A new model for the evolution of *Homo sapiens* from the Wallacean islands

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Abstract

Paul Storm (1995) investigated the pattern of evolution of modern man in Southeast Asia. He discovered that the populations of Southeast Asia could be subdivided in two types, the Sunda-type and the Sahul-type, on the basis of skull morphology. In his investigation he included two skulls from Flores. Flores is an island located in Wallacea between the Sunda and Sahul shelves. It has always been surrounded by water, even during periods of low sea level. The two skulls from Flores did not clearly resemble either the Sunda or Sahul skull type. Since Storm was most interested in the Wajak skulls from Java (Storm, 1995), he did not pursue the problem of the Flores skulls further.

In the present study, the role of these two skulls in the evolution of modern man in Southeast Asia is investigated. To this end, twelve prehistoric individuals (including the two skulls and their postcranial remains) from five caves and one open site have been described. Comparison with prehistoric and recent remains from the surrounding areas have led to a new model for the evolution of *Homo sapiens* from the Wallacean islands. This model assumes a separate line of evolution for the populations of Wallacea.

Key-words: Flores, *Homo erectus, Homo floresiensis, Homo sapiens,* migration model, Wallacean islands

Contents

1. Introduction

The question of whether Australasian evolution was multiregional (Wolpoff, 1989, 1992) or involved successive replacement (Stringer, 1984, 1992) has been the subject of many debates in palaeoanthropology. The multiregional evolution model contends that there is a direct line of descent between *Homo erectus* and the Australian Aboriginals. The replacement model, on the other hand, suggests that the *H. erectus* population was replaced by a second migration consisting of *Homo sapiens*. In 1995 Storm investigated this question by studying prehistoric material from the Indonesian Archipelago. If the multiregional evolution model was correct, there should be a connection between *H. erectus* (Solo skulls) and the Australian Aboriginals, presumably via Wajak (Java), visible in the skull morphologies. If the replacement model was correct, the skulls should not be similar morphologically. Storm (1995) concluded that he could not find a link between *H. erectus* and the modern human skulls and that consequently the replacement model was correct for Southeast Asia. Furthermore, he showed morphological differences between the *H. sapiens* skulls from the Sunda shelf and those from the Sahul shelf. According to his theory these two types developed from a common prototype into the Sunda- and Sahul-types approximately 60,000 years ago. The Sunda-type is found in China and Java and the Sahul-type is found in New Guinea and Australia.

By the end of the Pleistocene the sea levels dropped by about 200 m at the peak of the glaciation (about 18,000 years ago) (Bellwood, 1985). During this time Java became attached to mainland Southeast Asia, and Australia, New Guinea, and Tasmania formed another landmass. In between these two large continents lays an area of islands still surrounded by water, referred to as Wallacea (Bellwood, 1985). These islands lie between Huxley's line (marks the eastern border of the Sunda shelf) and Lydekker's line (the western border of the Sahul shelf). In order to reach Australia from the Sunda shelf, one has to cross Wallacea (figure 1). However, these islands could only be reached by swimming, flying, or floating. As a result they show none of the faunal diversity of Java. Flores ia a member of this archipelago, one of the Lesser Sunda Islands.

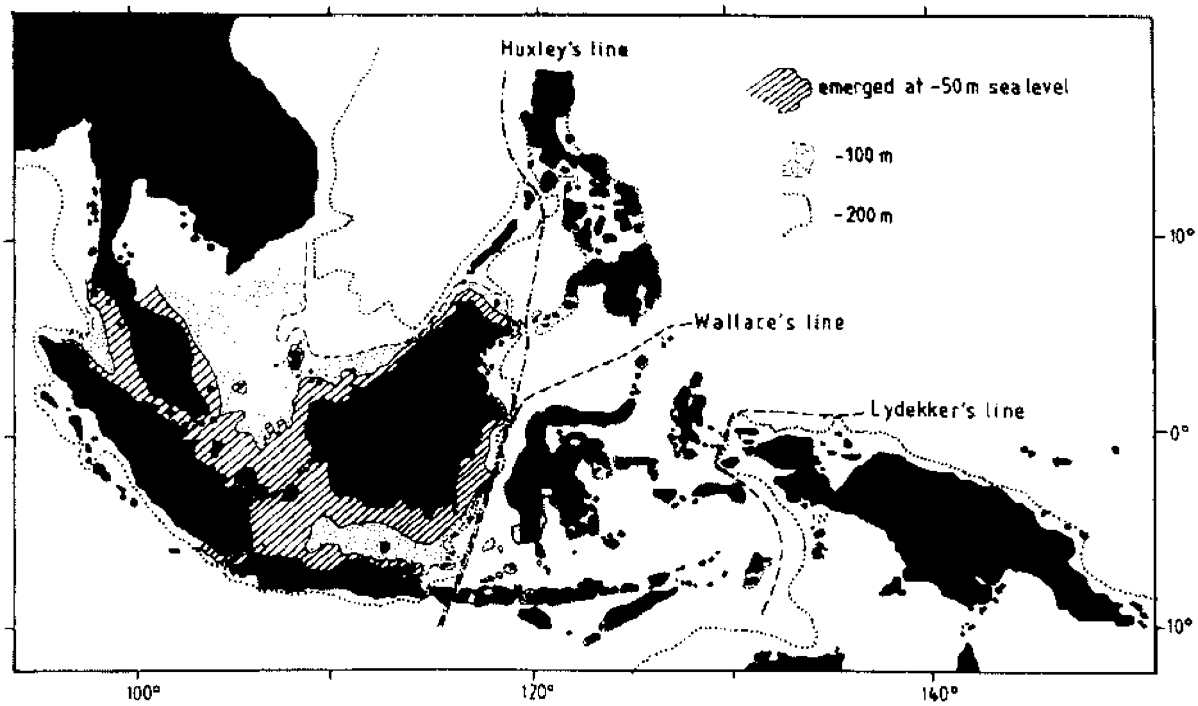


Figure 1. Map of Southeast Asia with Huxley's and Lydekker's lines (Van den Bergh, 1999).

At least twelve prehistoric individuals of *Homo sapiens* are known from Flores, excavated by Theodor Verhoeven in the 1950's. Only two of these individuals include a skull in a reasonably preserved condition. The rest of the individuals are fragmentary. Storm (1995) included these two skulls (Liang Momer E and Liang Togé) in his study. However, he could not place them in either the Sunda-type or the Sahul-type. In his evolutionary tree (figure 2) he does not mention the Flores finds, but places them in between the Sunda- and Sahul-types with a separate line of decent also starting at 60,000 BP.

There are many theories about the migration of population groups into Wallacea, most of which assume two or more different migration waves. These migrations must have come from either the Sunda or the Sahul shelf.

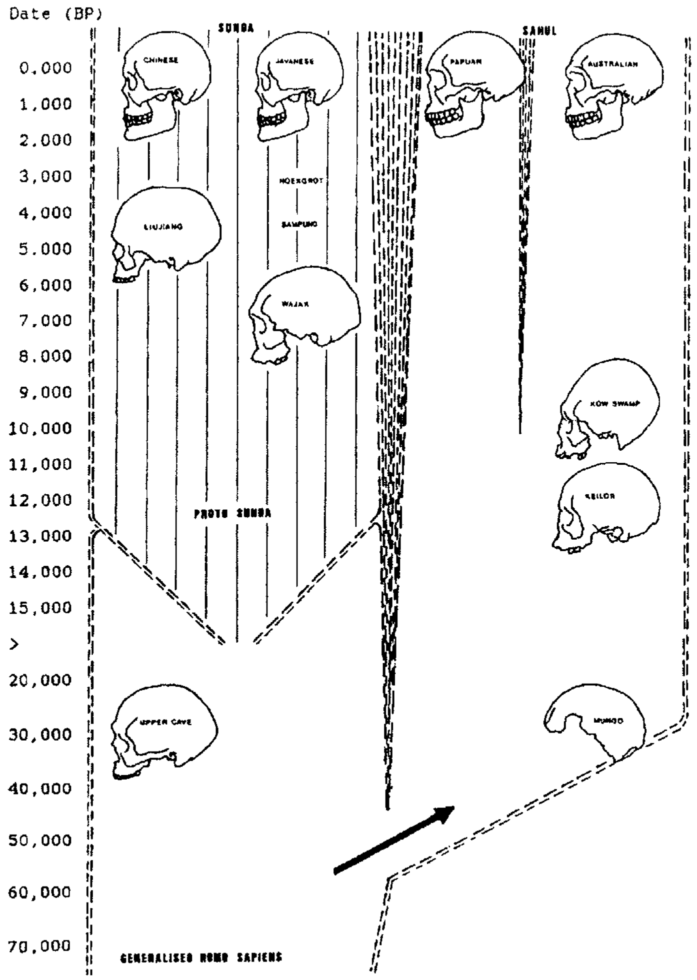


Figure 2. Storm's model for the evolution of Homo sapiens *in Australasia (Storm, 1995).*

Jacob (1967) found the skull from Liang Togé to be especially strange, being different from the normal morphology encountered in that area. Bellwood (1985) considered it a Melanesian, while Jacob (1967) could not decide between Negrito and Austromelanesian.

The purpose of this paper is to establish, whether the Liang Togé skeleton is different from the other material from Flores, and whether the Flores material in general is distinct from the rest of Southeast Asia. The material will be compared with other prehistoric material from on and around Flores, with recent material from other islands in Wallacea (Timor, Sumba), and the Sunda and Sahul shelves.

1.1. Father Theodor Verhoeven

All the specimens from Flores described below were found and excavated by Father Theodor Verhoeven. Verhoeven studied the classics at the University of Utrecht, with special attention to archaeology and prehistory. For four years he studied archaeology with Dr. G. van Hoorn at the University of Utrecht and spent several months in Italy studying the excavations at Pompeii, Herculanum and Ostia Tiberia for his doctoral thesis. He promoted on a patristic subject in July 1948. As a member of a Roman Catholic mission congregation, he was sent to be a teacher at the little seminary in Mataloko or Todabelu, in the Ngada region, on the island of Flores. Here he conducted archaeological research in several caves, including Liang Togé, Liang Momer, Liang Panas, Gua Alo, Liang X, and Aimere. He also did archaeological research on Sumba and Timor during his stay in Indonesia (Jacob, 1967).

2. Material and methods

The human material excavated by Verhoeven on Flores forms the basis of this study. A total of twelve individuals, found in six sites (five caves and one open site), are represented.

Measurements were taken according to the following author's definitions:

Martin (1914), with some additions from Martin (1928):

- Mid-shaft transverse and mid-shaft sagittal diameters of humerus
- Olecranon-coronoid distance of ulna
- Transverse diameters of capitulum and collum of radius
- All carpal bone measurements
- Vertebral foramen transverse and sagittal diameters
- Maximum length, direct length, trochanter-condyloid length, and trochanteric length of femur
- Intertrochanteric distance of femur
- Caput-trochanter distance of femur
- Posterior breadth and thickness of medial condyle of femur
- Breadth of intercondyloid fossa of femur
- Breadth of upper medial and upper lateral articular surfaces of tibia
- Mid-shaft transverse and mid-shaft sagittal diameters of fibula.

Storm (1995):

- Maxilloalveolar breadth
- Cheek height
- Mandibular length
- Corpus thickness at M_2
- Symphyseal thickness
- MD: mesiodistal diameter
- BL: buccolingual diameter

Jacob (1967, with modifications):

- Ectoconchion-porion distance: direct distance from ectoconchion to porion
- Vault thickness: measured at stephanion
- Height of mental foramen from mandibular base: distance between mental foramen and the lower border of the mandible, perpendicular to the mandibular base
- Sagittal diameter of condyloid process of mandible: direct distance between the anterior surface and the posterior surface of the condyloid process
- Transverse diameter of the condyloid process of mandible: direct distance between the buccal and labial edge of the condyloid process
- Inter-C distance: distance between the lingual alveolar borders at canine
- Inter-M_1 distance: distance between the lingual alveolar borders at M_1
- Inter-M_3 distance: distance between the lingual alveolar borders at M_3
- Posterior curved height of sacrum: distance between the in the median-sagittal plane positioned point on the posterior surface of the basis sacri and the corresponding point on the frontal side of the sacral apex, measured along the dorsal surface

Instruments used were a sliding calliper, a spreading calliper, tape, and an osteometric board. The method described by Maat *et al*. (2000) was used to estimate gender. This method grades certain non-metrical characteristics with a value between –2 (very feminine) and +2 (very masculine).

Age was estimated using the amount of endocranial suture obliteration as described by Maat *et al*. (2000), the amount of deterioration of the spongiosa structure in the humerus and femur heads as described by Maat *et al*. (2000), and the amount of dental attrition as described by Brothwell (1981) and Miles (1963).

Isolated teeth were identified using descriptions from Hillson (1996). Stature was estimated with reference to the work of several authors (see text).

Indices were mostly calculated according to Martin (1914) with additions from:

Martin (1928):

- Physiological length-transverse diameter of capitulum index of radius
- Humeroradial index (see radius)

- All carpal indices
- Transversosagittal index
- Vertebral foramen index

Storm (1995):

- Upper facial index
- Prognathic index
- Facial module
- Cross-sectional areas of upper M^1, M^2, and M^3
- Total cross-sectional area upper molars
- Mandibula L-H index
- Corpus mandibula module

Jacob (1967, with modifications):

- Breadth-auricular height index: (auricular height/cranial breadth) x 100
- Frontal index: (basion-prosthion distance/bizygomatic breadth) x 100
- Palatal breadth-depth index: (palatal depth/palatal breadth) x 100
- Foramen magnum index: (foramen magnum breadth/foramen magnum length) x 100
- Total sagittal index: (nasion-opisthion chord/nasion-opisthion arch) x 100
- Index of condyloid process of mandible: (sagittal diameter of condyloid process/transverse diameter of condyloid process) x 100
- Length index of ulna: (maximum length/physiological length) x 100
- Circumference-length index of femur: (mid-shaft circumference/length of femur) x 100

The results of this study are presented in tables and graphs.

2.1. Liang Togé

2.1.1. Location

Plate 1 (left). Liang Togé. Plate 2 (right; see text below). Liang Togé skeleton (see below). Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

Liang Togé (Liang Togé) (plate 1, 3, and 4), Flores, is an *abri sous roche* (overhanging cliff) northwest of Badjawa near Téong on the border of Ngada-Manggarai (figure 3). It was excavated by Verhoeven in 1954. The excavations started in October and the skeleton was found in a flexed burial at a depth of about one metre. The skull was lying beneath flat stones and was broken. The excavators picked up the isolated skull fragments and placed them on a ledge in the cave. At this time the excavation was interrupted by an epidemic in the nearby village Lépa. Verhoeven himself contracted the disease and was forced to return home. The excavations restarted in December, but by that time the isolated skull fragments had disappeared. The rest of the skeleton was coated in sediment, carried by rainwater coming down the sloped cliff wall during heavy rainfall. This water mingled with the chalky sand below to form a natural cement (Archive Verhoeven, XXVIa).


Plate 3 (left) and 4 (right). Liang Togé. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

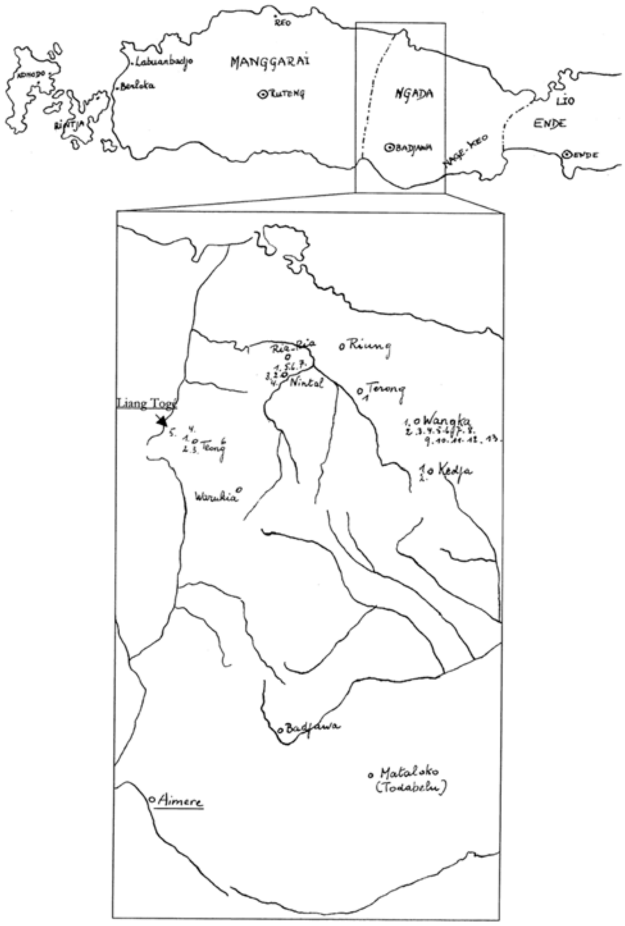


Figure 3. Map of central Flores showing the locations of Liang Togé and Aimere. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands; after original by Verhoeven.

2.1.2. Archaeological age

The deposit at Liang Togé (but not necessarily the precise layer which forms the matrix adhering to the specimens) has been dated to 3,550 ± 525 years BP (C14 method) (Jacob, 1967). Verhoeven did not trust this date completely (Verhoeven, 1968), suggesting that the date is a minimal age. Since the material had been extensively handled, contamination could have caused a falsely early date.

2.1.3. Material

Material available for study (plate 2) includes the left side of the skull, mandible and teeth, the upper limb bones (scapulae, humeri, ulnae, radii, and bones of the hand), vertebrae and sacrum, and the lower limb bones (innominate bones, femora, tibiae, a patella, fibulae, and bones of the foot). Some parts have been treated with acetic acid to remove the sediment.

2.1.4. Description

The skull (table 1)

Description	Measurements (cm)	Index	
Cranial length	17.7	Cranial index	62.2
Cranial breadth	± 11	Length-auricular height index	64.4
Auricular height	11.4	Breadth-auricular height index	103.6
Minimum frontal breadth	9.3	Transverse frontoparietal index	84.5
Bizygomatic breadth	±12.0		
Mid-facial breadth	± 10.0		
Maxilloalveolar breadth	5.7		
Ectoconchion-porion distance	6.3		
Nasion-gnathion distance	11.2	Total facial index	93.3
Nasion-prosthion distance	7.1	Upper facial index	64.6
Orbital breadth	4.1	Upper face index	71
Orbital height	3.3	Orbital index	80.5
Cheek height	2.1		
Nasal breadth	2.1		
Nasal height	4.9	Nasal index	42.9
Palatal length	5.4		
Palatal breadth	3.2	Palatal index	59.3
Palatal depth	1.5	Palatal breadth-depth index	46.9
Foramen magnum length	-		
Foramen magnum breadth	2.9		
Nasion-bregma chord	10.6		
Nasion-bregma arch	12.2	Frontal sagittal index	86.9
Bregma-lambda chord	11.9		
Bregma-lambda arch	13.8	Parietal sagittal index	116
Lambda-opisthion chord	8.8		
Lambda-opisthion arch	10.1	Occipital sagittal index	114.8
Nasion-opisthion chord	13.5		
Nasion-opisthion arch	36.1	Total sagittal index	37.4
Vault thickness	0.7		

Table 1. Liang Togé cranium measurements.

The right orbit, zygomatic process, almost the entire right skull base and the anterior part of the foramen magnum, temporal bone and part of right parietal bone are missing (plate 5). Based on the only slightly delimited glabella and superciliary arches, the almost vertical frontal inclination, the small mastoid process, the absence of a distinct external occipital protuberance, the gracile zygomatic arch, the absence of a supramastoid crest, and the round shape and the sharp margin of the orbit, the skull is sexed as female. An overview of the sex determination of the Flores material is given in table 93.

Plate 5. Liang Togé skull in anterior view. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The skeletal age, estimated by means of vault sutures, is between 30 and 60 years old. Because the outcome only just crosses the barrier between phases I and II, the skeletal age is most likely to be closer to 30. Jacob (1967) estimated the skeletal age between 30 and 40 years.

The cranial breadth has to be estimated, because of missing right side, as well as the bizygomatic breadth. The specimen shows excessive alveolar prognathism from a lateral view (plate 6). According to Jacob (1967) it is hyperprognathic, bordering on ultraprognathic. Dental protrusion is not present. In frontal outline the glabella is slightly delimited and as a result there is a slight nasion depression. The frontal outline slopes evenly backward, becoming flat at the parietal vault. It then slopes a little upward before it continues into the rounded occipital contour. The inion is not clearly marked.

Plate 6. Liang Togé skull in lateral view. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The mastoid process is small. Its axis constitutes an angle of almost 90° to the eye-ear plane. The external auditory porus is oval shaped, with its long axis running craniocaudal to ventrodorsal. The temporal line on the frontal bone is strongly developed.

The sphenoparietal suture is approximately six mm long, and the temporoparietal suture is curved and forms a well marked parietal notch above the mastoid process. The temporomalar suture is oriented dorsoventral to caudocranial, as in other human skulls. The length of the skull is decidedly greater than its breadth. The shape is ovoid.

The frontal bone is evenly rounded in transverse direction. No metopic suture is present, and there is little sign of a frontal protuberance. The orbit is mesoconch and shows a slight downwards and backwards inclination.

The lower halves of the nasal bones are missing (plate 5). The nose is leptorrhine (narrow and high). There are two anterior nasal spines, both of which are angled upwards. The lower boundary of the piriform aperture gradually merges into the alveolar plane with a very slight indication of an anterior crest (which does not reach the median plane). According to Martin (1928) this condition also occurs in the Oceanic 'Negro'.

There is no canine fossa in the skull, which is probably due to the strong alveolar protrusion (Martin, 1928). The infraorbital foramen is of normal human size and number.

The height of the skull, in contrast to the narrow breadth is apparent in posterior view (plate 7). The lateral surface rises up almost vertically before meeting the round vault contour. Occipital relief is weak (but covered with sediment) and the nuchal lines are round and visible on both sides of the median line. An external occipital protuberance is not present.

Plate 7. Liang Togé skull in posterior view. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The palate is deep and narrow. The zygomatic arch runs at an obtuse angle to the maxilla. A faint mastoid notch is visible medial to the mastoid process. Medially, a bony bridge divides the jugular foramen. The mandibular fossa is deep and the tuberculum articulare well defined.

The skull shape may be summarized as follows:

- It is ultradolichocephalic (very narrow compared to its length).
- It is hypsicephalic (large auricular height in relation to the length of the skull).
- The minimum frontal breadth is large compared to the breadth of the skull (ultrahypermegasem).
- It is hyperleptoprosopic (narrow face).
- The upper facial index reveals a very narrow face (small bizygomatic breadth compared to nasion-prosthion length).
- It is chamaeprosopic (broad face compared to length).
- The orbits are mesoconch (medium height/medium breadth).
- The nose is leptorrhine (high and narrow).
- The shape of the palate is very narrow (leptostaphyline border is 79.9, my calculation is 59.3).
-

The auricular height is a little greater than the breadth of the skull. The skull shape is long, high and narrow.

The teeth (table 2)

The dental arch of the maxilla is elliptical in shape, while the dental arch of the mandible is parabolic. All teeth are present, but the right I^2 of the maxilla and the right I_1, I_2, and P_1 are broken. Molar attrition for the maxilla is grade 4^- for both M^1, grade 3^- for both M^2, and grade 2^+ for both M^3. Molar attrition for the mandible is grade 4^+ for both M_1, grade 3^- for both M_2, and grade 2 for both M_3. This pattern of occlusal wear would indicate an age of about 30 years (Miles, 1963) or 25-35 years (Brothwell, 1981), if no correction is made for a more or less abrasive diet. Some correction needs to be made however and therefore the age estimates can only be very approximate. When depending on the validity of the age estimate made with endocranic suture obliteration, one can hypothesise that the wear of the Liang Togé teeth is likely to have been different from that of the Anglo-Saxon group used to make the uncorrected estimates. Because hunter-gatherers show less dental wear than agriculturists (Smith, 1984), the rate of occlusional wear in Liang Togé must have been lower. The plane of attrition of the incisors indicates psalidont occlusion (Martin, 1928). In the maxilla the plane of attrition changes from the lingual side in M^1 to the buccal side in M^3. In the mandible the plain of attrition changes from the buccal side in M_1 to the lingual side in M_3. According to Jacob (1967) this sort of wear is found in the

Australoids and it is probably brought about by the elliptical shape of the upper dental arch in contrast to the parabolic shape of the lower, or by strong anteroposterior chewing movements. The occlusal plane of the dental arch as a whole is rather flat, showing no oblique wear, which is concordant with the hypothesis that Liang Togé was a hunter-gatherer (Smith, 1984). Groove and cusp patterns of the two posterior molars are respectively +4 and Y4 on both sides. The pattern of M_1 is indistinct due to excessive attrition.

Mandibular	Diameter	Measurements (mm) Right	Left	Maxillary	Diameter	Measurements (mm) Right	Left
I_1	MD	-	5.1	I^1	MD	8.3	8.2
	BL	-	5.9		BL	7.2	7.1
I_2	MD	-	6.2	I^2	MD	7.2	-
	BL	-	6.2		BL	6.7	-
C	MD	7.1	7	C	MD	8	7.8
	BL	7.5	7.8		BL	8.4	8.9
P_1	MD	6.9	7	P^1	MD	6.9	6.9
	BL	-	8.8		BL	9.9	9.8
P_2	MD	7.3	7.6	P^2	MD	6.7	6.7
	BL	9.1	9.3		BL	10.3	10.1
M_1	MD	10.7	11.1	M^1	MD	10.2	9.8
	BL	11.4	11.4		BL	11.1	11.2
M_2	MD	11.4	10.9	M^2	MD	8.9	9.1
	BL	11.2	11.3		BL	11	11.3
M_3	MD	10.4	10.2	M^3	MD	8.3	8.3
	BL	11	10.9		BL	11.8	12
P_1-M_3 distance		48.3	46.3	P^1-M^3 distance		41	41.3
				Cross-sectional area upper M^1		113.2	109.8
				Cross-sectional area upper M^2		97.9	102.8
				Cross-sectional area upper M^3		97.9	99.6
				Total cross-sectional area upper molars		309	312.2

Table 2. Liang Togé teeth measurements.

The teeth are comparable in size to other teeth from material of Flores, although at the smaller end of the range (Jacob, 1967). The incisors are not shovel-shaped.

The cross-sectional area of the individual molars is medium (Martin, 1914), at the small side for the M^1 and the M^2, but small for the M^3. The total cross-sectional area of the upper molars is medium sized. It is closer to small, than any of the other teeth from Flores.

The mandible (table 3)

The right ramus of the mandible (plate 8) is missing. The base of the mandibular corpus has contact points in the mid-portion and at the gonion.

Because of the gracile appearance, and the small mentum, the mandible was sexed as female (table 93). The ramus is broad and extremely low. This is shown by the mandibula L-H index. The corpus is of medium size as shown by the corpus mandibula module.

The coronoid process is broad and has an obtuse tip. Its anterior and superior borders meet at an angle of about 90°. Its anterior border is convex and it fans out toward the corpus, forming a blunt linea obliqua. This serves as the lateral boundary of a very broad and deep mandibular recess (precoronoid fossa), which comprises the whole length of the anteromedial aspect of the coronoid process.

The small postmolar trigone is separated from the mandibular recess by a blunt and exceedingly low crest. This crest proceeds on the inner side of the ramus as the endocoronoid crest, which forms the medial border of the precoronoid fossa. In addition, the endocondyloid crest, as the lower border of the small triangular plane, is only faintly indicated. It merges in its anterior part with the endocoronoid crest, resulting in a well developed vertical torus at its junction. The anterior border of the ramus conceals the posterior part of M_3 in lateral view. Two vertical ridges can be found on the lateral side of the ramus located in the area of insertion of the masseter. The mandibular notch is shallow.

Description	Measurements (mm) Right	Left	Index	Right	Left
Mandibular length	100				
Minimum ramus breadth	-	36			
condyloid height	-	60.4	Ramus index	-	59.6
Coronoid height	-	48.2	Mandibula L-H index	-	48.2
Intermental breadth	44.3				
Dental arch length	51				
Corpus height at mental foramen	-	29.6			
Corpus height at M_2	27.9	26.4			
Corpus thickness at mental foramen	10.1	10.9	Mandibular thickness index	-	36.8
Corpus thickness at M_2	16.9	17.3			
Height of mental foramen from mandibular base	15.1	14.5			
Symphyseal height	32.2		Height index	86.6	82
Length of mandibular notch	-	38			
Depth of mandibular notch	-	9	Index of mandibular notch	-	23.7
Sagittal diameter of condyloid process	-	9.1			
Transverse diameter of condyloid process	-	22.2	Index of condyloid process	-	41
Inter-C distance	16.2				
Inter-M_1 distance	29.8				
Inter-M_3 distance	40.6				
Symphysis thickness	14.9		Corpus mandibula module	23	22.7

Table 3. Liang Togé mandible measurements.

Plate 8. Liang Togé mandible. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

In vertical view, the anterior and posterior borders of the condyle run almost parallel. In frontal view, the superior border of the condyle changes from concave laterally to convex medially, thus forming a sygmoid curve. The condylar axis lies in a horizontal plane, and runs in a mediolateral and dorsoventral direction. The condyloid process rises straight up and backwards, without the usual anterior curve of the cranial portion.

The ramus ascends steeply with a slight inclination toward the median plane in its superior portion. The mandibular angle shows a weak eversion. The goniol region is curved buccally, while the portion above it is curved lingually. This feature is not unusual and is encountered also in several Gua Cha mandibles; it is also seen in Caucasoid and 'Negroid' mandibles (Jacob, 1967).

The mandibular foramen is a small, circular hole behind the vertical torus. The pterygoid tuberosity proceeds upward to the posterior widening of the condyloid process. The mandibular lingula is broken. Its base is confined to the anteromedial side of the foramen. The mylohyoid groove is shallow and runs from a point approximately 5mm ventrocaudal of the foramen to the level of M_1 in the subalveolar fossa. The mylohyoid line and the alveolar portion form an obtuse projection medially. The alveolar border does not show any peculiarity.

The mental trigone reaches up to the infradentale. The mental tubercles are poorly marked. There is strong alveolar prognathism as in the maxilla. The mental foramen is small and opens posterosuperiorly. On each side it is situated below the posterior part of P_2 and approximately halfway up the mandibula.

Two small genial tubercles are observable, above which a tiny supraspinous fossula and a small genioglossal crest are evident. The shallow digastric fossae have a horizontal course.

The scapula (table 4)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Length of glenoid cavity	29	28.2			
Breadth of glenoid cavity	22.2	21.1	Glenoid cavity length-breadth	76.6	74.8
Acromial breadth	36.2	-			
Length of coracoid process	41	-			

Table 4. Liang Togé scapula measurements.

Of both scapulae only the cranioaxillary portion is preserved. The scapular notch appears to have been very shallow on both sides, although it is hard to tell, due to damage to the superior margin. The lateral margin, which is still present in the right scapula, is relatively strong developed. A strong crest runs caudally from the dorsocaudal border of the glenoid cavity. One gets the impression that the infraglenoid tuberosity is situated on the dorsocaudal border of the glenoid cavity. The insertion of the teres minor on the dorsal part of the axillary border is rather well marked. Ventral to this crest, a groove is present. The shape of the glenoid cavity is piriform and the surface is concave. The acromial extremity has a triangular shape. The trapezoid tubercle for insertion of the trapezius is apparent on the scapular spine, bordered by strong crests.

The humerus (table 5)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Length*	272				
Maximum length*	280				
Horizontal diameter of caput	31.9	-			
Vertical diameter of caput	38	-	Caput index	84	-
Subdeltoid circumference	51	49	Robusticity index	18.2	17.5
Mid-shaft maximum diameter	19	19.9			
Mid-shaft minimum diameter	11.6	11.8	Diaphyseal index	61.1	59.3
Mid-shaft transverse diameter	17	14.9			
Mid-shaft sagittal diameter	16	15.2			
Distal epiphyseal breadth	-	48.8			
Trochlear breadth	-	35.5	Trochlea-epicondylar index	-	72.8
Trochlear depth	-	22.2			
Capitulum breadth	-	14			
Olecranon fossa breadth	-	21			

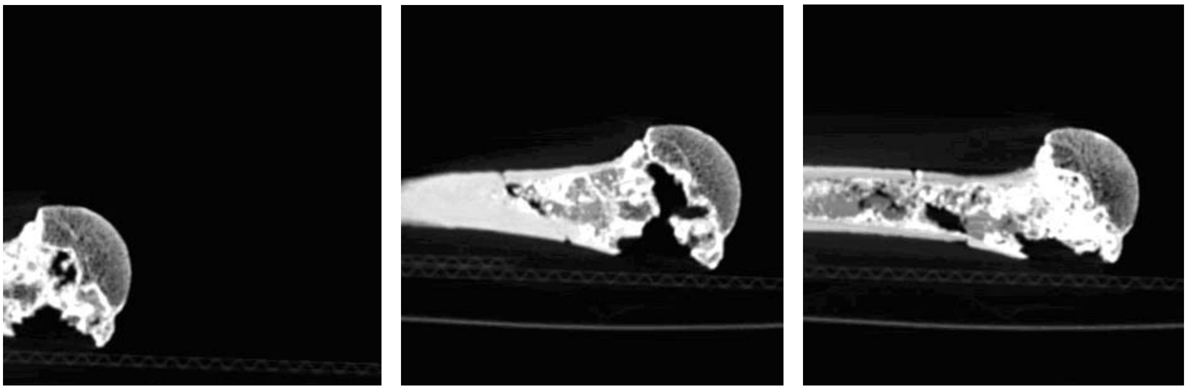
*Table 5. Liang Togé humerus measurements. *Estimated by combining measurements from right and left humerus.*

The left humerus (plate 21) lacks its proximal end, while the right humerus lacks its distal extremity. Both were therefore used to estimate the length of a complete humerus. The bone is extremely slender and small. The diaphysis is very flat, what is called platybrachy. The border between platybrachy and eurybrachy (more rounded) lies at a diaphyseal index of 76.5 and Liang Togé has an average of 60. The distal part has a triangular cross-section, but the rest of the bone is oval shaped.

The mean robusticity index (17.9) lies within the lower border of the range (16.6-25.2), showing that the bone is very slender in relation to its length. The radial groove is almost absent. The intertubercular groove is wide and shallow. The caput of the right humerus is ellipsoid.

The distal extremity of the left humerus has a moderately developed medial epicondyle. The olecranon fossa has a supratrochlear foramen; this characteristic is present to some degree in most modern human populations (it occurs mostly in women and more particularly in the left humerus). The olecranon fossa is elongated in transverse direction. The coronoid fossa is well defined. Its shape is triangular and the walls slope steeply down to the supratrochlear foramen. The radial fossa is only slightly pronounced.

The spongiosa of the right humerus (scan 1) reveals a dense structure in the undamaged area. The growth disc can still be seen as a white line, indicating early adulthood. According to the criteria of Maat *et al*. (2000) the humerus is in phase I. In combination with the endocranial suture obliteration the age is therefore estimated at 29-54 years.



Scan 1. CT-scans of the Liang Togé right humerus taken 2 mm apart at approximately the centre of the head. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The ulna (table 6)

Description	Measurements (mm) Right	Left	Index	Right	Left
Maximum length	239.1	241.3			
Physiological length	208.9	212.3	Length index	114.5	113.7
Olecranon depth	22	21.9			
Olecranon breadth	18.7	19	Olecranon depth index	117.6	115.3
Olecranon-coronoid distance	-	23			
Upper transverse diameter	16.8	17			
Upper sagittal diameter	15.6	15.8	Platolenic index	107.7	107.6
Mid-shaft transverse diameter	12	12.1			
Mid-shaft sagittal diameter	10.7	10	Diaphyseal index	89.2	82.6
Minimum circumference	32	31	Length-circumference index	15.3	14.6

Table 6. Liang Togé ulna measurements.

Both ulnae are complete although slightly damaged. The right ulna is curved laterally in the usual way. However, there is no backward curve. The left ulna is completely straight. As with the humerus, the bones are slender. The length-circumference index therefore is small. The interosseus margin is slightly developed and the muscle impressions are weak (but the bones have been prepared in such a way that the outer layer has probably been peeled of). The cross-section of the diaphysis changes from quadrangular in the proximal part to triangular at mid-shaft to round in the distal section. The olecranon depth index reflects the greater depth compared to breadth. This is a rare individual variation, but is reported to be quite common among the Negrito's and Fire-landers (Martin, 1914). The diaphyseal index of the ulna is quite high, because the crista interosseus is not strongly developed. The cross-section of the proximal end shows absolutely no platoleny (transversal flattening).

On the contrary the bone is flattened in dorsoventral direction (euroleny). According to Jacob (1967) this high index value is due to the weak development of the interosseus margin.

The radius (table 7)

Description	Measurements (mm) Right	Left	Index	Right	Left
Maximum length	-	223.8			
Physiological length	-	209.5			
Parallel length	-	221			
Minimum circumference	30	30	Robusticity index	-	14.3
Transverse diameter of capitulum	-	18.5	Physiological length-transverse diameter of capitulum index	-	8.8
Transverse diameter of collum	-	10			
Mid-shaft transverse diameter	12.3	12	Diaphyseal index	73.2	70
Mid-shaft sagittal diameter	9	8.4	Humeroradial index	-	79.9

Table 7. Liang Togé radius measurements.

The left radius is intact, the right radius lacks its proximal part (above the radial tuberosity), and the distal extremity is damaged laterally. The bones are not long and again they are slender (robusticity index: 14.3). Muscular markings are faint. The interosseus margin of the radius is poorly developed as in the ulna. The radial tuberosity is located on the medial border. Proximal to it, the epiphysis is bent dorsally and laterally. The rest of the bone is straight. The diaphyseal index is low (meaning that the transverse diameter is smaller than average compared to the sagittal diameter). This is due to transversal flattening of the bone, and the poor crista development. The radial caput is regular, wide, and concave. Its border is not elevated. The distal end shows dorsoventral flattening. The distal articular surface is concave and lacks an elevated border. The ulnar notch is wide and almost flat.

The bones of the hand (table 8)

Most carpal bones are present, though most are damaged. The scaphoid bones (ossa naviculare) are both present and in good condition. The right scaphoid lacks part of its distal joint surface and the dorsal surface. Both the left and right scaphoids have damage around the edges, but the original shape is preserved.

Description		Measurements (mm) Right	Left	Index	Right	Left
Scaphoid	Maximum length	23	22.9	Length-breadth index	47.8	45
	Breadth	11	10.3	Length-height index	55.7	55.5
	Height	12.8	12.7	Height-breadth index	116.4	123.3
Lunate	Length	10.2	10	Length-breadth index	136.3	-
	Maximum breadth	13.9	-	Length-height index	71.3	-
	Maximum height	14.3	-	Height-breadth index	97.2	-
Triquetrum		P	P			
Pisiform	Maximum length	-	7			
	Maximum height	-	7.3	Length-height index	-	95.9
Trapezium		-	P			
Trapezoid	Maximum length	15	-	Length-breadth index	148.5	-
	Maximum breadth	10.1	-	Length-height index	97.4	-
	Maximum height	15.4	-	Height-breadth index	65.6	-
Capitate	Maximum length	20	-	Length-breadth index	61.5	-
	Maximum breadth	12.3	-	Length-height index	81.5	-
	Maximum height	16.3	-	Height-breadth index	75.5	-
Hamate	Maximum length	17.7	P	Length-breadth index	81.9	-
	Maximum breadth	14.5	-	Length-height index	97.8	-

	Maximum height	18.1	-	Height-breadth index	80.1	-
Metacarpal	D III	P	P			
	D IV	49.3	P			
	D V	-	P			
Phalanx i	D II	37.8	-			
	D III	44.4	43			
	D IV	P	-			
	D V	28.6	-			
Phalanx ii	D IV	26	25.5			

Table 8. Liang Togé handbone measurements (see below). -= Absent. P = Present, but too damaged for measuring.

Both lunates (ossa lunatum) are found. The right lunate is in good shape, the left is damaged on the dorsal and palmar surfaces. Of the right triquetrum (os triquetrum), only the most proximal part is preserved. The left triquetrum is better preserved, but all the sides are damaged to some degree. The right os pisiformis is missing. The left pisiform is missing its radial half. The right trapezium (os multangulum majus) is missing. The left trapezium is only represented by a fragment of the proximal palmar side. The right trapezoid (os multangulum minus) is in good shape. The left trapezoid is missing. Only the right capitate (os capitatum) is preserved, but it is relatively undamaged. The hamate bones (ossa hamatum) are both present and the right hamate is complete. The left is much more damaged, missing its hamulus (hamulus ossis hamati) on the palmar side.

On the right hand, the proximal part of the metacarpal (os metacarpi) of the third finger is preserved, and that of the fourth finger is complete, except that it has damage to the caput and the distal part of the corpus. The first phalanges are all preserved, except for that of the thumb. The first phalanx (phalanx proximalis) of digit two has damage to the lower part of the corpus., as does the first phalanx of digit three, but this is more extensive. The first phalanx of the fourth finger is missing its base, and the first phalanx of the fifth finger is complete. The second phalanx (phalanx media) is only preserved in digit four. The left hand has the base of the third metacarpal, and the caput of the fourth and fifth metacarpals. Only the first phalanx of the third finger and the second phalanx of the fourth digit are preserved.

The vertebrae (table 9)

Atlas and Axis						
Description	Measurements (mm)					
Anterior height of axis			32.3			
Height of axis body			20.7			
Thoracic and lumbar vertebrae						
Description	Measurements (mm)					
	T12	L1	L2	L3	L4	L5
Anterior height	-	-	-	-	25.7	-
Middle vertical diameter	-	21.1	22.3	-	22	18
Posterior height	24.2	24.9	25.9	27.8	25.1	23.7
Superior breadth	-	32.9	-		40.6	-
Middle transverse diameter	-	-	29.9	-	-	-
Inferior breadth	32.5	-	-	-	44.3	-
Inferior sagittal diameter	-	25	-	-	24.7	-
Middle sagittal diameter	-	-	-	-	21.9	23
Vertebral foramen transverse diameter	20.7	20.9	19.3	-	20.4	21.3
Vertebral foramen sagittal diameter	16.3	14.9	14.1	-	11.6	11.7
Index	T12	L1	L2	L3	L4	L5
Vertebral corpus index	-	-	-	-	97.7	-
Sagittovertical corpus index	-	-	-	-	100.5	78.3
Vertebral foramen index	78.7	71.3	73.1	-	56.9	54.9

Table 9. Liang Togé vertebra measurements.

Little is preserved of the vertebrae. The ventral parts of the atlas and axis, the twelfth thoracic vertebra, and the five lumbar vertebrae are known. The cranial surface of the T12 body is mostly missing except on the left side, but the caudal surface is intact. The transverse processes are broken as well as the spinous process. Both inferior articular processes are also missing.

Both the cranial and caudal surfaces of the vertebrate body of L1 are damaged anteriorly and the right lateral surface is also missing. The costal processes and spinous process are broken off. The right inferior articular process is also missing. The cement-like matrix in which the skeleton was found attaches the second and third lumbar vertebrae to each other. It was impossible to separate them without causing more damage. The right lateral surface and the right side of the anterior surface of the L2 body are damaged. The spinous process is also missing. L3 misses the anterior portion of its body, the right costal process, and the spinous process. Of L4, a small part of the anterior portion of the cranial surface is damaged, the right costal process is missing and the left is damaged, and the right inferior articular process and the spinous process is broken off. L5 is missing its anterior surface, part of the left superior articular process, both costal processes, the left inferior articular process, and part of the spinous process.

The anterior height could only be measured on L4. According to Martin (1914) its size is comparable with that of Japanese (meaning smaller than Europeans, but larger than Senoi). The posterior height of L4 is smaller than the anterior height, giving the vertebra a posterior wedge shape.

The sacrum (table 10)

Description	Measurements (mm)	Index	
Anterior direct height	93		
Superior anterior direct breadth	95.3	Height-breadth index	102.5
Anterior curved height	96	Anterior curvature index	96.9
Posterior direct height	91.6		
Posterior curved height	100		
Breadth of superior aperture of sacral canal	25.9		

Table 10. Liang Togé sacrum measurements.

The sacrum is damaged over its entire length. The left side, the distal right side, the middle and the distal part of the sacrum are damaged. Only four sacral vertebrae can be found. I have measured the height of the sacrum, although it is probably lacking its fifth vertebra. It would seem, that the height of the sacrum was not great, since it only just reaches the lower limit with four vertebrae. The sacrum is narrow, but this can be caused by damage. The lateral parts of the sacrum lie in a direct line with the basal plane (homobasality; Martin, 1914). The sacral canal is narrow. The anterior surface shows a weak vertical curvature. According to Jacob (1967), the sacral vertebrae have a grade 3 closure.

The innominate bone (table 11)

Description	Measurements (cm)		Index		
	Right	Left		Right	Left
Maximum length	168.7	-			
Iliac height	102.1	115			
Iliac breadth	137.4	133			
Height of iliac fossa	75.1	85	Iliac index	183	156.5
Breadth of iliac fossa	91.6	100			
Ischial height	59.2	-	Ischial height index	35.1	-
Maximum diameter of acetabulum	41.8	41			
Depth of small pelvis	76.3	-			
True height of small pelvis	111.7	-			

Table 11. Liang Togé innominate bone measurements.

The pelvic bones are much damaged, making it difficult to make exact measurements. The right pelvic bone consists of a large part of the ilium, missing the superior part in the middle of the iliac crest down to about the centre of the iliac fossa, and the ischium. The ilium looks crushed and all parts have unusual holes, which could be caused by damage, pathology or they could be bite marks. The left pelvic bone has an ilium, which is a bit more intact, looking less crushed and missing a smaller part on the same location as the right. The ischial body is present, but detached from the ilium. The pubic bone is no more than a large spine because of damage. Again all parts show unusual holes.

Because of the delimited pre-auricular sulcus, wide U-shaped sciatic notch, the double curved arc composé, the low, broad innominate bone, the flat s-formed iliac crest, and the low, broad iliac fossa, the pelvis was sexed as female (table 93). The ischial body is too damaged to give a reliable score for sex determination, so I have left it out. It does however look very gracile, with a small tuber ischiadicum, and therefore does not contradict the outcome. The depth of the small pelvis (distance between the tip of the tuber ischiadicum and the linea arcuata, measured perpendicular to the latter) is very small, lying close to the average of Senoi women (Martin, 1914). The maximum length and the iliac breadth also fall just below or on the same measure of Senoi women. On the other hand, the breadth of the iliac fossa is wide. The left iliac fossa exceeds all measurements given by Martin. The iliac index is high, confirming that Liang Togé is a woman, since the breadth of the ilium is much larger than the height.

The femur (table 12)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Maximum length	-	382.5			
Direct length	-	380.2			
Trochanter-condyloid length	-	363.3			
Trochanteric length	-	358			
Diaphyseal length	-	317			
Horizontal diameter of caput	37.7	38.2	Caput index	99.2	-
Vertical diameter of caput	38	-	Caput robusticity index	19.9*	-
Caput circumference	11.9	-			
Sagittal diameter of collum	19.3	-			
Vertical diameter of collum	25.1	-	Collum index	76.9	-
Upper breadth	79.9	-			
Intertrochanteric distance	61	-			
Caput-trochanter distance	76	-			
Subtrochanteric transverse diameter	28	26.8			
Subtrochanteric sagittal diameter	20	21	Platymeric index	71.4	78.4
Mid-shaft transverse diameter	-	22.8	Pilastric index	-	96.1
Mid-shaft sagittal diameter	-	21.9	Robusticity index	-	11.8
Mid-shaft circumference	-	70	Circumference-length index	-	18.4
Popliteal transverse diameter	-	32.2	Circumference-diaphyseal length index	-	22.1
Popliteal sagittal diameter	-	23	Popliteal index	-	71.4
Epicondylar breadth	-	59.6	Epicondylar-diaphyseal breadth index	-	38.3
Posterior breadth of medial condyle	-	25.6	Epicondylar-diaphyseal length index	-	18.8
Thickness of medial condyle	-	51.2			
Thickness of lateral condyle	-	51	Condylar index	-	85.6
Breadth of intercondyloid fossa	-	14.7	Femorohumeral index	-	71.5

*Table 12. Liang Togé femur measurements. * Calculated from caput measurements on right femur and length of left femur.*

The left femur (plate 9) has damage to the caput, the greater and lesser trochanter, and the lateral epicondyle. Of the right femur however, only the proximal epiphysis and a small part of the diaphysis remain. The caput and lesser trochanter of the right femur are intact. The bones are straight and slender. The slenderness of the bone is expressed by the robusticity index (11.8). This has a very low value, approaching the lower limit of the range (11.7 according to Martin, 1914). The diaphysis is very flat beneath the trochanters (anteroposterior flattening), which is shown by the low value of the platymeric index. The lesser trochanter is pronounced, and there is a small third trochanter on the dorsolateral side of the right femur. Because of damage it can not be determined whether it is also present on the left femur. The lesser trochanter points dorsomedially. It is located on the medial half of the femur. The intertrochanteric crest is weakly developed and muscle markings are faint (but again the bone surface has been peeled). The linea aspera is located in the middle of the dorsal surface. It is poorly developed, being only recognisable if looked at from the lateral side and not from the medial side (grade 1, Martin, 1914). The pilastric index is very low, indicating the poor development of the linea aspera. The cross-section of the diaphysis changes from oval in the subtrochanteric region to round with a ridge on the dorsal side by the linea aspera, to triangular in the distal part. The condylar index has a high value (85.6). This could be due to the damage to the lateral epicondyle, which may have made it appear less broad than in life.

Plate 9. Liang Togé right tibia and left femur. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The patella (table 13)

Description	Measurements (mm) Right	Index	Right
Height	35.2	Height index	51.7
Breadth	35.9	Breadth index	60.2
Thickness	18.4	Height-breadth index	98.1
Height of articular surface	24.2		
Breadth of medial articular surface	16		
Breadth of lateral articular surface	20.4		

Table 13. Liang Togé patella measurements.

Only the right patella is preserved. The shape is triangular. The crest on the articular surface is high. The lateral facet is hollowed (concave). According to Martin (1914) this is a characteristic associated with habitual squatting. The medial facet is also concave. The patella is medium high (index value between 50.0-54.9) and broad (index value > 56.0). The height and breadth indices correspond to the values given by Martin (1914) in Malayans and Negrito's. The height-breadth index is high, indicating that the height is almost as great as the breadth.

The tibia (table 14)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Spinomalleolar length	305		Femorotibial index	77.9	
Condylomalleolar length	300.2		Tibioradial index	74.6	
Length	296		Intermembral index	70.8	
Condyloastragalar length	286				
Proximal epiphyseal length	63.5				
Breadth of upper medial articular surface	28.2				
Breadth of upper lateral articular surface	25.8				
Transverse diameter at tibial tuberosity	37.9				
Sagittal diameter at tibial tuberosity	41.7				
Mid-shaft transverse diameter	16.5	17.4			
Mid-shaft sagittal diameter	24	32.4	Platycnemic index	67.4	74.4
Mid-shaft circumference	65.5	64			
Minimum circumference	61	60	Length-thickness index	20.3	-

Table 14. Liang Togé tibia measurements.

The left tibia is missing its proximal extremity and is damaged on the lateral side of the distal epiphysis. The right tibia (plate 9) has damage to both epiphyses. The proximal end has a large hole beneath the lateral articular surface and a smaller one beneath the medial articular surface. The distal end has damage on the lateral and posterior side of the articular surface. The bones are slender and straight.

Striking is the transverse flattening. The platycnemic index has to be measured at the nutrient foramen. However, this could not be located on the bone, so I have had to use the transverse and sagittal diameters at mid-shaft. As a result, the value of the platycnemic index becomes higher, thereby underestimating the platycnemia of the bone. With the measurements at mid-shaft, the index shows that the bones are not platycnemic. Jacob (1967) estimated the platycnemic index of the right tibia from measurements above mid-shaft to be less than 63.0, bringing it in the platycnemic range (< 64.9; after Khuff or < 62.9 after Manouvrier & Verneau in Martin, 1914). In contrast, the platycnemic index of the left tibia is very high. This could be caused by damage at mid-shaft, which has altered the shape of the shaft. The shape of the transverse section at mid-shaft corresponds to Hrdlička's type VI (Martin, 1914), which means irregular oval with a convex lateral side and a medial side which is flat or also convex. This shape is most commonly seen in 'Negro's'. The lateral articular surface of the head is convex, while the medial articular surface is concave and slopes down from the lateral to the medial border. The convexity of the lateral articular surface corresponds to Thomson's type 3 (Martin, 1914). As with the patella, this type is associated with habitual squatting. At the distal end of the bone a lateral squatting facet is visible. There is no sign of a medial squatting facet.

The fibula (table 15)

The right fibula misses the distal extremity and has a damaged head, while of the left fibula only the middle part of the diaphysis remains. Again the bones are slender and straight. The shape of the diaphysis is irregular quadrangular. The diaphyseal index is low (average 67.7; corresponds to that of Ona: 64.7, Martin, 1914).

The bones of the foot (table 16-20)

Not many bones of the foot are preserved. Both tali (table 16), both calcanei (table 17), and both naviculares (table 18) are present, as are both cuboidea, and the three left cuneiforms (table 19). The left metatarsals of digit I, II, III, and V, the right metatarsal of digit V, and both first phalanges of digit I are preserved (table 20).

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Mid-shaft maximum diameter	14.4	12.5			
Mid-shaft minimum diameter	9.1	9	Diaphyseal index	63.2	72
Mid-shaft transverse diameter	14	12.3			
Mid-shaft sagittal diameter	9	9.5			
Mid-shaft circumference	39	34			
Minimum circumference	26	-			

Table 15. Liang Togé fibula measurements.

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Length	44.2	42			
Height	24.5	26	Length-height index	55.4	61.9
Length of trochlea	24.2	-	Trochlear length index	54.8	-
Breadth of trochlea	25.1	-	Trochlear index	103.7	-
Anterior trochlear breadth	20	-			
Posterior trochlear breadth	19	18.8	Trochlear breadth index	95	-
Length of caput	-	30	Caput length index	-	71.4
Length of posterior calcanear articular surface	24.8	28.3			
Breadth of posterior calcanear articular surface	-	17.9	Posterior calcanear articular surface breadth index	-	63.3

Table 16. Liang Togé talus measurements.

The right talus is more damaged than the left. The head is damaged on all sides. The posterior part of the posterior calcanear articular surface is missing. And the body is punctured with unusual holes. The left talus has damage on its lateral side and to the anterior and lateral part of the trochlea. The trochlear length index of the talus is low, while the trochlear index is high. This indicates the shortness of the trochlea in comparison to the length of the talus and the breadth of the trochlea. The trochlear breadth index is high, showing little posterior narrowing of the trochlea. According to Martin (1914) narrowing of the posterior part of the talus is a character often seen in Japanese, Melanesians, Wedda, Senoi, and Negrito's, but is absent in Australians and Europeans.

The medial edge (tibial side) of the trochlea is lower than the lateral edge (fibular side) a characteristic found in 'Negro's', Wedda and Senoi (Martin, 1914). The posterior calcanear articular surface index is low, being in the range of Australians and Fire-landers (Martin, 1914).

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Length	65.7	64.9			
Height	34.8	31.3	Length-height index	53	48.2
Length of corpus	43.6	42.6	Corpus length index	66.4	65.6
Height of tuber	39.2	37.7	Tuber index	59.7	58.1
Length of posterior calcanear articular surface	16	16			

Table 17. Liang Togé calcaneus measurements.

Of both calcanei only the medial sides are found. Of the right calcaneus the medial side also has slight damage. The articular surface with the cuboid bone can only be found on the right calcaneus. The length-height index is above average, in the range of Firelanders and Peruans (Martin, 1914). The corpus length index is low (average 66.0), falling below Hylobates (67.8), which according to Martin (1914) stands at the lower limit of human values. This means the corpus is very short. The tuber index is low, but close to Australians. The anterior and medial articular surfaces are fused together.

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Breadth	36.3	33.9			
Minimum thickness	-	9.4			
Length of posterior articular surface	22.9	24.1			
Breadth of posterior articular surface	15.8	15.9	Posterior articular surface index	69	66

Table 18. Liang Togé naviculare measurements.

The right navicular bone is damaged anteriorly, leaving only the posterior articular surface completely intact. The left navicular bone is damaged dorsally. The posterior articular surface index is very low (67.5 average), since the lowest value given for humans is 73.1 for Negrito's (Martin, 1914). It is, however, still above the highest values given for apes (56.0). The shape of the posterior articular surface is egg-shaped (piriform).

Bone	Measurements (mm)	Left	Index	Left
Cuboideum	Medial length	31.3		
Cuneiform I (medial)	Superior length	20.8		
	Distal articular surface height	24.8		
	Distal height	25.7	Length-distal height index	123.6
Cuneiform II (intermediate)	Superior length	15.9		
	Middle superior breadth	16	Length-breadth index	100.6
Cuneiform III (lateral)	Superior length	18.2		
	Middle superior breadth	12	Length-breadth index	65.9
	Distal breadth	13.3		
	Proximal breadth	11	Breadth index	82.7

Table 19. Liang Togé cuboid and cuneiform measurements.

Of the right cuboid bone, only part of the posteriomedial side is preserved. The left cuboid bone only misses the anteroplantar part. The cuneiforms of the left foot are preserved. The first cuneiform consists of only the medial side and the distal articular surface. The second cuneiform consists of the dorsal surface and part of the proximal, medial and distal articular surfaces. The third cuneiform is complete.

Of the right foot, only the fifth metatarsal is present. It is damaged, but still in one piece. Due to damage to the middle of the body, no reliable measurement could be made of the height of the corpus. The first metatarsal of the left foot consists of two pieces: the base and the capitulum with a part of the body. These pieces cannot be reliably put together, so I could not measure the length. The left metatarsal II has damage to the capitulum in the form of a hole, but is complete. The left metatarsal III is also complete except for damage to the head and base. The fifth metatarsal of the left foot consists of only the base. The first phalanx was found of both the first toes. The right phalanx is missing its head and is very damaged overall. The left first phalanx is complete.

2.1.5. Stature estimation

There is much controversy about the correct method to calculate stature. It is more precise to use regression formulae, which are gender and race specific, when gender and race are known. However, gender and race are almost never certain for prehistoric specimens. The stature estimation may deviate more from the correct value, when either gender or race is incorrect, than when a non-specific formula is used. In order to have the most accurate result possible, the data of several different authors have been used to calculate stature. One is non-specific (Feldesman *et al.*, 1990), one is gender specific (Pearson, 1898), and some are gender and race specific (Trotter & Gleser, 1952, 1958; Bach, 1965; Bergman & The, 1955). Additionally, considering the fragmentary condition of most of the material, stature has also been estimated using the circumference of the long bones instead of the length (Bergman & The, 1955).

		Metatarsal and phalanx					
Bone		Measurements (mm)	Right	Left	Index	Right	Left
Metatarsal	D I	Length	-	P			
		Breadth of base	-	16			
		Height of base	-	22.5			
	D II	Length	-	63.3			
		Breadth of corpus	-	7	Length-breadth index	-	11.1
		Height of corpus	-	7.1	Breadth-height index	-	101.4
	D III	Length	-	58			
		Breadth of corpus	-	5.7	Length-breadth index	-	9.8
		Height of corpus	-	8.7	Breadth-height index	-	152.6
	D V	Length	52.8	P			
		Breadth of corpus	9.1	-	Length-breadth index	17.2	-
Phalanx i	D I	Length	P	26.3			
		Breadth of corpus	-	11	Length-breadth index	-	41.8
		Height of corpus	-	8.2	Breadth-height index	-	74.5

Table 20. Liang Togé metatarsal/phalanx measurements. -=Absent. P=Present, but too damaged of measuring.

Estimation of living stature for females according to Pearson (1898) in Martin (1914):

a. 72.844 + 1.945 femur = 147.24 cm
b. 71.475 + 2.754 humerus = 148.59 cm
c. 74.774 + 2.352 tibia = 145.38 cm
d. 81.224 + 3.343 radius = 156.04 cm
e. 69.154 + 1.126 femur + tibia = 146.03 cm*
f. 69.561 + 1.117 femur + 1.125 tibia = 146.41 cm*
g. 69.911 + 1.628 humerus + radius = 151.93 cm
h. 70.542 + 2.582 humerus + 0.281 radius = 149.13 cm
i. 67.435 + 1.339 femur + 1.027 humerus = 147.41 cm*
j. 67.469 + 0.782 femur + 1.120 tibia + 1.059 humerus – 0.711 radius = 144.74 cm

Average: 148.29 cm*

Femur = maximum length of femur (= 38.25 cm); humerus = maximum length of humerus (= 28.0 cm); tibia = condylomalleolar length of tibia (= 30.02 cm); radius = maximum length of radius (= 22.38 cm).
*e, f, and i are the most accurate formula's, but if a height is the result of two or more formulae, this can be accepted as the most likely stature height (Martin, 1914). It is best to take the average length from all formulae. In the case of pygmies the height will be overestimated.

Estimation of living stature by Feldesman et al. *(1990):*

Because it is not really clear to what 'race' the specimen from Liang Togé belonged, it may be better to use a race (and gender) independent femur/stature ratio as calculated by Feldesman *et al.* (1990). The authors say that this ratio is not only independent of race and gender, but also reasonably accurate for all possible human statures. Since Liang Togé was apparently very small, this may prevent additional errors to an already doubtful estimate, because race is not explicitly determinable.

The femur/stature ratio is calculated as follows:

F/S Ratio = Maximum femur length (cm) x 100/living stature.

Feldesman *et al.* (1990) calculated the ratio to be 26.74 using a number of recent skeletal samples of which the ante-mortem stature was known. This makes the result:

Stature (cm) = maximum femur length (38.25 cm) x 100 / 26.74 = 143.04 cm

Estimation of living stature divided in White and 'Negro' by Trotter & Gleser (1958):

American white:

a. 0.68 hum + 1.17 fem + 1.15 tib + 50.12 = 148.44 cm*
b. 1.39 (fem + tib) + 53.20 = 148.10 cm
c. 2.90 tib + 61.53 = 148.59 cm
d. 1.35 hum + 1.95 tib + 52.77 = 149.11 cm
e. 2.47 fem + 54.10 = 148.58 cm
f. 4.74 rad + 54.93 = 161.01 cm
g. 4.27 ulna + 57.76 = 160.33 cm
h. 3.36 hum + 57.97 = 152.05 cm

Hum = maximum length of humerus (= 28.0 cm), rad = maximum length of radius (= 22.38 cm), fem = maximum length of femur (= 38.25 cm), tib = condylomalleolar length of tibia (= 30.02 cm), ulna = maximum length of ulna (= 24.02 cm).
* The formulae are listed in order of preference (formula a. has the smallest standard deviation).

'Negro':

a. 0.44 hum – 0.20 rad + 1.46 fem + 0.86 tib + 56.33 = 145.84 cm*
b. 1.53 fem + 0.96 tib + 58.54 = 145.88 cm
c. 2.28 fem + 59.76 = 146.97 cm
d. 1.08 hum + 1.79 tib + 62.80 = 146.78 cm
e. 2.45 tib + 72.65 = 146.20 cm
f. 3.08 hum + 64.67 = 150.91 cm
g. 3.31 ulna + 75.38 = 154.89 cm
h. 3.67 rad + 71.79 = 153.93 cm

Hum = maximum length of humerus (= 28.0 cm), rad = maximum length of radius (= 22.38 cm), fem = maximum length of femur (= 38.25 cm), tib = condylomalleolar length of tibia (= 30.02 cm), ulna = maximum length of ulna (= 24.02 cm).
* The formulae are listed in order of preference (formula a. has the smallest standard deviation).

Estimation of corpse length for European females according to Bach (1965):

H = 98.38 + 2.121 humerus (1) ± 3.9 cm = 157.77 ± 3.9 cm
H = 99.44 + 2.121 humerus (2) ± 3.9 cm = 157.13 ± 3.9 cm
H = 116.89 + 1.925 radius (1b) ± 4.5 cm = 159.43 ± 4.5 cm
H = 106.69 + 1.313 femur (1) ± 4.1 cm = 156.91 ± 4.1 cm
H = 95.91 + 1.745 tibia (1b) ± 3.9 cm = 147.56 ± 3.9 cm

Average: 155.76 cm ± 1.83 cm

The low result of the tibia regressions implies that the tibiae are short compared to the rest of the long bones. This makes any stature calculation difficult. The short tibiae could be pathological, but there is no evidence for this. If it is pathological or at least unusual in her population, female height for her population may have been larger, bringing her more in range with (the 6% difference with) Liang Momer E.

Estimation of body length for Javanese females using length of long bones according to Bergman & The (1955):

a. 612 + 3.30 hum(r) = 1536.0 mm = 153.60 cm
b. 502 + 3.76 hum(l) = 1554.8 mm = 155.48 cm
c. 762 + 3.68 rad(l) = 1534.8 mm = 153.48 cm
d. 543 + 4.21 ulna(r) = 1549.6 mm = 154.96 cm
e. 449 + 4.68 ulna(l) = 1578.3 mm = 157.83 cm
f. 365 + 2.98 fem(l) = 1498.0 mm = 149.80 cm
g. 520 + 3.08 tib(r) = 1444.6 mm = 144.46 cm

Average: 152.80 cm

Hum = maximum length of humerus (= 280 mm estimated from right and left), rad = physiological length of radius (= 210 mm left), ulna = maximum length of ulna (= 239.1 mm/241.3 mm), fem = direct length of femur (= 380.2 mm left), tib = condylomalleolar length of tibia (= 300.2 mm right).

Jacob (1967) used a regression formula for the femur and tibia from Krogman to estimate the stature of Liang Togé at 148.4 cm. He also reported a later find of a male femur at Liang Togé. To estimate stature he used Bergman & The (1955). He compared the results of Liang Togé with the male and concluded they belong together because the difference in stature is almost 6%. However, I find it strange that he used two different regression formulae for the two individuals and then compare them directly, when they might be expected to give different results for the same individual. Therefore, since I do not have the male material, I have calculated Liang Togé's stature using Bergman & The (1955). The corpse length turns out to be higher than 148.4, 152.80 cm if the length of the long bones is used. The male stature was calculated at 159.4 cm using the mid-shaft circumference of the femur, making Liang Togé 6.9% smaller when using Jacob's stature estimation (Liang Togé's stature is 93.1% of the male's) and 4.1% smaller when using my estimation (or the stature of Liang Togé is 95.9% of the male stature). It is more accurate to calculate Liang Togé's length using the circumference of the humerus and femur, as was done with the male specimen. Her stature then is 151.34 cm. Then Liang Togé is 5.1% smaller than the male material (94.9% of the male height). This is still close to the 6% hypothesis.

Estimation of body length for Javanese females using circumference of long bones according to Bergman & The (1955):

101.5 + 0.98 subdeltoid circumference humerus(r) = 151.48 cm (= lower)
95.9 + 0.79 mid-shaft circumference femur = 151.20 cm (= higher)

Average: 151.34 cm

It is possible that the stature estimation using the circumference of the long bones underestimates the stature length as a result of the slenderness of the bones. To verify whether this last method underestimates stature or not, body length was also estimated by first calculating long bone length from the circumference, and then using these values of long bone lengths to calculate body length.

Estimation of body length for Javanese females by using circumference of long bones to first calculate length of long bones and then body length according to Bergman & The (1955):

Humerus maximum length = 161.9 + 2.22 subdeltoid circumference of humerus = 272.9 mm (= too small)
→ 612 + 3.30 hum(r) = 1512.6 mm = 151.26 cm
502 + 3.76 hum(l) = 1528.1 mm = 152.81 cm
Radius physiological length = 151.0 + 1.63 minimum circumference of radius = 199.9 mm (=too small)
→ 762 + 3.68 rad(l) = 1497.6 mm = 149.76 cm
Ulna maximum length = 152.5 + 2.53 minimum circumference of ulna = 232.2 mm (=too small)
→ 543 + 4.21 ulna(r) = 1520.6 mm = 152.06 cm
449 + 4.68 ulna(l) = 1535.7 mm = 153.57 cm
Femur direct length = 146.1 + 3.39 mid-shaft circumference of femur = 383.4 mm (= too long)
→ 365 + 2.98 fem(l) = 1507.5 mm = 150.75 cm
Tibia condylomalleolar length = 194.8 + 2.16 minimum circumference of tibia = 325.5 mm (=far too long)
→ 520 + 3.08 tib(r) = 1522.5 mm = 152.25 cm

Average: 151.78 cm

Fibula maximum length = 237.0 + 2.48 minimum circumference = 301.5 mm
→ 517 + 3.18 fib(r) = 1475.8 mm = 147.58 cm

Average: 151.26 cm

The length of the long bones calculated from the circumference differs somewhat from the actual length of the Liang Togé long bones. The humerus is longer than its circumference suggests, and the femur is shorter. This indicates that the Liang Togé humerus is more slender than that of the average Javanese female, and that the femur is more robust.

From the regression formula of Bergman & The (1955), it becomes apparent that the tibia is rather short in relation to the other long bones. In order to investigate whether this is a more common variation among the Javanese as near inhabitants to Flores, the data from Bergman & The (1955) were used to calculate stature for the long bones separately (tables 21-25). Individuals were selected on the basis of comparable long bone lengths to Liang Togé.

Humerus: (r+l: 280 mm)		Length (mm)	Stature (cm)	Length (mm)	Stature (cm)
Humerus	Right	280	153.6	286	155.58
	Left	276	153.98	280	155.48
Radius	Right	204	152.05	221	158.65
	Left	204	151.27	216	155.69
Ulna	Right	231	151.55	242	156.18
	Left	230	152.54	241	157.69
Femur	Right	396	155.7	389	153.61
	Left	397	154.81	387	151.83
Tibia	Right	331	153.95	328	153.02
	Left	334	155.34	326	152.82
Average stature			153.48		155.05

Table 21. Stature estimation of Javanese females with a humerus of equal length as Liang Togé.

Radius: (l: 210 mm)		Length (mm)	Stature (cm)	Length (mm)	Stature (cm)
Humerus	Right	295	158.55	297	159.21
	Left	288	158.49	291	159.62
Radius	Right	212	155.16	212	155.16
	Left	210	153.48	210	153.48
Ulna	Right	240	155.34	244	157.02
	Left	236	155.35	239	156.75
Femur	Right	392	154.51	409	159.59
	Left	395	154.21	414	159.87
Tibia	Right	323	151.48	329	153.33
	Left	323	151.87	333	155.03
Average stature			154.84		156.91

Table 22. Stature estimation of Javanese females with a radius of equal length as Liang Togé.

Ulna: (r: 239.1. l: 241.3)		Length (mm)	Stature (cm)	Length (mm)	Stature (cm)
Humerus	Right	290	156.9	289	156.57
	Left	283	156.61	283	156.61
Radius	Right	210	154.38	225	160.2
	Left	208	152.74	216	155.69
Ulna	Right	238	154.5	252	160.39
	Left	237	155.82	241	157.69
Femur	Right	401	157.2	395	155.41
	Left	405	157.19	399	155.4
Tibia	Right	338	156.1	342	157.34
	Left	336	155.98	345	158.82
Average stature			155.74		157.41

Table 23. Stature estimation of Javanese females with an ulna of equal length as Liang Togé.

If we select the individuals for length of femur or tibia, the stature length is lower than if we select for length of humerus, radius or ulna. This would suggest that there is indeed a difference in the combination of arm and leg length between Javanese women and Liang Togé. However, one individual selected for humerus also produces lower stature results if we look at the femur or tibia than if we look at the humerus, radius or ulna. This tendency, however, is not nearly as pronounced as with Liang Togé. Her limb bones, therefore, are differently proportioned.

The stature of Liang Togé lies between 143.04 and 155.76 cm. This is rather a large range. A summary of these results and those from other Flores caves is given in table 92. I have calculated the average stature height from these results, which is given in the conclusion. For comparison of the Flores material, the estimation based on the circumference of the long bones by Bergman & The (1955) is used, since this formula could be used in all cases where stature estimation was possible.

Femur: (l: 380.2 mm)		Length (mm)	Stature (cm)	Length (mm)	Stature (cm)
Humerus	Right	268	149.64	272	150.96
	Left	264	149.46	268	150.97
Radius	Right	195	148.56	204	152.05
	Left	190	146.12	200	149.8
Ulna	Right	225	149.03	230	151.13
	Left	221	148.33	226	150.67
Femur	Right	381	151.22	379	150.62
	Left	384	150.93	380	149.74
Tibia	Right	319	150.25	319	150.25
	Left	318	150.29	324	152.18
Average stature			149.38		150.84

Table 24. Stature estimation of Javanese females with a femur of equal length as Liang Togé.

Tibia: (r: 300.2 mm)		Length (mm)	Stature (cm)	Length (mm)	Stature (cm)
Humerus	Right	264	148.32	273	151.29
	Left	259	147.58	271	152.1
Radius	Right	198	149.72	189	146.23
	Left	191	146.49	188	145.38
Ulna	Right	221	147.34	214	144.39
	Left	217	146.46	212	144.12
Femur	Right	364	146.14	356	143.74
	Left	366	145.57	358	143.18
Tibia	Right	302	145.02	296	143.17
	Left	304	145.86	300	144.6
Average stature			146.85		145.82

Table 25. Stature estimation of Javanese females with a tibia of equal length as Liang Togé.

2.1.6. Other finds

Other finds include a tooth (upper canine), three metacarpals/metatarsals, three phalanges, and a part of the right auricular surface of the os coxae. These finds were also from Liang Togé, but from different and unknown layers (October 1954). They were first sent to Hooijer with the animal material. I describe them here as a comparison with the Liang Togé skeleton.

The canine roots are broken off. The occlusal attrition is in stage 3 of wear. Metacarpal IV right consists of the head and body. The base is absent. Phalanx i of the right DIII has slight damage at the head. It has about the same length as the Liang Togé skeleton (table 26). The first phalanx of the right DIV has a length of 41.9 mm. Phalanx ii of the right DII has a length of 25.7 mm, which is about same size as the Liang Togé skeleton's DIV phalanx ii, meaning this material is from a bigger individual than that of the Liang Togé skeleton. The metatarsal III of the left foot has its base and half of the dorsal part of the body. The right metatarsal II consists of the base and half of the body. The height is much greater than that of the Liang Togé skeleton metatarsal II (table 26).

Measurements (mm)		The other finds	Liang Togé
Upper canine	MD	7.9	8.0/7.8
	BL	8.6	8.4/8.9
Phalanx i DIII right	Length	43.1	44.4/43.0
Metatarsal II right	Breadth of corpus	6.9	7
	Height of corpus	8	7.1

Table 26. Comparison of Liang Togé to the other finds found in Liang Togé.

2.1.7. Conclusion

Gender: Female.
Age: 30-40 years (endocranial sutures: 30-60; teeth: 30; humerus spongiosa: 23-60).
Stature: Average of several different estimates is 149.60 cm. According to Bergman & The (1955) 151.34 cm.
Skull:

- It is ultradolichocephalic (very narrow compared to its length).
- It is hypsicephalic (large auricular height in relation to the length of the skull).
- The minimum frontal breadth is large compared to the breadth of the skull (ultrahypermegasem).
- It is hyperleptoprosopic (narrow face).
- The upper facial index reveals a very narrow face (small bizygomatic breadth compared to nasion-prosthion length).
- It is chamaeprosopic (broad face compared to length).
- The orbits are mesoconch (medium height/medium breadth).
- The nose is leptorrhine (high and narrow).
- The shape of the palate is very narrow (leptostaphyline border is 79.9 and Liang Togé has 59.3).
- The auricular height is a little bigger than the breadth of the skull.
- The skull shape is long high and narrow.
- The total cross-sectional area of the upper molars is medium sized.
- The mandible is very low.
- The corpus is of medium size.

Postcranial:

- Very slender bones with little muscle markings (although this may be an artefact resulting from preparation). Excepting the tibia, all long bones are flattened.
- The humerus has a low diaphyseal index, showing flattening of the bone (platybrachy). The caput index is low. Both humeri have a supratrochlear foramen.
- The ulna has a deep olecranon. The platolenic index of the ulna is very high, showing euroleny (dorsoventral flattening) of the upper shaft region. The diaphyseal index reveals little development of the crista interosseus.
- The diaphyseal index of the radius is low, which indicates transversal flattening.
- The low platymeric index of the femur indicates anteroposterior flattening. The low pilastric index shows poor development of the linea aspera.
- The tibia is not flattened transversely.
- The fibula has a low diaphyseal index, showing flattening of the bone.
- The talus has a high trochlear index, meaning a short trochlea. The calcaneus has a short corpus. The navicular has a low posterior articular surface index, meaning it is narrow and long.

2.2. Liang Momer

2.2.1. Location

Liang Momer is located a few kilometres northeast of Labuanbadjo (figure 4). It is an *abri sous roche* with a kitchen midden in front of it against the rock wall (Verhoeven, 1968). It was named after Father Mommersteeg. In 1950 they found late Palaeolithic flakes (Archive Verhoeven, VII). In 1951 a skeleton was found in flexed burial. Unfortunately, this skeleton was lost before examination. The skeletons discussed here were found in 1955. They were found in flexed burial and in association with Mesolithic cultural artefacts (flakes, shell, and bone implements).

2.2.2. Archaeological age

Based on the artefacts found in the kitchen midden the site has been dated to the Mesolithic period at about 5,000-3,000 BP (Jacob, 1967).

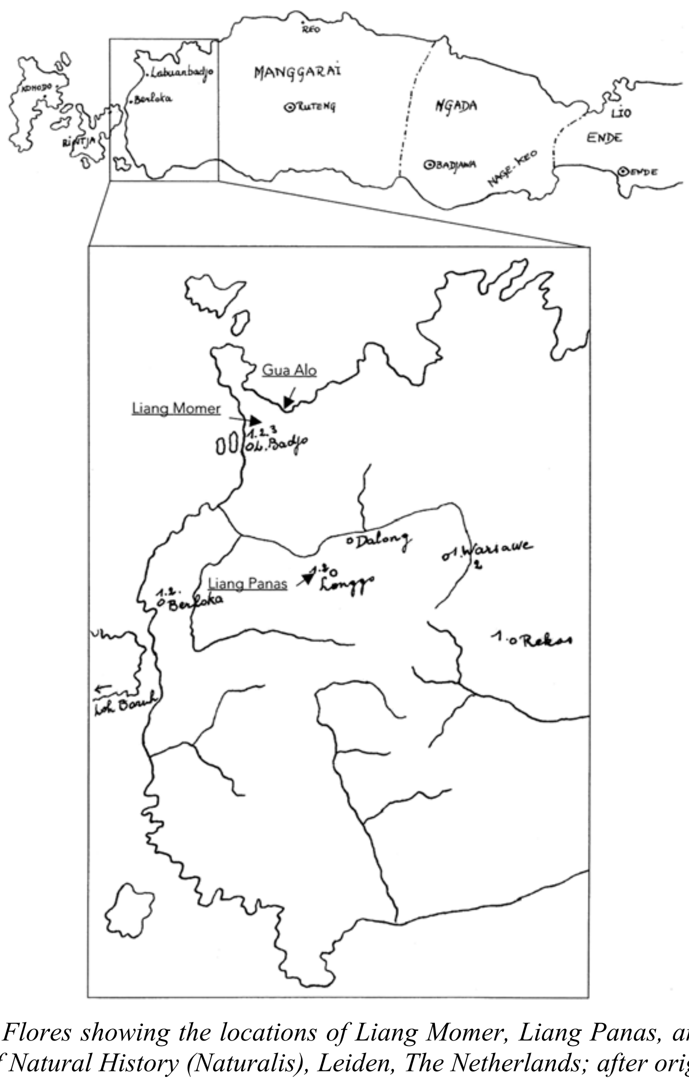


Figure 4. Map of West Flores showing the locations of Liang Momer, Liang Panas, and Gua Alo. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands; after original by Verhoeven.

2.2.3. Material

Five individuals have been found at this site, which were named Liang Momer A to E.:

Liang Momer A: Available for study are fragments of the skull, the mandible and teeth, bones of the hand, and bones of the foot. Furthermore there were fragments of the upper limb bones (including scapula, humerus, ulna, and radius), of vertebrae and sacrum, and of the lower limb bones (pelvis, femur, tibia, and fibula).

Liang Momer B: This find includes skull fragments, teeth, humerus, carpal bones, vertebrae, femur, and bones of the foot. Also there are fragments of manubrium, of sternum, fragments of radius, of ulna, of metacarpals, of phalanges, fragments of sacrum, of os coxae, of the tibia, and of the fibula.

Liang Momer C: Available for study are teeth, mandible, bones of the hand, innominate bone, and cervical vertebrae. There are also fragments of scapula, humerus, ulna, radius, and thoracic and lumbar vertebrae.

Liang Momer D: Available for study there are skull fragments, mandible and teeth, vertebrae, and innominate bone. Other finds are fragments of upper limb bones (scapula, humerus, ulna, radius, and bones of the hand), costae, and fragments of the femur and tibia.

Liang Momer E: Available for study (plate 10) are the skull, mandible and teeth, humeri, bones of the hand, vertebrae, innominate bone, femora, a patella, tibiae, a fibula, and bones of the foot. The skull is the most complete prehistoric skull found on Flores.

In the following description the most complete specimen Liang Momer E is first described.

Plate 10. Liang Momer E skeleton. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

2.2.4. Description

Liang Momer E

The skull (table 27, next page)

Skull E (plate 11) is better preserved than Liang Togé. Missing are parts to the right of the foramen magnum, parts of the sphenoid bone, parts of the orbits, the nose, the palate, and small portions of the vault.

In view of the massive prominent glabella, the marked superciliary arches, the indistinct frontal and parietal tubera, the very large mastoid process, the marked nuchal lines, the thick, high temporo-zygomatic process, and the quandrangular orbits with rounded margins, the skull is sexed as male (table 93).

The skeletal age of the skull, determined by degree of endocranial suture obliteration, lies between 30 and 60 years old. Jacob (1967) estimated the age to be between 45-50 years (determined by combining the degrees of suture obliteration). Judging from Martin (1914), I believe the age to be 40-45 years, since most sutures which start obliterating after 40 according to Martin (1914), have only started to close (phase 2; Maat *et al.*, 2000).

Plate 11. Liang Momer E skull in anterior view. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

Description	Measurements (cm)	Index	
Cranial length	18.2	Cranial index	70.3
Cranial breadth	12.8	Length-auricular height index	62.1
Auricular height	11.3	Breadth-auricular height index	88.3
Basion-bregma height	13.8	Length-basion/bregma height index	75.8
Maximum frontal breadth	11.4	Breadth-basion/bregma height index	107.8
Minimum frontal breadth	9.4	Cranial module	14.93
Biasteric breadth	10.1	Transverse frontoparietal index	73.4
Basion-prosthion distance	± 10.6	Transverse occipitoparietal index	97.5
Basion-nasion distance	10.4	Prognathic index	101.9
Upper facial breadth	10.6		
Bizygomatic breadth	13.1	Jugomalar index	75.6
Mid-facial breadth	9.9	Jugomandibular index	83.2
Maxilloalveolar breadth	6.1	Frontal index	± 80.9
Ectoconchion-porion distance	6.3	Total facial index	± 87.0
Nasion-gnathion distance	± 11.4	Facial module	10.2
Nasion-prosthion distance	± 6.9	Upper facial index	± 52.7
Ectoconchal breadth	10.1	Upper face index	± 69.7
Orbital breadth	± 4.0		
Orbital height	± 3.2	Orbital index	± 80.0
Cheek height	2.1		
Nasal breadth	± 2.5		
Nasal height	± 5.2	Nasal index	± 48.1
Foramen magnum length	3.9		
Nasion-bregma chord	11.1		
Nasion-bregma arch	13.2	Frontal sagittal index	84.1
Bregma-lambda chord	11.1		
Bregma-lambda arch	12.2	Parietal sagittal index	109.9
Lambda-opisthion chord	9.6		
Lambda-opisthion arch	11.1	Occipital sagittal index	115.6
Nasion-opisthion chord	13.8		
Nasion-opisthion arch	36.5	Total sagittal index	37.8
Vault thickness	0.7		

Table 27. Liang Momer E cranium measurements.

The glabella is very prominent. The forehead starts nearly vertically before sloping backward. The vault is evenly rounded from front to back. The inion is marked.

The left mastoid process is very large with a prominent mastoid crest (plate 12). The supramastoid crest is hardly marked. The right mastoid process is damaged on the superior and medial side. A mastoid crest is not evident, the supramastoid crest is marked. The axis of the mastoid process constitutes an angle of approximately 80° to the eye-ear plane. The external auditory porus is oval shaped (wider than Liang Togé), with its long axis running in craniocaudal and ventrodorsal direction. The temporal line on the frontal bone is faint. The sphenoparietal suture cannot be found, the temporoparietal suture is only visible for a small part. The temporomalar suture runs in its usual direction (craniocaudal and ventrodorsal). The vault is ovoid in shape, but the length is still greater than the breadth.

In anterior view (plate 11) the superciliary arches are marked. On the superior margin of the left orbit there is a supraorbital notch, while on the right there is a supraorbital foramen instead. The right canine fossa is very pronounced, giving a deep, rounded impression. The canine fossa is missing on the left. The nasal bones are missing. There are two anterior nasal spines. The nasal aperture is moderately wide without any distinct inferior border. The infraorbital foramen is of normal size and number.

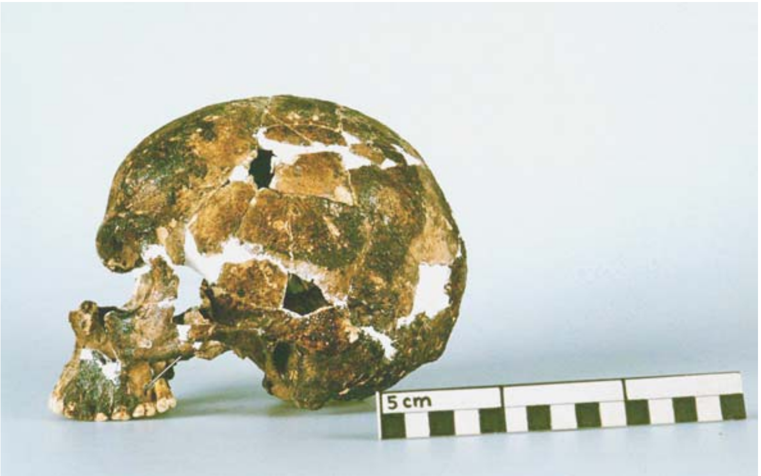


Plate 12. Liang Momer E skull in lateral view. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

A metopic suture is not present. There is little sign of a frontal protuberance. The cheekbone is not thick, and bilaterally the marginal process is evident. Both bones protrude and contribute to the great breadth of the face.

In occipital view (plate 13) the height of the skull is greater than the breadth. The side of the skull first slopes medially before sloping laterally (gable-shaped) and continues into the rounded contour of the vault. The superior nuchal line is strongly developed. The external occipital protuberance is not clearly confined.

Plate 13. Liang Momer E skull in occipital view. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The palate is deep. The jugular foramina are missing. The mandibular fossa is deep. The tuberculum articulare is thick and well defined. The skull may be summarized as follows:

- It is dolichocephalic (long compared to breadth).
- It is orthocephalic (medium auricular height compared to skull length).
- It is a high skull compared to its length (hypsicephalic).
- Height compared to breadth is hypsistenocephalic (very high compared to breadth).
- The cranial module reveals a medium sized skull.
- Minimum frontal breadth is large compared to cranial breadth (megasem).
- The face is medium to slightly prognathous.
- The total facial index reveals a medium high face (mesoprosopic).
- The facial module shows a large face.
- The upper facial index reveals a medium broad face.
- It is chamaeprosopic (broad face compared to length).
- The orbits are mesoconch (medium high).
- The nose is mesorrhine (medium high).
-

The biasteric breadth is almost as large as the cranial breadth. The skull is gable shaped.

The teeth (table 28)

Mandibular		Diameter (mm) Right	Left	Maxillary		Diameter (mm) Right	Left
I_1	MD	-	5.4	I^1	MD	8.8	8.9
	BL	-	6.1		BL	7.9	7.4
I_2	MD	-	-	I^2	MD	7.2	6.8
	BL	-	-		BL	6.9	7
C	MD	7.4	7.7	C	MD	7.9	8.1
	BL	8.8	8.1		BL	9.5	8.9
P_1	MD	7.3	7.8	P^1	MD	7.2	7
	BL	8.9	-		BL	10.1	10
P_2	MD	7.5	7.5	P^2	MD	7.1	7.1
	BL	9.2	9		BL	10.2	9.7
M_1	MD	11.3	11.3	M^1	MD	10.6	11.1
	BL	11	11.2		BL	11.3	11.1
M_2	MD	12.2	12	M^2	MD	10.8	10.8
	BL	10.8	10.8		BL	11.8	12
M_3	MD	10.9	11.9	M^3	MD	10.2	9.2
	BL	9.9	10.7		BL	11.8	11.8
	P_1-M_3 distance	49.7	50.2		P^1-M^3 distance	-	45.5
	Dental index	47.8	48.3		Dental index	-	43.8
					Cross-sectional area upper M^1	119.8	123.2
					Cross-sectional area upper M^2	127.4	129.6
					Cross-sectional area upper M^3	120.4	108.6
					Total cross-sectional area upper molars	367.6	361.4

Table 28. Liang Momer E teeth measurements.

The dental arches of the maxilla and the mandible are parabolic. On the maxilla all teeth are present. The right M^1 leans inward, while the M^2 leans outward. On the mandible the left I_1 and both I_2 are broken just above the alveolar region, the right P_2 is broken in half so that only the buccal side is present. Molar attrition for the maxilla is grade 3^+ for the right M^1, 4^- for left the M^1, grade 3 for the right M^2, 2^+ for the left M^2, and grade 2 for both M^3. Molar attrition for the mandible is grade 4^- for the right M_1, 3^+ for the left M_1, grade 3^+ for the right M_2, 3 for the left M_2, and grade 2^- for both M_3. This pattern of mandibular attrition would suggest an age of around 26 years (Miles, 1963) or 25-35 (Brothwell, 1981), which means that Liang Momer E may have been younger than Liang Togé. This is in contradiction with the pattern of endocranial suture obliteration, which suggests Liang Momer E as older. In this case, the plane of occlusion is completely flat, indicating that Liang Momer E chewed with lateral motion, as is common among hunter-gatherers, who have a more tough and fibrous food supply. The plane of attrition of the incisors indicates psalidont occlusion (Martin, 1928). Groove and cusp patterns of the mandibular molars are Y5 for M_1, 4+ for M_2, and +5 for M_3 on both sides (Martin, 1928; Hillson, 1996).

The incisors are not shovel-shaped. There is a strong dental tubercle present on the left upper lateral incisor.

The cross-sectional area of the M^1, M^2, and the right M^3 is medium, at the large side, but the left M^3 is medium, at the small side. The total cross-sectional area of the upper molars is large. The teeth are megadont (after Flower, 1885).

The mandible (table 29)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Mandibular length	112.3				
Bigonial breadth	109.2				
Minimum ramus breadth	38.1	42.1			
Condyloid height	69.9	72.4	Ramus index	54.5	58.1
Coronoid height	57.5	59	Mandibula L-H index	51.2	52.5
Intermental breadth	45.7				
Dental arch length	51				
Corpus height at mental foramen	29.9	29.6			
Corpus height at M_2	25.5	-	Robusticity index		
Corpus thickness at mental foramen	10.1	10.6	Mandibular thickness index	33.8	35.8
Corpus thickness at M_2	15.2	17.1			
Height mental foramen from mandibular base	13.2	13.8			
Length of incisura mandibulae	41.7	44			
Depth of incisura mandibulae	16.1	14.2	Index of incisura mandibulae	38.6	32.3
Sagittal diameter of condyloid process	9.1	8.5			
Transverse diameter of condyloid process	21.1	21	Index of condyloid process	43.1	40.5
Inter-C distance	17				
Inter-M_1 distance	34.7				
Inter-M_3 distance	45				
Symphysis thickness	14.7				

Table 29. Liang Momer E mandible measurements.

The left ramus is slightly damaged (plate 14). The base of the mandibular corpus has contact points in the mid-portion and at the gonion.

Because of the robust appearance of the mandible, the developed mental trigone, and the marked eminences on the angle, the mandible was sexed as male (table 93).

The ramus is broad and higher than the ramus from Liang Togé, but still low as shown by the mandibula L-H index. The coronoid process is broad and has an obtuse tip. Its anterior and superior borders make an angle of about 90°. Its anterior border is convex and it fans out toward the corpus forming a blunt linea obliqua. The mandibular recess (precoronoid fossa) is narrower and shallower than that of Liang Togé. It still comprises the whole length of the anteromedial aspect of the coronoid process.

The postmolar trigone is larger than that of Liang Togé. It is separated from the mandibular recess by a somewhat higher and sharper crest. This crest proceeds on the inner side of the ramus as the endocoronoid crest, which forms the medial border of the precoronoid fossa. The endocondyloid crest is not evident. The vertical torus is strongly developed. The anterior border of the ramus conceals a little of the posterior part of M_3 in lateral view. Only one faint vertical ridge can be found on the lateral side of the right ramus, (the left ramus is damaged in this area). The mandibular notch is deeper on the right and is convex anteriorly. Directly beneath the mandibular notch of both rami a prominent lateral torus traverses the surface.

The buccal side of the condyle is thicker than the lingual side, because the anterior border slopes towards the posterior border. The superior border of the condyles is convex. On the right ramus the lingual side of the condyle is higher than the buccal side, while on the left condyle the buccal side is higher. Both condyles are dented laterally on the buccal side. The axes of the condyles lie in a horizontal plane, and run in a mediolateral and dorsoventral direction. The condyloid process has the usual anterior curve of the cranial portion. The ramus ascends steeply with a slight inclination toward the median plane. The inferior part of the ramus curves to the buccal side, while the superior part curves lingually (see also Liang Togé).

Plate 14. Liang Momer E mandible, superior view. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The mandibular foramen is filled with matrix. However, the mandibular lingula is intact. The pterygoid tuberosity is well marked and proceeds upward toward the posterior widening of the condyloid process. The mylohyoid groove is extremely pronounced. Both can only be followed from the mandibular lingula to just about the height of M_3. The alveolar border is somewhat damaged on the left and frontal side of the dental arch.

The mental trigone reaches up to the infradentale and is distinct. The mental tubercles are poorly marked. There is no alveolar protrusion. The mental foramen is normal sized and opens posterosuperiorly. On each side it is situated below the anterior part of the P_2 and a little below halfway the mandibular height.

At the symphysis a supraspinous foramen, paraspinous foramina, and supraglenoidal and interglenoidal spines can be distinguished. At the base the digastric fossae are well defined and have a horizontal course.

The humerus (table 30)

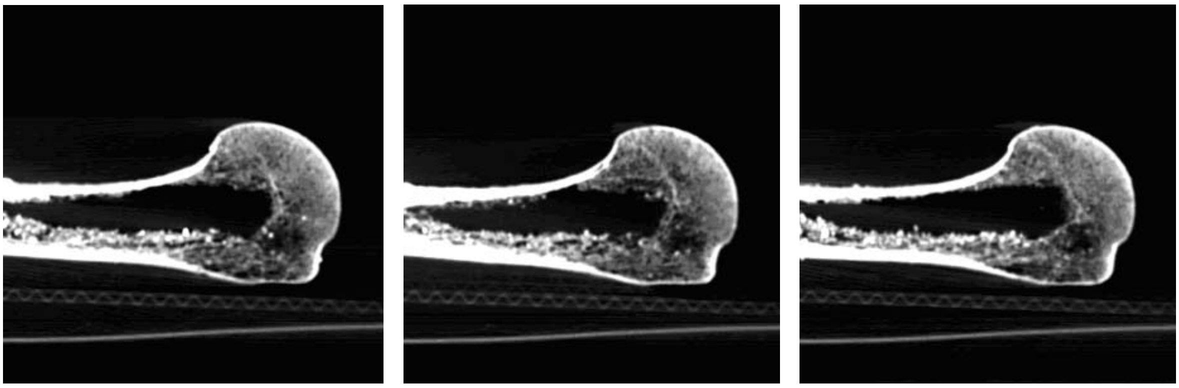
Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Length	323.3	321			
Maximum length	326.1	324.4			
Proximal epiphyseal breadth	47	47.3			
Horizontal diameter of caput	39	39.6			
Vertical diameter of caput	44.1	45.3	Caput index	88.4	87.4
Subdeltoid circumference	64	64	Robusticity index	19.6	19.7
Mid-shaft maximum diameter	21.2	21.3			
Mid-shaft minimum diameter	17	16	Diaphyseal index	80.2	75.1
Mid-shaft transverse diameter	20.2	20.5			
Mid-shaft sagittal diameter	19.3	19.6			
Distal epiphyseal breadth	69.1	-			
Trochlear breadth	43.5	-	Trochlea-epicondylar index	63	-
Trochlear depth	27	-			
Capitulum breadth	18	18.1			
Olecranon fossa breadth	24.8	26			

Table 30. Liang Momer E humerus measurements.

The right humerus is complete, the left has slight damage to the medial part of the distal epiphysis. It is of medium length and the bone is slender. This is confirmed by the low robusticity index. The caput is ellipsoid, with a caput index of 88, which is also fairly low.

The right diaphysis has a rounded oval shape, while that of the left humerus is oval shaped. This is confirmed by the diaphyseal index, which indicates platybrachy for the left humerus (< 76.5). The diaphyseal index of the right humerus indicates eurybrachy (> 76.5). The distal part of the bone is triangular in shape. The intertubercular groove is wide and shallow. The distal extremity of both humeri has a moderately developed medial epicondyle. Both olecranon fossae have a supratrochlear foramen. Since Liang Momer E is probably male, this is less common than it is in the Liang Togé material. The olecranon fossa is elongated in transverse direction. The coronoid fossa is well defined, and has steep walls. The radial fossa is more pronounced, than it is in the Liang Togé humeri.

In conclusion the humerus is slender, but on average not flattened. The spongiosa of the right humerus (scan 2) is dense, indicating a phase I. The shaft is damaged inside making the height of the marrow cavity a unreliable indicator. The age of this individual is estimated at 23-60 years.



Scan 2. CT-scans of the Liang Momer E right humerus taken 2 mm apart at approximately the centre of the head. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The bones of the hand (table 31)

Description		Carpus Measurements (mm) Right	Left	Index	Right	Left
Scaphoid	Maximum length	26.1	-	Length-breadth index	46.7	-
	Breadth	12.2	12.2	Length-height index	54.8	-
	Height	14.3	-	Height-breadth index	117.2	-
Lunate	Length	11.2	11.8	Length-breadth index	149.1	142.4
	Maximum breadth	16.7	16.8	Length-height index	62.6	65.9
	Maximum height	17.9	17.9	Height-breadth index	93.3	93.9
Triquetrum	Maximum length	16.7	16.9	Length-breadth index	144	145.7
	Maximum breadth	11.6	11.6	Length-height index	142.7	148.2
	Maximum height	11.7	11.4	Height-breadth index	100.9	98.3
Pisiform	Maximum length	9.3	9.6	Length-breadth index	57.8	58.9
	Maximum breadth	16.1	16.3	Length-height index	79.5	74.4
	Maximum height	11.7	12.9	Height-breadth index	72.7	79.1
Trapezium	Maximum length	12.8	-	Length-breadth index	83.7	-
	Maximum breadth	15.3	-	Length-height index	67	-
	Maximum height	19.1	-	Height-breadth index	124.8	-
Trapezoid	Maximum length	15.6	16.1	Length-breadth index	152.9	157.8
	Maximum breadth	10.2	10.2	Length-height index	91.8	94.7
	Maximum height	17	17	Height-breadth index	60	60
Capitate	Maximum length	23.1	23.2	Length-breadth index	73.2	70.7
	Maximum breadth	16.9	16.4	Length-height index	85.3	83.2

	Maximum height	19.7	19.3	Height-breadth index	85.8	85
Hamate	Maximum length	19.3	19.2	Length-breadth index	76.7	84.4
	Maximum breadth	14.8	16.2	Length-height index	91.5	-
	Maximum height	21.1	-	Height-breadth index	70.1	-
		Metacarpal				
Metacarpal	D I	47.7	46.7			
	D II	64.6	P			
	D III	63.3	63.9			
	D IV	57.2	P			
	D V	52.6	53.3			
		Phalanx				
Phalanx i	D I	32.1	-			
	D II	42.9	42.8			
	D III	49.6	49.3			
	D IV	45.8	47.2			
	D V	35.8	P			
Phalanx ii	D II	25.5	26			
	D III	31.4	32.7			
	D IV	P	29.9			
	D V	21.5	21.4			
Phalanx iii	D I	21	23.6			
	D II	P	17.8			
	D III	18.6	20.2			
	D IV	18.7	18.9			
	D V	-	18.1			
		Total finger length				
Total	D I	100.8	102.4*			
	D II	169.2#	170.6*			
	D III	162.9	166.1			
	D IV	144.3	143.8			
	D V	128.0*	128.6*			

*Table 31. Liang Momer E handbone measurements. *1 factor borrowed from opposite hand. #2 factors borrowed from opposite hand. - = Absent. P = Present but too damaged for measuring.*

The right scaphoid bone is complete, the left is missing its tubercle on the palmar side, making it impossible to measure length or height. Both lunates are completely present. Both triquetri are found in one piece. Both pisiforms are complete. Only the right trapezium is preserved. Both trapezoids and capitates are preserved. Both hamates are found, but the left is missing its hamulus on the palmar side, making it impossible to measure height. The metacarpals and phalanges are very well preserved. Except for the left first phalanx of the first digit and the right third phalanx of the fifth digit, all bones are present. Of the right hand only the second phalanx of the fourth finger, which lacks its base, is damaged. Damaged on the left hand are the second metacarpal, consisting of two pieces with a part of the corpus missing, the fourth metacarpal, which has only its head, and the first phalanx of the fifth finger, which consists of a base. Because most finger bones were present, I also calculated finger length by adding the lengths of the metacarpals and the phalanges.

Since not all bones of one hand were present or measurable, I used the values of the same bones of the other hand to fill in the gaps in the calculation of the finger lengths.

The vertebrae (table 32 & 33)

Vertebrae have been well preserved down to the level of T4. Further down much is damaged and no reliable guess about the order can be made. Therefore I only measuredthe first 11 vertebrae.

The atlas is almost complete except for the absence of the posterior tubercle. The axis is preserved in its entirity. The spinous process is bifid (bifurcation of the spinous process). According to Martin (1914) this bifurcation of the spinous process can be found on the second to fifth vertebra (C2-C5). C3 is intact apart from some slight damage to the anterior and posterior tubercles and the spinous process, which is bifid. C4 has slight damage to the anterior and posterior tubercles and the spinous process. The posterior edge of the right foramen transversarium recedes partly. The left side is filled with sediment. Of C5 only the body and the right superior and inferior articular process are preserved. On the right side three quarters of the edge of the foramen transversarium is still intact. In the posterior edge, a very small separate hole is visible.

Atlas and axis					
Description	Measurements (mm)				
Anterior height of axis	32.7				
Height of axis body	22.3				
Anterior height of atlas and axis	33.2				
Other cervical vertebrae					
	C3	C4	C5	C6	C7
Anterior height	11.2	11.8	11.2	11.5	14
Middle vertical diameter	9.1	9.3	10	9.9	10.8
Posterior height	11.1	11.7	12.4	11.8	14.1
Superior breadth	18.1	19.2	19	21.4	-
Middle transverse diameter	15.7	17	16.8	20.9	24.1
Inferior breadth	16.9	18.3	21.7	24.2	-
Superior sagittal diameter	15.3	15.7	15.4	15.2	16
Inferior sagittal diameter	15.9	16.1	15.8	16.9	16.3
Middle sagittal diameter	15.8	15.1	14	15.1	15.4
Vertebral foramen transverse diameter	19.3	20.9	20.1	-	20.2
Vertebral foramen sagittal diameter	14.8	14.5	-	-	12.9
Index	C3	C4	C5	C6	C7
Vertebral corpus index	99.1	99.2	110.7	102.7	100.7
Sagittovertical corpus index	57.6	61.6	71.4	65.6	70.1
Transversovertical index	71.3	69.4	66.7	55	58.1
Transversosagittal index	100.6	88.8	83.3	72.2	63.9
Vertebral foramen index	76.7	69.4	-	-	63.9

Table 32. Liang Momer E cervical vertebra measurements.

Description	Measurements (mm)			
	T1	T2	T3	T4
Anterior height	14.2	15.3	17.7	17.2
Middle vertical diameter	13.1	14	14.3	14.9
Posterior height	15	15.9	16.5	16.9
Superior breadth	20.3	21.7	-	-
Middle transverse diameter	19.5	-	23.1	22.7
Inferior breadth	-	-	23.9	25
Superior sagittal diameter	15.8	-	17.3	19.6
Inferior sagittal diameter	14.4	15.2	18.6	20.4
Middle sagittal diameter	15.2	15.7	17.5	18.7
Vertebral foramen transverse diameter	17.4	18.8	18.2	14.8
Vertebral foramen sagittal diameter	11.9	11.9	11.3	11.9
Description	Index			
	T1	T2	T3	T4
Vertebral corpus index	105.6	103.9	93.2	98.3
Sagittovertical corpus index	86.2	89.2	81.7	79.7
Transversovertical index	72.8	-	76.6	75.8
Transversosagittal index	78	-	75.8	82.4
Vertebral foramen index	68.4	63.3	62.1	80.4

Table 33. Liang Momer E thoracic vertebra measurements.

C6 consists of only the body. C7 has damage to its left posterior articular process and posterior tubercle, and its right transverse process. The body has a gap in the caudal surface and the left side. Again there is visible on the right posterior edge of the foramen transversarium a recession, which probably used to have been separated from the foramen itself. The spinous process is intact and not bifid. I have also found the spinous process of a cervical vertebra, which can only belong to either C6 or C5. I could not determine which, but the process is not bifid. This supports the observations of Martin (1914) about the presence of bifurcation of the spinous process.

T1 has slight damage to the caudal and left side of the body. Its spinous process is intact. T2 has damage to the anterocranial and anterocaudal edges of its body, its right transverse process, and the tip of the spinous process. T3 has damage to the anterocranial edge of the vertebral body, the left transverse process, the tip of the right transverse process, and the spinous process. T4 is damaged on the left lateral edges of the cranial and caudal surfaces of the body, the tip of the right transverse process, and the tip of the spinous process.
C3, C4, T3 and T4 have a greater anterior height than posterior height (posterior wedge shape).

According to Martin (1914) this wedge shape usually only occurs in the third (C3), fourth (C4), 22nd (L3), 23rd (L4), and 24th (L5) vertebrae. That the T3 and T4 also show this shape is unusual.

The innominate bone (table 34)

Description	Measurements (mm)	Index	
	Right		Right
Acetabular-symphyseal breadth	113.1		
Ischial height	79.1		
Length of pubic bone	87.9		
Symphysis height	39.6		
Length of foramen obturatorum	44.4		
Breadth of foramen obturatorum	48.5	Foramen obturatorum index	109.2
Maximum diameter of acetabulum	50		
Depth of small pelvis	101.3		
Frontal height of small pelvis	120		

Table 34. Liang Momer E innominate bone measurements.

The innominate bone is badly preserved. Of the left pelvis, only pieces were found that do not fit together. These pieces consist of parts of the ilium, acetabulum, and tuber ischiadicum. Of the right pelvis, one piece is large, consisting of the ischial body, except for the ischial spine, the pubic bone, the acetabulum, and the anterior part of the ilium. Apart from this some pieces remain of the auricular surface, and fragments of the ilium.
Because of the acute angled pubic arch and the broad ischial body with the strongly developed tuber ischiadicum on the right pelvic bone, the innominate bone was sexed as male (table 93).

The obturator foramen is sub triangular, boardering on oval. The middle of the anterior margin is pointed forward. The edges are rounded and the lower margin is round.

The femur (table 35)

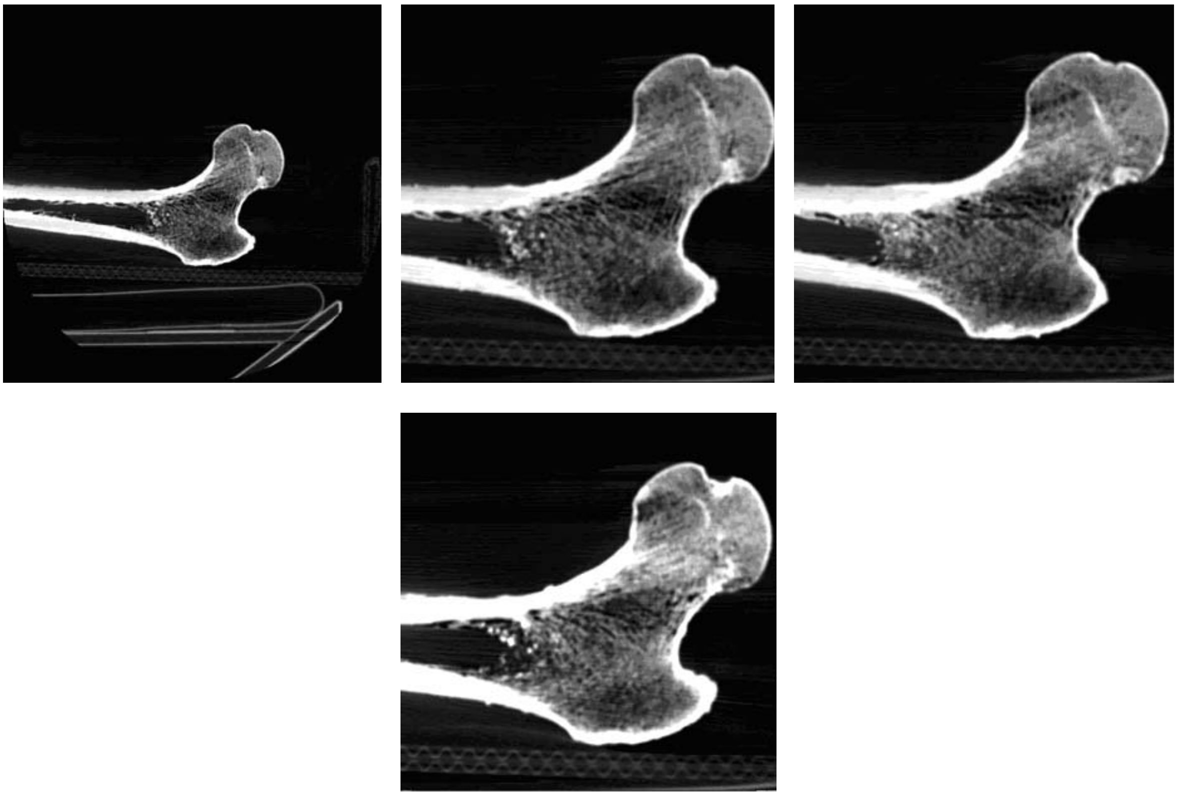
Both femora are complete, except for slight damage to the lesser trochanter of the right femur (plate 15). The bones are almost straight and they are slender. This is confirmed by the low robusticity index. The lesser trochanter is pronounced and points more medially than dorsally. It is located on the medial half of the femur. The intertrochanteric crest is well developed. The linea aspera is strongly developed (grade 3, Martin, 1914) as also shown by the high pilastric index. The cross-section of the diaphysis changes from oval in the subtrochanteric region to sub triangular at mid-shaft (the linea aspera forms the apex), to triangular in the distal region (with the base on the lateral side and the apex on the medial side). The platymeric index is high showing little antero-posterior flattening. The caput robusticity index is low, lying around the lowest limit of the range (Martin, 1914). The popliteal index is high, showing that the popliteal surface is convex.

The spongiosa of the right femur (scan 3) has a dense structure. The height of the marrow cavity is consistent with a phase II. In combination with the information from the endocranial suture obliteration and the spongiosa of the humerus, the age is estimated at about 34 years.

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Maximum length	449.3	448.6			
Direct length	446	447.1			
Trochanter-condyloid length	434.9	431.2			
Trochanteric length	428.8	429.1			
Diaphyseal length	377.3	377			
Horizontal diameter of caput	45	43.8	Caput index	103.7	101.9
Vertical diameter of caput	43.4	43	Caput robusticity index	19.8	19.4
Caput circumference	13.8	14			
Sagittal diameter of collum	23	23.2			
Vertical diameter of collum	29.9	29.2	Collum index	76.9	79.5
Upper breadth	91.6	90.6			
Intertrochanteric distance	64	64.5			
Caput-trochanter distance	78.5	77.8			
Subtrochanteric transverse diameter	30	29.5			
Subtrochanteric sagittal diameter	25.2	24.2	Platymeric index	84	82
Mid-shaft transverse diameter	25.3	25.2	Pilastric index	111.5	114.3
Mid-shaft sagittal diameter	28.2	28.8	Robusticity index	12	12.1
Mid-shaft circumference	85	87	Circumference-length index	19.1	19.5
Popliteal transverse diameter	32.2	32.9	Circumference-diaphyseal length index	22.5	23.1
Popliteal sagittal diameter	29	27.4	Popliteal index	90.1	83.3
Epicondylar breadth	76	-	Epicondylar-diaphyseal breadth index	33.3	-
Posterior breadth of medial condyle	27.8	30.3	Epicondylar-diaphyseal length index	20.1	-
Thickness of medial condyle	59.9	60			
Posterior breadth of lateral condyle	27	26.2			
Thickness of lateral condyle	59.2	58	Condylar index	77.9	-
Breadth of intercondyloid fossa	16.8	17.3	Femorohumeral index	72.5	71.8

Table 35. Liang Momer E femur measurements.

Plate 15. Liang Momer E right tibia and femur and the Liang Panas right femur (right). Notice that both femora are of equal size. The tibia has a bony protrusion on the left side of the distal epifysis (arrow). Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.



Scan 3. CT-scans of Liang Momer E right femur taken 2 mm apart at approximately the centre of the head. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The patella (table 36)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Height	40.3	40.2	Height index	48.8	48.7
Breadth	43.2	42.1	Breadth index	56.8	-
Thickness	22.4	22.1	Height-breadth index	93.3	95.5
Height of articular surface	29	28.9			
Breadth of medial articular surface	18.7	18.8			
Breadth of lateral articular surface	26	25.6			

Table 36. Liang Momer E patella measurements.

Both patellae are preserved. They are triangular in shape. The crest on the articular surface is distinct. The lateral facet is concave, a characteristic associated with habitual squatting (Martin, 1914) and the medial facet is also hollowed. The patella is low (height index value < 49.9) and broad (breadth index value > 56.0). The height index corresponds with those in 'Negro's' and Melanesians, while the breadth index is closer to those in Malayans and Chinese. The height breadth index is low, highlighting that the breadth is greater than the height. A notch at the proximal margin forms a very acute angle with the apex of the bone.

The tibia (table 37)

Both tibiae are present. The right tibia (plate 15) has slight damage to the border of the joint surface of the medial condyle. The left tibia also has damage to the border of the medial articular surface, damage to the border of the lateral articular surface, and a piece is missing in the medial and posterior surface at mid-shaft. The bones are slender (length-thickness index of 18.3 and 18.6) and show a posterior concavity. The platycnemia is striking. As with Liang Togé, I could not find the nutrient foramen. I therefore calculated the platycnemic index from the transverse and sagittal diameter at mid-shaft. In this case however, the higher index value shows platycnemia (R: 60.5, L: 63.1), even when the lowest border is used (< 62.9). The shape of the transverse section at mid-shaft is close to Hrdlička's type III (Martin, 1914). The posterior surface, however, is very narrow, but convex, as is the medial surface. The lateral surface is a little hollowed. This type is more common among men, especially American Indian men. The sagittal curvature of the lateral articular surface of the head is flat, corresponding to Thomson's type 1 (Martin, 1914). This however does not necessarily mean, that Liang Momer E did not squat. Type 1 has also been found among 'Negro's' and Thomson explains this as a compensation for the strong retroversion of the tibial head. The medial articular surface of the head is concave and slopes down from the lateral to the medial border. Squatting facets are present on the distal ends of both tibiae.

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Spinomalleolar length	382.7	383.8	Femorotibial index	83.9	83.9
Condylomalleolar length	379.4	378.5			
Length	374	374.9			
Condyloastragalar length	354	355			
Proximal epiphyseal length	77.1	74.2			
Breadth of upper medial articular surface	34.3	33.7			
Breadth of upper lateral articular surface	32.1	31.2			
Transverse diameter at tibial tuberosity	39.9	39.4			
Sagittal diameter at tibial tuberosity	47	45.2			
Mid-shaft transverse diameter	18.8	19.5			
Mid-shaft sagittal diameter	31.1	30.9	Platycnemic index	60.5	63.1
Mid-shaft circumference	82	82.2			
Minimum circumference	69.3	70.5	Length-thickness index	18.3	18.6

Table 37. Liang Momer E tibia measurements.

The presence of a bony projection on the lateroventral surface of the distal epiphysis of the right tibia (plate 15) is noteworthy. This is probably a remnant of the anterior tibio-fibular ligament (Feneis & Dauber, 2000).

The fibula (table 38)

	Measurements (mm)	Index	
	Left		Left
Mid-shaft maximum diameter	14.9		
Mid-shaft minimum diameter	9	Diaphyseal index	60.4
Mid-shaft transverse diameter	14.2		
Mid-shaft sagittal diameter	10.3		
Mid-shaft circumference	38		

Table 38. Liang Momer E fibula measurements.

Only the left fibula remains, and of this the proximal extremity is missing. The bone is slender and straight. The shape of the diaphysis is irregular quadrangular. The diaphyseal index is low, which is not uncommon for slender bones. For instance, a Senoi woman had a diameter of only 7mm, resulting in an index of 53.8 (Martin, 1914).

The bones of the foot (table 39-43)

Fewer bones of the foot are preserved than for the hands. Both tali, calcanei, naviculares, and cuboidei are present. Only the third cuneiform of the right foot is missing. All left metatarsals are present, but of the right foot, only the third metatarsal is preserved. All the first phalanges of the left foot are present, but only the phalanx of the first digit is present on the right foot. Of the third phalanges, only that of the first digit is found.

Description	Measurements (mm) Right	Left	Index	Right	Left
Length	48.8	50.9			
Height	30.1	30	Length-height index	61.7	58.9
Breadth	38.3	38.9	Length-breadth index	78.5	76.4
Length of trochlea	29.7	29	Trochlear length index	60.7	57
Breadth of trochlea	27.3	27.3	Trochlear index	91.9	94.1
Anterior trochlear breadth	22	21.9			
Posterior trochlear breadth	18.9	17.9	Trochlear breadth index	85.9	81.7
Length of caput	31.9	33	Caput length index	65.4	64.8
Length posterior calcanear articular surface	31.9	31.9			
Breadth of posterior calcanear articular surface	20.2	20.4	Posterior calcanear articular surface breadth index	63.3	64

Table 39. Liang Momer E talus measurements.

The right talus has slight damage to the medial side of its head. The left talus is complete. The length-height index is high (coming to values of Negrito's), while the length-breadth index is low (equal to Peruans and Melanesians; Martin, 1914). This means that the height of the talus is large compared to the breadth. The trochlear index is high, indicating its large breadth, compared to its length. The trochlear breadth index is high, showing no sign of posterior narrowing of the trochlea as seen in Japanese, Melanesians, Wedda, Senoi, and Negrito's, but not in Australians and Europeans (Martin, 1914). The medial edge of the trochlea (the tibial side) is higher than the lateral edge (the fibular side), a characteristic found in Japanese (Martin, 1914). The posterior calcanear articular surface index is low, being in the range of Australians and Fire-landers (Martin, 1914).

Both calcanei are intact, except for slight damage to the superior edge of the right tuber. The length-height index is low, corresponding to those of Negrito's and 'Negro's' (Martin, 1914). This indicates the small height, compared to the length. The tuber index is very low, being just above that of orang-utans (Martin, 1914). The posterior calcanear articular surface index is high, at the level of a gorilla (Martin, 1914). The anterior and medial articular surfaces are fused together.

Description	Measurements (mm) Right	Left	Index	Right	Left
Length	79.9	80.6			
Height	37.2	35.3	Length-height index	46.6	43.8
Middle breadth	41.3	41.9	Length-middle breadth index	51.7	52
Length of corpus	57.2	56.6	Corpus length index	71.6	70.2
Height of tuber	43	-	Tuber index	53.8	-
Length of posterior calcanear articular surface	27.3	27.3			
Breadth of posterior calcanear articular surface	23	23.5	Posterior calcanear articular surface index	84.2	86.1
Maximum breadth of cuboid articular surface	26.7	26.3			
Height of cuboid articular surface	23	22.9	Height-breadth index of cuboid articular surface	86.1	87.1

Table 40. Liang Momer E calcaneus measurements.

Both navicular bones are intact. The naviculares are not of the same shape. The posterior articular surface of the right navicular bone is ovoid (posterior articular surface index: 76.8), while the posterior articular surface of the left navicular bone is round (posterior articular surface index: 86.5). As a consequence the shape of the right navicular bone is long and narrow, while the left navicular bone is less long and wider. The thickness index is very low, falling below the lowest value given by Martin (1914). On the right navicular bone, the facets for the cuneiform bones can be separated well. On the left, this is not possible.

Description	Measurements (mm) Right	Left	Index	Right	Left
Breadth	40.9	-			
Minimum thickness	6.5	-			
Maximum thickness	17.3	17.8	Thickness index	37.6	-
Length of posterior articular surface	19.2	20.8			
Breadth of posterior articular surface	18.4	18	Posterior articular surface index	76.8	86.5

Table 41. Liang Momer E naviculare measurements.

Only the left cuboid bone is present, but it is complete. The first cuneiforms (medial cuneiforms) are both slightly damaged. The right cuneiform I has damage around the proximal articular surface, and on the plantar surface. The left cuneiform I has damage around both articular surfaces. The second cuneiforms (intermediate cuneiforms) are both damaged on the plantar side. Only the intact left cuneiform III (lateral cuneiform) is preserved.

		Measurements (mm) Right	Left	Index	Right	Left
Cuboideum	Medial length	-	32			
	Lateral length	-	18	Length index	-	56.3
Cuneiform I	Inferior length	26.1	26			
	Middle length	22.7	20.9			
	Superior length	24.8	24.9			
	Distal articular surface height	25.9	25.1			
	Proximal height	-	26.5	Height index	-	101.1
	Distal height	27.1	26.8	Length-distal height index	109.3	107.6
Cuneiform II	Superior length	14.9	14.9			
	Middle superior breadth	15.5	14.9	Length-breadth index	104	100
Cuneiform III	Superior length	-	22.7			
	Middle superior breadth	-	14.8	Length-breadth index	-	65.2
	Distal breadth	-	12.8			
	Proximal breadth	-	12.1	Breadth index	-	94.5

Table 42. Liang Momer E cuboid and cuneiform measurements.

The right foot is almost completely missing. Only the metatarsal of the third toe and the first phalanx of the first toe are preserved. The third metatarsal is missing its base. The left foot is almost complete, missing only the third phalanges of the second, third, fourth and fifth toe. The first metatarsal is broken and the middle part of the corpus is missing. The second metatarsal is complete. The third is missing its base, and has some damage to the medial side of the capitulum. The fourth metatarsal has slight damage to the lateral side of the capitulum. The fifth has a hole in the middle of its corpus. All first phalanges are present and intact, except for the phalanges of the third and fourth toes, which have some damage to the base. The third phalanx of the first toe is preserved and intact.

Stature estimation

Estimation of living stature for males according to Pearson (1899) in Martin (1914):

a. 81.306 + 1.880 femur = 165.72 cm
b. 70.641 + 2.894 humerus = 164.78 cm
c. 78.664 + 2.376 tibia = 168.71 cm
d. 71.272 + 1.159 femur + tibia = 167.24 cm*
e. 71.443 + 1.220 femur + 1.080 tibia = 167.15 cm*
f. 68.397 + 1.030 femur + 1.557 humerus = 165.29 cm*

Average: 166.48 cm

Femur = maximum length of femur (= 44.90 cm); humerus = maximum length of humerus (= 32.53 cm); tibia = condylomalleolar length of tibia (= 37.90 cm).
*See remarks in the Liang Togé description.

			Measurements (mm)		Index		
			Right	Left		Right	Left
Metatarsal	D I	Breadth of base	-	20.3			
		Height of base	-	27.1			
		Breadth of capitulum	-	20.1			
		Height of capitulum	-	18			
	D II	Length	-	75.7			
		Breadth of corpus	-	7.8	Length-breadth index	-	10.3
		Height of corpus	-	8.9	Breadth-height index	-	114.1
	D III	Breadth of corpus	7.2	7			
		Height of corpus	10.9	10.5	Breadth-height index	151.4	150
	D IV	Length	-	70.2			
		Breadth of corpus	-	7.9	Length-breadth index	-	11.3
		Height of corpus	-	10.1	Breadth-height index	-	127.8
	D V	Length	-	64			
		Breadth of corpus	-	7.9	Length-breadth index	-	12.3
		Height of corpus	-	10.1	Breadth-height index	-	127.8
Phalanx i	D I	Length	31.9	30.8			
		Breadth of corpus	12	12.1	Length-breadth index	37.6	39.3
		Height of corpus	10	9.9	Breadth-height index	83.3	81.8
	D II	Length	-	30			
		Breadth of corpus	-	6.9	Length-breadth index	-	23
		Height of corpus	-	6.6	Breadth-height index	-	95.7
	D III	Length	-	28.9			
		Breadth of corpus	-	6.2	Length-breadth index	-	21.5
		Height of corpus	-	6.8	Breadth-height index	-	109.7
	D IV	Length	-	26.2			
		Breadth of corpus	-	6.1	Length-breadth index	-	23.3
		Height of corpus	-	6.7	Breadth-height index	-	109.8
	D V	Length	-	22.4			
		Breadth of corpus	-	6.6	Length-breadth index	-	29.5
		Height of corpus	-	5.9	Breadth-height index	-	89.4
Phalanx iii	D I	Length	-	24.2			
		Breadth of corpus	-	11.3	Length-breadth index	-	46.7

Table 43. Liang Momer E metatarsal and phalanx measurements.

Estimation of living stature by Feldesman, Kleckner & Lundy (1990) (race and gender independent):

Stature (cm) = maximum femur length (right: 44.93 cm, left: 44.86 cm) x 100/26.74 = right: 168.03 cm, left: 167.76 cm.

Average: 167.90 cm

Estimation of living stature for males divided into American White, 'Negro', and Mongoloid according to Trotter & Gleser (1952, 1958):

American white:

a. 1.26 (fem + tib) + 67.09 = 171.42 cm*

b. 2.32 fem + 65.53 = 169.70 cm
c. 2.42 tib + 81.93 = 173.65 cm
d. 2.89 hum + 78.10 = 172.11 cm

Fem = maximum length of femur (= 44.90 cm); tib = condylomalleolar length of tibia (= 37.90 cm); hum = maximum length of humerus (= 32.53 cm).
*See remarks in the Liang Togé description.

'Negro':

a. 1.15 (fem + tib) + 71.75 = 166.97 cm*
b. 2.10 fem + 72.22 = 166.51 cm
c. 2.19 tib + 85.36 = 168.36 cm
d. 2.88 hum + 75.48 = 169.17 cm

Fem = maximum length of femur (= 449.0 mm); tib = condylomalleolar length of tibia (= 379.0 mm); hum = maximum length of humerus (= 325.3 mm).
*See remarks in the Liang Togé description.

Mongoloid:

a. 1.22 (fem + tib) + 70.37 = 171.39 cm*
b. 2.39 tib + 81.45 = 172.03 cm
c. 2.15 fem + 72.57 = 169.11 cm
d. 2.68 hum + 83.19 = 170.37 cm

Fem = maximum length of femur (= 44.90 cm); tib = condylomalleolar length of tibia (= 37.90 cm); hum = maximum length of humerus (= 32.53 cm).
*See remarks in the Liang Togé description.

Estimation of corpse length for West European males according to Breitinger (1937):

a. 2.715 hum + 83.21 = 170.69 cm
b. 1.645 fem + 94.31 = 168.17 cm
c. 1.988 tib + 95.59 = 170.04 cm

Average: 169.63 cm

Hum = length of humerus (= 32.22 cm); fem = maximum length of femur (= 44.90 cm); tib = length of tibia (= 37.45 cm).

Estimation of living stature for American white males according to Trotter (1970) in Maat et al. *(2000):*

a. 1.30 (fem + tib) + 63.29 = 170.93 cm
b. 2.38 fem + 61.41 = 168.27 cm
c. 2.52 tib + 78.62 = 174.13 cm
d. 3.08 hum + 70.45 = 170.64 cm

Fem = maximum length of femur (= 44.90 cm); tib = condylomalleolar length of tibia (= 37.90 cm); hum = maximum length of humerus (= 32.53 cm).
*See remarks in Liang Togé description.

Estimation of body length for Javanese males using the length of the long bones according to Bergman & The (1955):

a. 847 + 2.60 hum(r) = 1694.9 mm = 169.49 cm
b. 805 + 2.74 hum(l) = 1693.9 mm = 169.39 cm
c. 897 + 1.74 fem(r) = 1673.0 mm = 167.30 cm
d. 822 + 1.90 fem(l) = 1671.5 mm = 167.15 cm

e. 879 + 2.12 tib(r) = 1683.3 mm = 168.33 cm
f. 847 + 2.22 tib(l) = 1687.3 mm = 168.73 cm

Average: 168.40 cm

Hum = maximum length of humerus (= 326.1 mm/324.4 mm); fem = direct length of femur (= 446.0 mm/447.1 mm); tib = condylomalleolar length of tibia (= 379.4 mm/378.5 mm).

Estimation of body length for Javanese adult males using the circumference of the humerus and femur according to Bergman & The (1955):

151.7 +1.73 subdeltoid circumference humerus(r): 162.77 cm
106.9 + 7.0 mid-shaft circumference femur(r) = 166.40 cm

Average: 164.59 cm

Estimation of body length for Javanese females by using circumference of long bones to first calculate length of long bones and then body length according to Bergman & The (1955):

This checks whether the previous method underestimates stature.
Humerus maximum length = 213.3 + 1.45 subdeltoid circumference of humerus = 306.1 (this is far too small)
→ 847 + 2.60 hum(r) = 1642.9 mm = 164.29 cm
805 + 2.74 hum(l) = 1643.7 mm = 164.37 cm
Femur direct length = 223.5 + 2.46 mid-shaft circumference of femur = 435.1 (this is too small)
→ 897 + 1.74 fem(r) = 1654.1 mm = 165.41 cm
822 + 1.90 fem(l) = 1648.7 mm = 164.87 cm
Tibia condylomalleolar length = 160.8 + 2.74 minimum circumference of tibia = 350.7 (this is too small)
→ 879 + 2.12 tib(r) = 1622.5 mm = 162.25 cm
847 + 2.22 tib(l) = 1625.6 mm = 162.56 cm

Average: 163.96 cm

Liang Momer E stature ranges from 163.96 to 171.42 cm. The smallest of these results is given using the circumference of the long bones. However, because of the slenderness of these bones, these formulae probably underestimate stature (table 94).

A summary of these results is given in table 92. For comparison of the Flores material, the estimation based on the circumference of the long bones by Bergman & The (1955) is used.

Conclusion

Gender: Male
Age: 30-45 years (endocranial sutures: 30-60; teeth: approximately 26; Humerus spongiosa: 23-60; femur spongiosa: 35-55).
Stature: Average 168.17 cm. According to Bergman & The (1955) 164.59 cm.

The skull shape:

- It is dolichocephalic (long compared to breadth).
- It is orthocephalic (medium auricular height compared to skull length).
- A high skull compared to its length (hypsicephalic).
- Height compared to breadth is hypsistenocephalic (very high compared to breadth).
- The cranial module reveals a medium sized skull.
- Minimum frontal breadth is large compared to cranial breadth (megasem).
- The face is medium to slightly prognathous.
- The total facial index reveals a medium high face (mesoprosopic).
- The facial module shows a large face.

- The upper facial index reveals a medium broad face.
- It is chamaeprosopic (broad face compared to length).
- The orbits are mesoconch (medium high).
- The nose is mesorrhine (medium high).
- The biasteric breadth is almost as large as the cranial breadth.
- The skull is gable shaped.
- The total cross-sectional area of the upper molars is large.
- The mandible is low.

Postcranial:

- All bones are slender. Only the tibia and fibula are flattened however, in contrast to Liang Togé, where all bones, but the tibia are flattened.
- The humerus is slender (low robusticity index). The caput index is low. A supratrochlear foramen is present in both humeri.
- The robusticity index of the femur is low. The pilastric index of the femur is high (strongly developed linea aspera). The platymeric index is high (no antero-posterior flattening).
- The tibiae have low length-thickness indices (robusticity), indicating the slenderness of the bones. The tibiae have a low platycnemic index (transversely flattened bone).
- The fibula has a low diaphyseal index (flattening of the bone).

Liang Momer A

The skull

A part of the left parietal is present with intact sutures on the occipital and temporal side, and what appears to be a suture on the left frontal side. A distinct parietal tuber is present. The fragment of the right temporal bone consists of an oval shaped porion (tympanic portion), a very small mastoid process, the beginning of the zygomatic arch, and the mandibular fossa. There is no sign of a supramastoid crest. The left temporal bone consists of the tympanic portion, the mandibular fossa, and a part of the vault of the skull. The mastoid process is lacking, and so is the zygomatic arch, although its base can be discerned. The left occipital condyle and right frontal portion, including a frontal tuber are preserved. The orbital region bears a supraorbital foramen. The left part of the maxilla consists of the left side of the nasal aperture, of which the rim is indistinct. The alveolar border of the maxilla is complete up to the second premolar. The right maxilla consists of only of the alveolar border up to the nasal aperture. The left first incisor, canine, second premolar, and the right canine and first premolar are still present in the bone. The left zygomatic bone looks narrower than that of Liang Momer E and the frontal process is also much narrower than that of Liang Momer E. However, no measurements can be made.

Based on the very small mastoid process, the strong glabella and very strong superciliary arches, the rough zygomatic bone, the not evident supramastoid crest, the strong left parietal tuber, and present right frontal tuber the skull was sexed as female (table 93).

The teeth (table 44)

The left first incisor, both canines, the right first premolar, and the left second premolar are known of the maxillar arcade. The right canine, both first premolars, and the left second premolar are known from the mandibular arcade.

The maxillary teeth are severely worn. The pulp is visible in all teeth, only the root remains of the left first incisor, the left canine is worn up to the alveolar edge, and the left second premolar crown is worn obliquely almost to the root. Only the roots are preserved of the right canine and the right first premolar. The premolar has two roots. No measurements can be made with any certainty on the maxillary teeth.

The mandible preserved the right canine and P_1, and the left P_1 and P_2. The right P_1 has only one root. These teeth are also worn, but not down to the pulp. The enamel is only still present at the edge of the crown. The rest is dentine. The left P2 is damaged and only the root remains.

Some isolated teeth were found near the jawbones. Among these were two loose molars. One is a left lower third molar (referred to as molar 1), attrition stage 2, and the other is a lower molar (two roots, referred to as molar 2), judging from wear (attrition stage 5) probably the first, but it is too damaged for a clear determination. Also, two probable upper premolars are known, although their identification remains tentative. The wear stages of these teeth are inconsistent with the wear stages of the *in situ* lower premolars. The loose premolars are much less worn than the ones in the jaw, so they may in fact both be lower molars. The first tooth, referred to as premolar 1, is identified here as a left upper first premolar. It has two roots, but a small crown, missing one side (mesial or distal half). The second tooth, referred to as premolar 2, is identified here as a upper second premolar. It has one root with a groove and a sub square occlusal surface of a small crown, missing one half (mesial or distal), but the root is intact. Both premolars are worn down with only a small piece of the occlusal enamel remaining.

Mandibular	Diameter (mm)	Right	Left
C	MD	6	-
	BL	6.9	-
P_1	MD	6.3	6.1
	BL	8.2	8.3
Loose molar 1	MD	10.8	-
	BL	10.5	-
Loose molar 2	MD	11.9	-
	BL	11.1	-
Loose premolar 2	BL	9.1	-

Table 44. Liang Momer A teeth measurements.

Age determination is based on the wear of the two loose molars, since the skull was too fractured for scoring of the endocranial suture obliteration. According to the criteria of Miles (1963) the age is about 35, according to the criteria of Brothwell (1981) it is between 25 to 35.

The mandible (table 45)

	Measurements (mm)		Index		
	Right	Left		Right	Left
Length of incisura mandibulae	-	35.3			
Depth of incisura mandibulae	-	10	Index of incisura mandibulae	-	28.3
Transverse diameter of condyloid process	21.3	19.4			
Sagittal diameter of condyloid process	8	8	Index of condyloid process	37.6	41.2

Table 45. Liang Momer A mandible measurements.

The mandible is badly damaged in most areas. The right condyle and coronoid, the left condyle head, the right coronoid with part of the incisura mandibulae, and the symphyseal part, containing the right canine and P_1, and the left P_1 and P_2, are preserved. The left canine is broken off at the root. Also, pieces of the corpus are present. The chin is heavily damaged, but the mental trigone is visible and not prominent. The precoronoid fossa is deep and wide. The incisura mandibulae is deep, but shorter than that of Liang Momer E. It looks more gracile. The condyloid process is widest on the buccal side. The mandibular foramen is large. The lingula is broken off. On the whole there is much damage.

Postcranial

Many fragments of postcranium are known. Many of these cannot be identified, however some pieces can be recognized. These are fragments of scapula (right upper part of glenoid cavity and inferior part of coracoid process, left acromion, inferior part of left spine), humerus (fragments of the diaphysis), radius (left proximal and distal epiphysis, right proximal epiphysis, fragments of the diaphysis), ulna (right olecranon, right proximal epiphysis, left distal epiphysis, but without styloid process, and fragments of diaphysis), bones of the hand, vertebrae (including axis and atlas), fragments of sacrum (base and left lateral part, and a piece of the right lateral part), pelvis (tuber ischiadica, acetabulum), femur (head, greater trochanter, diaphyseal part beneath lesser trochanter of left femur, and other diaphyseal fragments, showing a not so gracile linea aspera), tibia (anterior part of left tibial epiphysis, and fragments of the diaphysis), fibula (proximal epiphysis and fragments of diaphysis), and bones of the foot.

The bones of the hand (table 46)

		Measurement (mm) Right	Left	Index	Right	Left
Capitate	Maximum length	22.3	-	Length-breadth index	61	-
	Maximum breadth	13.6	-	Length-height index	71.7	-
	Maximum height	16	-	Height-breadth index	85	-
Hamate	Maximum length	-	17.8	Length-breadth index	-	73.6
	Maximum breadth	-	13.1	Length-height index	-	100.6
	Maximum height	-	17.9	Height-breadth index	-	73.2
Metacarpal	D III	-	58			
	D IV	50	-			
	D V	51.2	-			
Phalanx i	D II	-	39			
	D III	-	41.3			
	D IV	-	40.2			
	D V	36.6	-			
Phalanx ii	D IV	25.2	25.5			
	D II	-	24			
	DIII	-	26.1			

Table 46. Liang Momer A handbone measurements.

Only the right capitate and left hamate remain of the carpus, but both are intact. Three intact metacarpals (of left DIII, right DIV, and right DV), and six phalanges (first phalanges of left DII, DIII, and DIV, and of right DV, and second phalanges of left DIII and DIV) are present.

The bones of the foot (table 47 & 48)

	Talus Measurements (mm) Right	Left	Index	Right	Left
Length	-	46			
Height	-	26.1	Length-height index	-	56.7
Breadth	-	35.6	Length-breadth index	-	77.4
Length of trochlea	-	27.8	Trochlear length index	-	60.4
Breadth of trochlea	24.9	25.2	Trochlear index	-	90.6
Anterior trochlear breadth	20.9	20.4			
Length of caput	-	28.3	Caput length index	-	61.5
Length of posterior calcanear articular surface	-	30.4	Posterior calcanear articular surface breadth index	-	92.4
Breadth of posterior calcanear articular surface	-	28.1			
	Calcaneus				
Height	32.1	-			
Length of corpus	46.9	-			
Height of tuber	36.9	-			
Length of posterior calcanear articular surface	24	-	Posterior calcanear articular surface index	72.1	-
Breadth of posterior calcanear articular surface	17.3	-			

Table 47. Liang Momer A talus and calcaneus measurements.

Description	Naviculare Measurements (mm) Left	Index	Left
Breadth	31.9		
Minimum thickness	7.1		
Maximum thickness	14.3	Thickness index	49.7
Length of posterior articular surface	22		
Breadth of posterior articular surface	17.4	Posterior articular surface index	79.1
	Metatarsal Left		
Metatarsal D I Breadth of base	24.6		
Height of base	14		

Table 48. Liang Momer A naviculare and metatarsal measurements.

Both tali, both calcanei, and the left navicular bone are present. A small fragment of the right navicular bone is attached to the right talus. The right talus is damaged posteriorly.

The left talus is complete, except for some damage to the posterior part of the trochlea. The right calcaneus is damaged anteriorly, missing the articular surface for the cuboid bone and the anterior and middle facets for the talus. Of the left calcaneus only the lateral and inferior part of the tuber remains.

The left navicular bone is intact. Of the left foot, the second and fifth metatarsals are present, but both are damaged. Of the second metatarsal the head and a part of the body remain and of the fifth only the base.

Conclusion

Gender: Female?
Age: 30-35 years?
Stature: unknown.

Liang Momer B

The skull

The skull fragments recovered include a part of the left frontal bone, the left temporal bone, and maxilla. The left frontal bone consists of the medial upper portion of the left orbit and the glabella. The orbital margin is sharp. There is a supraorbital notch. The glabella is not very prominent and neither is the superciliary arch above the left orbit. The left temporal bone comprises the mastoid process, the external auditory porus and the base of the temporo-zygomatic process. The mastoid process is small and the porus is oval. There is no sign of a supramastoid crest. The endocranial surface is damaged. The body, part of the frontal processes, and the right canine fossa remain of the maxilla. The canine fossa does not look very deep, but this is hard to verify, because the bone ends very close to the infraorbital foramen. The nasal aperture has no sharp lower margin. The maximum breadth of the nasal aperture is 24.7 mm. The palatal depth is 10 mm.

The teeth (table 49)

The shape of the maxillary dental arch is parabolic. The teeth still *in situ* include the right I^1, the right C, both P^1, the right P^2, the left M^1, the left M^2, and the left M^3, which had not yet erupted. The left canine and the right P^1 have damage to the crown. The left molars were found in isolation. The left M^3 was still developing, possessing a crown and a small part of the roots. The attrition of the upper molars is grade 2^+ for the right M^1, 3^- for the left M^1, grade 1^+ for the right M^2, 2^- for the left M^2. Cusp patterns of the maxilla molars are 4 for both M^1, 4 for both M^2, and 4- for both M^3.

Some mandibular teeth were found, although mostly in a very fragmented state. I identified the right first molar and both second molars from the crown. Occlusal surface wear was grade 2 for the right M_1 and grade 1^+ for both M_2. Cusp and fissure pattern for the mandibular left second molar is +4. The molar had no more roots. Only the distobuccal half of the crown remains of the right M_1. It possesses a distobuccal fifth cusp and therefore must have had at least 5 cusps. The right M_2 has only the distal and buccal surfaces of the crown.

Mandibular	Diameter (mm)	Right	Left	Maxillary	Diameter (mm)	Right	Left
I_1	MD	-	-	I^1	MD	9.2	-
	BL	-	-		BL	8.3	-
C	MD	-	-	C	MD	9.1	-
P_1	MD	-	-	P^1	MD	8.7	9
	BL	-	-		BL	11.6	10.6
P_2	MD	-	-	P^2	MD	7.7	-
	BL	-	-		BL	10.8	-
M_1	MD	13	-	M^1	MD	11.8	11.6
	BL	-	-		BL	12.4	13
M_2	MD	-	13.3	M^2	MD	11.8	11
	BL	-	12.2		BL	12.8	13.2
M_3	MD	-	-	M^3	MD	9.6	9.8
	BL	-	-		BL	12.8	13
				Cross-sectional area upper M^1		146.3	150.8
				Cross-sectional area upper M^2		151	145.2
				Cross-sectional area upper M^3		122.9	127.4
				Total cross-sectional area upper molars		420.2	423.4

Table 49. Liang Momer B teeth measurements.

Based on the dentition, the age is estimated to be about 15 years, but the standard deviation is 36 months, meaning that it could have been anywhere between 12 and 18 years.

The cross-sectional area of the M^{1+} and M^2 is large, the cross-sectional area of the M^3 is medium, at the large side. The total cross-sectional area of the upper molars is very large.

Postcranial

Among the postcranial remains are the manubrium, sternum (unfused → younger than 16), humerus (unfused caput → younger than 22; unfused distal extremities → younger than 17), the distal extremity of the right radius, the right proximal extremity of the ulna, fragments of the carpus, metacarpals, phalanges, vertebrae, costae, part of the promontorium of the sacrum (with epiphyseal plates), parts of the inferior part of the sacrum (unfused → younger than 14), os coxae (parts of ilium, ischium, and pubis: symphyseal surface; unfused at acetabulum → younger than 18), both proximal femural epiphyses (unfused capita and greater trochanter → younger than 19), distal extremity of right tibia (unfused → younger than 18), the right distal extremity of the fibula, and fragments of the bones of the foot (unfused tuber → younger than 20)

Combining the dental age (15 ± 36 months) with the presence of epiphyseal plates on the iliac crest (<14), sacrum (11-14) and sternum, I estimate the age to be between 12 and 14 years. Jacob (1967) estimates the age to have been younger than 12.

The humerus

The proximal epiphysis of the right humerus is present. The caput had not yet fused with the diaphysis, meaning the individual was younger than 22. The tuberculum majus is broken. There is only a small piece of diaphysis below the caput. The horizontal diameter of the caput is 32.0 mm, and the vertical diameter of the caput is 32.0 mm, making a caput index of 100.0. The left and right distal extremity of the humerus were also recovered. They are unfused, implying that this individual was younger than 17.

The bones of the hand (table 50)

The right scaphoid bone is preserved as the area around the proximal joint surface and the corresponding part on the distal surface. The left scaphoid is missing. Both lunate bones are present. The left bone is damaged on the superior radial side. The right trapezium is damaged on the superior surface and the radial surface, and to a lesser degree on the ulnar surface. The left trapezium is intact. The right capitate has some damage to the distal radial side. The left capitate bone has damage to the distal surface and the palmar surface. Both hamates are damaged on the dorsal surface, the left also lacks its hamulus.

Description		Measurements (mm)		Index		
		Right	Left		Right	Left
Scaphoid	Maximum length	P	-			
Lunate	Length	6.9	-	Length-breadth index	144.9	-
	Maximum breadth	10	7.1	Length-height index	52.7	-
	Maximum height	13.1	-	Height-breadth index	76.3	-
Trapezium	Maximum length	P	11	Length-breadth index	-	82.7
	Maximum breadth	-	13.3	Length-height index	-	119.6
	Maximum height	-	9.2	Height-breadth index	-	69.2
Capitate	Maximum length	19.9	P			
	Maximum height	10.3	-	Length-height index	51.8	-
Hamate	Maximum length	16.6	P	Length-breadth index	75.9	-
	Maximum breadth	12.6	-	Length-height index	88.6	-
	Maximum height	14.7	-	Height-breadth index	85.7	-

Table 50. Liang Momer B handbone measurements. - = Absent. P = Present, but too damaged for measuring.

Furthermore, there are fragments of metatarsals and six fragments of phalanges that remain. These bear unfused capita. Unfused metatarsals indicate an age younger than 20.

The vertebrae (table 51 & 52)

Description	Measurements (mm)									
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T12
Anterior height	-	-	-	9	-	-	-	-	-	14.9
Middle vertical diameter	8.5	9.5	10.5	11	11	12	-	14	13	17
Posterior height	-	-	10.4	10.8	10.9	-	11.1	-	12.5	-
Superior breadth	-	-	-	-	23.7	-	-	-	-	-
Middle transverse diameter	-	-	21.7	22	23.5	23.6	24.2	26.2	-	-
Inferior breadth	-	-	-	-	25.6	-	25.8	28	-	-
Superior sagittal diameter	-	-	-	17	-	-	-	-	-	-
Inferior sagittal diameter	-	-	-	17.6	-	-	-	-	-	-
Vertebral foramen transverse diameter	-	-	-	-	-	13.2	-	15.9	-	-
Vertebral foramen sagittal diameter	-	-	-	-	-	-	-	14	-	-
	Index									
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T12
Sagittovertical corpus index	-	-	-	52.9	-	-	-	-	-	-
Vertebral foramen index	-	-	-	-	-	-	-	88.1	-	-

Table 51. Liang Momer B thoracic vertebra measurements.

In total 10 thoracic and 5 lumbar vertebrae were discovered. The thoracic vertebrae are T1 to T9 and T12. All the lumbar vertebrae are found.

The arci of the vertebrae are missing on T1 to T7, T9, and T12. The corpi of T1 and T2 are both severely damaged on all edges, making it impossible to measure anything other than the middle vertical diameter. In the case of T2 it is even impossible to determine which is the caudal and which is the cranial surface. The body of T3 has damage to its anterior and lateral edges both cranially and caudally. The body of T4 is damaged on the cranial and caudal edges of the right lateral surface. The corpus of T5 is missing its anterior surface and the anterior part of the left caudal edge. T6 has damage to all the edges on its corpus. T7 is missing the entire anterior part of its corpus to beyond halfway on its cranial surface. T8 has its arcus, but the transverse processes and the spinous process are broken off. The body has damage cranially and caudally to the anterior and right lateral edges. T9 has damage to the anterior surface of the corpus and the right lateral surface. T12 consists of only the right lateral surface and the right half of the anterior surface of the body.

The lumbar vertebrae L2 to L4 still have their vertebral arches. The costal processes are all broken. L1 still bears its spinous process, but it was broken and repaired during the original preparation. The repair was not done correctly and therefore I have not measured the sagittal diameter of the vertebral foramen. The left lateral part of the arcus is missing. The corpus of L1 has slight damage to the left part of the anterior edge cranially, and both lateral edges caudally. The body of L2 is damaged on both anterolateral edges of the cranial surface, and both lateral edges of the caudal surface. L3 has damage to the right part of the cranial surface, the right lateral edge, and the right part of the anterior edge of the corpus. The caudal surface only has damage to the right part of the anterior edge. L4 and L5 are stuck together with matrix. L4 has damage to the right anterolateral edge and the left lateral edge of the cranial surface of the corpus. L5 has damage to both posterolateral edges of the caudal surface of the body.

Description	Measurements (mm)				
	L1	L2	L3	L4	L5
Anterior height	17	16.4	-	-	-
Middle vertical diameter	17	16	16	-	-
Posterior height	17.6	17.6	16	15.1	13.9
Superior breadth	30	32.1	-	37.8	39.1
Middle transverse diameter	29.3	30.6	32.9	35.3	36
Inferior breadth	-	-	37.5	38.8	39.2
Superior sagittal diameter	23.6	24.6	-	-	27.1
Middle sagittal diameter	-	-	-	25	24
Inferior sagittal diameter	24.1	25.9	26.5	27.2	26.2
Vertebral foramen transverse diameter	18.7	18.8	18.7	21.9	-
Vertebral foramen sagittal diameter	-	13.7	13.7	14	-
	Index				
	L1	L2	L3	L4	L5
Vertebral corpus index	103.5	107.3	-	-	-
Transversovertical index	58	53.6	-	-	-
Transversosagittal index	-	-	-	70.8	66.7
Vertebral foramen index	-	72.9	73.3	63.9	-

Table 52. Liang Momer B lumbar vertebra measurements.

The femur (table 53)

Description	Measurement (mm)		Index		
	Right	Left		Right	Left
Horizontal diameter of caput	33.3	34.7	Caput index	99.4	99.1
Vertical diameter of caput	33.5	35			
Caput circumference	106.3	110.5			
Sagittal diameter of collum	18.7	18.9			
Vertical diameter of collum	22.8	22.9	Collum index	82	82.5
Upper breadth	64	-			
Intertrochanteric distance	-	62.8			
Subtrochanteric transverse diameter	21.6	21.1			
Subtrochanteric sagittal diameter	15	17	Platymeric index	69.4	80.6

Table 53. Liang Momer B femur measurements.

The proximal epiphyses of both femora are present. There are epiphyseal plates on the capita and the greater trochanters. Unfused capita and greater trochanter indicate an age younger than 19. The right femur preserves its greater trochanter, which is glued in its proper place. The lesser trochanter is damaged. The left lacks its greater trochanter, but has an intact lesser trochanter. The diaphysis of the right femur reaches to above halfway, that of the left femur reaches down a little lower, but has only its posterior surface. The right femur is hyperplatymeric (high antero-posterior flattening), the left femur is less flattened, but still platymeric.

The bones of the foot (table 54-56)

Description	Talus Measurements (mm) Right	Index	Right
Length	44		
Height	25.7	Length-height index	58.4
Length of trochlea	27.2	Trochlear length index	61.8
Breadth of trochlea	26.6	Trochlear index	97.8
Anterior trochlear breadth	17.1		
Posterior trochlear breadth	16.9	Trochlear breadth index	98.8
Length of caput	26	Caput length index	59.1
Breadth of posterior calcanear articular surface	17.3		
	Calcaneus		
Length	60.6		
Middle breadth	36.8	Length-middle breadth index	60.7
Length of corpus	41.3	Corpus length index	68.2
Breadth of posterior calcanear articular surface	19.9		

Table 54. Liang Momer B talus and calcaneus measurements.

The right talus and calcaneus are present. The talus has damage to its head and the lateral process is missing. The calcaneus is more severely damaged and is missing the inferolateral part. The tuber is damaged on the medial side and the lateral side is missing. The superior surface of the calcaneus is damaged posteriorly. The inferior part of the articular surface for the cuboid bone is broken. The posterior facet for the talus is damaged posteriorly and laterally.

Description	Measurements (mm)		Index	
	Right	Left		Right
Minimum thickness	7.3	7.4		
Maximum thickness	12	-	Thickness index	60.8
Length of posterior articular surface	23	-		
Breadth of posterior articular surface	16.8	-	Posterior articular surface index	73

Table 55. Liang Momer B naviculare measurements.

The right navicular bone is damaged inferiorly and superiorly. There is a hole in the middle of the proximal articular surface. The same kind of hole can be found in the left navicular bone, but here it is larger. The left navicular bone is damaged, comprising of only the superolateral part.

Both cuboid bones are found. The right cuboid bone has damage to the lateral surface and the proximal part of the medial surface. The left cuboid bone is damaged on the proximal part of the dorsal and medial surfaces. The right cuneiform I has damage to the inferior parts of both sides. The left cuneiform I has damage to the proximal part of the inferior surface. Only the left cuneiform II is preserved. Only the dorsal surface and the superior part of the proximal surface remain. Both cuneiform III are missing their plantar surface.

The metatarsals of the first, second, third and fourth toe of the right toe remain. The first has only the head, which is broken. Of the other three only the base remains. The third phalanx of the first toe was also found and it is still intact. The left foot is more complete, with five metatarsals and one third phalanx preserved. Only the head remains of the first metatarsal. The metatarsal of the second toe is missing its head, but the top of the body bears an epiphyseal plate. This is also the case with the metatarsals of the third and fifth toe. Only the base and about half the body remain of the fourth metatarsal. The third phalanx of the first toe was also found intact. Three first phalanges were found, which have epiphyseal plates at their base. One second phalanx was found, likewise with an epiphyseal plate at its base. It is not clear if these phalanges are from the right or the left foot, but as the left foot is better preserved, it is likely that they are from there.

Os cuboideum and ossa cuneiformia							
			Measurements (mm)				
			Right	Left	Index	Right	Left
Cuboideum		Medial length	28.2	28.9			
		Lateral length	-	14	Length index	-	48.4
Cuneiform I		Inferior length	20.1	20.1			
		Middle length	19	19.6			
		Superior length	18.9	19.6			
		Distal articular surface height	23.1	23.7			
		Proximal height	20.1	-	Height index	123.9	-
		Distal height	24.9	24.8	Length-distal height index	131.7	126.5
Cuneiform II		Superior length	-	13.3			
		Middle superior breadth	-	12.7	Length-breadth index	-	95.5
Cuneiform III		Superior length	19.2	20.1			
		Middle superior breadth	14.6	14.1	Length-breadth index	-	70.1
		Distal breadth	14.1	14			
		Proximal breadth	11	11.6	Breadth index	78	82.9
			Metatarsal				
Metatarsal	D I	Breadth of capitulum	15.9	17.6			
		Height of capitulum	13.8	14.1			
	D II	Breadth of corpus	P	5.7			
		Height of corpus	-	7.8	Breadth-height index	-	136.8
	D III	Breadth of corpus	P	6.1			
		Height of corpus	-	8	Breadth-height index	-	131.1
	D IV	Breadth of corpus	P	5.3			
		Height of corpus	-	6.8	Breadth-height index	-	128.3
	D V	Breadth of corpus	-	6.7			
		Height of corpus	-	8.2	Breadth-height index	-	122.4
			Phalanges				
Phalanx i	DII	Length	-	19.7			
		Breadth of corpus	-	4	Length-breadth index	-	20.3
		Height of corpus	-	4	Breadth-height index	-	100
	DIII	Length	-	17.8			
		Breadth of corpus	-	4.2	Length-breadth index	-	23.6
		Height of corpus	-	4.4	Breadth-height index	-	104.8
	DIV	Length	-	15.9			
		Breadth of corpus	-	3.9	Length-breadth index	-	24.5
		Height of corpus	-	3.2	Breadth-height index	-	82.1
Phalanx ii	DII	Length	-	9.9			
		Breadth of corpus	-	5.1	Length-breadth index	-	51.5
		Height of corpus	-	3.8	Breadth-height index	-	74.5
Phalanx iii	D I	Length	17	16.8			
		Breadth of corpus	9.6	10	Length-breadth index	56.5	59.5
		Height of corpus	5	5.1	Breadth-height index	52.1	51

Table 56. Liang Momer B cuboid, cuneiform, metatarsal and phalanx measurements. - = Absent. P = Present but too damaged for measuring.

Conclusion

Gender: unknown.
Age: 12-14 years.
Stature: unknown.

The total cross-sectional area of the upper molars is very large. The femur has a low platymeric index: antero-posterior flattening.

Liang Momer C

The teeth

Two teeth were present among this material; one very worn molar (wear grade 6^-), and one molar, which looks hardly used (grade 1). This latter molar seems to be out of place, since it is unlikely that a mandible, which has lost at least three molars during life, should also contain a complete unworn molar. It is therefore probably a contamination from another grave. The very worn molar is damaged and very little of the crown remains. It bears two roots, and is thus likely to be a mandibular molar. Since all right mandibular molars were lost before death (there is a healed alveolar margin), it must be from the missing left side. Liang Momer C is likely to have been old and so the worn molar probably belongs with the mandible. The other molar is probably an unerupted left M_3, since it had no approximal wear facets. Its cusp and fissure pattern is X5 (Hillson, 1996).

The mandible (table 57)

Description	Measurements (mm) Right	Left	Index	Right	Left
Minimum ramus breadth	39.3	-			
Condyloid height	78.3	-	Ramus index	50.2	-
Coronoid height	62.2	-			
Intermental breadth	50.3				
Corpus height at mental foramen	23.9	-			
Corpus height at M_2	19.7	-	Robusticity index		
Corpus thickness at mental foramen	15.6	15.2	Mandibular thickness index	65.3	-
Corpus thickness at M_2	19.9	-			
Height of mental foramen from mandibular base	15.3	16.8			
Symphyseal height	26.3		Height index	74.9	
Length of incisura mandibulae	43.1	-			
Depth of incisura mandibulae	11.9	-	Index of incisura mandibulae	27.6	-
Sagittal diameter of condyloid process	9.8	10.5			
Transverse diameter of condyloid process	19.8	-	Index of condyloid process	49.5	-
Inter-C distance	16.7				
Symphysis thickness	16		Corpus mandibula module	20.5	

Table 57. Liang Momer C mandible measurements.

About three quarters of the mandible (plate 16) is preserved. The left ramus is missing, but the left condyloid process is present. The mandible is damaged on the buccal side. It is robust, shorter than that of Liang Momer E, but higher. All the right molars and the right P_2 were lost ante mortem. The right second premolar has left a healing socket. The right incisors, canine and first premolar are broken above their roots. The M_1, M_2, and P_2 on the left side were also lost ante mortem. The canine was lost post mortem and the left incisors and the first premolar were broken off. The condyloid process is higher than the coronoid process. The pterygoid tuberosity is well developed. The alveolar border is depressed at the level of the missing molars, probably because of the tooth loss. The mental foramina are at about two thirds of the corpus height. The mental trigone is prominent. The mental protuberances are clearly visible. Lingually, the digastric fossae are distinct. The corpus of the mandible is of medium size.

Based on the prominent mentum and thick inferior margin, the mandible was sexed as male (table 93). I cannot determine the inidividuals' age because of the lack of skull, symphyseal surface, femural or humeral head, or teeth. Judging from the mandible however, the ante-mortem loss of all right molars suggests an advanced age. If the worn molar found belongs to Liang Momer C, than the wear stage indicates an age of at least 35.

Plate 16. Liang Momer C mandible. Notice the antemortem loss of the molars. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

Postcranial

Several fragments of postcranium were found in addition to the bones of the hand, the innominate bone, and vertebrae (described below). Fragments of scapula were found including the superior part of lateral margin of left scapula.

There were also some pieces of the bones of the arm. Among these are a part of diaphysis and the medial part of the capitulum of the left humerus. The right ulna is preserved as the part just beneath the proximal epiphysis. The inferior part of the radial notch is visible, and so is the inferior part of the coronoid process. The posterior surface is broken. The head and radial tuberosity of the right radius, and part of the diaphysis of the left radius were also discovered. There are also many small fragments, which cannot be identified.

The bones of the hand (table 58)

Description		Measurements (mm)		Index	
		Right	Left		Right
Scaphoid	Maximum length	27.9	-	Length-breadth index	44.1
	Breadth	12.3	-	Length-height index	59.1
	Height	16.5	-	Height-breadth index	134.1
Capitate	Maximum length	21	-	Length-breadth index	66.7
	Maximum breadth	14	-	Length-height index	90
	Maximum height	18.9	-	Height-breadth index	74.1
Metacarpal	DII	-	P		
	DIII	67.6	P		
	DV	P	-		
Phalanx i	DII	P	-		
	DIII	P	-		
Phalanx ii	DIII	32	-		
	DV	23.1	-		
Phalanx iii	DI	24.7	-		
	DIII	20.9	-		

Table 58. Liang Momer C handbone measurements. - = Absent. P = Present, but too damaged for measuring.

The hands were very poorly preserved. Not all fragments can be determined. The scaphoid and capitate of the right carpus are preserved. Metacarpals found of the right hand are the third (whole) and fifth (caput) metacarpal, of the left hand the second (missing base) and third (caput) metacarpals remain.

Phalanges preserved on the right hand are phalanx iii of the first finger (undamaged), phalanx i of the second finger (the base and a piece of the body), phalanges i (the corpus and head), ii, and iii (both undamaged) of the third finger, and phalanx ii of the fifth finger (undamaged). No phalanges were found belonging to the left hand.

The innominate bone

Only the left os coxae is present. It consists of the ischium (tuber up to acetabulum), and the inferior part of the ilium (part of the auricular surface and the acetabulum). The pubis is missing entirely, and the acetabulum is damaged on that side. The ischial body is robust with a prominent tuber. The ischial height is 73.0, the maximum diameter of the acetabulum is 50.6.

Based on the narrow greater sciatic notch, the single curve of the arc composé, and the broad ischial body, the pelvis was sexed as male (table 93).

The vertebrae (table 59)

Description	Measurements (mm)			
	C3	C4	C5	C6
Anterior height	13.9	12.3	10.4	10.3
Middle vertical diameter	10	9.5	9	9
Posterior height	13.4	12.3	13.2	12.3
Superior breadth	16.9	18.7	19.8	-
Middle transverse diameter	20.6	19.5	19	-
Inferior breadth	20	22.3	21.6	22.7
Superior sagittal diameter	15	15.1	15.1	16
Inferior sagittal diameter	15.8	15.2	15.8	17.3
Middle sagittal diameter	15.2	14.9	14.3	15
	Index			
	C3	C4	C5	C6
Vertebral corpus index	96.4	100	126.9	119.4
Sagittovertical corpus index	63.3	62.5	57	52
Transversovertical index	67.5	63.1	54.7	-
Transversosagittal index	76.7	77.9	83.2	-

Table 59. Liang Momer C cervical vertebra measurements.

Cervical vertebrae C2, C3, C4, C5, and C6 are preserved. Only the anterior part of the axis remains, consisting of the dens and corpus. It is damaged at the inferior edge of the anterior surface. This makes it impossible to measure its height. C3 and C4 both consist of only the corpus vertebrae. C3 is damaged at the inferoanterior edge in a position a little left of the middle. C4 and C5 have intact corpi. C6 has damage on the inferior and left lateral surfaces.

Conclusion

Gender: Male.
Age: Over 35 years.
Stature: unknown.

Medium sized mandible.

Liang Momer D

The skull

The skull remains consist of pieces from the frontal, parietal, occipital, and both temporal bones. A round foramen magnum with both condyles can be identified. The mastoid process is very small. The external auditory porus is round. The mandibular fossa is shallow. The sygmoid curve is distinct. The left zygomatic bone is small and gracile. The maxilla consists of the alveolar border up to the lower border of the nasal cavity, the dental arch, and the palate. The medial portion of the dental arch has been damaged, causing the incisors (some of which have been broken off at their roots) to point at strange angles. The palatal length could not be measured due to damage to the medial portion. The palatal breadth is 27.8 mm, and the palatal depth is 7 mm. Palatal breadth-depth index is 25.2.

Because the individual was so young at death, a reliable gender determination cannot be made. The skull is in a very fragmented state, so that the only characters still determinable are the mastoid process and zygomatic bone. These are small and gracile, but that is the case in both young girls and boys. The same applies to the pelvis, of which the ilium and ischium can be scored.

The teeth (table 60)

Mandibular	Diameter (mm)	Right	Left	Maxillary	Diameter (mm)	Right	Left
I_1	MD	6	-	I^1	MD	9.2	9.4
	BL	7	-		BL	8.1	8.2
I_2	MD	6.4	-	I^2	MD	7.5	-
	BL	8.6	-		BL	7.2	-
P_1*	MD	8.3	-	P1	MD	7.3	-
	BL	9.7	-		BL	11	-
P_2*	MD	10.1	10.3	P^2*	MD	9.1	9.1
	BL	9.3	9.3		BL	10.1	10.9
M_1	MD	11.3	11.4	M^1	MD	11.2	11.1
	BL	11.5	11.8		BL	12	12.1
				Cross-sectional area upper M^1		134.4	134.3

*Table 60. Liang Momer D teeth measurements. * Measurements on deciduous teeth.*

The shape of the dental arch of both maxilla and mandible is parabolic. The maxilla contains 11 teeth: both I^1 and the right I^2. The right incisors are broken off at their roots. The left permanent C has not yet erupted. The right permanent P^1 is erupting. Both deciduous P^2, and both permanent M^1 are present. Both permanent M^2 (consisting of crown and part of the roots) are imbedded in the bone. All the permanent teeth show no wear. The deciduous P^2's are worn down to the dentine. The left I^1 is broken off below the alveolar border. The molar cusp pattern of both M^1 is 4. Both M^2 are still developing, but the crown has 3 cusps.

The mandible has the right I_1 and I_2, both broken off at the roots. The right permanent C and the left permanent P_1 are still below the alveolar border. The right P_1 and both P_2's are deciduous,. The left deciduous P_1 is absent. Both permanent M_1 are present. Both permanent M_2 are imbedded in the bone, so that the progress of development is not determinable. The crown of the left permanent M_3 is found in the bone below the coronoid. Below the right coronoid is also a void, which may have housed the right permanent M_3, but it is now empty. The permanent teeth have no evidence of wear, but the deciduous P_1 and P_2's are worn down so far that the occlusal surfaces consist of a border of enamel with dentine in the centre. All teeth above the alveolar border have been measured. The cusp and fissure patterns are +5 for both M_1 and +4 for the both still developing M_2.

From the eruption and mineralisation of the dentition, the age of Liang Momer D is estimated at about 9 years. The presence of the M_3 in the bone of the mandible suggests that the age should be about ten, but the stage of eruption of the premolars and canines is not advanced enough for this age.

The permanent teeth are big. The first incisors of the maxilla are shovel-shaped. Age according to dentition: 9 years ± 24 months.

The mandible (table 61)

The mandible (plate 17) is small and low, which is not unexpected considering the age. The symphyseal part is damaged and so are the labial surface of the left ramus and the right labial alveolar surface at the height of M_2. This damage makes it possible to see the left M_3 and the exact stage of progress of the still developing M_2. The base of the mandibular corpus has contact points at the height of the right canine, at the height of M_1, and at the gonion. As with the skull, it is not possible to determine the sex reliably.

The mandible has the normal gracile and small appearance of a child's mandible. The general shape of the mandible is much like that of Liang Momer E. I will therefore only comment on the differences.

The ramus is low. In the mandible of Liang Momer E, the right mandibular notch is shorter, but deeper, than the left. This is the opposite of the condition in Liang Momer D. The right condyloid process is semi-lunate, with the top of the curved surface approximately in the middle of the posterior surface, and the flat side positioned anteriorly. The left condyle has the top of the convex surface positioned on the labial side of the posterior surface, making it broader on that side. The buccal surface of the ramus is smooth, the labial surface of the angle shows muscular markings. The mylohyoid groove is very faint. The mental trigone is poorly developed. The mental tubercles are only weakly developed. The mental foramen is positioned between P_1 and P_2, and opens posterosuperiorly.

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Mandibular length	82				
Bigonial breadth	83				
Minimum ramus breadth	30.5	30.3			
Condyloid height	43.3	43	Ramus index	70.4	70.5
Coronoid height	38.1	38.8	Mandibula L-H index	46.5	47.3
Intermental breadth	41.6				
Corpus height at mental foramen	23.2	23			
Corpus thickness at mental foramen	12.8	12.7	Mandibular thickness index	55.2	55.2
Height of mental foramen from mandibular base	10.7	11			
Symphyseal height	19.3				
Length of incisura mandibulae	32.8	28			
Depth of incisura mandibulae	7.9	8.9	Index of incisura mandibulae	24.1	31.8
Sagittal diameter of condyloid process	8.9	8.4			
Transverse diameter of condyloid process	15.7	17	Index of condyloid process	56.7	49.4
Inter-C distance	18.2				
Inter-M_1 distance	32.9				
Symphysis thickness	12.5				

Table 61. Liang Momer D mandible measurements.

Plate 17. Liang Momer D mandible. Note the unerupted canine, premolars and molars. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

Postcranial

Fragments were found of the scapula, manubrium, humerus (distal extremity with epiphyseal plate), radius (proximal extremities with epiphyseal plates), ulna (proximal extremity, distal extremities with epiphyseal plates), finger bones (some metacarpals, first phalanges, second phalanges, one third phalanx, all with epiphyseal plates), vertebrae, costae, pelvis, and the left and right femural heads (the head of the femur is small and not yet fused with the femur diaphysis). Also, several small fragments of long bones were found, probably including the femur, tibia and/or humerus, and radius and/or ulna, judging by diameter.

All the material is small and slender. All epiphyses of the long bones show epiphyseal plates and indicate a young age at death.

The vertebrae (table 62-64)

	Atlas and axis			
Description	Measurements (mm)			
Anterior height of axis	26			
Height of axis body	11.8			
Anterior height of atlas and axis	25.4			
	Other cervical vertebrae			
	C3	C4	C6	C7
Anterior height	4.5	4.2	6.8	7.6
Middle vertical diameter	-	4	6.5	7.5
Posterior height	-	3.9	6.9	7.3
Superior breadth	15.1	15.2	-	23
Middle transverse diameter	16.9	15.9	21.7	21.3
Inferior breadth	15.3	15.6	23	22.9
Superior sagittal diameter	-	10	11.3	11.4
Middle sagittal diameter	10.6	10	10.5	10.5
Inferior sagittal diameter	10.4	10.6	11	12
Vertebral foramen transverse diameter	18.9	-	-	-
Vertebral foramen sagittal diameter	12.7	-	-	-
		Index		
	C3	C4	C6	C7
Vertebral corpus index	-	92.9	101.5	96.1
Sagittovertical corpus index	-	40	61.9	71.4
Transversovertical index	26.6	26.4	31.3	35.7
Transversosagittal index	62.7	62.9	48.4	49.3
Vertebral foramen index	67.2	-	-	-

Table 62. Liang Momer D cervical vertebra measurements.

In total six cervical vertebrae are known: atlas, axis, C3, C4, C6, and C7. The atlas is complete but broken. However, it cannot be repaired as the dorsal part is attached to the axis and would be further damaged if removed. The axis is intact, but attached to both the dorsal part of the atlas and C3. C3 itself is complete, but measurments at the dorsal end of the corpus is impossible. C4, C6, and C7 all consist of only the corpus. Additionally, C6 has damage to the left of the dorsal surface and left lateral side of the caudal surface. C7 has damage to the anterior and left lateral edge of the cranial surface.

I have been able to identify nine thoracic vertebrae. The first has only the corpus. It is very small, but high and round, confirming its identification as thoracic. However, it does not articulate well with C7, and so is probably T2, rather than T1. It has damage on the right lateral and anterior surfaces. The next in size is larger than T2, and is probably T4. It is deeper, but less high and consists of the corpus, the vertebral arch and both transverse processes. T5 is attached to T4 by matrix. It also consists of the body and arch, but only has the left transverse process. It has the same shape as T4, but is slightly larger. T7 is wider and higher than T5. It consists of the corpus, arch, spinous process, and left transverse process. It has a gap in the middle of the dorsal surface that goes inward to the centre of the corpus. This is probably due to damage and not some congenital defect, as there are fracture lines coming away from the gap.

T8 consists of the corpus and the right inferior articular process. T9 lies with the front of the corpus attached to T10 by the substrate. Both consist of only the corpus. T11 (which also consists only of the corpus) has damage on the cranial and left lateral surfaces. T12 is attached to L1. Its inferior surface is broken on the right lateral side, and nothing but the corpus remains.

Only two lumbar vertebrae remain, L1 and L2. They are attached to T12 by the substrate. They both consist of the corpus and the vertebral arch. L1 also has both superior articular surfaces and both inferior articular surfaces. L2 has the superior articular surfaces and the left costal process. L2 is damaged on the dorsal surface and on the right lateral surface.

Description	Measurements (mm)								
	T2	T4	T5	T7	T8	T9	T10	T11	T12
Anterior height	9.9	9.1	9.1	11.1	12.2	14	14	15.2	16.8
Middle vertical diameter	10	-	-	10.5	13	15	14.5	15	-
Posterior height	10.8	-	-	10	12.7	13.9	14.6	15.8	17
Superior breadth	-	17.2	18.2	21.3	22.7	24.8	27	-	30
Middle transverse diameter	16.8	16	16.8	19.8	21.6	23.1	26	26.9	29
Inferior breadth	17.9	17.8	18.4	21.7	25.3	26.8	27.9	30.5	-
Superior sagittal diameter	12.3	15.3	-	16.9	17.6	18.8	21.2	21.3	22.1
Middle sagittal diameter	11.5	15	-	17	16.5	16.5	17	20	19.5
Inferior sagittal diameter	13	-	16.8	17.8	18.7	-	20.6	21.6	-
Vertebral foramen transverse diameter	-	12	13.2	15.9	-	-	-	-	-
Vertebral foramen sagittal diameter	-	12.8	12.7	9	-	-	-	-	-
	Index								
	T2	T4	T5	T7	T8	T9	T10	T11	T12
Vertebral corpus index	109.1	-	-	90.1	104.1	99.3	104.3	103.9	101.2
Sagittovertical corpus index	87	-	-	61.8	78.8	90.9	85.3	75	-
Transversovertical index	58.9	56.9	54.2	56.1	56.5	60.6	53.8	56.5	57.9
Transversosagittal index	68.5	93.8	-	85.9	76.4	71.4	65.4	74.3	67.2
Vertebral foramen index	-	106.7	96.2	56.6	-	-	-	-	-

Table 63. Liang Momer D thoracic vertebra measurements.

Description	Measurements (mm)	
	L1	L2
Anterior height	16	16.2
Posterior height	13*	14*
Superior breadth	33	-
Middle transverse diameter	31.3	-
Inferior breadth	35.3	-
Superior sagittal diameter	22.2	-
Middle sagittal diameter	20.5	-
Inferior sagittal diameter	22.3	21.3
Vertebral foramen transverse diameter	20.2	-
Vertebral foramen sagittal diameter	14.3	-
	Index	
	L1	L2
Vertebral corpus index	81.3	86.4
Transversovertical index	51.1	-
Transversosagittal index	65.5	-
Vertebral foramen index	70.8	-

*Table 64. Liang Momer D lumbar vertebra measurements. *Measured with tape due to inaccessibility with sliding calliper.*

The innominate bone (table 65)

The right ilium has damage to the iliac surface and crest. Pieces of sacrum are attached to the auricular surface by the substrate. The left ischium has damage at the epiphyseal plate of the acetabulum. Both ischial bodies have the femur capita attached to it by the substrate. The iliac crest still has epiphyseal plates; These were not yet fused at the acetabulum (this occurs at the age of 15-18 years, meaning this individual is younger than 18). The ischium was probably fused with the pubic bone, since that side of the ischium has evidence of breakage. The tuber is small. Some parts of the sacrum are still attached to the right auricular surface. The iliac fossa is shallow, the iliac crest is moderately curved.

Description	Measurements (mm)		Index	
	Right	Left		Left
Iliac height	77	78.7		
Iliac breadth	-	90.6		
Height of iliac fossa	65.2	64.3	Iliac index	140.9
Breadth of iliac fossa	53.5	53.1		
Ischial height	50.8	-	Ischial height index	-

Table 65. Liang Momer D innominate bone measurements.

Conclusion

Gender: unknown.
Age: 9 ± 24 months.
Stature: unknown.

2.2.5. Conclusion

The average stature of males is about 168 cm.

Skull:

- It is dolichocephalic (long compared to breadth).
- It is orthocephalic (medium auricular height compared to skull length).
- A high skull compared to its length (hypsicephalic).
- Height compared to breadth is hypsistenocephalic (very high compared to breadth).
- The cranial module reveals a medium sized skull.
- Minimum frontal breadth is large compared to cranial breadth (megasem).
- The face is medium to slightly prognathous.
- The total facial index reveals a medium high face (mesoprosopic).
- The facial module shows a large face.
- The upper facial index reveals a medium broad face.
- It is chamaeprosopic (broad face compared to length).
- The orbits are mesoconch (medium high).
- The nose is mesorrhine (medium high).
- The biasteric breadth is almost as large as the cranial breadth.
- The skull is gable shaped.
- The total cross-sectional area of the upper molars is large in the case of Liang Momer E, and even very large in the case of Liang Momer B.
- The mandible is low, the corpus is of medium size.

Postcranial:

- All bones are slender. Only the tibia and fibula are flattened however, in contrast to Liang Togé, where all bones, but the tibia are flattened. The humeri both have a supratrochlear foramen.

2.3. Liang Panas

2.3.1. Location

Liang Panas is located inland (east) of Labuanbadjo, near Longgo village, desa Dalong (figure 4). A hot spring was found nearby (Panas is Indonesian for hot). Nearly all the tools were made out of stone, although a few were made out of shell. The industry is similar to that at Liang Momer, although because it is located further away from the shore, shells must have been harder to come by. The excavation took place in 1955, at the same time as the excavation in Liang Momer.

2.3.2. Archaeological age

Liang Panas had the same industry as Liang Momer and is therefore placed in the same period, about 5,000-3,000 BP.

2.3.3. Material

The material recovered includes skull fragments, teeth and mandible, humerus, ulna, radius, bones of the hand, innominate bone, femur, patella, tibia, and bones of the foot. Fragments of clavicula, costae, vertebrae, and fibula were also found.

2.3.4. Description

The skull

The only fragment of the skull to be found is part of the right temporal bone bearing the mastoid process. The mastoid process is of medium size. The sigmoid groove on the cerebral surface is deep.

The teeth (table 66)

Mandibular	Diameter (mm)	Right	Left	Maxillary	Diameter (mm)	Right	Left
I_1	MD	5.1	5.2	I^1	MD	-	-
	BL	6	6		BL	-	-
I_2	MD	5.7	-	I^2	MD	-	6.9
	BL	6.7	-		BL	-	6.9
C	MD	7.9	8	C	MD	-	-
	BL	8.3	8.3		BL	-	-
P_1	MD	7.6	-	P^1	MD	7.7	-
	BL	8.5	-		BL	10.5	-
P_2	MD	7.7	7.9	P^2	MD	-	-
	BL	8.9	8.9		BL	-	-
M_1	MD	11.4	11.3	M^1	MD	-	10.7
	BL	11.3	11.3		BL	-	13.4
M_2	MD	-	-	M^2	MD	-	10
	BL	-	-		BL	-	11.8
M_3	MD	12.9	-	M^3	MD	-	-
	BL	11.4	-		BL	-	-
				Cross-sectional area upper M^1		-	143.4
				Cross-sectional area upper M^2		-	118

Table 66. Liang Panas teeth measurements.

Four teeth were found *in situ*. These are the right canine, P_1, P_2, and M_1. The right M_2 is broken, but its two roots are still in the jawbone. Attrition of M_1 is grade 5. Molar cusp pattern is ?5.

Several isolated teeth were found at the site (Hillson, 1996); four incisors, a canine, two premolars, and four molars. The first incisor, right I_1, was found attached to the right I_2 in the matrix. The crown is broader than long, and the tooth is small. The crown is intact, but the root has damage to the tip. The crown of right I_2 is also broader than long, and the tooth is slightly larger than I_1. The crown is intact, but the root is missing its tip. The third incisor is about the same size as the right I_1. Therefore it probably is the left I_1. The crown is intact, but the root is broken. The fourth incisor is larger than the others, however comparisons with Liang Momer E indicate that it is most likely the left I^2. The crown is intact, but the root misses its tip. The isolated canine is of about the same size as the *in situ* lower right canine, and has the same shape; it must therefore be the lower left canine. Of this tooth only the crown remains. The first isolated premolar has about the same size as the right P_2, and has the same overall shape. It is therefore, probably the left P_2. The crown is intact, but the root is broken. The second isolated premolar has two roots, a triangular occlusal outline, and a mesial marginal ridge, which is higher than the distal ridge. Based on these characteristics this is probably the right P^1. The crown is intact, but the roots are missing their tips. The first isolated molar has two wear facets, three roots, a small crown compared to molar 2, and a flattened mesiobuccal root. This molar is the left M^1. The crown and roots are intact, but the crown is much worn. Occlusal wear is grade 5, the number of cusps is 4. The second isolated molar has three roots, two wear facets, and a flattened mesiobuccal root. The crown is larger than that of molar 1, but it has little wear. This is the left M^2. The crown is intact and two roots are broken. Occlusal wear is grade 3^-, the cusp number is 5. The third isolated molar has one wear facet, its mesiodistal diameter is larger than the buccolingual diameter, and it has a fifth cusp in distobuccal orientation. This is the right M_3. The crown only remains; it is slightly worn, grade 2, and the occlusal pattern is Y5. The fourth isolated molar has two wear facets, 5 cusps, and is about the same size as the right M_1. This is probably the left M_1. Only the crown remains. It is much worn, occlusal wear grade 5, and the occlusal pattern is ?5.

Based on the dentition the age is estimated to be 25-35 according to the criteria of Brothwell (1981), and approximately 30 according to the criteria of Miles (1963). The cross-sectional area of the upper M^1 is large and that of the M^2 is medium to small.

The mandible

The right half of the dental arch was found, including the mentum and the right coronoid process. The dental arch reaches a little beyond M_2. The alveolar part containing M_3 is broken, leaving no information. The mentum and right mental protuberance are pronounced, suggesting this individual was male (table 93). The digastric fossae are marked. Teeth still present in the mandible are the right canine, premolars, and first molar. The most anterior part of the alveolar surface is damaged, making it impossible to safely determine if the incisors are broken or missing. The second molar is broken, leaving only pieces of its two roots. The mental foramen is not visible, as the bone is damaged at that point.

Postcranial

Apart from the arm bones, bones of the hand, innominate bone, leg bones, and bones of the foot described below, other material was found, but in a fragmentary condition. Four fragments of clavicula were found, including the right sternal extremity and the inferior part of the glenoid cavity of the left scapula. Fibula fragments (including the distal extremity of the left fibula), thoracic and lumbar vertebra fragments, and rib fragments were also identified.

The humerus (table 67)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Proximal epiphyseal breadth	47.1	-			
Horizontal diameter of caput	38	-			
Vertical diameter of caput	41.6	-	Caput index	91.3	-
Mid-shaft maximum diameter	22.2	-			
Mid-shaft minimum diameter	15.8	-	Diaphyseal index	71.2	-
Mid-shaft transverse diameter	19.1	-			
Mid-shaft sagittal diameter	18	-			
Distal epiphyseal breadth	55.8	55.9			
Trochlear breadth	42.3	40.9	Trochlea-epicondylar index	75.8	73.2
Trochlear depth	25.2	24			
Capitulum breadth	15.3	13.9			
Olecranon fossa breadth	24.3	24.5			

Table 67. Liang Panas humerus measurements.

The right humerus is almost complete, preserved in two pieces. It is missing a part of the diaphysis just below the deltoid tuberosity, which would link the two pieces together. The length would have been over 29 cm. Only the distal extremity is preserved of the left humerus. The diaphyseal parts are damaged, as is the posterior part of the left trochlea. The caput is ellipsoid. The cross-section of the diaphysis at mid-shaft is oval shaped. The diaphyseal index indicates platybrachy (< 76.5). The cross-section of the distal part of the diaphysis is triangular in shape. The intertubercular groove is narrow and deep. Unfortunately in both humeri the olecranon fossa is damaged, making it impossible to determine if there was a supratrochlear foramen to be found in it. The olecranon fossa is oval shaped and elongated in transverse direction. The coronoid fossa has steep walls. The radial fossa is pronounced.

The ulna (table 68)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Olecranon depth	-	23			
Olecranon breadth	22	22.3	Olecranon depth index	103.1	-
Olecranon-coronoid distance	-	24.3			
Upper transverse diameter	18	19.1			
Upper sagittal diameter	22	22.6	Platolenic index	81.8	84.5
Mid-shaft transverse diameter	15.3	-			
Mid-shaft sagittal diameter	12.3	-	Diaphyseal index	80.4	-
Minimum circumference	32.5	33			

Table 68. Liang Panas ulna measurements.

Three pieces of the right ulna are preserved, the proximal extremity with a broken tip of the olecranon, the distal extremity missing its styloid process, and a large part of the diaphysis, including mid-shaft. The left ulna also consists of three pieces, the proximal extremity, distal extremity without the styloid process, and a small part of the diaphysis from the proximal half with the crista interosseus. The shape of the mid-shaft is prismatic. The interosseus border is medium developed. Diaphyseal index is low, confirming the development of the interosseus border. The platolenic index shows the upper part of the diaphysis is flattened transversely (platoleny). The olecranon is deeper than it is broad. This is also seen in Liang Togé, and is a common feature in Negrito's.

The radius (table 69)

Description	Measurements (mm)		Index	
	Right	Left		Right
Minimum circumference	38.5	37.5		
Transverse diameter of capitulum	22	21.4		
Transverse diameter of collum	11	12.1		
Mid-shaft transverse diameter	13.7	-		
Mid-shaft sagittal diameter	11.6	-	Diaphyseal index	84.7

Table 69. Liang Panas radius measurements.

The right radius is in three pieces. The caput is intact, the radial tuberosity is present on the second piece, along with the superior part of the crista interosseus. The third piece consists of the distal part of the diaphysis. The distal extremity is missing. The left radius has left four pieces, the proximal extremity with caput and radial tuberosity, the distal extremity, and two pieces of diaphysis, one from below mid-shaft and one from above mid-shaft. The distal extremity is narrow anteroposteriorly. The ulnar notch is almost flat. The diaphyseal index is rather high, indicating a more rounded shape of the bone, instead of a prismatic shape with a strong crista interosseus.

The bones of the hand (table 70)

A number of wristbones were found; part of the left scaphoid, consisting of the tubercle and the radial side of the proximal articular surface, the right lunate, the right triquetrum, the left trapezoid, the right capitate, and the right hamate were all found whole. The metacarpals recovered include the first metacarpal of the right and left hand. The right metacarpal I is in two pieces; the caput and half the corpus and the base. Only the base remains of the left metacarpal I. The caput remains of the second metacarpal of the left hand. The third metacarpal is recovered of both hands. The right consists of one part including the caput and approximately half the body. The left leaves two parts; one consisting of the base and half the body, the other is the caput. The fourth metacarpal of both hands is preserved. Only the base and caput of the right and the base and half of the body of the left metacarpal are recovered. The fifth metacarpal of the right and left hand is preserved. The right fifth metacarpal consists of two parts; one includes the caput and half the corpus, the other the base. Only the base was recovered of the left fifth metacarpal.

Description		Carpus Measurements (mm) Right	Left	Index	Right	Left
Scaphoid	Maximum length	-	P			
Lunate	Length	11.5	-	Length-breadth index	131.3	-
	Maximum breadth	15.1	-	Length-height index	71.4	-
	Maximum height	16.1	-	Height-breadth index	93.8	-
Triquetrum	Maximum length	14.3	-	Length-breadth index	125.4	-
	Maximum breadth	11.4	-	Length-height index	130	-
	Maximum height	11	-	Height-breadth index	96.5	-
Trapezoid	Maximum length	-	17.4	Length-breadth index	-	159.6
	Maximum breadth	-	10.9	Length-height index	-	115.2
	Maximum height	-	15.1	Height-breadth index	-	72.2
Capitate	Maximum length	22	-	Length-breadth index	62.3	-
	Maximum breadth	13.7	-	Length-height index	79.1	-
	Maximum height	17.4	-	Height-breadth index	78.7	-
Hamate	Maximum length	21	-	Length-breadth index	73.3	-
	Maximum breadth	15.4	-	Length-height index	105	-
	Maximum height	20	-	Height-breadth index	77	-
		Metacarpal				
Metacarpal	D I	P	P			
	D II	-	P			
	D III	P	P			
	D IV	P	P			
	D V	P	P			
		Phalanx				
Phalanx i	D I	29.3	30			
	D II	-	42.8			
	D III	P	45.9			
	D IV	-	P			
	D V	33	P			
Phalanx ii	D II	23.8	P			
	D III	28.9	28.6			
	D IV	P	P			
	D V	19.5	P			
Phalanx iii	D V	17	-			

Table 70. Liang Panas handbone measurements. - = Absent. P = Present, but too damaged for measuring.

The phalanges include the first phalanges of the right and left DI, and of the left DII in their entirety. The first phalanx of the right DIII has the base and half the body on one piece and the caput on another. The first phalanx of the left DIII is complete, except for a cavity just below the caput. Of the first phalanges of the left DIV and DV only the bases remain. The first phalanx of the right DV is whole.

The second phalanges are found of the right and left DII, the right and left DIII, the right and left DIV, and the right and left DV. The second phalanx of the left DII has only the base present, both second phalanges of DIV comprise of only the caput and half the corpus. The second phalanx of the left DV leaves only the proximal half. Finally, the third phalanx of DV is found in one piece.

The innominate bone

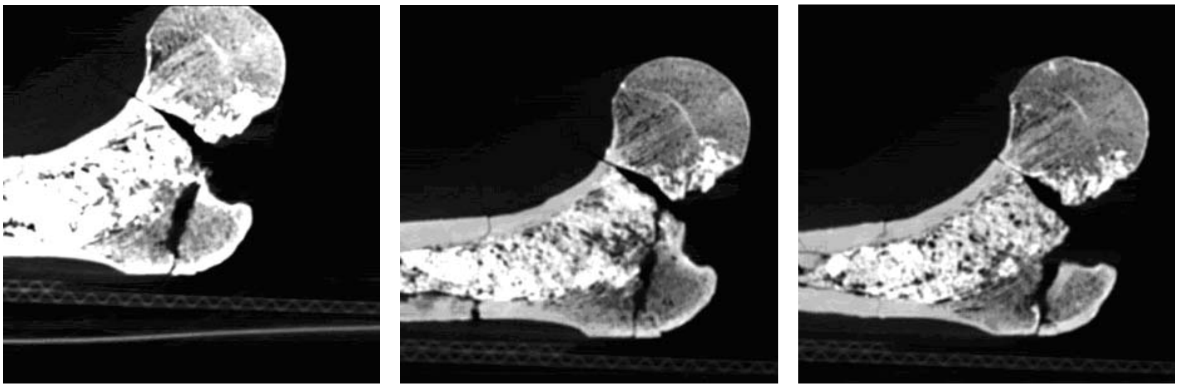
The right tuber ischiadicum, the posterior part of the acetabulum, and a small part of ilium are preserved, as is the caudal part of the right auricular surface, including the cranial part of the edge of the incisura ischiadica major. Besides this, many fragments are present.

The tuber ischiadica is strongly developed, which suggests that this individual was male (table 93). Although the body of the ischium is narrow, which would indicate it was a female. However, when combined with the information from the mandible, the majority of the characteristics suggest masculinity. The spina ischiadica is broken. Ischial height is 69.7 mm.

The femur (table 71)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Horizontal diameter of caput	42.4	-			
Vertical diameter of caput	41.5	-	Caput index	102.2	-
Caput circumference	136.2	-			
Sagittal diameter of collum	23.8	-			
Upper breadth	85.9	-			
Intertrochanteric distance	64	-			
Caput-trochanter distance	78	-			
Subtrochanteric transverse diameter	29.3	-			
Subtrochanteric sagittal diameter	24.1	-	Platymeric index	82.3	-
Epicondylar breadth	73	75.6			
Posterior breadth of medial condyle	23	24.1			
Thickness of medial condyle	57.3	59.2			
Posterior breadth of lateral condyle	29.9	29.6			
Thickness of lateral condyle	56.1	57.9	Condylar index	76.8	76.6
Breadth of intercondyloid fossa	20.4	20.3			

Table 71. Liang Panas femur measurements.



Scan 4. CT-scans of the Liang Panas right femur taken 2 mm apart at approximately the centre of the head (see text next page).

The right femur consists of two large pieces. The proximal epiphysis is in good condition with some damage on the cranial surface of the collum. The distal extremity was also recovered. The medial condyle has some damage on the anterior half of the medial surface. Both extremities also include a part of the diaphysis, although these two parts cannot be united. The length of the femur, therefore, was probably above 40 cm, bringing it in the same range as Liang Momer E (plate 15). The left femur consists of the distal extremity, including only a very small part of shaft on the medial side, and a part of the diaphysis containing a piece of the linea aspera. The lateral condyle is damaged on the anterior part of the lateral and on the medial part of the posterior surface. The lesser trochanter is marked. It is located on the medial half of the femur and points more in a medial than posterior direction. The intertrochanteric crest is marked. A reconstruction of the diaphysis has been attempted, but shows no more than a hint of the general shape. The linea aspera is not very pronounced (grade 2, Martin, 1914), but only the inferior part is visible, due to the fragmented form of the shaft. The shape of the proximal part of the shaft is oval, the distal part of the shaft has a triangular shape which has its base laterally and its apex medially (as with the Liang Momer E femur). There is only slight antero-posterior flattening as shown by the platymeric index.

The right femural head (scan 4, previous page) is damaged, but a CT-scan of the most proximal part reveals a dense structure of spongiosa. This indicates a phase I (Maat *et al.*, 2000). The age of this individual is estimated at 23-40 years.

The patella (table 72)

Description	Measurements (mm)		Index	
	Right	Left		Right
Height	39.3	38.9		
Breadth	39	-	Breadth index	53.4
Thickness	18.9	18.5	Height-breadth index	100.8
Height of articular surface	28.2	28.9		
Breadth of medial articular surface	19.3	18.3		
Breadth of lateral articular surface	20	-		

Table 72. Liang Panas patella measurements.

Both patellae were recovered. The left is missing a part of the lateral edge. The shape is triangular. The crest on the articular surface is evident. Both the lateral and medial facets are concave. A hollow lateral facet is associated with squatting. The breadth index shows the right patella is medium broad. The height is greater than the breadth.

The tibia (table 73)

Description	Measurements (mm)		Index	
	Right	Left		Left
Proximal epiphyseal length	68.9	67.5		
Breadth of upper medial articular surface	31.1	32.4		
Breadth of upper lateral articular surface	30	29.2		
Transverse diameter at tibial tuberosity	37.2	36.9		
Sagittal diameter at tibial tuberosity	41.3	43		
Mid-shaft transverse diameter	-	21.9		
Mid-shaft sagittal diameter	-	32.8	Platycnemic index	66.8
Mid-shaft circumference	-	86		

Table 73. Liang Panas tibia measurements.

Both tibiae consist of the proximal and distal extremities. The right tibia is in two pieces and lacks most of the upper half of its diaphysis. The lower part of the diaphysis is missing various pieces. The left tibia is in three pieces. The proximal piece consists of the proximal epiphysis and the upper third of the diaphysis. The second piece is diaphysis, which is very damaged. The third piece is the distal epiphysis and a small part of diaphysis, which was incorrectly glued together during the original preparation. As a result there is some overlap of bone on the anterior surface. The tibia would have been about the same length as that of Liang Momer E. The shape of the transverse section at mid-shaft is most like Hrdlička's type IV. This type is only rarely found in females, suggesting that this tibia belonged to a male individual. This is in accordance with the length of the bone, which comes close to the length of the tibia of Liang Momer E, a rather large male. The medial articular surface of the head is concave. The sagittal curvature of the lateral articular surface of the head conforms to Thomson's type 1 (see Liang Momer E). Squatting facets can be found on the anterior and medial borders of both distal extremities, but are most defined on the right tibia. The platycnemic index indicates the bone is mesocnemic, meaning that there is no transverse flattening of the mid-shaft.

The bones of the foot (table 74-77)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Length	-	51			
Height	29.9	30.1	Length-height index	-	59
Breadth	41.7	38.6	Length-breadth index	-	75.7
Length of trochlea	35.1	36.9	Trochlear length index	-	72.4
Breadth of trochlea	27.8	27.8	Trochlear index	79.2	75.3
Anterior trochlear breadth	20.7	22			
Posterior trochlear breadth	18	18.3	Trochlear breadth index	87	83.2
Length of caput	28.9	30.2	Caput length index	-	59.2
Length of posterior calcanear articular surface	30	31.3			
Breadth of posterior calcanear articular surface	21.9	21	Posterior calcanear articular surface breadth index	73	67.1

Table 74. Liang Panas Talus measurements.

The bones of the foot, which were recovered are the right and left talus, right and left calcaneus, right naviculare, right and left cuboid bone, right cuneiform I, II, and III, and several metatarsals and phalanges. Part of the right foot has been glued together. This block consists of the talus, calcaneus, naviculare, cuboid bone and all three cuneiforms (of which the third was put in incorrectly). The left foot was also partly reconstructed by glung together the calcaneus, cuboid bone and third to fifth metatarsus. This makes certain measurements difficult or impossible.

The right and left tali are both complete. As in Liang Momer E, the talus is high compared to its breadth. The trochlear index is low, indicating that the trochlea is narrow and long. This is confirmed by the trochlear length index, which is high. The trochlear breadth index is also high, demonstrating that there is no posterior narrowing of the trochlea. The posterior calcanear articular surface breadth index is high, which is most common in Europeans.

The right calcaneus is missing its anterior part, including the cuboid articular surface and the sustentaculum tali. The left calcaneus is missing the sustentaculum tali and has damage on the anterior part of the inferior surface. The calcaneus is of medium height. The tuber index is very low.

The right navicular bone is complete. The posterior articular surface is ovoid as indicated by the low posterior articular surface index.

Description	Measurements (mm)		Index	
	Right	Left		Left
Length	-	74.3		
Height	35.7	35.8	Length-height index	48.2
Length of corpus	-	53.6	Corpus length index	72.1
Height of tuber	39	39.9	Tuber index	53.7
Length of posterior calcanear articular surface	-	27.3		
Maximum breadth of cuboid articular surface	-	29		
Height of cuboid articular surface	-	24.3	Height-breadth index of cuboid articular surface	83.8

Table 75. Liang Panas calcaneus measurements.

Both cuboid bones are complete. The right cuneiform I is complete. The right cuneiform II is missing the plantar surface and the right cuneiform III is missin its anterioplantar corner.

The right metatarsal I is complete, but the left consists of only the base. The right metatarsal II has its caput and half of its corpus. The left metatarsal II has the base and half the corpus. Metatarsal III of the right foot has the caput and base. The left metatarsal III has its base and half of the body on one piece and the caput on another. The metatarsals IV of the right and left foot both consist of the base and half the body, with the caput on a separate piece. The right metatarsal V preserves only the base. The left has two parts including the base and half the body and a loose caput.

Description	Measurements (mm)	Index	
	Right		Right
Breadth	37.4		
Length of posterior articular surface	28		
Breadth of posterior articular surface	19.1	Posterior articular surface index	68.2

Table 76. Liang Panas naviculare measurements.

Only first phalanges are known. Phalanx i of the left first toe consists of the most distal part of the caput. Phalanx i of the right second toe is complete, while the left leaves only the distal half. Of the first phalanx of the left third toe only the distal half remains. The first phalanx of the right fifth toe is complete.

	Os cuboideum and ossa cuneiformia					
	Description	Measurements (mm)		Index		
		Right	Left		Right	Left
Cuboideum	Medial length	33.5	33.9			
	Lateral length	15.6	15.8	Length index	46.6	46.6
Cuneiform I	Inferior length	25.5	-			
	Middle length	19.5	-			
	Superior length	21.2	-			
	Proximal articular surface height	21.8	-			
	Distal articular surface height	24	-			
	Proximal height	25.4	-	Height index	114.2	-
	Distal height	29	-	Length-distal height index	136.8	-
Cuneiform II	Superior length	15.9	-			
	Middle superior breadth	15.5	-	Length-breadth index	97.5	-
Cuneiform III	Superior length	20.7	-			
	Distal breadth	11.3	-			
	Proximal breadth	11.8	-	Breadth index	104.4	-
	Metatarsal and phalanx					
Metatarsal D I	Length	59.3	-			
	Breadth of base	19	19.5			
	Height of base	27.2	28.3			
	Breadth of corpus	13.3	-			
	Height of corpus	12	-			
	Breadth of capitulum	20.9	-			
	Height of capitulum	18.7	-			
D II	Breadth of corpus	7.3	7.8			
	Height of corpus	9	9.1	Breadth-height index	123.3	116.7
D III	Breadth of corpus	P	6.2			
	Height of corpus	-	8.6	Breadth-height index	-	138.7
D IV	Breadth of corpus	6.3	6.4			
	Height of corpus	8.8	8.2	Breadth-height index	139.7	128.1
D V	Breadth of corpus	P	7.6			
	Height of corpus	-	8.6	Breadth-height index	-	113.2
Phalanx i D II	Length	29.8	-			
	Breadth of corpus	6.9	6.9	Length-breadth index	23.2	-
	Height of corpus	6.1	6.2	Breadth-height index	88.4	89.9
D III	Breadth of corpus	-	6	Length-breadth index		
	Height of corpus	-	5.2	Breadth-height index	-	86.7

D V	Length	23.6	-			
	Breadth of corpus	7.1	-	Length-breadth index	30.1	-
	Height of corpus	6.2	-	Breadth-height index	87.3	-

Table 77. Liang Panas cuboid, cuneiform, metatarsal and phalanx measurements. - = Absent. P = Present, but too damaged for measuring.

2.3.5. Conclusion

Gender: Male.
Age: 30-35 years (teeth: approximately 30; femur spongiosa: 23-40).
Stature: similar to Liang Momer, 168 cm.

Skull:

- The cross-sectional area of the upper M^1 is large, that of the M^2 is medium to small.

Postcranial:

- The humerus has a low diaphyseal index indicating platybrachy.
- The ulna reveals transverse flattening (low platolenic index: platoleny). The diaphyseal index is also low revealing a medium developed crista interosseus. The olecranon is deeper than broad.
- The radius has a high diaphyseal index (rounded shape of diaphysis).
- The platymeric index of the femur shows no antero-posterior flattening.
- The tibia has no transverse flattening (mesocnemic).

2.4. Aimere

2.4.1. Location

Aimere is an open site located at the south coast of West-Flores, southwest of Badjawa (figure 3). The material, discovered in 1955, was found on the surface associated with potsherds (Jacob, 1967).

2.4.2. Archaeological age

This site is thought to originate from the Mesolithic period at about 5,000-3,000 BP (Jacob, 1967).

2.4.3. Material

The material recovered consists of skull fragments, teeth, and the mandible. Fragments of scapula were also found.

2.4.4. Description

The skull

The skull is in a fragmentary condition. The only pieces that remain are the left part of the frontal bone, a part of the occipital bone (consisting of the external occipital protuberance), the left temporal bone (with the auditory porus, mastoid process, and onset of the zygomatic process), the right mastoid process, fragments of parietal bone, and the maxilla. Based on the marked nuchal lines, muscle relief, and the marked external occipital protuberance, the skull is sexed as male (table 93).

The frontal bone shows a strong temporal line. The coronal suture is not obliterated. The occipital bone has a pronounced occipital protuberance and strongly developed nuchal lines. The left mastoid process is voluminous, the supramastoid crest is medium developed. The auditory porus is oval. The right mastoid is decidedly smaller. The maxilla consists of the dental arch, missing all the incisors and canines, the alveolar border, and part of the palate.

The teeth (table 78)

Mandibular	Diameter (mm)	Right	Left	Maxillary	Diameter (mm)	Right	Left
P_1	MD	-	-	P^1	MD	8.1	8.1
	BL	-	-		BL	10.7	10.9
P_2	MD	7.8	7.8	P^2	MD	7.8	7.4
	BL	9.3	9.2		BL	10.6	10.2
M_1	MD	12.3	11.9	M^1	MD	11.3	10.9
	BL	12.6	12.2		BL	12.1	12.2
M_2	MD	11.4	11.6	M^2	MD	10.3	10.3
	BL	11.3	11.4		BL	12.4	12
M_3	MD	-	-	M^3	MD	11.1	11.2
	BL	-	-		BL	12.2	12
P_1-M_3 distance		-	-	P^1-M^3 distance		46.5	48.2
				Cross-sectional area upper M^1		136.7	133
				Cross-sectional area upper M^2		127.7	123.6
				Cross-sectional area upper M^3		135.4	134.4
				Total cross-sectional area upper molars		399.8	391

Table 78. Aimere teeth measurements.

The maxilla retains all the premolars and molars. The anterior alveolar border is broken, leaving no trace of the incisors or canines. Occlusal wear patterns of the molars are 4^- for the right M^1, 4 for the left, grade 3^- for the right M^2, 2^+ for the left, and grade 1 for the right and left M^3. Because of the wear not all cusp patterns can be discerned. Molar cusp patterns are 4 for both M^1, 4 for both M^2, and 3 for both M^3.

The mandible contains both second premolars and both first and second molars. The third molars are unerupted, although the left side shows that space was being made for the third molar. The incisors, canines and first premolars are all broken post-mortem. The roots are still visible in the bone. Molar wear stages are 4 for the right M_1, 4^+ for the left M_1, and grade 3 for both M_2. Molar cusp patterns are ?6 for the right M_1, ?5 for the left M_1, and +4 for both M_2.

Based on the dentition the age was estimated to be 26-32 according to the criteria of Miles (1963) and 25-35 according to the criteria of Brothwell (1981). The upper third molar was not consistent with this finding. It was unworn and therefore suggests an age of around 18, just after the eruption of the third molars. There are two possible explanations for this. Firstly, the eruption period of the third molars is highly variable, and so in this individual the eruption may have occured at a relative late age; Secondly, the diet of this population could have been very wearing on the other teeth, making this individual seem older than was the case.

The cross-sectional areas of the individual molars are all medium to large. The second molars are the smallest. The total cross-sectional area of the upper molars is large.

The mandible (table 79)

Description	Measurements (mm) Right	Left	Index	Right	Left
Intermental breadth	53				
Corpus height at mental foramen	27.2	26.2			
Corpus height at M_2	26.9	27			
Corpus thickness at mental foramen	12.3	13.2	Mandibular thickness index	45.2	50.4
Corpus thickness at M_2	18.1	17.8			
Height of mental foramen from mandibular base	14.7	15.2			
Inter-M_1 distance	37.4				
Symphysis thickness	14.6				

Table 79. Aimere mandible measurements.

The mandible (plate 18) is very wide. Both rami are broken, leaving no condyle or coronoid process. Only the section of the dental arch comprising the second premolars to the second molars is present on both sides.

Plate 18. Aimere mandible. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

Based on the prominent mentum and thick inferior margin, the mandible was sexed as male (table 93). The anterior part of the alveolar border shows post-mortem breakage of all incisors, canines and first premolars. The mentum is prominent. Both M_3 are unerupted, but the large area between the second molar and the precoronoid fossa suggests that the M_3 was present in the bone. The mental foramina are positioned at about halfway between the base and the alveolar border at the height of P_2. On the lingual surface of the symphysis menti two genial tubercles and a genioglossal crest are present. The digastric fossae are well developed. Two paraspinous fossae are present above them. The mylohyoid line is poorly developed in comparison to Liang Momer E. It has only a distinct ridge at the height of the M_2.

Postcranial

A fragment of the right scapula was found. It has part of the glenoid cavity and the inferior part of the acromion.

2.4.5. Conclusion

Gender: Male.
Age: 26-32 years.
Stature: unknown.

Skull:

- The total cross-sectional area of the upper molars is large.

2.5. Gua Alo

2.5.1. Location

This cave is located near Labuanbadjo, south of Liang Momer, in West-Flores (figure 4). The site was excavated in 1955, associated with flakes similar to those of Liang Momer. The skeletons were found extended above the Toalian (Archive Verhoeven, XXVIk). Gua Alo (together with Liang X) are supposed to be younger remains than that of the other caves.

2.5.2. Archaeological age

This site is thought to be younger than Aimere and is estimated at < 3,000 years (Jacob, 1967).

2.5.3. Material

Two individuals were found in this cave, which were named Gua Alo 1 and 2. A humerus of a third person, a female, is also found, refered to as Gua Alo 3. Gua Alo 1 consists of skull fragments, teeth, and mandible; Gua Alo 2 consists of skull fragments, mandible, and teeth. Postcranial finds include fragments of clavicula, scapula, humerus, ulna, radius, phalanges, costae, and femur. Of the Gua Alo 3 individual only a part of the right humerus is known.

2.5.4. Description

Gua Alo 1

The skull

The skull consists of several pieces, including part of the right and left temporal bone, the right parietal bone, and a part of the right side of the occipital bone, bordering the asterion. Also, a very small piece of maxilla is preserved holding the right M^1 and M^2, as well as the socket for the M^3.

The right temporal bone has the mastoid process and the posterior part of the zygomatic arch running anteriorly to the temporozygomatic suture. The mastoid process is damaged at the apex. It is of moderate size. The temporo-zygomatic process is thick and high. The part of the left temporal bone contains the oval auditory porus. The right parietal bone contains a parietal tuber, which is mildly developed. The occipital bone has a strong nuchal line and strong muscle markings on the nuchal plane. Based on the strong nuchal line, and the thick and high temporo-zygomatic process the skull was sexed as male (table 93).

The teeth (table 80)

Mandibular	Diameter	Right	Left	Maxillary	Diameter	Right	Left
I_1	MD	5	-	I^1	MD	9.5	9.4
	BL	6.1	-		BL	-	-
I_2	MD	5.8	5.8	I^2	MD	8.1	-
	BL	6.7	6.9		BL	-	-
C	MD	7	7	C	MD	-	8.7
	BL	8.9	8.6		BL	-	9.4
P_1	MD	6.9	6.8	P^1	MD	-	6.5
	BL	8.6	8.6		BL	-	10.6
P_2	MD	7	6.7	P^2	MD	-	6.8
	BL	8.8	8.9		BL	-	10.4
M_1	MD	11.2	11.5	M^1	MD	-	10.7
	BL	10.6	10.5		BL	-	12
M_2	MD	10.7	11.2	M^2	MD	-	9.3
	BL	10.2	9.9		BL	-	12
M_3	MD	11.2	11.4	M^3	MD	8.5	-
	BL	10.3	10.6		BL	11	-
P_1-M_3 distance		47.6	48.2	P^1-M^3 distance		-	-
				Cross-sectional area upper M^1		-	128.4
				Cross-sectional area upper M^2		-	111.6
				Cross-sectional area upper M^3		93.5	-
				Total cross-sectional area upper molars		333.5	

Table 80. Gua Alo 1 teeth measurements.

The maxilla still contains the left M^1 and M^2. The M^1 is missing its roots. The left M^3 was erupted, as its socket is present. The M^1 has 4 cusps, the M^2 has 3. The wear stage is 1^+ for M^1 and 1 for M^2.

The teeth present in the mandible are the right I_1, both I_2, both C, both P_2, both M_1, both M_2, and both M_3. All missing teeth were lost post mortem. The cusp and fissure patterns are: Y5 for both M_1, +4 for both M_2, and X6 for both M_3. The attrition grades are: 3^+ for the right M_1, 3 for the left M_1, grade 1^+ for both M_2, and grade 1 for both M_3. Apart from the teeth present in the jaw, some other teeth were found.

Both lower first premolars were found. The right P_1 has a broken lingual root tip, the left P_1 is missing both root tips. All four upper incisors were found with signs of labial filing (plate 19), in all cases down to the dentine. Both I^1 are shovel-shaped. The right I^2 is missing the mesial half of its crown tip and is semi shovel-shaped. The left I^2 is missing the top of its crown, and it is impossible to determine the presence of a shovel-shape. I have not measured the buccolingual diameter of these incisors, because the labial filing has reduced it, making the measurement unfit for comparison. The left upper canine was identified by distal skewing of the crown. The left P^1 and P^2 were both recovered. The P^2 is missing its roots. Finally, the right M^3 was recovered. The crown has 3 cusps, because of a reduced distolingual cusp. It has two roots, because the lingual and distobuccal roots are fused together. The occlusal wear is in stage 1. Based on the dentition the age is estimated at 17-25 years according to the criteria of Brothwell (1981) and 17 according to the criteria of Miles (1963).

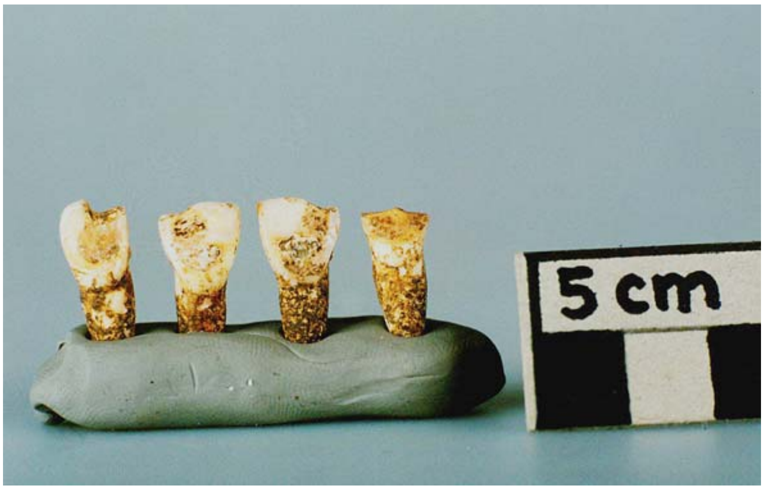


Plate 19. Labial filing of the Gua Alo 1 upper incisors. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The maxillary first molars show surprisingly little wear compared to the mandibular first molars. When used to estimate age on the bases of attrition, the result is around 12 years old. This is impossible however, since the third molars had erupted in both the mandible and the maxilla. The individual should therefore be around 18 at the least. For age estimation I have therefore only used the mandibular molars.

The total cross-sectional area of the molars is of medium size (Storm, 1995). The cross-sectional area of the individual molars range from small to medium-large (Storm, 1995). The M^1 is the largest and the M^3 is the smallest.

The mandible (table 81)

The mandible (plate 20) is missing the left ramus and right condyle. It is very robust with large mental protuberances and a thick corpus at the height of M_2. It retains almost all its teeth, except for the left first incisor and both first premolars.

The ramus is broad and higher than that of Liang Momer E and Gua Alo 2. Muscle markings are strong on the pterygoid and masseteric tuberosities. Both the lateral and vertical torus is well developed. The mylohyoid line of Gua Alo 1 is stronger than that of Gua Alo 2. The mandibular base is thick. The mental foramina are positioned at the posterior end of P_2. Lingually of the symphysis a distinct genioglossal crest is evident above which a supraspinous foramen is visible. The digastric fossae are strongly developed.

Based on the strong mental protuberances, strong muscle markings on the angle and thick inferior margin, the mandible is sexed as male (table 93).

Conclusion

Gender:	Male.
Age:	around 17 years.
Stature:	unknown.
Skull:	

- The total cross-sectional area of the molars is of medium size.
- Labial filing of upper incisors.

Description	Measurements (mm) Right	Measurements (mm) Left	Index	Right	Left
Minimum ramus breadth	35.2	-			
Coronoid height	66.5	-			
Intermental breadth	47.4				
Dental arch length	46.8				
Corpus height at mental foramen	31.8	31.4			
Corpus height at M_2	30.4	30.1			
Corpus thickness at mental foramen	14.2	13.7	Mandibular thickness index	44.7	43.6
Corpus thickness at M_2	17.9	17.2			
Height of mental foramen from mandibular base	16.4	15			
Inter-C distance	16.3				
Inter-M_1 distance	31.9				
Inter-M_3 distance	42.7				
Symphysis thickness	15.2				

Table 81. Gua Alo 1 mandible measurements.

Plate 20. Gua Alo 1 mandible. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

Gua Alo 2

The skull

The skull is fragmented. There are pieces of frontal bone, temporal bone, and parietal bone. The posterior half of the temporo-zygomatic process is present on the left side. It is rather thick and slightly rounded. This posterior part is more laterally extended in Liang Momer E than it is here. The supramastoid crest has two ridges. The maxilla is also preserved. It is in two parts, consisting of the premolars and first two molars on both sides. On the left part the canine was lost post mortem, and above the empty socket the nasal aperture starts. The lower border of the nasal aperture is not distinct. Based on the thick temporo-zygomatic process and the presence of a supramastoid crest, the skull is sexed as male (table 93).

The teeth (table 82)

The teeth still present in the maxilla are the P^1, both P^2, both M^1, and both M^2. Cusp pattern and attrition for the right M^1 is 4, stage 3, the left M^1 is 4, stage 3^-, the right M^2 is 4, stage 2, the left M^2 is 3, stage 1^+. The left M^2 has two roots, because the lingual root fused with the mesiobuccal root.

Mandibular	Diameter (mm)	Right	Left	Maxillary	Diameter (mm)	Right	Left
I_1	MD	6.4	6.2	I^1	MD	-	-
	BL	6.2	6.1		BL	-	-
I_2	MD	7	6.9	I^2	MD	7.9	7.6
	BL	6.6	6.9		BL	6.5	6.6
C	MD	7.5	7.7	C	MD	8	7.8
	BL	7.8	8.5		BL	8.9	8.7
P_1	MD	6.8	6.4	P^1	MD	6.9	7.2
	BL	8.2	8.4		BL	10.5	10
P_2	MD	7	6.7	P^2	MD	6.8	6.9
	BL	8.1	8.5		BL	10.2	9.6
M_1	MD	11.5	11.2	M^1	MD	10.7	10.7
	BL	10.8	10.4		BL	12.1	11.9
M_2	MD	10.8	10.2	M^2	MD	9.2	9
	BL	10.4	10.5		BL	11.8	11
M_3	MD	10.9	10.9	M^3	MD	-	8.1
	BL	10.4	11		BL	-	9.9
P_1-M_3 distance		-	46	P^1-M^3 distance		-	-
				Cross-sectional area upper M^1		129.5	127.3
				Cross-sectional area upper M^2		108.6	99
				Cross-sectional area upper M^3		-	80.2
				Total cross-sectional area upper molars		-	306.5

Table 82. Gua Alo 2 teeth measurements.

The teeth still present in the mandible are the left C, P_1, P_2, M_1, M_2, and M_3. The left M_3 has been exposed to carious. Cusp pattern and attrition stage for the M_1 is +5, wear 3, the M_2 is +4, wear 2, the M_3 is +6, wear 2.

There were also other teeth found at the site. Among these six incisors were found. Four of these were identified as lower incisors by their small size, their broader-than-long crowns, and their mesiodistally compressed roots. The other two were both identified as upper second incisors by their larger size, their longer-than-broad crowns, and their rounded triangular roots. The upper incisors are shovel-shaped and show labial filing. The left I_2 is shovel-shaped. A lower right canine, which lacks its root tip, was recovered. A right lower first premolar is missing its root tip. A right lower second premolar has a broken root. Furthermore, both upper canines were recovered. The left canine is missing its root tip. Four isolated molars were found. Three of these molars were from the mandible. The right M_1 has two approximal wear facets, ?5 cusp pattern and stage 3 occlusal wear. The roots are broken. The right M_2 has two wear facets, a +4 cusp pattern, and wear stage 2^-. The right M_3 has one approximal wear facet, +5 cusp pattern, and occlusal wear stage 1^+. The distal root tip is broken. The last molar was from the maxilla. It has three cusps with occlusal wear stage 1. It has one wear facet, and a triangular crown shape. This molar has only one root, but it contains two grooves; it is apparently formed from three roots, which are fused together. This molar is most likely a reduced left upper third molar. The M^3 from the right side is not present, but the socket is preserved. The shape of the socket suggests that the right M^3 also had only one root with two grooves.

Based on the dentition the age is estimated at 17-25 according to the criteria of Brothwell (1981) and 19-21 according to the criteria of Miles (1963). The total cross-sectional area of the molars is of medium size. The cross-sectional area of the individual molars range from small (M^3) to medium-large (M^1).

Three other teeth were found. One is a molar with two wear facets, 4 cusps, and wear stage 3. The mesiodistal diameter is 10.4 mm and the buccolingual diameter is 12.0 mm. This is probably a right M^1, but Gua Alo 2 already has one. The material must therefore be mixed. Since Gua Alo 1 misses its right upper first molar, this one could belong to that individual. The overall shape is comparable. However, the wear is more extensive on this loose crown, than it is on the left M^1 of Gua Alo 1. Since I have only the third molar from the right side (which is more worn than the left M^3) of Gua Alo 1, it is hard to determine whether this could be explained by unequal wear between both sides. Two further teeth were recovered, but their identification presents a problem. The crowns look like those of upper premolars, but the roots are very small. The measurements of these teeth are MD 6.8 mm, BL 9.7 mm, and MD 7.0 mm, BL 9.8 mm. Also, all premolars are accounted for in Gua Alo 2. However, the socket to the right of the left P^1 is small. The upper canines do not fit very well in their sockets, since their roots are too long. The canines stick out so far that the inferior border of the crown is at the height of the superior border of the P^1 crown. One of the premolars did fit into this socket. Perhaps this individual had an extra pair of premolars, but there does not seem to be enough room in the jaw for this to be the case. Since these premolars are not the only teeth that seem out of place, for I also have an extra molar, it seems likely that these teeth all belonged to another individual. As discussed below, there was also a humerus found, that does not belong to either Gua Alo 1 or 2. Perhaps these teeth are from that third individual.

The mandible (table 83)

Absolute measurements (mm)	Left	Index	Left
Minimum ramus breadth	37.2		
Condyloid height	59	Ramus index	63.1
Corpus height at mental foramen	26.7		
Corpus height at M_2	25.7		
Corpus thickness at mental foramen	12.5	Mandibular thickness index	46.8
Corpus thickness at M_2	17.1		
Height of mental foramen from mandibular base	14.4		
Depth of incisura mandibulae	12.1		

Table 83. Gua Alo 2 mandible measurements.

The left part of the mandible is present from the ramus anteriorly to the level of the canine. Of the other side the coronoid process and lateral part of the mandible body is present up to the level of M_1. Based on the broad ramus, thick inferior margin, and strong muscle relief on the angle, the mandible is sexed as male (table 93).

The ramus is broad. Muscle markings on the angle of the mandible are strong, and the vertical torus as well as the lateral torus is well developed. The head of the condyloid process is present on both sides. They are both missing the medial half, however. On both sides the apex of the coronoid process is damaged. The mandibular notch is deep. The mental foramen is positioned below P_2 at approximately halfway up the corpus. A fistula is present in the buccal alveolar border at the distal root of the left M_1.

Postcranial

Fragments of clavicula, scapula (right glenoid cavity, acromion), humerus, ulna, radius, phalanges, costae, and femur were found.

The humerus (table 84)

Description	Measurements (mm)	Index	
	H1		H1
Subdeltoid circumference	62.5		
Mid-shaft maximum diameter	22.5		
Mid-shaft minimum diameter	16.7	Diaphyseal index	74.2
Mid-shaft transverse diameter	21.4		
Mid-shaft sagittal diameter	21.2		
Distal epiphyseal breadth	57.9		
Capitulum breadth	14.4		
Olecranon fossa breadth	26.5		

Table 84. Gua Alo 2 humerus 1 measurements.

Two pieces of humerus were found. One is a right humerus and one is a left humerus. Since these bones are not alike in structure (plate 21), I have named them humerus 1 and humerus 2 for this description. Humerus 1 will be discussed here. Humerus 2 will be discussed under Gua Alo 3, since it definitely does not belong to either Gua Alo 1 or 2.

The diaphysis and distal extremity of the left humerus (H1) are preserved. The trochlea is missing. The coronoid fossa is shallow. The deltoid tuberosity is well developed. The olecranon fossa is more ovoid than triangular. It has no supratrochlear foramen. The diaphyseal index is low, revealing flattening of the bone (platybrachy). Humerus 1 does not have a supratrochlear foramen.

Plate 21. From left to right: Gua Alo 2 humerus 1, Gua Alo 3 humerus 2, Liang Togé left and right humerus, and Liang Momer E right humerus. Notice the difference in size between the Gua Alo 2 and Gua Alo 3 humerus. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The ulna

Only the proximal part of the right diaphysis remains of the ulna. It has a strong crista interosseus. The mid-shaft transverse diameter is 14.0 mm, the mid-shaft sagittal diameter is 10.0 mm. This makes the diaphyseal index 71.4, confirming the strong development of the crista interosseus.

The radius (table 85)

The proximal part (including the head, radial tuberosity, and crista interosseus) is preserved of the right radius. The radial tuberosity is strongly developed. The diaphyseal index is high, revealing a more rounded shape of the diaphysis.

Description	Measurements (mm)	Index	
	Right		Right
Transverse diameter of capitulum	21.3		
Transverse diameter of collum	15.4		
Mid-shaft transverse diameter	16.5	Diaphyseal index	77.6
Mid-shaft sagittal diameter	12.8		

Table 85. Gua Alo 2 radius measurements.

The femur (table 86)

Description	Measurements (mm)		Index		
	Right	Left		Right	Left
Mid-shaft transverse diameter	21.5	22.1	Pilastric index	124.2	119
Mid-shaft sagittal diameter	26.7	26.3	Robusticity index		
Mid-shaft circumference	77	74	Circumference-length index		

Table 86. Gua Alo 2 femur measurements.

Two pieces of femur were discovered. The pieces are very much alike and they probably belong to one individual.

Only the distal diaphyseal part of the right and left femur is preserved. Both diaphyses reveal a strong linea aspera with the high pilastric index, suggesting male gender.

Stature estimation

Estimation of body length for Javanese adult males using the circumference of the humerus and femur according to the criteria of Bergman & The (1955):

Humerus 1: Subdeltoid circumference: 62.5 mm
151.7 + 1.73 subdeltoid circumference = 162.51 cm
Humerus maximum length = 213.3 + 1.45 subdeltoid circumference of humerus = 303.9 mm
→ 805 + 2.74 hum(l) = 1637.7 mm = 163.77 cm
Right femur: mid-shaft circumference: 77.0 mm.
106.9 + 7.0 mid-shaft circumference = 160.80 cm
Femur direct length = 223.5 + 2.46 mid-shaft circumference of femur = 412.9 mm
→ 897 + 1.74 fem(r) = 1615.4 mm = 161.54 cm
Left femur: mid-shaft circumference: 74.0 mm
106.9 + 7.0 mid-shaft circumference = 158.70 cm
Femur direct length = 223.5 + 2.46 mid-shaft circumference of femur = 405.5 mm
→ 822 + 1.90 fem(l) = 1592.5 mm = 159.25 cm

Average male stature:

160.67 cm using circumference to calculate stature directly.
161.52 cm using circumference to calculate long bone length to calculate stature.

For an overview of stature estimations of the Flores material see table 92.

Conclusion

Gender: Male.
Age: 19-21 years.
Stature: 160.67 cm (using the criteria of Bergman & The, 1955).
Skull:

- The total cross-sectional area of the molars is of medium size.
- Labial filing of upper incisors.

Postcranial:

- The diaphyseal index of the humeri is low, showing platybrachy. The diaphyseal index of the ulna is low: strong development of crista interosseus.
- The radius has a high diaphyseal index: more rounded diaphyseal shape.
- The femora have a strong developed linea aspera (high pilastric index).

Gua Alo 3

The humerus (table 87)

Description	Measurements (mm) H2	Index	H2
Subdeltoid circumference	47		
Mid-shaft maximum diameter	17.4		
Mid-shaft minimum diameter	12.8	Diaphyseal index	73.6
Mid-shaft transverse diameter	16.9		
Mid-shaft sagittal diameter	14.9		

Table 87. Gua Alo 3 humerus 2 measurements.

The diaphysis of this right humerus is present from above the deltoid tuberosity to the beginning of the distal epiphysis. The bone is very thin compared to the Gua Alo 2 humerus found (plate 21). The deltoid tuberosity is poorly developed. The bone is flattened, as with the humerus of Gua Alo 2. From the overall gracile appearance of this humerus, it seems to have belonged to a female. Since neither Gua Alo 1 nor 2 is female, this would have to have belonged to a third burial. The supernumerary teeth described above could have belonged to this individual.

Stature estimation

Estimation of body length for Javanese adult males using the circumference of the humerus and femur according to the criteria of Bergman & The (1955):

Humerus 2: Subdeltoid circumference: 47.0 mm
101.5 + 0.98 subdeltoid circumference humerus(r) = 147.56 cm
Humerus maximum length = 161.9 + 2.22 subdeltoid circumference of humerus = 266.2 mm (= too small)
→ 612 + 3.30 hum(r) = 1490.5 mm = 149.05 cm

Average female stature:

147.56 cm using circumference to calculate stature directly.
149.05 cm using circumference to calculate long bone length to calculate stature.

For an overview of stature estimations of the Flores material see table 92.

Conclusion

Gender: Probably female.
Age: unknown
Stature: 147.56 cm (according to the criteria of Bergman & The, 1955).

Postcranial:

- This female has a slender humerus, which shows platybrachy.

2.5.5. Conclusion

The male stature is about 160 cm and the female stature is about 148 cm.

Skull:

- The total cross-sectional area of the molars is of medium size.
- There is labial filing of upper incisors.

Postcranial:

- The diaphyseal index of the humeri is low, revealing platybrachy.
- The diaphyseal index of the ulna is low: strong development of crista interosseus.
- The radius has a high diaphyseal index: more rounded diaphyseal shape.
- The femora have a strong developed linea aspera (high pilastric index).

2.6. Liang X

2.6.1. Location

Liang X is located south of Reo in Manggarai (figure 5). Excavations took place in 1955 and 1956. The remains were found above the Toalian, in stretched burial (Archive Verhoeven, XXVIk). Flakes and beads were discovered beside the human remains (Jacob, 1967). Liang X (together with Gua Alo) is thought to be a younger burial than that of the other caves.

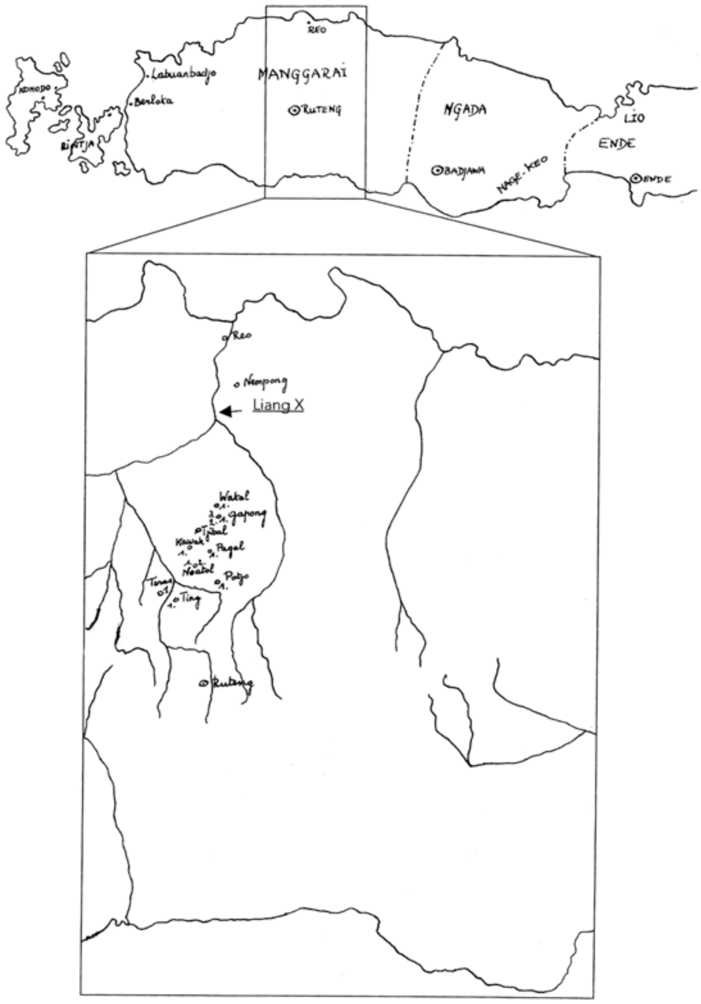


Figure 5. Map of West Flores showing the location of Liang X. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands; after original by Verhoeven.

2.6.2. Archaeological age

This site is thought to be contemporary with Gua Alo and is estimated at <3,000BP (Jacob, 1967).

2.6.3. Material

Skull fragments, teeth, mandible fragments, ulna, radius, vertebrae, and femur fragments were found, along with clavicula, scapula, and costa fragments.

2.6.4. Description

The skull

Two fragments of skull remain. The first consists of the right part of the frontal bone, bregma and part of both parietal bones. The second piece is made up of the left temporal bone, asterion, part of the left parietal, and part of the occipital bone. The left mastoid process is small. The supramastoid crest is slightly developed. The auditory porus is damaged. The frontal and right parietal bone bear the frontal and parietal tubera. The skull is mostly broken along the sutures, showing little suture obliteration. The age estimated from the degree of suture obliteration is 23-40 years. The endocranial suture obliteration could only be scored in six places and the skull was partly reconstructed by gluing the fragments together. Since the vault was mostly broken along the sutures, fusing was not far advanced, but the actual stage of fusion was difficult to determine.

Because of the small mastoid process, the only slight presence of a supramastoid crest, and the size of the frontal and parietal tubera, the skull was sexed as female (table 93).

The teeth (table 88)

Mandibular	Diameter (mm)	Right	Left	Maxillary	Diameter (mm)	Right	Left
I_1	MD	5.3	5.2	I^1	MD	8.3	7.9
	BL	6.1	6		BL	-	-
I_2	MD	6	6.2	I^2	MD	-	4.7
	BL	6.9	6.7		BL	5.5	-
C	MD	6.7	6.7	C	MD	7.9	8
	BL	7.5	7.7		BL	-	-
P_1	MD	7.4	7.3	P^1	MD	7.1	7.1
	BL	8.5	8.5		BL	9.7	9.6
P_2	MD	7.6	7.6	P^2	MD	7	7
	BL	8.9	8.8		BL	9.6	9.7
M_1	MD	11.7	-	M^1	MD	10.3	10.6
	BL	11	-		BL	11.2	11.6
M_2	MD	11.4	11.5	M^2	MD	9.6	9.6
	BL	10.5	10.4		BL	10.9	11.1
M_3	MD	11.3	11.4	M^3	MD	9.4	9.9
	BL	10.2	10.2		BL	11	10.8
					Cross-sectional area upper M^1	115.4	123
					Cross-sectional area upper M^2	104.6	106.6
					Cross-sectional area upper M^3	103.4	106.9
					Total cross-sectional area upper molars	323.4	336.5

Table 88. Liang X teeth measurements.

Only four teeth were still imbedded in the mandible. These were the right P_1, P_2, M_1, and M_2. Both the molars are affected by carious. The occlusal wear is grade 3^+ for the right M_1, and 1^+ for the right M_2. Cusp patterns are ?5 for the right M_1, +4 for the right M_2. In addition, a number of isolated teeth were found at the site, in fact, all the teeth of this individual were recovered.

Distal skewing of the crown, the broader-than-long crown, and the size difference between the first and second incisors, identified all four mandibular incisors. All incisors are intact. Both lower canines were found and the orientation was determined through the more prominent mesial margin.

The number of cusps and the contrast in size between the buccal and lingual cusps in the first premolar identified both left lower premolars. Furthermore, the size and shape of these premolars are comparable to the right lower premolars still in the mandible. Four mandibular molars were found, which were all identified based on the number of approximal wear facets, the presence of two roots, the crown shape, and the crown size. The left M_1 is so much worn, that there is hardly any crown left. The exposed dentine in the occlusal surface is hollowed. Measurements of diameters are not possible. The other molars were the left M_2, and both M_3's. The right third molar is missing the tip of its distal root. Occlusal wear stages are grade 6 for left M_1, $1^+$for left M_2, and 1 for both M_3. Cusp patterns are +4 for the right M_2, X4 for the left M_2, X5 for both M_3.

The maxillary incisors show labial filing (plate 22). The right I^2 has been filed on the distal surface. Perhaps during life this incisor was turned in its socket. On all incisors the labial filing has exposed the dentine. Filing of the first incisors has even exposed the root canal. Measurements of the buccolingual diameter were not made, since the labial filing has reduced this measurement, which makes the diameter useless for comparison. The exception is the right I^2, which was filed on the distal instead of the labial surface. Of this incisor I have not measured the mesiodistal diameter for the same reason as stated above.

The upper canines also show signs of labial filing, again preventing the measurement of the buccolingual diameter. The mesial skewing of the lingual cusp and the presence of one or two roots identify all four upper premolars.

The flattened mesiobuccal root, the size of crown, and the divergence of the roots identified all upper molars. All molars are intact, but both M^1 have traces of carious. All molars have three roots. Occlusal wear stages are grade 1 for right M^1, 3 for left M^1, grade 1 for right M^2, 2^- for left M^2, and grade 1 for both M^3. Cusp number is 4 for right M^1, 4 for left M^1, 4 for right M^2, 5 for left M^2, and 4 for both M^3.

The age estimated from the dentition is 17-25 years according to the criteria of Brothwell (1981) and 18-21 years according to the criteria of Miles (1963). In both the mandible and the maxilla, attrition is most severe on the left side. This could be due to preferential left sided chewing.

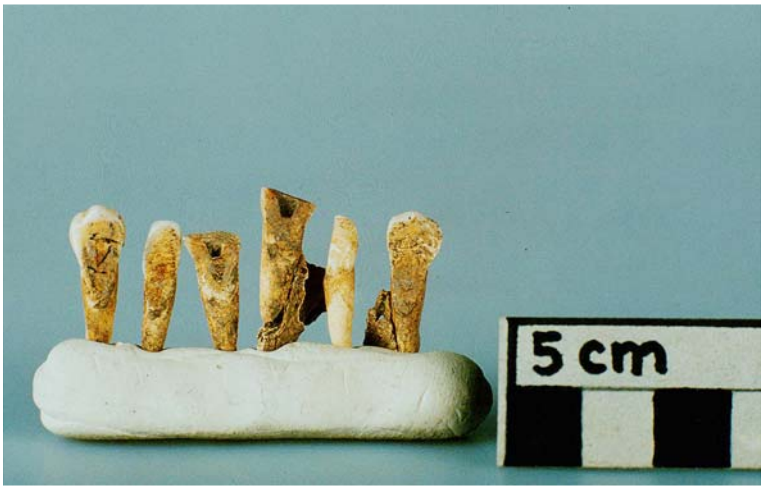


Plate 22. Labial filing of the Liang X upper incisors and canines. The right I^2 (second from the right) has been filed sideways. Courtesy of the National Museum of Natural History (Naturalis), Leiden, The Netherlands.

The cross-sectional area of the individual molars is medium to small. The M^1 is the largest, but the other are of comparable size. The total cross-sectional area of the upper molars is medium.

The mandible

Only two small fragments of the mandible are preserved. The first bears both the right premolars, the second holds the right first and second molars. The mental foramen is located beneath P_2. The base is missing and so is most of the lingual surface.

Postcranial

Fragments of clavicula, scapula, costae, vertebrae, ulna, radius and femur are known.

The ulna (table 89)

The proximal extremity of the left ulna was found. It has some damage to the surface of the olecranon. The platolenic index is low, showing transversal flattening (platoleny) of the upper section of the shaft.

Description	Measurements (mm) Left	Index	Left
Olecranon depth	18		
Olecranon breadth	18.4	Olecranon depth index	97.8
Olecranon-coronoid distance	18.6		
Upper transverse diameter	14.4		
Upper sagittal diameter	19.7	Platolenic index	73.1

Table 89. Liang X ulna measurements.

The radius

The proximal extremity of the left radius, containing the head and radial tuberosity, was recovered. The edge of the head is damaged. The transverse diameter of the collum is 10.4 mm.

The vertebrae (table 90)

Two cervical vertebrae were discovered in a relatively good condition. They both have intact vertebral arches. Their vertebral bodies are in both cases damaged anteriorly, but in the case of the largest, this damage extends along the caudal surface. The smallest vertebra has a bifurcated spinous process. Since the last cervical vertebra with a bifid spinous process is C5, the smallest is probably C5 and the largest C6.

Description	Measurements (mm) C6	C7	Index	C6	C7
Middle vertical diameter	7.8	-	Vertebral foramen index	59.9	56.8
Posterior height	10.4	10.9			
Superior breadth	-	23.6			
Middle transverse diameter	18.6	25.6			
Inferior breadth	19.4	-			
Vertebral foramen transverse diameter	22.2	22.2			
Vertebral foramen sagittal diameter	13.3	12.6			

Table 90. Liang X vertebrae measurements.

The femur (table 91)

Description	Measurements (mm) Right	Index	Right
Horizontal diameter of caput	38	Caput index	103
Vertical diameter of caput	36.9		
Caput circumference	12.4		
Vertical diameter of collum	24.7		

Table 91. Liang X femur measurements.

The head of the right femur was found. It has damage to its upper surface.

2.6.5. Conclusion

Gender: Female.
Age: 18-21 years.
Stature: unknown.

Skull:

- The total cross-sectional area of the upper molars is medium.
- Labial filing of upper incisors.

Postcranial:

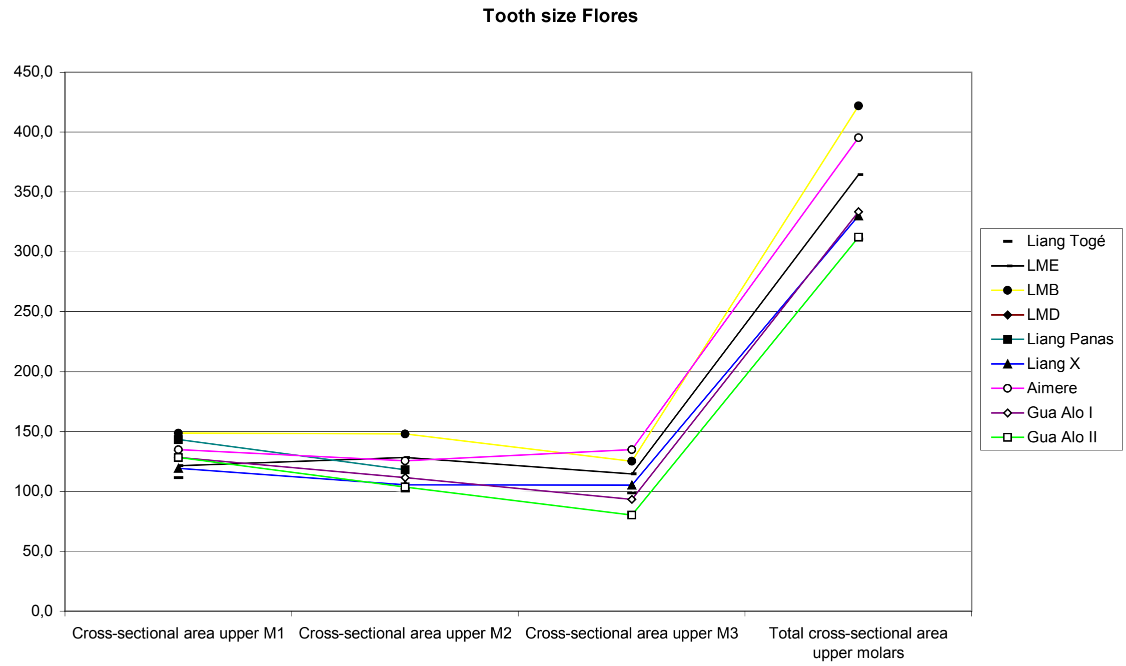
- The ulna has a low platolenic index showing transverse flattening (platoleny).

3. General conclusion of Flores material

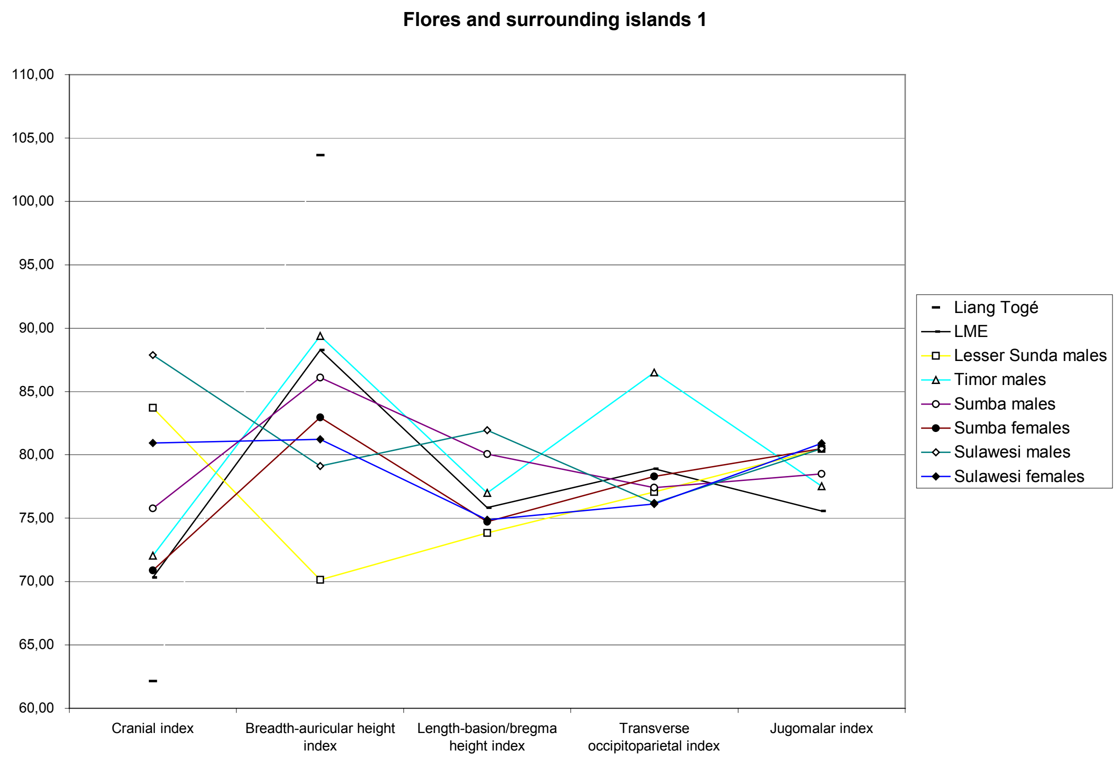
Differences between Liang Togé and other prehistoric material from Flores:

1. The cranial shape is different. Liang Togé does not have a gable shaped skull. The lateral sides are almost vertical. The cranial breadth therefore is rather small, causing three cranial indices to be different from Liang Momer E (cranial index, breadth-auricular height index, and transverse frontoparietal index; graph 2 and 3, next page).
2. Upper facial index and nasal index of Liang Togé are different from Liang Momer E in that Liang Togé tends to have a narrower face and nose.
3. The alveolar prognathism of Liang Togé is not seen in Liang Momer E. This is a Negrito character, according to Jacob (1967). It is however also seen in Australia, and in a lesser degree in New Guinea and Java (Martin, 1928). It is also seen in one of the Sulawesi (Celebes) skulls.
4. There is a difference in teeth size between Liang Momer E and Liang Togé. Liang Togé is rather small in comparison to the teeth from the other sites with the exception of Gua Alo (graph 1). On the whole, a trend can be seen in tooth size between the older and younger caves. The Mesolithic Liang Momer, Liang Panas,

and Aimere have the largest molars, while the Neolithic Liang X and Gua Alo have the smallest molars. Liang Togé is Mesolithic, but also has small molars. This could be due to sexual dimorphism. The only other female represented is the Neolithic Liang X.



Graph 1. Tooth sizes of the Flores material.

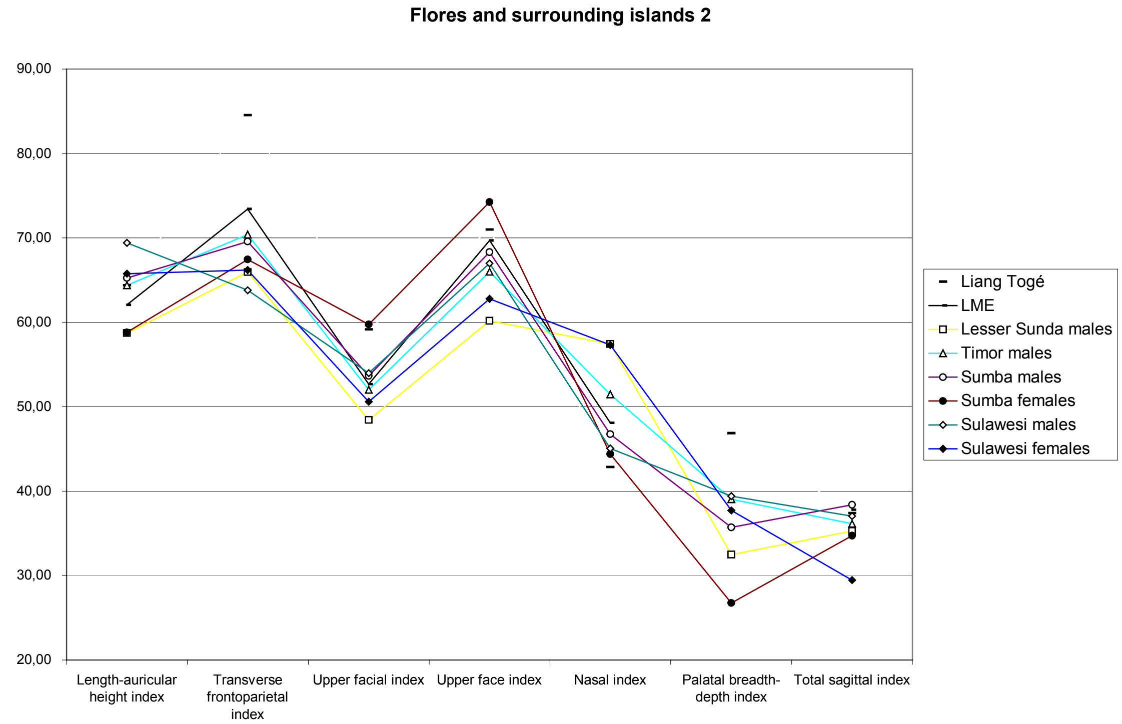


Graph 2. Comparison Liang Togé and Liang Momer E to surrounding islands in Wallacea.

5. Liang Togé shows flattening of all the long bones except for the tibia, while the tibia and fibula are the only long bones flattened in Liang Momer E. Liang X has ulnar flattening, but in a different direction than Liang

Togé. Humeral flattening is seen in Gua Alo. Humeral and ulnar flattening (again in a different direction from Liang Togé) is found in Liang Panas. All in all flattening of the long bones to some degree seems to be common. Ulnar flattening however occurred in transverse direction in Liang Panas and Liang X, while the flattening was dorso-ventral in Liang Togé. Jacob (1967) ascribed this dorso-ventral flattening to the weak development of the crista interosseus. Jacob (1967) denies the absence of platycnemia in the tibia of Liang Togé by stating that his measurements above mid-shaft showed distinct platycnemia. I cannot see this in his measurements and have no knowledge of his method. I will however allow some uncertainty about the absence or presence of platycnemia in the Liang Togé tibiae.

6. Stature length of Liang Togé is small compared to Liang Momer E (table 92). It is unfortunate that stature length could not be calculated for most of the other caves, although the bones from Liang Panas most likely have a similar size to Liang Momer E, and therefore also a similar stature. The Gua Alo material showed a stature length of around 160 cm if the circumference of the humerus and femora were used for stature estimation. This comes close to the male size of Liang Togé. However, the general appearance of the humerus of Gua Alo 2 does suggest that this estimation is too low. The humerus of Gua Alo 3 is probably female. The circumference is similar to Liang Togé. When using a set of female equations, the stature is a little smaller than Liang Togé. There is an 8% difference in height between the males and females in the Gua Alo population. This is close to the 6% hypothesis. Liang Togé is 6% shorter than the Gua Alo male.
7. Liang Togé has short tibiae, which is not seen in Liang Momer E or Javanese women (table 94). The corpus of the calcaneus is also short, meaning the heel is short.



Graph 3. Comparison Liang Togé and Liang Momer E to surrounding islands in Wallacea.

Similarities:

1. The slenderness of the long bones was present even in the male bones of Liang Momer E. It is unfortunate that the robusticity index could not be calculated in any other material. It is true that Liang Togé showed the largest amount of slender long bones.
2. Both Liang Togé and Liang Momer E show a supratrochlear foramen in their humeri. This is not present in the material from Gua Alo however. It could not be determined in the rest of the material.
3. Liang Togé has a deep olecranon, which is also seen in Liang Panas (although in a slighter degree), but not in Liang X. This is a rare individual variation reported to be quite common in the Negrito. Liang Panas and Liang X are not far apart in value, however. The Liang Panas olecranon is a little deeper than broad and the Liang X olecranon is just a little broader than deep.

4. General discussion

4.1. Flores material

4.1.1. Stature

Liang Momer E and Liang Panas are of much greater stature than Liang Togé and almost 10 cm taller than the current average male height on Flores (Keers, 1948). The younger Gua Alo material however is rather close to Liang Togé in stature. If Liang Momer E and Liang Panas are older and if they are the ancestors of Liang Togé, they must have shrunk over the generations. If Liang Momer E and Liang Panas are part of a different immigration, they represent another population. The Gua Alo population lived in approximately the same area as the Liang Momer population; the only difference is in time. It is possible that stature reduced in the period between Liang Momer and Gua Alo. It is also possible that stature had already reduced before Liang Togé's time.

Stature reduction has been linked to tropical rainforest habitats (Bulbeck, 1996). Another possibility is that the stature difference reflects a regional difference. It has been shown that pygmy populations are locally adapted to life in mountainous tropical forest with limited nutritional resources (Gajdusek, 1970; Howells 1973). A decreased stature is advantageous in that environment, because of the high ratio of strength to body weight. Their neighbouring populations, living at lower altitudes by the sea, are usually of normal stature. If this is the case with Liang Momer E and Liang Togé, it does not explain why the entire population on Flores today is as short as the male Liang Togé or Gua Alo populations.

Many islands in the area have populations as short as Liang Togé and the recent Flores inhabitants. Furthermore, the oldest prehistoric material of modern man tends to be larger than the younger prehistoric material. It is most likely that this stature reduction is the result of adaptation to the environment. And, since the environment is comparable in the entire region (tropical), the stature reduction is seen in many places.

Bulbeck (1996) shows approximately the same pattern for the Malay Peninsula. The Hoabinhian material (*e.g.* Gua Cha 10-4,000 years, Guar Kepah approximately 4,000 years) has a relatively tall stature (male range 162-175 cm), while the Neolithic material (Gua Baik, Gua Cha 3-2,000 years) shows a reduced stature (male range 150-163 cm) comparable to recent Senoi and Semang. The time period for this Malayan stature reduction is comparable to the time period between Liang Momer E and Liang Togé.

4.1.2. Teeth

In the past, tooth size reduction was seen as a result of invasions of smaller toothed populations. Hooijer (1950a, 1952) disputed this by observing that tooth size reduction, as well as stature reduction, is also seen in other mammalian island dwellers, such as deer and tigers. In his opinion, in both animals and humans, this was not the result of migration, but an evolutionary adaptation to island life. Brown (1992b) mentioned the possibility of tooth size reduction as a secondary result of stature reduction; *i.e.* a smaller face and jaw reduces the space available for tooth development. This would explain the smaller molars in Liang Togé and Gua Alo, as they both have undergone stature reduction. Furthermore, considering the similarity in culture between Liang X and Gua Alo, it is likely that Liang X was also small in stature. The stature reduction and the tooth reduction both fall within the same time period in Flores prehistory.

4.1.3. Limb bones

Liang Togé has rather short tibiae compared to the femur and even more so compared to the upper limb bones (as seen in the stature estimation). This is demonstrated by the rather low tibia/femur index (table 94). There are two possible causes for this rather unusual phenomenon:

1. Cold adaptation. Allen's rule states that organisms in cold climates will tend to have shorter extremities than their warm climate conspecifics in order to minimise heat loss through the limbs. Modern humans in cold climates tend to have shorter limbs (Trinkaus, 1981). Usually the distal limb bones are shortened in relation to the proximal limb bones. But Flores has a tropical environment, where cold is highly unusual. Furthermore, this rule does not only apply to the legs, but also to the arm bones. Shortening of the distal arm bones in Liang Togé is not seen. Indeed, the humeroradial index is rather high conforming to the index in tropical populations. Therefore, cold adaptation is not a reasonable option in this case. In addition, Holliday (1999) states that humeroradial and tibiafemoral indices are not correlated with shortening of the limb, meaning that although it is expected that the index decreases as a consequence of distal limb bone shortening in cold adaptation, this is not the case (since they loose the most heat).

2. Adaptation to low-gear locomotion. Hildebrand (1974) described a pattern seen in large-bodied mammals such as deer and pigs in island environments. Alongside a reduction in stature, these animals become adapted to low-gear locomotion (such as jumping and short-distance dashing in narrow and rugged areas) by shortening of the limbs. Baba (2000) described a similar pattern in the Minatogawa Man. He argued that the Late Pleistocene Minatogawa Man had different postcranial characteristics from the younger Jomon and recent Japanese populations, because they were adapted to the island environment in which they lived. Holliday (1999) stated that short tibiae are metabolically cheaper than long tibiae during locomotion. Poor nutrient conditions and moderate stress in manipulation and locomotion supposedly caused most of these adaptations in the Minatogawa Man. The shortness of the leg and heel was also interpreted as an adaptation to low-gear locomotion.

The tibia and heel of Liang Togé are rather short. This could be an indication that Liang Togé is island adapted in a similar way to Minatogawa. The short tibia and heel is not seen in Liang Momer E or Liang Panas. The short heel is seen in the juvenile Liang Momer B, but considering the age, this may not be a reliable value. It is possible that the heel would have grown longer before adulthood.

The material from Liang Momer and Liang Panas is thought to be older than Liang Togé. The fact that they are not island adapted in the manner discussed above, would suggest that the population of Liang Momer and Liang Panas were newcomers to the island. However, as already noted above, stature reduction, which is also linked to island habitats for mammals (Hooijer, 1950a) ha not been reported in archaeological remains of modern human populations in Southeast Asia until approximately the time period between Liang Momer E and Liang Togé. An exception may be the recent find of a short bodied hominin on Flores (Brown *et al.*, 2004; Morwood *et al.*, 2004 and Morwood *et al.*, 2005). It is not yet clear if this hominin (named LB1), *Homo floresiensis*, is a microcephalic *Homo sapiens*, an island dwarf form of *H. sapiens* or an island dwarf form of *Homo erectus*. If *H. floresiensis* is indeed (a subspecies of) *H. sapiens*, then it must have belonged to a different, perhaps more ancient, population than both Liang Momer E and Liang Togé, since it is far shorter (around 1 m), has a very small brain (Falk *et al.*, 2005), and shows some other abnormal cranial features (suggested to be evidence of either decent from *H. erectus*, or of microcephaly, or even of both (Brown *et al.*, 2004; Richards, 2006)). Because no signs of microcephaly have been found in the remains described in this paper, it seems unlikely that microcephaly was a common occurrence in the populations present on Flores at the time of Liang Momer E and Liang Togé. Furthermore, I have found no evidence of any individuals with as short a stature as LB1. The stone tools found at Liang Bua also do not resemble the stone tools found at either Liang Momer or Liang Togé, but seem to be similar to the stone tools found in much older layers (840-700 kyr BP) of another archeological site on Flores, called Mata Menge (Brumm *et al.*, 2006). The stone tools found at Mata Menge are too old to have been made by *H. sapiens*.

Because stature reduction in Southeast Asia appeares to have taken place quite suddenly in the time period between Liang Momer E and Liang Togé on most islands in the area, it is most likely that stature reduction at the time of Liang Togé was not an island adaptation, but the result of some other change (perhaps a climate change). It is possible that the shortening of the heel took place in parallel to the reduction in stature. If this is the case, the ancestors of Liang Momer E and Liang Panas could have lived on Flores a long time without the adaptations seen in Liang Togé. Perhaps the stature reduction has the same cause as the tibia shortening seen in Liang Togé, whatever this cause may have been.

Short tibiae are not seen in Javanese females (table 94). All three limb proportion indices, which involve the tibia, fall outside the Javanese female range. If shortening of the tibia is an island adaptation, this is clearly not seen on Java; it may never have been present or it may have disappeared. With the onset of agriculture man started adapting the environment to his needs, instead of adapting to the environment. This could have removed the selection pressures for shorter tibiae, allowing the tibiae to lengthen again. Because Java was attached to mainland Southeast Asia during the Pleistocene, and the environmental conditions (flora and fauna) are different from those on Flores. These differences in environment could also have caused or influenced the difference in limb proportion.

Flattening of the limb bones could indicate nutrient deficiency. However, no sign of nutrient deficiency can be found in the teeth (in the shape of email hypoplasia), or elsewhere (except perhaps for the sacrum and pelvis of Liang Momer E, but this is most likely caused by post-mortem damage). There are also no signs of osteoarthritis, but neither Liang Togé nor Liang Momer E were very old at the time of death. The platybrachy seen in Liang Togé is also seen in Liang Panas and Gua Alo. This makes it unlikely to be caused by some deficiency. It is more likely, that it is a common humeral shape in these populations. Table 94 shows that flattening of the long bones is also seen in the Javanese population. The humerus of Liang Momer E is severely flattened, since the circumference-length index falls below the Javanese male range. Liang Togé falls within Javanese female range. Clearly, the variation in long bone robusticity is great. Furthermore, differences in robusticity are seen between males and females.

Bones from Toalian caves in Southwest Sulawesi (Bola Batoe, Lompoa rock-shelter in Hooijer, 1950b; Lamontjong in Sarasin & Sarasin, 1905) are slender and small. Those from Lompoa are even more slender than those from Liang Togé. This could signify the similarity of early inhabitants of Wallacea. The stone culture of Liang Togé is related to the Toalian, but is more primitive in that it has no geometric shapes (table 95). However, there must have been some kind of contact between the islands.

4.1.4. Burial custom

The Liang Togé skeleton was not the only skeleton studied to be found in a flexed burial. All skeletons from Liang Momer were flexed. The first flexed skeleton to be discovered at Liang Momer was lost before examination. This skeleton was not found in association with the skeletons described above and no statements can be made about its age. Heekeren (Archive Verhoeven, XIV) was of the opinion that this skeleton must have been younger than the stone period (young Palaeolithic based on the flakes), since in that period only secondary burials (parts only) were the custom. This observation however, was not made for the Flores culture and is in any case not a very strong argument. On Borneo for instance, flexed burials are found in Niah, Sarawak from about 9,000 BC onwards. Flexed burials were also found on Eastern Java in the Sampung Bone Industry in Gua Lawa (Bellwood, 1985). Whatever the age of the flexed skeletons from Liang Momer may be, the presence of the young Palaeolithic artefacts at least proves that humans were occupying the area in that period. The fact that the skeletons at Liang Togé and Liang Momer were all in flexed burial supports the theory that both groups belonged to the same culture.

4.1.5. Artefacts

The artefacts found at Liang Togé are different from those at Liang Momer and Liang Panas. No artefacts were found in the grave (Archive Verhoeven, XXXVIb), but they were found in all layers. Liang Togé was found in the top layer at about 1m depth (figure 6).

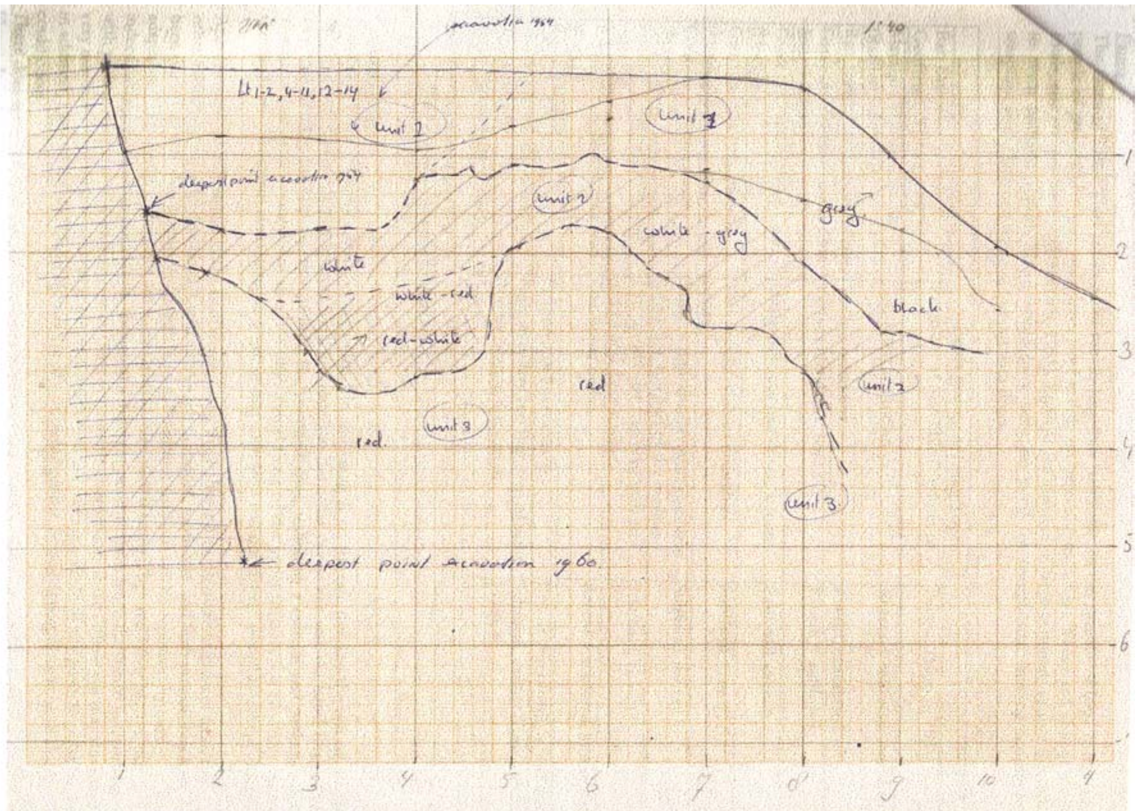


Figure 6. Stratigraphy of Liang Togé (Archive Verhoeven). Layers and finds: Layer 1: 1-1.6 m thick, grey to yellowish-grey sediment, abundant artefacts, some seashells, Liang Togé at approximately 1 m depth. Layer 2: 0.5-0.8 m thick, hard, white to white-grey travertinous limestone, artefacts (flakes) and rodent bones and jaws. Layer 3: minimal thickness about 3 m, red to reddish-brown sediment, artefacts found till about 1.5 m below layer 2. Rodent remains were found in all layers. Hooijer (1967) only described material from layer 1.

Heekeren (1967) concluded that the industry in Liang Togé represented a backward development of a non-ceramic, semi-microlithic industry of a Palaeolithic character. He thought the people that made the artefacts were poor stone-workers, although he could not explain the contradiction between the poor skill in the fabrication of the artefacts and the skilful choice of the raw material.

Initially, Heekeren (Archive Verhoeven, XIV) linked the flake culture found in Liang Togé to the Toalian culture. But the Flores culture on the whole differs from the Toalian culture in respect of arrowheads among other things (Verhoeven, 1968). In Toalian, numerous, strongly carved heads, have been found, while these are absent on Flores. Little ornaments made of mother-of-pearl are characteristic for the Flores culture (table 95).

4.1.6. Fauna

The fauna of Liang Togé consisted of mostly large rats (table 96). In the absence of large mammals, the people of prehistoric Flores must have lived mainly on berries, nuts, tubers, leaves and shoots, shellfish, fowls, rats and porcupines (Heekeren, 1955). Perhaps the absence of large mammals caused the industry to seem underdeveloped. There would have been no need for complicated hunting techniques or weapons, since there was nothing to hunt with them.

4.1.7. Cultural change

A noteable difference is seen between Gua Alo and Liang X, and the rest of the sites. Shovel-shaped incisors were not found in the other caves, nor was labial filing. These two characteristics turn up together at both the youngest sites, indicating a cultural and perhaps even a change in population somewhere after 3,000 BP. Labial filing of the upper incisors is a Neolithic custom (Jacob, 1967). These two characteristics together may indicate a cultural change as well as a racial change.

Apart from some differences in the skull shape, finds from the Liang Togé site shows little physical differences from the other prehistoric material described. Variations in stature, tooth size, and limb proportions have been described for other prehistoric populations in Southeast Asia and can be explained by local adaptation. The cranial differences are more difficult to explain if Liang Togé and Liang Momer did indeed belong to the same population, though at different points in time. However, the sample-size is so small (one skull at each site), that these differences may not mean very much. There is variation between skulls in any given population, and also, Liang Togé and Liang Momer are of a different gender, so that sexual dimorphism in skull shape could occur.

There does appear to be a cultural difference between Liang Togé and the other Mesolithic caves on Flores. It is difficult to determine the cause of this, as Liang Togé is the only site to have been precisely dated. I have assumed that Liang Togé is the youngest of the Mesolithic caves, but this may not be so. For stature reduction to have occurred between the times of Liang Momer E and Liang Togé, a number of generations is needed between them. If dating of Liang Momer gives approximately the same or even a younger date than Liang Togé, than the idea of adaptation has to be revised, because Liang Togé and Liang Momer E could not have belonged to the same population.

4.2. Comparison with material outside of Flores

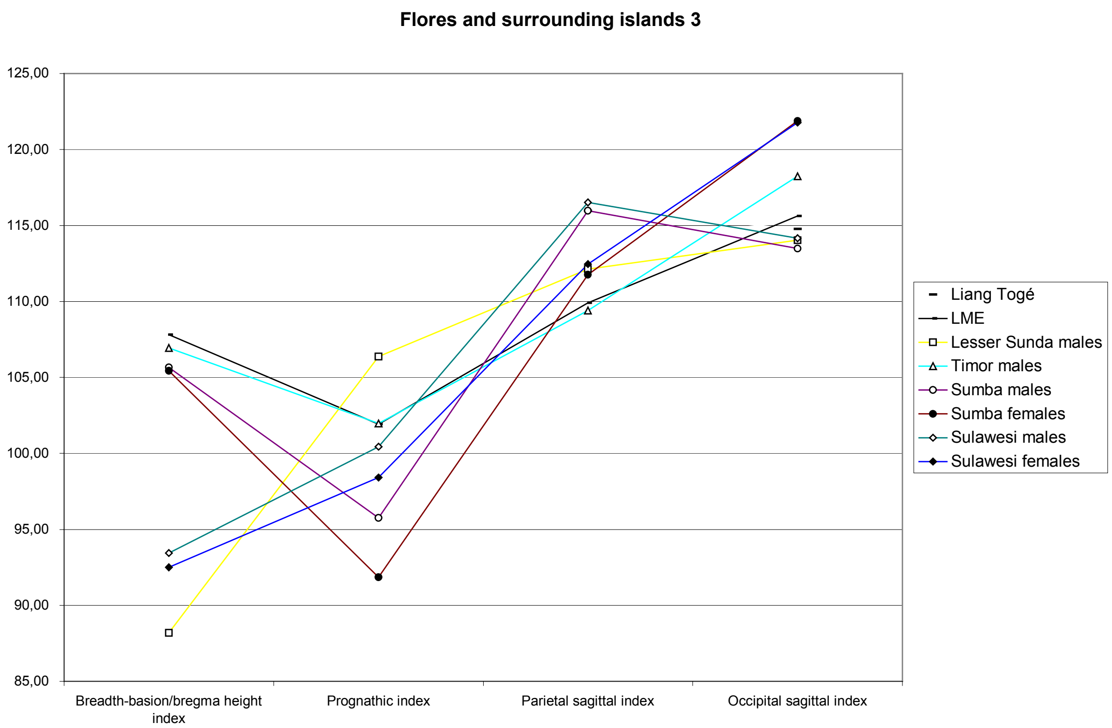
The measurements from the recent skulls of the Lesser Sunda Islands, Timor, Sumba, and Sulawesi, represented in the graphs, were taken for this study on material present in the Nationaal Natuurhistorisch Museum, Leiden. No complete descriptions were made of these skulls, because it was out of the scope of this investigation.

The measurements from the recent skulls from China, Java, New-Guinea, and Australia, and the prehistoric skulls Upper Cave 1 and 2, Liujiang, Wajak 1 and 2, Hoekgrot, Gua Kepah B347, Kanalda, Keilor, Kow Swamp 5 and 15, and Lake Mungo 1 and 3 are taken from Storm (1995).

4.2.1. Flores and the surrounding islands (graph 2-6)

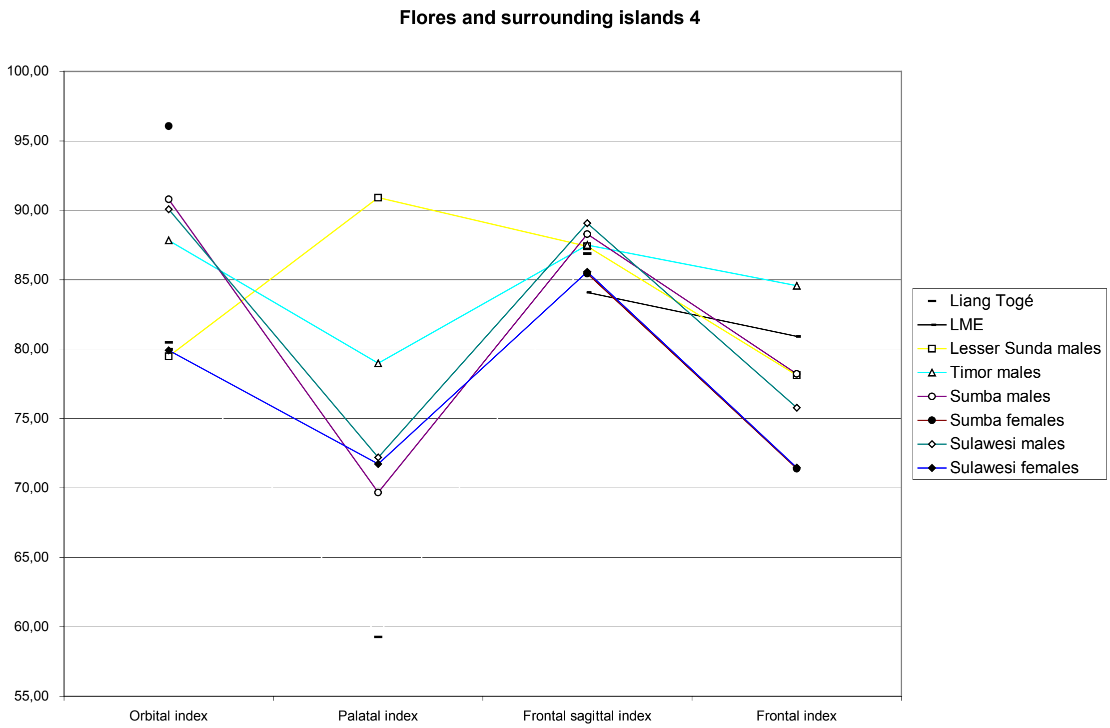
1. Cranial index (graph 2): Liang Togé has a very low value. The Sumba female is dolichocephalic, while the Sulawesi female is brachycephalic. Liang Momer E is dolichocephalic and close to Timor. The Sumba males are mesocephalic, and the Sulawesi and Lesser Sunda Islands males are brachycephalic.
2. Breadth-auricular height index (graph 2): Liang Togé has an extremely high value here. The Sumba and Sulawesi females are almost identical to each other. Liang Momer E is close to Timor and Sumba males. The Lesser Sunda Islands male has a very low value and the Sulawesi males are found in the middle.

3. Length-basion/bregma index (graph 2): Liang Momer E is close to Timor and Lesser Sunda Islands. The Sulawesi and Sumba males have higher values.
4. Transverse occipitoparietal index (graph 2): Liang Momer E is close to Sumba, Sulawesi, and the Lesser Sunda Islands. Timor on the other hand has a much higher value.
5. Jugomalar index (graph 2): Liang Momer E has a somewhat low value. Timor and Sumba males are close. The Sulawesi and Lesser Sunda males have higher values.
6. Length-auricular height index (graph 3): Liang Togé is close to the Sulawesi females, while the Sumba female has a lower value. Liang Momer E has an intermediate value, with the Lesser Sunda Islands below and the Timor, Sulawesi and Sumba males above him.
7. Transverse frontoparietal index (graph 3): Liang Togé has a very high value in this case too. The Sulawesi and Sumba females again are close to each other. Liang Momer E also has a high value, but is not far from the Timor and Sumba males. The Sulawesi and Lesser Sunda males have lower values.
8. Upper facial index (graph 3): Liang Togé has a narrow face, but this is also seen in the Sumba female. The Sulawesi females on the other hand have a much lower value (broader faces). Liang Momer E has a value close to the Timor, Sumba, and Sulawesi males. The Lesser Sunda Islands male has the broadest face.
9. Upper face index (graph 3): Liang Togé has a high value, but the Sumba female exceeds this value. Like the upper facial index this indicates a narrow face. The Sulawesi females have much broader faces. Liang Momer E has the narrowest face of the males, but is not far from the Timor, Sumba, and Sulawesi males. The Lesser Sunda Islands male again has the broadest face.
10. Nasal index (graph 3): Liang Togé has a narrow nose, and the Sumba female approaches this low index value. The Sulawesi females have much broader noses. Liang Momer E has a just mesorrhine nose, close to Sumba, Sulawesi, and Timor. The Lesser Sunda male has the broadest nose.



Graph 4. Comparison Liang Togé and Liang Momer E to surrounding islands in Wallacea.

11. Palatal breadth-depth index (graph 3): Liang Togé has a very high value meaning a narrow and deep palate. The Sumba female has a very low value, while the Sulawesi females are somewhat intermediary. Liang Momer E value not available.
12. Total sagittal index (graph 3): Liang Togé has a high value. Sulawesi females have a low value and the Sumba female lies in the middle. Liang Momer E is close to all males.
13. Breadth-basion/bregma index (graph 4): Liang Momer E has a high value. Close by are Timor and Sumba. Sulawesi and Lesser Sunda have very low values.
14. Prognathic index (graph 4): Liang Momer E is slightly prognathous. Timor and Sulawesi males have values that come close. The Sumba males are orthognathous, and the Lesser Sunda male is prognathous.

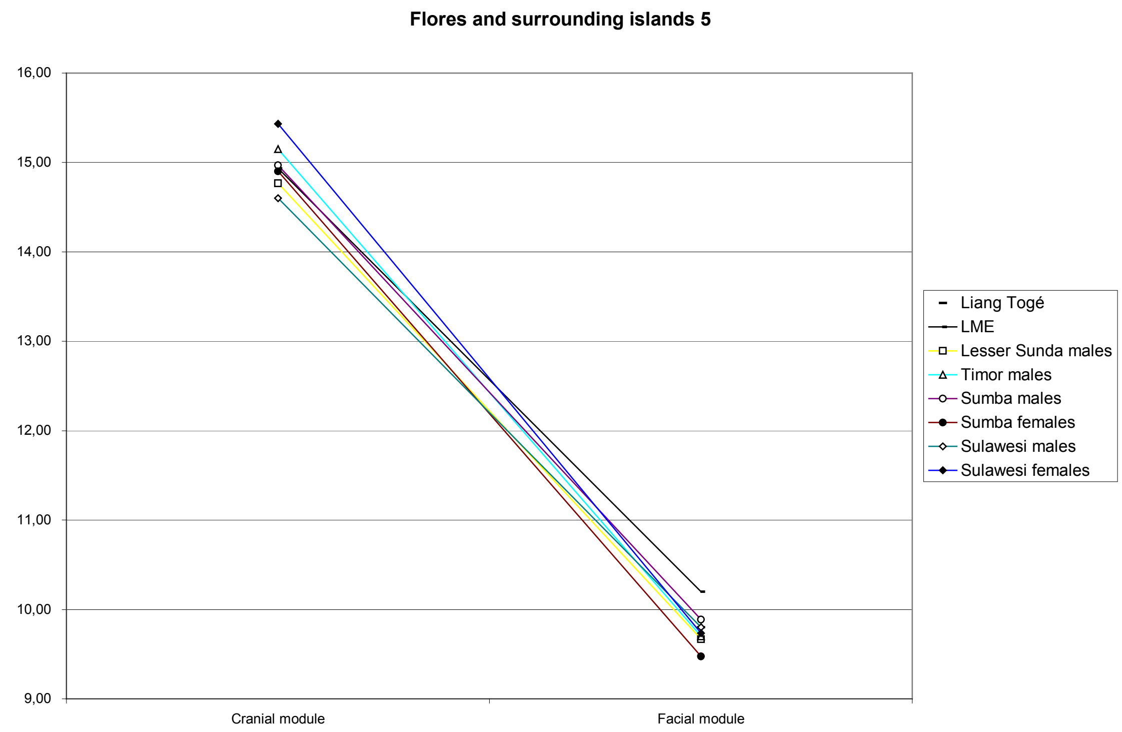


Graph 5. Comparison Liang Togé and Liang Momer E to surrounding islands in Wallacea.

15. Parietal index (graph 4): Liang Togé has a very high value, meaning a bulbous parietal, which is only seen in the Sumba and Sulawesi males. The Sumba and Sulawesi females have medium bulbous parietals. Liang Momer E has a low value like Timor. The Lesser Sunda male has an intermediate value.
16. Occipital sagittal index (graph 4): Liang Togé is again in the male range. The Sulawesi and Sumba females have much higher values, meaning more bulbous occipitals. Liang Momer E leans toward a flat occipital, but the Sulawesi, Sumba, and Lesser Sunda males are flatter. The Timor males are more bulbous.
17. Orbital index (graph 5): Liang Togé has mesoconch orbits like the Sulawesi females. The Sumba females on the other hand have hypsiconch orbits. Liang Momer E is mesoconch, as is the Lesser Sunda male. Timor, Sulawesi, and Sumba males are hypsiconch.
18. Palatal index (graph 5): The palate of Liang Togé is very narrow (low index value). Sulawesi females tend to have broader palates. This value is not available for the Sumba female. Liang Momer E value not available.
19. Frontal sagittal index (graph 5): Liang Togé has a high value for a female, meaning a rather bulbous frontal bone. The Sumba and Sulawesi females are close to each other. Liang Momer E has rather a low value, falling below the female values. The other males are all alike with a higher value.
20. Frontal index (graph 5): Liang Momer E has an intermediate value between Timor on the one hand and Sumba and the Lesser Sunda on the other. Sulawesi males have a rather low value.
21. Cranial module (graph 6): Liang Momer E has a skull size close to Sumba males. Timor males have larger skulls, and Lesser Sunda and Sulawesi males have smaller ones.
22. Facial module (graph 6): Liang Togé has a large face like the Sulawesi females. The Sumba female has a smaller face. Liang Momer E has a large face. Of the recent males, Sumba and Sulawesi have the largest faces, while the other two have smaller faces.

Liang Togé is similar to Sumba females in five respects (upper facial index, upper face index, nasal index, total sagittal index, and frontal sagittal index [graph 3 and 5]) and is similar to Sulawesi females in three respects (length-auricular height index, orbital index, and frontal sagittal index [graph 3 and 5]). The Sumba population seems to be most similar in anatomical proportions to Liang Togé, although the palatal breadth-depth index (graph 3) and the facial module (graph 6) differ.

Liang Togé has some notable differences from the present inhabitants of the surrounding islands:



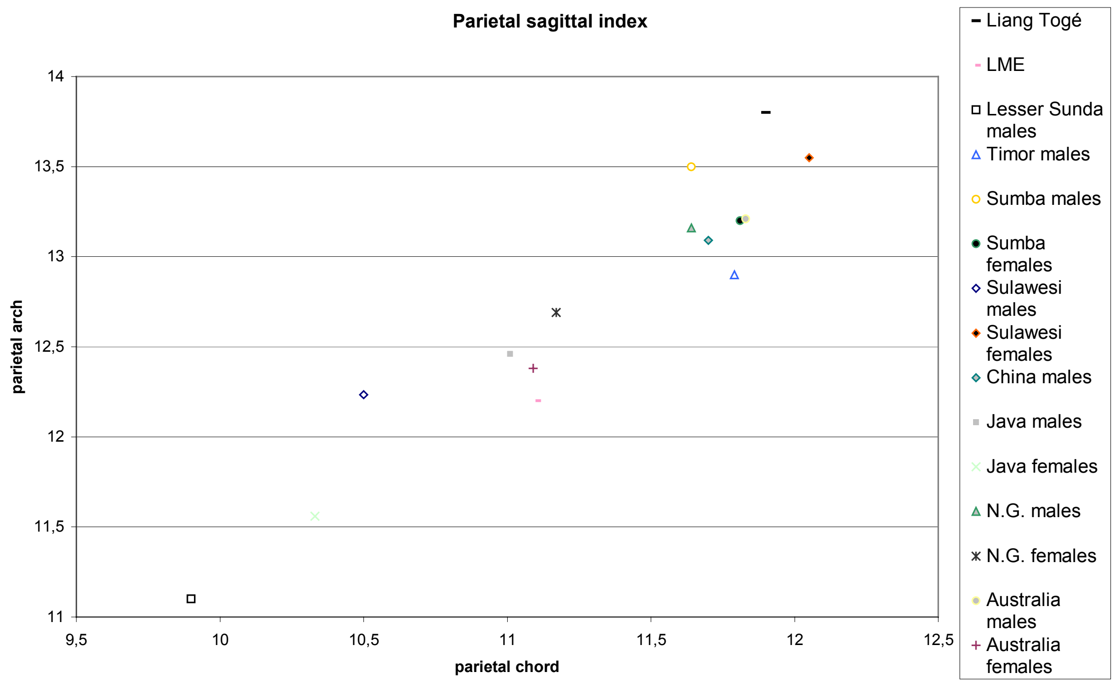
Graph 6. Comparison Liang Togé and Liang Momer E to surrounding islands in Wallacea.

1. The extreme dolichocephalic shape of the skull (cranial index, graph 2)
2. The very large minimum frontal breadth compared to the cranial breadth (transverse frontoparietal index, graph 3)
3. A very high breadth-auricular height index (graph 2)
4. A very high palatal breadth-depth index (graph 3)
5. A very low palatal index (graph 5)

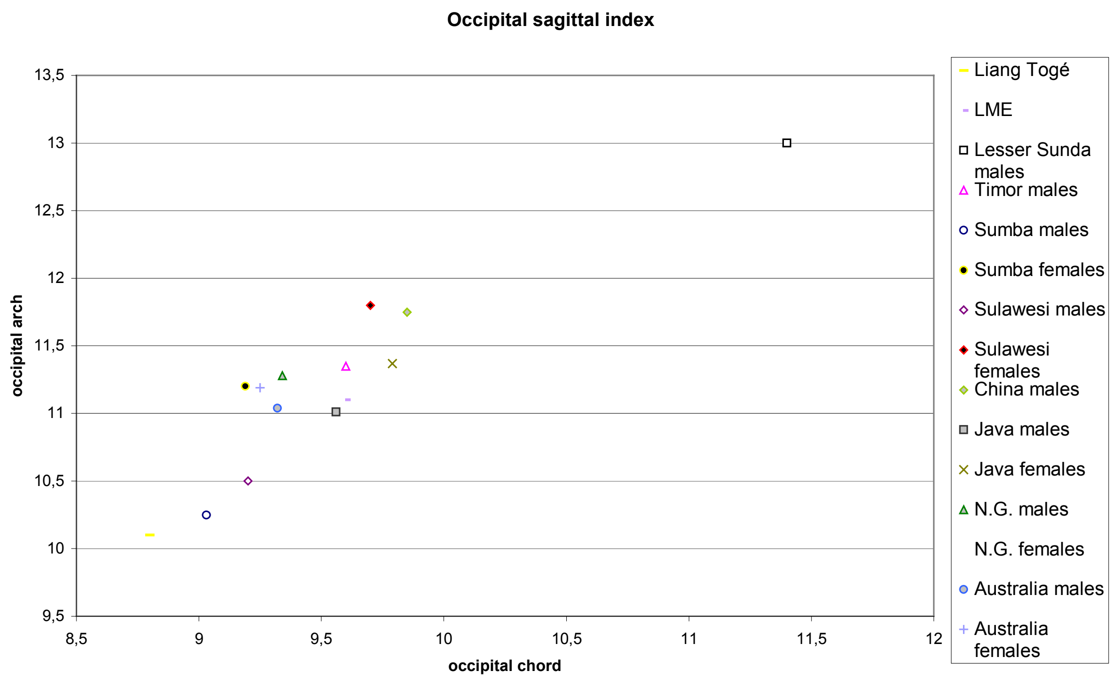
Note that the first three of these indices are calculated using cranial breadth. The cranial breadth of Liang Togé is an estimation due to the missing right half of the skull. The other factors involved in these three indices are within the normal range. However, to bring the three indices into a normal range would require the cranial breadth to be increased by 1.0-1.5cm (table 97), which is an unlikely figure, since the estimation could not be that far off.

Liang Momer E is morphologically similar to inhabitants of Timor (cranial index, length-basion/bregma index, prognathic index, and the parietal sagittal index; graph 2 and 4). Liang Momer E also resembles inhabitants of Sumba (transverse occipitoparietal index, occipital sagittal index, and cranial module; graph 2, 4, and 6). In several cases however, Liang Momer E resembles both these populations (breadth-auricular height index, jugomalar index, length-auricular height index, transverse frontoparietal index, upper facial index, upper face index, nasal index, total sagittal index, breadth-basion/bregma index, and the frontal index; graph 2 to 5). Inhabitants of Sulawesi come close in the upper facial index, the upper face index, the nasal index, the prognathic index, and the occipital sagittal index (graph 3 and 4). In habitants of the Lesser Sunda Islands come close in the orbital index and the frontal index (graph 5). The cranial module of Liang Momer E is of medium size and closest to inhabitants of Sumba. The facial module is large and far above the recent values in Wallacea (graph 6).

Liang Togé is similar in five respects to inhabitants of Sumba, four of which are also shared by Liang Momer E with inhabitants of Sumba (and of Timor). This means that the differences between Liang Togé and Liang Momer E in these four characters could very well be caused by sexual dimorphism. For instance, in the case of the upper facial index, Liang Togé is close to the Sumba female and Liang Momer E is close to the Sumba male. This means that since the Sumba male and female are part of the same population, Liang Momer E and Liang Togé could be part of the same population too. The exception is the frontal sagittal index, which is low for Liang Momer E and falls below the values for recent males and females. The facial module also deviates in Liang Momer E from the values seen in recent males and females (graph 6).



Graph 7. Scatter diagram of parietal sagittal index (see text below).



Graph 8. Scatter diagram of occipital sagittal index.

Due to the lack of Timor females for comparison, I cannot judge whether Liang Togé is similar to the Timor population. However, Liang Momer E and Timor males are similar in several respects, which are also seen in Liang Togé, Liang Momer E and the Sumba population. This similarity between Timor and Sumba males could also be present between Timor and Sumba females, meaning that Liang Togé could resemble the recent Timor females. The populations of these two eastern Lesser Sunda Islands are thought to be of

Australomelanesian origin. This correlates to the hypothesis that the original inhabitants of the Lesser Sunda Islands were descended from Proto-Sahuls on their way to Australia.

The parietal sagittal index of Liang Togé is difficult to place. The bulbous parietal of Liang Togé is similar only to the male skulls from Wallacea, while the females tend to have more flattened parietals. In the scatter diagram (graph 7) it became clear that Liang Togé does not differ that much from Sulawesi and Sumba females in the absolute measurements. These females tend to have a larger parietal chord and arch than the males, as does Liang Togé. The difference between Liang Togé and the Sumba and Sulawesi females is that Liang Togé has a somewhat larger arch, making the index value higher. If Liang Togé belongs to the same population as the inhabitants of Sumba and Sulawesi, then this difference may represent normal variation, or a gradual shift over time. The value of Liang Momer E is comparable to that of Timor males. In the case of Timor however, the males measured tended to have flattened parietals. Unfortunately, there were no female skulls available for study and therefore any sexual dimorphy of this characteristic could not be assessed.

In the case of the occipital sagittal index (graph 4 and 8) Liang Togé also falls into the male range with a flat occipital, eventhough the skull is undoubtedly that of a female (see table 93). Liang Momer E has approximately the same value here.

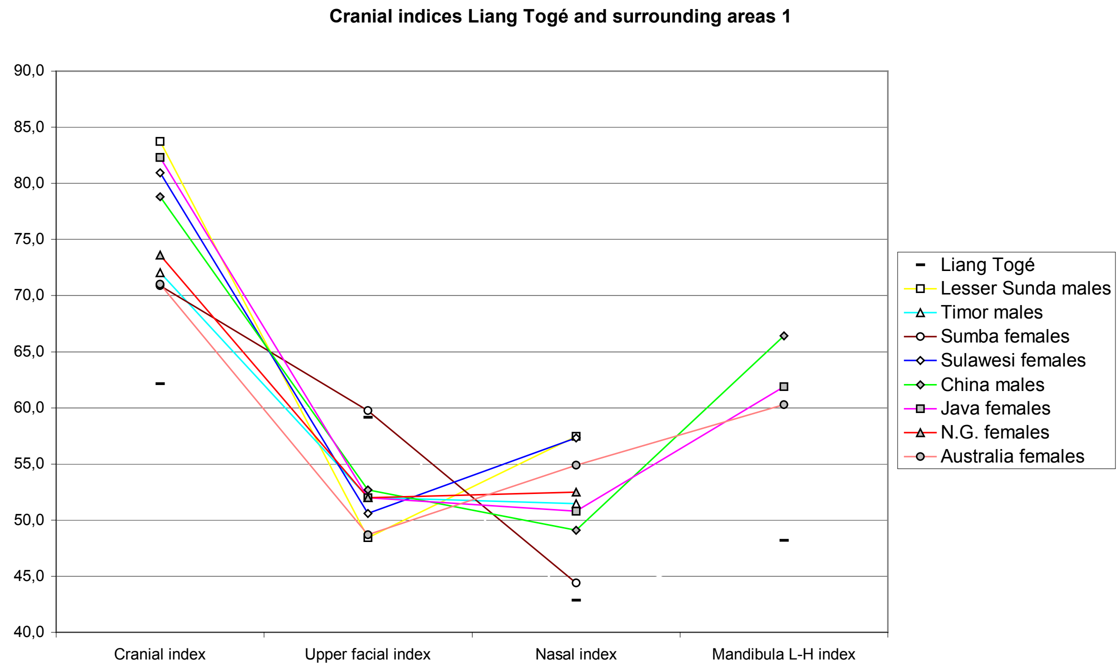
Because the cranial, facial and corpus mandibula modules are sensitive to size decreases between prehistoric and recent material, they may be unreliable as race indicators. For instance, Liang Momer E has a large face, but it is impossible to say whether this has decreased into recent times or not. This makes the range of possible affinities endless and therefore useless.

4.2.2. Liang Togé and the surrounding areas (graph 9-11)

The occipital sagittal index is the only index in which Liang Togé lies close to an average value of one of the surrounding areas, namely Java (graph 10).

Liang Togé is very different from all or most of the surrounding areas in the following indices:

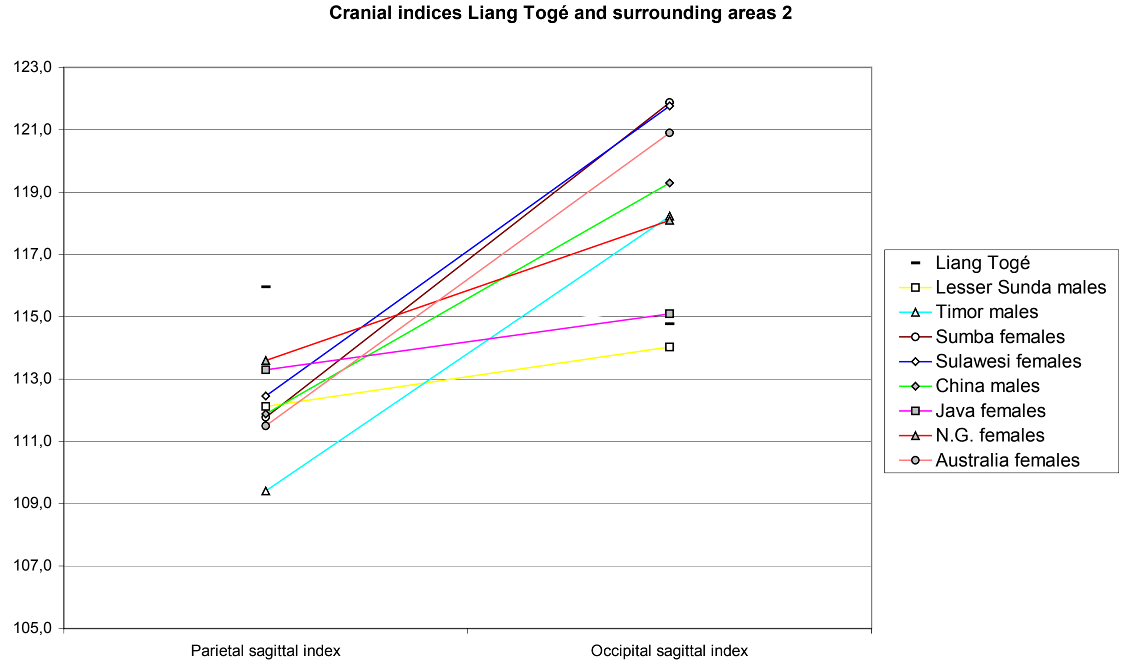
1. Cranial index (graph 9). Liang Togé is extremely dolichocephalic and falls outside of the range of all surrounding areas (although the lowest values in the Australian and New Guinea range are close).



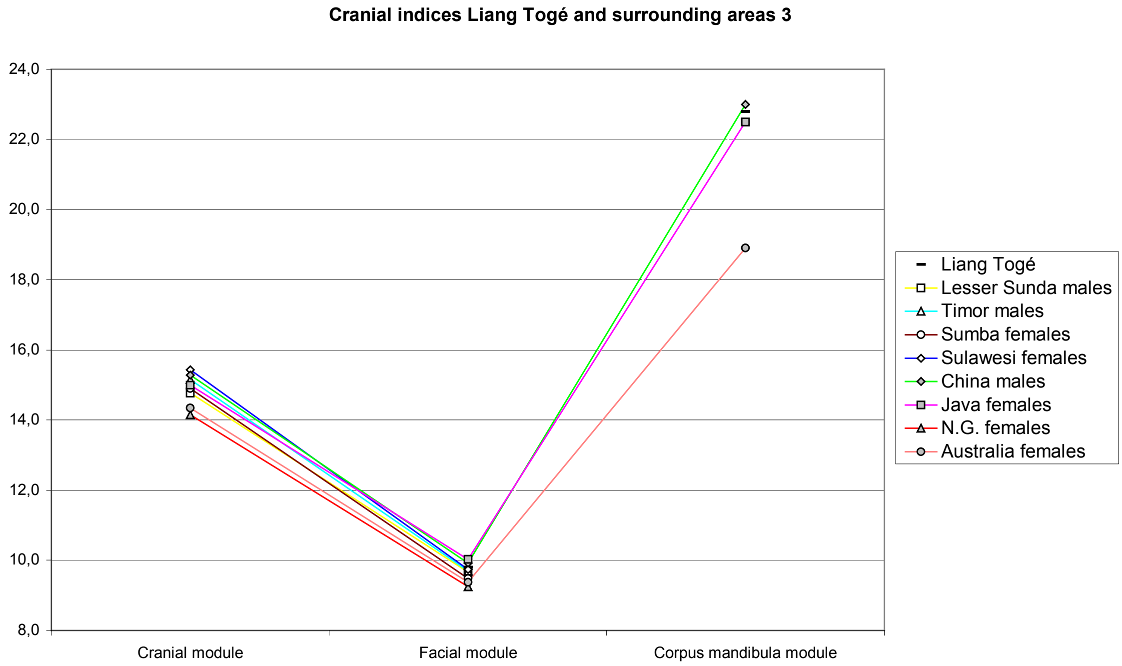
Graph 9. Comparing Liang Togé to surrounding areas China, Java, New Guinea, and Australia.

2. The upper facial index (graph 9) is very high, only approached by the highest value found in the New Guinea skulls. Unlike the cranial index, however, this high value was also found in a female skull from Sumba.
3. The nasal index (graph 9) is similar to the previous indices. The extremely low value of Liang Togé falls only just within the female range of New Guinea, but is still seen on Sumba.

4. The parietal sagittal index is very high for a female. New Guinea and Java come closest (graph 10).



Graph 10. Comparing Liang Togé to surrounding areas China, Java, New Guinea, and Australia.



Graph 11. Comparing Liang Togé to surrounding areas China, Java, New Guinea, and Australia.

5. The mandibula L-H index of Liang Togé is much lower than all of the surrounding areas (graph 9). Note that the mandibula L-H index could not be calculated for the Wallacean recent material since mandibles were not available.
6. The facial module of Liang Togé is large, but Javanese females on average have larger faces. Australia and New Guinea females have smaller faces (graph 11).
7. The corpus mandibula module is also large, just above the Javanese female average and below the Chinese male average. Australians have much smaller mandibles (graph 11).

Since only one index can be placed in one of the four areas, no definite statement can be made about the origin of Liang Togé. The other five characters clearly stand out from the surrounding areas. Yet, some of these (no. 2 and 3) are still found in the Wallacea area, meaning that these characters have not disappeared there. This leads to think that descendants of Liang Togé could still be living in Wallacea and this narrow face and nose could then be unique characteristics for the area, caused by a long period of evolutionary isolation.

Information about the nasal index of Chinese females is not available. This makes it impossible to determine whether this sexual dimorphism perhaps is present in China as well. This strong difference between the sexes is definitely not found in the other surrounding areas, which makes it less probable that it could occur in China.

4.2.3. Liang Momer E and the surrounding areas (graph 12-14)

1. The cranial index of Liang Momer E is dolichocephalic and lies closest to those of inhabitants of Australia and New Guinea (graph 12).
2. The length-basion/bregma height index comes close to the Chinese average (graph 12).
3. The upper facial index is closest to those of inhabitants of China and Java (graph 12).
4. The nasal index again is closest to China (graph 12).
5. The mandibula L-H index (graph 12). This value is very low in the case of Liang Momer E, as it is in the case of Liang Togé. This is not seen in any of the surrounding areas, but unfortunately I do not have mandibles from the surrounding islands to see whether this difference could reflect a unique Wallacean trend. In Australia, however, low mandibles such as that of Liang Momer E are not uncommon.
6. The breadth-basion/bregma height index (graph 13). Liang Momer E has a high value for the breadth-basion/bregma index, which is not close to the male averages of any of the surrounding areas and falls only within the range of Australia and New Guinea.
7. Liang Momer E has rather a flat parietal bone (parietal sagittal index, graph 13). This feature is shared with males from Timor, but is below all the averages of the surrounding areas. A value between 109.0 and 111.9 is however quite common in both China and Australia (Storm, 1995).
8. The occipital sagittal index of Liang Momer E lies close to the Javan male average (graph 13).
9. Cranial module: Liang Momer E is close to Java and Australia (graph 14).
10. Facial module: Liang Momer E is large, but falls within the recent male range (graph 14).

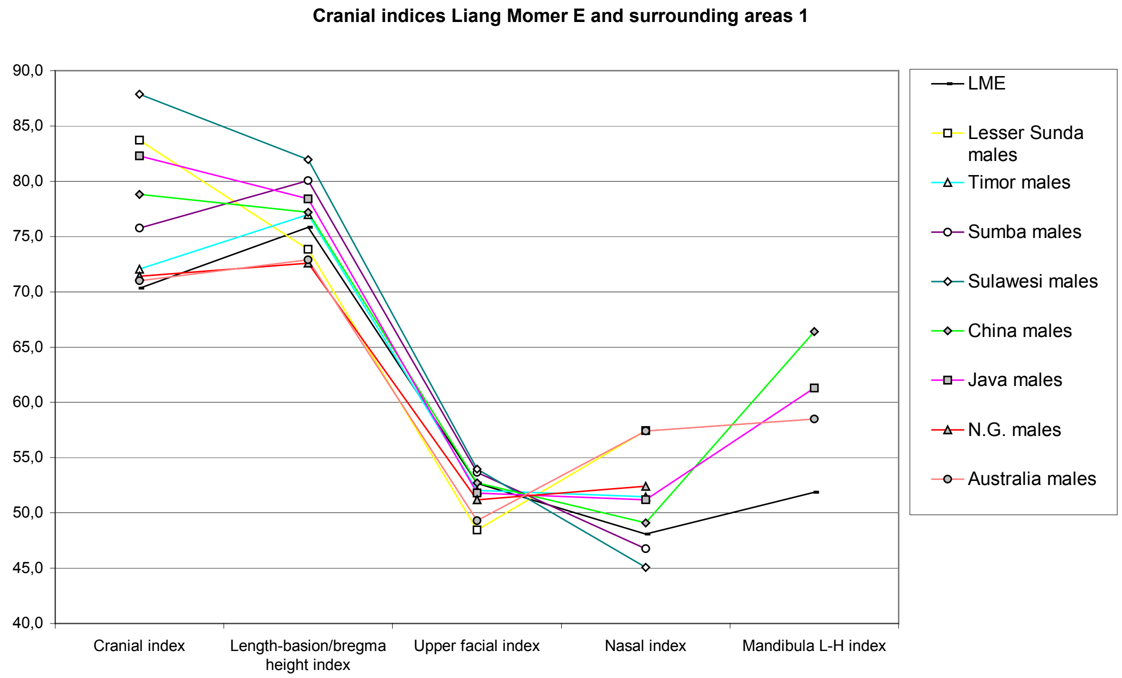
Judging from this list Liang Momer E is most similar to Sunda (mostly China), because only the dolichocephalic shape of the skull is a unique Sahul characteristic. This correlates with the observed trend that prehistoric material is usually dolichocephalic and that most populations must have undergone some broadening of the skull over time. However, Liang Momer E is different from the surrounding areas in the mandibula L-H index and the breadth-basion/bregma index. Clearly, it is not possible to see Liang Momer E as a true Sunda-type, because it shows some unique characteristics not found on that shelf.

Interbreeding

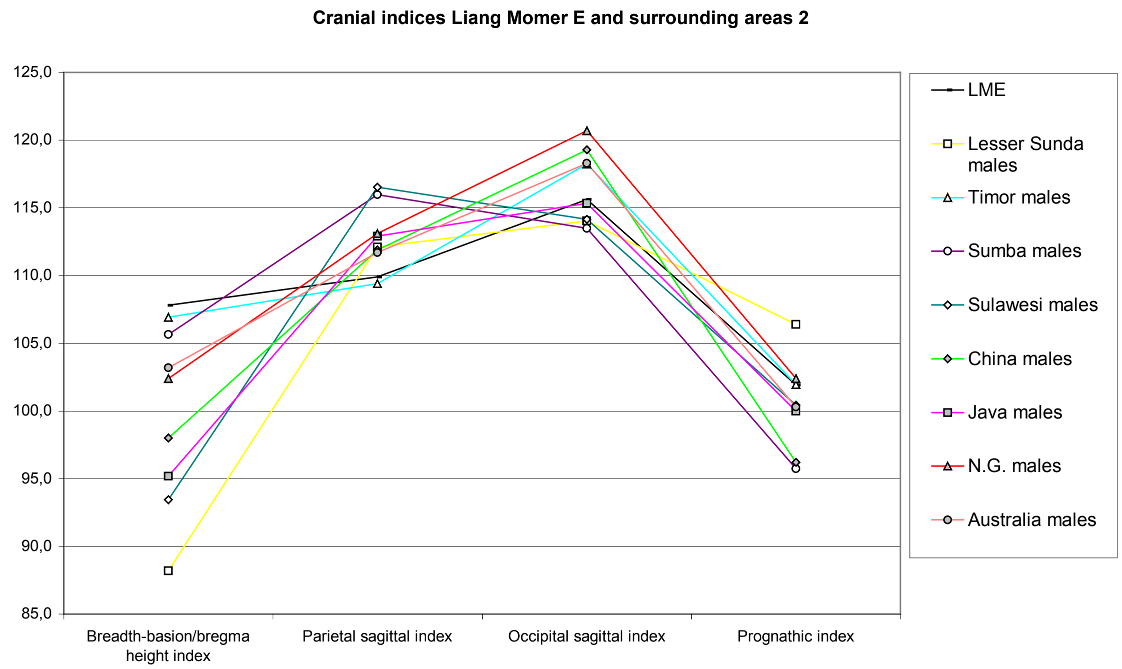
Interbreeding has undoubtedly taken place at least in recent times. This could be the reason for differences seen between the four studied islands.

1. The cranial index (graph 2) is brachycephalic in the skulls from Sulawesi and the Lesser Sunda Islands, while it is dolichocephalic to mesocephalic in skulls from Timor and Sumba. This difference in cranial index could be due to for example Javanese interbreeding, causing skulls from Sulawesi, the Lesser Sunda Islands, and in a lesser degree Sumba to broaden (graph 9).
2. The skull from the Lesser Sunda Islands is prognathic (prognathic index, graph 13), while the skulls from Sumba tend to be orthognathic. The prognathism of the Lesser Sunda Islands skull is an unusual value for the surrounding areas, but is seen in 19% of the New Guinea males. Timor has a value close to the New Guinea and Australian averages. Sulawesi is close to Java and Sumba is the only island more orthognathous than the China average.
3. Male skulls from Sulawesi and Sumba tend to have bulbous parietals and flat occipitals (parietal and occipital sagittal indices, graph 13), while the females show the reverse trend (graph 10). The skull from the Lesser Sunda Islands also has a flat occipital. Timor is an exception, because the male skulls tend more toward a flat parietal and bulbous occipital. The parietal sagittal index of Timor is the lowest of all, but this value is well inside the Chinese and Australian male range. Sulawesi and Sumba have the highest values, but fall inside the Javanese male range. The skull from the Lesser Sunda Islands is close to all areas, which on average do not show much difference from each other. New Guinea however tends to be somewhat more

bulbous, while Australia tends to be more flat. The occipital sagittal index of Timor males is close to the Australian male average, while the other three male averages are close to the Javanese male average (graph 10). The females from Sulawesi and Sumba, however, are close to the Australian female average.



Graph 12. Comparing Liang Momer E to surrounding areas China, Java, New Guinea, and Australia.



Graph 13. Comparing Liang Momer E to surrounding areas China, Java, New Guinea, and Australia.

Some differences cannot be easily explained by a theory of gene flow from the surrounding areas:

1. The skull from the Lesser Sunda Islands is very low, while the skulls from Sulawesi tend to be shorter. This causes differences in the length-basion/bregma height and the breadth-basion/bregma height indices (graph

9, 10, 12, and 13). Interestingly, in the length-basion/bregma index, inhabitants of Timor are more similar to inhabitants of China, those of inhabitants of Sumba and Sulawesi are close to inhabitants of Java, and that of the inhabitants of the Lesser Sunda Islands is close to inhabitants of New Guinea and Australia (graph 9). The breadth-basion/bregma height index is interesting since inhabitants of Sumba and Timor have a very high value, and inhabitants of Sulawesi and the Lesser Sunda Islands a very low value (graph 10). Only inhabitants from Sulawesi come close to the recent Javanese average. Thus, although inhabitants of Timor and Sumba are closer to the Sahul side of the range and inhabitants of Sulawesi and the Lesser Sunda Islands are closer to the Sunda side, all four have exaggerated values compared to the surrounding areas. The fact that inhabitants of both Timor and Sumba still show this character in mostly the same form, suggests that interbreeding between these two islands has not been very important in this respect. There has been only a minor decrease in the index value, leaving them both still above the average values of the surrounding areas. Sulawesi and the Lesser Sunda Islands have much lower values, which might be due to Sunda interbreeding.

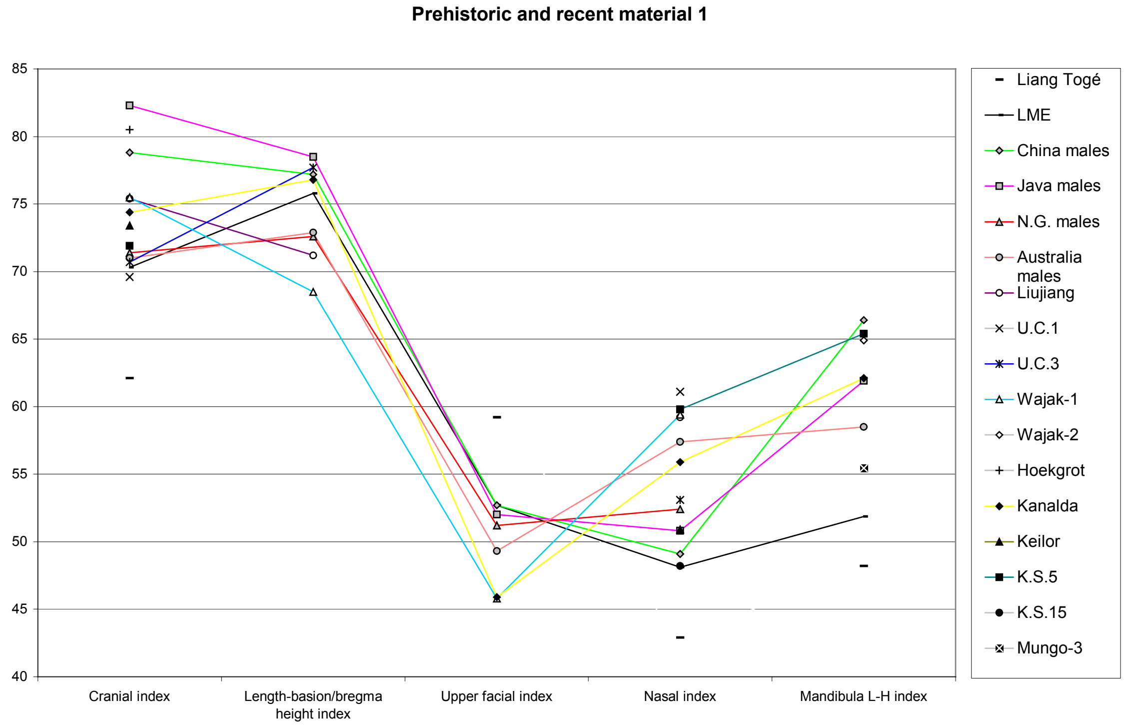
Graph 14. Comparing Liang Momer E to surrounding areas China, Java, New Guinea, and Australia.

2. Sumba females tend to have narrow faces (upper facial index [graph 9]), while Sulawesi females tend to have broader faces. The Lesser Sunda Islands male skull had the broadest face of the males, Sulawesi and Sumba males the narrowest (graph 12). Inhabitants of Sulawesi and the Lesser Sunda Islands are close to the recent Australian average, which means broad faces. Inhabitants of Timor are close to the other three areas. The Sumba female, as discussed above, has a very narrow face similar to Liang Togé, and therefore the value exceeds far above the averages of the surrounding areas. It is possibly a Wallacean trend.
3. The Sumba female measured also has a narrow nose (nasal index, graph 9 and 12), while the Sulawesi females have broad noses. The Sumba female value is only just inside the New Guinea and Java female range, falling far below the areas' averages. The Sulawesi females are close to the Australian female average. Sulawesi males on the other hand have narrow noses. This points to either a very large sexual dimorphism, or the studied collection of male skulls represents another population on Sulawesi than the female skulls. The skull from the Lesser Sunda Islands is the only skull with a broad nose coming close to the Australian average (graph 12). Inhabitants of Timor are close to inhabitants of both New Guinea and Java, and inhabitants of Sulawesi are closest to inhabitants of China.

4.3. Flores in prehistory (graphs 15-19)

Above I have noted some morphological dissimilarities between the prehistoric material from Flores and recent material from Wallacea from the Sunda and Sahul types, suggesting that this may be due to a separate line of decent in evolution. If this is indeed so, there may be some evidence of this found in other prehistoric material (table 98).

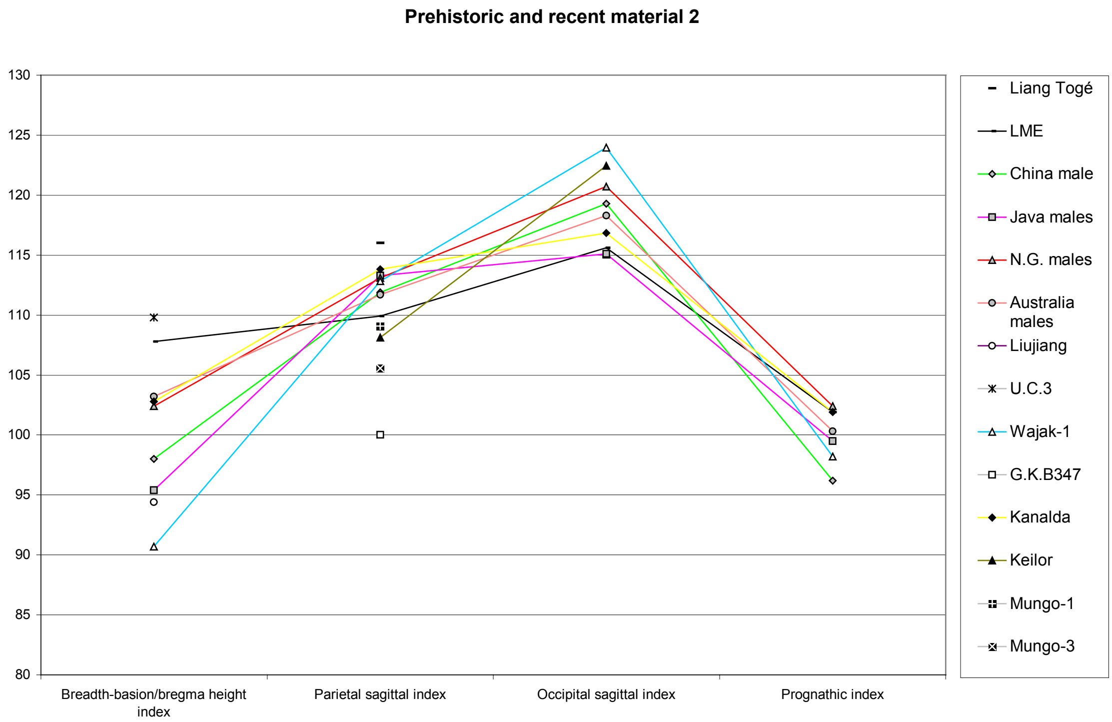
1. Cranial index: Liang Momer E is closest to Upper Cave 1 and 3, while Liang Togé is extremely dolichocephalic (graph 15). Only Hoekgrot deviates from the overall dolichocephalic to slightly mesocephalic skull shape in the prehistoric specimens.
2. Length-basion/bregma height index: Liang Momer E is close to Kanalda and Upper Cave 3 (graph 15). The value for Liang Togé is not available. Wajak-1 and Liujiang have very low values for this index.



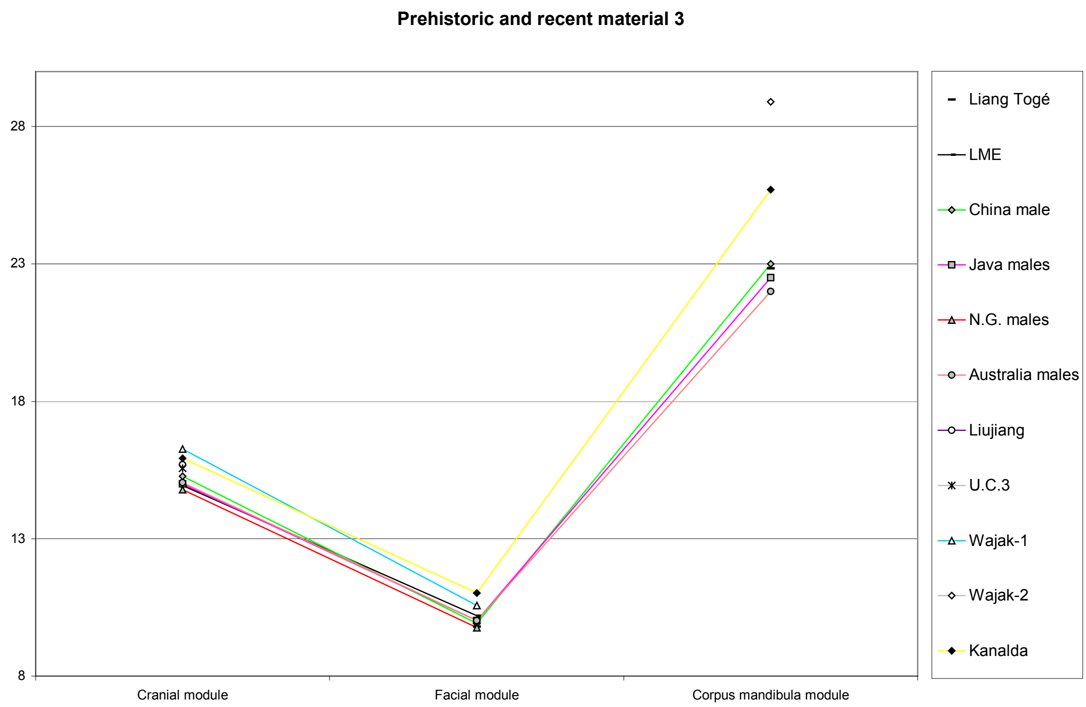
Graph 15. Comparing Liang Togé and Liang Momer E to other prehistoric specimens from Southeast Asia.

3. Upper facial index: This could only be calculated for Kanalda and Wajak-1. Both are of the same low value, indicating a broad face (graph 15). Inhabitants of Australia show the closest similarity to these prehistoric specimens, having partly preserved a broad face. Liang Momer E has a higher value, as have all other materials.
4. Nasal index: Liang Momer E is close to Kow Swamp 15 in this respect (graph 15). Liang Togé is extremely leptorrhine for prehistoric material.
5. Mandibula L-H index: Liang Momer E and Liang Togé both have very low mandibles (graph 15) compared to the other prehistoric and recent material. The only prehistoric specimen to have a similar value is Lake Mungo 3, the oldest Australian specimen found.
6. Breadth-basion/bregma height index: Liang Momer E comes close to Upper Cave 3 (graph 16). Kanalda has the next closest value, identical to recent Australians and New Guinea. Liujiang and Wajak-1 both have lower values than their descendants.
7. Parietal sagittal index: Liang Momer E is closest to Mungo-1 and Keilor (graph 16). The tendency to bulbous parietals present in recent Sulawesi and Sumba males is not seen in prehistoric males.
8. Occipital sagittal index: Liang Momer E and Liang Togé are closest to Kanalda (graph 16). However, Keilor is close to Wajak-1 on the other end of the recent range.
9. Prognathic index: Liang Momer E is identical to Kanalda in this respect (graph 16). Wajak-1 is slightly orthognathous and lies inbetween the recent values for Java and China.
10. Cranial module: Liang Momer E falls in the modern range and is closest to inhabitants of Java (graph 17). The value for Liang Togé is not available. Wajak-1 has the largest module, followed by Kanalda, Wajak-2, and Liujiang. Upper Cave 3 is only just a little larger than recent Chinese males. As discussed above, the cranial module has decreased since prehistoric time and Liang Momer E has a skull size within the modern range.

11. Facial module: Liang Momer E is only just above the modern averages (graph 17). Liang Togé falls within the modern female range (graph 11). Kanalda and Wajak-1 both have large faces. In this case there is a trend towards smaller faces as well.



Graph 16. Comparing Liang Togé and Liang Momer E to other prehistoric specimens from Southeast Asia.

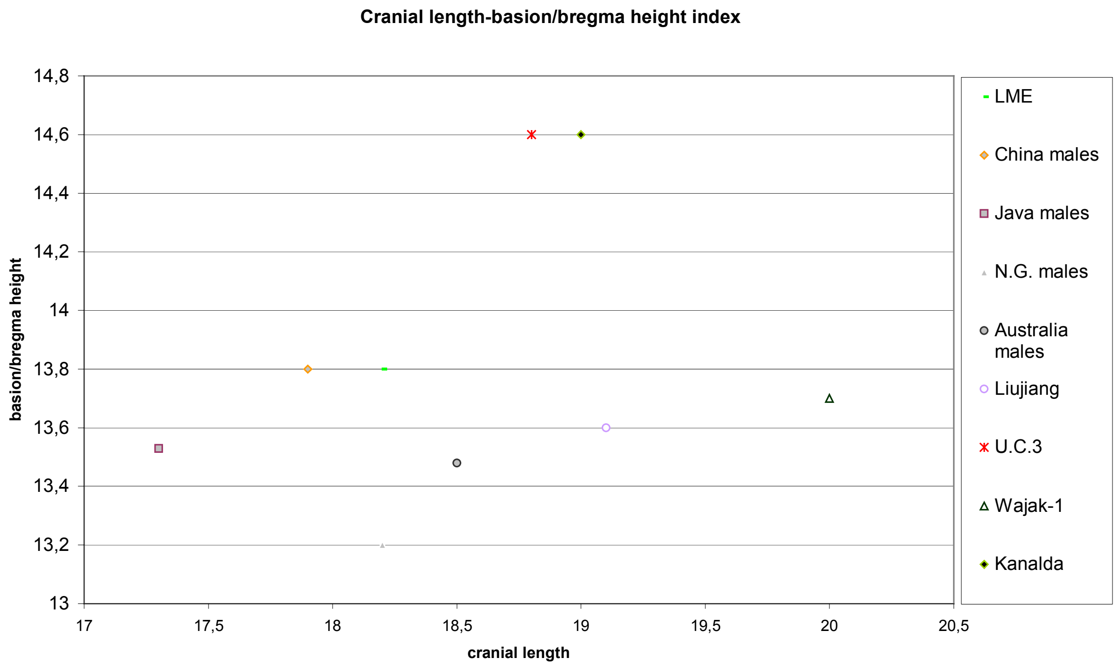


Graph 17. Comparing Liang Togé and Liang Momer E to other prehistoric specimens from Southeast Asia.

12. Corpus mandibula module: Liang Togé is again in the modern range, close to Java females. Wajak-2 and Kanalda show much larger mandibles. Here again, there is a trend towards smaller mandibles.

Storm (1995) suggested, that Upper Cave represented a site where a 'generalised' *Homo sapiens* population lived, and that this population therefore represented the ancestor of both the Sunda and Sahul populations. The same could be true for the Lake Mungo specimens, which are dated to about the same period as Upper cave.

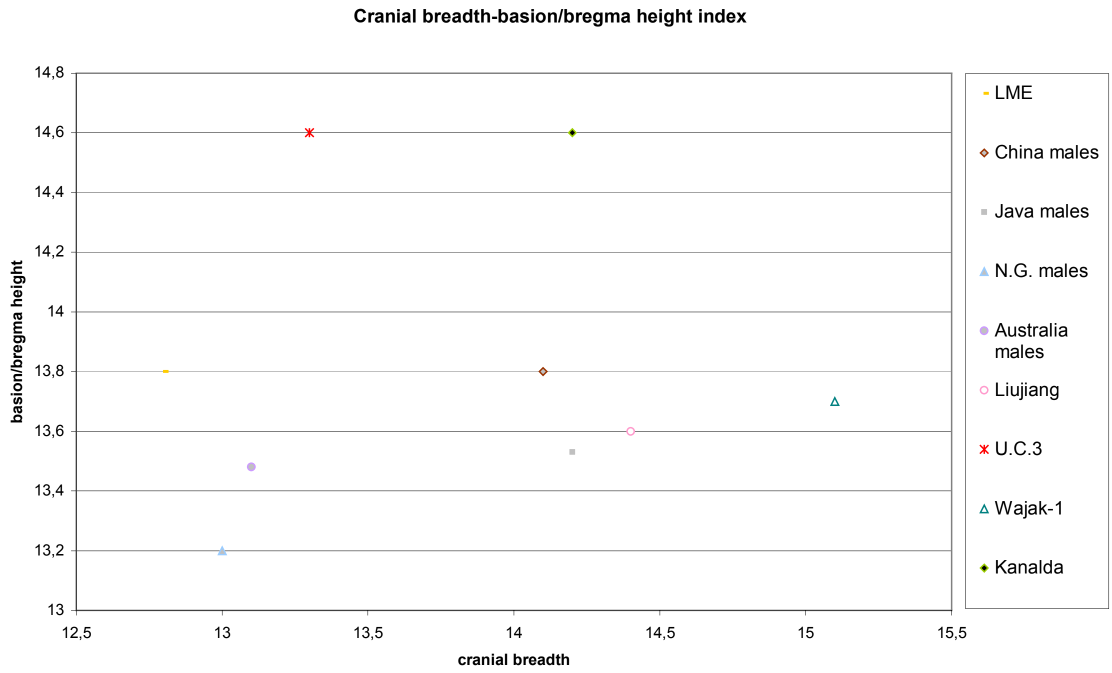
The difference in value of the breadth-basion/bregma height index between Wajak and Liujiang and their respective descendants seems odd, since this suggests that if Upper Cave 3 is part of an ancestral populatin, the index value first decreases, and then later increases again. This is unlikely if it is assumed that the population stayed in the same area and therefore under the same environmental pressures. An explanation would be genetic drift, but since there is no reason to assume there have been periods of isolation, which could make the population small enough for gene flow to have an effect, this is not a very likely option. The scatter diagram sheds some light on this problem (graph 18). The lengths of the Upper Cave skulls show some variation, in that Upper Cave 3 is of medium length, while Upper Cave 1 has the longest skull of the prehistoric and recent material studied. Kanalda has the same skull height and length as Upper Cave 3 (shown by the similar index value), but both Wajak-1 and Liujiang have significantly lower skulls, while still within the length range of the Upper Cave specimens. Their skull height is approximately the same as the male averages of the recent Javanese and Chinese populations. This could mean that the low length-basion/bregma values of Wajak-1 and Liujiang only reflect a decrease of skull height compared to skull length in the time between Upper Cave on the one hand and Wajak-1 and Liujiang on the other. This decrease was later followed by a decrease of skull length leading to the recent high index values in China and Java. The difference in breadth-basion/bregma height index is probably also linked to the early decrease in cranial height. In this case it was only later caught up by the decrease in breadth of the skull (graph 19).



Graph 18. Scatter diagram of the length-basion/bregma height index.

The mandibula L-H index of Lake Mungo-3 is intermediate between Liang Momer E and Liang Togé on the one hand and the other prehistoric specimens on the other. If Lake Mungo represents another population of generalised *Homo sapiens* like Upper Cave, this would correlate with a separate evolutionary history in Wallacea. While the trend on both the Sunda and Sahul shelves was towards a higher mandible, on Flores the mandibles became lower.

The similarity in parietal sagittal index between Liang Momer E and the old Mungo-1 could mean that this is also a primitive characteristic, derived from the generalised *Homo sapiens.* Lake Mungo-1 is dated at 24,000 BP, which brings it close to Upper Cave. It is therefore not unlikely that Lake Mungo-1 is also a generalised *H. sapiens*. The bulbous parietals of the recent Sulawesi and Sumba males could be a more recent local trend.



Graph 19. Scatter diagram of the breadth-basion/bregma height index.

The prognathic index could not be calculated for Liang Togé, but Jacob (1967) placed her in the "hyperprognathous range, bordering to ultraprognathism". Prognathism is not seen in a strong degree among the other prehistoric specimens. However, prognathism is not uncommon in recent Australian Aboriginal females and is also seen in the male skull from the Lesser Sunda Islands. In addition, prehistoric material is known to be more prognathic than their modern descendants.

A difference in the sizes of skulls and faces is usually found when comparing prehistoric material to recent populations. The difference is caused by a gracilisation trend towards smaller skull and faces. This trend is shown through the cranial and facial modules. It is also seen in the corpus mandibula module. This poses a problem when interpreting these values for Liang Momer E and Liang Togé. When the values fall within the modern range this could mean two things. Firstly, it could mean that they had already reached the modern size and there has not been much more change since. Secondly, the descendants of Liang Momer E and Liang Togé could have decreased further in this size and should be sought among the populations with the lowest modules. Since the results of these gracilisation trends are unknown, neither the cranial nor the facial module is much use in the study of affinity with recent populations.

4.4. Summary (table 99)

1. The breadth-basion/bregma height index that revealed a different trend in Wallacea from the surrounding areas shows similarity with Upper Cave 3 (graph 16).
2. The parietal sagittal index of Liang Momer E is close to that of Lake Mungo-1, while the mandibula L-H index of Lake Mungo-1 is intermediate between Liang Momer E, Liang Togé, and the other prehistoric and recent specimens.
3. Other indices, where Liang Momer E was closest to the populations of China or Java, show the resemblance of Liang Momer E to prehistoric material from Australia (length-basion/bregma height index, nasal index, parietal sagittal index, and the occipital sagittal index, graph 15 and 16).

The breadth-basion/bregma height index value of Liang Momer E, which is close to Upper Cave 3, but far from any of the younger prehistoric specimens, suggests a close affinity between these two specimens. The absence of this character in either the Proto-Sunda or Proto-Sahul specimens that predate Liang Momer E, may mean that Liang Momer E reveals a primitive characteristic, which was later lost before the Proto-Sunda and Proto-Sahul lineages diverged. In the model made by Storm (1995) this is the generalised *Homo sapiens* population to which Upper Cave 3 belonged. The similarity with Lake Mungo could be explained in the same way as the similarity with Upper Cave. Both sites are about the same age and could therefore very well represent two examples of generalised *H. sapiens* populations.

The third observation shows that these characteristics, which are now typical for the Sunda type, were also present in prehistoric Australian populations. This could mean that these characteristics were found in the generalised *Homo sapiens* and remained unchanged in the Sahul types for a long time. Afterwards they disappeared in the Sahul type, but somehow reappeared in the Sunda type. More logically would be that the Sunda type also conserved these characteristics, but this idea does not fit with the prehistoric evidence from the Sunda shelf. Three indices, namely the length-basion/bregma height index, the nasal index and the occipital sagittal index suggest that Wajak-1 and Liujiang did not have index values like their descendants or like Upper Cave. It is therefore unlikely that the Sunda-type preserves these characteristics since the generalised *Homo sapiens*. This demonstrates, the caution needed when trying to establish relationships between prehistoric and recent populations using indices (eventhough they are to some degree independent from absolute body size or gender). If nothing else, the presence of these characteristics in Australian prehistoric material as well as recent Sunda populations shows that they do not necessarily indicate relationships to Sunda populations. It also suggests a connection with Proto-Sahuls, and is not consistent with a special relationship to Sunda populations, because Liang Momer E is unlike the more or less contemporary Proto-Sunda Wajak-1 and Liujiang in all these respects. It is more likely that Liang Momer E has separated from the Sahul lineage, if a choice must be made between the two. However, the breadth-basion/bregma height index is consistent with the descendance of Liang Momer E and Liang Togé directly from the generalised *H. sapiens*.

Data from the upper facial index, nasal index, mandibula L-H index, breadth-basion/bregma height index, and perhaps the parietal sagittal index is consistent with separate evolution in Wallacea. The upper facial index and nasal index show a unique trend towards the very narrow face and nose of Sumba females, which corresponds to Liang Togé.

The mandibula L-H index shows extremely low mandibles in Liang Momer E and Liang Togé, not seen frequently anywhere else in Southeast Asia and Australia. The breadth-basion/bregma height index shows the high value of Liang Momer E, which is not found in surrounding areas or other prehistoric specimens, except for the generalised Upper Cave 3.

The parietal sagittal index is less clear, but the bulbous male parietals seen in the recent material is not seen in the surrounding areas or in the prehistoric specimens. This may be caused by the size of my sampling, but it is very consistent among the Sumba and Sulawesi males measured. An explanation could be a fairly recent local trend towards these bulbous parietals.

4.5. Present day Flores

In 1948 Keers published an anthropological study of the Lesser Sunda Islands. She documented different population groups to which she asscribed different origins. For instance, she distinguished Negrito groups from Proto-Malays (more Mongoloid characters like lighter skin, and straight hair). This study gives additional information about the male characteristics on the islands Flores, Sumba and Timor. Most of the groups are mesocephalic tending to dolichocephalic, leptoprosopic, and leptorrhine to mesorrhine. Both Liang Togé and Liang Momer E are similar in these respects. Both Liang Togé and Liang Momer E are much more dolichocephalic than any of the Flores inhabitants, but this can be explained in two ways. First, brachycephalisation is a possible local trend, which has occurred independently in several places, and could very well have broadened the skulls here. Second, Javanese or Chinese interbreeding in recent times has influenced the skull shape towards the mesocephalic range. Furthermore, Liang Momer E is too tall to be a member of any of the groups on Flores, Sumba, or Timor, since the male average lies around 159 cm. But this can be explained by the assumption that the descendants of Liang Momer E have reduced in stature to be better adapted to their environment. Of the groups on Flores, three are most likely to be related to Liang Togé and Liang Momer E, namely either one of the two dolichocephalic groups (one in Manggarai, one in Maumere) or the Negrito's in Badjawa (Ngada).

4.5.1. The Negrito's

The Negrito group found in the Badjawanese country is a little different from the other Negrito's found on Flores. The cranial index is slightly lower, leaning more towards dolichocephaly (42%; Keers, 1948). The total facial index is higher than that of the Lio Negrito's caused by a narrower and shorter face. The most striking difference is the nasal index, which is much lower in these Badjawanese Negrito's (leptorrhine to mesorrhine). Keers also examined Negrito groups on Sumba and Timor. Most important is the group on Sumba (Umba Wangu), which has even a more leptorrhine nose and narrow face, but the cranial index is more mesocephalic to brachycephalic.

According to Keers (1948) none of the Negrito groups found on the Eastern Little Sunda Islands are much like the Negrito's from the Philippines or the Mincopies of the Andaman Islands. The Philippine Negrito's are much smaller for one thing (male average 148 cm) and they are more brachycephalic.

The name Negrito has probably been given to several populations, which have little affinity with the Philippine Negrito's, based on certain somatoscopical characteristics are hair form or short stature. On the Lesser Sunda Islands, however, there is not much difference in stature between the Negrito's and the other tribes. The Negrito's are not even the shortest groups (Keers, 1948).

Tasmanians and inland tribes of Papua New Guinea have also been described as Negrito's (Huxley, 1870, for Tasmania; Jacob, 1967 for NG). However, Pardoe (1991) has shown this is not the case with Tasmanians. In his opinion, Tasmanians are simply a form of Australians with the differences as a result of isolation by distance. For Papua New-Guinea the idea is that the inland population, which were supposed to be Negrito's, are actually simply Papua New Guinea populations adapted to life in mountainous tropical forest with limited nutritional resources (Gajdusek, 1970; Howells, 1973) by a decreased stature. A high ratio of strength to body weight is advantageous in such an environment. Another possibility is that their short stature is the result of a local and recent mutation at perhaps a single genetic locus (Gates, 1961). Studies of African pygmies have shown that they are markedly deficient in the production of the insulin-like growth factor IGF-1 (Merimee *et al.*, 1981). It is believed that this deficiency was selected for by environmental conditions, and a tendency to short stature in the interiors of other large islands in Melanesia has also been noted (Bellwood, 1985).

The original population of Flores were nomadic food-gatherers and hunters as told by the oral tradition of some tribes (Heekeren, 1955). Agriculture came with the arrival of food-producing peoples on the island. These immigrants compelled them to move to the less favourable parts of the island. Some of the original tribes adopted agriculture. Others continued their nomadic food-gathering way of life down to recent times, as can be concluded from the microlith of beer-bottle glass in the Soki cave.

4.6. Migration and Evolution models

Over the years many migration and evolution models have been devised to explain the human fossil record in Australasia. These migration models vary from four to only one original migration. The initial settling of island Southeast Asia and Australia is assumed to have resulted from migrations from the Sunda shelf. The people probably made use of the islands along the way by which several routes into the area are possible (figure 7).

I. In the four waves theory the Indonesian Archipelago was populated by:

1. Wedda.
2. Negrito. Particularly the Negrito's as found on the Philippines and in Malaya.
3. Proto-Malay. These are probably mixtures of Negrito's (or Australoids) and Southern Mongoloid invaders.
4. Deutero-Malay. These are presumably a mixture of Proto-Malay and a second migration of Southern Mongoloids.

In 1948, Keers made an anthropological study of the Eastern Lesser Sunda Islands to investigate the success of each of these migration waves. She could not trace Wedda characteristics on the eastern Lesser Sunda Islands, although she did find traces of them on Sulawesi. They are certainly present in Malaya. Keers (1948) reported Negrito's on the Lesser Sunda Islands, but she classified these primarily based on hair form, chin form, and shape of the forehead. They are rather different in skull morphology from the Philippine Negrito's, however, as she herself concluded. It is possible that these Negrito's are related to each other, it is more probable to be caused by a mutual Australomelanesian origin. Another possibility is that the likeness between these different Negrito groups is caused by similar environmental adaptations. This is thought to be true for the short stature, but could also be true for the frizzy hair and other characteristics. In West-Sumba and West-Flores Keers found the Proto-Malay, but they were not seen more to the east. Keers (1948) did not find Deutero-Malay on the eastern Lesser Sunda Islands.

Bellwood (1985) dates the first Mongoloid invasion at approximately 1000 BC. He also states that the early metal phase is associated with southern Mongoloid populations (Southern Mongoloid material mostly post-dates 1000 BC). This Mongoloid expansion is associated with the onset of rice-cultivation (Bellwood, 1985). Both Liang Togé and Liang Momer E predate rice-cultivation, being hunters-and-gatherers. They also do not have shovel-shaped incisors, which is in high frequency in Mongoloids and the presence of shovel-shape is used as a criteria for Mongoloid descent in the fossil record.

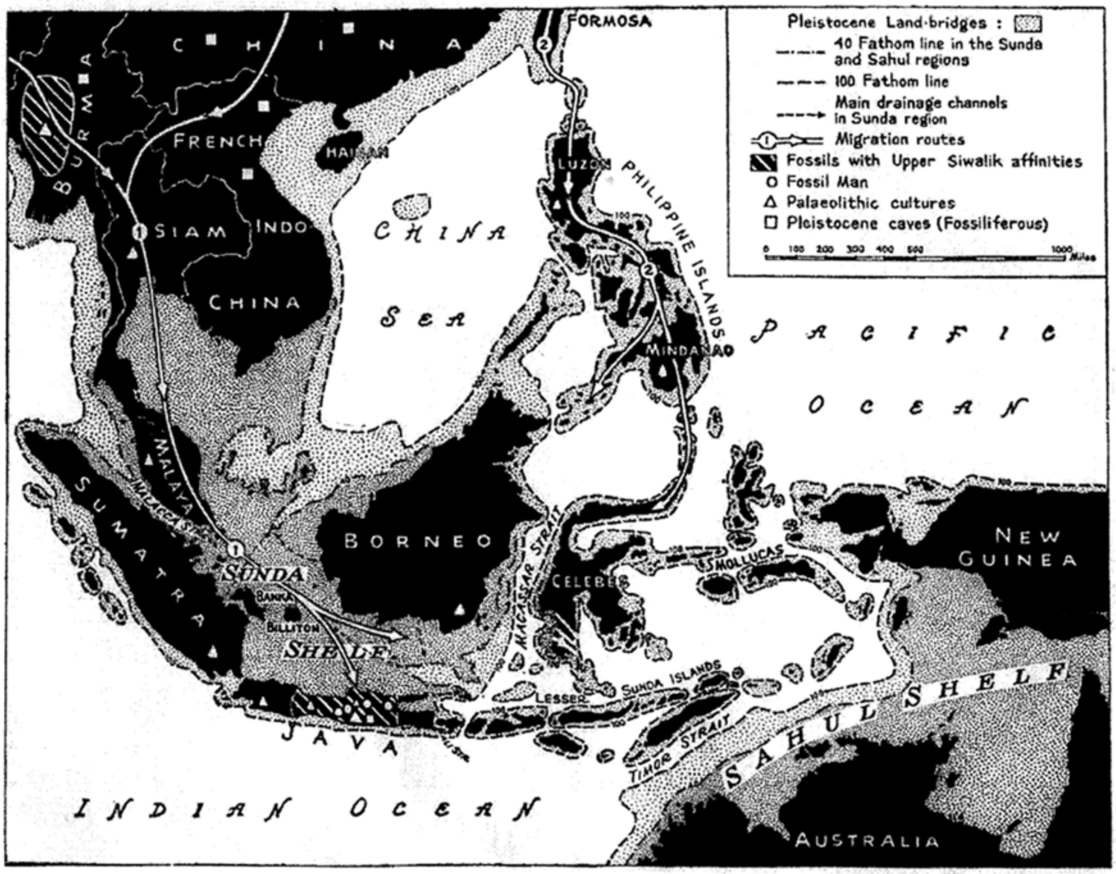


Figure 7. Two possible migration routes from the Sunda shelf to Wallacea from which migration to Australia and New Guinea is possible (after Heekeren, 1957).

II. Birdsell made a three-wave theory for Australia in 1949. This theory seeks to explain the prehistoric finds in Australia.

The populations involved in the successive migrations are (Storm, 1995):

1. Negrito represented by Niah (Borneo) and Mungo (Australia).
2. Murrayians represented by Liujiang (China) and Wajak (Java), Keilor and Kow Swamp (Australia).
3. Carpentarians.

The Carpentarians are now generally thought to be the result of recent contact between Aborigines and non-Aborigines along the north coast of Australia rather than a separate wave of colonists. There has, therefore, been a general rejection of the three-wave theory (Flood, 1983; see also Bellwood, 1985). But "Birdsell's belief that Australian variation does not derive from one single founder population alone has recently come back into favour" (Bellwood, 1985). This is partly due to the discovery of the gracile and robust populations of Australian prehistory. The gracile type (represented by Lake Mungo and Keilor) is thought by several authors to come from China. The robust type (represented by Kow Swamp and other sites as Coobool Creek and Cohuna) is suggested to stem from the Indonesian *Homo erectus* population as found in Ngandong, although the dating post-dates that of some gracile types. The morphology suggests that the robust type must have been present in the area from much earlier because of their more primitive morphology. There are no specimens found on Sundaland (or outside of Australia) that could be linked to the robust forms of Australian prehistoric specimens. This could mean that either they evolved in Australia, or that they just have not been found yet. Thorne (1977) suggests that they evolved outside of Australia.

However, not all agree with the robust and gracile separation. The robustness of WLH-50 could very well be caused by pathology. The vault thickening is in any case different from that in Asian *Homo erectus*. Peter Brown ascribes the archaic features of Kow Swamp individuals to cranial deformation (Flood, 1983). Lake

Mungo-1 is similar to Kow Swamp females and Lake Mungo 3 is just as likely a robust female as a gracile male (Brown, 2000).

Each of these three waves must have someway or other crossed Wallacea and they would most likely have left members behind on the islands. Liang Momer E and Liang Togé would then have been part of the Murrayian wave. But Liujiang and Wajak-1 do not resemble Liang Momer E or Liang Togé. It is therefore not very likely that these were part of a single migration wave. As for the Negrito's, I have already discussed that there is not a widespread group of Negrito's found in Southeast Asia.

III. The two-migrations theories described below are based on an original Australoid population, which was replaced by or mixed with Southern Mongoloids. There are two variations to this model given by Bellwood (1985):

a) Bellwood suggested that Australia and New Guinea were populated by at least 40,000 years ago from the Indo-Malaysian Archipelago (presumably the Wallacean end of it). Australia and New Guinea have undergone independent differentiation since, but still retain clear traces of their common origin. The Indo-Malaysian populations left behind after the settlement of Australia and New Guinea continued to diversify, and underwent certain trends in cranial and facial gracilisation convirgently with adjacent Mainland Southeast Asia populations. These groups remained phenotypically as Australoids, in some cases to the present. From 3,000 BC onwards, the Indo-Malaysian region was settled from the north by linguistically related and expanding populations of Southern Mongoloids, the Austronesian-speaking populations. The expansion was clearly underway by about 4,000 BC in Taiwan, by 2,500 BC in the Philippines and eastern Indonesia generally, and by perhaps 1,000 BC or later in western Indonesia. This presumed (but unproven) late date for western Indonesia might suggest that densely populated islands such as Java were still occupied by bands of small and gracile Australoid hunters and collectors into the first millennium BC. However, recent work investigating the origin of the present Austronesian speaking inhabitants of Southeast Asia using genetics (*e.g.* Capelli *et al*., 2001) states that their paternal heritage leads back to earlier settlers of the area and not the more recent invaders. They do find some evidence of northern interbreeding, which confirms the change seen after 1,000 BC, but this Mongoloid invasion is perhaps better viewed as the arrival of a limited number of Mongoloids, which mixed with the local inhabitants and caused a change of culture associated with the rise of agriculture. This scenario makes it possible that characteristics found in Liang Momer E and Liang Togé (Pre-Mongoloid invasion) are still present in the recent inhabitants of Flores and the surrounding islands.

b) An alternative model is the Southern Mongoloid replacement Model for the Indo-Malaysian Archipelago. In this model, the majority of Island Southeast Asian peoples belong to a Southern Mongoloid population, which has replaced or absorbed an earlier Australoid (or "Austromelanesian") population. This replacement is thought to be confined mainly to the Neolithic and later periods. Material from Niah (Borneo) and Tabon (Philippines) shows Australoid finds from before 1,000 BC, but a sudden increase in incisor shovelling occurs in burials all post-dating 1,000 BC. This racial change is not seen in Gua Cha, which ranges from 10,000 to 2,000 BP. This model assumes that the reduction of teeth was a result of the development of agriculture, and that the smaller tooth sized Mongoloids invaded the islands via the Philippines replacing the larger tooth sized Australoids. This replacement caused the cline in tooth size from China to Australia.

Bellwood (1985) does not believe that teeth reduction was linked to the development of agriculture and this is the main difference between his model and the Southern Mongoloid replacement model. In the material from the other Flores sites a sudden change in tooth morphology appears in Gua Alo and Liang X. This increase in shovel-shaped incisors is accompanied by the onset of labial filing. This change could very well be caused by a migration of Southern Mongoloids into the area at some point after 1,000 BC, which corresponds nicely with dates of Gua Alo and Liang X at younger than 3,000 BP. Unfortunately, not much of the morphology is left for Gua Alo and Liang X to investigate this.

Jacob (1967) also favoured two-migration models based on the replacement of an Australoid race by a Mongoloid invasion. At that time the dating of Wajak was unknown, which resulted in these two models:

a) The Austromelanesian and Mongoloid model. In this model the Austromelanesians came first and then differentiated into the Australians and Melanesians. Mijsberg (1940) thought this separation occurred before they left the Asiatic continent. However, Jacob (1967) stated that no really Australoid looking specimen has been found in Southeast Asia. This has been contradicted by a number of other authors who have compared Niah to Lake Mungo. Brothwell (1960) for instance concluded that "Niah is of Australoid affinity". Furthermore Thorne (1977) argued that Niah in terms of its general structure would appear to fit within the morphological type represented by the Lake Mungo skeletons. Jacob (1967) considers the Niah people as the possible forerunners of the Australoids. The first round of interbreeding between the Austromelanesians and the Mongoloids resulted in the Proto-Malays, whereas the second one, between the Proto-Malays and the Mongoloids constituted the Deutero-Malays with increased Mongoloid characteristics. Hence more Austromelanesians and Proto-Malays were of older age and found in the east, and more Deutero-Malays and Mongoloids were of younger age and found in the west. If Niah is similar to Mungo, this supports the idea that Australian Aboriginals have come from Sundaland, because Borneo was attached to Sunda when sea levels were lower during the last ice age. Furthermore it makes it likely that these gracile Proto-Sahuls (Lake Mungo) travelled eastward from either Java, or China (via Philippines to Borneo or Sulawesi) (figure 7).

b) The second two-migration theory starts with Wajak, which later differentiated into the Austromelanesians and Malay races. Then the Mongoloid migration followed. According to this hypothesis, the Wajak stage is comparable to the Cro-Magnon of Europe, and Wajak man inhabited Southeast Asia after the Neanderthals became extinct. Thus, no real Australoid or Malay races were present earlier; their remains might be expected only from the period after their differentiation from Wajak. The Australomelanesians travelled southward and eastward, while the Malays remained in the west or migrated to the Northeast. It could be this last group from which the Polynesians originated. Later the Mongoloids moved southward from the north. The Australoids developed in Melanesia or Australia.

Wajak man was more precisely dated after this publication of Jacob (1967), making it clear that Wajak cannot be the ancestor of the Austromelanesians and Malay races because he is too recent (Shutler *et al*., 2004). Jacob (1967) considered Sampung as an Austromelanesian, Guar Kepah and Flores as Proto-Malays (Austromelanesians mixed with Mongoloids) and Leang Tjadang as a population with a more dominant Mongoloid element (Deutero-Malays).

IV. Single migration model (Bellwood, 1985):

a) This Indo-Malaysian continuity model was foreshadowed by Weidenreich (1945) when he pointed out that brachycephalisation could have evolved locally in different populations. Hooijer pointed out that tooth size was not a reliable race indicator (1950a, 1952). Turner and Swindler in 1978 suggested a Late Pleistocene link between the Southern Mongoloids and Melanesians on the basis of dental characteristics. They saw the incisor shovelling of the Mongoloids as proof of the separation of the Melanesians from the Mongoloids, because they do not commonly show this characteristic. Bulbeck (1982) investigated the occurrence of grade or clade changes by examining a large amount of cranial material from the Late Pleistocene through to recent Southern Mongoloid. Continuous and unbroken trends throughout his study are: occurrence of the Sundadont dentition (dental characteristics of the Late Pleistocene Sundaland populations); size reductions in teeth, faces and palates; and a reduction of facial prognathism; but a recent increase in the occurrence of upper incisor shovelling.

Thus this model implies that there was no migration of Mongoloids from the north, and with the exception of teeth characteristics, the changes in morphology in the absence of a rigidly-defined chronology for the remains can be caused by changes in cline or grade or both. This theory seems unlikely, simply because the increase in shovel-shaped incisors is very sudden. This can be explained best by migration of a population with this characteristic in high frequency, the Southern Mongoloids.

b) The model of regional continuity in Australoid and Mongoloid evolution suggests that the *Homo erectus* populations have passed on at least some of their locally-distinctive morphological characteristics to the present Mongoloids and Australoids (*cf*. Weidenreich, 1946; Coon, 1962). *H. erectus* has been found on Flores and this proves, that they were capable of crossing the water. If they came that far, they may have made it to Australia as well. If so, that could explain the gracile and robust *Homo sapiens* finds in Australia, as perhaps the robust type descended from *H. erectus*, while the gracile type could represent a later *H. sapiens* migration.

In contrast, Mellars & Stringer (1989) state that "Lake Mungo and Niah (Borneo) are the oldest material from that region (24,700 and 39,000) and do not show the combination of "possible" regional features, but they are present in WLH-50 and other prehistoric material". This would contradict the above model and demand a more recent dispersal model (such as described in Storm, 1995). Also, many authors do not accept that Upper Cave resembles the modern Chinese. Of course if there is no resemblance, this breaks up the regional continuity model. However, Brown (1992a) states that Upper Cave 1 may not be a modern Mongoloid, but the only differences between Upper Cave 1 and mid-Holocene to recent Chinese crania are similar to the differences, which distinguish terminal Pleistocene and mid-Holocene crania in other parts of the world. Terminal Pleistocene crania tend to be longer, with great supraorbital breadth, low rectangular orbits, deeper facial skeletons, and they are generally more prognathic and have larger dentitions than their mid-Holocene counterparts.

Supporters of the regional continuity model have emphasised the resemblance between Javanese *Homo erectus* and the undated WLH-50 cranium from Australia. This is based on the apparently archaic thickness of the WLH-50 vault. But the vault of WLH-50 is thickened everywhere, while Asian *H. erectus* and early *Homo sapiens* vaults are preferentially thickened at the parietal eminence and asterion, but not elsewhere. Therefore, the vault thickness of WLH-50 is probably pathological.

In Australasia *Homo erectus* and terminal Pleistocene *Homo sapiens* are found, but not early *H. sapiens* (if Ngandong is considered to be *H. erectus*) comparable to Dali. If such an early *H. sapiens* cannot be found, it favours the out-of-Africa model, because it could be likely that *H. sapiens* did not enter Southeast Asia until relatively late.

5. Conclusion

The migration models discussed above usually concentrate on specimens from either mainland Southeast Asia or Australia. Not much attention has been paid to the Flores specimens described above. They are, however, the most complete specimens found in Wallacea from prehistoric times and as such can reveal much about early migrations in the area. Based on information derived from the Flores specimens, I have come to a new model for migration and evolution in Southeast Asia.

In contrast with Storm (1995), I have placed the date of dispersal of the different groups of the generalised type at 40,000 BP. I have based this on the dates of the generalised specimens. Niah has been dated to about 40,000 BP, Upper Cave is dated between 34,000 to 24,000 BP, and Lake Mungo-1 is dated at 24,000 BP (although Lake Mungo-3 is thought to be a little older, between 40,000 and 30,000 BP). Artefacts suggestive of human occupation have been found from older dates, but the lack of knowledge about the morphology of those populations makes it impossible to use them in this model.

5.1. A new model for the evolution of *Homo sapiens* from the Wallacean islands

About 40,000 years ago a generalised *Homo sapiens* (meaning without regional characteristics present in modern populations) lived in mainland Southeast Asia. At one point some of these people decided to leave and cross the water toward the islands in Wallacea, possibly due to over-crowding, or lack of food sources, etc. The generalised type has probably used the islands as stepping-stones on the way to Australia. It is unlikely that these people had knowledge of the existence of Australia, meaning that they did not aim to reach it. They simply moved in that direction from island to island and the topography of these islands draws almost a direct line from Java to Australia. Every time they reached another island, they probably stayed there for a while until forced to move on again. Undoubtedly a subpopulation remained behind on each island, becoming isolated from both the group on the Sunda shelf and the group moving to Australia. In this way the generalised *H. sapiens* spread out over Southeast Asia. Representatives of the generalised population are found in China (Upper Cave), Borneo (Niah), and Australia (Lake Mungo). This population had certain characteristics, which are represented in either Upper Cave or Lake Mungo in this study (table 99).

Unfortunately, none of the characters can be determined in material from both these sites, but since they belonged to the same population, it is possible that a character present in the one was also present in the other. Among these generalised characteristics were a high and narrow skull (Upper Cave) and a comparably low parietal sagittal index (Lake Mungo). Initially all the generalised characters were present in the populations inhabiting Southeast Asia. This means Niah is probably another representative of this population, although material is scarce. The water barrier isolating Wallacea, Sunda, and Sahul from each other prevented gene flow and caused separate evolution in each of these three regions. Storm hypothesised in 1995 that this generalised type consequently dispersed into two separate lineages, namely the Sunda type and the Sahul type (figure 2). On the Sunda shelf, this resulted in the loss of all generalised characteristics except for the broad nose by the time of Wajak and Liujiang (table 99). The fact that neither Wajak nor Liujiang have any characters in common with Liang Momer E or Liang Togé proves that this water barrier was very significant between Java and Wallacea.

In Australia most of the generalised characteristics were still present in at least one of the different populations, except for the mandible, which had already a higher ramus (table 99). Storm (1995) could not place Liang Momer E or Liang Togé into either of these two types because in Wallacea a third pattern had arisen (figure 8). While a lot of characteristics remained the same, the face and nose became narrower than those of the surrounding areas and the mandibular ramus became lower (table 99). At least two of these unique features of Liang Togé and Liang Momer E still exist in Wallacea, namely the narrow nose and face. Liang Momer E and Liang Togé therefore are direct descendants of the generalised type, which have undergone their own evolution and they are ancestors to at least part of the populations of Sumba and Timor.

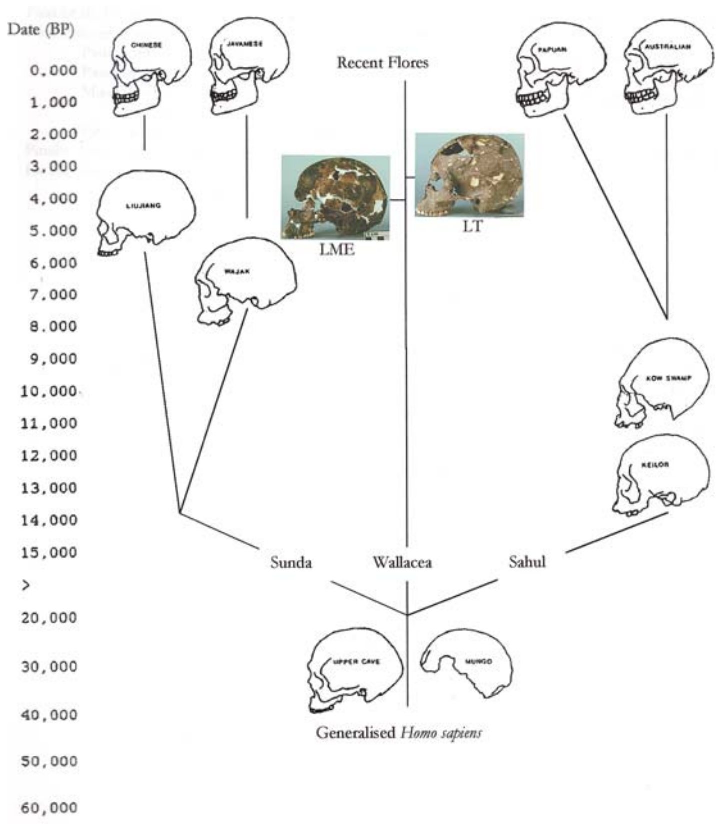


Figure 8. Representation of my model for evolution of modern man in Southeast Asia.

After 3,000 BP a population with a high frequency of shovel-shaped incisors and the habit to file their upper front teeth invaded Flores as shown by the material from Liang X and Gua Alo. It is possible that these were Southern Mongoloids.

Into more recent times, an increase in interbreeding with the Sunda and Sahul shelves can be seen in the different trends between the four studied Wallacean islands. The differences with Liang Momer E can in most cases be explained by a trend towards the closer of the two shelves (Australia and New Guinea for Timor, Java for Sumba and Sulawesi). The unknown origin of the skull from (somewhere on) the Lesser Sunda Islands makes this distinction difficult, but it seems to have some characters of both shelves mixed together.

The presence of people on Sumba and Timor, which resemble Liang Momer E and Liang Togé rather closely, makes it highly likely that such people can also be found on Flores itself. The most probable candidates are the more Australoid looking tribes (the Negrito's found by Keers in 1948), since they are thought to have lived on the island since before the migrating Mongoloids (the Proto-Malays found by Keers in 1948).

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8. Appendix

Method	Characteristic	Liang Togé	Liang Togé male	Liang Momer E	Gua Alo 3	Gua Alo 2
Pearson, 1898		148.29		166.48		
Feldesman *et al.*, 1990	Gender & race independent	143.04		167.9		
Trotter & Gleser, 1952, 1958	American white	148.44		171.42		
	Negro	145.84		166.97		
	Mongoloid males			171.39		
Trotter, 1970	American white males			170.93		
Breitinger, 1937	West European males			169.63		
Bach, 1965	West-European females	155.76				
Bergman & The, 1955	Javanese					
	Long bones	152.8		168.4		
	Circumference direct	151.34	159.4	164.59	147.56	160.67
	Circumference à long bones	151.26		163.96	149.05	161.52
Average		149.6	159.4	168.17	148.31	161.1

Table 92. Different methods for stature calculation and their outcomes.

Skull	Liang Togé	Liang Momer E	Liang Momer A	Liang Momer C	Liang Panas	Aimere	Gua Alo 1	Gua Alo 2	Liang X
Glabella	-1	2	1						
Superciliary arch	-1	1	2						
Frontal/parietal tubera		1	-1				-1	-1	-1
Frontal inclination	-1	-1							
Mastoid process	-2	2	-2		0	0	0		-1
Nuchal plane	0	1				2	1		0
External occipital process	-1	0				1			
Temporo-zygomatic process	-1	1					1	1	
Zygomatic bone	-1	0	0						
Supramastoid crest	-2	1	-1			0		1	-1
Orbit	-1	1							
Mandible	Liang Togé	Liang Momer E	Liang Momer A	Liang Momer C	Liang Panas	Aimere	Gua Alo 1	Gua Alo 2	Liang X
General	-1	1		1		1	1	1	
Mentum	-1	1		1	1	1	2		
Angle	0	1		0			1	1	
Inferior margin	0	0		1	1	1	1	1	
Pelvis	Liang Togé	Liang Momer E	Liang Momer A	Liang Momer C	Liang Panas	Aimere	Gua Alo 1	Gua Alo 2	Liang X
Pre-auricular sulcus	-1			-1	1				
Greater sciatic notch	-1			1					
Pubic angle		1							
Arc composé	-1			1					
Innominate bone	-1								
Obturator foramen		0							

Ischial body		1		1	0				
Iliac crest	-1								
Iliac fossa	-1								
Pelvic inlet									
Gender	Female	Male	Female	Male	Male	Male	Male	Male	Female

Table 93. Sex determination of Flores material.

	Liang Togé	Javanese females	Range	Liang Momer E	Javanese males	Range
Humerus/tibia index	93.3	86.1	80.8-92.2	86	87.3	81.5-91.6
Tibia/femur index	79	83	79.5-86.8	84.9	82	78.8-84.9
Radius/tibia index	69.8	62.6	57.6-65.9	-	65.2	61.3-70.1
Humerus/femur index	73.6	71.4	67.0-76.3	72.9	71.6	67.3-74.8
Humerus circumference/length index	18.2	18.6	16.5-20.8	14.1	19.6	16.8-22.9
Radius circumference/length index	14.3	15.2	13.1-18.3	-	16.7	14.5-20.8
Femur circumference/length index	18.4	18.5	16.4-19.8	19.5	18.8	15.5-21.5
Tibia circumference/length index	20.3	18.8	16.1-24.0	18.3	20	17.1-22.3

Table 94. Limb proportions and robusticity of Liang Togé and Liang Momer E compared to recent Javanese males and females. Javanese data derived from Bergman & The (1955).

- Shapeless flakes or waste-products without bulb of percussion and without signs of secondary trimming.
- Crude flakes with bulbs of percussion and use-marks.
- Small blades varying in length.
- Asymmetrical scrapers with marginal retouche along the sharp edges.
- Small ornaments made of mother-of-pearl, pierced by one or two round holes.
- Small cores displaying some preliminary knapping and the chopping of a part forming a plain platform before the flakes were detached.
- Large core without platform.

Table 95. List of artefacts from Liang Togé (Heekeren, 1967).

Bat: *Dobsonia* cf. *peroni* (E. Geoffroy); (Hooijer, 1967)	Fragment of mandible (Verhoeven, undated).	Recent. (Musser, 1981)
Macaque: *Macaca fascicularis* (Raffles) subspecies	One lower last molar.	Recent + subfossil, introduced.
Rat: *Rattus rattus* (L.) subspecies	Various mandibles.	Recent, introduced.
Giant rat: *Papagomys armandvillei besar* (Hooijer)	Various mandibles, bones.	Recent + subfossil.
Giant rat: *Papagomys verhoeveni* (Hooijer)	Maxilla, various mandibles, bones.	Subfossil, extinct.
Giant rat: *Spelaeomys florensis* (Hooijer)	Two maxilla, various mandibles, bones.	Subfossil, extinct.
Giant rat: *Floresomys naso* (Musser)	Piece of right dentary with complete molar row and part of the incisors.	Subfossil, extinct.
Giant rat: *Komodomys rintjanus* (Musser)	Left mandibular fragment with an incisor and three molars.	Subfossil, extinct?
Porcupine: *Hystrix javanica* (van Weers)*	One upper molar.	Recent + subfossil, introduced.
Pig: *Sus scrofa* (L.)	Fragment of lower canine.	Recent + subfossil, introduced.

Monitor lizard: *Varanus hooijeri* (Brongersma)	Right maxillary and fragment of right dentary bearing three teeth.	Subfossil, extinct (Brongersma, 1958).
Shell: *Cyclotus politus* (Sow.)		

*Table 96. Fauna list of Liang Togé. *First recorded as* Acanthion brachyurus (L.).

	Liang Togé CB = 11.0 cm	Liang Togé CB = 11.5 cm	Liang Togé CB = 12.0 cm	Liang Togé CB = 12.5 cm	Liang Togé CB = 13.0 cm	Liang Momer E	Sumba female	Sulawesi females
Cranial index	62.1	65	67.8	70.6	73.4	70.3	70.9	80.9
Breadth-auricular height index	103.6	99.1	95	91.2	87.7	88.3	82.9	81.2
Transverse frontoparietal index	84.5	80.9	77.5	74.4	71.5	73.4	67.4	66.2

Table 97. Correction for cranial breadth estimation.

	Site	Abbreviation	Gender	Date (BP)	Source
China	Upper Cave 1 (Shandingdong, Zhoukoudian)	U.C. 1	male	24-34'000	Storm (1995)
	Upper Cave 2	U.C. 2	female	24-34'000	Storm (1995)
	Upper Cave 3	U.C. 3	?	24-34'000	Storm (1995)
	Liujiang		male	4-5'000	Storm (1995)
Java	Wajak-1		male	6'560	Storm (1995)
	Wajak-2		male	6'560	Storm (1995)
	Hoekgrot	H.G.	female	3'265	Storm (1995)
	Gua Jimbe	G. Jimbe	?	2'650	Storm (1995)
Malaya	Guar Kepah B347	G.K. B347	?	4-5'000	Bulbeck (1996)
Philippines (Palawan)	Tabon		?	23'000	Mellars & Stringer (1989)
Borneo	Niah		?	39'820	Brown (2001)
Australia	Kanalda (Coobool Creek)		male	14'300	Brown (2001)
	Keilor		male	12'000	Brown (2001)
	Kow Swamp 5	K.S. 5	male	9'590	Brown (2001)
	Kow Swamp 15	K.S. 15	male	9'590	Brown (2001)
	Lake Mungo 1	Mungo-1	female	24'000	Brown (1992a)
	Lake Mungo 3	Mungo-3	male	30'000	Brown (2001)
Flores	Liang Bua 1 (*Homo floresiensis*)	LB1	female	18'000	Brown (2004)

Table 98. Overview of prehistoric specimens and their dating.

	Liang Togé	Liang Momer E	Upper Cave	Liujiang	Wajak	HG	Guar Kepah	Kanalda	Kow Swamp	Keilor	Lake Mungo
Cranial index	--	-	-	0	0	+		0	-	0	
Length-basion/bregma height index		+	+	0	-			+			

Upper facial index	+	0			-		-			
Nasal index	--	-	0/+	+	+		+	-/++	0	
Mandibula L-H index	-	-			+		+	+		0
Breadth-basion/bregma height index		+	+	-	-		0			
Parietal sagittal index	+	-			0	--	0		-	-
Occipital sagittal index	-	-			+		-		+	
Prognathic index		+			-		+			
Cranial module		-	0	0	0/+		+			
Facial module	-	0			+		+			
Corpus mandibula module	-				+		0			

Table 99. Characteristics of Liang Togé, Liang Momer E, and other prehistoric specimens. -- = Relatively very low index value. - = Relatively low index value. 0 = Relatively medium index value. + = Relatively high index value. ++ = Relatively very high index value.

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