Alo-1,-2	O	Alo.1,-2	NNM	2
Liang Momer-E	O	L.M.E	NNM	1
Liang Toge	O	L.T.	NNM	1
CHINA				
Liujiang	R	Liuj.	NHM	1
Upper Cave-1,-2,-3	R	U.C.1,-2,-3	NHM	3
AUSTRALIA				
Kanalda	O		NHM	1
Keilor	R		NHM	1
Kow Swamp-1,-5,-15	R	K.S.1,-5,-15	NHM	3
Mungo-1,-3	R		NHM	2
TOTAL				32

N = number; O = original; R = replica; NHM = Natural History Museum, London; NNM = Nationaal Natuurhistorisch Museum, Leiden; UMU = Universiteits Museum, Utrecht.

Table 2. Number of recent skulls studied from the various institutions.

	AEM	NHM	C/S	UMU	Total
China	63*	—	—	—	63
Java	89**	—	16	—	105
Papua N.G.	—	—	64	—	64
Australia	3	35	1	3#	42

* = Chinese 'Koelies', probably all male skulls; ** = sex known (80 males, 9 females); # = replicas.
AEM= Anatomical Embryological Museum, Leiden Univ.
NHM= Natural History Museum, London, U.K.
C/S= CA/SNWS, Cultural Anthropol. and Sociol. of Non-Western Societies, Leiden Univ.
UMU = Universiteits Museum, Utrecht.

Table 3. The measurements (right side is used, if not possible the left side).

Measurements (see Tables 24-58)	Abbr.	Def.	Instr.
24. glabella-occipital length	GOL	How.	SP
25. basion-bregma height	BBH	How.	SP
26. maximum cranial breadth	XCB	How.	SP
27. frontal chord	FRC	How.	SP
28. parietal chord	PAC	How.	SP
29. parietal arch	S2	Brt.	TA
30. occipital chord	OCC	How.	SP
31. occipital arch	S3	Brt.	TA
32. max. supraorbital breadth	MSB*	L&M.	SP
33. min. postorbital diameter	MPD*	L&M.	SP
34. basion-nasion length	BNL	How.	SP
35. basion-prosthion length	BPL	How.	SP
36. nasion-prosthion height	NPH	How.	SL
37. bizygomatic breadth	ZYB	How.	SP
38. width fronto-nasal artic.	FNA	-	SL
39. nasal height	NLH	How.	SL
40. nasal breadth	NLB	How.	SL
41. maxilloalveolar length	MAL*	L&M.Bass	SP
42. maxilloalveolar breadth	MAB	How.L&M.	SP
43. cheek height	WMH	How.	SL
44. mandibular length	ML	Brt.	OB
45. bi-condylar breadth	W1	Brt.	SL
46. coronoid height	CrH	Brt.	OB
47. corpus height	CHe*	Brw.	SL
48. corpus thickness	CTh*	Brw.	SL
49. symphysis height	SHe*	Brw.	SL
50. symphysis thickness	STh*	Brw.	SL
51. ramus breadth	RB'	Brt.	SL
52. total length from P3 to M3	P3-M3	-	SL
53. mesiodistal length of M1	M1 MD	-	SL
54. buccolingual breadth of M1	M1 BL	-	SL
55. mesiodistal length of M2	M2 MD	-	SL
56. buccolingual breadth of M2	M2 BL	-	SL
57. mesiodistal length of M3	M3 MD	-	SL
58. buccolingual breadth of M3	M3 BL	-	SL

* = abbreviation used, not from the author mentioned under definition.
Definition according to:
L&M. = Larnach & Macintosh, 1966/1970
How. = Howells, 1973
Brt. = Brothwell, 1981
Bass = Bass, 1987
Brw. = Brown, 1989
Instruments used:
SL = sliding/dial calliper (Helios & Mitutoyo)
SP = spreading calliper (GPM)
OB = osteometric board (self made)
TA = tape

Table 4. Mammals from Holocene Javanese sites. Except for the site Sampung, which has been excavated by van Stein Callenfels in the period 1928-1930, all sites have been excavated by Dubois in 1890. Determination of the faunas which have been excavated by Dubois were carried out under the supervision of J. de Vos.

	W	S	K	H	J
Primates					
Nycticebus cougang	-	+	-	+	+
Macaca fascicularis	-	+	+	+	+
Presbytis cristatus	+	+	-	+	+
Cercopithecidae	+	+	+	+	+
Homo sapiens	+	+	+	+	+
Carnivora					
Paradoxurus hermaphroditus	-	+	+	+	-
Lutrea cinera	-	+	-	-	-
Martes flavigula	-	-	-	-	+
Arctogalidia sp.	-	-	-	-	+
Felis silvestris catus	-	-	+	-	-
Felis bengalensis	-	+	-	-	-
Panthera tigris	+	+	-	-	-
Cuon javanicus	-	+	-	-	+
Canis lupus familiaris	-	-	-	+	-
Rodentia					
Hystrix javanica	+	+	+	+	+
Proboscidae					
Elephas maximus	-	+	-	+	-
Perissodactyla					
Rhinoceros sondaicus	+	+	-	+	+
Tapirus indicus	+	-	-	-	+
Artiodactyla					
Sus scrofa	+	+	+	-	+
Sus verrucosus	-	-	+	-	+
Suidae indet.	+	+	+	+	+
Tragulus javanicus	-	+	+	+	+
Muntiacus muntjac	+	+	+	+	+
Rusa timorensis	+	+	+	+	+
Capricornis sumatraensis	-	-	-	-	+
Bos sondaicus	+?	+	-	-	+?
Bubalus bubalus	+?	+	-	-	+?
Bovinae indet.	+	+	+	+	+

+ = recorded; - = not recorded; ? = uncertain.

Meaning of letters:	identification of fauna:
W(ajak)	van den Brink, 1983.
S(ampung)	Dammerman, 1932, 1934 (based on van den Brink, 1983).
K(ecil)	Span, 1993.
H(oekgrot)	Storm, 1990.
J(imbe)	van den Brink, 1983.

Table 5. Javanese biostratigraphy (sources: de Vos et al., 1982, de Vos, 1983; Sondaar, 1984; Leinders et al., 1985; Theunissen et al., 1990; this study).

Fauna	Dating	Remarks
Subrecent *	10 560 2650	'Modern' looking open woodland fauna, origin from the mainland hominid species: *Homo sapiens*
Punung **	80 000	'Modern' looking humid forest fauna, origin from the mainland, hominid species probably *Homo sapiens*
Ngandong	100 000 200 000	'Archaic' looking open woodland fauna origin from the mainland, hominid species: *Homo erectus soloensis*
Kedung Brubus	800 000	'Archaic' looking open woodland fauna origin from the mainland, hominid species: *Homo erectus erectus*
Trinil H.K.	1 000 000	'Archaic' looking open woodland (impoverished mainland fauna) hominid species: *Homo erectus erectus*
Ci Saat	1 200 000	'Archaic' looking island fauna, poor in species with new arrivals, hominid species: unknown (***)
Satir	1 500 000	'Archaic' looking unbalanced island fauna, partly mangrove forest, hominid species: unknown (***).

* = faunal assemblages from Wajak, Sampung, G. Kecil, Hoekgrot, and G. Jimbe;
** = age Punung fauna de Vos (pers. comm.);
*** = recently claims have been made for the presence of hominids in Java as early as 1.81 and 1.66 Ma BP (Swisher et al., 1994).

Table 6. Human activities in Javanese sites (Holocene sites excavated by Dubois in 1890; remains recorded by the author).

	Wajak	Kecil	Hoekgrot	Jimbe
Human remains	+	+	+	+
Cultural remains	+	+	+	+
Domesticated animals	-	+	+	-
Remains from the sea	+	-	+	-
Cutmarks on bones	+	-	+	-
Burnt bones	+	+	+	-

+ = recorded; - = not recorded; ? = uncertain.

Table 7. Cultural remains in Javanese sites (Holocene sites; except for S(ampung), the remains are recorded by the author). Localities are indicated by their initials (see Table 4); for an explanation of the symbols see Table 6.

	W	S	K	H	J
Bone tools	-	+	+	+	+
Stone artifacts	+	+	-	-	-
Arrow points	-	+	-	-	-
Stone adzes	-	+	-	-	-
Grinding stones	-	+	-	-	-
Ornam. shell	-	+	-	-	-
Pottery remains	-	+	-	+	-?
Bronze artifacts	-	+	-	-	-

Table 8. C-14 analyses bone samples (Holocene Javanese sites; from Shutler et al., in press).

Site	Sample	Date (BP)	Period
Wajak	Human (femur)	6560 ± 140	Mesolithic
	Fauna	10 560 ± 75	Mesolithic
Kecil	Fauna	3060 ± 85	Neolithic
Hoekgrot	Human (red skel.)	3265 ± 55	Neolithic
	Fauna	2655 ± 60	Neolithic
Jimbe	Fauna	2650 ± 55	Neolithic

Table 9. Sex of the Wajak skulls; characters used are those suggested by Acsadi & Nemeskeri (1970); Larnach & Macintosh (1966, 1970, 1971); Workshop (1980).

Character	Wajak-1	Wajak-2
Cranium		
General size	+	+
Glabella	+	+
Arcus superciliaris	+	+
Arcus supraorbitalis	-	-
Maximum supraorbital breadth	+	+
Inclinatio frontale	+	+?
Tubera frontalia	+	?
Tubera parietalia	0	?
Processus mastoideus	-	+
Crista supramastoidea	0	+
Protuberantia occipitalis externa	-	+?
Nuchal plane	-?	?
Orbital form	+	+
Malar bone	+?	?
Size palate	+	+
Mandible		
General size	+	+
Length mandible	?	+
Protuberantia mentalis	?	0
Impression corpus mandibulae	+	+
Minimum ramus breadth	+	+
Caput mandibulae	?	+
Teeth		
General size	+	+

+ = indication male; - = indication female; 0 = indication indifferent; ? = unknown/uncertain.

Table 10. Estimated age (in years) of the Wajak skulls.

Method	Wajak-1	Wajak-2
Development dentition (Ubelaker, 1978)	> 21	> 21
Dental attrition (Brothwell, 1981)	17-25	17-25 (closer to 25)
Suture closer (Montagu, 1960)	22-24 (closer to 22)	-

Table 11. Measurements (in mm) of Wajak-1.

Measurements	Dubois, 1920	Jacob, 1967	Santa Luca, 1980	this study
Neurocranium:				
Cranial length	200	200	201	200 * (1)
Nasio-occip. l.	-	-	194	192 * (1)
Basion-bregma h.	140	137	-	137 * (1)
Cranial breadth	145	151	151	151 * (1)
Bi-auricular b.	-	-	141	138 (5)
Bi-mastoid b.	-	119	-	120 *
Nasion-bregma c.	119	119	114	115 * (1)
Bregma-lambda c.	113	111	119	117 (1)
Bregma-lambda a.	130	122	132	132 (2)
Lambda-opist. c.	-	107	107	96 * (1)
Lambda-opist. a.	-	135	127	120 * (2)
Basion-nasion l.	107	108	-	109 * (1)
Viscerocranium:				
Bi-zygomatic b.	-	138	-	144 ** (1)
Orbital height	33	35	-	35
Orbital breadth	42	44	-	43
Nasal height	50	49	-	52 * (1)
Nasal breadth	30	30	-	31 * (1)

Explanation of symbols:
a. = arc; b. = breadth; c. = chord; d. = diameter; h. = height; l. = length;
* = not possible to measure exactly; ** = estimation.
Definition measurement according to: (1) = Howells, 1973; (2) = Brothwell, 1981; (3) = Larnach & Macintosh, 1966/1970; (4) = Bass, 1987; (5) = Martin, 1928; (6) = Brown, 1989.

Table 12. Measurements (in mm) Wajak-1 & Wajak-2; for explanation of symbols see Table 11.

Measurements	Def.	Wajak-1	Wajak-2
Neurocranium:			
Minimum frontal b.	(5)	97	103
Viscerocranium:			
Interorbital b.		28	31 **
Maxilla length	(3/4)	61 **	62 **
Maxilla breadth	(1/3)	71	80 *
Internal palatal b.		44	53 *
Mandible:			
Corpus height M1/M2	(6)	34 *	37
Corpus thickness M1/M2	(6)	19	21
Minimum ramus breadth	(2)	41 **	46

Table 13. Measurements teeth (in mm) Wajak-1 & Wajak-2.

	Wajak-1		Wajak-2	
	R	L	R	L
MAXILLA				
Mesio-distal:				
Canine	-	-	9.4	9.6
Premolar P3	6.9	-	7.7	7.7
Premolar P4	7.2	-	7.8	7.8
Molar M1	11.0	-	-	11.8
Molar M2	-	10.6	10.7	10.8
Molar M3	8.0	-	10.4	10.8
Bucco-lingual:				
Canine	-	-	10.1	10.0
Premolar P3	-	-	11.0	11.2
Premolar P4	11.0	-	10.8	10.8
Molar M1	13.8	-	-	13.1
Molar M2	-	13.7	13.3	13.3
Molar M3	13.2	-	13.1	12.8
MANDIBLE				
Mesio-distal:				
Incisor I1	-	-	5.9	5.7
Incisor I2	-	-	6.8	6.8
Canine	-	-	-	7.7
Premolar P3	-	-	-	8.5
Premolar P4	-	-	7.6	-
Molar M1	-	-	12.5	12.7
Molar M2	11.5	-	11.6	11.4
Molar M3	12.9	-	-	11.5
Bucco-lingual:				
Incisor I1	-	-	7.2	7.2
Incisor I2	-	-	7.6	7.4
Canine	-	-	-	9.5
Premolar P3	-	-	-	8.8
Premolar P4	-	-	8.4	-
Molar M1	12.0	-	12.5	12.5
Molar M2	11.6	-	11.1	11.0
Molar M3	11.5	-	-	11.1

Table 14. Sex of Kanalda skull; characters used are those suggested by Acsadi & Nemeskeri (1970).

Characters	Indication
1 cranium in general: large	+
2 zygomatic arches: broad	+
3 os zyg.: high/robust (left side not very irregular)	+
4 proc. zygomaticus: heavy (right side less robust)	+
5 maxilla: large	+
6 teeth: large	+
7 glabella: robust (not extremely massive/prominent)	+
8 arcus superciliaris: robust (not extremely marked)	+
9 os frontale: oblique/high (medium inclined)	+
10 form orbita: clearly angled (quadrangular)	+
11 margo supraorbitalis: (very) rounded	+
12 linea temporalis: clearly present	+
13 tubera frontalia: indistinct developed	+
14 tubera parietalia: moderate developed	0
15 processus mastoideus: large (not extreme)	+
16 crista supramastoidea: weak/small	-
17 linea nuchae: weak	-
18 prot. occipitalis externa: weak (there is damage)	0
19 mandibula in general: (very) robust	+
20 protuberantia mentalis: weak/small	-
21 angulus mandibulae: eminences present	+
22 margo mandibulae: thick	+
23 caput mandibulae: broad and thick	+

+ = masculine; 0 = indifferent; - = femine; proc. = processus; prot. = protuberantia; zyg. = zygomaticum.

Table 15. Suture obliration of Kanalda skull (scheme used is the degree of obliteration according to Broca; Workshop, 1980).

	Part	Right	Middle	Left
Sutura coronalis	I	0		0
	II	0		0
	III	0		0
Sutura sagittalis	I		0	
	II		1	
	III		1	
	IV		1	
Sutura lambdoidea*	I	0		2
	II	0		0
	III	0		2

* = there are wormian bones, two at the left side, four at the right side.

Table 16. Measurements-I (in mm) of Kanalda skull (numbers and measurement definitions used are those of Brown, 1989).

Nr.	Cranial variables			Right	Left
04	biparietal	142			
05	glabella-opisthocranion	190			
06	glabella-lambda	187			
07	basion-bregma	146			
08	basion-nasion	107			
09	basion-nasospinale	102			
10	basion-prosthion	109			
11	basion-lambda	120			
12	basion-inion	86			
13	biauriculare	130			
14	biasterion	117			
16	glabella-bregma	116			
17	nasion-bregma	117			
20	supraorbital breadth	115			
22	min.dist.temp.lin.front.	95			
24	bizygion	152			
25	bizygomaxillare	99			
26	bistephanion	105			
28	opisthion-inion	50 *			
29	opisthion-lambda	100 *			
30	opisthion-asterion	71 *	#	73	69
31	opisthion-glabella	151 *			
32	basion-sphenobasion	31			
33	basion-asterion	85	#	85	84
34	basion-mastoidale	56	#	55	57
35	basion-staphylion	47			
36	bregma-lambda	123			
40	lambda-inion	66			
41	lambda-asterion	86	#	86	85
45	nasion-nasospinale	56			
46	nasion-prosthion	74 *			
47	nasospinale-prosthion	18 *			
48	nasal breadth	31			
49	orbital height	30	#	29	30
50	orbital breadth	42	#	42	41
51	biectoconchion	103			
52	alveolar length	63			
53	alveolar breadth (M2-M2)	79			
54	bicanine breadth	47			
57	frontal arc	133			
58	parietal arc	140			
59	occipital arc	118 *			
87	auriculare-bregma	135	#	135	134
88	auriculare-nasion	116	#	115	117
89	auriculare-nasospinale	124	#	123	125
90	auriculare-prosthion	132	#	131	133
91	auriculare-zygomaxillare	76	#	74	77
92	auriculare-lambda	122	#	122	121
93	auriculare-inion	106	#	105	106

94 auriculare-opisthion	84 * #	84*	84 *
95 auriculare-basion	71 #	71	70
96 auriculare-glabella	123 #	122	123
Mandibular dimensions			
68 symphysial height	36 *		
69 symphysial thickness	15		
70 corpus height M1-M2	35		
71 corpus height M2-M3	33 R		
72 bicondylar breadth	135		
73 bigonial breadth	106		
74 mandibular length	116		
75 ramus height	63		
77 minimum ramus breadth	37		
Buccolingual dimensions of maxillary teeth			
60 I1		8.9	8.9
61 I2		5.7	7.6
62 C		9.7	9.7
63 P1		11.2	11.2
64 P2		10.8	10.8
65 M1		13.3	13.4
66 M2		14.4	13.8
67 M3		—	13.1
Buccolingual dimensions of mandibular teeth			
79 I1		6.7	6.8
80 I2		—	6.9
81 C		9.6	9.2
82 P1		10.1	8.8
83 P2		9.1	9.6
84 M1		12.7	12.8
85 M2		12.5	12.6
86 M3		12.3	—

R = right side; * = estimation; # = mean of left and right side.
There is a difference between the definitions of landmarks of Brown and some others used in this study. These are: basion, bregma, lambda, prosthion. In this case for basion and bregma this makes no difference, but for lambda and prosthion it does. The area of prosthion is broken.
Measurement numbers:
49. Measurement taken lateral, not medial in the area of the supraorbital notches.
50. Os lacrimale is broken and the lateral margins of the orbita are rounded.
54. Maximum.
74. & 75. Seen from anterior to posterior, margo inferior of mandible is rounded, therefore fixation on the osteometric board is hard.

Table 17. Measurements-II (in mm) of Kanalda skull (measurement definitions used are those from Howells, 1973).

Definitions		Measurements	
GOL	Glabello-occipital length	190	
NOL	Nassio-occipital length	186	
BNL	Basion-nasion length	107	
BBH	Basion-bregma height	146	
XCB	Maximum cranial breadth	142	
XFB	Maximum frontal breadth	117	
STB	Bistephanic breadth	110	
ZYB	Bizygomatic breadth	152	
AUB	Biauricular breadth	130	
WCB	Minimum cranial breadth	75	
ASB	Biasterionic breadth	117	
BPL	Basion-prosthion length	109	
NPH	Nasion-prosthion height	69.7	
NLH	Nasal height	55.3	
OBH	Orbit height, left	29.7	
JUB	Bijugal breadth	127	
NLB	Nasal breadth	30.9	
MAB	Palate breadth, external	80	
MDH	Mastoid height	28	R/L
MDB	Mastoid width	16.3	R
ZMB	Bimaxillary breadth	100.9	
FMB	Bifrontal breadth	107.3	
EKB	Biorbital breadth	107.4	
WNB	Simotic chord	9.1	
IML	Malar length, inferior	45.7	
XML	Malar length, maximum	61.5	
WMH	Cheek height	24.2	
FOL	Foramen magnum length	38.9	
FRC	Nasion-bregma chord	117	
PAC	Bregma-lambda chord	123	
OCC	Lambda-opisthion chord	101	

R = right side; L = left side.

Table 18. Sexual dimorphism of Recent Javanese & Australians (most of the haracters used are those suggested by the Workshop, 1980; the average scores are given).

Characters:
1 = glabella
2 = arcus superciliaris
3 = inclinatio frontale
4 = orbita (form + margo superior)
5 = os zygomaticum (height + surface)
6 = processus zygomaticus
7 = tubera frontalia
8 = tubera parietalia
9 = processus mastoideus
10 = crista supramastoidea
11 = protuberantia / torus occipitalis externa
12 = nuchal region (crista occipitalis + nuchal lines)
13 = mandibula total aspect
14 = protuberantia mentalis
15 = angulus mandibulae

	Javanese			Australians		
	males	females	diff.	males	females	diff.
Cranium						
	N=79	N=9	—	N=29-34	N=7-8	—
1	-0.6	-1.2	0.6	+1.6	-0.1	1.7
2	-0.2	-1.2	1.0	+1.6	-0.6	2.2
3	0.0	-0.2	0.2	+1.8	+0.5	1.3
4	-0.3	-0.7	0.4	+1.3	-0.8	2.1
5	+0.5	-0.6	1.1	0.0	-1.4	1.4
6	+0.2	-0.3	0.5	+0.1	-1.6	1.7
7	-0.2	+0.2	0.4	+1.6	+1.6	0.0
8	-0.6	-0.9	0.3	+0.2	+0.4	0.2
9	-0.4	-0.9	0.5	-0.5	-0.2	0.3
10	+0.5	-0.6	1.1	+0.8	-0.6	1.4
11	-0.5	-1.1	0.6	+0.6	-1.1	1.7
12	-0.2	-0.7	0.5	+0.9	-0.4	1.3
Sum	-1.8	-8.2	7.2	+10.0	-4.3	15.3
Mandible						
	N=71-75	N=9	—	N=19	N=5	—
13	+0.4	-0.7	1.1	+0.5	-0.4	0.9
14	+0.3	-0.4	0.7	-1.1	-1.2	0.1
15	+0.4	-0.6	1.0	+0.3	-0.4	0.7
Sum	+1.1	-1.7	2.8	-0.3	-2.0	1.7

+ = masculine; 0 = indifferent; - = femine; N = number; diff. = difference between average male and female score.

Table 19. Sexual dimorphism prehistoric skulls (for characters see Table 18).

	Wajak-1 male	Wajak-2 male	Sampung male	Hoekgrot female?	L.T. female	L.M.E male?
1	++?	++	0	+	-	0
2	+	+	++	+	-	0
3	++	++?	++	0?	+	-?
4	+	+	+		-	0
5	+?		+	-	-?	0
6			++	+	-	0
7	++		++	-	+	0
8	0		-?	—?	+	+
9	-	++	-	—	—	0
10	0	+	-	+	0?	0
11	—	+?		—	-	+
12	- ?				0?	
13	++	++	++	-	-	+
14		0	0?		-	—
15			++	0	0	+

	Liuj. male	U.C.1 male	U.C.2 female	U.C.3 ?
1	+	++	0	+
2	+	++	-	—
3	++	++		+
4	+	+	-	+
5	0	+	0	0
6		++		
7	++	++	0	++
8	++	++		0
9	-	0	++	-
10	0	0	—	
11	—	+	—	—
12	0	-	-	0

	Kanalda male	Keilor male	K.S.1 male	K.S.5 male
1	++	0	++	++?
2	++	++	++	++
3	+	++?	++	++?
4	++	++	++?	+
5	++?	+		+
6	++?			
7	+	++	++	++?
8	0	++	—?	0?
9	+	0?		+
10	-			++
11	0?	+		-
12	-	+		++?
13	++		++	++
14	—		0	—
15	0?		++	++

+ = indication male; ++ = indication male (strong); - = indication female; — = indication female (-strong); 0 = indifferent; ? = uncertain.

Table 20. Recession frontal bone (frontal subtense * 100 / frontal chord).

	Recent Java	Recent Australia
Total series (N)	50	38
Minimum value	17.9	19.0
Average value	23.1	23.3
Maximum value	28.7	28.8
Standard dev.	2.1	1.9
Males		
Number	42	30
Minimum value	17.9	19.0
Average value	23.2	22.8
Maximum value	28.7	26.2
Standard dev.	2.1	1.6
Females		
Number	8	8
Minimum value	20.6	21.2
Average value	22.4	25.0
Maximum value	25.7	28.8
Standard dev.	1.8	2.3

Prehistoric groups Solo	Indonesia	China	Australia
Solo-1: 14.0	Wajak-1: 21.7	Liuj.: 23.7	Kanalda: 20.5
Solo-4: 13.6	Sampung: 18.9	U.C.3: 21.7	Keilor: 20.7
Solo-6: 13.2	L.T.: 17.2		K.S.1: 14.2
Solo-11: 10.5	L.M.E: 22.5		K.S.5: 12.0

Table 21. Archaic characters (%) in recent crania (number is given after percentage).

1 = Low Skull (Length/height index <= 64.9)
2 = Postorbital constriction (index <= 74.9)
3 = Torus supraorbitalis robust and 'straight'
4 = Clear development superstructures
5 = Parietalia converge above crista supramastoidea
6 = Superior border temporal squama low & straight
7 = Fissure between pr. mastoideus & cr. petrosa
8 = Seen from lateral side, sharp angle os occipitale
9 = Torus occipitalis (opistocranion = inion)

	China (N)	Java (N)	New Guinea (N)	Australia (N)
1	0.0(63)	0.0(103)	0.0(56)	0.0(37)
2	0.0(62)	0.0(104)	0.0(61)	5.3(38)
3	0.0(63)	0.0(105)	0.0(64)	0.0(42)
4	0.0(63)	1.0(105)	0.0(61)	7.1(42)
5	0.0(63)	0.0(105)	0.0(64)	2.4(42)
6	0.0(62)	0.0(104)	0.0(64)	0.0(42)
7	0.0(63)	1.0(104)	6.3(63)	2.6(38)
8	0.0(63)	0.0(105)	0.0(63)	0.0(41)
9	0.0(63)	0.0(105)	0.0(62)	0.0(41)

Table 22. Archaic characters in Prehistoric crania (for explanation of characters see Table 21).

	1	2	3	4	5	6	7	8	9
INDONESIA									
Gua Kepah B347			-	-	-			-	-
Gua Kepah C77			-						
Wajak-1	-	-	-	-	-	-	-	-	-
Wajak-2			-					-	-
Hoekgrot			-	-	-		-	-	-
Sampung-H			-	-			±	-	-
Liang Toge			-	-	-		-	-	-
Liang Momer E	-		-	-	-	-	-	-	-
Gua Alo-1							-		
Aimere								-	-
JAVA: Middle Pleistocene									
Solo-1			+	±	+		+	±	+
Solo-3				±	+				
Solo-4			+	±					
Solo-5			+	±	+	+	+	+	±
Solo-6	+		+	+	+	+	+	+	+
Solo-9			+	±	+			+	±
Solo-10			+	±	+			+	±
Solo-11	+	+	+	+	+	+	+	+	+
CHINA									
Liujiang	-	-	-	-	-	-		-	-
Upper Cave-1			±	-	-	-	-	±	±
Upper Cave-2		-	-			-		-	-
Upper Cave-3	-	-	-	-			±	-	-
AUSTRALIA									
Kanalda	-	-	-	±	-	-	-	-	-
Keilor			-	-	-	-	-	-	-
Kow Swamp-1			±	-		-			
Kow Swamp-5			±		-	-	-	-	-
Kow Swamp-15			±						
Mungo-1			-	-	-			-	-
Mungo-3			-	-				±	±

- = absent; ± = ambiguous; + = present.

Table 23. Average developments of characters (the individual scores of Wajak-1 and Wajak-2 are given).

Characters	Solo score (N)	China score (N)	Australia score (N)	Indonesia score (N)	Wajak -1	-2
metopic ridge	1.7(7)	0.3(4)	1.8(5)	0.2(5)	0	-
bregmatic em.	1.9(7)	0.3(4)	0.0(5)	0.0(5)	0	-
coronal ridge	1.3(8)	0.0(3)	0.0(6)	0.0(5)	0	-
supraorb. to.	3.6(7)	0.5(4)	1.0(7)	0.0(6)	0	0
saggital ri.	2.1(8)	0.8(4)	0.2(5)	0.8(5)	1	-
obelion de.	2.1(8)	1.8(4)	0.8(5)	2.0(5)	4	-
angular torus	3.1(8)	0.3(3)	0.8(5)	0.0(4)	0	-
supramas. cr.	3.0(7)	1.3(4)	1.7(3)	1.3(6)	1	2
supramas. su.	3.0(7)	1.5(4)	0.7(3)	2.0(6)	1	4
mastoid crest	2.6(7)	1.8(4)	1.7(3)	1.2(5)	1	3
occipital to.	3.6(7)	0.0(4)	1.0(5)	0.3(6)	0	0
superior arm	1.7(7)	0.3(4)	0.4(5)	0.3(4)	0	0
inferior arm	2.8(6)	0.5(4)	1.0(4)	0.0(5)	0	0
occipital cr.	2.3(6)	1.0(4)	1.8(5)	1.0(5)	0	1

de. = depression; cr. = crest; em. = eminence; ri. = ridge; su. = sulcus; to. = torus; supramas. = supramastoid.

Development (Scores): 0 = absent; 1 = very slight; 2 = small; 3 = medium; 4 = large; 5 = robust.

Groups (prehistoric skulls): Solo: I, III, IV, V, VI, IX, X, XI; China: Liuj., U.C.1-3; Australia: Kanalda, Keilor, K.S.1, 5, 15, Mungo-1, 3; Indonesia: Wajak-1, 2, Hoekgrot, Sampung-H, L.T., L.M.E.

Table 24. Glabella occipital length (GOL) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	105	64	39
Average value	179.2	172.0	176.6	183.6
Standard dev.	6.3	7.3	7.5	8.7
Range	164-197	155-191	160-191	166-202
Distribution %				
151-160	0.0	3.8	1.6	0.0
161-170	9.5	39.0	21.9	5.1
171-180	47.6	42.9	42.2	33.3
181-190	39.7	13.3	29.7	38.5
191-200	3.2	1.0	4.7	20.5
201-210	0.0	0.0	0.0	2.6
Males (N)	63	79	30	31
Average value	179.2	172.8	182.0	185.2
Standard dev.	6.3	7.2	5.3	8.7
Range	164-197	156-191	170-191	167-202
Distribution %				
151-160	0.0	2.5	0.0	0.0
161-170	9.5	35.4	3.3	3.2
171-180	47.6	45.6	33.3	25.8
181-190	39.7	15.2	53.3	41.9
191-200	3.2	1.3	10.0	25.8
201-210	0.0	0.0	0.0	3.2
Females (N)		9	34	8
Average value		165.3	171.7	177.5
Standard dev.		6.3	5.6	5.4
Range		155-174	160-183	166-184
Distribution %				
151-160		11.1	2.9	0.0
161-170		66.7	38.2	12.5
171-180		22.2	50.0	62.5
181-190		0.0	8.8	25.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	191	Wajak-1	200	Kanalda	190
U.C.1	207	Hoekgrot	174	Keilor	199
U.C.3	188	Sampung	186	K.S.5	192
		L.T.	177		
		L.M.E	182		
		G.K.B347	197		

Table 25. Basion bregma height (BBH) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	103	56	37
Average value	138.2	134.5	129.5	133.1
Standard dev.	4.5	5.5	4.7	7.1
Range	126-150	114-145	116-140	121-145
Distribution %				
106-115	0.0	1.0	0.0	0.0
116-125	0.0	3.9	17.9	18.9
126-135	27.0	53.4	73.2	48.6
136-145	69.8	41.7	8.9	32.4
146-155	3.2	0.0	0.0	0.0
Males (N)	63	78	24	29
Average value	138.2	135.3	132.0	134.8
Standard dev.	4.5	5.2	4.2	6.7
Range	126-150	122-145	125-140	122-145
Distribution %				
116-125	0.0	2.6	4.2	10.3
126-135	27.0	51.3	79.2	48.3
136-145	69.8	46.2	16.7	41.4
146-155	3.2	0.0	0.0	0.0
Females (N)		9	32	8
Average value		128.8	127.7	126.9
Standard dev.		3.4	4.2	4.6
Range		124-134	116-138	121-132
Distribution %				
116-125		22.2	28.1	50.0
126-135		77.8	68.8	50.0
136-145		0.0	3.1	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	136	Wajak-1	137	Kanalda	146
U.C.3	146	L.M.E	139		

Table 26. Maximum cranial breadth (XCB) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	105	57	38
Average value	141.1	141.4	127.6	130.1
Standard dev.	5.0	5.3	5.7	5.2
Range	132-151	129-157	116-140	121-140
Distribution %				
111-120	0.0	0.0	7.0	0.0
121-130	0.0	1.0	64.9	47.4
131-140	49.2	44.8	28.1	52.6
141-150	47.6	50.5	0.0	0.0
151-160	3.2	3.8	0.0	0.0
Males (N)	63	79	27	30
Average value	141.1	141.9	129.5	131.2
Standard dev.	5.0	5.0	5.8	4.9
Range	132-151	132-157	121-140	121-140
Distribution %				
121-130	0.0	0.0	59.3	36.7
131-140	49.2	44.3	40.7	63.3
141-150	47.6	50.6	0.0	0.0
151-160	3.2	5.1	0.0	0.0
Females (N)		9	30	8
Average value		137.8	125.9	125.9
Standard dev.		4.3	5.2	4.2
Range		132-144	116-137	121-131
Distribution %				
111-120		0.0	13.3	0.0
121-130		0.0	70.0	87.5
131-140		66.7	16.7	12.5
141-150		33.3	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	144	Wajak-1	151	Kanalda	142
U.C.1	144	Hoekgrot	140	Keilor	146
U.C.3	133	L.T.	112	K.S.5	138
		L.M.E	130	Mungo-1	130

Table 27. Frontal chord (FRC) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	104	64	38
Average value	110.7	108.7	106.2	110.8
Standard dev.	4.5	4.7	4.7	5.9
Range	98-121	98-119	95-118	98-123
Distribution %				
91-95	0.0	0.0	1.6	0.0
96-100	1.6	4.8	9.4	5.3
101-105	7.9	18.3	31.3	13.2
106-110	44.4	39.4	43.8	23.7
111-115	30.2	27.9	10.9	34.2
116-120	14.3	9.6	3.1	21.1
121-125	1.6	0.0	0.0	2.6
Males (N)	63	78	30	30
Average value	110.7	109.0	108.2	112.0
Standard dev.	4.5	4.9	4.4	5.7
Range	98-121	98-119	100-118	98-123
Distribution %				
96-100	1.6	5.1	3.3	3.3
101-105	7.9	17.9	23.3	6.7
106-110	44.4	35.9	50.0	26.7
111-115	30.2	29.5	16.7	33.3
116-120	14.3	11.5	6.7	26.7
121-125	1.6	0.0	0.0	3.3
Females (N)		9	34	8
Average value		105.8	104.4	106.5
Standard dev.		4.1	4.3	4.5
Range		100-112	95-114	100-111
Distribution %				
86-95		0.0	2.9	0.0
96-105		44.4	52.9	50.0
106-115		55.6	44.1	50.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	115	Kanalda	117
Hoekgrot	106	Keilor	111
L.T.	107	K.S.1	120
L.M.E	112		
G.K.B347	111		

Table 28. Parietal chord (PAC) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	104	64	36
Average value	117.0	109.2	113.9	116.6
Standard dev.	6.6	6.1	5.8	6.5
Range	98-139	97-125	98-128	105-131
Distribution %				
91-100	1.6	7.7	1.6	0.0
101-110	14.3	55.8	26.6	19.4
111-120	60.3	33.7	60.9	52.8
121-130	20.6	2.9	10.9	22.2
131-140	3.2	0.0	0.0	5.6
Males (N)	63	78	30	28
Average value	117.0	110.1	116.4	118.3
Standard dev.	6.6	5.9	4.4	5.7
Range	98-139	97-125	108-128	105-131
Distribution %				
91-100	1.6	3.8	0.0	0.0
101-110	14.3	53.8	10.0	7.1
111-120	60.3	38.5	76.7	60.7
121-130	20.6	3.8	13.3	25.0
131-140	3.2	0.0	0.0	7.1
Females (N)		9	34	8
Average value		103.3	111.7	110.9
Standard dev.		3.9	6.0	6.3
Range		99-110	98-125	105-122
Distribution %				
91-100		33.3	2.9	0.0
101-110		66.7	41.2	62.5
111-120		0.0	47.1	25.0
121-130		0.0	8.8	12.5

Prehistoric skulls

Indonesia		Australia	
Wajak-1	117	Kanalda	123
G.K.B347	129	Keilor	123
		Mungo-1	110
		Mungo-3	108

Table 29. Parietal arch (S2) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	102	64	36
Average value	130.9	123.3	129.1	130.3
Standard dev.	8.7	7.8	6.8	8.4
Range	104-159	107-140	108-143	113-148
Distribution %				
101-110	1.6	3.9	1.6	0.0
111-120	11.1	35.3	10.9	13.9
121-130	28.6	42.2	48.4	36.1
131-140	49.2	18.6	34.4	38.9
141-150	7.9	0.0	4.7	11.1
151-160	1.6	0.0	0.0	0.0
Males (N)	63	76	30	28
Average value	130.9	124.6	131.6	132.1
Standard dev.	8.7	7.7	5.4	7.4
Range	104-159	107-140	118-142	115-148
Distribution %				
101-110	1.6	3.9	0.0	0.0
111-120	11.1	30.3	6.7	3.6
121-130	28.6	43.4	33.3	39.3
131-140	49.2	22.4	56.7	42.9
141-150	7.9	0.0	3.3	14.3
151-160	1.6	0.0	0.0	0.0
Females (N)		9	34	8
Average value		115.6	126.9	123.8
Standard dev.		5.6	7.1	9.2
Range		107-125	108-143	113-139
Distribution %				
101-110		11.1	2.9	0.0
111-120		66.7	14.7	50.0
121-130		22.2	61.8	25.0
131-140		0.0	14.7	25.0
141-150		0.0	5.9	0.0

Prehistoric skulls

Indonesia		Australia	
Wajak-1	132	Kanalda	140
G.K.B347	129	Keilor	133
		Mungo-1	120
		Mungo-3	114

Table 30. Occipital chord (OCC) in mm.

	China	Java	N.G.	Australia
Total series (N)	62	99	19	33
Average value	98.5	95.9	92.7	93.1
Standard dev.	5.6	6.0	3.6	4.6
Range	82-112	80-114	85-102	82-101
Distribution %				
71- 80	0.0	1.0	0.0	0.0
81- 90	8.1	18.2	26.3	24.2
91-100	54.8	59.6	68.4	69.7
101-110	32.3	20.2	5.3	6.1
111-120	4.8	1.0	0.0	0.0
Males (N)	62	74	9	25
Average value	98.5	95.6	93.4	93.2
Standard dev.	5.6	6.0	4.3	4.8
Range	82-112	80-109	88-102	82-101
Distribution %				
71- 80	0.0	1.4	0.0	0.0
81- 90	8.1	20.3	22.2	28.0
91-100	54.8	58.1	66.7	64.0
101-110	32.3	20.3	11.1	8.0
111-120	4.8	0.0	0.0	0.0
Females (N)		9	10	8
Average value		97.9	92.0	92.5
Standard dev.		7.9	2.9	4.3
Range		87-114	85-94	83-97
Distribution %				
71- 80		0.0	0.0	0.0
81- 90		11.1	30.0	12.5
91-100		55.6	70.0	87.5
101-110		22.2	0.0	0.0
111-120		11.1	0.0	0.0

Prehistoric skulls

Indonesia		Australia	
Wajak-1	96	Kanalda	101
		Keilor	107

Table 31. Occipital arch (S3) in mm.

	China	Java	N.G.	Australia
Total series (N)	62	99	19	33
Average value	117.5	110.6	110.6	110.8
Standard dev.	8.7	8.0	6.0	7.4
Range	99-147	91-134	96-125	93-125
Distribution %				
91-100	3.2	9.1	5.3	6.1
101-110	14.5	48.5	52.6	36.4
111-120	54.8	30.3	36.8	48.5
121-130	21.0	11.1	5.3	9.1
131-140	3.2	1.0	0.0	0.0
141-150	3.2	0.0	0.0	0.0
Males (N)	62	74	9	25
Average value	117.5	110.1	112.8	110.4
Standard dev.	8.7	8.1	6.5	8.0
Range	99-147	91-129	106-125	93-125
Distribution %				
91-100	3.2	12.2	0.0	4.0
101-110	14.5	47.3	55.6	44.0
111-120	54.8	31.1	33.3	40.0
121-130	21.0	9.5	11.1	12.0
131-140	3.2	0.0	0.0	0.0
141-150	3.2	0.0	0.0	0.0
Females (N)		9	10	8
Average value		113.7	108.7	111.9
Standard dev.		10.8	5.0	5.6
Range		102-134	96-113	100-117
Distribution %				
81-100		0.0	10.0	12.5
101-120		66.7	90.0	87.5
121-140		33.3	0.0	0.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	119	Kanalda	118
		Keilor	131

Table 32. Maximum supraorbital breadth (MSB) in mm.

	China	Java	N.G.	Australia
Total series (N)	62	105	61	38
Average value	104.1	104.3	100.3	107.9
Standard dev.	4.0	3.7	4.4	5.3
Range	94-116	94-112	88-109	99-121
Distribution %				
86- 90	0.0	0.0	1.6	0.0
91- 95	1.6	1.9	8.2	0.0
96-100	21.0	15.2	37.7	5.3
101-105	38.7	42.9	39.3	36.8
106-110	33.9	36.2	13.1	26.3
111-115	3.2	3.8	0.0	23.7
116-120	1.6	0.0	0.0	5.3
121-125	0.0	0.0	0.0	2.6
Males (N)	62	79	28	30
Average value	104.1	104.6	103.4	109.6
Standard dev.	4.0	3.6	3.3	4.7
Range	94-116	94-112	96-109	103-121
Distribution %				
91- 95	1.6	1.3	0.0	0.0
96-100	21.0	11.4	14.3	0.0
101-105	38.7	45.6	57.1	26.7
106-110	33.9	38.0	28.6	33.3
111-115	3.2	3.8	0.0	30.0
116-120	1.6	0.0	0.0	6.7
121-125	0.0	0.0	0.0	3.3
Females (N)		9	33	8
Average value		99.8	97.7	101.8
Standard dev.		2.7	3.3	1.8
Range		95-103	88-103	99-105
Distribution %				
86- 90		0.0	3.0	0.0
91- 95		11.1	15.2	0.0
96-100		44.4	57.6	25.0
101-105		44.4	24.2	75.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	108	Wajak-1	118	Kanalda	115
U.C.1	118	L.T.	106	Keilor	117
U.C.2	109	L.M.E	108	K.S.1	120
U.C.3	120				

Table 33. Minimal postorbital diameter (MPD) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	104	63	38
Average value	89.9	88.2	82.6	86.8
Standard dev.	3.9	3.5	3.9	3.6
Range	80-98	79-99	75-91	80-95
Distribution %				
71- 75	0.0	0.0	1.6	0.0
76- 80	1.6	1.9	27.0	5.3
81- 85	11.1	20.2	50.8	31.6
86- 90	39.7	54.8	19.0	50.0
91- 95	41.3	22.1	1.6	13.2
96-100	6.3	1.0	0.0	0.0
Males (N)	63	78	29	30
Average value	89.9	88.6	84.2	87.7
Standard dev.	3.9	3.5	4.0	3.4
Range	80-98	79-99	76-91	80-95
Distribution %				
76- 80	1.6	1.3	17.2	3.3
81- 85	11.1	16.7	48.3	20.0
86- 90	39.7	56.4	31.0	60.0
91- 95	41.3	24.4	3.4	16.7
96-100	6.3	1.3	0.0	0.0
Females (N)		9	34	8
Average value		85.2	81.3	83.5
Standard dev.		2.6	3.3	2.2
Range		80-88	75-88	80-87
Distribution %				
71-75		0.0	2.9	0.0
76-80		11.1	35.3	12.5
81-85		44.4	52.9	75.0
86-90		44.4	8.8	12.5

Prehistoric skulls China		Indonesia		Australia	
Liujiang	93	Wajak-1	96	Kanalda	90
U.C.2	89				
U.C.3	95				

Table 34. Basion nasion length (BNL) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	104	56	36
Average value	98.6	97.6	95.7	100.4
Standard dev.	4.0	4.2	4.8	5.3
Range	90-110	88-110	84-108	91-109
Distribution %				
81-85	0.0	0.0	1.8	0.0
86-90	3.2	4.8	14.3	0.0
91-95	17.5	24.0	30.4	22.2
96-100	47.6	48.1	37.5	25.0
101-105	30.2	20.2	14.3	30.6
106-110	1.6	2.9	1.8	19.4
111-115	0.0	0.0	0.0	2.8
Males (N)	63	79	24	28
Average value	98.6	98.0	99.3	102.0
Standard dev.	4.0	3.9	3.8	4.9
Range	90-110	90-110	93-108	92-111
Distribution %				
86-90	3.2	1.3	0.0	0.0
91-95	17.5	24.1	16.7	10.7
96-100	47.6	51.9	45.8	21.4
101-105	30.2	19.0	33.3	39.3
106-110	1.6	3.8	4.2	25.0
111-115	0.0	0.0	0.0	3.6
Females (N)		9	32	8
Average value		92.2	92.9	94.9
Standard dev.		3.5	3.6	2.5
Range		88-98	84-99	91-98
Distribution %				
81-85		0.0	3.1	0.0
86-90		44.4	25.0	0.0
91-95		33.3	40.6	62.5
96-100		22.2	31.3	37.5

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	108	Wajak-1	109	Kanalda	107
U.C.1	108	L.M.E	104		
U.C.3	108				

Table 35. Basion prosthion length (BPL) in mm.

	China	Java	N.G.	Australia
Total series (N)	60	98	47	21
Average value	94.5	97.7	98.2	100.9
Standard dev.	4.9	4.9	5.3	4.8
Range	84-106	88-110	87-111	91-109
Distribution %				
81- 85	3.3	0.0	0.0	0.0
86- 90	20.0	9.2	4.3	0.0
91- 95	30.0	26.5	34.0	14.3
96-100	38.3	38.8	27.7	38.1
101-105	6.7	20.4	27.7	28.6
106-110	1.7	5.1	4.3	19.0
111-115	0.0	0.0	2.1	0.0
Males (N)	60	75	21	16
Average value	94.5	97.4	101.2	101.9
Standard dev.	4.9	4.7	4.2	4.3
Range	84-106	88-110	93-111	91-109
Distribution %				
81- 85	3.3	0.0	0.0	0.0
86- 90	20.0	9.3	0.0	0.0
91- 95	30.0	28.0	9.5	6.3
96-100	38.3	38.7	33.3	37.5
101-105	6.7	20.0	47.6	31.3
106-110	1.7	4.0	4.8	25.0
111-115	0.0	0.0	4.8	0.0
Females (N)		7	26	5
Average value		95.0	95.8	97.6
Standard dev.		3.6	4.9	5.1
Range		89-100	87-109	92-105
Distribution %				
86- 90		14.3	7.7	0.0
91- 95		42.9	53.8	40.0
96-100		42.9	23.1	40.0
101-105		0.0	11.5	20.0
106-110		0.0	3.8	0.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	107	Kanalda	109

Table 36. Nasion prosthion height (NPH) in mm.

	China	Java	N.G.	Australia
Total series (N)	60	99	52	23
Minimum value	58.7	58.8	50.6	50.4
Average value	70.0	68.9	63.6	65.4
Maximum value	81.3	83.1	72.4	74.4
Standard dev.	4.7	4.5	4.4	5.6
Distribution %				
50.1-55.0	0.0	0.0	3.8	4.3
55.1-60.0	1.7	4.0	17.3	8.7
60.1-65.0	11.7	13.1	36.5	30.4
65.1-70.0	36.7	44.4	36.5	39.1
70.1-75.0	35.0	31.3	5.8	17.4
75.1-80.0	10.0	5.1	0.0	0.0
80.1-85.0	5.0	2.0	0.0	0.0
Males (N)	60	75	25	18
Minimum value	58.7	58.8	57.6	58.4
Average value	70.0	69.5	65.2	66.9
Maximum value	81.3	83.1	71.1	74.4
Standard dev.	4.7	4.6	3.2	4.4
Distribution %				
55.1-60.0	1.7	4.0	4.0	5.6
60.1-65.0	11.7	12.0	40.0	27.8
66.1-70.0	36.7	40.0	48.0	44.4
70.1-75.0	35.0	34.7	8.0	22.2
75.1-80.0	10.0	6.7	0.0	0.0
80.1-85.0	5.0	2.7	0.0	0.0
Females (N)		7	27	5
Minimum value		62.6	50.6	50.4
Average value		65.6	62.0	60.2
Maximum value		69.8	72.4	69.0
Standard dev.		2.3	4.9	6.8
Distribution %				
50.1-55.0		0.0	7.4	20.0
55.1-60.0		0.0	29.6	20.0
60.1-65.0		42.9	33.3	40.0
66.1-70.0		57.1	25.9	20.0
70.1-75.0		0.0	3.7	0.0

Prehistoric skulls

Indonesia		Australia	
Wajak-1	66	Kanalda	69.7
L.T.	71	K.S.15	77

Table 37. Bizygomatic breadth (ZYB) in mm.

	China	Java	N.G.	Australia
Total series (N)	62	105	53	35
Average value	133.5	133.0	122.8	131.6
Standard dev.	4.7	5.0	5.9	7.6
Range	122-144	117-145	113-138	120-150
Distribution %				
111-115	0.0	0.0	13.2	0.0
116-120	0.0	1.0	20.8	5.7
121-125	3.2	5.7	37.7	20.0
126-130	21.0	21.0	18.9	22.9
131-135	41.9	40.0	7.5	22.9
136-140	27.4	24.8	1.9	20.0
141-145	6.5	7.6	0.0	2.9
146-150	0.0	0.0	0.0	5.7
Males (N)	62	79	22	27
Average value	133.5	133.6	127.1	134.1
Standard dev.	4.7	4.4	5.0	6.7
Range	122-144	123-144	120-138	121-150
Distribution %				
116-120	0.0	0.0	4.5	0.0
121-125	3.2	3.8	40.9	7.4
126-130	21.0	16.5	31.8	25.9
131-135	41.9	43.0	18.2	29.6
136-140	27.4	30.4	4.5	25.9
141-145	6.5	6.3	0.0	3.7
146-150	0.0	0.0	0.0	7.4
Females (N)		9	31	8
Average value		126.7	119.7	123.1
Standard dev.		4.9	4.4	2.7
Range		117-134	113-129	120-128
Distribution %				
111-115		0.0	22.6	0.0
116-120		11.1	32.3	25.0
121-125		22.2	35.5	62.5
126-130		44.4	9.7	12.5
131-135		22.2	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
U.C.1	143	Wajak-1	144	Kanalda	152
		L.M.E	136		

Table 38. Width fronto-nasal art. (FNA) in mm.

	Java	Australia
Total series (N)	50	37
Minimum value	6.3	6.5
Average value	10.9	11.6
Maximum value	19.7	16.4
Standard dev.	2.7	2.1
Distribution %		
6.1- 8.0	14.0	10.8
8.1-10.0	32.0	8.1
10.1-12.0	26.0	45.9
12.1-14.0	16.0	24.3
14.1-16.0	8.0	8.1
16.1-18.0	2.0	2.7
18.1-20.0	2.0	0.0
Males (N)	42	30
Minimum value	6.3	7.9
Average value	11.0	11.8
Maximum value	19.7	16.4
Standard dev.	2.9	2.1
Distribution %		
4.1- 8.0	16.7	10.0
8.1-12.0	50.0	46.7
12.1-16.0	28.6	40.0
16.1-20.0	4.8	3.3
Females (N)	8	7
Minimum value	9.3	6.5
Average value	10.2	10.4
Maximum value	11.8	11.9
Standard dev.	1.0	2.0
Distribution %		
6.1- 8.0	0.0	14.3
8.1-10.0	62.5	14.3
10.1-12.0	37.5	71.4

Prehistoric skulls Indonesia		Australia	
Wajak-2	13.2	Kanalda	11.7
Hoekgrot	11.2	Keilor	16.4
L.T.	7.5		

Table 39. Nasal height (NLH) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	105	64	38
Minimum value	44.9	45.2	40.5	42.5
Average value	52.3	52.5	48.9	49.6
Maximum value	57.9	62.7	58.7	57.1
Standard dev.	2.8	3.2	3.1	3.6
Distribution %				
40.1-45.0	1.6	0.0	7.8	10.5
45.1-50.0	15.9	22.9	60.9	50.0
50.1-55.0	66.7	55.2	28.1	31.6
55.1-60.0	15.9	20.0	3.1	7.9
60.1-65.0	0.0	1.9	0.0	0.0
Males (N)	63	79	30	30
Minimum value	44.9	47.1	45.7	42.5
Average value	52.3	53.0	50.3	50.2
Maximum value	57.9	62.7	58.7	57.1
Standard dev.	2.8	3.1	2.6	3.6
Distribution %				
40.1-45.0	1.6	0.0	0.0	6.7
45.1-50.0	15.9	15.2	53.3	50.0
50.1-55.0	66.7	60.8	43.3	33.3
55.1-60.0	15.9	21.5	3.3	10.0
60.1-65.0	0.0	2.5	0.0	0.0
Females (N)		9	34	8
Minimum value		45.2	40.5	43.2
Average value		49.5	47.7	47.3
Maximum value		54.0	56.7	51.3
Standard dev.		2.9	2.9	3.0
Distribution %				
40.1-45.0		0.0	14.7	25.0
45.1-50.0		66.7	67.6	50.0
50.1-55.0		33.3	14.7	25.0
55.1-60.0		0.0	2.9	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	46.1	Wajak-1	51.7	Kanalda	55.3
U.C.1	55.2	L.T.	48.9	Keilor	51.7
U.C.2	47.7			K.S.5	51.2
U.C.3	51.0			K.S.15	55.4

Table 40. Nasal breadth (NLB) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	104	59	38
Minimum value	21.9	22.7	22.1	23.0
Average value	25.6	26.8	25.6	28.2
Maximum value	30.6	30.9	30.5	34.0
Standard dev.	1.8	1.8	1.8	2.3
Distribution %				
20.1-22.0	3.2	0.0	0.0	0.0
22.1-24.0	14.3	4.8	18.6	2.6
24.1-26.0	42.9	27.9	45.8	13.2
26.1-28.0	31.7	43.3	27.1	39.5
28.1-30.0	6.3	20.2	6.8	23.7
30.1-32.0	1.6	3.8	1.7	15.8
32.1-34.0	0.0	0.0	0.0	5.3
Males (N)	63	78	27	30
Minimum value	21.9	23.1	22.1	24.2
Average value	25.6	26.8	26.3	28.8
Maximum value	30.6	30.9	30.5	34.0
Standard dev.	1.8	1.8	1.8	2.0
Distribution %				
20.1-22.0	3.2	0.0	0.0	0.0
22.1-24.0	14.3	5.1	7.4	0.0
24.1-26.0	42.9	24.4	40.7	3.3
26.1-28.0	31.7	46.2	37.0	43.3
28.1-30.0	6.3	20.5	11.1	26.7
30.1-32.0	1.6	3.8	3.7	20.0
32.1-34.0	0.0	0.0	0.0	6.7
Females (N)		9	32	8
Minimum value		22.7	22.5	23.0
Average value		25.6	25.0	25.9
Maximum value		27.6	28.1	28.8
Standard dev.		1.5	1.5	1.8
Distribution %				
22.1-24.0		11.1	28.1	12.5
24.1-26.0		44.4	50.0	50.0
26.1-28.0		44.4	18.8	25.0
28.1-30.0		0.0	3.1	12.5

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	27.3	Wajak-1	30.7	Kanalda	30.9
U.C.1	33.7	L.T.	22	Keilor	26.3
U.C.2	27.1			K.S.5	30.6
U.C.3	27.1			K.S.15	26.7

Table 41. Maxillo-alveolar length (MAL) in mm.

	China	Java	N.G.	Australia
Total series (N)	58	96	49	21
Average value	52.8	54.3	56.4	58.5
Standard dev.	3.4	3.3	2.9	3.4
Range	44-62	47-65	51-62	51-64
Distribution %				
41-45	1.7	0.0	0.0	0.0
46-50	25.9	10.4	0.0	0.0
51-55	51.7	54.2	36.7	14.3
56-60	19.0	32.3	55.1	61.9
61-65	1.7	3.1	8.2	23.8
Males (N)	58	73	22	16
Average value	52.8	54.1	58.2	59.6
Standard dev.	3.4	3.1	2.0	2.8
Range	44-62	47-65	54-62	54-64
Distribution %				
41-45	1.7	0.0	0.0	0.0
46-50	25.9	12.3	0.0	0.0
51-55	51.7	54.8	9.1	6.3
56-60	19.0	31.5	77.3	62.5
61-65	1.7	1.4	13.6	31.3
Females (N)		7	27	5
Average value		52.9	55.0	55.0
Standard dev.		3.1	2.8	2.9
Range		48-57	51-61	51-58
Distribution %				
46-50		14.3	0.0	0.0
51-55		57.1	59.3	40.0
56-60		28.6	37.0	60.0
61-65		0.0	3.7	0.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	61	Kanalda	64
Wajak-2	62		
L.T.	60		

Table 42. Maxillo-alveolar breadth (MAB) in mm.

	China	Java	N.G.	Australia
Total series (N)	53	94	44	32
Average value	64.3	65.6	62.1	66.4
Standard dev.	4.2	3.2	3.2	3.6
Range	53-72	59-74	56-72	58-73
Distribution %				
51-55	1.9	0.0	0.0	0.0
56-60	18.9	4.3	36.4	6.3
61-65	34.0	45.7	45.5	31.3
66-70	41.5	42.6	15.9	46.9
71-75	3.8	7.4	2.3	15.6
Males (N)	53	71	18	26
Average value	64.3	65.6	64.1	67.3
Standard dev.	4.2	3.1	3.0	3.2
Range	53-72	59-74	58-72	60-73
Distribution %				
51-55	1.9	0.0	0.0	0.0
56-60	18.9	2.8	11.1	3.8
61-65	34.0	47.9	55.6	19.2
66-70	41.5	42.3	27.8	57.7
71-75	3.8	7.0	5.6	19.2
Females (N)		9	26	6
Average value		63.6	60.7	62.5
Standard dev.		3.2	2.6	2.6
Range		60-70	56-66	58-65
Distribution %				
56-60		22.2	53.8	16.7
61-65		55.6	38.5	83.3
66-70		22.2	7.7	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	64	Wajak-1	71	Kanalda	80
U.C.1	68	Wajak-2	80	Keilor	72
U.C.2	72	L.T.	59	K.S.15	71
U.C.3	66	L.M.E	63		

Table 43. Cheek height (WMH) in mm.

	China	Java	N.G.	Australia
Total series (N)	63	105	64	39
Minimum value	18.3	19.2	13.8	17.7
Average value	25.5	24.1	19.4	20.6
Maximum value	30.7	28.9	25.5	26.5
Standard dev.	2.7	2.4	2.2	2.2
Distribution %				
12.1-16.0	0.0	0.0	3.2	0.0
16.1-20.0	1.6	4.8	54.7	51.3
20.1-24.0	34.9	44.8	39.0	38.5
24.1-28.0	47.6	44.8	3.1	10.3
28.1-32.0	15.9	5.7	0.0	0.0
Males (N)	63	79	30	31
Minimum value	18.3	19.2	16.2	17.7
Average value	25.5	24.2	20.0	20.9
Maximum value	30.7	28.9	25.5	26.5
Standard dev.	2.7	2.3	2.3	2.3
Distribution %				
16.1-18.0	0.0	0.0	20.0	3.2
18.1-20.0	1.6	2.5	30.0	45.2
20.1-22.0	9.5	15.2	40.0	29.0
22.1-24.0	25.4	31.6	3.3	9.7
24.1-26.0	15.9	25.3	6.7	9.7
26.1-28.0	31.7	20.3	0.0	3.2
28.1-30.0	12.7	5.1	0.0	0.0
30.1-32.0	3.2	0.0	0.0	0.0
Females (N)		9	34	8
Minimum value		19.2	13.8	17.8
Average value		21.8	18.9	19.4
Maximum value		24.5	23.4	20.8
Standard dev.		2.1	2.1	1.2
Distribution %				
12.1-14.0		0.0	2.9	0.0
14.1-16.0		0.0	2.9	0.0
16.1-18.0		0.0	32.4	25.0
18.1-20.0		33.3	26.5	37.5
20.1-22.0		22.2	32.4	37.5
22.1-24.0		22.2	2.9	0.0
24.1-26.0		22.2	0.0	0.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	24.8	Kanalda	24.2
Hoekgrot	20.8	Keilor	24.1
Sampung	23.5		
L.T.	21.0		
L.M.E	21.4		

Table 44. Mandibular length (ML) in mm.

	China	Java	Australia
Total series (N)	63	98	20
Average value	101.7	104.3	105.0
Range	89-118	93-115	97-112
Standard dev.	6.6	5.4	4.6
Distribution %			
86- 90	3.2	0.0	0.0
91- 95	15.9	8.2	0.0
96-100	17.5	18.4	25.0
101-105	41.3	25.5	25.0
106-110	12.7	34.7	40.0
111-115	7.9	13.3	10.0
116-120	1.6	0.0	0.0
Males (N)	63	75	15
Average value	101.7	104.3	106.1
Range	89-118	93-115	99-112
Standard dev.	6.6	5.4	4.3
Distribution %			
86-90	3.2	0.0	0.0
91-95	15.9	9.3	0.0
96-100	17.5	16.0	13.3
101-105	41.3	26.7	26.7
106-110	12.7	36.0	46.7
111-115	7.9	12.0	13.3
116-120	1.6	0.0	0.0
Females (N)		9	5
Average value		102.0	101.6
Range		94-114	97-108
Standard dev.		5.5	4.4

Prehistoric skulls

Indonesia		Australia	
Wajak-2	111	Kanalda	116
L.T.	100	K.S.5	107
L.M.E	112	Mungo-3	110
G.K.C77	109		

Table 45. Bi-condylar breadth (W1) in mm.

	China	Java	Australia
Total series (N)	62	98	18
Minimum value	107.5	102.9	99.1
Average value	120.6	119.1	113.4
Maximum value	131.0	130.4	125.5
Standard dev.	5.6	5.5	6.9
Distribution %			
95.1-100.0	0.0	0.0	5.6
100.1-105.0	0.0	1.0	11.1
105.1-110.0	3.2	5.1	11.1
110.1-115.0	11.3	16.3	22.2
115.1-120.0	35.5	29.6	38.9
120.1-125.0	27.4	35.7	5.6
125.1-130.0	16.1	11.2	5.6
130.1-135.0	6.5	1.0	0.0
Males (N)	62	75	14
Minimum value	107.5	102.9	99.1
Average value	120.6	119.4	114.7
Maximum value	131.0	130.4	125.5
Standard dev.	5.6	5.2	7.0
Distribution %			
95.1-105.0	0.0	1.3	7.1
105.1-115.0	14.5	17.3	28.6
115.1-125.0	62.9	70.7	57.1
125.1-135.0	22.6	10.7	7.1
Females (N)		9	4
Minimum value		107.4	104.5
Average value		115.7	108.9
Maximum value		124.3	115.0
Standard dev.		5.3	5.0

Prehistoric skulls Indonesia		Australia	
L.T.	122	Kanalda	135.0
L.M.E	120.2	K.S.5	136.9

Table 46. Coronoid height (CrH) in mm.

	China	Java	Australia
Total series (N)	63	98	20
Average value	67.3	63.8	61.9
Range	56-80	54-79	52-74
Standard dev.	5.0	5.2	4.9
Distribution %			
51-55	0.0	4.1	10.0
56-60	12.7	19.4	25.0
61-65	20.6	44.9	45.0
66-70	39.7	20.4	15.0
71-75	25.4	8.2	5.0
76-80	1.6	3.1	0.0
Males (N)	63	75	15
Average value	67.3	64.5	62.0
Range	56-80	54-79	53-66
Standard dev.	5.0	5.3	3.9
Distribution %			
51-55	0.0	2.7	6.7
56-60	12.7	17.3	20.0
61-65	20.6	45.3	53.3
66-70	39.7	21.3	20.0
71-75	25.4	9.3	0.0
76-80	1.6	4.0	0.0
Females (N)		9	5
Average value		59.3	61.4
Range		54-63	52-74
Standard dev.		3.2	8.0

Prehistoric skulls

Indonesia		Australia	
Wajak-2	72	Kanalda	72
Sampung-H	68	Kow Swamp-5	70
Liang Momer	59	Mungo-3	61
Gua Alo-1	67		
Gua Kepah C77	58		

Table 47. Corpus height (CHe) in mm.

	China	Java	Australia
Total series (N)	46	71	18
Minimum value	21.2	20.9	21.8
Average value	28.6	27.7	26.7
Maximum value	33.6	34.3	30.5
Standard dev.	2.8	2.3	2.4
Distribution %			
18.1-21.0	0.0	1.4	0.0
21.1-24.0	8.7	2.8	16.7
24.1-27.0	17.4	26.8	38.9
27.1-30.0	45.7	54.9	38.9
30.1-33.0	23.9	12.7	5.6
33.1-36.0	4.3	1.4	0.0
Males (N)	46	53	14
Minimum value	21.2	20.9	23.7
Average value	28.6	27.7	27.0
Maximum value	33.6	32.8	30.5
Standard dev.	2.8	2.3	2.1
Distribution %			
18.1-21.0	0.0	1.9	0.0
21.1-24.0	8.7	3.8	7.1
24.1-27.0	17.4	22.6	50.0
27.1-30.0	45.7	56.6	35.7
30.1-33.0	23.9	15.1	7.1
33.1-36.0	4.3	0.0	0.0
Females (N)		6	4
Minimum value		24.4	21.8
Average value		26.8	25.5
Maximum value		29.1	29.2
Standard dev.		1.8	3.4

Prehistoric skulls Indonesia				Australia	
Wajak-1	33.7	Gua Alo-1	29.3	Kanalda	35.3
Wajak-2	36.7	Gua Alo-2	25.6	Kow Swamp-1	32.8
Sampung-H	30.6	Aimere	26.5		
Liang Toge	26.2	Gua Kepah C77	25.6		

Table 48. Corpus thickness (CTh) in mm.

	China	Java	Australia
Total series (N)	62	92	20
Minimum value	11.1	10.5	12.0
Average value	14.9	15.1	14.1
Maximum value	18.6	19.1	17.4
Standard dev.	1.7	1.5	1.7
Distribution %			
10.1-12.0	3.2	2.2	10.0
12.1-14.0	29.0	16.3	45.0
14.1-16.0	38.7	56.5	30.0
16.1-18.0	27.4	21.7	15.0
18.1-20.0	1.6	3.3	0.0
Males (N)	62	71	15
Minimum value	11.1	10.5	12.0
Average value	14.9	15.1	14.2
Maximum value	18.6	19.1	17.4
Standard dev.	1.7	1.6	1.6
Distribution %			
10.1-12.0	3.2	2.8	13.3
12.1-14.0	29.0	16.9	40.0
14.1-16.0	38.7	54.9	33.3
16.1-18.0	27.4	21.1	13.3
18.1-20.0	1.6	4.2	0.0
Females (N)		8	5
Minimum value		13.4	12.1
Average value		14.9	13.7
Maximum value		16.4	17.2
Standard dev.		1.0	2.2

Prehistoric skulls Indonesia				Australia	
Wajak-1	19.0	Liang Momer-E	14.1	Kanalda	16.5
Wajak-2	20.8	Gua Alo-1	16.4	Kow Swamp-1	14.2
Hoekgrot	15.4	Gua Alo-2	14.6		
Sampung-H	17.4	Aimere	15.3		
Liang Toge	15.4	Gua Kepah C77	15.2		

Table 49. Symphysis height (SHe) in mm.

	China	Java	Australia
Total series (N)	49	78	16
Minimum value	27.0	25.1	12.6
Average value	34.4	32.4	31.2
Maximum value	41.7	40.7	37.0
Standard dev.	3.7	3.3	5.8
Distribution %			
X-30.0	16.3	23.1	12.5
30.1-35.0	38.8	57.7	68.8
35.1-40.0	38.8	17.9	18.8
40.1-X	6.1	1.9	0.0
Males (N)	49	59	12
Minimum value	27.0	25.1	30.3
Average value	34.4	32.5	32.9
Maximum value	41.7	40.7	37.0
Standard dev.	3.7	3.3	1.9
Distribution %			
25.1-30.0	16.3	22.0	0.0
30.1-35.0	38.8	57.6	83.3
35.1-40.0	38.8	18.6	16.7
40.1-45.0	6.1	1.7	0.0
Females (N)		7	4
Minimum value		27.3	12.6
Average value		31.0	26.2
Maximum value		33.9	36.0
Standard dev.		2.4	10.6

Prehistoric skulls China		Indonesia		Australia	
U.C.1	31.8	Wajak-2	40.2	Kanalda	36.0
		Sampung	32.3	K.S.5	37.1
		L.T.	32.3		

Table 50. Symphysis thickness (STh) in mm.

	China	Java	Australia
Total series (N)	63	95	20
Minimum value	9.7	11.2	10.7
Average value	14.1	14.9	13.7
Maximum value	18.6	19.0	16.4
Standard dev.	1.8	1.6	1.4
Distribution %			
8.1-10.0	1.6	0.0	0.0
10.1-12.0	9.5	4.2	15.0
12.1-14.0	36.5	25.3	45.0
14.1-16.0	38.1	50.5	35.0
16.1-18.0	12.7	14.7	5.0
18.1-20.0	1.6	5.3	0.0
Males (N)	63	74	15
Minimum value	9.7	11.2	10.7
Average value	14.1	14.7	13.9
Maximum value	18.6	19.0	16.4
Standard dev.	1.8	1.5	1.4
Distribution %			
8.1-10.0	1.6	0.0	0.0
10.1-12.0	9.5	5.4	13.3
12.1-14.0	36.5	28.4	40.0
14.1-16.0	38.1	50.0	40.0
16.1-18.0	12.7	12.2	6.7
18.1-20.0	1.6	4.1	0.0
Females (N)		8	5
Minimum value		12.5	11.8
Average value		14.4	13.2
Maximum value		18.2	14.5
Standard dev.		1.7	1.2

Prehistoric skulls Indonesia				Australia	
Wajak-2	17.8	Gua Alo-1	15.2	Kanalda	15.0
Sampung-H	15.5	Aimere	14.2	Kow Swamp-1	14.4
Liang Toge	15.1	Gua Kepah C77	13.4	Kow Swamp-5	14.2
Liang Momer-E	14.0			Mungo-3	14.5

Table 51. Ramus breadth (RB') in mm.

	China	Java	Australia
Total series (N)	63	98	20
Minimum value	28.5	27.1	28.4
Average value	33.3	33.9	33.4
Maximum value	42.2	41.3	40.2
Standard dev.	2.8	2.6	3.4
Distribution %			
25.1-30.0	9.5	7.1	25.0
30.1-35.0	61.9	65.3	35.0
35.1-40.0	27.0	24.5	35.0
40.1-45.0	1.6	3.1	5.0
Males (N)	63	75	15
Minimum value	28.5	27.1	29.3
Average value	33.3	33.8	33.3
Maximum value	42.2	41.3	39.3
Standard dev.	2.8	2.6	2.8
Distribution %			
25.1-30.0	9.5	6.7	20.0
30.1-35.0	61.9	66.7	46.7
35.1-40.0	27.0	25.3	33.3
40.1-45.0	1.6	1.3	0.0
Females (N)		9	5
Minimum value		30.0	28.4
Average value		32.4	33.7
Maximum value		34.5	40.2
Standard dev.		1.7	5.2

Prehistoric skulls China		Indonesia		Australia	
U.C.1	41.4	Wajak-1	41	Kanalda	37.2
		Wajak-2	45.5	K.S.1	35.2
		Hoekgrot	34.9	K.S.5	35.0
		Sampung	39.0	Mungo-3	32.5
		L.T.	35.7		
		L.M.E	38.0		
		Alo.1	34.9		
		Alo.2	36.4		
		G.K.C77	37.8		

Table 52. Length upper P3-M3 in mm.

	China	Java	N.G.	Australia
Total series (N)	35	49	9	14
Minimum value	36.3	37.3	38.4	41.7
Average value	40.8	42.6	42.3	44.6
Maximum value	45.3	47.4	44.6	50.4
Standard dev.	2.1	2.4	1.9	2.4
Males (N)	35	39	4	10
Minimum value	36.3	38.0	38.4	42.0
Average value	40.8	42.7	42.2	45.0
Maximum value	45.3	47.4	44.6	50.4
Standard dev.	2.1	2.3	2.7	2.6
Females (N)		4	5	4
Minimum value		37.3	40.8	41.7
Average value		41.6	42.3	43.5
Maximum value		44.5	44.2	45.3
Standard dev.		3.3	1.4	1.5

Prehistoric skulls Indonesia				Australia	
Wajak-1	45.5	Aimere	46.5	Kanalda	48.5
Wajak-2	49.1	G.K.C77	41.8	K.S.15	47.9
L.T.	40.4				
L.M.E	45.6				

Table 53. Mesiodistal length upper M1 in mm.

	China	Java	N.G.	Australia
Total series (N)	53	96	32	28
Minimum value	7.4	9.4	9.6	9.8
Average value	10.0	10.6	10.7	10.9
Maximum value	11.3	12.9	12.6	12.6
Standard dev.	0.6	0.6	0.6	0.6
Males (N)	53	71	11	22
Minimum value	7.4	9.4	9.6	9.8
Average value	10.0	10.6	10.7	11.0
Maximum value	11.3	12.0	12.6	12.6
Standard dev.	0.6	0.6	0.9	0.7
Females (N)		9	21	6
Minimum value		10.0	9.6	10.4
Average value		10.9	10.7	10.9
Maximum value		12.9	11.6	11.3
Standard dev.		0.9	0.5	0.4

Prehistoric skulls Indonesia				Australia	
Wajak-1	11.0	L.T.	9.9	Kanalda	11.4
Wajak-2	11.8	L.M.E	10.8	K.S.15	10.8
Hoekgrot	10.9	Alo.1	10.5		
G.Jimbe	10.8	Alo.2	10.5		
G.Kecil	10.3	Aimere	11.0		
		G.K.C77	10.5		

Table 54. Buccolingual length upper M1 in mm.

	China	Java	N.G.	Australia
Total series (N)	47	94	32	27
Minimum value	9.0	10.2	10.3	11.1
Average value	10.9	11.5	11.4	12.5
Maximum value	12.2	12.9	12.4	14.2
Standard dev.	0.6	0.6	0.6	0.7
Males (N)	47	69	11	21
Minimum value	9.0	10.2	10.3	11.1
Average value	10.9	11.5	11.5	12.6
Maximum value	12.2	12.9	12.3	14.2
Standard dev.	0.6	0.6	0.7	0.6
Females (N)		9	21	6
Minimum value		10.3	10.8	11.6
Average value		11.3	11.4	12.3
Maximum value		12.4	12.4	13.7
Standard dev.		0.7	0.5	0.8

Prehistoric skulls Indonesia				Australia	
Wajak-1	13.8	L.T.	11.5	Kanalda	13.4
Wajak-2	13.1	L.M.E	11.3	K.S.15	12.8
Hoekgrot	11.7	Alo.1	11.7		
G.Jimbe	12.5	Alo.2	11.8		
G.Kecil	11.8	Aimere	12.1		
		G.K.C77	11.5		

Table 55. Mesiodistal length upper M2 in mm.

	China	Java	N.G.	Australia
Total series (N)	57	95	27	31
Minimum value	7.9	7.3	7.5	8.4
Average value	9.2	9.5	9.4	10.2
Maximum value	10.6	11.3	11.1	12.7
Standard dev.	0.6	0.7	0.7	0.9
Males (N)	57	72	13	25
Minimum value	7.9	7.5	7.5	8.4
Average value	9.2	9.5	9.3	10.3
Maximum value	10.6	11.3	11.1	12.7
Standard dev.	0.6	0.7	1.0	1.0
Females (N)		8	14	6
Minimum value		9.1	8.6	9.1
Average value		9.5	9.4	9.9
Maximum value		10.0	10.0	10.7
Standard dev.		0.4	0.4	0.6

Prehistoric skulls Indonesia				Australia	
Wajak-1	10.6	L.T.	8.5	Kanalda	11.8
Wajak-2	10.8	L.M.E	10.8	K.S.15	12.0
Hoekgrot	10.5	Alo.1	8.8		
G.Jimbe	9.6	Alo.2	8.8		
G.Kecil	9.4	Aimere	10.2		
		G.K.C77	10.0		

Table 56. Buccolingual length upper M2 in mm.

	China	Java	N.G.	Australia
Total series (N)	55	95	27	31
Minimum value	9.6	9.3	10.0	11.1
Average value	11.1	11.3	11.4	12.9
Maximum value	12.4	12.8	13.1	16.1
Standard dev.	0.7	0.7	0.9	1.0
Males (N)	55	72	13	25
Minimum value	9.6	10.0	10.2	11.4
Average value	11.1	11.3	11.5	13.1
Maximum value	12.4	12.8	13.1	16.1
Standard dev.	0.7	0.6	1.0	1.0
Females (N)		8	14	6
Minimum value		10.3	10.0	11.1
Average value		11.1	11.2	12.3
Maximum value		11.7	13.0	12.9
Standard dev.		0.5	0.7	0.7

Prehistoric skulls Indonesia				Australia	
Wajak-1	13.7	L.T.	11.8	Kanalda	13.8
Wajak-2	13.3	L.M.E	11.3	K.S.15	13.5
Hoekgrot	12.2	Alo.1	11.9		
G.Jimbe	13.1	Alo.2	10.7		
G.Kecil	12.6	Aimere	12.7		
		G.K.C77	11.5		

Table 57. Mesiodistal length upper M3 in mm.

	China	Java	N.G.	Australia
Total series (N)	38	65	18	22
Minimum value	6.0	7.1	7.5	7.9
Average value	8.3	8.9	9.0	9.3
Maximum value	10.4	11.2	11.1	10.7
Standard dev.	0.8	0.8	1.0	0.8
Males (N)	38	51	11	17
Minimum value	6.0	7.3	7.6	8.4
Average value	8.3	8.9	9.1	9.5
Maximum value	10.4	11.2	11.1	10.7
Standard dev.	0.8	0.8	1.1	0.8
Females (N)		4	7	5
Minimum value		7.8	7.5	7.9
Average value		8.9	8.7	8.7
Maximum value		10.0	9.4	9.7
Standard dev.		0.9	0.7	0.7

Prehistoric skulls Indonesia				Australia	
Wajak-1	8.0	L.T.	7.6	Kanalda	10.5
Wajak-2	10.8	L.M.E	9.6	K.S.15	9.9
Hoekgrot	8.8	Alo.1	8.3		
G.Jimbe	7.6	Aimere	10.8		
		G.K.C77	8.4		

Table 58. Buccolingual length upper M3 in mm.

	China	Java	N.G.	Australia
Total series (N)	38	65	18	22
Minimum value	7.8	9.2	8.8	10.4
Average value	10.5	11.1	10.8	12.3
Maximum value	12.7	13.1	12.4	14.1
Standard dev.	1.2	0.9	0.9	1.0
Males (N)	38	51	11	17
Minimum value	7.8	9.2	8.8	10.8
Average value	10.5	11.0	10.9	12.5
Maximum value	12.7	12.7	12.4	14.0
Standard dev.	1.2	0.8	1.1	0.9
Females (N)		4	7	5
Minimum value		9.6	10.2	10.4
Average value		10.7	10.7	11.7
Maximum value		11.5	11.4	14.1
Standard dev.		0.9	0.4	1.4

Prehistoric skulls Indonesia				Australia	
Wajak-1	13.2	L.T.	12.1	Kanalda	13.1
Wajak-2	12.8	L.M.E	11.4	K.S.15	12.8
Hoekgrot	11.3	Alo.1	10.8		
G.Jimbe	12.6	Aimere	12.8		
		G.K.C77	10.5		

Table 59. Cranial index (XCB*100/GOL).

	China	Java	N.G.	Australia
Total series (N)	63	105	57	38
Minimum value	69.0	69.7	63.9	63.1
Average value	78.8	82.3	72.5	71.0
Maximum value	88.0	93.6	82.1	76.9
Standard dev.	4.0	4.4	3.6	2.8
Distribution %				
60.0-64.9	0.0	0.0	1.8	2.6
65.0-69.9	1.6	1.0	22.8	31.6
70.0-74.9	14.3	4.8	52.6	57.9
75.0-79.9	46.0	23.8	19.3	7.9
80.0-84.9	30.2	46.7	3.5	0.0
85.0-89.9	7.9	19.0	0.0	0.0
90.0-94.9	0.0	4.8	0.0	0.0
Males (N)	63	79	27	30
Minimum value	69.0	70.7	63.9	63.1
Average value	78.8	82.3	71.4	71.0
Maximum value	88.0	93.6	77.8	76.9
Standard dev.	4.0	4.4	3.5	2.9
Distribution %				
60.0-64.9	0.0	0.0	3.7	3.3
65.0-69.9	1.6	0.0	33.3	30.0
70.0-74.9	14.3	5.1	44.4	56.7
75.0-79.9	46.0	25.3	18.5	10.0
80.0-84.9	30.2	48.1	0.0	0.0
85.0-89.9	7.9	17.7	0.0	0.0
90.0-94.9	0.0	3.8	0.0	0.0
Females (N)		9	30	8
Minimum value		78.2	68.4	66.3
Average value		83.4	73.6	71.0
Maximum value		86.2	82.1	73.2
Standard dev.		2.6	3.4	2.3
Distribution %				
65.0-69.9		0.0	13.3	37.5
70.0-74.9		0.0	60.0	62.5
75.0-79.9		11.1	20.0	0.0
80.0-84.9		44.4	6.7	0.0
85.0-89.9		44.4	0.0	0.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	75.4	Wajak-1	75.5	Kanalda	74.7
U.C.1	69.6	Hoekgrot	80.5	Keilor	73.4
U.C.3	70.7	L.T.	63.3	K.S.5	71.9
		L.M.E	71.4		

Cranial index:
65.0-69.9 = hyperdolichocrany (very narrow skull)
70.0-74.9 = dolichocrany (narrow skull)
75.0-79.9 = mesocrany (medium skull)
80.0-84.9 = brachycrany (broad skull)
85.0-89.9 = hyperbrachycrany (very broad skull)

Table 60. Length-height index (BBH*100/GOL).

	China	Java	N.G.	Australia
Total series (N)	63	103	56	37
Minimum value	70.3	70.8	67.2	65.3
Average value	77.2	78.4	73.7	72.6
Maximum value	85.2	88.4	81.2	79.6
Standard dev.	2.9	3.5	3.0	3.2
Distribution %				
65.0-69.9	0.0	0.0	10.7	24.3
70.0-74.9	19.0	16.5	58.9	51.4
75.0-79.9	66.7	51.5	28.6	24.3
80.0-84.9	12.7	26.2	1.8	0.0
85.0-89.9	1.6	5.8	0.0	0.0
Males (N)	63	78	24	29
Minimum value	70.3	71.8	67.2	65.3
Average value	77.2	78.5	72.6	72.9
Maximum value	85.2	88.4	79.5	79.6
Standard dev.	2.9	3.4	3.1	3.3
Distribution %				
65.0-69.9	0.0	0.0	20.8	20.7
70.0-74.9	19.0	16.7	58.3	51.7
75.0-79.9	66.7	51.3	20.8	27.6
80.0-84.9	12.7	24.4	0.0	0.0
85.0-89.9	1.6	7.7	0.0	0.0
Females (N)		9	32	8
Minimum value		74.0	69.0	66.5
Average value		78.0	74.4	71.5
Maximum value		83.2	81.2	75.3
Standard dev.		3.2	2.7	2.9
Distribution %				
65.0-69.9		0.0	3.1	37.5
70.0-74.9		11.1	59.4	50.0
75.0-79.9		55.6	34.4	12.5
80.0-84.9		33.3	3.1	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	71.2	Wajak-1	68.5	Kanalda	76.8
U.C.3	77.7	L.M.E	76.4		

Length-height index:
65.0-69.9 = chamaecrany (low skull)
70.0-74.9 = orthocrany (medium skull)
75.0-79.9 = hypsicrany (high skull)

Table 61. Breadth-height index (BBH*100/XCB).

	China	Java	N.G.	Australia
Total series (N)	63	103	50	36
Minimum value	88.0	85.1	92.0	93.1
Average value	98.0	95.2	101.9	102.6
Maximum value	107.4	106.7	113.1	114.4
Standard dev.	4.3	4.3	4.8	4.5
Distribution %				
70.0-85.9	0.0	1.9	0.0	0.0
86.0-91.9	6.3	22.3	0.0	0.0
92.0-97.9	47.6	55.3	26.0	13.9
98.0-103.9	34.9	17.5	34.0	47.2
104.0-109.9	11.1	2.9	36.0	33.3
110.0-115.9	0.0	0.0	4.0	5.6
Males (N)	63	78	22	28
Minimum value	88.0	85.7	92.0	93.1
Average value	98.0	95.4	102.4	103.2
Maximum value	107.4	106.7	113.1	114.4
Standard dev.	4.3	4.4	5.3	4.6
Distribution %				
70.0-85.9	0.0	1.3	0.0	0.0
86.0-91.9	6.3	21.8	0.0	0.0
92.0-97.9	47.6	55.1	18.2	14.3
98.0-103.9	34.9	17.9	40.9	39.3
104.0-109.9	11.1	3.8	36.4	39.3
110.0-115.9	0.0	0.0	4.5	7.1
Females (N)		9	28	8
Minimum value		88.2	93.4	93.1
Average value		93.5	101.5	100.9
Maximum value		97.8	110.8	108.2
Standard dev.		3.4	4.5	4.3
Distribution %				
86.0-91.9		22.2	0.0	0.0
92.0-97.9		77.8	32.1	12.5
98.0-103.9		0.0	28.6	75.0
104.0-109.9		0.0	35.7	12.5
110.0-115.9		0.0	3.6	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	94.4	Wajak-1	90.7	Kanalda	102.8
U.C.3	109.8	L.M.E	106.9		

Breadth-height index:
70.0-85.9 = hypertapeinocrany (very low skull)
86.0-91.9 = tapeinocrany (low skull)
92.0-97.9 = metriocrany (medium skull)
98.0-103.9 = acrocrany (high skull)
104.0-109.9 = hyperacrocrany (very high skull)

Table 62. Post-orbital constriction (MPD*100/MSB).

	China	Java	N.G.	Australia
Total series (N)	62	104	61	38
Minimum value	80.0	78.1	75.7	71.4
Average value	86.4	84.7	82.3	80.5
Maximum value	93.9	92.2	88.2	86.5
Standard dev.	2.8	2.7	2.9	3.2
Distribution %				
70.0-74.9	0.0	0.0	0.0	5.3
75.0-79.9	0.0	4.8	19.7	39.5
80.0-84.9	32.3	51.0	59.0	47.4
85.0-89.9	59.7	40.4	21.3	7.9
90.0-94.9	8.1	3.8	0.0	0.0
Males (N)	62	78	28	30
Minimum value	80.0	78.7	75.7	71.4
Average value	86.4	84.8	81.5	80.1
Maximum value	93.9	92.2	86.7	86.5
Standard dev.	2.8	2.6	3.1	3.3
Distribution %				
70.0-74.9	0.0	0.0	0.0	6.7
75.0-79.9	0.0	2.6	32.1	43.3
80.0-84.9	32.3	52.6	53.6	43.3
85.0-89.9	59.7	41.0	14.3	6.7
90.0-94.9	8.1	3.8	0.0	0.0
Females (N)		9	33	8
Minimum value		78.4	77.5	77.7
Average value		85.5	83.1	82.1
Maximum value		90.6	88.2	86.1
Standard dev.		3.9	2.7	2.8
Distribution %				
75.0-79.9		11.1	9.1	25.0
80.0-84.9		33.3	63.6	62.5
85.0-89.9		44.4	27.3	12.5
90.0-94.9		11.1	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	86.1	Wajak-1	81.4	Kanalda	78.3
U.C.2	81.7				
U.C.3	79.2				

Post-orbital constriction:
70.0-74.9 = very strong constriction
75.0-79.9 = strong constriction
80.0-84.9 = medium constriction
85.0-89.9 = small constriction
90.0-94.9 = very small constriction

Table 63. Parietal index (S2*100/PAC).

	China	Java	N.G.	Australia
Total series (N)	63	102	64	36
Minimum value	106.1	105.0	108.3	107.6
Average value	111.9	113.1	113.3	111.7
Maximum value	116.4	121.7	117.1	117.7
Standard dev.	1.9	2.6	1.7	2.2
Distribution %				
106.0-108.9	6.3	3.9	1.6	11.1
109.0-111.9	42.9	30.4	17.2	47.2
112.0-114.9	47.6	45.1	65.6	36.1
115.0-117.9	3.2	16.7	15.6	5.6
118.0-120.9	0.0	2.9	0.0	0.0
121.0-123.9	0.0	1.0	0.0	0.0
Males (N)	63	76	30	28
Minimum value	106.1	105.0	108.3	107.6
Average value	111.9	113.3	113.1	111.7
Maximum value	116.4	121.7	117.0	117.7
Standard dev.	1.9	2.8	1.8	2.3
Distribution %				
106.0-108.9	6.3	3.9	3.3	10.7
109.0-111.9	42.9	28.9	20.0	46.4
112.0-114.9	47.6	43.4	66.7	35.7
115.0-117.9	3.2	18.4	10.0	7.1
118.0-120.9	0.0	3.9	0.0	0.0
121.0-123.9	0.0	1.3	0.0	0.0
Females (N)		9	34	8
Minimum value		108.1	110.2	107.6
Average value		111.8	113.6	111.5
Maximum value		114.0	117.1	114.4
Standard dev.		1.8	1.7	2.2
Distribution %				
106.0-108.9		11.1	0.0	12.5
109.0-111.9		44.4	14.7	50.0
112.0-114.9		44.4	64.7	37.5
115.0-117.9		0.0	20.6	0.0

Prehistoric skulls

Indonesia		Australia			
Wajak-1	112.8	Kanalda	113.8	Mungo-1	109.1
G.K.B347	107.8	Keilor	108.1	Mungo-3	105.6

Parietal index:
103.0-108.9 = flat parietal
109.0-114.9 = medium parietal
115.0-120.9 = bulbous parietal

Table 64. Occipital index (S3*100/OCC).

	China	Java	N.G.	Australia
Total series (N)	62	99	19	33
Minimum value	111.5	108.6	112.9	113.2
Average value	119.2	115.4	119.3	119.0
Maximum value	132.4	126.5	125.0	125.8
Standard dev.	4.3	3.5	2.9	3.2
Distribution %				
106.0-108.9	0.0	2.0	0.0	0.0
109.0-111.9	3.2	16.2	0.0	0.0
112.0-114.9	11.3	28.3	5.3	15.2
115.0-117.9	30.6	32.3	21.1	21.2
118.0-120.9	24.2	16.2	42.1	42.4
121.0-123.9	17.7	4.0	26.3	18.2
124.0-126.9	9.7	1.0	5.3	3.0
127.0-129.9	1.6	0.0	0.0	0.0
130.0-132.9	1.6	0.0	0.0	0.0
Males (N)	62	74	9	25
Minimum value	111.5	108.6	117.0	113.2
Average value	119.2	115.1	120.7	118.3
Maximum value	132.4	126.5	125.0	123.8
Standard dev.	4.3	3.5	2.7	3.2
Distribution %				
103.0-108.9	0.0	1.4	0.0	0.0
109.0-114.9	14.5	48.6	0.0	20.0
115.0-120.9	54.8	44.6	55.6	60.0
121.0-126.9	27.4	5.4	44.4	20.0
127.0-132.9	3.2	0.0	0.0	0.0
Females (N)		9	10	8
Minimum value		108.8	112.9	117.7
Average value		116.1	118.1	120.9
Maximum value		122.0	121.5	125.8
Standard dev.		4.5	2.5	2.3
Distribution %				
103.0-108.9		11.1	0.0	0.0
109.0-114.9		22.2	10.0	0.0
115.0-120.9		55.6	70.0	75.0
121.0-126.9		11.1	20.0	25.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	125.0	Kanalda	116.8
		Keilor	122.4

Occipital index:
103.0-108.9 = very flat occipital
109.0-114.9 = flat occipital
115.0-120.9 = medium occipital
121.0-126.9 = bulbous occipital
127.0-132.9 = very bulbous occipital

Table 65. Upper facial index (NPH*100/ZYB).

	China	Java	N.G.	Australia
Total series (N)	59	99	44	21
Minimum value	44.5	42.3	43.1	40.6
Average value	52.7	51.8	51.6	49.2
Maximum value	62.3	62.5	59.3	55.9
Standard dev.	3.8	3.4	3.6	3.2
Distribution %				
40.0-44.9	1.7	3.0	6.8	4.8
45.0-49.9	27.1	25.3	27.3	66.7
50.0-54.9	47.5	56.6	50.0	23.8
55.0-59.9	16.9	14.1	15.9	4.8
60.0-64.9	6.8	1.0	0.0	0.0
Males (N)	59	75	19	16
Minimum value	44.5	42.9	44.7	46.3
Average value	52.7	52.0	51.2	49.3
Maximum value	62.3	62.5	55.1	55.9
Standard dev.	3.8	3.5	3.0	2.5
Distribution %				
40.0-44.9	1.7	2.7	5.3	0.0
45.0-49.9	27.1	25.3	31.6	75.0
50.0-54.9	47.5	54.7	57.9	18.8
55.0-59.9	16.9	16.0	5.3	6.3
60.0-64.9	6.8	1.3	0.0	0.0
Females (N)		7	25	5
Minimum value		46.7	43.1	40.6
Average value		52.0	52.0	48.7
Maximum value		55.8	59.3	53.9
Standard dev.		3.1	4.0	5.1
Distribution %				
40.0-44.9		0.0	8.0	20.0
45.0-49.9		14.3	24.0	40.0
50.0-54.9		57.1	44.0	40.0
55.0-59.9		28.6	24.0	0.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	45.8	Kanalda	45.9

Upper facial index:
40.0-44.9 = very broad face
45.0-49.9 = broad face
50.0-54.9 = medium face
55.0-59.9 = narrow face
60.0-64.9 = very narrow face

Table 66. Prognathic index (BPL*100/BNL).

	China	Java	N.G.	Australia
Total series (N)	60	98	47	21
Minimum value	89.8	92.0	93.5	93.6
Average value	96.2	100.0	102.5	100.8
Maximum value	106.3	109.1	112.6	109.8
Standard dev.	3.6	3.6	3.8	4.4
Distribution %				
85.0-89.9	5.0	0.0	0.0	0.0
90.0-94.9	31.7	7.1	4.3	9.5
95.0-99.9	46.7	41.8	12.8	33.3
100.0-104.9	15.0	41.8	57.4	38.1
105.0-109.9	1.7	9.2	21.3	19.0
110.0-114.9	0.0	0.0	4.3	0.0
Males (N)	60	75	21	16
Minimum value	89.8	92.0	99.0	93.6
Average value	96.2	99.5	102.4	100.3
Maximum value	106.3	107.4	107.1	109.8
Standard dev.	3.6	3.4	2.5	4.6
Distribution %				
85.0-89.9	5.0	0.0	0.0	0.0
90.0-94.9	31.7	8.0	0.0	12.5
95.0-99.9	46.7	46.7	9.5	31.3
100.0-104.9	15.0	37.3	71.4	43.8
105.0-109.9	1.7	8.0	19.0	12.5
Females (N)		7	26	5
Minimum value		98.9	93.5	97.9
Average value		103.5	102.6	102.5
Maximum value		109.1	112.6	107.1
Standard dev.		3.8	4.6	4.0
Distribution %				
90.0-94.9		0.0	7.7	0.0
95.0-99.9		14.3	15.4	40.0
100.0-104.9		57.1	46.2	20.0
105.0-109.9		28.6	23.1	40.0
110.0-114.9		0.0	7.7	0.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	98.2	Kanalda	101.9

Prognathic index:
85.0-89.9 = strong orthognathous face
90.0-94.9 = orthognathous face
95.0-99.9 = medium, slightly orthognathous face
100.0-104.9 = medium, slightly prognathous face
105.0-109.9 = prognathous face
110.0-114.9 = strong prognathous face

Table 67. Nasal index (NLB*100/NLH).

	China	Java	N.G.	Australia
Total series (N)	63	104	59	37
Minimum value	40.0	41.0	39.7	48.5
Average value	49.1	51.2	52.4	56.9
Maximum value	60.7	61.8	62.7	69.6
Standard dev.	4.1	4.1	4.0	4.8
Distribution %				
38.0-42.9	6.3	2.9	1.7	0.0
43.0-47.9	33.3	19.2	5.1	0.0
48.0-52.9	42.9	42.3	57.6	24.3
53.0-57.9	15.9	33.7	23.7	32.4
58.0-62.9	1.6	1.9	11.9	32.4
63.0-67.9	0.0	0.0	0.0	8.1
68.0-72.9	0.0	0.0	0.0	2.7
Males (N)	63	78	27	29
Minimum value	40.0	41.0	44.4	48.7
Average value	49.1	50.8	52.4	57.4
Maximum value	60.7	61.8	59.1	69.6
Standard dev.	4.1	4.1	3.6	4.6
Distribution %				
38.0-42.9	6.3	3.8	0.0	0.0
43.0-47.9	33.3	19.2	7.4	0.0
48.0-52.9	42.9	47.4	55.6	17.2
53.0-57.9	15.9	26.9	22.2	37.9
58.0-62.9	1.6	2.6	14.8	34.5
63.0-67.9	0.0	0.0	0.0	6.9
68.0-72.9	0.0	0.0	0.0	3.4
Females (N)		9	32	8
Minimum value		43.2	39.7	48.5
Average value		51.9	52.5	54.9
Maximum value		56.9	62.7	64.4
Standard dev.		4.1	4.3	5.2
Distribution %				
38.0-42.9		0.0	3.1	0.0
43.0-47.9		11.1	3.1	0.0
48.0-52.9		33.3	59.4	50.0
53.0-57.9		55.6	25.0	12.5
58.0-62.9		0.0	9.4	25.0
63.0-67.9		0.0	0.0	12.5

Prehistoric skulls China		Indonesia		Australia	
Liujiang	59.2	Wajak-1	59.4	Kanalda	55.9
U.C.1	61.1	L.T.	45.0	Keilor	50.9
U.C.2	56.8			K.S.5	59.8
U.C.3	53.1			K.S.15	48.2

Nasal index:
38.0-42.9 = hyperleptorrhiny (very narrow nasal aperture)
43.0-47.9 = leptorrhiny (narrow nasal aperture)
48.0-52.9 = mesorrhiny (medium nasal aperture)
53.0-57.9 = platyrrhiny (broad nasal aperture)
58.0-62.9 = hyperplatyrrhiny (very broad nasal aperture)

Table 68. Maxillo-alveolar index (MAB*100/MAL).

	China	Java	N.G.	Australia
Total series (N)	51	91	35	19
Minimum value	105.2	103.1	100.0	103.6
Average value	121.7	121.3	109.3	113.3
Maximum value	140.0	142.3	126.3	122.6
Standard dev.	8.2	7.8	5.4	5.8
Distribution %				
100.0-104.9	0.0	2.2	20.0	5.3
105.0-109.9	7.8	2.2	40.0	21.1
110.0-114.9	13.7	14.3	25.7	31.6
115.0-119.9	11.8	23.1	8.6	21.1
120.0-124.9	29.4	28.6	2.9	21.1
125.0-129.9	21.6	16.5	2.9	0.0
130.0-134.9	11.8	9.9	0.0	0.0
135.0-139.9	2.0	1.1	0.0	0.0
140.0-144.9	2.0	2.2	0.0	0.0
Males (N)	51	70	15	14
Minimum value	105.2	103.1	101.7	105.3
Average value	121.7	121.5	109.6	113.1
Maximum value	140.0	142.3	126.3	121.7
Standard dev.	8.2	7.5	6.5	5.1
Distribution %				
.....-109.9	7.8	1.4	60.0	28.6
110.0-114.9	13.7	17.1	26.7	28.6
115.0-.....	78.4	81.4	13.3	42.9
Females (N)		7	20	5
Minimum value		115.8	100.0	103.6
Average value		120.6	109.0	114.1
Maximum value		125.0	117.0	122.6
Standard dev.		4.0	4.6	8.0

Prehistoric skulls

Indonesia		Australia	
Wajak-1	116.4	Kanalda	125.0
Wajak-2	129.0		
L.T.	98.3		

Maxillo-alveolar index:
.........-109.9 = dolichurany (narrow palate)
110.0-114.9 = mesurany (medium palate)
115.0-......... = brachyurany (broad palate)

Table 69. Mandibular index (W1*100/ML).

	China	Java	Australia
Total series (N)	62	98	18
Minimum value	102.5	96.7	95.4
Average value	118.9	114.4	108.3
Maximum value	141.3	133.5	122.8
Standard dev.	8.6	7.6	6.7
Distribution %			
91.0-100.9	0.0	2.0	11.1
101.0-110.9	22.6	29.6	55.6
111.0-120.9	38.7	48.0	27.8
121.0-130.9	30.6	19.4	5.6
131.0-140.9	6.5	1.0	0.0
141.0-150.9	1.6	0.0	0.0
Males (N)	62	75	14
Minimum value	102.5	100.9	95.4
Average value	118.9	114.7	108.4
Maximum value	141.3	133.5	122.8
Standard dev.	8.6	7.6	7.3
Distribution %			
91.0-100.9	0.0	1.3	14.3
101.0-110.9	22.6	29.3	50.0
111.0-120.9	38.7	46.7	28.6
121.0-130.9	30.6	21.3	7.1
131.0-140.9	6.5	1.3	0.0
141.0-150.9	1.6	0.0	0.0
Females (N)		9	4
Minimum value		101.0	105.0
Average value		113.7	107.9
Maximum value		121.7	114.4
Standard dev.		6.7	4.4

Prehistoric skulls Indonesia		Australia	
L.T.	122.0	Kanalda	116.4
L.M.E	107.3	K.S.5	127.9

Mandibular index:
91.0-100.9 = very narrow mandible
101.0-110.9 = narrow mandible
111.0-120.9 = medium mandible
121.0-130.9 = broad mandible
131.0-140.9 = very broad mandible

Table 70. Mandibula L-H index (CrH*100/ML).

	China	Java	Australia
Total series (N)	63	98	20
Minimum value	54.2	50.5	49.5
Average value	66.4	61.3	58.9
Maximum value	83.3	77.3	68.5
Standard dev.	6.2	5.5	4.3
Distribution %			
41.0-50.9	0.0	3.1	5.0
51.0-60.9	12.7	49.0	80.0
61.0-70.9	66.7	39.8	15.0
71.0-80.9	17.5	8.2	0.0
81.0-90.9	3.2	0.0	0.0
Males (N)	63	75	15
Minimum value	54.2	50.9	49.5
Average value	66.4	61.9	58.5
Maximum value	83.3	77.3	66.7
Standard dev.	6.2	5.6	4.0
Distribution %			
41.0-50.9	0.0	1.3	6.7
51.0-60.9	12.7	49.3	80.0
61.0-70.9	66.7	38.7	13.3
71.0-80.9	17.5	10.7	0.0
81.0-90.9	3.2	0.0	0.0
Females (N)		9	5
Minimum value		50.9	53.6
Average value		58.3	60.3
Maximum value		62.8	68.5
Standard dev.		4.7	5.4

Prehistoric skulls

Indonesia		Australia	
Wajak-2	64.9	Kanalda	62.1
L.M.E	52.7	K.S.5	65.4

Mandibula length-height index:
41.0-50.9 = very low mandible
51.0-60.9 = low mandible
61.0-70.9 = medium mandible
71.0-80.9 = high mandible
81.0-90.9 = very high mandible

Table 71. Cranial module ({GOL+XCB+BBH}/3).

	China	Java	N.G.	Australia
Total series (N)	63	103	50	36
Minimum value	142.3	136.0	133.3	137.3
Average value	152.8	149.3	144.3	148.8
Maximum value	160.3	160.3	153.7	161.3
Standard dev.	3.6	4.4	4.8	6.0
Distribution %				
130.0-134.9	0.0	0.0	2.0	0.0
135.0-139.9	0.0	3.9	14.0	5.6
140.0-144.9	3.2	9.7	38.0	19.4
145.0-149.9	12.7	44.7	32.0	30.6
150.0-154.9	54.0	31.1	14.0	25.0
155.0-159.9	27.0	9.7	0.0	16.7
160.0-164.9	3.2	1.0	0.0	2.8
Males (N)	63	78	22	28
Minimum value	142.3	138.7	141.0	139.7
Average value	152.8	149.9	147.9	150.4
Maximum value	160.3	160.3	153.7	161.3
Standard dev.	3.6	4.0	3.4	5.7
Distribution %				
135.0-139.9	0.0	1.3	0.0	3.6
140.0-144.9	3.2	10.3	18.2	14.3
145.0-149.9	12.7	41.0	54.5	25.0
150.0-154.9	54.0	34.6	27.3	32.1
155.0-159.9	27.0	11.5	0.0	21.4
160.0-164.9	3.2	1.3	0.0	3.6
Females (N)		9	28	8
Minimum value		138.7	133.3	137.3
Average value		144.0	141.5	143.4
Maximum value		149.0	151.0	146.3
Standard dev.		3.6	3.7	3.6
Distribution %				
130.0-134.9		0.0	3.6	0.0
135.0-139.9		22.2	25.0	12.5
140.0-144.9		22.2	53.6	37.5
145.0-149.9		55.6	14.3	50.0
150.0-154.9		0.0	3.6	0.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	157.0	Wajak-1	162.7	Kanalda	159.3
U.C.3	155.7	L.M.E	150.3		

Cranial module:
.........-139.9 = very small skull
140.0-144.9 = small skull
145.0-149.9 = medium skull
150.0-154.9 = large skull
155.0-......... = very large skull

Table 72. Facial module ({BPL+NPH+ZYB}/3).

	China	Java	N.G.	Australia
Total series (N)	59	98	41	20
Minimum value	91.9	90.4	86.5	88.8
Average value	99.2	100.0	94.7	98.6
Maximum value	105.8	108.7	103.5	105.1
Standard dev.	3.2	3.4	4.0	4.6
Distribution %				
85.0-89.9	0.0	0.0	17.1	5.0
90.0-94.9	13.6	6.1	34.1	15.0
95.0-99.9	42.4	43.9	39.0	40.0
100.0-104.9	42.4	42.9	9.8	35.0
105.0-109.9	1.7	7.1	0.0	5.0
Males (N)	59	75	17	15
Minimum value	91.9	90.4	93.2	94.8
Average value	99.2	100.2	97.6	100.2
Maximum value	105.8	108.7	103.5	105.1
Standard dev.	3.2	3.3	2.9	3.6
Distribution %				
90.0-94.9	13.6	4.0	17.6	6.7
95.0-99.9	42.4	42.7	58.8	40.0
100.0-104.9	42.4	45.3	23.5	46.7
105.0-109.9	1.7	8.0	0.0	6.7
Females (N)		7	24	5
Minimum value		93.0	86.5	88.8
Average value		95.7	92.5	93.8
Maximum value		98.0	99.3	99.0
Standard dev.		2.3	3.3	4.2
Distribution %				
85.0-89.9		0.0	29.2	20.0
90.0-94.9		42.9	45.8	40.0
95.0-99.9		57.1	25.0	40.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	105.7	Kanalda	110.2

Facial module:
85.0-89.9 = very small face
90.0-94.9 = small face
95.0-99.9 = medium face
100.0-104.9 = large face
105.0-109.9 = very large face

Table 73. Maxilloalveolar module (MAL*MAB/100).

	China	Java	N.G.	Australia
Total series (N)	51	91	35	19
Minimum value	24.6	28.8	29.7	31.6
Average value	33.9	35.7	35.0	38.4
Maximum value	42.8	43.6	41.0	44.6
Standard dev.	3.8	3.1	3.1	4.1
Distribution %				
20.0-24.9	2.0	0.0	0.0	0.0
25.0-29.9	13.7	1.1	2.9	0.0
30.0-34.9	39.2	40.7	42.9	26.3
35.0-39.9	41.2	49.5	48.6	31.6
40.0-44.9	3.9	8.8	5.7	42.1
Males (N)	51	70	15	14
Minimum value	24.6	30.1	31.3	34.0
Average value	33.9	35.5	37.0	39.8
Maximum value	42.8	43.6	41.0	44.6
Standard dev.	3.8	3.0	2.3	3.7
Distribution %				
20.0-24.9	2.0	0.0	0.0	0.0
25.0-29.9	13.7	0.0	0.0	0.0
30.0-34.9	39.2	44.3	6.7	14.3
35.0-39.9	41.2	48.6	80.0	28.6
40.0-44.9	3.9	7.1	13.3	57.1
Females (N)		7	20	5
Minimum value		28.8	29.7	31.6
Average value		33.7	33.5	34.4
Maximum value		39.2	38.9	37.7
Standard dev.		3.7	2.8	2.5
Distribution %				
25.0-29.9		14.3	5.0	0
30.0-34.9		57.1	70.0	60.0
35.0-39.9		28.6	25.0	40.0

Prehistoric skulls Indonesia		Australia	
Wajak-1	43.3	Kanalda	51.2
Wajak-2	49.6		
L.T.	35.4		

Maxilla module:
20.0-24.9 = very small maxilla
25.0-29.9 = small maxilla
30.0-34.9 = medium maxilla
35.0-39.9 = large maxilla
40.0-44.9 = very large maxilla

Table 74. Mandibula module ({ML+W1+CrH}/3).

	China	Java	Australia
Total series (N)	62	98	18
Minimum value	89.3	86.7	86.7
Average value	96.6	95.7	93.4
Maximum value	105.2	105.6	99.0
Standard dev.	4.0	3.8	4.4
Distribution %			
85.0-89.9	8.1	7.1	27.8
90.0-94.9	25.8	33.7	22.2
95.0-99.9	45.2	48.0	50.0
100.0-104.9	17.7	10.2	0.0
105.0-109.9	3.2	1.0	0.0
Males (N)	62	75	14
Minimum value	89.3	86.7	87.0
Average value	96.6	96.0	94.2
Maximum value	105.2	105.6	97.8
Standard dev.	4.0	3.7	3.7
Distribution %			
85.0-89.9	8.1	6.7	14.3
90.0-94.9	25.8	32.0	28.6
95.0-99.9	45.2	49.3	57.1
100.0-104.9	17.7	10.7	0.0
105.0-109.9	3.2	1.3	0.0
Females (N)		9	4
Minimum value		86.8	86.7
Average value		92.4	90.4
Maximum value		97.1	99.0
Standard dev.		3.1	5.8

Prehistoric skulls Indonesia		Australia	
L.M.E	97.1	Kanalda	107.7
		K.S.5	104.6

Mandibula module:
85.0-89.9 = very small mandible
90.0-94.9 = small mandible
95.0-99.9 = medium mandible
100.0-104.9 = large mandible
105.0-109.9 = very large mandible

Table 75. Corpus mandibula module ({CHe+CTh+SHe+STh}/4).

	China	Java	Australia
Total series (N)	41	63	15
Minimum value	18.6	19.7	15.1
Average value	23.0	22.5	21.3
Maximum value	26.7	26.7	24.2
Standard dev.	2.1	1.5	2.4
Distribution %			
15.0-19.9	12.2	1.6	13.3
20.0-24.9	70.7	95.2	86.7
25.0-29.9	17.1	3.2	0.0
Males (N)	41	48	12
Minimum value	18.6	19.7	20.0
Average value	23.0	22.5	22.0
Maximum value	26.7	25.0	23.5
Standard dev.	2.1	1.4	1.2
Distribution %			
15.0-19.9	12.2	2.1	0.0
20.0-24.9	70.7	95.8	100.0
25.0-29.9	17.1	2.1	0.0
Females (N)		4	3
Minimum value		20.3	15.1
Average value		21.7	18.9
Maximum value		23.0	24.2
Standard dev.		1.1	4.8

Prehistoric skulls Indonesia		Australia	
Wajak-2	28.9	Kanalda	25.7
Sampung	24.0		
L.T.	22.7		

Corpus mandibula module:
15.0-19.9 = small corpus
20.0-24.9 = medium corpus
25.0-29.9 = large corpus

Table 76. Cross-sectional area upper M1 (MD*BL).

	China	Java	N.G.	Australia
Total series (N)	47	94	32	27
Minimum value	66.6	97.8	103.0	114.3
Average value	109.5	122.2	122.6	137.1
Maximum value	128.4	160.0	155.0	176.1
Standard dev.	11.4	12.7	11.8	14.1
Distribution %				
60.1-80.0	2.1	0.0	0.0	0.0
80.1-100.0	12.8	2.1	0.0	0.0
100.1-120.0	63.8	45.7	50.0	3.7
120.1-140.0	21.3	43.6	40.6	63.0
140.1-160.0	0.0	8.5	9.4	25.9
160.1-180.0	0.0	0.0	0.0	7.4
Males (N)	47	69	11	21
Minimum value	66.6	97.8	103.0	114.3
Average value	109.5	122.1	124.1	138.1
Maximum value	128.4	154.8	155.0	176.1
Standard dev.	11.4	12.0	16.5	14.7
Distribution %				
60.1-80.0	2.1	0.0	0.0	0.0
80.1-100.0	12.8	2.9	0.0	0.0
100.1-120.0	63.8	42.0	36.4	4.8
120.1-140.0	21.3	47.8	45.5	57.1
140.1-160.0	0.0	7.2	18.2	28.6
160.1-180.0	0.0	0.0	0.0	9.5
Females (N)		9	21	6
Minimum value		104.0	111.2	120.6
Average value		123.8	121.8	133.4
Maximum value		160.0	143.8	154.8
Standard dev.		17.8	8.9	11.7
Distribution %				
100.1-120.0		55.6	57.1	0.0
120.1-140.0		33.3	38.1	83.3
140.1-160.0		11.1	4.8	16.7

Prehistoric skulls Indonesia				Australia	
Wajak-1	151.8	L.T.	113.9	Kanalda	152.8
Wajak-2	154.6	L.M.E	122.0	K.S.15	138.2
Hoekgrot	127.5	Alo.1	122.9		
G.Jimbe	135.0	Alo.2	123.9		
G.Kecil	121.5	Aimere	133.1		
		G.K.C77	120.8		

Cross-sectional area molars:
.........-80.0 = very small
80.1-100.0 = small
100.1-120.0 = medium, at the small side
120.1-140.0 = medium, at the large side
140.1-160.0 = large
160.1-......... = very large

Table 77. Cross-sectional area upper M2 (MD*BL). For an explanation of the values see Table 76.

	China	Java	N.G.	Australia
Total series (N)	55	95	27	31
Minimum value	75.8	67.9	76.5	101.0
Average value	102.3	107.9	106.7	133.0
Maximum value	131.4	140.1	140.2	204.5
Standard dev.	12.0	12.4	15.3	21.3
Distribution %				
60.1-80.0	1.8	1.1	3.7	0.0
80.1-100.0	43.6	23.2	25.9	0.0
100.1-120.0	47.3	61.1	55.6	29.0
120.1-140.0	7.3	13.7	11.1	35.5
140.1-160.0	0.0	1.1	3.7	25.8
160.1-180.0	0.0	0.0	0.0	6.5
180.1-200.0	0.0	0.0	0.0	0.0
200.1-220.0	0.0	0.0	0.0	3.2
Males (N)	55	72	13	25
Minimum value	75.8	85.5	76.5	101.6
Average value	102.3	107.4	108.4	135.6
Maximum value	131.4	140.1	140.2	204.5
Standard dev.	12.0	11.8	19.7	22.5
Distribution %				
40.1-80.0	1.8	0.0	7.7	0.0
80.1-120.0	90.9	87.5	69.2	32.0
120.1-160.0	7.3	12.5	23.1	56.0
160.1-200.0	0.0	0.0	0.0	8.0
200.1-240.0	0.0	0.0	0.0	4.0
Females (N)		8	14	6
Minimum value		93.7	91.0	101.0
Average value		105.8	105.1	121.9
Maximum value		117.0	130.0	132.7
Standard dev.		7.3	10.2	10.8
Distribution %				
80.1-100.0		12.5	21.4	0.0
100.1-120.0		87.5	71.4	16.7
120.1-140.0		0.0	7.1	83.3

Prehistoric skulls Indonesia				Australia	
Wajak-1	145.2	L.T.	100.3	Kanalda	162.8
Wajak-2	143.6	L.M.E	122.0	K.S.15	162.0
Hoekgrot	128.1	Alo.1	104.7		
G.Jimbe	125.8	Alo.2	94.2		
G.Kecil	118.4	Aimere	129.5		
		G.K.C77	115.0		

Table 78. Cross-sectional area upper M3 (MD*BL). For an explanation of the values see Table 76.

	China	Java	N.G.	Australia
Total series (N)	38	65	18	22
Minimum value	54.6	71.4	74.5	82.2
Average value	87.7	99.0	97.1	114.5
Maximum value	129.0	137.8	136.5	149.8
Standard dev.	16.6	14.6	15.6	17.4
Distribution %				
40.1-60.0	5.3	0.0	0.0	0.0
60.1-80.0	26.3	7.7	16.7	0.0
80.1-100.0	42.1	47.7	55.6	22.7
100.1-120.0	23.7	32.3	22.2	54.5
120.1-140.0	2.6	12.3	5.6	9.1
140.1-160.0	0.0	0.0	0.0	13.6
Males (N)	38	51	11	17
Minimum value	54.6	71.4	74.5	90.7
Average value	87.7	98.5	99.3	118.4
Maximum value	129.0	137.8	136.5	149.8
Standard dev.	16.6	14.4	18.8	16.7
Distribution %				
40.1-60.0	5.3	0.0	0.0	0.0
60.1-80.0	26.3	5.9	18.2	0.0
80.1-100.0	42.1	51.0	45.5	11.8
100.1-120.0	23.7	31.4	27.3	58.8
120.1-140.0	2.6	11.8	9.1	11.8
140.1-160.0	0.0	0.0	0.0	17.6
Females (N)		4	7	5
Minimum value		74.9	76.5	82.2
Average value		95.8	93.8	101.4
Maximum value		115.0	101.9	118.4
Standard dev.		16.6	8.9	13.9

Prehistoric skulls Indonesia				Australia	
Wajak-1	105.6	L.T.	92.0	Kanalda	137.6
Wajak-2	138.2	L.M.E	109.4	K.S.15	126.7
Hoekgrot	99.4	Alo.1	89.6		
G.Jimbe	95.8	Aimere	138.2		
		G.K.C77	88.2		

Table 79. Total cross-sectional area upper molars (M1{MD*BL} + M2{MD*BL} + M3{MD*BL}).

	China	Java	N.G.	Australia
Total series (N)	29	60	11	20
Minimum value	253.5	257.4	272.0	303.8
Average value	303.6	330.3	322.2	383.2
Maximum value	357.6	414.7	386.9	459.1
Standard dev.	29.4	33.5	30.5	38.8
Distribution %				
250.1-300.0	48.3	21.7	9.1	0.0
300.1-350.0	37.9	48.3	72.7	15.0
350.1-400.0	13.8	26.7	18.2	55.0
400.1-450.0	0.0	3.3	0.0	25.0
450.1-500.0	0.0	0.0	0.0	5.0
Males (N)	29	47	6	15
Minimum value	253.5	273.7	272.0	338.7
Average value	303.6	329.4	321.8	393.7
Maximum value	357.6	414.7	386.9	459.1
Standard dev.	29.4	32.8	38.8	36.4
Distribution %				
250.1-300.0	48.3	23.4	16.7	0.0
300.1-350.0	37.9	46.8	66.7	13.3
350.1-400.0	13.8	25.5	16.7	46.7
400.1-450.0	0.0	4.3	0.0	33.3
450.1-500.0	0.0	0.0	0.0	6.7
Females (N)		3	5	5
inimum value		295.5	303.5	303.8
Average value		327.9	322.6	351.5
Maximum value		357.3	352.5	379.9
Standard dev.		31.0	21.1	29.3

Prehistoric skulls Indonesia				Australia	
Wajak-1	402.6	L.T.	306.1	Kanalda	453.2
Wajak-2	436.5	L.M.E	353.5	K.S.15	427.0
Hoekgrot	355.1	Alo.1	317.2		
G.Jimbe	356.5	Aimere	400.9		
		G.K.C77	324.0		

Total cross-sectional area molars:
250.1-300.0 = small
300.1-350.0 = medium
350.1-400.0 = large
400.1-450.0 = very large
450.1-500.0 = extraordinary large

Table 80. Development (%) inclinatio frontale.

		China	Java	N.G.	Australia
Total series (N)		63	105	64	42
vertical	(0)	23.8	18.1	7.8	2.4
ambiguous	(1)	58.7	69.5	78.1	26.2
strong	(2)	17.5	12.4	14.1	71.4
Males (N)		63	79	30	34
vertical	(0)	23.8	15.2	3.3	0.0
ambiguous	(1)	58.7	70.9	66.7	17.6
strong	(2)	17.5	13.9	30.0	82.4
Females (N)		9	34	8	
vertical	(0)	22.2	11.8	12.5	
ambiguous	(1)	66.7	88.2	62.5	
strong	(2)	11.1	0.0	25.0	

Prehistoric skulls China		Indonesia				Australia	
Liujiang	2	Wajak-1	2	L.T.	1	Kanalda	1
U.C.1	2	Wajak-2	2	L.M.E	1	Keilor	2
U.C.3	1	Hoekgrot	1			K.S.1	2
		Sampung	2			K.S.5	2

Table 81. Presence (%) keeling of the vault.

	China	Java	N.G.	Australia
Total series (N)	63	105	63	42
trace/distinct	6.3	1.0	31.7	50.0
Males (N)	63	79	29	34
trace/distinct	6.3	1.3	55.2	50.0
Females (N)		9	34	8
trace/distinct		0.0	11.8	50.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	0	Wajak-1	0	Kanalda	2
U.C.1	0	Sampung	0	Keilor	0
U.C.3	0	L.T.	0	K.S.1	0
		L.M.E	0	K.S.5	2
		G.K.B347	0	Mungo-1	0
				Mungo-3	1

0 = absent; 1 = trace/slight; 2 = distinct.

Table 82. Development (%) median frontal ridge.

		China	Java	N.G.	Australia
Total series (N)		63	105	57	41
absent	(0)	93.7	93.3	77.2	51.2
trace	(1)	6.3	4.8	22.8	26.8
distinct	(2)	0.0	1.9	0.0	22.0
Males (N)		63	79	28	33
absent	(0)	93.7	94.9	75.0	48.5
trace	(1)	6.3	5.1	25.0	24.2
distinct	(2)	0.0	0.0	0.0	27.3
Females (N)			9	29	8
absent	(0)		100.0	79.3	62.5
trace	(1)		0.0	20.7	37.5
distinct	(2)		0.0	0.0	0.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	0	Wajak-1	0	Kanalda	2
U.C.1	0	Sampung	0	Keilor	0
U.C.2	1	L.T.	0	K.S.1	1
U.C.3	0	L.M.E	0		
		G.K.B347	0		

Table 83. Development (%) glabella.

		China	Java	N.G.	Australia
Total series (N)		63	105	64	42
smooth	(0)	36.5	21.0	14.1	2.4
slightly	(1)	36.5	35.2	23.4	9.5
delimited	(2)	23.8	36.2	21.9	11.9
marked	(3)	1.6	5.7	18.8	14.3
massive	(4)	1.6	1.9	21.9	61.9
Males (N)		63	79	30	34
smooth	(0)	36.5	20.3	0.0	2.9
slightly	(1)	36.5	32.9	3.3	2.9
delimited	(2)	23.8	39.2	13.3	5.9
marked	(3)	1.6	5.1	36.7	11.8
massive	(4)	1.6	2.5	46.7	76.5
Females (N)			9	34	8
smooth	(0)		55.6	26.5	0.0
slightly	(1)		11.1	41.2	37.5
delimited	(2)		33.3	29.4	37.5
marked	(3)		0.0	2.9	25.0
massive	(4)		0.0	0.0	0.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	3	Wajak-1	4	Kanalda	4
U.C.1	4	Wajak-2	4	Keilor	2
U.C.2	2	Hoekgrot	3	K.S.1	4
U.C.3	3	Sampung	2	K.S.5	4
		L.T.	1	K.S.15	4
		L.M.E	2		

Table 84. Development (%) superciliary arches.

		China	Java	N.G.	Australia
Total series (N)		63	105	63	42
smooth	(0)	4.8	13.3	9.5	2.4
slightly	(1)	44.4	22.9	22.2	9.5
delimited	(2)	31.7	47.6	33.3	11.9
marked	(3)	17.5	12.4	9.5	21.4
very marked	(4)	1.6	3.8	25.4	54.8
Males (N)		63	79	29	34
smooth	(0)	4.8	8.9	0.0	0.0
slightly	(1)	44.4	21.5	0.0	2.9
delimited	(2)	31.7	51.9	24.1	2.9
marked	(3)	17.5	13.9	20.7	26.5
very marked	(4)	1.6	3.8	55.2	67.6
Females (N)			9	34	8
smooth	(0)		44.4	17.6	12.5
slightly	(1)		33.3	41.2	37.5
delimited	(2)		22.2	41.2	50.0
marked	(3)		0.0	0.0	0.0
very marked	(4)		0.0	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	3	Wajak-1	3	Kanalda	4
U.C.1	4	Wajak-2	3	Keilor	4
U.C.2	1	Hoekgrot	3	K.S.1	4
U.C.3	0	Sampung	4	K.S.5	4
		L.T.	1	K.S.15	4
		L.M.E	2		

Table 85. Development (%) zygomatic trigones.

		Java	Australia
Total series (N)		50	41
absent/slight	(0)	100.0	78.0
medium	(1)	0.0	19.5
large	(2)	0.0	2.4
Males (N)		41	33
absent/slight	(0)	100.0	72.7
medium	(1)	0.0	24.2
large	(2)	0.0	3.0
Females (N)		8	8
absent/slight	(0)	100.0	100.0
medium	(1)	0.0	0.0
large	(2)	0.0	0.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	0	Wajak-1	0	Kanalda	1
U.C.1	2	Wajak-2	0	Keilor	0
U.C.2	0	Hoekgrot	0	K.S.1	2
U.C.3	0	Sampung	0	K.S.5	1
		L.T.	0	K.S.15	2
		L.M.E	0	Mungo-1	0
				Mungo-2	1

Table 86. Development (%) frontal tubera.

		China	Java	N.G.	Australia
Total series (N)		63	105	60	42
missing/indist.	(0)	27.0	26.7	46.7	97.6
moderate	(1)	25.4	29.5	46.7	2.4
medium/marked	(2)	47.6	43.8	6.7	0.0
Males (N)		63	79	29	34
missing/indist.	(0)	27.0	25.3	69.0	97.1
moderate	(1)	25.4	31.6	27.6	2.9
medium/marked	(2)	47.6	43.0	3.4	0.0
Females (N)			9	31	8
missing/indist.	(0)		44.4	25.8	100.0
moderate	(1)		11.1	64.5	0.0
medium/marked	(2)		44.4	9.7	0.0

Prehistoric skulls China		Indonesia		Australia	
Liujiang	0	Wajak-1	0	Kanalda	0
U.C.1	0	Hoekgrot	2	Keilor	0
U.C.2	1	Sampung	0	K.S.1	0
U.C.3	0	L.T.	0	K.S.5	0
		L.M.E	1	K.S.15	0
				Mungo-3	0

Table 87. Development (%) parietal tubera.

		China	Java	N.G.	Australia
Total series(N)		63	105	64	41
missing/indist.	(0)	22.2	8.6	20.3	43.9
moderate	(1)	31.7	41.0	31.3	22.0
medium/marked	(2)	46.0	50.5	48.4	34.1
Males (N)		63	79	30	34
missing/indist.	(0)	22.2	10.1	26.7	41.2
moderate	(1)	31.7	41.8	40.0	23.5
medium/marked	(2)	46.0	48.1	33.3	35.3
Females (N)			9	34	7
missing/indist.	(0)		0.0	14.7	57.1
moderate	(1)		33.3	23.5	14.3
medium/marked	(2)		66.7	61.8	28.6

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	0	Wajak-1	1	Kanalda	1
U.C.1	0	Hoekgrot	2	Keilor	0
U.C.3	1	Sampung	2	K.S.1	2
		L.T.	0	K.S.5	1
		L.M.E	0	Mungo-1	2
				Mungo-3	0

Table 88. Development (%) mastoid process.

		China	Java	N.G.	Australia
Total series (N)		63	104	58	41
very small	(0)	23.8	19.2	65.5	46.3
small	(1)	27.0	30.8	20.7	14.6
medium	(2)	33.3	27.9	6.9	22.0
large	(3)	9.5	12.5	6.9	9.8
very large	(4)	6.3	9.6	0.0	7.3
Males (N)		63	79	25	33
very small	(0)	23.8	17.7	40.0	33.3
small	(1)	27.0	31.6	32.0	18.2
medium	(2)	33.3	30.4	12.0	27.3
large	(3)	9.5	13.9	16.0	12.1
very large	(4)	6.3	6.3	0.0	9.1
Females (N)			9	33	8
very small	(0)		44.4	84.8	100.0
small	(1)		22.2	12.1	0.0
medium	(2)		22.2	3.0	0.0
large	(3)		0.0	0.0	0.0
very large	(4)		11.1	0.0	0.0

Prehistoric skulls

China		Indonesia				Australia	
Liujiang	1	Wajak-1	1	L.T.	0	Kanalda	3
U.C.1	2	Wajak-2	4	L.M.E	2	Keilor	2
U.C.2	4	Hoekgrot	0	Alo.1	3	K.S.5	3
U.C.3	1	Sampung	1				

Table 89. Development (%) supramastoid crest.

		China	Java	N.G.	Australia
Total series (N)		63	105	63	42
smooth/small	(0)	23.8	21.0	30.2	21.4
medium	(1)	41.3	35.2	52.4	33.3
marked/strong	(2)	34.9	43.8	17.4	45.2
Males (N)		63	79	29	34
smooth/small	(0)	23.8	20.3	17.2	11.8
medium	(1)	41.3	29.1	48.3	32.4
marked/strong	(2)	34.9	50.6	34.5	55.9
Females (N)			9	34	8
smooth/small	(0)		44.4	41.2	62.5
medium	(1)		33.3	55.9	37.5
marked/strong	(2)		22.2	2.9	0.0

Prehistoric skulls

China		Indonesia				Australia	
Liujiang	1	Wajak-1	1	L.T.	1	Kanalda	0
U.C.1	1	Wajak-2	2	L.M.E	1	K.S.5	2
U.C.2	0	Hoekgrot	2	Aimere	1		
		Sampung	0				

Table 90. Development (%) occipital torus.

		China	Java	N.G.	Australia
Total series (N)		63	105	61	41
absent	(0)	46.0	75.2	41.0	22.0
trace	(1)	30.2	17.1	23.0	19.5
distinct	(2)	23.8	7.6	36.1	58.5
Males (N)		63	79	28	33
absent	(0)	46.0	74.7	21.4	12.1
trace	(1)	30.2	16.5	21.4	21.2
distinct	(2)	23.8	8.9	57.1	66.7
Females (N)			9	33	8
absent	(0)		88.9	57.6	62.5
trace	(1)		11.1	24.2	12.5
distinct	(2)		0.0	18.2	25.0

Prehistoric skulls

China		Indonesia				Australia	
Liujiang	0	Wajak-1	0	L.T.	1	Kanalda	1
U.C.1	2	Wajak-2	0	L.M.E	2	Keilor	2
U.C.2	0	Hoekgrot	0	Aimere	1	K.S.5	1
U.C.3	0	Sampung	0			Mungo-1	0
						Mungo-3	2

Table 91. Development (%) external occipital protuberance.

		Java	Australia
Total series (N)		49	39
absent	(0)	40.8	76.9
trace	(1)	32.7	17.9
distinct	(2)	26.5	5.1
Males (N)		40	32
absent	(0)	40.0	71.9
trace	(1)	30.0	21.9
distinct	(2)	30.0	6.3
Females (N)		8	7
absent	(0)	50.0	100.0
trace	(1)	50.0	0.0
distinct	(2)	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	0	Wajak-1	0	Kanalda	1
U.C.1	0	Wajak-2	2	Keilor	0
U.C.2	0	Hoekgrot	0	K.S.5	0
U.C.3	0	L.T.	0	Mungo-1	0
		L.M.E	0	Mungo-3	1

Table 92. Development (%) nuchal lines / occipital crest.

		China	Java	N.G.	Australia
Total series (N)		63	105	31	40
smooth	(0)	3.2	9.5	0.0	2.5
slightly	(1)	20.6	26.7	32.3	10.0
evident	(2)	41.3	46.7	32.3	30.0
marked	(3)	20.6	14.3	29.0	35.0
marked/rough	(4)	14.3	2.9	6.5	22.5
Males (N)		63	79	13	33
smooth	(0)	3.2	8.9	0.0	3.0
slightly	(1)	20.6	24.1	7.7	3.0
evident	(2)	41.3	48.1	23.1	24.2
marked	(3)	20.6	16.5	53.8	42.4
marked/rough	(4)	14.3	2.5	15.4	27.3
Females (N)			9	18	7
smooth	(0)		11.1	0.0	0.0
slightly	(1)		44.4	50.0	42.9
evident	(2)		44.4	38.9	57.1
marked	(3)		0.0	11.1	0.0
marked/rough	(4)		0.0	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	2	Wajak-1	1	Kanalda	1
U.C.1	1	Aimere	4	Keilor	3
U.C.2	1			K.S.5	4
U.C.3	2				

Table 93. Development (%) orbital form / supraorbital margin.

	China	Java	N.G.	Australia
Total series(N)	63	105	63	42
round/sharp (0)	39.7	15.2	0.0	2.4
round/sharp (1)	36.5	25.7	14.3	11.9
transistory (2)	19.0	37.1	39.7	19.0
quadr./rounded (3)	4.8	14.3	34.9	23.8
quadr./rounded (4)	0.0	7.6	11.1	42.9
Males (N)	63	79	29	34
round/sharp (0)	39.7	17.7	0.0	0.0
round/sharp (1)	36.5	24.1	0.0	2.9
transistory (2)	19.0	36.7	27.6	14.7
quadr./rounded (3)	4.8	13.9	51.7	29.4
quadr./rounded (4)	0.0	7.6	20.7	52.9
Females (N)		9	34	8
round/sharp (0)		22.2	0.0	12.5
round/sharp (1)		22.2	26.5	50.0
transistory (2)		55.6	50.0	37.5
quadr./rounded (3)		0.0	20.6	0.0
quadr./rounded (4)		0.0	2.9	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	3	Wajak-1	3	Kanalda	4
U.C.1	3	Wajak-2	3	Keilor	4
U.C.2	1	Sampung	3	K.S.5	3
U.C.3	3	L.T.	1	K.S.15	4
		L.M.E	2		

Table 94. Flattened (%) lower orbital border.

		China	Java	N.G.	Australia
Total series (N)		63	105	64	42
absent	(0)	84.1	69.5	67.2	31.0
trace	(1)	11.1	28.6	23.4	31.0
distinct	(2)	4.8	1.9	9.4	38.1
Males (N)		63	79	30	34
absent	(0)	84.1	72.2	63.3	29.4
trace	(1)	11.1	26.6	23.3	26.5
distinct	(2)	4.8	1.3	13.3	44.1
Females (N)			9	34	8
absent	(0)		88.9	70.6	37.5
trace	(1)		11.1	23.5	50.0
distinct	(2)		0.0	5.9	12.5

Prehistoric skulls

China		Indonesia				Australia	
U.C.1	2	Wajak-1	0	L.T.	1	Kanalda	1
U.C.2	2	Wajak-2	0	L.M.E	1	K.S.5	2
U.C.3	0	Hoekgrot	0	G.K.C77	0	K.S.15	0
		Sampung	0				

Table 95. Development (%) phaenozygy.

		China	Java	N.G.	Australia
Total series (N)		63	105	62	42
absent	(0)	20.6	26.7	3.2	2.4
ambiguous	(1)	44.4	53.3	19.4	9.5
distinct	(2)	34.9	20.0	77.4	88.1
Males (N)		63	79	28	34
absent	(0)	20.6	27.8	3.6	2.9
ambiguous	(1)	44.4	58.2	3.6	5.9
distinct	(2)	34.9	13.9	92.9	91.2
Females (N)			9	34	8
absent	(0)		44.4	2.9	0.0
ambiguous	(1)		44.4	32.4	25.0
distinct	(2)		11.1	64.7	75.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	1	Wajak-1	2	Kanalda	2
U.C.1	2	L.T.	2	Keilor	2
U.C.2	2	L.M.E	2	K.S.5	2

Table 96. Development (%) os zygomaticum.

		China	Java	N.G.	Australia
Total series (N)		63	105	64	42
low/smooth	(0)	3.2	1.0	29.7	11.9
low/smooth	(1)	6.3	13.3	31.3	23.8
medium	(2)	39.7	44.8	32.8	45.2
high/irreg.	(3)	41.3	24.8	6.3	16.7
high/irreg.	(4)	9.5	16.2	0.0	2.4
Males (N)		63	79	30	34
low/smooth	(0)	3.2	0.0	6.7	5.9
low/smooth	(1)	6.3	12.7	26.7	14.7
medium	(2)	39.7	40.5	56.7	55.9
high/irreg.	(3)	41.3	30.4	10.0	20.6
high/irreg.	(4)	9.5	16.5	0.0	2.9
Females (N)			9	34	8
low/smooth	(0)		11.1	50.0	37.5
low/smooth	(1)		33.3	35.3	62.5
medium	(2)		55.6	11.8	0.0
high/irreg.	(3)		0.0	2.9	0.0
high/irreg.	(4)		0.0	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	2	Wajak-1	2	Kanalda	4
U.C.1	3	Hoekgrot	1	Keilor	3
U.C.2	2	Sampung	3	K.S.5	3
U.C.3	2	L.T.	1	K.S.15	3
		L.M.E	2		

Table 97. Development (%) inferior border nasal aperture.

		China	Java	N.G.	Australia
Total series (N)		63	102	64	41
sharp border	(0)	38.1	14.7	21.9	2.4
two ridges	(1)	49.2	51.0	48.4	31.7
smooth border	(2)	12.7	34.3	29.7	65.9
Males (N)		63	77	30	34
sharp border	(0)	38.1	14.3	23.3	2.9
two ridges	(1)	49.2	51.9	56.7	35.3
smooth border	(2)	12.7	33.8	20.0	61.8
Females (N)			8	34	7
sharp border	(0)		12.5	20.6	0.0
two ridges	(1)		75.0	41.2	14.3
smooth border	(2)		12.5	38.2	85.7

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	2	Wajak-1	2	Kanalda	2
U.C.1	2	Wajak-2	2	Keilor	1
U.C.2	2	L.T.	2	K.S.5	2
U.C.3	2	L.M.E	1	K.S.15	2

Table 98. Development (%) subnasal prognathism.

		Java	Australia
Total series (N)		50	38
absent	(0)	12.0	5.3
small	(1)	44.0	47.4
medium	(2)	44.0	44.7
large	(3)	0.0	2.6
Males (N)		41	32
absent	(0)	14.6	6.3
small	(1)	48.8	53.1
medium	(2)	36.6	37.5
large	(3)	0.0	3.1
Females (N)		8	6
absent	(0)	0.0	0.0
small	(1)	25.0	16.7
medium	(2)	75.0	83.3
large	(3)	0.0	0.0

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	0	Wajak-1	2	Kanalda	1
U.C.1	1	Wajak-2	1	Keilor	1
U.C.2	1	L.T.	2	K.S.5	1
U.C.3	1	L.M.E	0	K.S.15	1

Table 99. Development (%) palatine torus.

		China	Java	N.G.	Australia
Total series (N)		62	105	45	40
absent	(0)	72.6	91.4	84.4	37.5
trace/weak	(1)	21.0	5.7	13.3	35.0
distinct	(2)	6.5	2.9	2.2	27.5
Males (N)		62	79	21	33
absent	(0)	72.6	92.4	76.2	36.4
trace/weak	(1)	21.0	5.1	19.0	39.4
distinct	(2)	6.5	2.5	4.8	24.2
Females (N)			9	24	7
absent	(0)		88.9	91.7	42.9
trace/weak	(1)		11.1	8.3	14.3
distinct	(2)		0.0	0.0	42.9

Prehistoric skulls

China		Indonesia		Australia	
Liujiang	2	Wajak-1	0	Kanalda	2
U.C.1	1	Wajak-2	0	Keilor	2
U.C.2	1	L.T.	0	K.S.5	0
U.C.3	1	G.K.C77	0	K.S.15	2

Table 100. Development (%) mental protuberance.

		China	Java	Australia
Total series (N)		63	98	24
small/rounded	(0)	0.0	9.2	54.2
small	(1)	11.1	17.3	20.8
medium	(2)	27.0	31.6	12.5
prominent	(3)	33.3	27.6	8.3
very prominent	(4)	28.6	14.3	4.2
Males(N)		63	75	19
small/rounded	(0)	0.0	6.7	52.6
small	(1)	11.1	18.7	21.1
medium	(2)	27.0	25.3	15.8
prominent	(3)	33.3	32.0	5.3
very prominent	(4)	28.6	17.3	5.3
Females (N)			9	5
small/rounded	(0)		22.2	60.0
small	(1)		11.1	20.0
medium	(2)		55.6	0.0
prominent	(3)		11.1	20.0
very prominent	(4)		0.0	0.0

Prehistoric skulls

Indonesia				Australia	
Wajak-2	2	Alo.1	2	Kanalda	0
Sampung	2	Aimere	1	K.S.1	2
L.T.	1			K.S.5	0
L.M.E	0			Mungo-3	2

Table 101. Development (%) mental trigone.

		Java	Australia
Total series (N)		50	22
slight	(0)	16.0	54.5
medium	(1)	52.0	45.5
marked	(2)	32.0	0.0
Males (N)		41	18
slight	(0)	17.1	50.0
medium	(1)	51.2	50.0
marked	(2)	31.7	0.0
Females (N)		8	4
slight	(0)	12.5	75.0
medium	(1)	62.5	25.0
marked	(2)	25.0	0.0

Prehistoric skulls

Indonesia		Australia	
Wajak-2	1	Kanalda	0
L.T.	1	K.S.1	1
L.M.E	0	K.S.5	0
		Mungo-3	1

Table 102. Dev. (%) anterior mandibular incurvature.

		Java	Australia
Total series (N)		49	21
slight	(0)	8.2	47.6
medium	(1)	71.4	42.9
marked	(2)	20.4	9.5
Males (N)		40	17
slight	(0)	10.0	47.1
medium	(1)	65.0	41.2
marked	(2)	25.0	11.8
Females (N)		8	4
slight	(0)	0.0	50.0
medium	(1)	100.0	50.0
marked	(2)	0.0	0.0

Prehistoric skulls

Indonesia		Australia	
Wajak-2	1	Kanalda	1
Sampung	1	K.S.1	1
L.T.	1	K.S.5	1
L.M.E	0		

Table 103. Projection of the chin (%).

		Java	Australia
Total series (N)		49	22
negative	(0)	20.4	59.1
neutral	(1)	28.6	22.7
positive	(2)	51.0	18.2
Males (N)		40	18
negative	(0)	22.5	66.7
neutral	(1)	25.0	16.7
positive	(2)	52.5	16.7
Females (N)		8	4
negative	(0)	0.0	25.0
neutral	(1)	50.0	50.0
positive	(2)	50.0	25.0

Prehistoric skulls

Indonesia		Australia	
Wajak-2	0	Kanalda	0
Sampung	1	K.S.1	1
L.T.	1	K.S.5	0
L.M.E	2	Mungo-3	0

Table 104. Decline planum alveolare (%).

		Java	Australia
Total serie (N)		49	22
vertical	(0)	6.1	9.1
slight decline	(1)	30.6	22.7
moderate/greater decline	(2)	63.3	68.2
Males (N)		40	18
vertical	(0)	7.5	11.1
slight decline	(1)	30.0	27.8
moderate/greater decline	(2)	62.5	61.1
Females (N)		8	4
vertical	(0)	0.0	0.0
slight decline	(1)	37.5	0.0
moderate/greater decline	(2)	62.5	100.0

Prehistoric skulls

Indonesia		Australia	
Wajak-2	1	Kanalda	2
Sampung	2	K.S.1	1
L.T.	1	K.S.5	2
L.M.E	1	Mungo-3	1

Table 105. Development (%) mylohyoid line.

		Java	Australia
Total series (N)		50	22
slight	(0)	36.0	50.0
medium	(1)	42.0	31.8
marked	(2)	22.0	18.2
Males (N)		41	18
slight	(0)	36.6	44.4
medium	(1)	43.9	33.3
marked	(2)	19.5	22.2
Females (N)		8	4
slight	(0)	25.0	75.0
medium	(1)	37.5	25.0
marked	(2)	37.5	0.0

Prehistoric skulls

Indonesia				Australia	
Wajak-1	1	L.T.	0	Kanalda	0
Wajak-2	2	L.M.E	1	K.S.1	2
Hoekgrot	1			K.S.5	0
Sampung	2			Mungo-3	1

Table 106. Development (%) sulcus extramolaris.

		Java	Australia
Total series (N)		50	21
slight	(0)	14.0	52.4
medium	(1)	66.0	33.3
marked	(2)	20.0	14.3
Males (N)		41	17
slight	(0)	17.1	41.2
medium	(1)	61.0	41.2
marked	(2)	22.0	17.6
Females (N)		8	4
slight	(0)	0.0	100.0
medium	(1)	87.5	0.0
marked	(2)	12.5	0.0

Prehistoric skulls

Indonesia				Australia	
Wajak-1	0	L.T.	1	Kanalda	2
Wajak-2	2	L.M.E	0	K.S.1	1
Hoekgrot	0			K.S.5	0
Sampung	1			Mungo-3	2

Table 107. Development (%) lateral prominence.

		Java	Australia
Total series (N)		50	22
slight	(0)	16.0	59.1
medium	(1)	44.0	40.9
marked	(2)	40.0	0.0
Males (N)		41	18
slight	(0)	17.1	61.1
medium	(1)	39.0	38.9
marked	(2)	43.9	0.0
Females (N)		8	4
slight	(0)	12.5	50.0
medium	(1)	75.0	50.0
marked	(2)	12.5	0.0

Prehistoric skulls

Indonesia				Australia	
Wajak-1	1	L.T.	0	Kanalda	1
Wajak-2	2	L.M.E	0	K.S.1	2
Hoekgrot	1			K.S.5	0
Sampung	2			Mungo-3	1

Table 108. Depth (%) fossa precoronoidea.

		Java	Australia
Total series (N)		50	22
shallow	(0)	56.0	45.5
medium	(1)	30.0	31.8
deep	(2)	14.0	22.7
Males (N)		41	18
shallow	(0)	58.5	50.0
medium	(1)	26.8	38.9
deep	(2)	14.6	11.1
Females (N)		8	4
shallow	(0)	37.5	25.0
medium	(1)	50.0	0.0
deep	(2)	12.5	75.0

Prehistoric skulls

Indonesia		Australia	
Wajak-2	1	Kanalda	1
Hoekgrot	1	K.S.1	2
Sampung	0	K.S.5	0
L.T.	1	Mungo-3	1
L.M.E	0		

Table 109. Development (%) angulus mandibulae.

		China	Java	Australia
Total series (N)		63	98	24
smooth/slight	(0)	25.4	21.4	33.3
moderate	(1)	28.6	39.8	29.2
marked/strong	(2)	46.0	38.8	37.5
Males (N)		63	75	19
smooth/slight	(0)	25.4	17.3	31.6
moderate	(1)	28.6	40.0	26.3
marked/strong	(2)	46.0	42.7	42.1
Females (N)			9	5
smooth/slight	(0)		55.6	40.0
moderate	(1)		33.3	40.0
marked/strong	(2)		11.1	20.0

Prehistoric skulls

Indonesia				Australia	
Hoekgrot	1	L.M.E	2	Kanalda	1
Sampung	2	Alo.1	2	K.S.1	2
L.T.	1	Alo.2	1	K.S.5	2
				Mungo-3	2

Table 110. Size (%) planum triangulare.

		Java	Australia
Total series (N)		50	21
small	(0)	8.0	4.8
medium	(1)	28.0	66.7
large	(2)	64.0	28.6
Males (N)		41	17
small	(0)	9.8	5.9
medium	(1)	24.4	64.7
large	(2)	65.9	29.4
Females (N)		8	4
small	(0)	0.0	0.0
medium	(1)	50.0	75.0
large	(2)	50.0	25.0

Prehistoric skulls

Indonesia		Australia	
Wajak-2	2	Kanalda	2
Hoekgrot	1	K.S.1	2
Sampung	0	K.S.5	1
L.T.	0	Mungo-3	1
L.M.E	0		

Table 111. Wajak, Recent Javanese and Australians (percentages of the male series are given). From Tables 43, 59-68, 70-73, 75, 79-95, 97-108, 110.

Characteristic	W-1	W-2	Java	Australia
59 Cranial index medium	+	?	25.3	10.0
60 L/H index low	+	?	0.0	20.7
61 B/H index low	+	?	23.1	0.0
62 Constriction medium	+	?	52.6	43.3
63 Parietal dev. medium	+	?	72.3	82.1
64 Occipital protruding	+	?	5.4	20.0
65 Face broad	+	?	28.0	75.0
66 Face slightly orthognathous	+	?	46.7	31.3
67 Aperture very broad	+	?	2.6	44.8
68 Palate broad	+	+	81.4	42.9
70 L/H mandible medium	?	+	38.7	13.3
71 Neurocr. very large	+	?	12.8	25.0
72 Viscero. very large	+	?	8.0	6.7
73 Maxilla very large	+	+	7.1	57.1
75 Corpus mandi. large	?	+	2.1	0.0
79 Molars very large	+	+	4.3	40.0
80 Incl. front. strong	+	+	13.9	82.4
81 Keeling absent	+	?	98.7	50.0
82 Front. ridge absent	+	?	94.9	48.5
83 Glabella massive	+	+	2.5	76.5
84 Superc. rid. marked	+	+	13.9	26.5
85 Zygomatic t. slight	+	+	100.0	72.7
86 Tub. front. indist.	+	?	25.3	97.1
87 Tub. pari. moderate	+	?	41.8	23.5
88 Proc. mastoi. small	+	-	31.6	18.2
88 Pr. mas. very large	-	+	6.3	9.1
89 C. sup. mas. medium	+	-	29.1	32.4
89 C. sup. mas. marked	-	+	50.6	55.9
90 Torus occ. absent	+	+	74.7	12.1
91 Prot. occ. absent	+	-	40.0	71.9
91 Prot. occ. distinct	-	+	30.0	6.3
92 Nuch. plane slight	+	-	24.1	3.0
93 Orbits quadr/roun.3	+	+	13.9	29.4
94 Flat orb. b. absent	+	+	72.2	29.4
95 Phaenozygy distinct	+	?	13.9	91.2
43 Cheek heig. >= 24.1	+	?	50.7	12.9
97 Aper. smooth border	+	+	33.8	61.8
98 Subnasal prognath.	+	+	85.4	93.7
99 Torus palat. absent	+	+	92.4	36.4
100 Mentum medium dev.	?	+	25.3	15.8
101 Trigonum medium	?	+	51.2	50.0
102 Inc. mand. medium	?	+	65.0	41.2
103 Proj. chin negative	?	+	22.5	66.7
104 Alv. slight decline	?	+	30.0	27.8
105 Mylohyoid r. medium	+	-	43.9	33.3
105 Mylohyoid r. marked	-	+	19.5	22.2
106 Sulcus extr. slight	+	-	17.1	41.2
106 Sulcus extr. marked	-	+	22.0	17.6
107 Lat. prom. medium	+	-	39.0	38.9
107 Lat. prom. marked	-	+	43.9	0.0
108 F. precor. medium	?	+	26.8	38.9
110 Pl. triang. large	?	+	65.9	29.4

+ = present; - = absent; ? = unknown.

Table 112. Craniofacial changes, in Nubia and Java (information of Nubia from Armelagos et al., 1984).

Character	Nubian trend Meso—>his. pop.	Javanese trend Wajak—>his. pop.	
Neurocranium:			
Cranial form	more globular	more globular	
Cranial length	decrease	decrease	
Cranial height *	increase	increase	
Frontal chord	increase	decrease	#
Parietal chord	increase	decrease	#
Glabellar region	decrease	decrease	
Occipital region	decrease	limited change	
Viscerocranium:			
Prognathism	decrease	slight increase	#
Cheek height	decrease	decrease	
Mandible:			
Symphysis height	decrease	decrease	
Symph. thickness	decrease	decrease	
Ramus breadth	decrease	decrease	
Coronoid height	decrease	decrease	
Teeth			
Dental size	decrease	decrease	

* = relative; # = trend different direction; his. = historical; pop. = population.

Table 113. (Micro)evolutionary changes of the skull: decrease of the modern human skull during the Late Pleistocene / Holocene, reported from various parts of the world.

Regions/Author(s)	Observation	Discussion
Europe:		
Frayer (1977)	dental reduction	techno-cultural changes
Spoor & Sondaar (1986/88)	reduction	food, isolation (island)
Africa:		
Rightmire (1984)	reduction	agriculture
Carlson & van Gerven (1979)	reduction morph.	agriculture
Armelagos et al. (1984)	reduction morph.	agriculture
Calcango (1986)	dental reduction	agriculture
Southeast Asia:		
Hooijer (1950/52)	dental reduction	temperature
Bulbeck (1982)	reduction morph.	
Australia:		
Brown (1987/89/92)	reduction	temperature

morph. = morphological changes.

Table 114. Modules (%) of recent male skulls (from Tables 71-79).

	China	Java	N.G.	Australia
Total skull:				
71 neurocranium large	30.2	12.8	0.0	25.0
72 viscerocr. large	44.1	53.3	23.5	53.4
Masticatory app.:				
73 maxilla large	45.1	55.7	93.3	85.7
74 mandibula large	20.9	12.0	—	0.0
75 corpus mand. large	17.1	2.1	—	0.0
Molars:				
76 crossect. M1 large	0.0	7.2	18.2	38.1
77 crossect. M2 large	7.3	12.5	23.1	68.0
78 crossect. M3 large	0.0	0.0	0.0	17.6
79 tot. cros. large	13.8	29.8	16.7	86.7

Table 115. Indices (%) of recent male skulls (from Tables 59-70).

	China	Java	N.G.	Australia
Neurocranium:				
59 cranial ind. broad	38.1	69.6	0.0	0.0
60 L/H index high	81.0	83.4	20.8	27.6
61 B/H index high	46.0	21.7	81.8	85.7
62 P-orb.con. strong	0.0	2.6	32.1	50.0
63 parietal flat	6.3	3.9	3.3	10.7
64 occipital flat	14.5	50.0	0.0	20.0
Viscerocranium:				
65 broad face	28.8	28.0	36.9	75.0
66 (slight) prognat.	16.7	45.3	90.4	56.3
67 broad nasal apert.	17.5	29.5	37.0	82.7
68 broad palate	78.4	81.4	13.3	42.9
Mandible:				
69 broad mandible	38.7	22.6	—	7.1
70 high mandible	20.7	10.7	—	0.0

Table 116. Non-metrical characters (%) of recent male skulls (from Tables 80-110).

	China	Java	N.G.	Australia
Neurocranium:				
80 incl. front. strong	17.5	13.9	30.0	82.4
81 presence keeling	6.3	1.3	55.2	50.0
82 presence med. ridge	0.0	0.0	0.0	27.3
83 glabella massive	1.6	2.5	46.7	76.5
84 superc. very marked	1.6	3.8	55.2	67.6
85 zygomat. med./large	—	0.0	—	27.2
86 tubera absent/slight	27.0	25.3	69.0	97.1
87 tubera absent/slight	22.2	10.1	26.7	41.2
88 pr.mast. very large	6.3	6.3	0.0	9.1
89 supramast.cr. marked	34.9	50.6	34.5	55.9
90 distinct torus	23.8	8.9	57.1	66.7
91 distinct protuber.	—	30.0	—	6.3
92 nuchal area marked	34.9	19.0	69.2	69.7
Viscerocranium:				
93 orbits strong masc.	0.0	7.6	20.7	52.9
94 lower border flat	4.8	1.3	13.3	44.1
95 dist. phaenozygy	34.9	13.9	92.9	91.2
96 zygomat. high/irreg	50.8	46.9	10.0	23.5
97 smooth lower border	12.7	33.8	20.0	61.8
98 subn. progn. clear	—	36.6	—	40.6
99 palatal torus dist.	6.5	2.5	4.8	24.2
Mandibula:				
100 mentum small/rounded	0.0	6.7	—	52.6
101 trig. mentale slight	—	17.1	—	50.0
102 incur. mand. slight	—	10.0	—	47.1
103 proj. chin negative	—	22.5	—	66.7
104 decl. pl. alv. dist.	—	62.5	—	61.1
105 mylohyoid r. marked	—	19.5	—	22.2
106 sulcus extr. slight	—	17.1	—	41.2
107 lat. prom. slight	—	17.1	—	61.1
108 deep fossa precor.	—	14.6	—	11.1
109 ang. mand. strong	46.0	42.7	—	42.1
110 pl.tr. small/medium	—	34.2	—	70.6

Table 117. The 'Sunda type' morphology (based on recent male crania from China, Java, Papua New Guinea, and Australia; Tables 24-58, 59-70, 80-110).

'Character'	'Sunda type' (China/Java)
	More rounded skull
Cranial index	broader
Length/Height index	higher
Postorbital constriction	smaller
Phaenozygy	weaker
Upper facial index	higher
Inclinatio frontale	weaker
Keeling	weaker
	Flat face with high zygomatic bones
Prognathic index	lower
Cheek height	larger
	Limited outgrowth of 'superstructures'
Median frontal ridge	weaker
Glabella	weaker
Superciliary ridges	weaker
Zygomatic trigones	weaker
Occipitalis torus	weaker
Nuchal area (lines/crest)	more 'smooth'
Palatine torus	weaker
	Retaining juvenile characters
Frontal tubera	stronger
Parietal tubera	stronger
Form orbits	more 'rounded'
	Interpretation: neoteny trends stronger

Table 118. Size of prehistoric male skulls (based on Tables 71-79).

Table:	71	72	73	74	75	76	77	78	79
China:									
Liujiang	+								
Java:									
Wajak-1	++	+	+			+	++	+	+
Wajak-2			++		++	+	++	++	++
Sampung-H					+				
Australia:									
Kanalda	+	++	++	++	++	+	+	+	+
K.S.5				++					

+ = surpassing average of recent male series; ++ = surpassing maximum of recent male series.
71 = cranium; 72 = face; 73 = maxilla; 74/75 = mandible (total/corpus); 76/77/78/79 = cross-sectional area molars (M1/M2/M3/total).

Table 119. Liujiang (China), Wajak-1 (Java) and Keilor (Australia).

Table	Liujiang	Wajak-1	Keilor
Measurements in mm (Tables 24-58)			
24 GOL	191	200	199
25 BBH	136	137	—
26 XCB	144	151	146
27 FRC	—	115	111
28 PAC	—	117	123
29 S2	—	132	133
30 OCC	—	96	107
31 S3	—	119	131
32 MSB	108	118	117
33 MPD	93	96	—
34 BNL	108	109	—
39 NLH	46.1	51.7	51.7
40 NLB	27.3	30.7	26.3
42 MAB	64	71	72
43 WMH	—	24.8	24.1
Modules (Tables 71-79)			
71 Neurocranium	157.0	162.7	—
Indices (Tables 59-70)			
59 Cranial index	75.4	75.5	73.4
60 Length-height ind.	71.2	68.5	—
61 Breadth-height ind.	94.4	90.7	—
62 Postorbital constr.	86.1	81.4	—
63 Parietal index	—	112.8	108.1
64 Occipital index	—	125.0	122.4
67 Nasal index	59.2	59.4	50.9
Non-metrical characters (Tables 80-110)			
80 Inclinatio frontale	strong	strong	strong
81 Keeling	absent	absent	absent
82 Med. frontal ridge	absent	absent	absent
83 Glabella	marked	massive	delim.
84 Supercil. ridges	marked	marked	massive
85 Zygomatic trigones	slight	slight	slight
86 Tubera frontalia	indist.	indist.	indist.
87 Tubera parietalia	indist.	moderate	indist.
88 Processus mast.	small	small	medium
89 Crista supramast.	medium	medium	—
90 Torus occipitalis	absent	absent	present
91 Protuberantia occ.	absent	absent	absent
92 Nuchal lines/crest	evident	slightly	marked
93 Orbits	masc.3	masc.3	masc.4
95 Phaenozygy	ambiguous	present	present
97 Inf. border nasal	smooth	smooth	ambig.
98 Subnasal prognat.	absent	medium	small
99 Torus palatinus	dist.	absent	dist.

Table 120. Wajak (Java) and Kow Swamp (Australia).

	W-1	W-2	K.S.1	K.S.5	K.S.15
Measurements in mm (Tables 24-58)					
24 GOL	200	—	—	192	—
26 XCB	151	—	—	138	—
27 FRC	115	—	120	—	—
32 MSB	118	—	120	—	—
36 NPH	66	—	—	—	77
39 NLH	51.7	—	—	51.2	55.4
40 NLB	30.7	—	—	30.6	26.7
42 MAB	71	80	—	—	71
44 ML	—	111	—	107	—
46 CrH	—	72	—	70	—
47 CHe	33.7	36.7	32.8	—	—
48 CTh	19.0	20.8	14.2	—	—
49 SHe	—	40.2	—	37.1	—
50 STh	—	17.8	14.4	14.2	—
51 RB'	41	45.5	35.2	35.0	—
52 P3-M3	45.5	49.1	—	—	47.9
Modules (Tables 71-79)					
76 Cros. M1	151.8	154.6	—	—	138.2
77 Cros. M2	145.2	143.6	—	—	162.0
78 Cros. M3	105.6	138.2	—	—	126.7
79 Tot. cros.	402.6	436.5	—	—	427.0
Indices (Tables 59-70)					
59 Cranial	75.5	—	—	71.9	—
67 Nasal	59.4	—	—	59.8	48.2
70 L/H mand.	—	64.9	—	65.4	—
Non-metrical characters (Tables 80-110)					
80 Incl. fr.	strong	strong	strong	strong	—
81 Keeling	absent	—	absent	present	—
82 Med. fr.	absent	—	trace	—	—
83 Glabella	massive	massive	massive	massive	massive
84 Superc.	marked	marked	massive	massive	massive
85 Zyg. tr.	slight	slight	large	medium	large
86 Tub. fr.	indist.	—	indist.	indist.	indist.
87 Tub. par.	moderate	—	marked	moderate	—
88 Pr. mast.	small	v large	—	large	—
89 Cr. supr.	medium	strong	—	strong	—
90 Torus occ.	absent	absent	—	trace	—
91 Prot. occ.	absent	distinct	—	absent	—
92 Occ. area	slight	—	—	rough	—
93 Orbits	masc.3	masc.3	—	masc.3	masc.4
94 Flat orb.	absent	absent	—	distinct	absent
95 Phaenozygy	distinct	—	—	distinct	—
97 Inf. nasal	smooth	smooth	—	smooth	smooth
98 Subn. pr.	medium	small	—	small	small
99 T. palat.	absent	absent	—	absent	dist.
100 Mentum	—	medium	medium	small r	—
101 Trigonum	—	medium	medium	slight	—
102 Incurvat.	—	medium	medium	medium	—
103 Project.	—	negative	neutral	negative	—

104 Plan alv.	—	slight d	slight d	great d	—
105 Mylohyoid	medium	marked	marked	slight	—
106 S. extram.	slight	marked	medium	slight	—
107 Lat. prom.	medium	marked	marked	slight	—
108 F. precor.	—	medium	deep	shallow	—
110 Pl. trian.	—	large	large	medium	—

d = decline; r = rounded; v = very.

Table 121. Kanalda and Wajak-1.

Feature	Kanalda (original)	Wajak-1 (replica)	Ind.
Glabella	present	present	? (1)
Arcus supercil.	marked	marked	#
Arcus supraorb.	more swollen	more flat	*
Phaenozygy	present	present	? (2)
Keeling	clearly present	more rounded	*
Slope os front.	more steep	more oblique	*
Torus occipit.	little present	absent	*
Sharpness orb.	rounded/flat	more sharp	*
Prognathism	present	present	* (3)
Frontal ridge	present	absent	* (4)
Tubera pariet.	present	present	# (5)
Prot. occ. ext.	weak/small	absent	*
Inf. bor. nas.	non anthr.	non anthr.	#
Tubera front.	slight	absent	?
Proc. mastoideus	larger	smaller	*
Os zygomaticum	marked/oblique	marked/straight	*
Form orbita	more angled	less angled	*
Os nasale	high	flat	*

* = indication: more or less different; # = indication: more or less the same; ? = indication: uncertain.

1 = Comparison difficult because of damage in Wajak-1.

2 = In the Kanalda skull this feature is extreme, very obvious; in the Wajak skull it is clearly present as far as can be judged.

3 = Although this feature is present in both skulls, in the Kanalda skull it is more total prognathism; while in the Wajak skull it is more subnasal prognathism. Alveolar prognathism is weak in the Kanalda skull.

4 = Presence in the Kanalda skull is not strong.

5 = Although present in both skulls, they are a little stronger in the Wajak skull.

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Special Issue (1993)

2 Janssen, A.W. & R. Janssen. Proceedings Symposium Molluscan Palaeontology - 11th International Malacological Congress Siena, 30th August - 5th September 1992. 436 pp, num. figs & tables .... Dfl. 234.00

1994

104 Freudenthal, M. Cricetidae (Rodentia, Mammalia) from the Upper Oligocene of Mirambueno and Vivel del Río (prov. Teruel, Spain), 1-55, 4 pls.
Freudenthal, M., M. Hugueney & † E. Moissenet. The genus *Pseudocricetodon* (Cricetidae, Mammalia) in the Upper Oligocene of the province of Teruel (Spain), 57-114, 5 pls.
Hugueney, M. *Theridomys truci* de l'Oligocène de Saint-Martin-de-Castillon (Vaucluse, France), nouvelle espèce du genre *Theridomys* (Rodentia, Mammalia) et sa relation avec la lignée de *Theridomys lembronicus*. [*Theridomys truci* from the Oligocene of Saint Martin de Castillon (Vaucluse, France), a new species of the genus *Theridomys* (Rodentia, Mammalia) and its relationships with the *Theridomys lembronicus* lineage], 115-127, 2 pls, Leiden, September 1994 .... Dfl. 64.00

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