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# BIO-ANTHROPOLOGICAL STUDIES OF EARLY HOLOCENE HUNTER-GATHERER SITES AT HUIYAOTIAN AND LIYUPO IN GUANGXI, CHINA

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National Museum of Nature and Science Tokyo,
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# PREFACE

This monograph is a product of a multi-disciplinary and multi-national research project by researchers from China, Japan, and Australia to understand the prehistory of Guangxi Province in China based on our bio-anthropological analyses of the early Holocene hunter-gatherer sites of Huiyaotian and Liyupo. The principle focus of this volume are the micro-evolutionary history, specific and general aspects of health, subsistence strategies, and burial practices of these ancient hunter-gatherers. We hope that this monograph will provide an invaluable source of information concerning prehistoric peoples in East Asia.

The editors would like to thank all of the authors for their contributions to this volume.

Hirofumi Matsumura 松村博文
Hsiao-chun Hung 洪曉純
Li Zhen 李珍
Kenichi Shinoda 篠田謙一

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# CONTENTS

# 1
# Introduction

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## PROJECT CONCEPT

Guangxi Province in Southern China has produced a great quantity of important and unique prehistoric human remains. For example, the Liujiang materials are well-known Late-Pleistocene human fossils, and subsequent early to middle Holocene sites, such as Dalongtan, Zengpiyan, and Dingsishan, exhibit transition stages between hunter-gatherer subsistence to agricultural development. This research project focused on two shell-midden sites in southwestern Guangxi that were settled by early hunter-gatherers, Huiyaotian and Liyupo, which date to approximately 9,000 to 7,000 years BP and are contemporary with the early rice-farming societies in the middle and lower Yangtze River Valley. The site of Huiyaotian is located in the Qingxiu District in the eastern suburban area of the City of Nanning on a terrace along the Yongjiang River. Liyupo is located in Longan County around 80 km northwest of Nanning. Huiyaotian is notable for its inhumation burials, which are customarily in a flexed positioned style (four-limbs tightly flexed at the joints) but also are found with a squatting style. The burial practice of Liyupo is also unique, in that people in a flexed position were covered frequently with large stones.

Another unique and significant feature of these prehistoric foragers is their skeletal morphology, particularly their cranial forms that exhibit identifiable characteristics, which are distinctive from present-day East Asians. Current cranial morphology reflects the fact that Eastern Eurasia has been widely occupied by people morphologically adapted to an extremely cold climate during the last glacial period, who display the characteristics of very flat face and proportionally short limbs. Hypothetically, individuals with these characteristics would have dispersed throughout Eastern/Southeastern Asia along with an agricultural society that included plant and animal domestication from the Neolithic period onward. At the very least, the pre-Neolithic hunter-gatherers of Huiyaotian and Liyupo visually present a very different cranial form from later occupants of the area.


Figure 1-1. Research participants at the excavation of Huiyaotian and the monuments at Huiyaotian and Liyupo (Lower left: Yamagata M., Matsumura H., Shinoda K., Sawada J., Nguyen LC., and Li Z.; Lower right: front Huang Q., Hung HC., Yamagata M., Miyama E., rear Huang Y., Liu J., Matsumura H., Li Z., Kaifu Y., and Watanabe S.).

Studying the population history of East Asia has been difficult due to various migration processes and intermixing of populations throughout prehistory. Focusing on an area adjacent to Guangxi, for instance Vietnam in the early Holocene, it can be seen that the so-called epi-Paleolithic Hoabinhian foragers exhibited Australo-Melanesian characteristics. It has been argued that a similar indigenous population occupied Southeast Asia and replaced or intermixed with later Neolithic agricultural populations originating from northern mainland China. This population history model in Southeast Asia is known as the "two-layer" model.[1][2][3][4][5]

Given this perspective from the population history of surrounding regions, the discovery of human skeletal remains at the shell-midden sites of Huiyaotian and Liyupo is very important evidence of early hunter-gatherers and their unique mortuary practices. These cranial remains provide a valuable opportunity to evaluate the "two-layer" model

Figure 1-2. Views of post-excavation activities by the research members (cleaning and reconstructing, 3D scanning, DNA sampling skeletons at the storage Nanning City Museum) and members at the symposium at the Guangxi Institute of Cultural Relic Protection and Archaeology organized by the Director, Lin Qiang (seventh from the right).

hypothesis in mainland China. Thereby, based on discussion and agreements between Director Lin Qing, Professor Li Zhen (Guangxi Institute of Cultural Relic Protection and Archaeology, China), Dr. Hsiao-chun Hung (Australian National University), Professor Zhang Chi (Peking University), and Professor Hirofumi Matsumura (Sapporo Medical University) in March 2011, a joint research program focusing on the archaeological human remains from these two key sites was established. The research, including excavation and post-excavation activity, was carried out from 2012 to 2016 (see Figures 1-1 and 1-2).

## VOLUME STRUCTURE

This volume is a product of multi-disciplinary and multi-national efforts over the past five years. The first section (Chapters 2–8) presents the basic information concerning the human remains from Huiyaotian, and the second section (Chapters 9–14) describes the materials from Liyupo. These two sections provide general information on the sites, including location, cultural context, burial distribution, C14 chronology, and morphometric data recorded for the human skeletal and dental remains excavated from the cemeteries. Furthermore, detailed descriptions of the posture observed in one of the best-preserved cases of the unique squatting burials at Huiyaotian are included.

The third section (Chapters 15–19) explores comprehensive studies using materials from the two sites. The morphometric analyses address cranial and dental limb affinity in comparison with surrounding population samples from East/Southeast Asia and the Western Pacific. The paleopathological study assesses stress markers in terms of dental enamel hypoplasia, cribra orbitalia, and oral diseases in comparison with later Neolithic agricultural population samples from the surrounding area. An examination of ancient mitochondrial DNA is presented in this section. Lastly, a summary of this project is given in Chapter 20.

## CONFERENCE PRESENTATIONS

In addition to the material included in this volume, the results of this project were presented in the 69th Annual Meeting of the Anthropological Society Japan, with the titles listed below.

*Unique Flexed Burial Human Remains of Prehistoric Hunter-Gatherers in Yongjiang Region*, *Guangxi*, *China* — *Challenging Hypothesis on the Population History of Eastern Eurasia* — presented by Matsumura H, Li Z, Huang Y, Huang Q, Kubota S, Nguyen LC, Miyama E, Yamagata M, Watanabe S, Sawada J, Shinoda K, Kaifu Y, and Hung HC. Abstract: *Anthropol. Sci.*, 2015, 123: 9.

*Paleopathological Findings in the Prehistoric Hunter-gatherer Skeletons of Yongjiang Region*, *Guangxi*, *China* — presented by Sawada J, Li Z, Huang Y, Huang Q, Kubota S, Miyama E, Watanabe S, Yamagata M, Nguyen, LC, Hung H, and Matsumura H. *Anthropol. Sci*., 2015, 123: 10.

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# 2
# Huiyaotian Site in Nanning, Guangxi, China

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This chapter presents a brief introduction of the Huiyaotain site in Nanning, Guangxi, which is one of the key sites of our focus for this international archaeological collaboration research.

## SITE LOCATION AND RESEARCH HISTORY

Huiyaotian is located at the foot of Huiyaotian hill, which is in the south of San'an garden, Qingxiu district, Nanning city, Guangxi (Figure 2-1). The site is located on the first terrace on the left bank of Yongjiang River, and about 12–15 meters above the river. The extant area of the Huiyaotian site is 1800 square meters, about 60 meters long (east-west) by 30 meters wide (north-south). It is one of the well-preserved shell mounds in Yongjiang river basin. It is surrounded by short hills in the east, west and north.

Huiyaotian was discovered in 1973, and now is a protected cultural relic of Guangxi Zhuang Autonomous Region. The site was first excavated by a joint archaeological team from the Relic and Archaeology Institution of Guangxi, and Nanning City Museum, from April to July in 2006. The 2006 excavation opened 11 test pits of 5 by 5 meters for each square, about 280 square meters of total exposed area, located in the east, west and north portions of the site. This excavation discovered a clear stratigraphic sequence, with a large number of important cultural and natural relics. Because the landscape of Huiyaotian is higher at its north portion, the stratigraphic deposit therefore leans from north to south. The thickness of the cultural component is about 60 to 120 cm, in a matrix composed mainly of river shells (Figure 2-2).

## CHRONOLOGY

Three samples including 2 charred *Canarium* sp. seed fragments and one human tooth have produced AMS dating results (see Table 2-1). The results indicate the age of Huiyaotian is about 7,000–6,300 cal. BC. This dating and its archaeological findings (see below) are congruent with the Dingsishan Cultural Phase of the Guangxi region. As noticed previously, while rice-growing economies were developing in the Middle

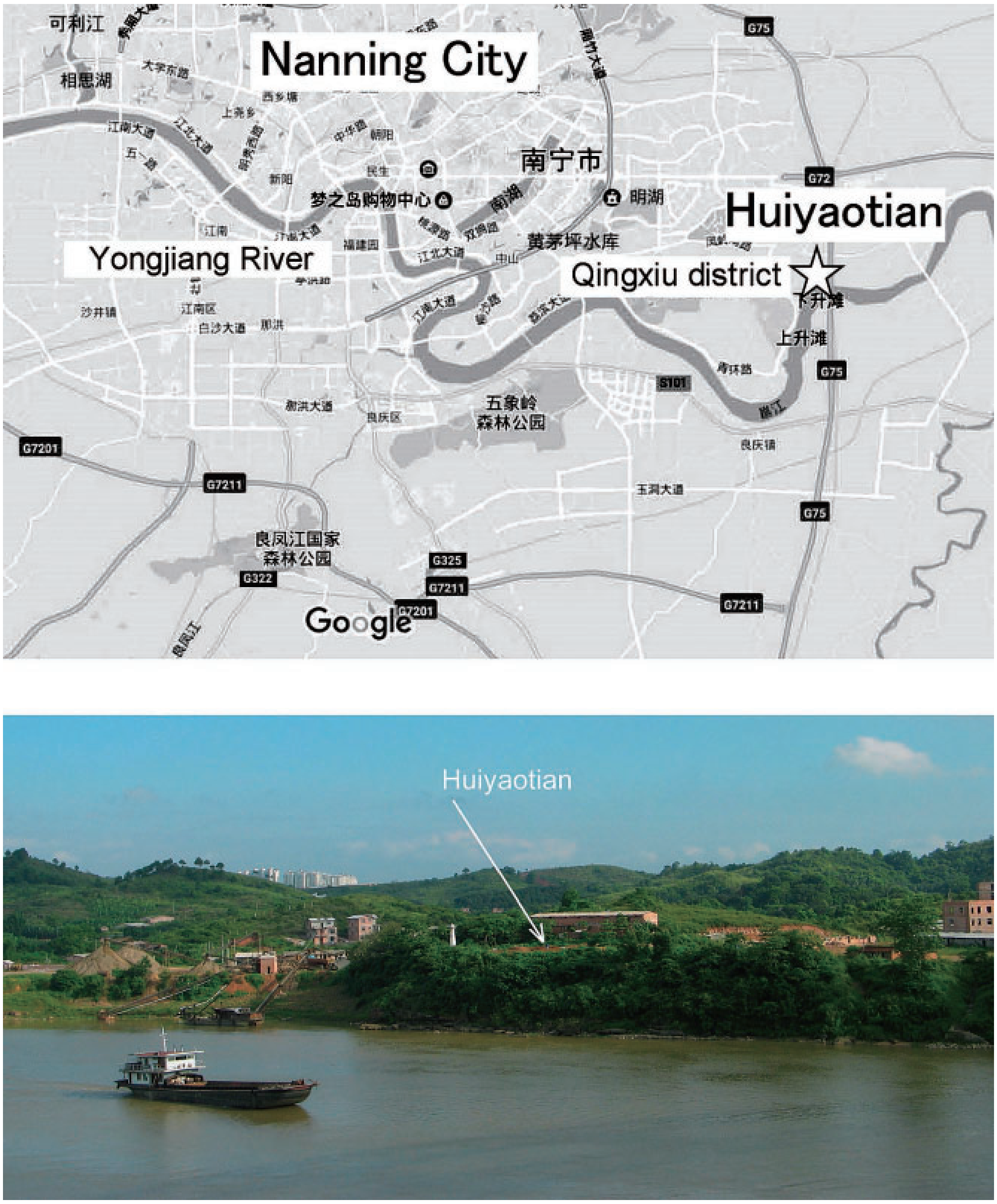


Figure 2-1. The location of Huiyaotian site (upper image; map data: Google), and its setting a viewed from across the Yongjiang River (lower image).

and Lower Yangtze, a contemporary complex hunting-gathering group termed the Dingsishan Culture continued in existence and grew in the southern Guangxi region, *c.* 7,000–3,000 BC (Zhang and Hung [1]). At the Dingsishan site itself, 16 burials have been excavated from phase 2 and 133 from phase 3, within a 500 square-meters excavated area. These cemeteries included flexed, squatted and even dismembered burials, all without grave goods (Guangxi Team *et al.* [2]). The artifacts found in Dingsishan

Figure 2-2. The stratigraphy of east profile of T1209 at Huiyaotian.

Table 2-1. Results of carbone 14 dating for Huiyaotian materials.

| LAB No. | MATERIAL | d13C | CONVENTIONAL AGE | 2 SIGMA CALIBRATION | D14C |
|---|---|---|---|---|---|
| BETA429239 | charred Canarium seed fragment from layer 5 of T1004 | -27.0 o/oo | 7740 +/- 30 BP | Cal BC 6640 to 6480 (Cal BP 8590 to 8430) | -618.5 +/- 1.4 o/oo |
| BETA429238 | charred Canarium seed fragment from layer 3 of T1004 | -26.2 o/oo | 7510 +/- 30 BP | Cal BC 6435 to 6365 (Cal BP 8385 to 8315) | -607.4 +/- 1.5 o/oo |
| BETA429237 | human tooth from layer 4 of T1003 | -20.4 o/oo | 8060 +/- 40 BP | Cal BC 7080 to 7025 (Cal BP 9030 to 8975) | -633.4+/- 1.8 o/oo |

shell middens (phases 1 to 3) include polished stone axes and adzes (made of stone and bone), arrowheads, awls, needles, spears and hooks (all made of bone), shell tools and pottery. The most common shell tools are perforated so called *fish-headed* knives. The pottery was greyish-brown in color with coarse quartz or sand temper. Pottery surfaces are parallel ribbed or cord marked. Large quantities of aquatic and terrestrial animal bones have been discovered in Dingsishan (Lu [3]; Zhang and Hung [1]).

## ARCHAEOLOGICAL FINDINGS FROM HUIYAOTIAN

In the 2006 season of archaeological excavation at Huiyaotian, more than 60 human burials, trash pits, post holes, and varied artifacts made by pottery, bone and clam have

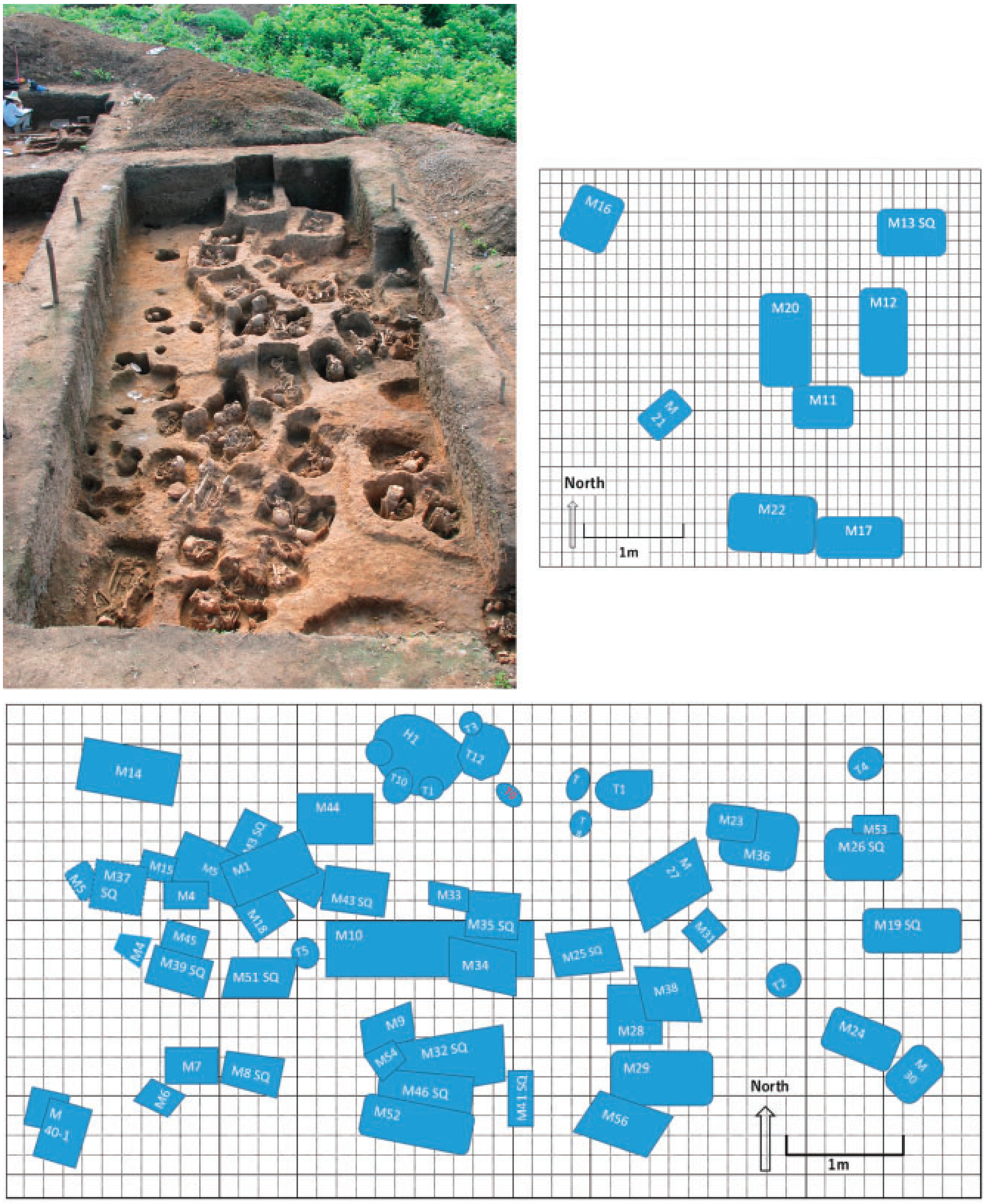


Figure 2-3. Huiyaotian cemetery from 2006 eexcavation, and the layout of human burials in two trenches (M: human burial; T: post hole; H: trash-pit).

been discovered.

1. Human burials and other features

Human burials were distributed primarily in the southern part of the site, and con-

Figure 2-4. Recovery of human skeletons from Huiyaotian by the project members in 2012.

centrated in an area about 40 meters in length and 10–15 meters in width. Many of those burials were arranged in east-west direction along the river bank (Figures 2–3 and 2–4). Most graves contained single individuals, although some were joint burials. They mainly were buried in flexed positions. The forms of flexed position at Huiyaotian including upturned, bent, lateral recumbent, and squatted. Overall, about 50% of the burials were in flexed-squatted position, and then the next most common forms were in flexed-lateral recumbent position. Overall, only 1 was in extended position, and only 3 were dismembered. The authors have noticed that the squatted burials usually were located in the deeper layers, while the flexed burials or dismembered burials were found in the upper layers. At Huiyaotian, the burial pits were mostly in rectangle or square shapes.

Regarding burial goods, only very few burials have been found with 1 or 2 polished tools made of stone, bone or clam, but it is uncertain if those were placed there intentionally. Overall, most of the burials at Huiyaotian were without any burial goods. Some of the burials had small stones associated with the human skeletons, in which some of them were found on the top of the skeletons.

With the cemetery, 13 post holes and 2 trash pits have been identified in trenches T1003 and T1004. Those post holes were mostly in round or oval shapes. Some of them were filled with stones or shells in the bottom. One representative post hole (see T4 in Figure 2-3) was round shaped, about 34–42 cm in diameter, and 38 cm in depth. The trash pits at Huiyaotian contained potsherds, animal bones, shells and stones.

## 2. Artifacts

Unearthed artifacts from Huiyaotian include pottery and varied tools made of stone, clam, animal bone and horn.

### *(1). Pottery*

The pottery is mainly reddish brown ware (about 50%), and there are also some in greyish-brown, greyish-black, greyish-yellow and red colors. Most pottery is sandy ware containing temper of quartz or shell fragments. Few potsherds contained charcoal temper or purely clay without inclusions. All pottery had been decorated with cord marks. The sizes of cords on Huiyaotian pottery can be divided into three approximate categories of coarse, middle and fine, in which about 96% belongs to the middle size. Only very few pieces had been decorated with incised line designs above the corded patterns. Because the firing temperature was low for this assemblage, all unearthed remains are potsherds, and no complete pots have been found. However, the pottery vessel forms are rather simple as jars or cauldrons with a round base, either with open mouth or contracted mouth. The only one available reconstructed pottery vessel is a reddish sand ware with middle size of cord marked decoration below its rim (Figure 2-5).

### *(2). Tools made of stone, clam, bone and horn*

The stone implements include polished adzes, axes and grinding basin stones (Figure 2-6). Most of the adzes or axes are partially polished, especially on their blade portions, and many of them have shown use-wear marks on the blades.

Clam implements comprise 50% of the artifacts from Huiyaoyian (Figure 2-7: 1-5). They are polished knives and perhaps daggers. In fact, most of them are knives in a “fish head” form. They were mainly made of *Margaritiana* sp. and some of *Lamprotula* sp. clam. Many of them are in triangle shape with one perforation, and often intention-

Figure 2-5.  Cord marked pottery unearthed from Huiyaotian.

ally chipped at the point part, thus producing a shape similar to a fish head. It is one of the unique characters of Dingsishan shell tools.

The number of bone implements unearthed from Huiyaotian is limited. They are in


Figure 2-6. Representative stone artifacts from Huiyaotian: stone adzes (1–4), stone axes (5–7) and grinding basin stone (8).

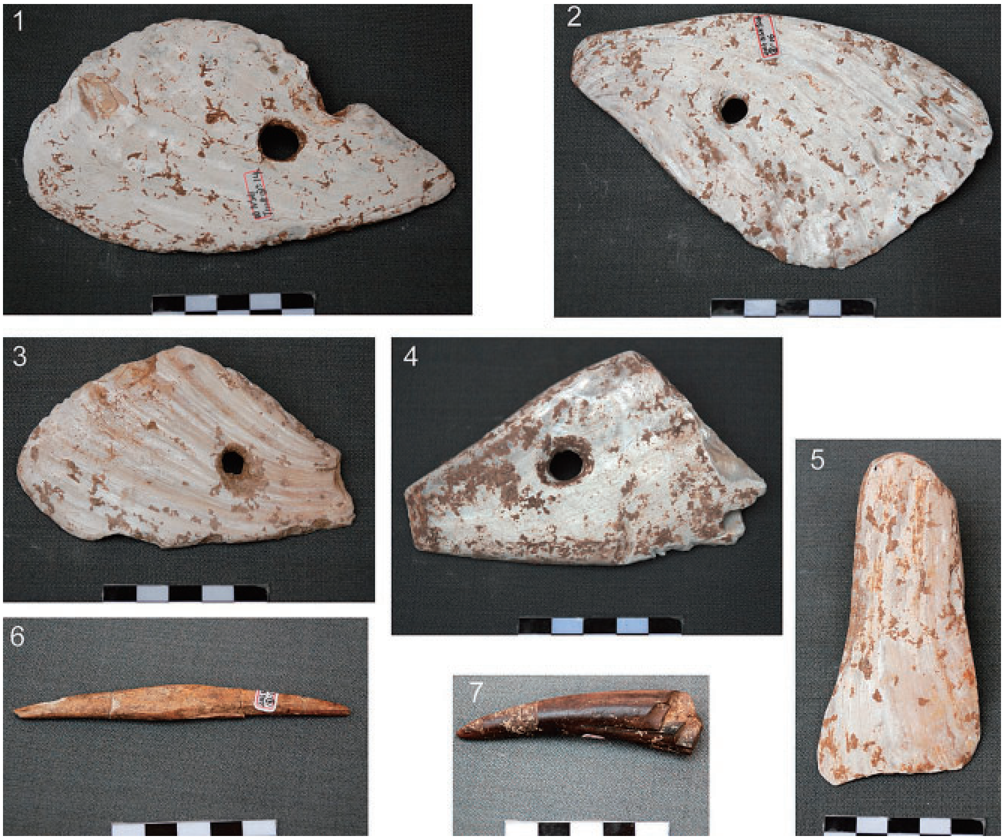

Figure 2-7. Shell knives (1–4), shell dagger (?)(5), bone awl (6) and horn tool (7).

the forms of awls, shovels and arrowheads. The raw materials of those bone tools are the limb bones of mammals. Moreover, there are also small findings of tools made of animal teeth and horns (Figure 2-7: 6–7).

## 3. Animal remains

Remains from both aquatic and terrestrial animals are rather abundant at Huiyaotian. The identified fauna include mollusks (Gastropoda, Pulmonata, and Lamellibranchia), arthropods (Crustacea), and vertebrates (Pisces, Reptilia, Aves, and Mammalia). Within these seven classes, 53 species are identified from Huiyaotian.

Among the remains of molluska, *Bellamya* occupied more than 95%. Aquatic animals include river fish such as yellowcheek carps, and turtles. Terrestrial animals include monkeys (Cercopithecidae), voles (*Microtus* sp.), bamboo rats (*Rhizomys* sp.), Chinese porcupines (*Hystrix hodgsoni* Gray), dogs (*Canis familiaris* Linnaeus), raccoon dogs (*Nyctereutes procyonoides* Gray), hog-nosed badgers (*Arctonyx collaris* F. Cuvier), hog-nosed badgers (*Arctonyx collaris* F. Cuvier), Asian elephants (*Elephas maximus* Linnaeus), wild pigs (*Sus scrofa* Linnaeus), barking deers (*Muntiacus vaginalis*, Boddaert), Chinese Muntjaks (*Muntiacus reevesi* Ogilby), Sambars (*Rusa unicolor*

Kerr), Sika deer (*Cervus Nippon* Termminck), and water buffalos (*Bubalus* sp.).

## CULTURAL IMPLICATION OF THE HUIYAOTIAN SITE

The cultural remains unearthed from Huiyaotian are similar to those reported from the other Dingsishan cultural sites, such as at the Dingsishan site itself. The parallels are most clear in the similar burial practices, similar pottery and stone stools, and very rich fauna remains from both aquatic and terrestrial animals. The discoveries at Huiyaotian definitely enrich the understanding of Dingsishan Culture in the Guangxi region.

Our work at Huiyaotian has successfully provided some reliable dates, thus overcoming the limited chronometric results from other Dingsishan sites. The new C14 dating at Huiyaotian ca. 7,000–6,300 BC confirms it is among one of the earlier Dingsishan sites in the Nanning region, and specifically it represents the early-middle stage within the extended period of Dingsishan Culture. The cultural assemblage and other findings from Huiyaotian can be regarded as a type-site for future comparison study to increase our understanding of the Holocene hunter-gather societies of southern China.

## ABBREVIATIONS

IA: Institute of Archaeology
ATGZ: Archaeological Team of the Guangxi Zhuang Autonomous Region
CASS: Chinese Academy of Social Science

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# 3
# Burial Practice and Individual Descriptions of Human Skeletal Remains at Huiyaotian

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The state of preservation of 60 skeletal individuals excavated between 2012 and 2014 at the site of Huiyaotian is described below together with sex and age determinations and notes on their condition of preservation. Aspects of the burial pits undisturbed nor heavily damaged are exhibited in Appendix Figure 3-A. The best-preserved skull and appendicular bones are displayed in the photographs included in Appendix Figure 3-B.

Age estimates were made based on the tooth eruption phase, extent of tooth attrition, cranial suture closure, postcranial epiphyseal unions, pubic symphyseal face morphology, sequential changes of sternal rib ends, and the severity of osteoarthritis. Age classes for adult individuals were assigned as follows:

Young adult (20–29 years)
Middle-aged adult (30–49 years)
Old adult (over 50 years old)

For recording occlusal surface wear of the dentition, a simple five-phase scheme of Broca[1] was adopted. Sex determination was based on pelvic indicators, cranial morphology, and epiphyseal size of the long bones. As far as the permanent dentition is concerned, the tooth presence and condition was recorded via standard recording protocols, as per the following example.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | M2 | M1 | P2 | P1 | C | X | I1 | I1 | X | C | P1 | P2 | M1 | M2 | M3 |
| M3 | M2 | M1 | P2 | P1 | C | / | X | X | / | C | P1 | P2 | M1 | M2 | △ |

I: incisor, C: canine, P: premolar, M: molar
0: tooth missing but socket present, △: only tooth root remaining
X: socket closed, /: socket broken and tooth missing

## Burial Practice

As described below, as well as in Chapter 4, most burials at Huiyaotian are of the flexed-position type. Some cases are on the side with flexed limbs while others are positioned squatting style. Among these inhumations, moreover, we found two types of curious burials, which will be very important for reconstructing burial practice.

One curiosity is that a part of the body or the limbs had lost their anatomical position. It is unlikely that this was due to natural forces, such as soil pressure, or to later disturbances by artificial means, animal activity, or tree roots. Such abnormalities are detected in burial Nos. 29 and 56-1 (see Appendix Figure 3A). In No. 29, the knee joint of the femur and tibia neighbors the pelvis, showing an anatomically impossible orientation. A similar case is observed in No. 56-1, in which the chest and neck, along with the skull, lie on the face (dorsally) despite the hip lying on the back (ventrally).

Another unique case is found in several burials (e.g., Nos. 6, 7, 9, 15, and 22; see Appendix Figure 3A). Here, packages of long bones stand upright in the burial pit, as if they were tightly bundled firewood. Although some articular joints maintain the anatomical position, the tightly composed limb packages are highly improbable in the natural postmortem condition.

Considering such mismatched anatomical positions and bundled long bone components, these inhumations may be regarded as secondary burials. Furthermore, given such anatomical orientations, we can plausibly assume the cadavers were primarily under aerial sepulture elsewhere, after which people responsible for mummification transported the cadavers with wrapping, or often with bundled long bones, to this site for secondary inhumation. As a result of mummification, some portions were accidentally deviated at the articular joints, and thus anatomical misplacement occurred during burial. This burial practice might be, if our assumptions are acceptable, peculiar among early Holocene hunter-gatherers in this region.

## M3

Condition: poor; Burial Type: squatting
Age: adult; Sex: male
Remarks:
The cranium was severely damaged, and the postcranial bones were fragmented. It is notable that an anomaly is observed for tooth condition. The canines are erupted from the surface of cheeks and superiorly positioned from the alveolar. The glabella is well protruding, and the mastoid process is moderate in size. The mandibular chin is angulated. The tooth wear grade is at the Broca's 3rd level, in which dentine is exposed at the large area of crown surface. The following teeth are remaining.

| △ | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |

**M4**
Condition: poor; Burial Type: flexed
Age: adult; Sex: female
Remarks:
The great sciatic notch of the pelvis is wide, indicating a female. A deep groove is observable below the sacroiliac joint surface, which is assumed to have been formed by pregnancy stress. All the limbs are fragmentally remaining, and the shafts are slender.

**M5**
Condition: moderate; Burial Type: flexed
Age: adult; Sex: male
Remarks:
The limb shafts are long and slender. The muscle attachment areas are smooth on the upper limbs, while the lower limbs are well developed at the gluteus maximus on the femurs and the soleus regions of tibiae. The tibial shafts are laterally vending. The squatting facets are present at the talus. The vertebrae have week lipping.

**M6**
Condition: poor; Burial Type: squatting
Age: adult 40–60 years; Sex: female
Remarks:
All the portions are fragmented. Only large pieces of the limb shafts are remaining, which are slender with weak muscle attachment areas. The great sciatic notch of the pelvis is wide, indicating that it is a female. A deep groove is present below the illiosacral joint surface indicating a birth relic. The linea asperea is well developed at the femoral shaft. The tibial shaft is very flat. Several teeth are also present, whose crown surfaces are worn at the Broca's 3rd level, indicating a probably middle or late mature age.

**M7**
Condition: moderate; Burial Type: squatting
Age: adult middle mature; Sex: female
Remarks:
The skull is in relatively good condition with the exception of smashed occipital bones. The glabella region of the frontal bone is flat and the mastoid process is small, clearly indicating a female. The teeth are severely worn, suggesting a middle mature age. The limbs are compact, but the shape indicates the well-developed muscles. The talus has a squatting facet. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | M1 | P2 | △ | C | I2 | / | I1 | I2 | C | △ | P2 | M1 | M2 | M3 |
| △ | M2 | × | P2 | P1 | C | △ | I1 | I1 | I2 | △ | △ | △ | × | M2 | ○ |

**M8**
Condition: poor; Burial Type: squatting
Age: adult; Sex: male
Remarks:
The skull portion only included a smashed calvaria and the mandible body. At least the outer surface of sagittal suture is not fused. Teeth are missing post mortem. The great sciatic notch of the pelvis is narrow, a male feature. The preservation of the upper limbs is excellent. The humeri are long and robust, and all of the muscle attachments are well developed. Furthermore, the humeral radial and ulnal shaft and the femoral shaft are well vending. The cervical and thoracic vertebrae are partially preserved, and lipping is not observed.

**M9**
Condition: good; Burial Type: squatting
Age: adult middle mature; Sex: male
Remarks:
This skeleton was excavated in a manner to retain the original anatomical position for museum exhibition. This individual was probably buried in a secondary context, because the limbs are very tightly neighbored as if they were wrapped by wires or cloths. Dental wear is at the 3rd grade, indicating a middle mature age. The glabella region of the frontal bone is well protruding, and the mastoid process is large. The condyles of all limbs are wide, indicating a male.

**M10**
Condition: poor or moderate; Burial Type: squatting
Age: adult young mature; Sex: male
Remarks:
The cranial remains are very fragmented. The limbs are well preserved; the tibias are nearly complete. The humeral and femoral head diameters are large, exhibiting a size typical of a male. The upper canine remains have crown surfaces of Broca's 2 grade. The sagittal and coronoid sutures are not fused on either the outer or inner surfaces. The condylar fused line with clear groove indicate this individual was young mature at death. The marginal condition of vertebral bodies shows young adult status as well. The limb lengths (the right femur=440, the right tibia=358mm) and robustness are moderate within male ranges.

**M11**
Condition: moderate; Burial Type: flexed
Age: adult middle mature; Sex: female
Remarks:
The cranium is in poor condition despite the post-cranial remains being relatively well preserved. The tooth enamel show severe attrition of a 4th grade. The limbs are in relatively in good condition despite broken proximal and distal ends. The limbs are slender and moderate in the size of females, suggesting that this individual was a middle mature woman.

## M12

Condition: poor; Burial Type: flexed
Age: adult young mature; Sex: female
Remarks:
Only the jaws and limb bones are well preserved. These are very slender and gracile, indicating this individual is female. The tooth wear is 2nd grade, from which the age is estimated to be young mature. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | / |
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | / | I2 | C | P1 | P2 | M1 | M2 | M3 |

## M13

Condition: poor; Burial Type: flexed
Age: adult middle mature; Sex: female
Remarks:
Only the large fragmental skull and limbs are well preserved. The teeth have entirely lost their crown surfaces due to severe attrition. The cranial sutures are not fused at the bregma portion. The limb shafts are very slender with narrow condyles, indicating a female. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | / | P1 | C | I2 | / | / | / | / | / | P2 | M1 | M2 | / |
| M3 | M2 | M1 | P2 | / | / | / | / | / | / | ○ | P1 | P2 | M1 | M2 | M3 |

## M14

Condition: good; Burial Type: flexed
Age: adult middle mature; Sex: male
Remarks:
The skull is in relatively good condition in terms of the anterior portion, although the glabella area is compressed. The mastoid process of temporal bone is moderate in size. The mandible is nearly complete. The post cranial skeleton remains partially in good condition. The size, thickness, and robustness show moderate male features. The pelvis and vertebrae remain fragmented. The weak lipping is presented at the edge of vertebral bodies. The tooth attrition is heavy at 3rd or 4th level. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | P1 | ○ | △ | △ | I1 | / | C | P1 | P2 | / | / | / |
| / | / | M1 | P2 | P1 | C | ○ | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |

## M15

Condition: unknown; Burial Type: unknown secondary packaged
Age: child 3–5 years old; Sex: unknown
Remarks:
The skeleton was very compactly packed in the tomb, evidently showing inhumation in a secondary burial. No permanent teeth have erupted. The set of deciduous teeth indicates the age of this infant was between 3 and 5 years old.

### M16

Condition: poor; Burial Type: flexed
Age: adult middle mature; Sex: female
Remarks:
The skull is highly fragmented. The mandible body and the mastoid process of the temporal bones are small and gracile, exhibiting the characteristics of a female. Several heavily worn teeth (4th grade) remain, indicating a middle mature age. The limb bone shafts are in good condition and are of moderate size and robustness. The maximum length was measured in situ: the femoral length is 460mm, and the femoral head diameter is 43mm.

### M17

Condition: poor; Burial Type: flexed
Age: adult; Sex: unknown
Remarks:
The skull and all body were detected, but the condition of preservation is very poor.

### M18

Condition: poor; Burial Type: flexed
Age: adult; Sex: male
Remarks:
Only the humerus and femur are in partially good condition. Others are fragmented. The limb articular joints are all robust and wide, indicating the bones of male. The vertebral spine has no lipping, suggesting a mature age.

### M19

Condition: good; Burial Type: flexed
Age: adult middle mature; Sex: female
Remarks:
The skull is well preserved and displays the characteristics of a female, such as a flat glabella, elevated frontal bone, smooth occipital nuchal plane, and small mastoid process. The facial skeleton is broken and incomplete. The teeth are attributed to the 4th level, and the cranial sutures are fused on the inner surface, suggesting a middle mature age. The cranial vault is very thick, while the mastoid process is small, and the glabella is not protruding. The limb bones are also small and compact, presenting female features.

| / | / | M1 | P2 | P1 | C | I2 | / | / | I2 | C | P1 | P2 | M1 | M2 | M3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | ○ | ○ | P1 | C | I2 | / | △ | / | / | / | P2 | M1 | M2 | ○ |

**M20**

Condition: good; Burial Type: flexed
Age: adult middle mature; Sex: female
Remarks:
Generally, the skeleton is in relatively good condition and well preserved. The broad sciatic notch of the pelvis, the smooth muscle attachment of limb bones, the glacial skull, and the mandible indicate a female. The tooth wear is severe corresponding to the 4th grade, while the cranial suture is not fused. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | △ | × | P2 | P1 | C | △ | I1 | I1 | I2 | C | P1 | P2 | △ | M2 | M3 |
| ○ | M2 | M1 | △ | ○ | C | / | / | ○ | × | ○ | ○ | P2 | M1 | M2 | M3 |

**M21**

Condition: poor; Burial Type: unknown
Age: unknown; Sex: unknown
Remarks:
Only the small fragments remain due to this disturbance of this burial and its destruction during a later period.

**M22**

Condition: poor; Burial Type: flexed
Age: unknown; Sex: female?
Remarks:
Only a few fragments remain.

**M23**

Condition: poor; Burial Type: unknown
Age: adult mature; Sex: female
Remarks:
The skull was crushed by soil pressure, although some portions remain. The mastoid process of the temporal bone is very small, and the glabella portion is flat on the elevated frontal bone, suggesting a female. The dental wear processed at the level of Broca's 3rd grade. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | P2 | ○ | ○ | / | / | / | / | / | / | P2 | M1 | M2 | × |
| / | △ | M1 | / | / | / | / | / | / | / | / | P1 | P2 | × | × | × |

**M24**

Condition: poor; Burial Type: flexed
Age: adult; Sex: unknown
Remarks:
Only the small pieces of limbs and unknown pieces remain.

## M25
Condition: poor; Burial Type: squatting
Age: adult mature; Sex: male
Remarks:
The skull was damaged and only present in small fragments. Only the right arm is preserved. The relatively large humeral head suggests a male. Dental wear processed at the level of Broca's 3rd grade. The remaining teeth are as follows.

| M3 | M2 | M1 | P2 | P1 | / | I2 | I1 | I1 | / | / | P1 | P2 | M1 | M2 | M3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | / | / | / |

## M26
Condition: good; Burial Type: squatting
Age: adult middle mature; Sex: male
Remarks:
This individual was excavated in a manner to retrain its buried anatomical position for museum exhibition. The dental wear is severe corresponding to a 4th grade and showing completely exposed dentine. The cranial suture is fused on the outer surface, suggesting a middle mature age. The limb bones are moderate in size with relatively strong muscle attachment areas.

## M27
Condition: poor; Burial Type: flexed
Age: adult mature; Sex: male
Remarks:
The skeleton is highly fragmented. A few fragments of the lower molars remain and the crown wear corresponds to Broca's 4th grade. Vertebral lipping is not present, indicating the age of this individual was not yet old. The femoral head diameter is 45mm, within range of male size, but the humerus is slender and the deltoid muscle is weak.

## M28
Condition: poor; Burial Type: flexed
Age: adult middle mature; Sex: male
Remarks:
Only the lower limbs are well preserved. The large humeral condyles suggest a male sex. A few teeth are preserved and the crowns are severely worn to the 3rd grade. The vertebrae have lipping.

### M29

Condition: good; Burial Type: flexed secondary burial
Age: adult middle mature; Sex: female
Remarks:
The skull is in good condition, except the left side, which was crushed by soil pressure. The mastoid process of the temporal bone is small and the glabella projection is weak, showing female features. The major cranial sutures were completely fused on the outer surface. The teeth are severally worn at the level of Broca's 4th grade. The limbs are slender, but the femoral and tibial shafts are strongly vending. This individual was separated between the body trunk and the lower extremities at the sacro-lumber joint, and the lower limbs were positioned in the opposite direction against the trunk's lumber vertebrate and sacrum. This deviation from normal anatomical position of body and the limb segments are evidence of a secondary burial. The following teeth remain.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |
| / | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |

### M30

Condition: poor; Burial Type: squatting
Age: adult middle mature; Sex: male
Remarks:
Of the skull, only the mandible remains. The teeth are worn at the 3rd level. The limb bones are partially well preserved, of which the proximal and distal ends of the shafts are damaged. The humeral condyles are very wide, indicating a male.

### M31

Condition: poor; Burial Type: unknown
Age: unknown; Sex: unknown
Remarks:
Only very small fragments remain.

### M32

Condition: poor; Burial Type: flexed
Age: adult young or middle mature; Sex: female
Remarks:
Most of the post cranial skeleton is missing due disturbance, but the cranium remains. The skull is very large, but the vertically elevated frontal bone and flat glabella region indicate a female. The coronoid suture is not fused on the outer surface. Most of the teeth were missing, but those excavated are moderately worn at Broca's 3rd grade. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | M1 | ○ | P1 | ○ | ○ | ○ | / | I2 | C | / | / | △ | M2 | M3 |
| / | i | / | / | / | / | / | / | I1 | I2 | C | P1 | / | M1 | M2 | M3 |

## M33

Condition: poor; Burial Type: unknown
Age: unknown; Sex: unknown
Remarks:
Only very small fragments were detected in this burial.

## M34

Condition: poor or moderate; Burial Type: flexed
Age: adult middle mature; Sex: female
Remarks:
The skull is heavily damaged. The mastoid process of temporal bone is quite small and the attachment area of the neck muscles on the occipital bone is very smooth. The cranial sutures are not fused on either side. The postcranial bones are partially preserved except the vertebrae and ribs, which are missing. The great sciatic notch of pelvis is wide, indicating a female. The limb size is moderate among females. The remaining teeth are severally worn to the level of Broca's 4th grade, indicating a middle mature age. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | / | / | / | / | / | ○ | C | P1 | P2 | ○ | / | / |
| M3 | M2 | M1 | P2 | × | C | / | I1 | I1 | I2 | C | P1 | P2 | M1 | / | / |

## M35

Condition: moderate; Burial Type: squatting
Age: adult middle mature; Sex: male
Remarks:
The cranium is partially well preserved, which shows entirely large robust morphology. The cranial sutures are not fused on either side. The four limbs are relatively in good condition, although the proximal and distal ends are broken. The femoral head is very large, and muscle attachment areas are robust with well ridged surface or tuberosity, showing male characteristics. The tooth attrition is in the Broca's 3rd grade, allowing an estimate of middle mature age. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |
| △ | M2 | ○ | ○ | ○ | ○ | ○ | ○ | ○ | I2 | C | P1 | P2 | M1 | M2 | M3 |

## M36-1

Condition: poor; Burial Type: unknown secondary burial
Age: adult middle mature; Sex: female
Remarks:
This is a highly fragmented skeleton. Some of the bones are partially burned. The large humeral head indicates a probable female sex. The following teeth are present and are heavily worn to Broca's 4th grade.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | M1 | ○ | P1 | C | I2 | / | / | / | / | P1 | P2 | M1 | / | / |
| / | / | M1 | P2 | △ | C | I2 | I1 | I1 | I2 | C | P1 | / | / | / | / |

**M36-2**
Condition: poor; Burial Type: unknown
Age: adult middle mature; Sex: male
Remarks:
Very small numbers of skull and limb fragments are preserved. Only the mandible is nearly complete. The robust big mandible is apparently that of a male. The tooth wear is to Broca's 3rd level. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |

**M37**
Condition: moderate; Burial Type: squatting
Age: adult middle mature; Sex: female
Remarks:
A heavily damaged skeleton was unearthed from this burial. All portions of the skeleton are fragmented. The femoral head is small, and the mastoid process of temporal bone is gracile, showing female characteristics. Several heavily worn teeth were also detected.

**M38**
Condition: poor; Burial Type: flexed
Age: adult middle mature; Sex: female
Remarks:
Only small numbers of fragmental bones and fragile broken mandible were present. The mandible size is compact and the teeth are severally worn to Broca's 4th grade. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | P2 | P1 | C | / | I1 | I1 | I2 | C | P1 | P2 | M1 | / | / |
| / | ○ | M1 | P2 | P1 | C | / | / | / | / | △ | P1 | ○ | ○ | / | / |

**M39**
Condition: moderate; Burial Type: squatting
Age: adult middle mature; Sex: female
Remarks:
The cranium is missing the right side. The facial skeleton and frontal and occipital bones present gracile female features. The limb bones are also compact. Other body portions are highly fragmented. The cranial sutures are not fused on the outer surface. Several teeth are preserved, whose crowns are worn to Broca's 4th grade.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |
| / | M2 | M1 | / | / | / | / | / | △ | I2 | C | ○ | △ | △ | M2 | M3 |

**M40-1**
Condition: poor; Burial Type: unknown
Age: adult middle mature; Sex: female
Remarks:
The skull with a fragmented jaw is associated with several worn teeth of Broca's 4th grade.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | / | × | × | × | × | × | × | / | / | × | × | M3 |
| / | / | / | / | △ | △ | I2 | I1 | I1 | I2 | C | △ | △ | M1 | M2 | △ |

**M40-2**
Condition: poor; Burial Type: unknown
Age: child; Sex: unknown
Remarks:
Only the fragments of the skull are preserved.

**M41**
Condition: poor; Burial Type: unknown
Age: Child; Sex: unknown
Remarks:
Only a large shell was detected, regarded as an associated burial material.

**M42**
Condition: poor; Burial Type: squatting
Age: adult; Sex: unknown
Remarks:
Heavily damaged bones remain. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | △ | M1 | ○ | ○ | ○ | △ | ○ | ○ | ○ | ○ | P1 | P2 | M1 | / | M3 |
| / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |

**M43**
Condition: excellent; Burial Type: squatting
Age: adult late middle mature; Sex: male
Remarks:
The skull shows nearly complete preservation. The limbs are in partially good condition. As for the skeletal features, the small mastoid process of the temporal bone and slender limbs are likely female, but other skeletal traits, including the glabella projection, fontal leaning, the wide humeral condyle of the limbs, and wide femoral head, indicate a male. Consequently, this individual is identified as gracile man. The teeth are worn to the Broca's 4th grade, and the cranial sutures are completely closed, suggesting a late middle mature age. The bones of the body trunk, such as the ribs and vertebrae, are absent. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| △ | △ | M1 | P2 | ○ | ○ | ○ | ○ | ○ | ○ | C | P1 | P2 | M1 | M2 | △ |
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | △ | I2 | C | △ | P2 | M1 | M2 | M3 |

**M44**

Condition: poor; Burial Type: unknown
Age: adult middle mature; Sex: male
Remarks:
The burial includes heavily damaged bones. Only the cranial vault is partially well preserved. The glabella of frontal bone is well protruding, indicating a male. The cranial sutures are not fused on the outer surface. The following teeth are present, which are severely worn (missing the occlusal surface).

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | △ | △ | △ | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | / | M3 |
| / | M2 | M1 | P2 | P1 | / | / | / | / | I2 | C | P1 | P2 | M1 | / | / |

**M45-1**

Condition: moderate; Burial Type: squatting
Age: adult mature; Sex: female
Remarks:
The skull is well preserved in terms of the cranial vault and mandible. The facial features are damaged. The cranial size is compact and gracile, showing female characteristics. The cranial suture is fused partially on the outer side and completely on the inner one. The limbs are well preserved, small, and gracile. The humeral condyle is small, showing female features. The following teeth are present. These remaining teeth are worn at the Broca's 3rd or 4th level.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | / | / | / | / | / | / | / | / | / | M1 | M2 | / |
| ○ | M2 | M1 | P2 | P1 | C | I2 | △ | / | I2 | C | P1 | P2 | M1 | M2 | M3 |

**M45-2**

Condition: moderate; Burial Type: unknown
Age: unknown; Sex: male
Remarks:
The skull is broken into small fragments. The mandible body is in good condition. The teeth are in the Broca's 4th attrition level. The limb bones are robust with large heads and condyles, clearly indicating that this individual is male. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | △ | △ | △ | / | / | ○ | ○ | △ | P1 | P2 | M1 | M2 | ○ |
| ○ | M2 | M1 | △ | P1 | / | △ | △ | I1 | I2 | C | P1 | △ | M1 | M2 | △ |

## M46-1

Condition: moderate; Burial Type: squatting
Age: adult late middle mature; Sex: male
Remarks:
The cranial calvaria and a part of the facial skeleton with the mandible are well preserved. The postcranial remains are some fragments of upper limb and left side of lower limbs are preserved and in good condition. The coronal suture is partially fused on the inner surface. The remaining limbs are parts of the right arm. The maxillary teeth and mandibular molars were removed ante mortem. Only the heavily worn anterior teeth of mandible were in place. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |
| M3 | × | × | × | P1 | C | / | △ | △ | I2 | C | P1 | P2 | × | M2 | △ |

## M46-2

Condition: poor; Burial Type: unknown secondary burial
Age: adult; Sex: female
Remarks:
The several fragments of upper limbs and well-preserved lower limbs are detected. These are compact and gracile, and the articular joints are narrow indicating a female.

## M51

Condition: moderate; Burial Type: squatting
Age: adult young mature; Sex: male
Remarks:
The skull is heavily damaged and in small fragments. The limbs are well preserved, which are characterized by a very thick robust morphology, including well-developed deltoid muscles attachment areas on the humerus. The great sciatic notch of the pelvis is quite narrow, presenting a male feature. The following teeth are remaining and are wear processed on the level of Broca's 3rd grade.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |

## M52

Condition: poor; Burial Type: flexed
Age: adult; Sex: unknown
Remarks:
Only the fragile fragments of limb bones were detected.

**M53**
Condition: poor; Burial Type: unknown
Age: child; Sex: unknown
Remarks:
The limbs unearthed are very fragile and fragmented.

**M54**
Condition: excellent; Burial Type: unknown
Age: adult middle mature; Sex: male
Remarks:
The skull is in very good condition, except the missing right frontal portion. The glabella of the frontal bone and the mastoid process of the temporal bone are ridged, and the frontal bone is leaning back, exhibiting male morphology. The limbs are moderately sized, and the muscle attachment development is characteristic of a male. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | △ |
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | △ | I2 | C | P1 | P2 | M1 | M2 | M3 |

**M55**
Condition: poor; Burial Type: unknown
Age: adult middle mature; Sex: female
Remarks:
The jaws and large fragments of upper and lower limbs remain. All the head and condyles of limbs are quite small, indicating a female. The following teeth are present, with the crowns worn to the level of Broca's 4th grade.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | △ | M1 | △ | ○ | ○ | I2 | I1 | △ | I2 | C | △ | △ | / | / | / |
| / | / | / | P2 | P1 | C | △ | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | △ |

**M56-1**
Condition: good; Burial Type: flexed
Age: adult mature; Sex: male
Remarks:
The skull is partially preserved, while the postcranial bones are in relatively good condition. The protruding glabella of the skull and the wide femoral condyle suggest a male. The lumber bodies have strong lipping, allowing for a mature age estimate. The following teeth are remaining, of which the crown surfaces are worn to Broca's 4th level.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | P2 | P1 | C | I2 | I1 | / | I2 | C | P1 | P2 | M1 | M2 | / |
| M3 | M2 | M1 | P2 | P1 | / | I2 | I1 | I1 | I2 | C | △ | P2 | M1 | M2 | M3 |

**M56-2**
Condition: poor; Burial Type: squatting
Age: adult; Sex: female
Remarks:
Only a few limb fragments and mandible were detected in this burial. The skeletal size is quite small, indicating a female.

**M56-3**
Condition: poor; Burial Type: unknown
Age: adult; Sex: unknown
Remarks:
Only fragments of the femoral and tibial shafts were unearthed from this burial.

**M57**
Condition: poor; Burial Type: unknown
Age: adult young or middle mature; Sex: female
Remarks:
A few large cranial vault fragments are remaining. The cranial suture is not fused. The limbs are relatively small, probably that of a female.

**M58**
Condition: poor; Burial Type: unknown
Age: adult middle mature; Sex: male
Remarks:
Fragments of the skull, mandible, and hand bones are preserved. The glabella is well protruding, and the teeth are worn to Broca's 4th level.

**M59**
Condition: poor; Burial Type: unknown
Age: child approximately 13–14 years old; Sex: unknown
Remarks:
This skeleton is heavily damaged, and all portions are fragmented. The skeletal morphology appears to be that of a sub-adult. The dental wear is Broca's 1st grade, and the third molars are not yet erupted, suggesting an age of about 13–14 years old.

| × | M2 | M1 | P2 | P1 | C | I2 | I1 | / | I2 | C | P1 | P2 | M1 | M2 | × |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | P1 | / | / | / | ○ | ○ | C | P1 | P2 | M1 | M2 | / |

**M60**

Condition: poor; Burial Type: unknown
Age: adult mature; Sex: male
Remarks:
The skull is well preserved in the posterior potion, including occipital and parietal bones. The facial skeletons are also well preserved except the frontal bone. The mastoid process is large, and the glabella is moderately protruding, indicating a male. The cranial sutures are completely fused only on the inner surface. All limb shafts are well preserved. The following teeth remain with a dental wear of Broca's 3rd grade, which provides an estimate of middle mature age.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | / |
| M3 | M2 | M1 | ○ | ○ | C | I2 | I1 | ○ | ○ | ○ | ○ | ○ | ○ | M2 | M3 |

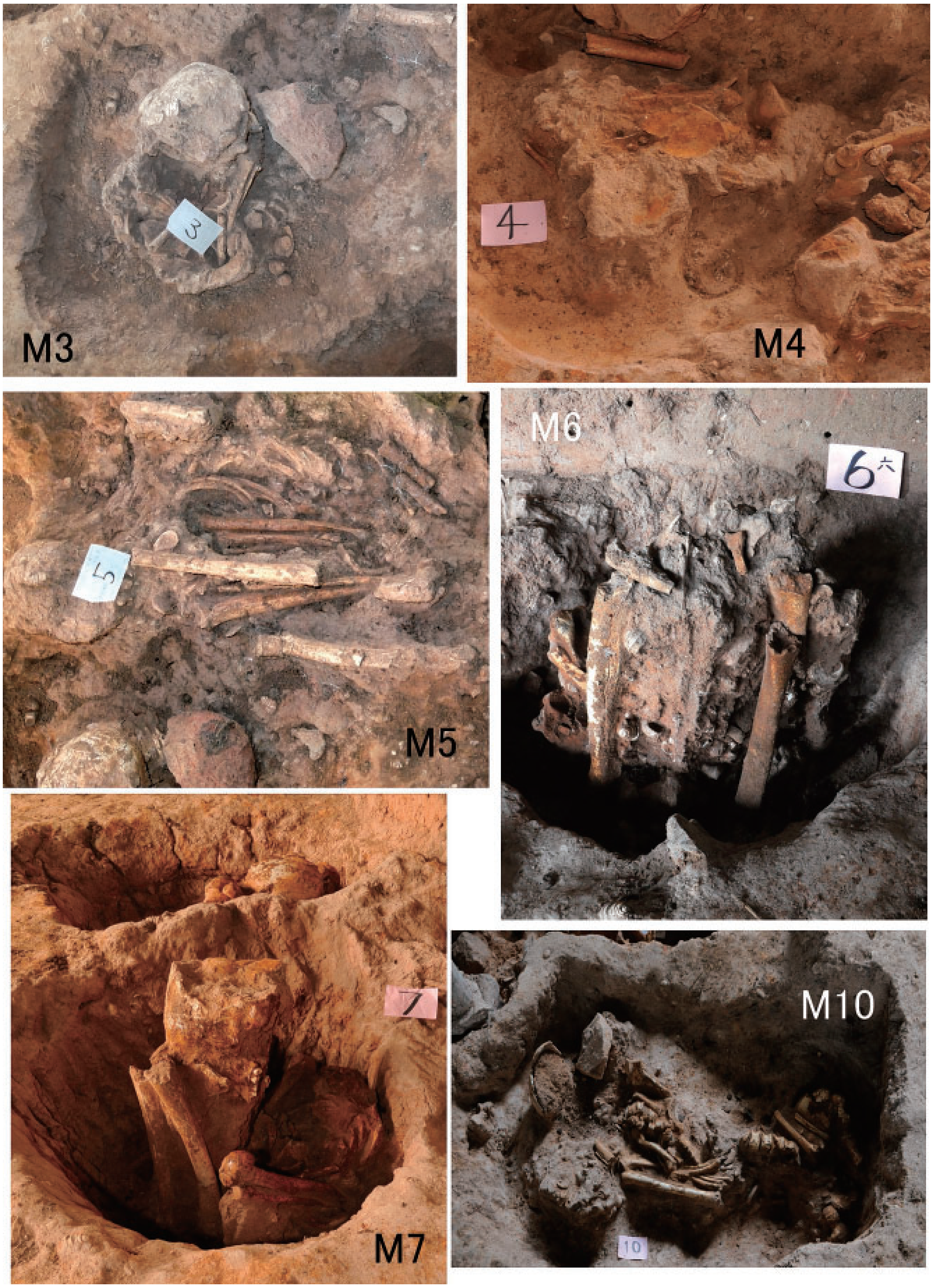
## LITERATURE CITED

[1] Broca P. Instructions relative a `l'étude anthropologique du Syste`me dentaire. Bulletin de la Societe ´Anthropologique du Paris 2, 1879: 128–152.

## Appendix Figures 3-A

Burial aspects at Huiyaotian.

Figure 3-A (top). Burial aspects at Huiyaotian.

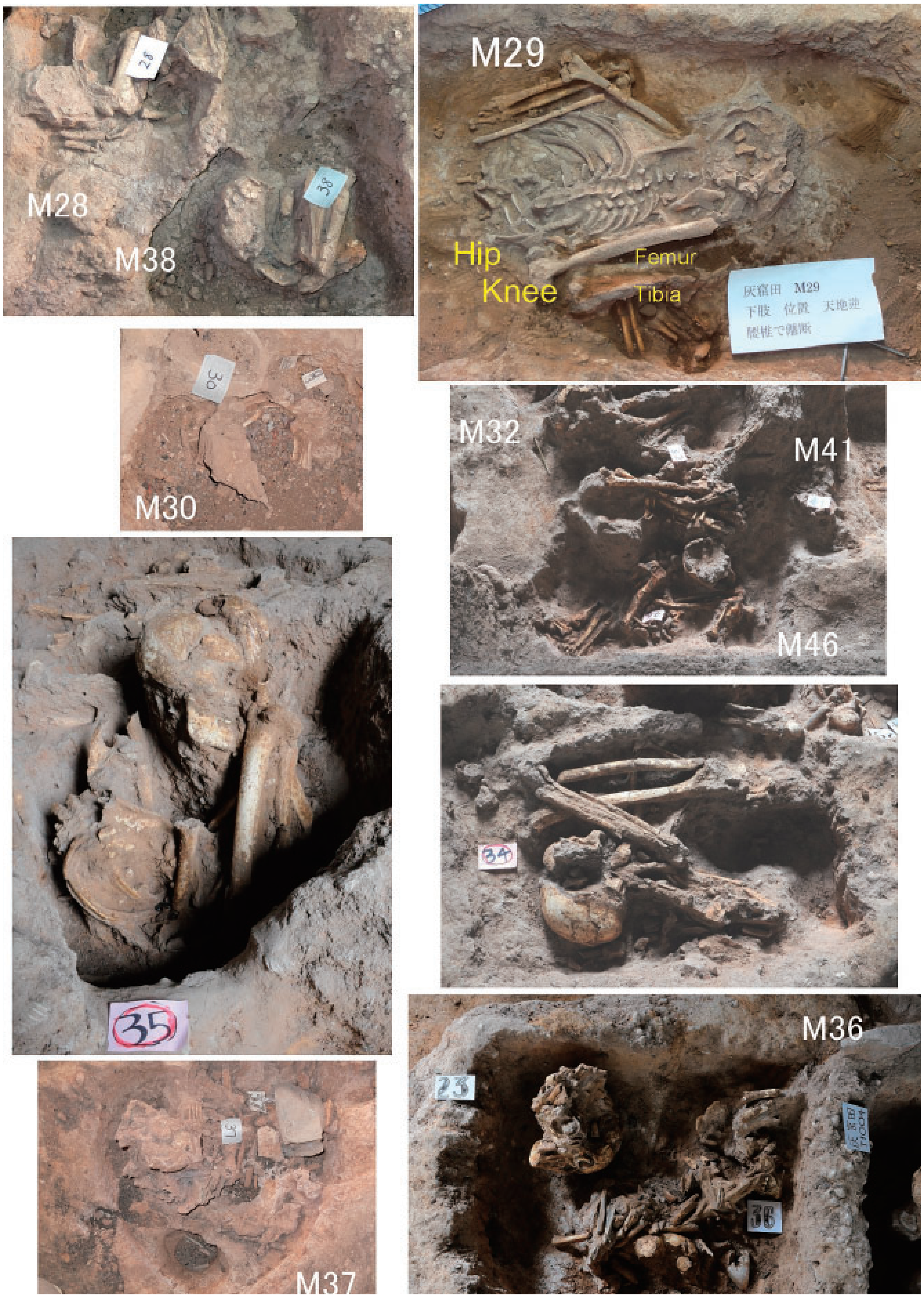



Appendix Figure 3-A (Continued 1).

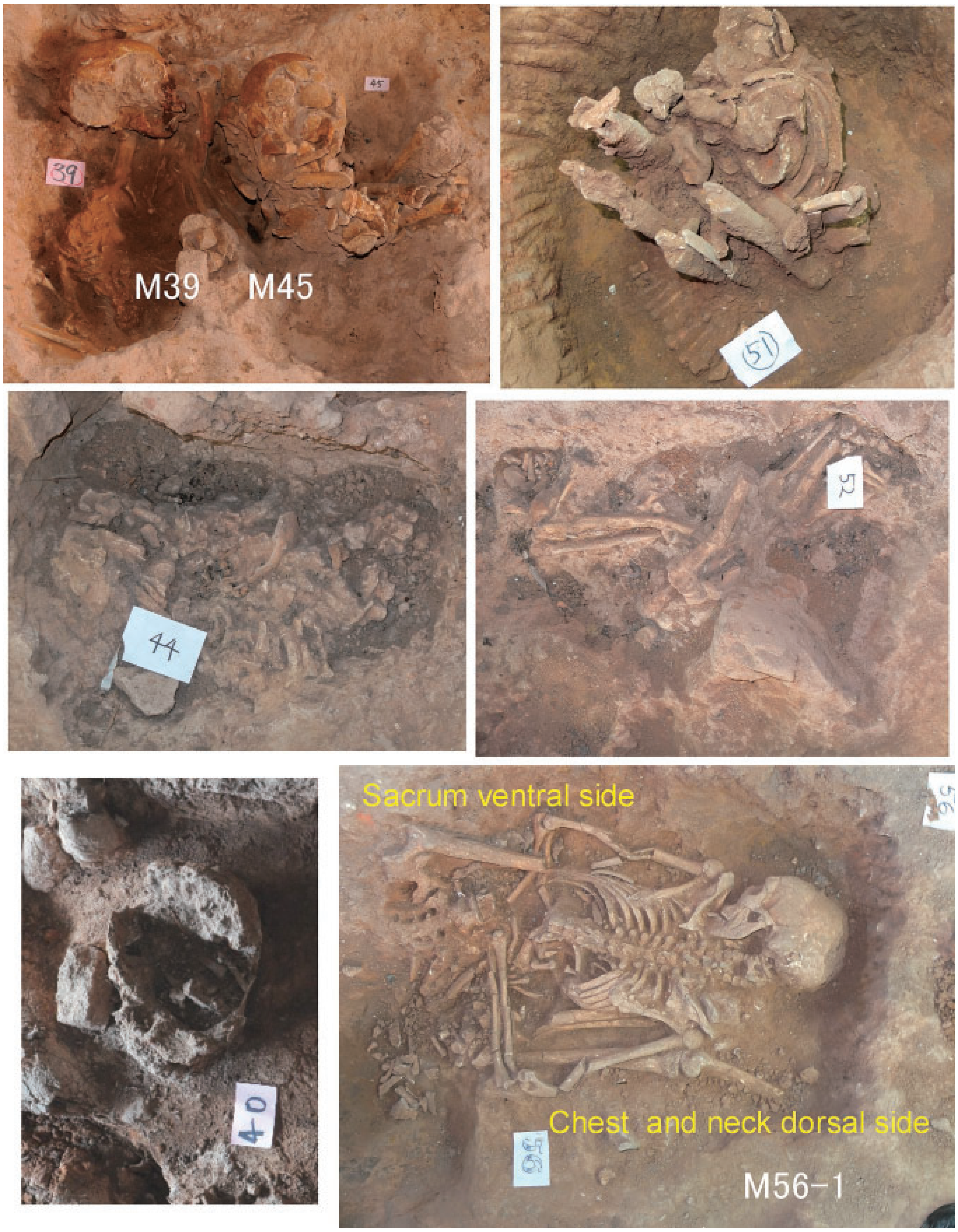

Appendix Figure 3-A (Continued 2).


Appendix Figure 3-A (Continued 3).


Appendix Figure 3-A (Continued 4).



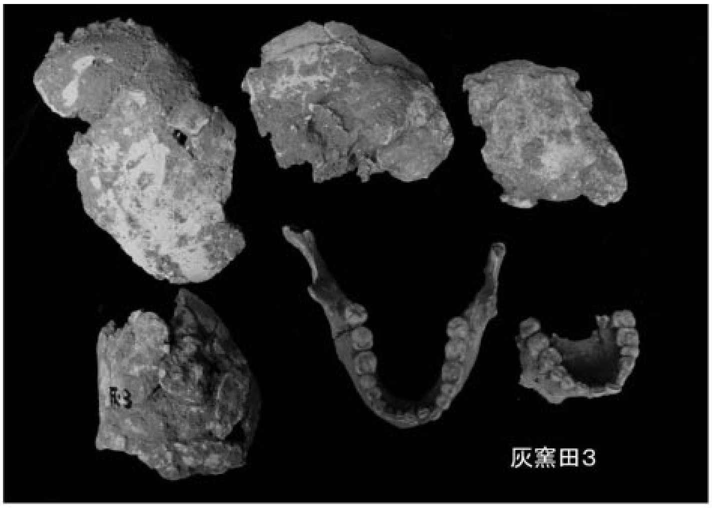

Appendix　Figure 3-A (Continued 5).




Appendix Figure 3-A (Continued 6).

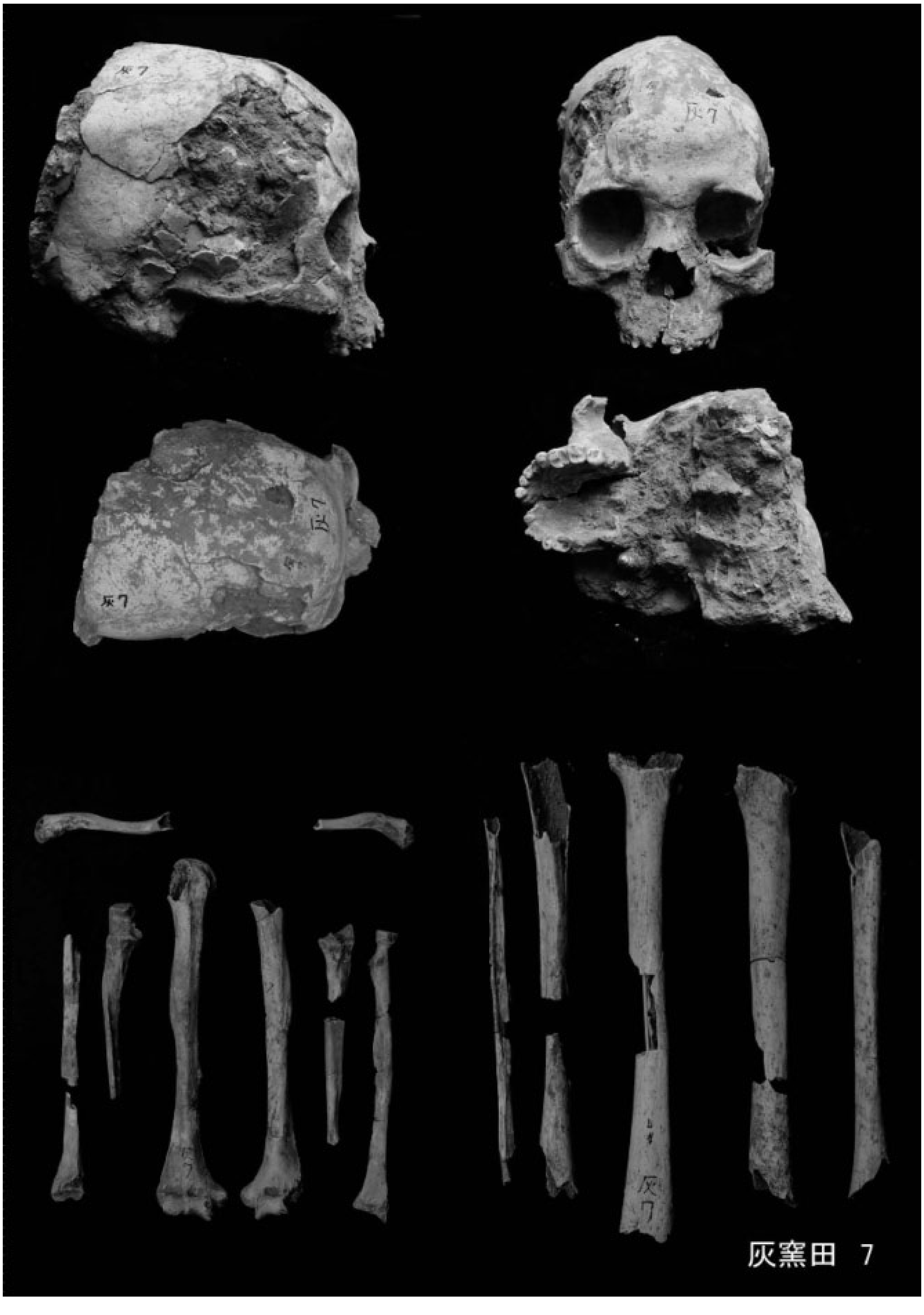
## Appendix Figures 3-B

Reconstructed human skeletal remains from Huiyaotian


灰窯田3


灰窯田5


灰窯田 6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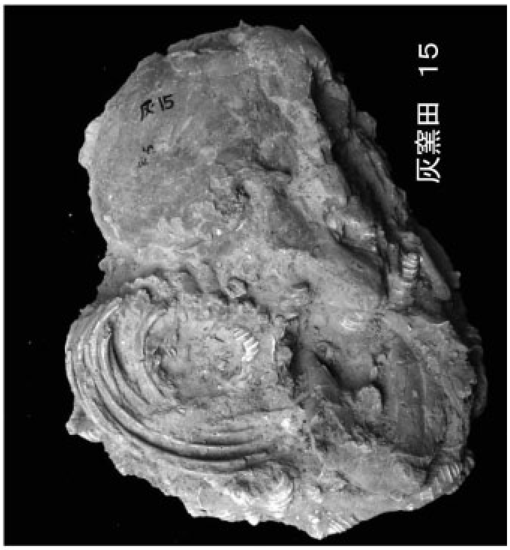
灰窯田11


灰窯田8


灰窯田10


灰窯田12


灰窯田13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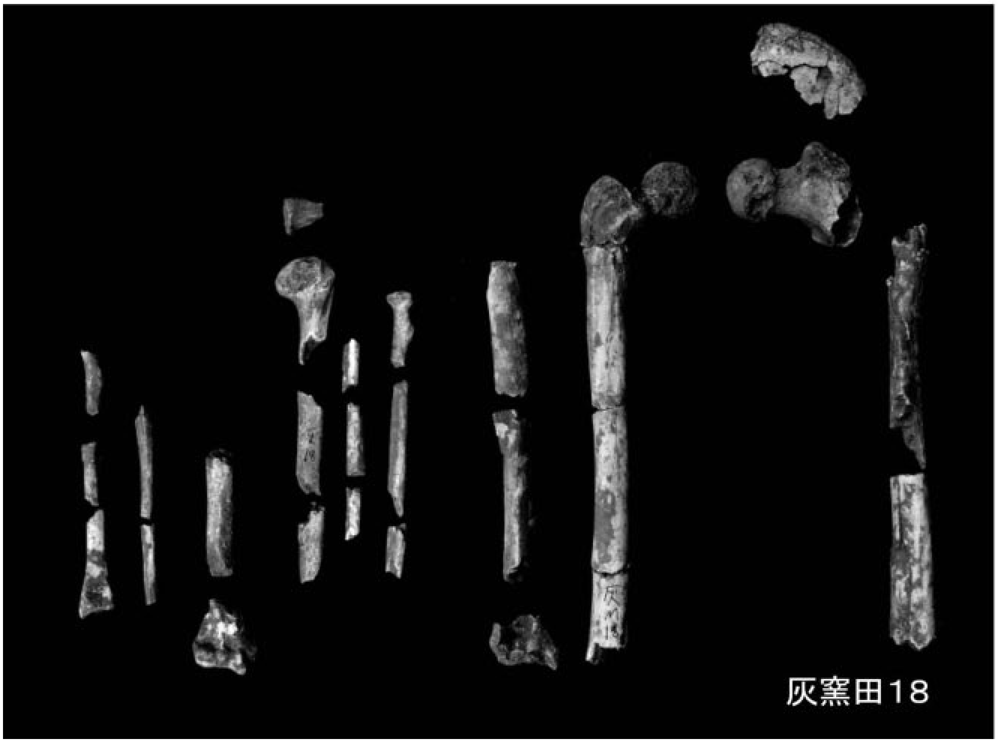
灰窯田14


灰窯田16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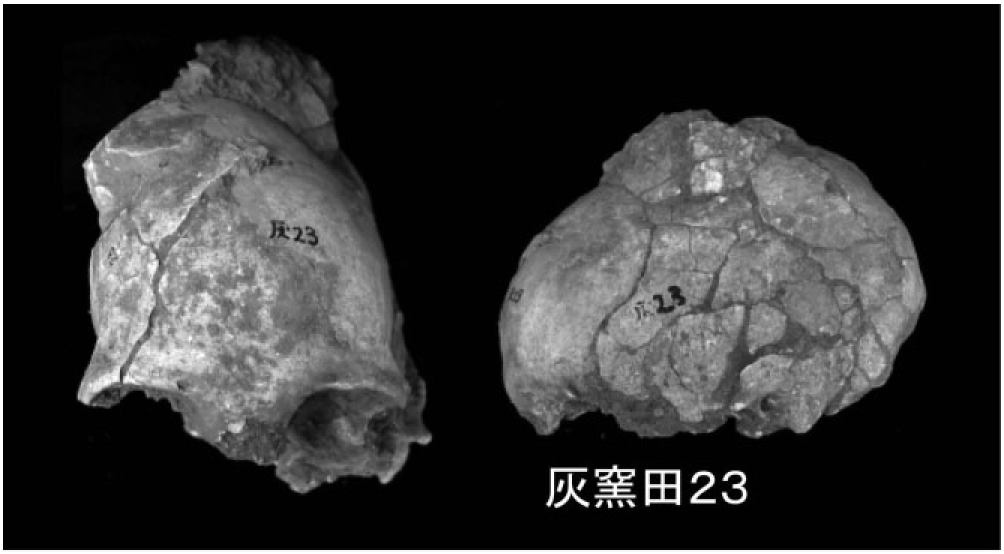
灰窯田19


灰窯田20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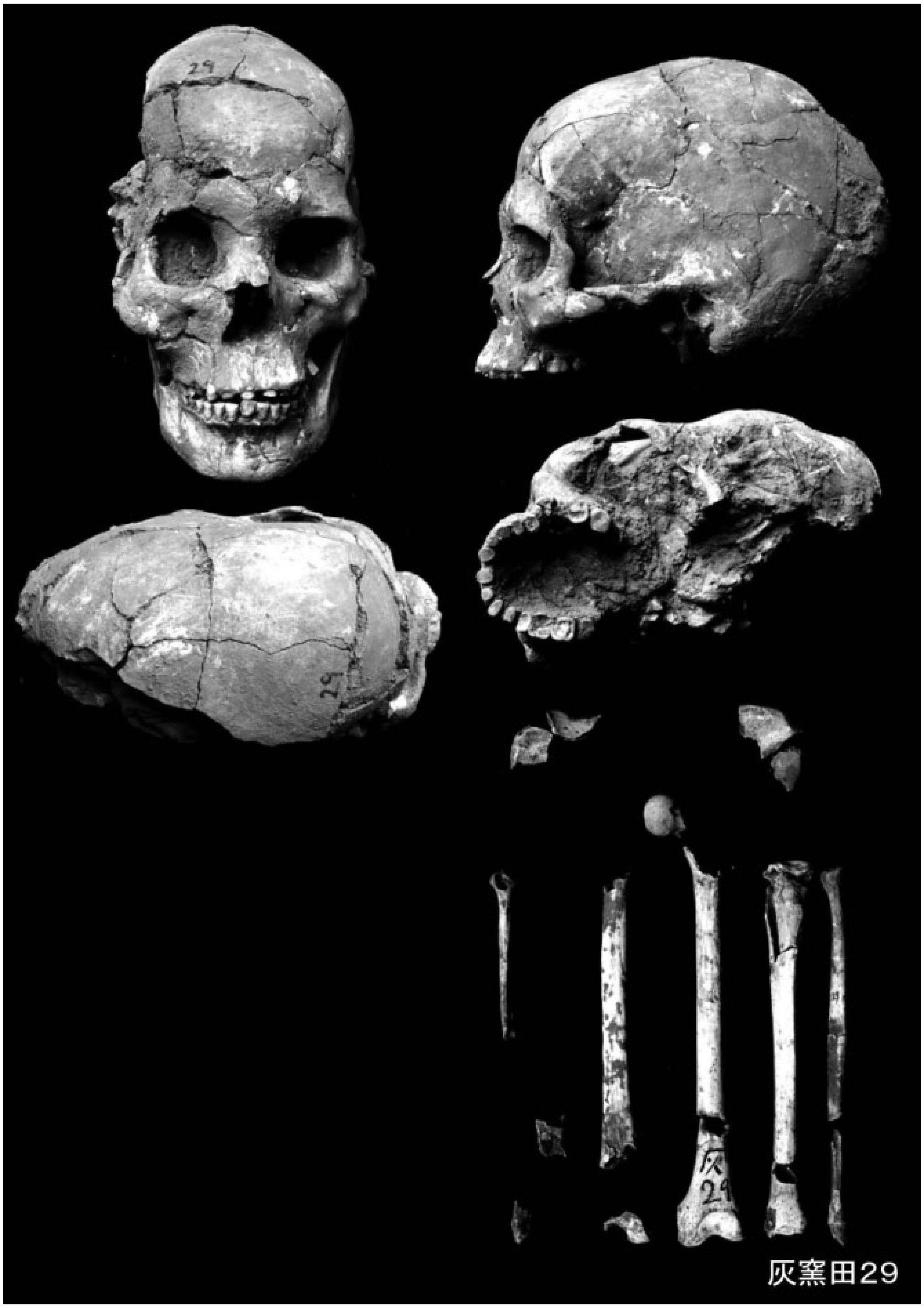
灰窯田28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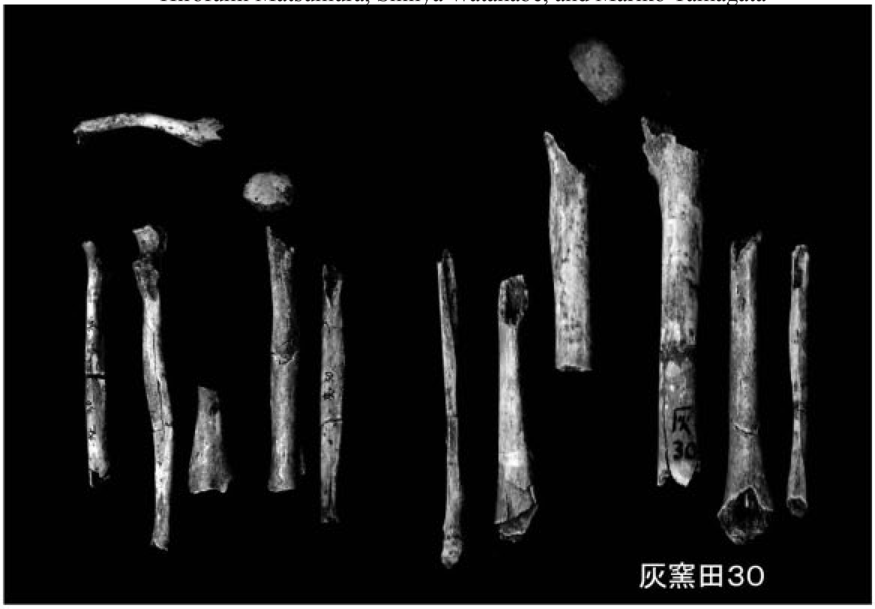
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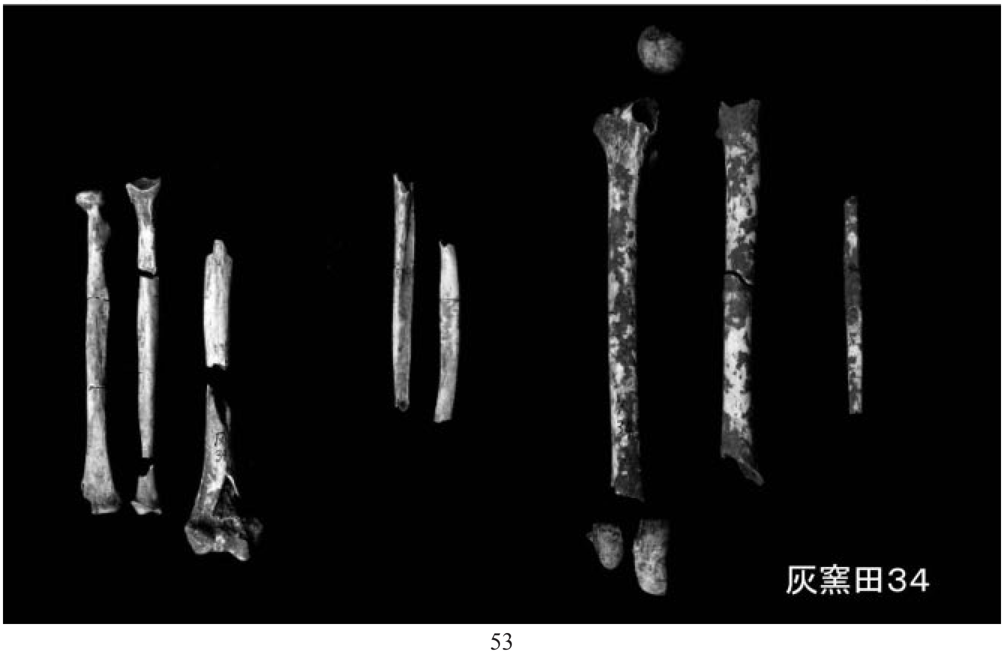
灰窯田32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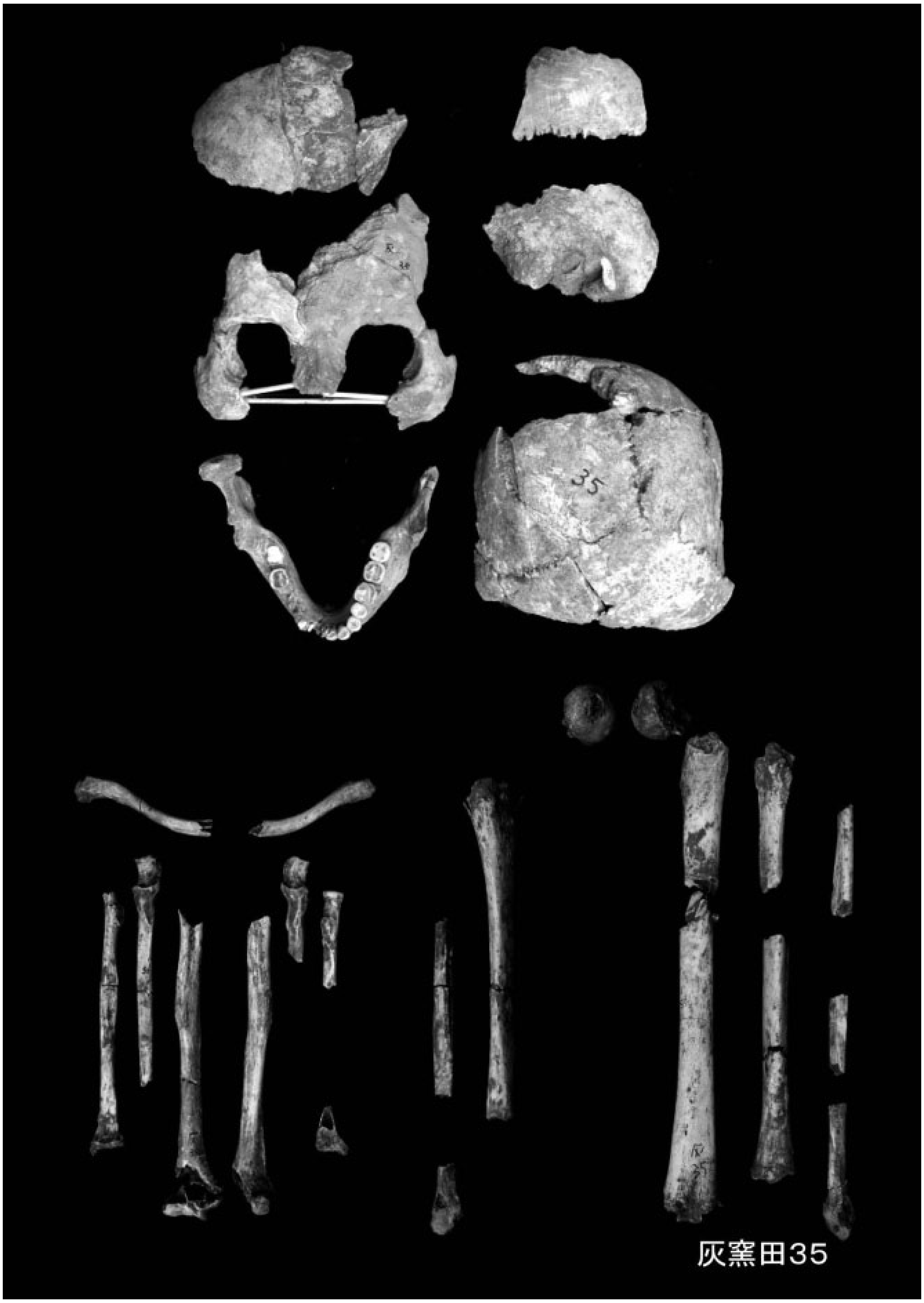
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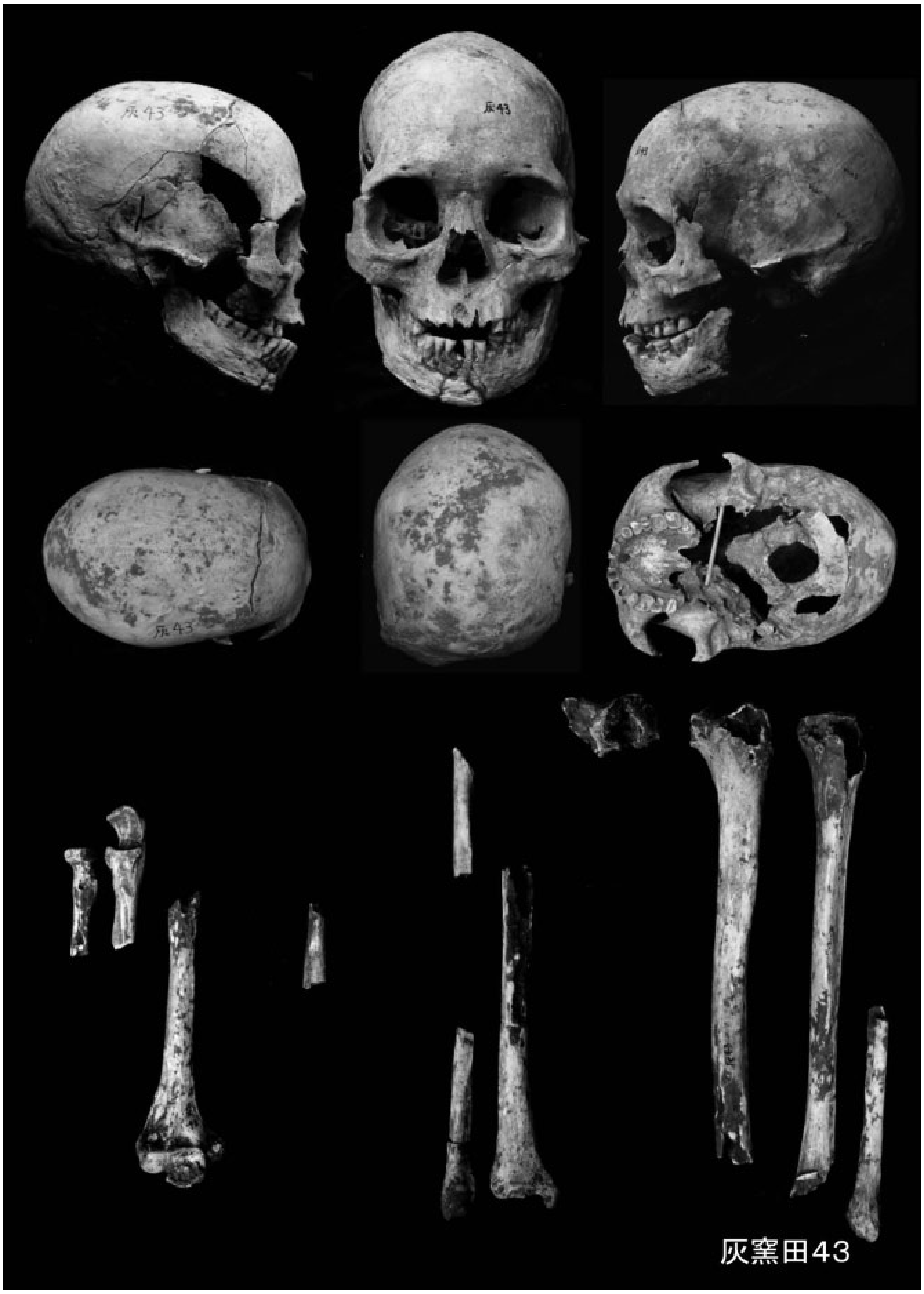
灰窯田39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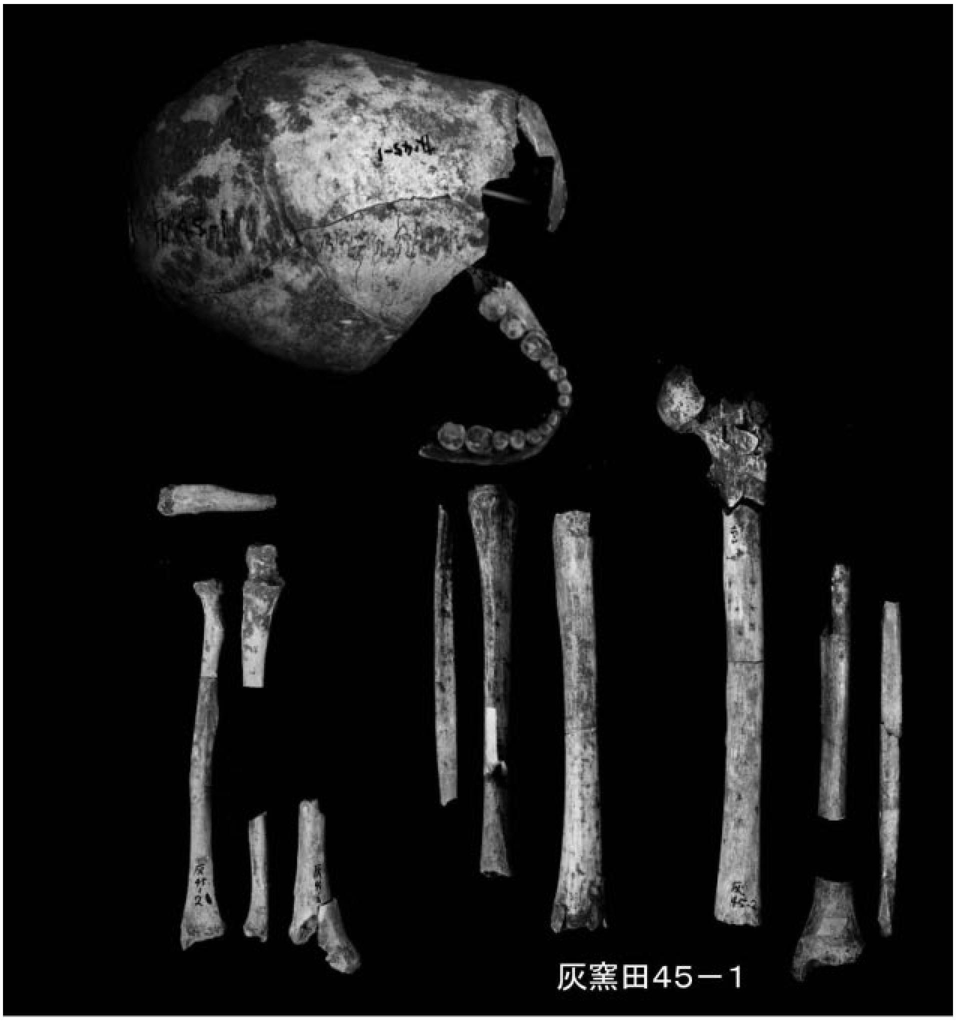
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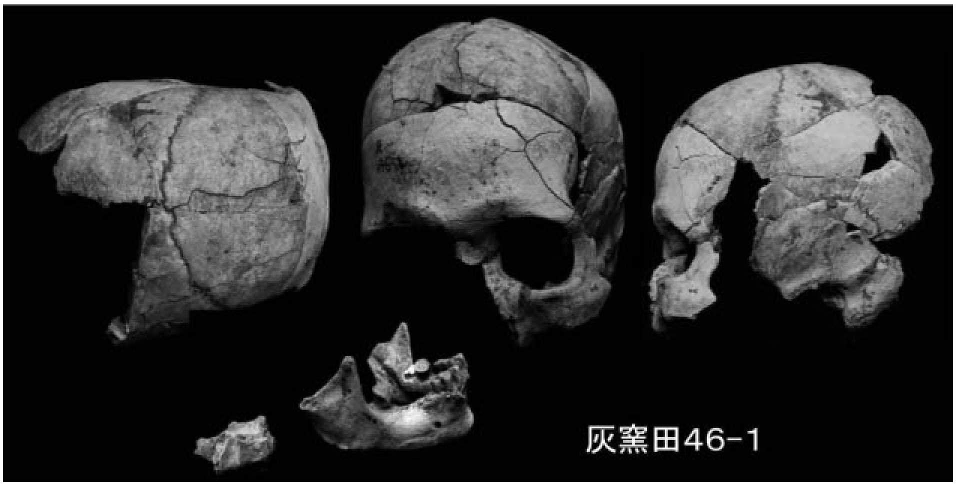
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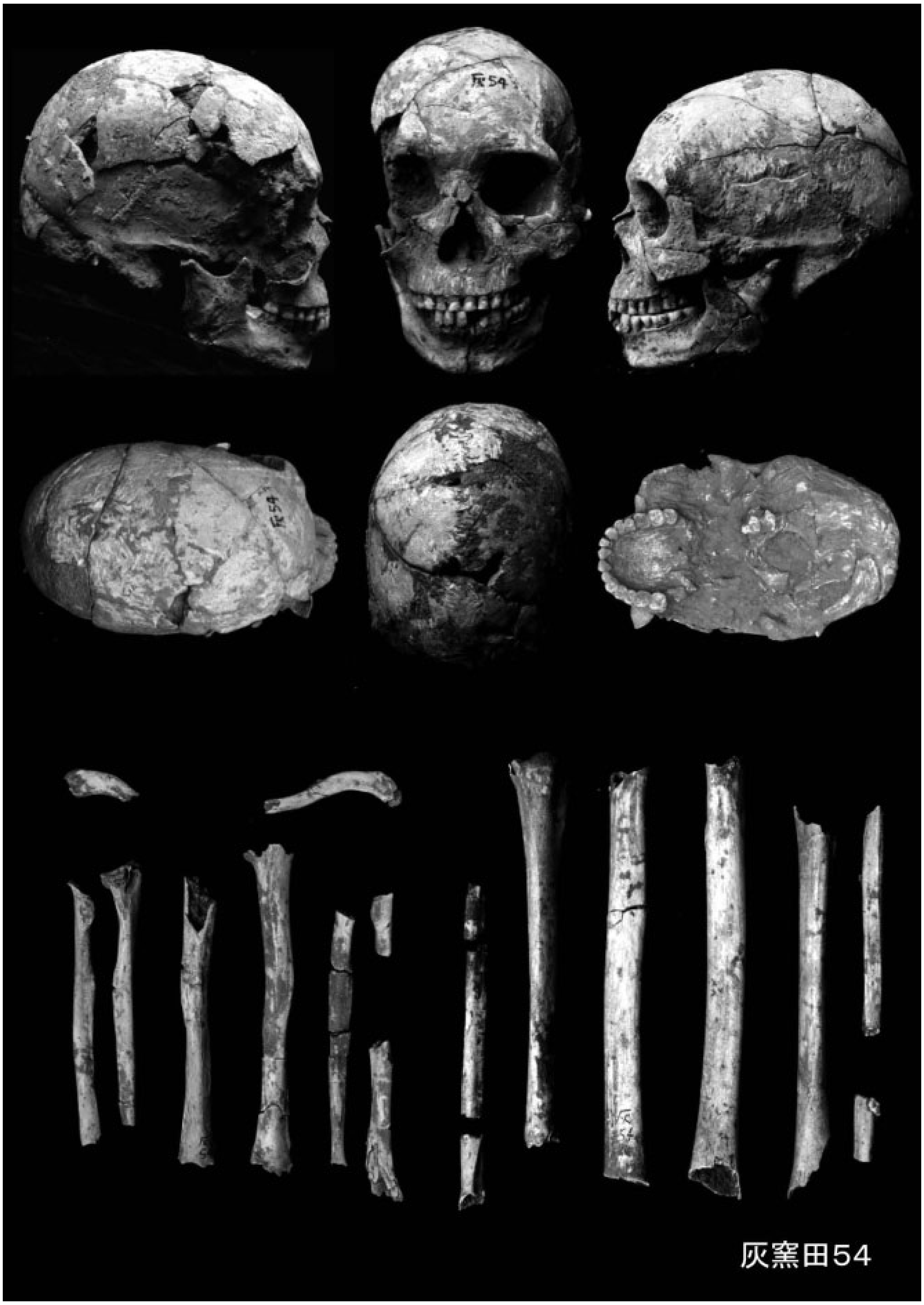
灰窯田56-1


灰窯田57


灰窯田54


灰窯田51


灰窯田60

# 4
# Unique Squatting Burial Posture Observed at Huiyaotian

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Huiyaotian is a Neolithic mass burial site located near Nanning, the capital of the Guangxi Zhuang Autonomous Region, South Central China. This site is unique in that it contains a number of skeletons buried in a squatting posture. Among the 60 excavated human skeletons, the burial posture could be confirmed in 37 cases. Among the 37 burials with confirmed burial posture, 16 were flexed burials, one was an extended burial, two were secondary burials, and as many as 18 were squatting burials. This chapter describes the details of the posture observed in one of the best-preserved cases of the squatting burials.

## MATERIALS AND METHODS

In this chapter, the burial posture of M26 is described, which is the skeleton of an adult male individual (Figure 4-1). The skeleton was excavated and brought to the laboratory without isolating each bone. Some bones are still embedded in soil, but the position and orientation of the individual bones can be identified mostly. Three-dimensional (3D) surface scans were taken using an Artec EVA portable scanner (Figures 4-2, 4-3, 4-4).

Figure 4-1. The skeleton of M26 excavated at Huiyaotian.

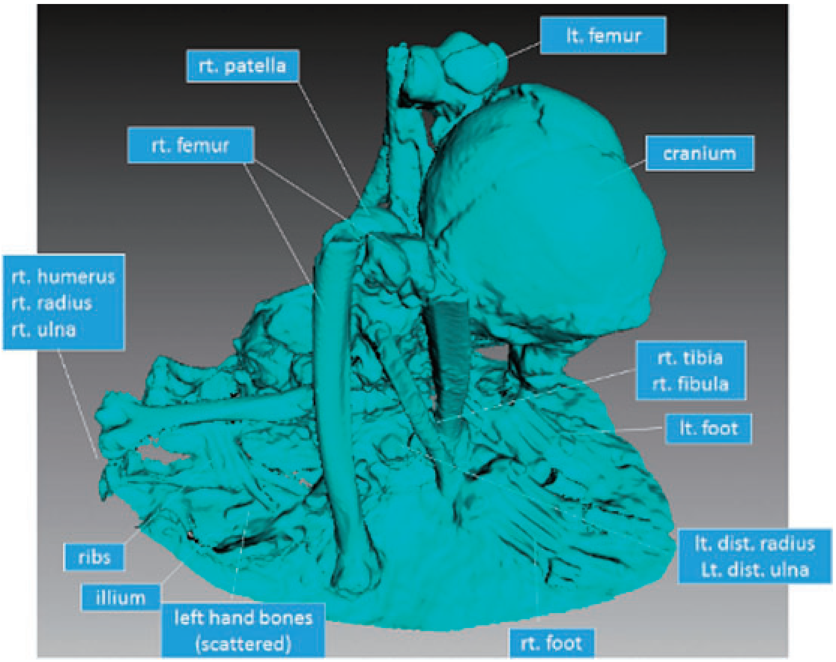


Figure 4-2. Surface scan of M26 (superior diagonal view).

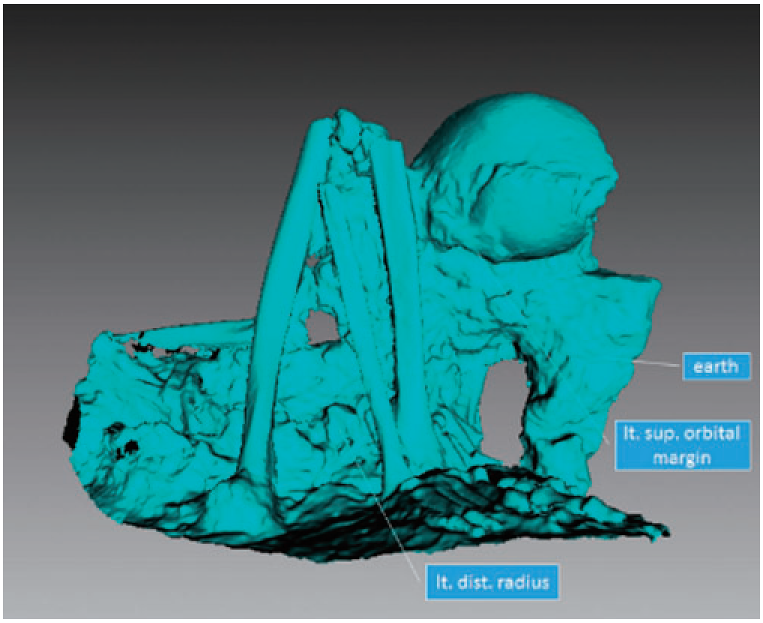


Figure 4-3. Surface scan of M26 (anterolateral view).

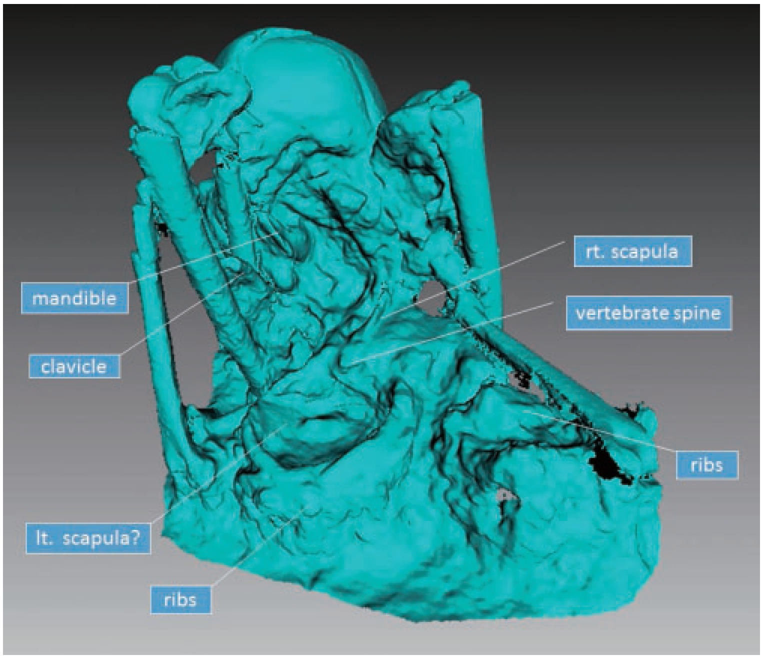


Figure 4-4. Surface scan of M26 (posterolateral view).

## DESCRIPTION

The skeleton is mostly complete and maintains the original articulated relationship, although the ribcage is collapsed and partly missing. The position of each bone is indicated in Figures 4-2, 4-3, and 4-4.

The broken pelvis is on the ground, and the right and left femora stand almost vertically with their distal ends oriented towards the top. On both sides, the knee joint is flexed strongly so that the foot is located immediately medial to the hip joint. The bones of each foot are mostly complete. The right and left feet are laid side-by-side, directly below the cranium. The cranium is currently at the level of the knee joints with the face looking downward. It is possible that the cranium was originally at a higher level, but later dropped downward during decay.

The right and left shoulders, rib cage, and the upper limb bones are collapsed downward, but the positional relationship of the humerus, radius and ulna clearly indicate that the arms were crossed below the thigh, and each hand was inserted below the knee joint of the opposite side.

In summary, the body of M26 is folded in a very compact manner. This compact squatting posture may have been made by tying body with rope, though more simply the corpus may have been forced into the narrow pit.

## ACKNOWLEDGMENTS

I am grateful to Dr. Kazuhiro Sakaue for his helpful comments and input.

# 5
# Paleopathological Description of the Huiyaotian Human Remains

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[2] Public Collaboration Center, Tokyo University of the Arts, Tokyo, Japan
[3] Toshima Ward Education Board, Tokyo, Japan
[4] Center for Cultural Resource Studies, Kanazawa University, Kanazawa, Japan

## INTRODUCTION

This chapter briefly describes the fundamental paleopathological findings of the prehistoric buried human remains from the Huiyaotian site. Our pathological investigation targets stress markers (cribra orbitalia [CO] and linear enamel hypoplasia [LEH]), oral health indicators (dental caries, periodontitis, and antemortem tooth loss [AMTL]), external auditory exostosis (EAE), postcranial lesions (vertebral osteophyte, ossification of anterior longitudinal ligament [OALL], periostitis, and limb arthritis), traumatic injuries, and other osteopathological abnormalities.

## MATERIALS AND METHODS

The fifty-one burials and several scattered or intermixed human remains recovered in the Huiyaotian excavations in 2012 and 2013 were used in the study. The subjects were skulls, permanent teeth, vertebrae, superior and inferior limb girdles, limb long bones, patellae, tali, and calcanei. All paleopathological data of the Huiyaotian human remains were collected by one of the authors (J.S.).

The following are the details of the methods used during the observation and recording of data concerning paleopathological characteristics. (1) CO: The identification criteria were pursuant to Nathan and Haas[1]. (2) LEH: Upper and lower first incisors (UI1 and LI1) and upper and lower canines (UC and LC) were observed with a 10× magnifying lens under a light-emitting diode (LED) light (Panasonic, PF-425). According to Goodman and Rose[2] and Hillson[3], enamel defects such as horizontal furrows and pits in a row parallel to the perikymata grooves on the crown surface were identified as LEH. Any crown surfaces of more than half of the original crown height were out of scope to avoid the influences of teeth wear, and the presence or absence of hypoplasia within half of the original crown height were recorded. (3) Dental caries: The identification criteria were pursuant to Hillson[3]. (4) Periodontitis, AMTL, OALL, and periostitis: The identification criteria were pursuant to Ortner[6]. For periostitis, adult limb long bones with diaphysis remaining in more than half of the original length were used. (5) Vertebral osteophyte and limb arthritis: The identification criteria were pursuant to Rogers[4] and Bridges[5]. For the investigation of vertebral osteophyte, the cervical, thoracic, and lumbar vertebrae were used. For the investigation of limb arthritis, the glenoid cavity of the scapula, proximal and distal ends of the humerus, radius, femur, and tibia, trochlear notch of the ulna, acetabulum of the os coxae, articular surface of the patella, distal end of the fibula, calcaneal articular surface of the talus, and posterior talar articular surface of the calcaneus of adult were used.

## PATHOLOGICAL DESCRIPTION

The frequencies of the occurrence of pathological characteristics are shown in Tables 5-1, 5-2, 5-3 and 5-4. Individual paleopathological information is listed below. The abbreviations used for the permanent tooth types are as follows: U, upper; L, lower; I, incisor; C, canine; P, premolar; and M, molar. The occurrence data for each pathological condition are summarized in the supplementary tables (Tables 5-S1, 5-S2, 5-S3, 5-S5).

Table 5-1. Frequencies of stress markers and oral health indicators

| | CO[1] | LEH[2] | | | | Dental caries[2] | Periodontitis[3] | AMTL[3] |
|---|---|---|---|---|---|---|---|---|
| | | UI1 | UC | LI1 | LC | | | |
| N | 2/21 | 9/13 | 9/17 | 2/14 | 10/26 | 11/548 | 10/687 | 23/687 |
| % | 9.5 | 69.2 | 52.9 | 14.3 | 38.5 | 2.0 | 1.5 | 3.3 |

[1] Number of orbital roofs with CO/Total number of orbital roofs remains. The left and right were combined.
[2] Number of teeth with LEH/Total number of teeth remains. Abbreviations for tooth type are as follows: U is upper, L is lower, I is incisor, and C is canine.
[3] Number of teeth lost antemortem/Total number of sockets in maxilla and mandible remains.

Table 5-2. Frequencies of vertebral osteophytes and OALL

| | Vertebral osteophyte | | | OALL[1] |
|---|---|---|---|---|
| | Cervical | Thoracic | Lumbar | |
| N | 3/43 | 4/74 | 5/23 | 3/140 |
| % | 7.0 | 5.4 | 21.7 | 2.1 |

[1] Number of OALL/Total number of vertebrae remains

Table 5-3. Frequencies of periostitis[1]

| | Humerus | Radius | Ulna | Femur | Tibia | Fibula |
|---|---|---|---|---|---|---|
| N | 1/35 | 1/25 | 0/25 | 0/41 | 2/40 | 1/23 |
| % | 2.9 | 4.0 | 0.0 | 0.0 | 5.0 | 4.3 |

[1] The left and right were combined.

Table 5-4. Frequencies of limb arthritis[1]

| | Scapula glenoid cavity | Humerus proximal | Humerus distal | Radius proximal | Radius distal |
|---|---|---|---|---|---|
| N | 1/19 | 0/13 | 0/33 | 0/25 | 1/27 |
| % | 5.3 | 0.0 | 0.0 | 0.0 | 4.0 |

| | Ulna trochlear notch | Os Coxae acetabular | Femur proximal | Femur distal | Patella |
|---|---|---|---|---|---|
| N | 0/37 | 0/5 | 0/28 | 0/10 | 4/20 |
| % | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 |

| | Tibia proximal | Tibia distal | Fibula distal | Talus subtalar | Calcaneus talar |
|---|---|---|---|---|---|
| N | 0/3 | 0/20 | 0/20 | 1/36 | 1/22 |
| % | 0.0 | 0.0 | 0.0 | 2.8 | 4.5 |

[1] The left and right were combined.

### M3, adult, male

One LEH line was found in the left LC (the right LC enamel was broken postmortem). Both UCs were impacted.

### M4, adult, female

The right tuberosity of the radius was unnaturally bulging.

### M5, adult, male

No abnormal pathological traits were found.

### M6, adult 40–60 years, female

Cervical caries was found on the distal side of the left LP2. A mild degree of vertebral osteophyte was observed in an upper thoracic vertebra.

### M7, adult middle mature, female

Cervical caries was found on the distal side of the left LM2. Both LM1s were lost antemortem (AMTL). A possible case of OALL was observed in two fragments of the lower thoracic vertebrae (Figure 5-1). Arthritis was found in the right distal end of the radius.

### M8, adult, male

No abnormal pathological traits were found.

### M9, adult middle mature, male

Four LEH lines were found in the left LC. The right LC was lost postmortem.

### M10, adult young mature, male

Three LEH lines were found in the left UC. The right UC was lost postmortem.

### M10 different, child 3–5 years, sex unknown

The mandible of the child was intermixed with the burial remains of M10. No abnormal pathological traits were found.

### M11, adult middle mature, female

Smooth surface caries was found on the distal side of the right UM1. The left LM1 was lost antemortem. Mild periostitis was observed in the left humerus, left radius, and left tibia diaphyses. Small bone erosion due to arthritis was found in the articular facets of both patellae.

### M12, adult young mature, female

One LEH line was found in the right UI1. The crown of the left UI1 was coated with soil. A mild degree of periostitis was observed in the right fibula.

The right talus and right calcaneus of another individual (adult, sex unknown) were intermixed with the burial remains of M12. Medium bony lipping formations were observed at the margins of the posterior talocrural articular surfaces of both bones (the posterior calcaneal articular surface of the talus and posterior talar articular surface of the calcaneus).

### M13, adult middle mature, female

Cervical caries was found on the distal side of the left UM2 and fissure caries was found in the right LM1. Periodontitis was observed in the regions of both LM1s.

### M14, adult middle mature, male

Cervical caries was found on the distal side of the right LM1. A mild degree of vertebral osteophyte was observed in one middle thoracic vertebra. A possible case of OALL was observed in two fragments of the cervical vertebrae.

### M16, adult middle mature, female

One LEH line was found in the left UI1 (the right UI1 was lost postmortem).

### M18, adult, male

No abnormal pathological traits were found.

### M19, adult middle mature, female

Fissure caries was observed in the left UM3 and right LM3.

### M20, adult middle mature, female

Three LEH lines were observed in both UI1s, and two LEH lines were observed in both UCs. Periodontitis was observed in the regions of both UM1s. The right UM1 was lost antemortem. Mild periostitis was observed in the right tibia diaphysis (Figure 5-1).

Small bone erosion due to arthritis was found in the articular facet of the right patella (Figure 5-1).

**M23, adult mature, female**

Periodontitis was observed in the regions of the right UC, right UP1, right UM1, and right UM2. The left UM3, left LM1, left LM2, and left LM3 were lost antemortem.

**M24, adult, sex unknown**

No abnormal pathological traits were found.

**M25, adult mature, male**

Three LEH lines were found in both UI1s two LEH lines were observed in the left LI1 (the crown of the right LI1 was coated with soil), and four LEH lines were observed in both LCs (Figure 5-1).

**M26, adult middle mature, male**

No abnormal pathological traits were found.

**M27, adult mature, male**

No abnormal pathological traits were found.

**M28, adult mature, male**

Two LEH lines were found in the right LC. The left LC was lost postmortem.

**M29, adult middle mature, female**

One LEH line was found in the right LC. The crown of the left LC was coated with soil.

**M30, adult middle mature, male**

Severe vertebral osteophytes were observed in four lumbar vertebrae (Figure 5-1).

**M32, adult young or middle mature, female**

Two LEH lines were found in the left UC and one LEH line was found in the left LC (the right UC and LC were lost postmortem). Cervical caries was found on the distal side of the left LM1.

**M34, adult middle mature, female**

Two LEH lines were found in the left UC. The right LC was lost postmortem. The right LP1 was lost antemortem. A mild vertebral osteophyte was observed in two cervical vertebrae.

**M35, adult middle mature, male**

Mild vertebral osteophyte was observed in two middle thoracic vertebrae and one lumbar vertebra. A possible case of OALL was observed in a fragment of one lower thoracic vertebra. Mild bony lipping was formed at the margin of the glenoid cavity of the left scapula. Small bone erosion due to arthritis was found in the articular facet of the left patella.

### M36-1, adult middle mature, female

No abnormal pathological traits were found.

### M36-2, adult middle mature, male

No abnormal pathological traits were found.

### M37, adult middle mature, female

One LEH line was found in the left UI1 and two LEH lines were found in the left UC (the right UI1 and UC were lost postmortem).

### M38, adult middle mature, female

One LEH line was found in the left UI1 (the right UI1 was lost postmortem). One LEH line was found in both UCs.

### M39, adult middle mature, female

No abnormal pathological traits were found.

### M40, adult middle mature, sex unknown

Both UI1s, both UI2s, both UCs, and the left UM1 and UM2 were lost antemortem.

Two adult mandibles were intermixed with the burial remains of M40. Individual recognition was difficult based on gross morphology alone, so in this report, they were assigned the numbers mandible 40-1 and 40-2 for descriptive purposes. Mandible 40-1 had no abnormal pathological traits. The left LM1 and LM2 of mandible 40-2 were lost antemortem.

### M42, adult, sex unknown

No abnormal pathological traits were found.

### M43, adult late middle mature, male

One LEH line was found in the left LI1. The right LI1 was damaged. Four LEH lines were found in both LCs. The right UI1 of another individual, which had one LEH line, was intermixed with the burial remains of M43.

### M44, adult middle mature, male

One LEH line was found in the left UI1 and both UCs. The crown of the right UI1 could not be observed because of its severe attrition. Fissure caries was found in the right LM2; the same tooth also had cervical caries on its distal side.

### M45-1, adult mature, female

Periodontitis was observed in the left LM1 region.

**M45-2, adult, male**

No abnormal pathological traits were observed.

The mandible of another individual (adult, sex unknown) was intermixed with the burial remains of M45-2. No abnormal pathological traits were observed in it.

**M46-1, adult late middle mature, male**

Mild CO was observed in both orbital roofs. A cervical caries was found on the mesial side of the right LP1. The right LP2, both LM1s, and the right LM2 were lost antemortem (Figure 5-1).

**M46-2, adult, female**

No pathological traits were observed.

**M51, adult young mature, male**

One LEH line was found in both LCs.

**M53, child, sex unknown**

No pathological traits were observed.

**M54, adult middle mature, male**

One LEH line was found in both UI1s, the left UC, and the right LC. The crowns of the right UC and left LC could not be observed because of calculi.

**M55, adult middle mature, female**

Two adult mandibles were intermixed with the burial remains of M55. Since individual recognition was difficult, in this study, they were assigned the numbers mandible 55-1 and 55-2 for descriptive purposes. Mandible 55-1 had no abnormal pathological traits. Mandible 55-2 had one LEH line in the right LC; the left LC was broken.

**M56-1, adult mature, male**

One LEH line was found in both UCs. Periodontitis was observed in the region of the left LM1. A mild vertebral osteophyte was observed in one cervical vertebra.

**M56-2, adult, female**

Periodontitis was observed in the right LM1 region.

**M56-3, adult, sex unknown**

No abnormal pathological traits were found.

**M57, adult young or middle mature, female**

No abnormal pathological traits were found.

**M58, adult middle mature, male**

No abnormal pathological traits were found.

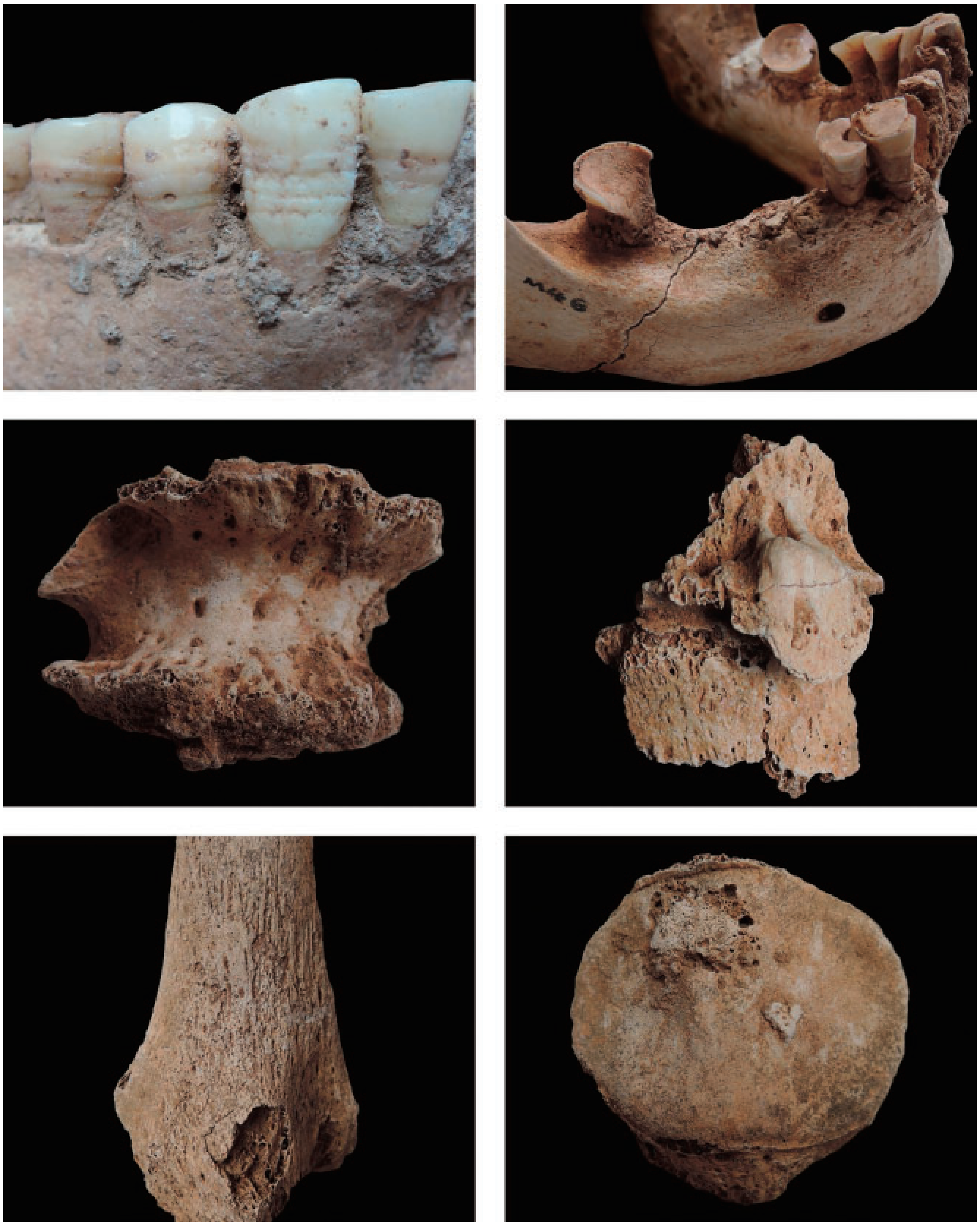

Figure 5-1. LEH, AMTL, vertebral osteophyte, OALL, periostitis, and arthritis in the Huiyaotian human remains. (The upper left is the LEHs in the lower teeth of the burial of M25; the upper right is the AMTL of the burial of M46-1; the middle left is the osteophyte in the lumbar vertebra of the burial of M30; the middle right is the OALL in the thoracic vertebrae of the burial of M7; the lower left is the periostitis in the right tibia of the burial of M20; the lower right is the arthritis in the right patella of the burial of M20).

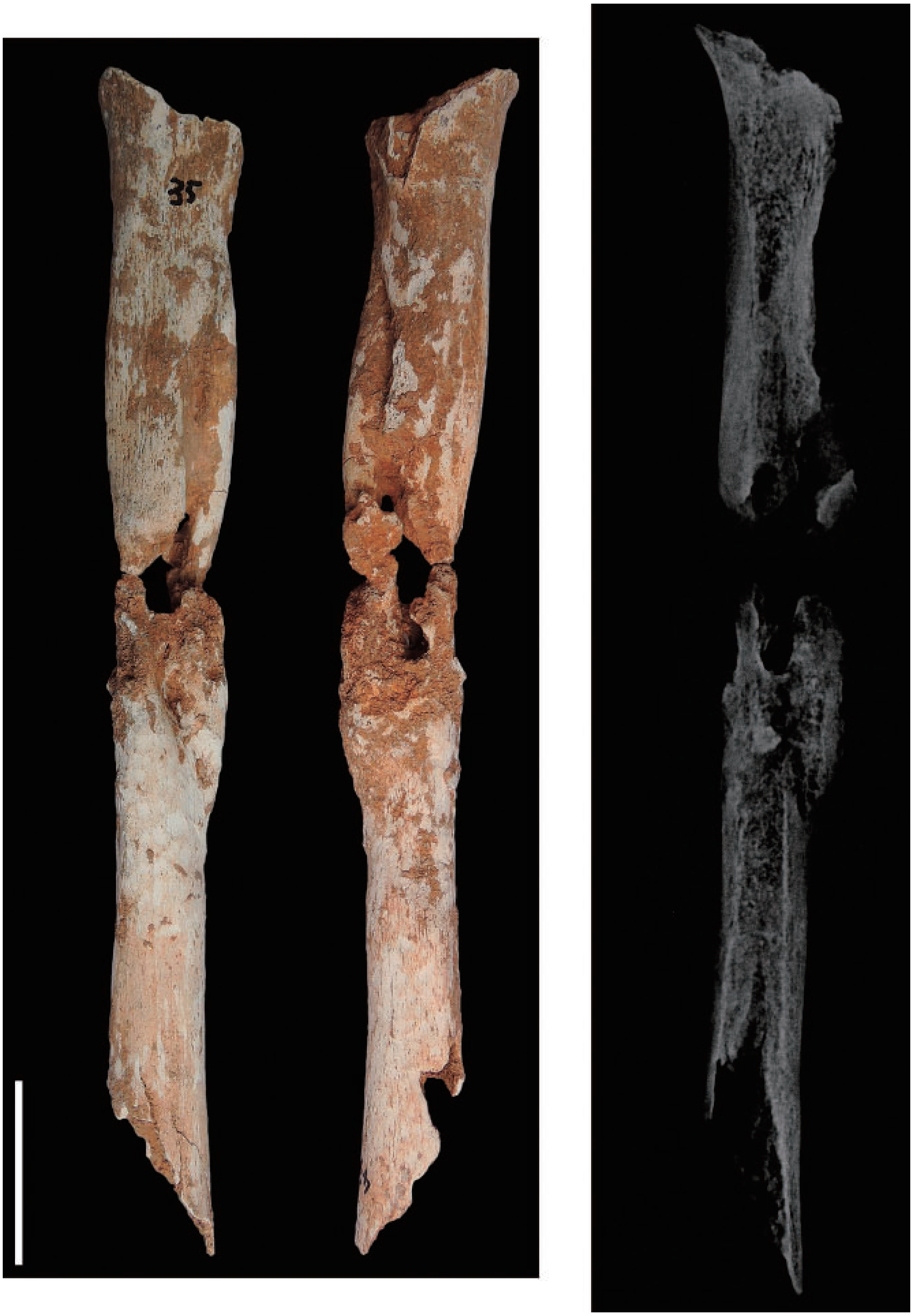


Figure 5-2. Severe traumatic femur of an unknown individual. (The left is the frontal aspect, the middle is the dorsal aspect, and the right is the X-ray photograph. Scale bar is 5 cm).

### Severe traumatic femur of an unknown individual

The upper segment of the adult left femur was unearthed from the burial of M35, and the lower segment of the same femur was found in the burial of M43. This femur was from a different individual than from the burials of M35 and M43, and the burial attributed was unknown. Its midshaft was vertically divided and twisted (Figure 5-2); it seemed awkwardly healed from a severe trauma such as a complete femur fracture. Most probably, the femoral artery had been severely damaged in the incident. This peculiar archaeological specimen suggests that the Huiyaotian prehistoric people had healing techniques for treating severe injuries with major artery damage. Their community must have had a care system that allowed for the survival of patients with complete femur fractures, even if they could not lead to full recovery.

## CONCLUSION

The paleopathological features of human remains reflect the health and life level of their community and living environment. The occurrences and frequencies of each pathological trait were as follows:

1) Stress markers (CO and LEH): The frequencies of CO based on the number of orbits, of LEH in UI1 based on the number of UI1, of LEH in UC based on the number of UC, of LEH in LI1 based on the number of LI1, and of LEH in LC based on the number of LC were 9.5% (2/21), 69.2% (9/13), 56.3% (9/16), 14.3% (2/14), and 38.5% (10/26), respectively.

2) Oral health indicators (dental caries, periodontitis, and AMTL): The frequencies of dental caries based on the number of permanent teeth, of periodontitis based on the number of sockets, and of AMTL based on the number of sockets were 2.0% (11/547), 1.5% (10/687), and 3.3% (23/687), respectively.

3) Vertebrae lesions: The frequencies of cervical osteophyte based on the number of cervical vertebrae, of thoracic osteophyte based on the number of thoracic vertebrae, of lumbar osteophyte based on the number of lumbar vertebrae, and of OALL based on the number of all vertebrae were 7.0% (3/43), 5.4% (4/74), 21.7% (5/23), and 2.1% (3/140), respectively.

4) Periostitis: The frequencies of periostitis in the humerus, radius, ulna, femur, tibia, and fibula were 2.9% (1/35), 4.0% (1/25), 0.0% (0/25), 0.0% (0/41), 5.0% (2/40), and 4.3% (1/23), respectively.

5) Limb arthritis: The frequency of arthritis in the glenoid cavity of the scapula, distal end of the radius, patella, talus, and calcaneus were 5.3% (1/19), 4.0% (1/27), 20.0% (4/20), 2.8% (1/36), and 4.5% (1/22), respectively. No arthritis was found in other articular portions.

Aside from the above, a severe traumatic femoral fracture of an unknown individual was found. The healing condition of this fractured femur suggests that the Huiyaotian inhabitants had high injury treatment techniques and were able to care for seriously injured persons.

## ACKNOWLEDGMENT

We extend our gratitude to Dr. Li Zhen for support.

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Table 5-S1. Occurrence of CO, LEH, and dental caries

| Burial | CO[1] | | LEH[1, 2] | | | | Dental caries | |
|---|---|---|---|---|---|---|---|---|
| | L | R | UI1 | UC | LI1 | LC | N[3] | tooth type[2] |
| M3 | | | − | | − | + | 0/29 | |
| M6 | | | | | | | 1/5 | LP2 (L) |
| M7 | − | | | | − | − | 1/19 | LM2 (L) |
| M9 | | | | | | + | 0/1 | |
| M10 | | | | + | | | 0/1 | |
| M11 | | | | − | | | 1/10 | UM1 (R) |
| M12 | | | + | − | | − | 0/28 | |
| M13 | | | | | | | 2/17 | UM2 (L), LM1 (R) |
| M14 | | | − | − | − | − | 1/18 | LM1 (R) |
| M16 | | | + | | | | 0/3 | |
| M18 | | − | | | | | 0/3 | |
| M19 | | − | | | | | 2/20 | UM3 (L), LM3 (R) |
| M20 | − | − | + | + | | | 0/19 | |
| M23 | − | − | | | | | 0/9 | |
| M25 | | | + | | + | + | 0/25 | |
| M26 | | | | | | | 0/1 | |
| M27 | | | | | | | 0/2 | |
| M28 | | | | | | + | 0/3 | |
| M29 | − | − | | | | + | 0/26 | |
| M30 | | | | | − | | 0/3 | |
| M32 | | | | + | | + | 1/13 | LM1 (L) |
| M34 | | | | + | − | − | 0/13 | |
| M35 | − | − | | | | − | 0/8 | |
| M36-1 | | | | | − | − | 0/16 | |
| M36-2 | | | − | − | − | − | 0/27 | |
| M37 | | − | + | + | | | 0/2 | |
| M38 | | | + | + | | | 0/14 | |
| M39 | | | | | | − | 0/6 | |
| M40 | − | − | | | | | 0/1 | |
| M40-1 | | | | | − | − | 0/7 | |
| M42 | | | | | | | 0/5 | |
| M43 | − | − | | − | + | + | 0/21 | |
| M43 intermix | | | + | | | | 0/1 | |
| M44 | − | | + | + | | − | 1/21 | LM2 (R) |
| M45-1 | − | | | | | − | 0/15 | |
| M45-2 | | | | | − | − | 0/16 | |
| M45-2 intermix | | | | | − | − | 0/5 | |
| M46-1 | + (mild) | + (mild) | | | | − | 1/8 | LP1 (R) |
| M51 | | | − | − | − | + | 0/31 | |
| M54 | − | | + | + | | + | 0/30 | |
| M55 | | | | − | | | 0/5 | |
| M55-1 | | | | | − | − | 0/11 | |
| M55-2 | | | | | | + | 0/2 | |
| M56-1 | | | | + | | − | 0/27 | |
| M58 | | | | | | | 0/1 | |

[1] Symbol "+" indicates CO/LEH presence, and "−" indicates CO/LEH absence.
[2] Abbreviations for tooth type are as follows: U is upper, L is lower, I is incisor, C is canine, P is premolar, and M is molar.
[3] Number of caries teeth/Total number of teeth remains

Table 5-S2. Occurrence of periodontitis and AMTL

| Burial | Number of sockets | Periodontitis | | AMTL | |
|---|---|---|---|---|---|
| | | N | Region | N | Tooth type |
| M3 | 30 | 0 | | 0 | |
| M6 | 1 | 0 | | 0 | |
| M7 | 29 | 0 | | 2 | LM1 (L, R) |
| M11 | 6 | 0 | | 1 | LM1 (L) |
| M12 | 18 | 0 | | 0 | |
| M13 | 17 | 2 | LM1 (L, R) | 0 | |
| M14 | 22 | 0 | | 0 | |
| M16 | 5 | 0 | | 0 | |
| M18 | 3 | 0 | | 0 | |
| M19 | 24 | 0 | | 0 | |
| M20 | 29 | 1 | UM1 (L, R) | 1 | UM1 (R) |
| M23 | 16 | 4 | UC (R), UP1 (R), UM1 (R), UM2 (R) | 4 | UM3 (L), LM1 (L), LM2 (L), LM3 (L) |
| M25 | 23 | 0 | | 0 | |
| M27 | 2 | 0 | | 0 | |
| M29 | 31 | 0 | | 0 | |
| M30 | 9 | 0 | | 0 | |
| M32 | 15 | 0 | | 0 | |
| M34 | 18 | 0 | | 1 | LP1 (R) |
| M35 | 16 | 0 | | 0 | |
| M36-1 | 15 | 0 | | 0 | |
| M36-2 | 32 | 0 | | 0 | |
| M38 | 21 | 0 | | 0 | |
| M39 | 10 | 0 | | 0 | |
| M40 | 9 | 0 | | 8 | UI1 (L, R), UI2 (L, R), UC (L, R), UM1 (L), UM2 (L) |
| M40-1 | 12 | 0 | | 0 | |
| M40-2 | 6 | 0 | | 2 | LM1 (L), LM2 (L) |
| M42 | 13 | 0 | | 0 | |
| M43 | 32 | 0 | | 0 | |
| M44 | 23 | 0 | | 0 | |
| M45-1 | 17 | 1 | LM1 (L) | 0 | |
| M45-2 | 29 | 0 | | 0 | |
| M45-2 intermix | 5 | 0 | | 0 | |
| M46-1 | 15 | 0 | | 4 | LP2 (R), LM1 (L, R), LM2 (R) |
| M51 | 31 | 0 | | 0 | |
| M54 | 32 | 0 | | 0 | |
| M55 | 12 | 0 | | 0 | |
| M55-1 | 13 | 0 | | 0 | |
| M55-2 | 9 | 0 | | 0 | |
| M56-1 | 28 | 1 | LM1 (L) | 0 | |
| M56-2 | 8 | 1 | LM1 (R) | 0 | |
| M58 | 1 | 0 | | 0 | |

Table 5-S3. Occurrence of osteophyte and OALL

| Burial | Vertebral osteophyte[1] | | | OALL |
|---|---|---|---|---|
| | Cervical | Thoracic | Lumbar | |
| M5 | | 0/4 | | |
| M6 | | 1/2 | | |
| M7 | 0/3 | 0/4 | | Lower thoracic |
| M8 | | 0/9 | | |
| M10 | 0/7 | 0/4 | 0/5 | |
| M14 | 0/3 | 1/3 | | Cervical |
| M18 | 0/5 | 0/6 | 0/2 | |
| M20 | 0/2 | 0/3 | 0/1 | |
| M25 | | 0/6 | | |
| M26 | 0/4 | 0/9 | 0/4 | |
| M28 | | 0/2 | 0/1 | |
| M29 | 0/5 | 0/2 | 0/1 | |
| M30 | | | 4/4 | |
| M32 | 0/1 | | | |
| M34 | 2/2 | | | |
| M35 | | 2/3 | 1/1 | Lower thoracic |
| M37 | 0/1 | 0/3 | | |
| M39 | 0/1 | | | |
| M42 | 0/4 | | | |
| M51 | 0/4 | 0/8 | 0/3 | |
| M54 | | 0/4 | 0/1 | |
| M55 | | 0/2 | | |
| M56-1 | 1/1 | | | |

[1] Number of osteophyte vertebrae/Total number of vertebrae remains

Table 5-S4. Occurrence of periostitis[1]

| Burial | Humerus | | Radius | | Ulna | | Femur | | Tibia | | Fibula | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | R | L | R | L | R | L | R | L | R | L | R |
| M4 | − | | | − | − | | | | | | | |
| M5 | | − | − | − | − | − | | − | − | − | − | − |
| M6 | | − | | | | | − | − | | − | | |
| M7 | − | − | − | | − | − | − | − | − | − | − | |
| M8 | − | − | − | | − | − | | | | − | | |
| M10 | − | − | | | | | − | − | | − | | − |
| M11 | + | − | + | | − | | − | − | + | | | |
| M12 | − | − | − | − | − | − | | − | | − | | + |
| M13 | | − | | − | | − | | | − | | | |
| M14 | − | − | − | − | | − | − | − | − | − | − | |
| M16 | | | | | | | − | − | − | − | − | − |
| M18 | | | − | | | | − | − | | | | |
| M19 | − | − | | | | | − | − | | − | | |
| M20 | | − | | − | | − | − | − | | + | | − |
| M25 | | | | − | | − | | | | | | |
| M27 | | − | | | | | | | | | | |
| M28 | − | | | | | | − | − | − | − | | |
| M29 | − | | | − | | | − | − | − | | − | − |
| M30 | − | | | − | − | − | − | | − | − | − | − |
| M34 | | − | | − | | − | − | − | | | | |
| M35 | − | − | | − | | − | | − | − | − | | |
| M39 | | | | | | | | − | − | − | | |
| M43 | | − | | | | | − | | − | − | | − |
| M45-1 | − | − | − | − | − | | − | | − | − | − | − |
| M45-2 | | | | − | | − | − | − | | | − | − |
| M46-1 | | − | | | | | | | | | | |
| M46-2 | | | | | | | − | | − | | | |
| M51 | − | − | − | − | − | − | − | − | − | − | − | − |
| M54 | − | − | | − | | − | − | − | − | − | | |
| M55 | | | | | | | | | − | − | | |
| M56-1 | | − | | − | − | − | | − | − | − | | − |
| M57 | | | | | | | − | | − | − | − | − |
| Extra from M35 and 43 | | | | | | | − | | | | | |

[1] Symbol "+" indicates perio stitis presence, and "−" indicates periostitis absence.

## Table 5-S5. Occurrence of limb arthritis[1]

| Burial | Scapula glenoid cavity | | Humerus proximal | | Humerus distal | | Radius proximal | | Radius distal | | Ulna trochlear notch | | Os Coxae acetabulum | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | R | L | R | L | R | L | R | L | R | L | R | L | R |
| M3 | | − | | | | | − | | − | | | | | |
| M4 | | | | | − | − | − | | | | − | − | | |
| M5 | | − | | | | | − | | − | − | − | − | | |
| M6 | | | | | | − | | | | | | − | | |
| M7 | | − | | − | − | − | − | − | − | + | − | − | | − |
| M8 | | | − | | − | | | − | | − | − | − | | |
| M9 | | | | | | | − | − | − | − | | | | |
| M10 | − | − | − | − | − | | | | − | | | | | |
| M11 | | | | | − | | | | | | | | | |
| M12 | | − | | | − | − | | | | | − | − | | |
| M12 intermix | | | | | | | | | | | | | | |
| M13 | | | | | | − | | − | | | − | − | | |
| M14 | | | | | − | − | − | − | − | | | − | | |
| M16 | | | − | − | | | | | | | | | | |
| M18 | | | | | | − | | − | | − | | | | |
| M19 | | | − | | | | | | − | | − | − | | |
| M20 | | | | | | − | | − | − | − | | − | | |
| M23 | − | | | | − | | | | | | | − | | |
| M25 | − | | − | | | | | − | | − | | − | | |
| M27 | | | − | − | | − | | | − | | | | | |
| M28 | − | | | | − | | − | − | | | | | | |
| M29 | | | | | | − | | − | | − | − | | | |
| M30 | | | | | | − | | | | | | − | | |
| M32 | | | | | − | | | | | | − | | | |
| M34 | | − | | | | − | | − | | − | | − | | |
| M35 | + | | | | − | − | − | | | − | − | − | | |
| M36-1 | − | − | − | − | | | | | | | | − | | |
| M37 | | − | | | | | | | − | | | | | |
| M39 | | | | | | | | | | | | | | − |
| M40 | | | | | | − | | | | − | | | | |
| M43 | | | | | | − | | − | | | | − | | |
| M44 | | − | | | − | | | | | | | | | |
| M45-1 | | | − | | | | | | − | − | − | | | |
| M45-2 | | − | | | | | | − | | − | | − | | |
| M46-1 | | | | | | − | | | | | − | | | |
| M46-2 | | | | | | − | | | | | | − | | |
| M51 | − | − | | | | − | − | − | | | − | − | − | |
| M54 | − | | | | | | | | | | | | | |
| M55 | | | | | − | | | | | − | − | − | − | − |
| M56-1 | | | | | − | − | − | − | | − | − | − | | |
| M56-2 | | | | | | | | | | | | | | |
| M56-3 | | | | | | | | | | | | | | |
| M57 | | | | | | | | | | − | | | | |

| Burial | Femur proximal | | Femur distal | | Patella | | Tibia proximal | | Tibia distal | | Fibula distal | | Talus subtalar | | Calcaneus talar | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R |
| M3 | | | | | | | | | | | | | | | | |
| M4 | | | | | | | | | | | | | | | | |
| M5 | | | | | | | | | − | − | − | | − | − | − | − |
| M6 | | | | | | | | | | | − | | | | | − |
| M7 | | | | | | − | | | | | | | | − | | |
| M8 | | | | | | | | | | | | | − | − | − | − |
| M9 | | − | | | | | | | | | | − | | | − | − |
| M10 | − | − | | − | | | | − | | − | | − | | | | |
| M11 | − | − | | | + | + | | | | | | | | | | |
| M12 | − | | | | − | − | | | | − | | | − | − | − | − |
| M12 intermix | | | | | | | | | | | | | | + | | + |
| M13 | | | | | | | | | | | | − | | | | |
| M14 | | − | − | − | | | − | | − | − | | | − | | | |
| M16 | − | − | | | | | | | | | | − | − | − | | |
| M18 | − | − | | | | | | | | − | | | | − | | − |
| M19 | − | − | | | | − | | | | | | | − | − | | |
| M20 | − | − | | | | + | | | − | − | | | − | − | − | − |
| M23 | | | | | | | | | | | | | | | | |
| M25 | | | | | | | | | | | | | | | | |
| M27 | | | | | | | | | | | | | | | | |
| M28 | | | | − | | − | | | − | | − | | | − | | − |
| M29 | | | − | | − | − | − | | | | − | − | | | | |
| M30 | | | | | | | | | | | | − | − | − | | |
| M32 | | | | | | | | | | | | − | | | | |
| M34 | | | | | − | | | | | | | | | − | | − |
| M35 | − | − | | | + | − | | | | | | | − | | − | |
| M36-1 | | | | | | | | | | | | | | | | |
| M37 | − | − | | | | | | | − | | − | | − | | − | − |
| M39 | | − | | − | | | | | − | | | − | − | − | | − |
| M40 | | | | | | | | | | | | | | | | |
| M43 | | − | | | | | | | − | | − | − | − | − | | |
| M44 | | | | | | | | | | | | | | | | |
| M45-1 | | | | | | | | | − | − | − | | | | | |
| M45-2 | − | | | | | | | | | − | | − | | | | |
| M46-1 | | | | | | | | | | | | | | | | |
| M46-2 | | | | | | | | | | | | | − | − | | |
| M51 | − | − | | | | | | | − | − | − | − | − | − | − | |
| M54 | | | − | − | − | − | | | | | | | − | | | |
| M55 | − | − | | | | − | | | − | − | | − | | − | | |
| M56-1 | − | − | | − | | − | | | | | | | − | − | − | |
| M56-2 | | | | | − | | | | | | | | | | | |
| M56-3 | | | | | − | | | | | | | | | | | |
| M57 | | | − | | − | | | | | | | | − | − | | − |

[1] Symbol “+” indicates arthritis presence, and “−” indicates arthritis absence.

# 6
# Morphometric Records of the Huiyaotian Human Skulls

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Of the sixty burials excavated at Huiyaotian during the 2008 and 2013 seasons, skull measurements were taken for thirteen adult males and nine adult females following Martin's measurement definitions (Bräuer[1]). The recorded data set consists of thirty-two cranial measurements and representative cranial indices. In the case of incomplete preservation, when half of the portion was complete, some measurements were estimated by the doubling the value of the complete side. The measurement data are given in Table 6-1.

## REFERENCE

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Table 6-1. Cranial and mandibular measurements (mm) and indices for the Huiyaotian

| Martin's No.<br>Sex (M=male, F=female) | M3<br>M | M7<br>F | M9<br>M | M14<br>M | M19<br>F | M20<br>F | M23<br>F | M25<br>M | M26<br>M | M29<br>F | M32<br>F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Maximam cranial length | — | — | 192 | 187 | 192 | 200 | — | 198 | 194 | 208 | — |
| 5 Basion-nasion length | — | 98 | — | — | — | — | — | — | — | 100 | — |
| 8 Maximam cranial breadth | — | 130 | 142 | 137 | — | — | — | — | 147 | 140 | — |
| 9 Minimum frontal breadth | — | 92 | — | 99 | 101 | 91 | — | — | — | 100 | — |
| 10 Maximaum frontal breadth | — | 112 | — | 119 | 117 | — | — | — | — | — | — |
| 12 Maximum occipital breadth | — | — | — | — | — | — | — | — | — | — | — |
| 17 Basion-bregma height | — | 135 | — | — | 155 | — | — | — | — | 139 | — |
| 29 Frontal chord | — | 107 | — | — | — | 110 | — | — | — | — | — |
| 30 Parietal chord | — | — | — | — | 122 | 126 | — | — | — | — | — |
| 31 Occipital chord | — | — | — | — | 100 | — | — | — | — | — | — |
| 40 Basion-prosthion breadth | — | — | — | — | — | — | — | — | — | 102 | — |
| 43 Upper facial breadth | — | 102 | — | 113 | 112 | 107 | — | — | — | 114 | — |
| 45 Bizygomatic breadth | — | 140 | 143 | — | 140 | 142 | — | — | — | 146 | — |
| 46 Bimaxillary breadth | — | 106 | 107 | — | 102 | 108 | — | — | — | 106 | — |
| 48 Upper facial height | — | 69 | 66 | — | 71 | 67 | — | — | — | 69 | 59 |
| 51 Orbital breadth | — | 39 | 44 | 45 | 42 | 46 | — | — | — | 43 | — |
| 52 Orbital height | — | 39 | 30 | 36 | 36 | 33 | — | — | — | 30 | — |
| 54 Nasal breadth | 31 | 26 | 28 | 28 | 27 | 30 | — | — | — | 28 | — |
| 55 Nasal height | — | 50 | 50 | — | 53 | 52 | — | — | — | 49 | — |
| 60 Upper alveolar length | — | — | — | — | — | 61 | — | — | — | 61 | — |
| 61 Upper alveolar breadth | 66 | — | — | — | — | 65 | — | — | — | 67 | — |
| 8:1 Cranial index | — | — | 74.0 | 73.3 | — | — | — | — | 75.8 | 67.3 | — |
| 48:45 Upper facial index | — | 49.3 | 46.2 | — | 50.7 | 47.1 | — | — | — | 47.3 | — |
| 43(1) Frontal chord | — | 94 | — | 98 | — | 102 | — | — | — | 104 | — |
| 43c Frontal subtense | — | 13.9 | — | 17.4 | — | 4.5 | — | — | — | 17.9 | — |
| 57 Simotic chord | — | 10.7 | 7.4 | 11.6 | — | — | — | — | — | 13.2 | — |
| 57a Simotic subtense | — | 2.9 | 2.2 | 2.9 | — | — | — | — | — | 2.4 | — |
| 46b Zygomaxillary chord | — | 100 | — | — | — | 107 | — | — | — | 106 | — |
| 46c Zygomaxillary subtense | — | 7.1 | — | — | — | 31.8 | — | — | — | 25.9 | — |
| 43c:43(1) Frontal index | — | 14.7 | — | 17.8 | — | 4.4 | — | — | — | 17.2 | — |
| 57a:57 Simotic index | — | 27.4 | 30.5 | 25.3 | — | — | — | — | — | 18.0 | — |
| 46c:46b Zygomaxillary index | — | 7.1 | — | — | — | 29.7 | — | — | — | 24.5 | — |
| 66 Bigonial breadth | — | — | — | 118 | — | 100 | — | — | — | 95 | — |
| 68 Mandibular length | 88 | — | — | 83 | — | 88 | — | — | — | 80 | — |
| 69 Symphyseal height | 33 | — | — | 35 | 35 | 33 | — | — | — | 37 | — |
| 70 Ramus height | — | — | — | 61 | 62 | 63 | — | — | — | 57 | — |
| 71 Ramus breadth | — | — | — | 42 | 38 | 44 | — | — | — | 37 | — |

Table 6-1. (continued)

| Martin's No. / Sex | M34 F | M35 M | M36-1 F | M39 F | M43 M | M45-2 M | M46-1 M | M51 M | M54 M | M56-1 M | M58 M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Maximam cranial length | 214 | 215 | — | 197 | 193 | 194 | — | — | 200 | — | — |
| 5 Basion-nasion length | — | — | — | — | 108 | — | — | — | 102 | — | — |
| 8 Maximam cranial breadth | — | — | — | — | 128 | 141 | 139 | — | 127 | — | — |
| 9 Minimum frontal breadth | — | 102 | | 102 | 92 | — | 104 | — | 91 | — | — |
| 10 Maximaum frontal breadth | — | — | — | — | 113 | — | 116 | — | — | — | — |
| 12 Maximum occipital breadth | — | — | — | — | 113 | — | — | — | 111 | — | — |
| 17 Basion-bregma height | — | — | — | — | 142 | — | — | — | 135 | — | — |
| 29 Frontal chord | — | — | — | — | 87 | — | 123 | — | 117 | — | — |
| 30 Parietal chord | — | — | — | — | — | — | — | — | 122 | — | — |
| 31 Occipital chord | — | — | — | — | — | — | — | — | 99 | — | — |
| 40 Basion-prosthion breadth | — | — | — | — | 101 | — | — | — | 101 | — | — |
| 43 Upper facial breadth | — | — | — | 120 | 110 | — | 112 | — | 114 | — | — |
| 45 Bizygomatic breadth | — | — | — | — | 140 | — | — | — | 144 | — | — |
| 46 Bimaxillary breadth | — | 107 | — | | 103 | — | — | — | 100 | — | — |
| 48 Upper facial height | — | 65 | — | 66 | 69 | — | — | — | 66 | — | — |
| 51 Orbital breadth | — | 45 | — | | 45 | — | 41 | — | 44 | 43 | — |
| 52 Orbital height | — | 33 | — | 31 | 36 | — | 35 | — | 34 | 35 | — |
| 54 Nasal breadth | — | 33 | 29 | 28 | 29 | — | 27 | — | 31 | — | — |
| 55 Nasal height | — | 49 | — | 50 | 52 | — | 48 | — | 52 | — | — |
| 60 Upper alveolar length | — | — | — | — | 51 | — | — | — | — | — | — |
| 61 Upper alveolar breadth | — | — | — | — | 64 | — | — | — | — | — | — |
| 8:1 Cranial index | — | — | — | — | 66.3 | 72.7 | — | — | 63.5 | — | — |
| 48:45 Upper facial index | — | — | — | — | 49.1 | — | — | — | 45.8 | — | — |
| 43(1) Frontal chord | — | 108 | — | — | 102 | — | 101 | — | 102 | — | — |
| 43c Frontal subtense | — | 14.8 | — | — | 17.7 | — | 27.3 | — | 20.6 | — | — |
| 57 Simotic chord | — | 10.0 | — | 10.1 | 10.0 | — | 9.1 | — | 9.7 | 10.2 | 9.5 |
| 57a Simotic subtense | — | 4.4 | — | 2.9 | 4.8 | — | 1.1 | — | 2.4 | 3.6 | 2.7 |
| 46b Zygomaxillary chord | — | 106 | — | — | 103 | — | — | — | 100 | — | — |
| 46c Zygomaxillary subtense | — | 18.1 | — | — | 19.5 | — | — | — | 28.4 | — | — |
| 43c:43(1) Frontal index | — | 13.7 | — | — | 17.4 | — | 27.1 | — | 20.2 | — | — |
| 57a:57 Simotic index | — | 43.8 | — | 28.8 | 47.5 | — | 11.9 | — | 25.1 | 35.2 | 28.0 |
| 46c:46b Zygomaxillary index | — | 17.1 | — | — | 19.0 | — | — | — | 28.4 | — | — |
| 66 Bigonial breadth | — | 113 | — | — | — | — | 101 | — | 92 | — | — |
| 68 Mandibular length | — | 88 | 88 | — | — | — | 86 | — | 85 | — | — |
| 69 Symphyseal height | — | 37 | 35 | — | 33 | — | 40 | 38 | 34 | — | — |
| 70 Ramus height | — | 68 | — | — | — | — | — | — | 65 | — | — |
| 71 Ramus breadth | — | 43 | 49 | — | 45 | — | 36 | 40 | 39 | — | — |

# 7
# Morphometric Records of the Huiyaotian Human Teeth

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Metric dental traits are represented by the mesiodistal and buccolingual crown diameters, except for the third molars. The measurements were taken according to the system of Fujita[1]. The dental measurements and observations were made on the right teeth when available. Twenty-one nonmetric dental traits were scored using protocols and criteria given in Table 7-1 and Matsumura[2]. All traits were scored for both sexes on the basis of presence/absence to facilitate statistical comparisons. The recorded crown measurements and nonmetric scores are given in Table 7-2.

Table 7-1. Criteria for presence in the 21 nonmetric dental characteristics.

| Trait | Tooth | Description | Critera | Presence |
|---|---|---|---|---|
| Shoveling | UI1, UI2 | Hanihara *et al.*, 1970 | Depth of Lingual Fossa (DFL) | DLF>=0.5mm |
| double shoveling | UI, UI2 | Suzuki and Sakai, 1973 | 3=+++(strong), 2=++(moderate), 1=+(weak)) | 2–3 |
| dental tubercle | UI, UI2 | Turner II *et al.*, 1991 | 0=none, 1=faint, 2=trace, 3(strong ridging)–6(strong cusp) | 3–6 |
| Spine | UI1 | 0:none 1:present | 1=single, 2=double, 3=triple | 1 |
| interruption groove | UI2 | Turner II *et al.*, 1991 | 0=none, 1=M(mesial), 2=Med(central), 3=d(distal) | 1–3 |
| winging (bilateral) | UI1 | Enoki and Dahlberg, 1958 | 0=straight, 1=counter wing, 2=bilateral wing, 3=uni-counter wing, 4=uni-lateral wing | 1 |
| De Terra's tubercle | UP1 | Saheki, 1958 | 0=none, 1=+(faint ridging), 2=++(small cusp), 3=+++(large cusp) | +, ++, +++ |
| double roots | UP1, UP2 | Turner II *et al.*, 1991 | 1=single, 2=double, 3=triple | 2–3 |
| Carabelli's trait | UM1 | Dahlberg's P-plaque | 0=a(none), 1=b, 2=c, 3=d, 4=e, 5=f, 6=g | d–g |
| hypocone reduction | UM2 | Dahlberg's P-plaque | 0=3(none), 1=3+(faint hyp cusp), 2=4-(small hyp cusp) , 3=4-(large hyp cusp) 4=4(full size hyp cusp) | 3+ |
| sixth cusp | LM1 | Turner II *et al.*, 1991 | 0=none, 1(much small cusp)–5(much larger cusp) | 1–5 |
| seventh cusp | LM1 | Turner II *et al.*, 1991 | 0=none, 1(faint)–4(large) | 2–4 |
| Protostylid | LM1 | Dahlberg's P-plaque | 0=none, 1=pit, 2=curved groove, 3(secondary grrove)–5(free apex) | 3–5 |
| deflecting wrinkle | LM1 | Turner II *et al.*, 1991 | 0=none, 1=faint, 2=moderately deflect, 3=L-shape | 2–3 |
| groove pattern Y | LM1 | Jørgensen, 1955 | 1=Y, 2=+, 3=X | Y |
| groove pattern X | LM2 | Jørgensen, 1955 | 1=Y, 2=+, 3=X | X |
| number of cusps (hypoconulid reduction) | LM2 | Turner II *et al.*, 1991 | 4=0(no hyld), 5=1(small hyld)–5(very large hyld), 6=with cusp 6 | 4 (4 cusps molar) |

U: Upper, L: Lower, I:Incisor, C: Canine, P: Premolar, M: Molar.

Table 7-2. Dental crown measurements (mm) and the presence of nonmtric tooth traits of the Huiyaotian.

| Sumple Number | | M3 | M6 | M9 | M10 | M12 | M14 | M20 | M25 | M29 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | | M | F | M | M | F | M | M | M | F | M |
| Mesiodistal diameters (mm) | | | | | | | | | | | |
| | UI1 | 8.45 | — | — | — | 8.30 | — | — | 9.38 | — | — |
| | UI2 | 6.75 | — | — | — | 6.96 | — | — | 8.03 | — | — |
| | UC | 8.05 | — | — | 8.22 | 7.78 | — | — | — | — | — |
| | UP1 | — | — | 7.43 | — | 6.60 | — | — | 8.16 | — | — |
| | UP2 | — | — | 6.92 | — | 6.83 | — | — | 7.54 | — | — |
| | UM1 | — | — | — | — | 10.25 | — | — | 11.21 | — | — |
| | UM2 | 10.46 | — | — | — | 9.52 | — | — | 10.47 | 11.00 | — |
| | LI1 | 5.31 | — | — | — | 5.18 | — | — | 5.96 | — | 5.08 |
| | LI2 | 6.33 | — | — | — | 6.12 | — | — | 5.89 | — | 5.14 |
| | LC | 7.72 | — | — | — | 6.59 | — | — | 7.56 | — | 6.07 |
| | LP1 | 7.64 | — | — | — | 6.78 | — | — | 7.95 | 6.59 | 7.09 |
| | LP2 | 7.14 | — | — | — | — | — | — | 7.60 | 6.41 | 7.41 |
| | LM1 | 12.28 | — | — | — | — | — | — | 12.42 | — | — |
| | LM2 | 12.50 | — | — | — | 11.29 | — | — | 12.10 | — | — |
| Buccolingual diameters (mm) | | | | | | | | | | | |
| | UI1 | 7.19 | — | — | — | 6.65 | — | 6.85 | 7.52 | — | — |
| | UI2 | 6.69 | — | — | — | 6.04 | — | 6.87 | 7.15 | — | — |
| | UC | — | — | — | 8.89 | 7.42 | — | 8.03 | — | — | — |
| | UP1 | — | — | — | — | 8.83 | — | — | 10.15 | — | — |
| | UP2 | 10.06 | — | — | — | 8.75 | — | — | 10.14 | — | — |
| | UM1 | 12.41 | — | — | — | 11.52 | — | — | 12.26 | — | — |
| | UM2 | 12.21 | — | — | — | 11.79 | — | — | 11.77 | 12.42 | — |
| | LI1 | 7.00 | — | — | — | 5.88 | 5.52 | — | 6.21 | 5.96 | — |
| | LI2 | 6.22 | — | — | — | 6.20 | 6.36 | — | 7.29 | 7.17 | 5.91 |
| | LC | 7.58 | — | — | — | 7.18 | 8.23 | — | 8.63 | 8.75 | 6.71 |
| | LP1 | 8.15 | — | — | — | 7.85 | 8.75 | — | 9.00 | — | 8.24 |
| | LP2 | 9.13 | — | — | — | 8.09 | 9.00 | — | 8.88 | — | 7.78 |
| | LM1 | 11.82 | — | — | — | 10.28 | 11.81 | — | 11.94 | 11.90 | — |
| | LM2 | 11.41 | — | — | — | 9.93 | 11.65 | — | 10.94 | 11.20 | — |
| shovelling | UI1 | — | — | — | — | 1 | — | — | 0.6 | — | — |
| shovelling | UI2 | — | — | — | — | 0.8 | — | — | 0.5 | — | — |
| double shovelling | UI1 | 0 | — | — | — | 1 | — | — | 0 | — | — |
| double shovelling | UI2 | 0 | — | — | — | 0 | — | — | 1 | — | — |
| dental tubercle | UI1 | — | — | — | — | 0 | — | — | 0 | — | — |
| dental tubercle | UI2 | — | — | — | — | 0 | — | — | 0 | — | — |
| spine | UI1 | — | — | — | — | 2 | — | — | 0 | — | — |
| interruption groove | UI2 | — | — | — | — | 0 | — | — | 0 | — | — |
| winging (bilateral) | UI1 | 2 | — | — | — | — | — | — | — | 0 | — |
| De Terra's tubercle | UP1 | — | — | — | — | — | — | — | — | — | — |
| double rooted | UP1 | — | — | — | — | 1 | — | — | 2 | — | — |
| double rooted | UP2 | — | — | — | — | 1 | — | — | 1 | — | — |
| Carabelli's trait | UM1 | — | — | — | — | 0 | — | — | — | — | — |
| hypocone reduction | UM2 | 3 | 1 | — | — | 0 | — | — | 3 | 3 | — |
| sixth cusp | LM1 | — | — | — | — | — | 0 | — | 0 | — | — |
| seventh cusp | LM1 | — | — | — | — | — | — | — | 2 | — | — |
| protostylid | LM1 | — | — | — | — | — | 0 | — | 0 | — | — |
| deflecting wrinkle | LM1 | — | — | — | — | — | — | — | — | — | — |
| groove pattern Y | LM1 | — | — | — | — | — | — | — | 2 | — | — |
| groove pattern X | LM2 | 3 | 2 | — | — | 3 | — | — | 3 | — | — |
| number of cusps | LM2 | 6 | 5 | — | — | 5 | 5 | — | 4 | — | — |

U: Upper, L: Lower, I: Incisor, C: Canine, P: Premolar, M: Moler

Table 7-2 (continued).

| Sample Number | | M34 | M36-2 | M37 | M39 | M43 | M45-2 | M51 | M54 | M55 | M56-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | | F | M | F | F | M | M | M | M | F | M |
| Mesiodistal diameters (mm) | | | | | | | | | | | |
| | UI1 | — | 8.58 | 9.66 | — | — | — | 8.35 | — | — | — |
| | UI2 | — | 7.68 | 8.78 | — | — | — | 7.54 | — | — | — |
| | UC | 8.52 | 8.53 | — | — | — | — | 8.14 | — | — | — |
| | UP1 | 6.08 | 7.55 | — | — | — | — | — | — | — | — |
| | UP2 | 7.04 | 6.77 | — | — | — | — | — | — | — | — |
| | UM1 | — | 10.54 | — | — | — | — | — | — | — | — |
| | UM2 | — | 10.28 | — | — | — | — | 9.43 | — | — | — |
| | LI1 | 5.16 | — | — | — | 5.55 | — | 4.96 | 5.38 | 5.45 | — |
| | LI2 | — | — | 5.59 | — | 6.13 | — | 5.67 | 6.27 | 5.93 | — |
| | LC | — | 7.71 | 7.75 | — | 6.64 | — | 7.20 | 7.49 | 7.26 | 8.08 |
| | LP1 | — | 6.37 | — | — | 6.68 | — | 6.68 | 7.83 | 7.37 | 7.83 |
| | LP2 | — | 6.82 | — | — | 8.33 | — | 6.94 | 7.00 | — | 7.72 |
| | LM1 | — | 12.27 | — | — | 11.05 | — | 11.74 | — | — | 11.60 |
| | LM2 | — | 11.75 | — | — | 10.6 | — | 11.37 | — | — | 11.28 |
| Buccolingual diameters (mm) | | | | | | | | | | | |
| | UI1 | — | 8.18 | 8.14 | — | — | — | — | — | — | — |
| | UI2 | — | 7.46 | 6.87 | — | — | — | — | — | — | — |
| | UC | 8.93 | 8.68 | — | — | — | — | 8.06 | — | — | — |
| | UP1 | 10.10 | 10.91 | — | — | — | — | — | — | — | — |
| | UP2 | 9.32 | 9.18 | — | — | — | — | — | — | — | — |
| | UM1 | — | 13.17 | — | — | 11.55 | — | — | — | — | — |
| | UM2 | — | 12.98 | — | — | 11.02 | — | 12.36 | 12.51 | — | — |
| | LI1 | 6.55 | 6.17 | — | — | 5.9 | 5.6 | 5.68 | 7.70 | — | — |
| | LI2 | 6.34 | 7.65 | 6.39 | 6.42 | 6.5 | 5.75 | 5.81 | 7.89 | 7.24 | — |
| | LC | 7.91 | 8.60 | 8.18 | 7.70 | 7.9 | 6.84 | 7.49 | 9.40 | — | — |
| | LP1 | 7.92 | 8.36 | — | — | 8.72 | 8.05 | 7.93 | 8.85 | 8.72 | — |
| | LP2 | — | 8.41 | — | — | 8.35 | 7.87 | 7.93 | 8.95 | 9.95 | — |
| | LM1 | — | 11.45 | — | — | 11.01 | 11.45 | 10.79 | 10.6 | 12.12 | — |
| | LM2 | — | 10.84 | — | 10.06 | 10.54 | 10.95 | 11.05 | 10.59 | 11.41 | — |
| shovelling | UI1 | — | 0.4 | 0.6 | — | — | — | — | — | — | — |
| shovelling | UI2 | — | 0.5 | 0.4 | — | — | — | — | — | — | — |
| double shovelling | UI1 | — | 0 | 0 | — | — | — | 0 | 0 | — | — |
| double shovelling | UI2 | — | 0 | 0 | — | — | — | 0 | 0 | — | — |
| dental tubercle | UI1 | — | 0 | 2 | — | — | — | — | — | — | — |
| dental tubercle | UI2 | — | 1 | 0 | — | — | — | — | — | — | — |
| spine | UI1 | — | 0 | 1 | — | — | — | — | — | — | — |
| interruption groove | UI2 | — | 1 | 0 | — | — | — | — | — | — | — |
| winging (bilateral) | UI1 | — | 0 | — | — | 0 | — | 2 | 2 | — | — |
| De Terra's tubercle | UP1 | — | — | — | — | — | — | — | — | — | — |
| double rooted | UP1 | — | — | — | — | — | — | — | — | — | — |
| double rooted | UP2 | — | — | — | — | — | — | — | — | — | 1 |
| Carabelli's trait | UM1 | — | — | — | — | — | — | — | — | — | — |
| hypocone reduction | UM2 | — | 3 | — | — | — | — | 2 | — | — | — |
| sixth cusp | LM1 | — | — | — | — | — | — | 0 | — | — | — |
| seventh cusp | LM1 | — | — | — | — | — | — | — | — | — | — |
| protostylid | LM1 | — | — | — | — | — | — | 0 | — | — | — |
| deflecting wrinkle | LM1 | — | — | — | — | — | — | — | — | — | — |
| groove pattern Y | LM1 | — | — | — | — | — | — | — | — | — | — |
| groove pattern X | LM2 | — | — | — | — | 2 | — | — | — | 2 | — |
| number of cusps | LM2 | — | — | — | — | 5 | — | 5 | — | 5 | — |

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# 8
# Morphometric Records of the Huiyaotian Human Limb Bones

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This chapter provides metric data on the major long bones of the upper and lower limbs, together with shaft diameter indices and proportions of long bone lengths for the Huiyaotian people.

The skeletal measurements were taken from six segments of long bones, consisting of the humerus, radius, ulna, femur, tibia, and fibula, following the method of Martin and Saller[1]. The measurements were recorded for only one side per segment. Regarding incomplete long bones, when a certain part proximal and/or distal end was missing, maximum length was estimated using the formulae of Wright and Vasquez[2], regression equations based on specific landmarks to estimate total lengths of long bones. The measurements are given in Tables 8-1 and 8-2.

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Table 8-1. Upper limb bone measurements (mm) recorded for the Huiyaotian series.

| Sample No. | M4 | M5 | M6 | M7 | M8 | M9 | M10 | M11 | M12 | M13 | M14 | M18 | M19 | M20 | M23 | M25 | M26 | M27 | M29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | F | M | F | F | M | M | M | F | F | F | M | M | F | F | F | M | M | M | F |
| Humerus | R | L | R | R | L | L | L | - | L | R | L | R | R | R | L | L | R | R | R |
| 1. Max. length | — | 333 | — | 290 | 310 | — | — | — | — | — | *325* | — | 265 | — | — | — | — | — | — |
| 2. Total length | — | 330 | — | 285 | 300 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 4. Bi-epicondylar width | 53 | 58 | 54 | 59 | 64 | — | — | — | 49 | 53 | — | 55 | — | 59 | 56 | — | — | — | 51 |
| 5. Max. mid-shaft diameter | — | 23 | 18 | 24 | 21 | — | — | — | 17 | 19 | 22 | — | — | — | — | — | 24 | 21 | 20 |
| 6. Min. mid-shaft diameter | — | 16 | 14 | 15 | 16 | — | — | — | 14 | 14 | 16 | — | — | — | — | — | 16 | 16 | 15 |
| 9. Transv. head diameter | — | — | — | — | 40 | — | 40 | — | — | — | — | — | — | — | — | 39 | — | — | — |
| 10. Max. sagittal head diameter | — | 36 | — | 38 | 45 | — | 41 | — | — | — | — | — | — | — | — | 42 | — | — | — |
| 6/5. Mid-shaft cross-section index | — | 69.6 | 77.8 | 62.5 | 76.2 | — | — | — | 82.4 | 73.7 | 72.7 | — | — | — | — | — | 66.7 | 76.2 | 75 |
| 9/10. Head cross-section index | — | — | — | — | 88.9 | — | 97.6 | — | — | — | — | — | — | — | — | 92.9 | — | — | — |
| Radius | — | L | R | L | R | — | — | L | R | L | R | — | — | R | — | R | — | — | R |
| 1. Max. length | — | 249 | — | 234 | 251 | — | — | — | — | — | — | — | — | 235 | — | 242 | — | — | 227 |
| 4. Max. Transv. shaft diameter | — | 17 | 17 | 17 | 17 | — | — | 15 | 12 | 13 | 17 | — | — | 14 | — | 16 | — | — | 16 |
| 5. Sagittal shaft diameter | — | 11 | 10 | 11 | 13 | — | — | 9 | 9 | 8 | 13 | — | — | 11 | — | 11 | — | — | 11 |
| 5/4. Mid-shaft cross-section index | — | 64.7 | 58.8 | 64.7 | 76.5 | — | — | 60 | 75 | 61.5 | 76.5 | — | — | 78.6 | — | 68.8 | — | — | 68.8 |
| Ulna | R | — | L | R | R | — | — | L | R | R | R | — | — | R | — | R | — | — | — |
| 1. Max. length | — | — | — | — | 267 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 2. Physiological length | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 230 | — | — | — |
| 6. Olecranon breadth | 22 | — | — | 22 | — | — | — | — | 24 | — | 25 | — | — | — | — | — | — | — | — |
| 11. Dorso-ventral shaft diameter | — | 15 | — | 11 | 15 | — | — | 13 | 11 | 12 | — | — | — | 12 | — | 14 | — | — | — |
| 12. Transv. shaft diameter | — | 18 | — | 19 | 17 | — | — | 13 | 12 | 14 | — | — | — | 13 | — | 15 | — | — | — |
| 11/12. Shaft cross-section index | — | 83.3 | — | 57.9 | 88.2 | — | — | 100 | 91.7 | 85.7 | — | — | — | 92.3 | — | 93.3 | — | — | — |

*Italic:* estimated value via formulae from Wright and Vasquez (2003), (M14: H7–H3: 290 mm)
M=Male, F=Female, R=Right, L=Left

Table 8-1 (continued).

| Burial No. | M30 | M34 | M35 | M39 | M43 | M45-2 | M46-2 | M51 | M54 | M54' | M55 | M56 | Average | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | M | F | M | F | M | M | F | M | M | ? | F | M | Males | | | Females | | |
| Humerus | — | R | R | R | R | — | R | — | R | L | — | R | n | Mean | SD | n | Mean | SD |
| 1. Max. length | — | — | — | — | — | — | 280 | — | — | — | — | — | 3 | 322.5 | 12 | 3 | 278.3 | 13 |
| 2. Total length | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 315.0 | 21 | 1 | 285.0 | — |
| 4. Bi-epicondylar width | — | 53 | — | — | 32 | — | — | 64 | — | 51 | — | 63 | 6 | 56.0 | 12 | 9 | 54.1 | 3.4 |
| 5. Max. mid-shaft diameter | — | — | 25 | 19 | — | — | — | — | 25 | — | — | 25 | 8 | 23.3 | 1.8 | 6 | 19.5 | 2.4 |
| 6. Min. mid-shaft diameter | — | — | 17 | 14 | — | — | — | — | 18 | — | — | 16 | 8 | 16.4 | 0.7 | 6 | 14.3 | 0.5 |
| 9. Transv. head diameter | — | — | — | — | — | — | — | — | — | 34 | — | — | 3 | 39.7 | 0.6 | 0 | — | — |
| 10. Max. sagittal head diameter | — | — | — | — | — | — | — | — | — | 38 | — | — | 4 | 41.0 | 3.7 | 1 | 38.0 | — |
| 6/5. Mid-shaft cross-section index | — | — | 68 | 73.7 | — | — | — | — | 72 | — | — | 64 | 8 | 70.7 | 4.4 | 6 | 74.2 | 6.6 |
| 9/10. Head cross-section index | — | — | — | — | — | — | — | — | — | 89.47 | — | — | 3 | 93.1 | 4.3 | 0 | — | — |
| Radius | R | R | R | — | — | R | — | R | R | L | ? | R | n | Mean | SD | n | Mean | SD |
| 1. Max. length | — | — | — | — | — | 229 | — | — | — | — | — | 276 | 5 | 249.4 | 17 | 3 | 232.0 | 4.4 |
| 4. Max. Transv. shaft diameter | 14 | 14 | 17 | — | — | 12 | — | 16 | 11 | 13 | 19 | 13 | 10 | 15.0 | 2.3 | 9 | 15.2 | 2.2 |
| 5. Sagittal shaft diameter | 10 | 8 | 12 | — | — | 11 | — | 12 | 6 | 10 | 12 | 12 | 10 | 11.1 | 2 | 9 | 9.9 | 1.5 |
| 5/4. Mid-shaft cross-section index | 71.4 | 57.1 | 70.6 | — | — | 91.7 | — | 75.0 | 54.5 | 76.9 | 63.2 | 92.3 | 10 | 74.2 | 11 | 9 | 65.3 | 27 |
| Ulna | R | R | R | — | R | — | — | R | — | R | — | R | n | Mean | SD | n | Mean | SD |
| 1. Max. length | — | — | — | — | — | — | — | 259 | — | — | — | — | 2 | 263.0 | 5.7 | 0 | — | — |
| 2. Physiological length | — | — | — | — | — | — | — | 233 | — | 221 | — | — | 2 | 231.5 | 2.1 | 0 | — | — |
| 6. Olecranon breadth | — | — | 24 | — | 24 | — | — | 25 | — | 25 | — | — | 4 | 24.5 | 0.6 | 3 | 22.7 | 1.2 |
| 11. Dorso-ventral shaft diameter | 13 | 12 | 14 | — | — | — | — | 15 | 15 | 12 | — | 15 | 8 | 14.5 | 0.8 | 6 | 11.8 | 0.8 |
| 12. Transv. shaft diameter | 16 | 12 | 14 | — | — | — | — | 15 | 16 | 11 | — | 14 | 8 | 15.6 | 1.4 | 6 | 13.8 | 1.5 |
| 11/12. Shaft cross-section index | 81.3 | 100 | 100 | — | — | — | — | 100 | 93.8 | 109.1 | — | 107.1 | 8 | 93.4 | 8.9 | 6 | 87.9 | 16 |

M=Male, F=Female, R=Right, L=Left

Table 8-2. Lower limb bone measurements (mm) and indicies recorded for the Huiyaotian series.

| Sample No. | M5 | M6 | M7 | M8 | M9 | M10 | M11 | M12 | M14 | M16 | M18 | M19 | M20 | M26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | M | F | F | M | M | M | F | F | M | F | M | F | F | M |
| Femur | ? | L | R | L | L | R | ? | L | R | R | L | ? | L | R |
| 1. Max. length | — | — | — | 435 | (428) | — | — | — | (450) | 460 | — | — | 420 | — |
| 2. Physiological length | — | — | — | 432 | — | — | — | — | — | — | — | — | — | — |
| 6. Sagittal mid-shaft diameter | — | 29 | 29 | 27 | — | 28 | — | — | 31 | — | 26 | 25 | 31 | 29 |
| 7. Transv. mid-shaft diameter | — | 24 | — | 25 | — | 24 | — | — | 26 | — | 25 | 23 | 26 | 27 |
| 9. Transv. proximal shaft diameter | 34 | — | 35 | 31 | — | 30 | — | — | — | 33 | 32 | 31 | 29 | — |
| 10. Sagittal proximal shaft diameter | 26 | — | 26 | 22 | — | 24 | — | — | — | 24 | 26 | 25 | 26 | — |
| 18. Vertical head diameter | — | — | — | 46 | — | 45 | 41 | 37 | — | — | 44 | 39 | 44 | — |
| 19. Sagittal head diameter | — | — | — | 45 | — | 43 | 40 | — | — | — | 43 | 40 | 44 | — |
| 21. Bicondylar width | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 6/7. Mid-shaft cross-section index (Pilastric) | — | 120.8 | — | 108 | — | 116.7 | — | — | 119.2 | — | 104 | 108.7 | 119.2 | 107.4 |
| 10/9. Prox. shaft cross-section index (Platymeric) | 76.5 | — | 74.3 | 71.0 | — | 80.0 | — | — | — | 72.7 | 81.3 | 80.6 | 89.7 | — |
| 19/18. Head cross-section index | — | — | — | 97.83 | — | 95.56 | 97.56 | — | — | — | 97.73 | 102.6 | 100 | — |
| Tibia | L | R | L | L | — | R | — | L | L | — | — | — | R | R |
| 1. Total length | — | — | — | — | — | 367 | — | — | 339 | — | — | — | — | — |
| 1a. Max. length | — | — | — | — | — | 362 | — | — | 344 | — | — | — | — | — |
| 3. Epicondylar breadth | — | — | — | — | — | 70 | — | — | — | — | — | — | — | — |
| 8. Max. sagittal mid-shaft diameter | 29 | 29 | 27 | 31 | — | 28 | — | — | 26 | — | — | — | — | 29 |
| 9'. Transv. mid-shaft diameter | 23 | 19 | 20 | 21 | — | 21 | — | — | 19 | — | — | — | — | 21 |
| 8a. Max. sagit. Diam. at nutrient foramen | 36 | — | 37 | 34 | — | 34 | — | 27 | 31 | — | — | — | 34 | — |
| 9a'. Transv. diameter at nutrient foramen | 24 | — | 23 | 22 | — | 27 | — | 19 | 21 | — | — | — | 22 | — |
| 9'/8. Mid-shaft cross-section index | 79.3 | 65.5 | 74.1 | 67.7 | — | 75.0 | — | — | 73.1 | — | — | — | — | 72.4 |
| 9a'/8a. Shaft cross-section index | 66.7 | — | 62.2 | 64.7 | — | 79.4 | — | 70.4 | 67.7 | — | — | — | 64.7 | — |
| Fibula | ? | — | R | R | — | R | — | — | L | — | — | — | R | R |
| 1. Max. length | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 2. Max. mid-shaft diameter | 15 | — | 16 | 16 | — | 15 | — | 14 | 14 | — | — | — | — | 19 |
| 3. Min. mid-shaft diameter | 10 | — | 12 | 14 | — | 14 | — | 8 | 12 | — | — | — | — | 12 |
| 3/2. Mid-shaft cross-section index | 66.7 | — | 75.0 | 87.5 | — | 93.3 | — | 57.1 | 85.7 | — | — | — | — | 63.2 |

M=Male, F=Female, R=Right, L=Left, Parenthesis: measurement taken in situ

Table 8-2 (continued 1).

| Sample No. | M27 | M28 | M29 | M30 | M34 | M35 | M39 | M43 | M45-2 | M46-2 | M51 | M54 | M55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | M | M | F | M | F | M | F | M | M | F | M | M | F |
| Femur | ? | L | L | L | R | ? | R | L | R | R | R | R | R |
| 1. Max. length | — | — | — | — | — | — | — | — | — | (395) | — | — | — |
| 2. Physiological length | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 6. Sagittal mid-shaft diameter | — | — | — | — | 25 | 33 | 26 | 25 | 28 | — | 27 | 28 | 30 |
| 7. Transv. mid-shaft diameter | — | — | — | — | 24 | 29 | 24 | 26 | 26 | — | 27 | 27 | 25 |
| 9. Transv. proximal shaft diameter | — | 30 | 30 | 29 | 28 | 34 | 27 | 28 | 29 | — | 33 | 35 | 31 |
| 10. Sagittal proximal shaft diameter | — | 25 | 24 | 25 | 22 | 25 | 23 | 20 | 21 | — | 26 | 23 | 23 |
| 18. Vertical head diameter | 45 | — | 39 | — | — | 51 | 41 | — | 51 | — | 47 | — | — |
| 19. Sagittal head diameter | — | — | 38 | — | — | 51 | 40 | — | — | — | 46 | — | — |
| 21. Bicondylar width | — | 76 | 67 | — | — | — | — | — | — | — | — | — | — |
| 6/7. Mid-shaft cross-section index (Pilastric) | — | — | — | — | 104.2 | 113.8 | 108.3 | 96.15 | 107.7 | — | 100 | 103.7 | 120 |
| 10/9. Prox. shaft cross-section index (Platymeric) | — | 83.3 | 80.0 | 86.2 | 78.6 | 73.5 | 85.2 | 71.4 | 72.4 | — | 78.8 | 65.7 | 74.2 |
| 19/18. Head cross-section index | — | — | 97.44 | — | — | 100 | 97.56 | — | — | — | 97.87 | — | — |
| Tibia | — | L | R | — | — | — | R | L | L | | — | R | — |
| 1. Total length | — | — | 340 | — | — | — | — | 330 | — | — | — | — | — |
| 1a. Max. length | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 3. Epicondylar breadth | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 8. Max. sagittal mid-shaft diameter | — | — | 26 | — | — | — | — | — | — | — | — | — | — |
| 9'. Transv. mid-shaft diameter | — | — | 19 | — | — | — | — | — | — | — | — | — | — |
| 8a. Max. sagit. Diam. at nutrient foramen | — | 37 | — | — | — | — | 31 | — | 32 | — | — | 35 | — |
| 9a'. Transv. diameter at nutrient foramen | — | 26 | — | — | — | — | 19 | — | 20 | — | — | 22 | — |
| 9'/8. Mid-shaft cross-section index | — | — | 73.08 | — | — | — | — | — | — | — | — | — | — |
| 9a'/8a. Shaft cross-section index | — | 70.27 | — | — | — | — | 61.29 | — | 62.5 | — | — | 62.86 | — |
| Fibula | — | — | L | — | — | — | — | — | — | | L | — | — |
| 1. Max. length | — | — | 333 | — | — | — | — | — | — | — | — | — | — |
| 2. Max. mid-shaft diameter | — | — | 17 | — | — | — | — | — | — | — | 16 | — | — |
| 3. Min. mid-shaft diameter | — | — | 12 | — | — | — | — | — | — | — | 9 | — | — |
| 3/2. Mid-shaft cross-section index | — | — | 70.6 | — | — | — | — | — | — | — | 56.3 | — | — |

M=Male, F=Female, R=Right, L=Left, Parenthesis: measurement taken in situ

Table 8-2 (continued 2).

| Sample No. | M56 | M57 | Average | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sex | M | F | Males | | | Females | | |
| Femur | R | L | n | Mean | SD | n | Mean | SD |
| 1. Max. length | *449* | — | 2 | 435.0 | 10.8 | 3 | 425.0 | 32.8 |
| 2. Physiological length | — | — | 1 | 432.0 | — | 0 | — | — |
| 6. Sagittal mid-shaft diameter | 28 | 27 | 11 | 28.18 | 2.2 | 8 | 27.8 | 2.3 |
| 7. Transv. mid-shaft diameter | 27 | 24 | 11 | 26.27 | 1.3 | 7 | 24.3 | 1.0 |
| 9. Transv. proximal shaft diameter | 35 | 29 | 12 | 31.67 | 2.5 | 9 | 30.3 | 2.5 |
| 10. Sagittal proximal shaft diameter | 23 | 24 | 12 | 23.83 | 2.0 | 9 | 24.1 | 1.4 |
| 18. Vertical head diameter | — | — | 7 | 47.0 | 2.9 | 6 | 40.2 | 2.6 |
| 19. Sagittal head diameter | — | — | 5 | 45.6 | 3.3 | 5 | 40.4 | 2.2 |
| 21. Bicondylar width | 81 | — | 2 | 78.5 | 3.5 | 1 | 67.0 | — |
| 6/7. Mid-shaft cross-section index (Pilastric) | 103.7 | 112.5 | 11 | 107.3 | 7.0 | 7 | 113.4 | 6.7 |
| 10/9. Prox. shaft cross-section index (Platymeric) | 65.7 | 82.8 | 12 | 75.48 | 6.6 | 9 | 79.8 | 5.6 |
| 19/18. Head cross-section index | — | — | 5 | 97.8 | 1.6 | 5 | 99.0 | 2.3 |
| Tibia | L | R | n | Mean | SD | n | Mean | SD |
| 1. Total length | 375 | — | 4 | 352.8 | 21.6 | 1 | 340.0 | — |
| 1a. Max. length | — | — | 2 | 353.0 | 12.7 | 0 | — | — |
| 3. Epicondylar breadth | — | — | 1 | 70.0 | — | 0 | — | — |
| 8. Max. sagittal mid-shaft diameter | — | — | 5 | 28.6 | 1.8 | 3 | 27.3 | 1.5 |
| 9'. Transv. mid-shaft diameter | — | — | 5 | 21.0 | 1.4 | 3 | 19.3 | 0.6 |
| 8a. Max. sagit. Diam. at nutrient foramen | 36 | 32 | 8 | 34.38 | 2.1 | 5 | 32.2 | 3.7 |
| 9a'. Transv. diameter at nutrient foramen | 24 | 22 | 8 | 23.25 | 2.4 | 5 | 21.0 | 1.9 |
| 9'/8. Mid-shaft cross-section index | — | — | 5 | 73.51 | 4.2 | 3 | 70.9 | 4.7 |
| 9a'/8a. Shaft cross-section index | 66.67 | 68.75 | 8 | 67.6 | 5.4 | 5 | 65.5 | 4.0 |
| Fibula | L | — | n | Mean | SD | n | Mean | SD |
| 1. Max. length | — | — | 0 | — | — | 1 | 333.0 | — |
| 2. Max. mid-shaft diameter | 16 | — | 7 | 15.9 | 1.6 | 3 | 15.7 | 1.5 |
| 3. Min. mid-shaft diameter | 10 | — | 7 | 11.6 | 2.0 | 3 | 10.7 | 2.3 |
| 3/2. Mid-shaft cross-section index | 62.5 | — | 7 | 73.6 | 14.8 | 3 | 67.6 | 9.3 |

*Italic*: values estimated via formulae from Wright and Vasquez (2003), (M56 F1–F6: 433)
M=Male, F=Female, R=Right, L=Left, Parenthesis: measurement taken in situ

# 9
# Liyupo Site in Longan, Guangxi, China

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This chapter presents a brief introduction of the Liyupo site in Longan, Guangxi, which is one of the key sites of our focus for this international archaeological collaboration research.

## SITE LOCATION AND RESEARCH HISTORY

Liyupo site is located at Gengyetun, Jianan village, Dingdang town, Longan County of Guangxi. It is about 53 km away from Nanning City (Figure 9-1). The geographical coordinates of the site are 107.9616° (East longitude) and 23.1781° (northern latitude). This site was found in the third season of Cultural Relic Investigation by the Cultural Relic Management Institute of Longan County in May 2008. After the discovery of the site, a small scale of preliminary excavation was then conducted from May to June in the same year by the Relic and Archaeology Institution of Guangxi, Nanning City Museum, and Cultural Relic Management Institute of Longan County.

The geomorphic feature of the site is a lowland among peak cluster of karst topography. Liyupo itself is located on a small soil mound surrounded by limestone hills, about 150 m above current sea level. Between the small soil mound and hills are wetland rice farms. The soil mound is in the shape of a peach seed, and its long axis is northeast–southwest. The size of this mound is around 32 meters long and 20 meters wide, roughly 600 sq meters.

About 300 meters to the northwest of the site, there is an underground river in the foot of the hill which formed a 2-3 meters wide stream named Beigeng stream flowing constantly. The stream flows from north to east then turns to the south passing by the east of the site. This stream eventually connects to Wuming River which is the branch of Youjiang River. The nearest distance from the east side of Liyupo to Beigeng stream is 5 meters. The highest portion of the site is about 2.5 meters above the stream. In the middle of the site, there is a pit about 10 meters long, 0.8 meters wide and 0.8 meters deep, which was caused by treasure hunters in the 1990s. Some human and animal bones were exposed in this pit. Currently, the site is full of a clump of bushes.

During the 2008 season of excavation, 2 test pits of 2 by 4 meters, and 1 test pit of 2 by 3 meters were opened in the middle and north of the site. The total excavation area was 26 sq meters in total for 2008, including three excavation units, T8, T11 and T12.

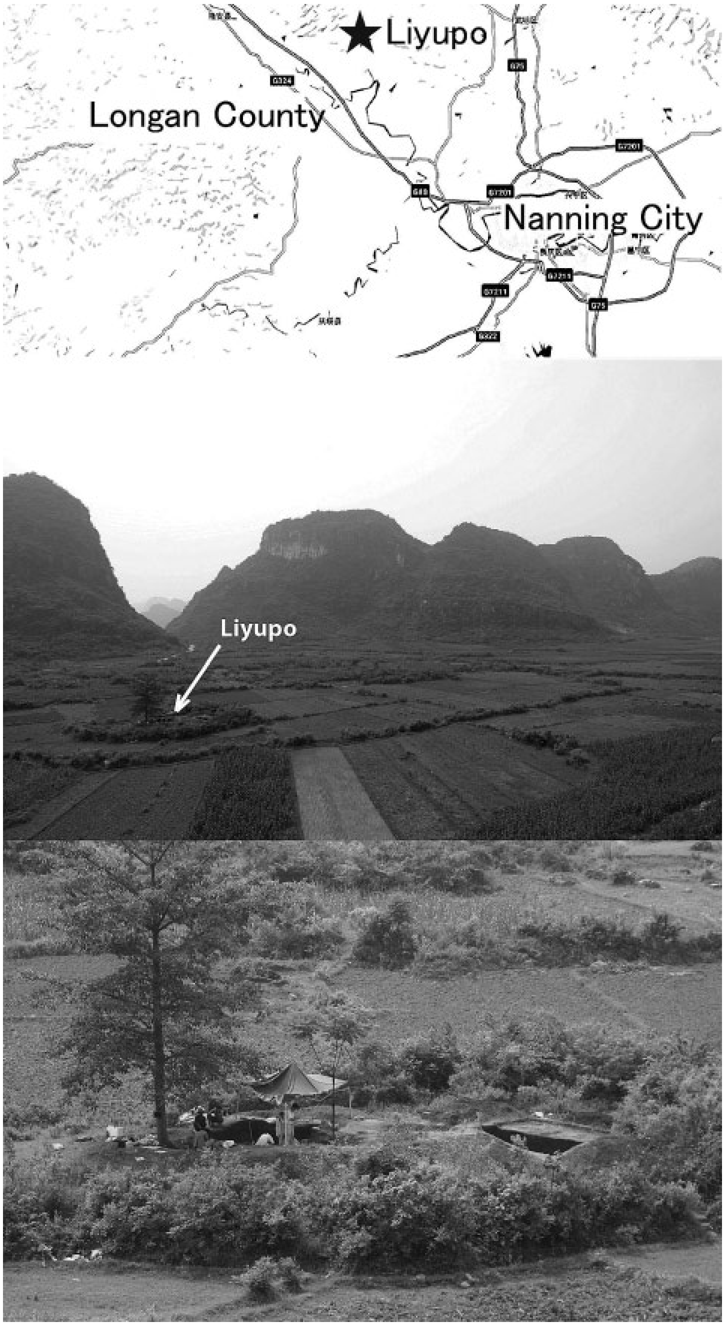


Figure 9-1. The location (map data: Google), view and landscape of Liyupo Site in Longan, Guangxi, China.

The deepest cultural deposit is about 170 cm, and the stratigraphic accumulations can be divided into 8 layers.

## STRATIGRAHY AND CHRONOLOGY

The cultural deposit is about 170 cm at its deepest part, and the stratigraphic accumulations can be divided into 8 layers. The archaeological findings included human burials, pottery, tools made of stone, bone and clam, and remains of aquatic or terrestrial animals. The cultural remains can be divided into two phases.

**Phase 1 (Early Phase)**: It includes layers 4 to 8 of T11, layers 4 to 6 of T8, and human burials from the base soil layer. The deposit from this phase contains a certain amount of shell remains, with limited findings of artifacts, including polished tools made of stone (axe, adze and grinding basin stone), bone and shells. The edges of axes and adzes had been well polished, but the body parts still retained chopping scars. Shell tools are all shovels, and bone tools are all small awls.

The number of potsherds is very small. Most of them are greyish brown or greyish black cord-marked potsherds with fine sand as temper. Many human burials have been found from this phase. They are flexed burials, either upturned or lateral recumbent.

**Phase 2 (Late Phase)**: It includes layer 3, and the human remains from layer 4.
The deposit from this phase did not contain shell. The artifact remains are small,

Table 9-1. AMS dates from Liyupo.

| LAB No. | MATERIAL | d13C | CONVENTIONAL AGE | 2 SIGMA CALIBRATION | D14C |
|---|---|---|---|---|---|
| BETA429242 | charred *Canarium* sp. seed fragment from layer 3 | −25.2 o/oo | 6450 +/− 30 BP | Cal BC 5480 to 5365 (Cal BP 7430 to 7315) | −552.0 +/− 1.7 o/oo |
| BETA429241 | Charcoal from layer 2 | −25.9 o/oo | 7190 +/− 30 BP | Cal BC 6075 to 6010 (Cal BP 8025 to 7960) | −591.4 +/− 1.5 o/oo |
| BETA429240 | Human bone from layer 3 | −20.9 o/oo | 6470 +/− 30 BP | Cal BC 5480 to 5370 (Cal BP 7430 to 7320) | −553.1 +/− 1.7 o/oo |
| BA120617 | Human bone from Burial M35 | | 6000 +/− 40 BP | Cal BC 4995 to 4792 (Cal BP 6944 to 6741) | |
| IAAA-143260 | Human tooth from Burial M12 | −20.14±0.49 | 6768 +/− 29 | 7667cal BP to 7580cal BP (95.4%) | |

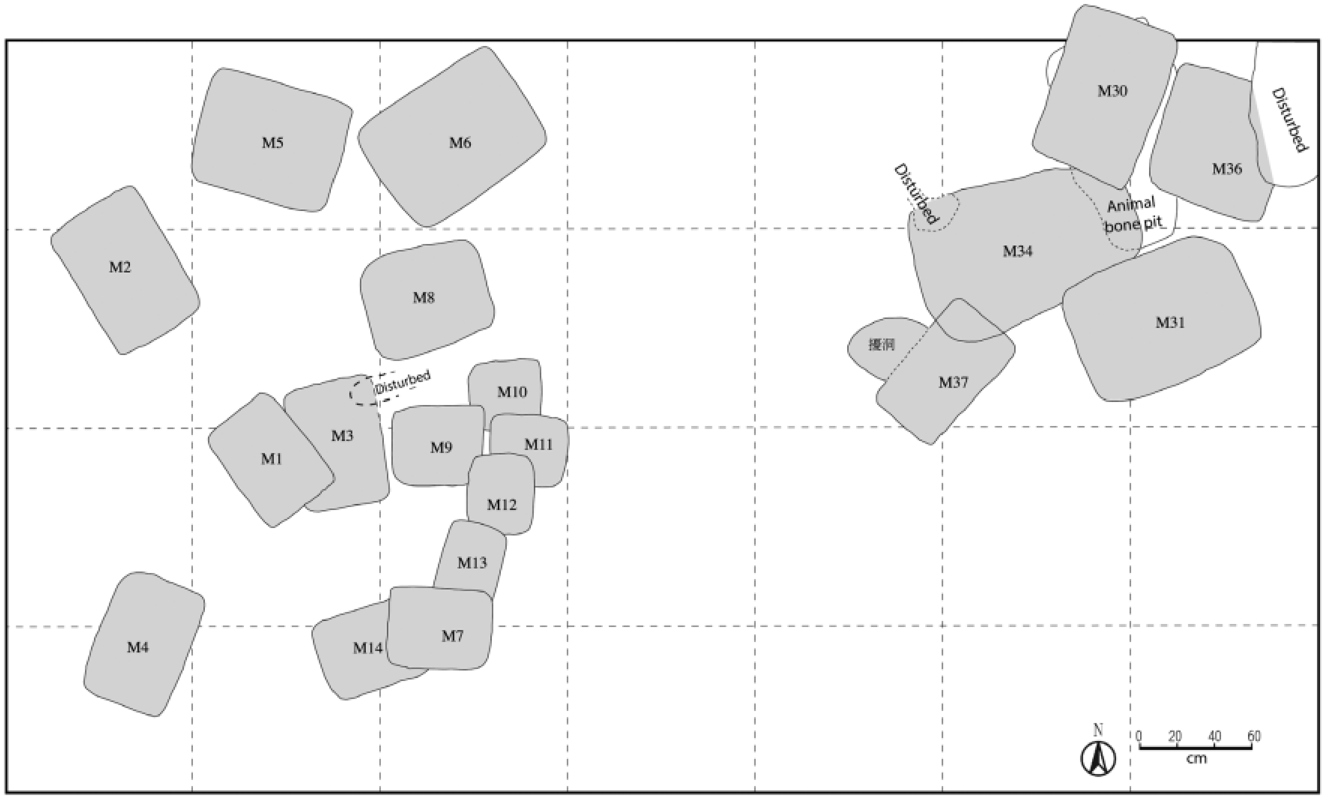


Figure 9-2. The distribution of human burials from the Layer 3 of T11 and T12, at the Liyupo site, Longan, Guangxi, China (excavated in 2008).

including stone tools, bone tools, shell tools and potsherds. Most of the unearthed stone tools are stone adzes and stone pestles. It seems the choice of the raw materials of making stone tools had more concerns at this stage.

Potsherds discovered from this layer are orange-yellowish color with charcoal as temper. Still, many human remains have been found in this layer. Like those from the earlier phase, they are flexed burials, either upturned or lateral recumbent. During this stage, it was common to place large stones above the human remains, as seen many human burials that were discovered under one or more natural rocks.

In total so far, 5 AMS dates have been produced from the 2008 excavation at Liyupo. The dating samples include charred *Canarium* sp. seed, charcoal, human bones and human tooth. The 5 AMS dates confirm the age of Liyupo site is ca. 5600 to 5000 cal. BC, although one of the results (BETA429241) shows it could be as early as 6075 to 6010 cal. BC (Table 9-1).

## ARCHAEOLOGICAL FINDINGS FROM LIYUPO

**1. Human burials** (Figures 9-2, 9-3, 9-4, 9-5)

In total, 43 human burials were identified from the 2008 excavation. Those discovered human burials mainly concentrated in the northeastern portion of the central zone at Liyupo site, mainly from T11 and T12, and some from southwest corner of T8. Among all discoveries, more than 50% have been found in layer 3.

The distribution of burials was very dense, but no consistent direction of burial arrangement has been noticed at the site. The burial pits are usually shallow and small in rectangular shape, and each contains only one individual. All of them are flexed

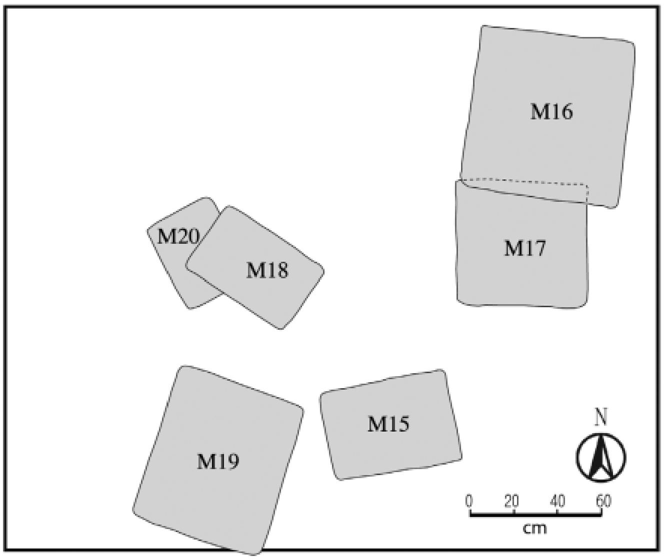


Figure 9-3. The distribution of human burials from the Layer 4 of T11 and T12, at the Liyupo site, Longan, Guangxi, China (excavated in 2008).

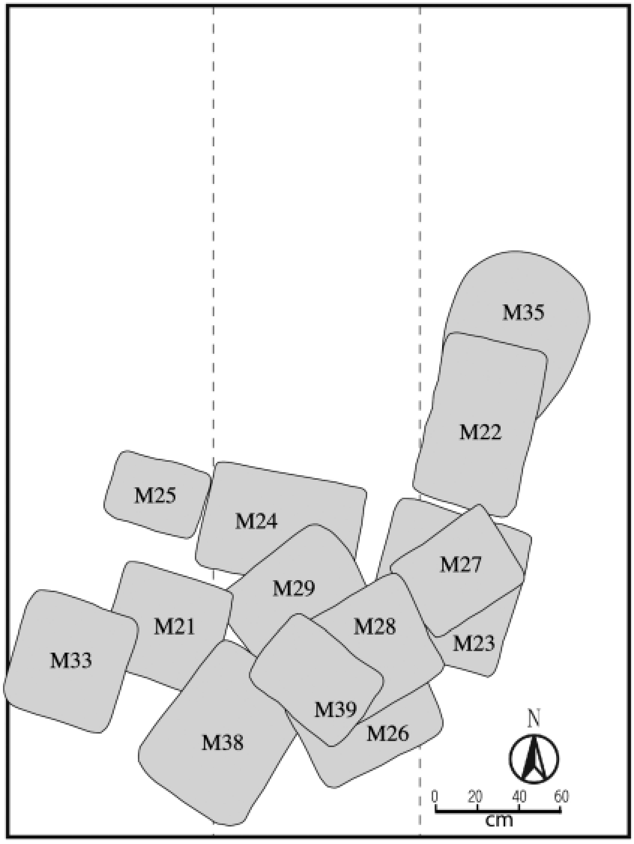


Figure 9-4. The distribution of human burials from the Layer 5 of T11 and T12, at the Liyupo site, Longan, Guangxi, China (excavated in 2008).

burials, either upturned or lateral recumbent. At Liyupo, there is no burial in squatting position, or dismembered burials like those seen in Huiyaotain or Dingshishan.

As mentioned, almost all burial pits from the later phase of Liyupo (especially from layer 3) have been covered by pieces of limestone. Those stones were in different sizes, including the smallest of approximate fist size, while the largest was measured at 50×40×13 cm. Those rocks were intentionally placed over the buried individual, mostly over chest or belly of the body, or on the head. This practice was seen commonly at Liyupo, but only one similar example has been recorded from the well-known Dingsishan site. Presumably, this kind of burial practice was related with a belief in spirits. All of the graves in Liyupo have no grave goods.

## 2. Artifacts

Beside human remains, other unearthed cultural remains are limited from this site. As mentioned, the findings include pottery and tools made of stone, clam and bone. In total, only 3 pieces of potsherds have been found from the 2008 excavation. They are all sandy ware with cord marks.

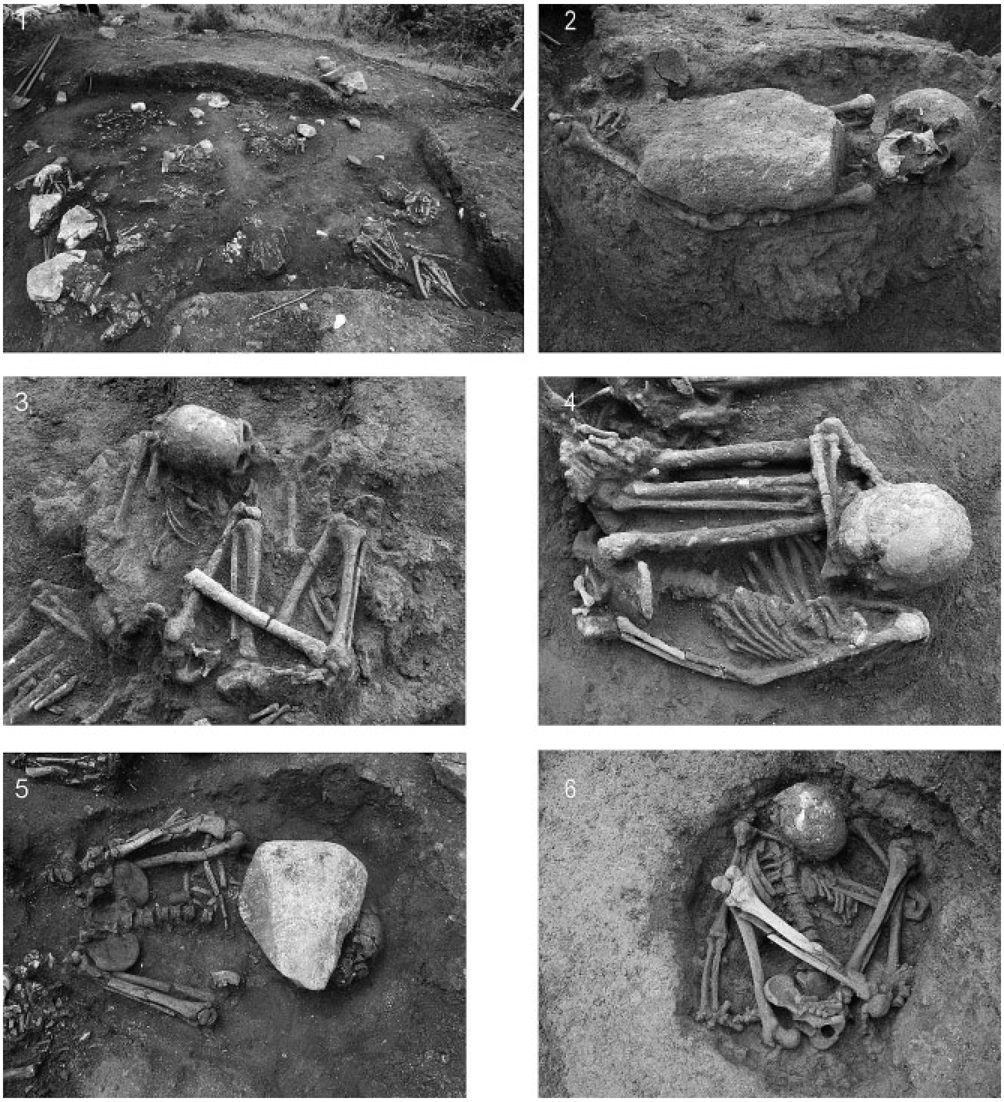


Figure 9-5. Some examples of human burials excavated from Liyupo. 1. Human burials found in layer 3 of T11; 2. Burial M22; 3. Burial M23 (after removing the large rock above the skeleton); 4. Burial M28; 5. Burial M34; 6. Burial M35.

Stone tools can be distinguished into two groups, namely chipped stone tools and polished stone tools. The first group was mainly micro-flakes chipped from quartz gravel. The second group included stone adzes, grinding basin stones, and small pestles. The stone adzes from Liyupo were polished mainly on their blade portions. Many of the discovered grinding basin stones showed multiple faces of smooth polished marks.

Stone pestles can be grouped into three types of cone shape, rectangular shape, and "bowling pin" shape. The cone shaped and "bowling pin" shaped pestles also have been

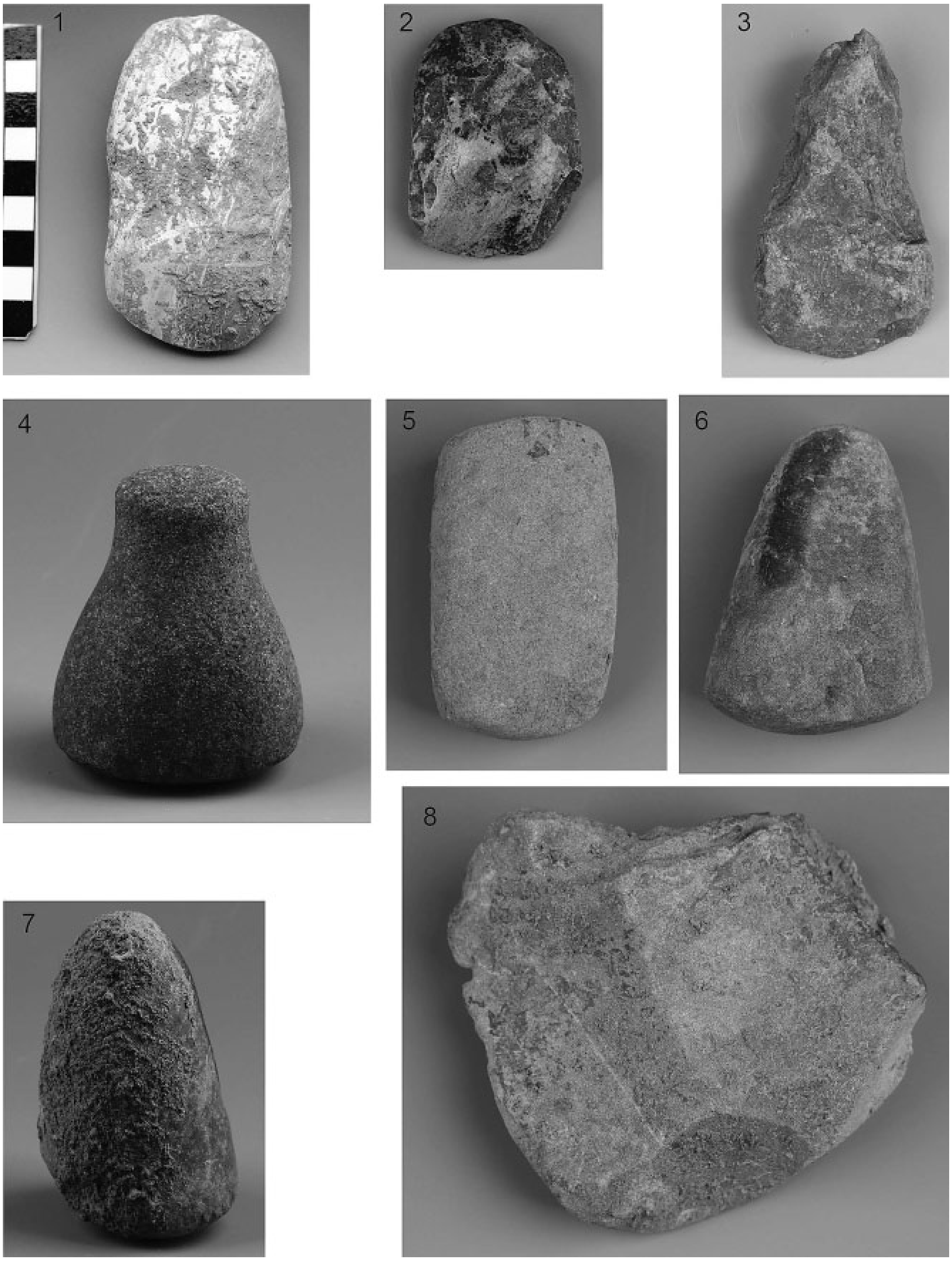


Figure 9-6. Stone artifacts unearthed from Liyupo site in Longan, Guangxi, China; 1. Stone adze (No. 1 of Layer 6 in T8); 2. Stone adze (No. 2 of Layer 3 in T11); 3. Stone adze (surface collection); 4. Stone pestle (No. 1 of Layer 3 in T11); 5. Stone pestle (No. 1 of Layer 6 in T11); 6. &7. Stone pestle (No. 3 of Layer 3 in T11; 6. Front side and 7. lateral side); 8. Grinding basin stone (No. 1 of Layer 8 in T11).

discovered from Hecun, Jiangxian, and Ganzao shell middens in the Zuojiang Valley, Gexinqiao, baida, and Kantun in the Youjiang Valley, and Beidaling in Honghe Valley. The “bowling pin” shape pestles have a unique form, and they can be used as a time index for future study.

Other findings from Liyupo include bone awls and needles made of animal bones, and shell shovels made of river clams.


Figure 9-7. Bone needles (1) and awls (2, 3, 4) made of animal bones unearthed from Liyupo, Guangxi, China; 1. from Layer 5 in T2; 2. No. 2 of Layer 5 in T8; 3. No. 2 of Layer 3 in T8; 4. No. 4 of Layer 5 in T8.

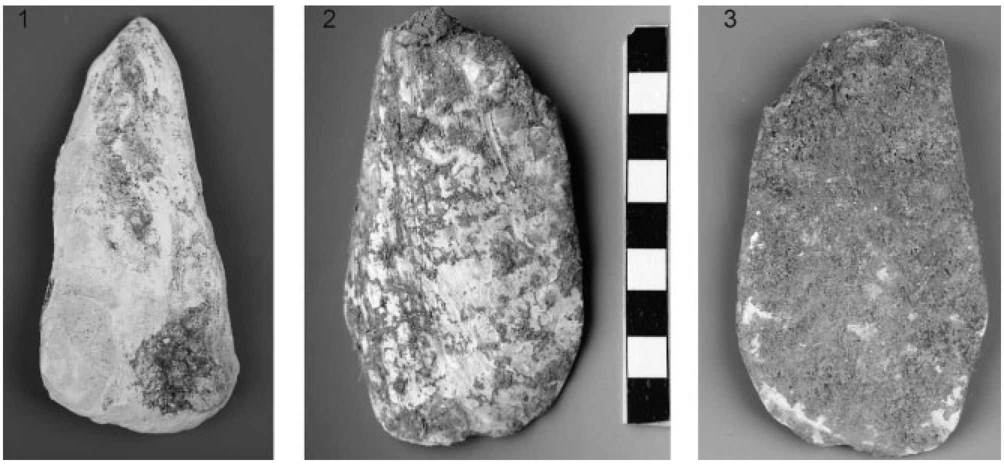


Figure 9-8. Shell shovels made of river clams unearthed from Liyupo, Guangxi, China; 1. No. 4 of Layer 3 in T11; 2. & 3. No. 2 of Layer 8 in T11 (2. front side and 3. Back side).

### 3. Shell and animal remains

Aquatic and land mollusks, and land animal remains have been found from Liyupo. The identified aquatic mollusks include *Bellamya quadrata* (Benso), *Semisucospira henriettae* (Gray), and *Lamprotula* sp. The land mollusks include *Cyclophorus songmaensis* Morele, *Cyclophorus exaltatus* (Pfeiffer) and *Ptychopoma* sp. The land animal remains are still under study.

## CULTURAL IMPLICATION OF THE LIYUPO SITE

The landscape and geographical setting of Liyupo is rather different from Huiyaotian, furthermore reflected in the different subsistence strategy at these two sites. The small river next to Liyupo probably could not provide enough food supplies for the local population, thus many land mollusks were consumed. The Liyupo site also presents a different organization of burial practice from that of the Huiyaotian site. In terms of cultural affiliation, both Liyupo and Huiyaotian are regarded as expressions of the Dingsishan Culture, but chronologically Liyupo and Huiyaotian have more than 1000 years of time difference. From this study, two sets of human remains, burial practices, artifact assemblages and faunal remains can provide excellent examples for us to understand the details of Dingsishan Culture during its long-term development.

# 10
# Individual Descriptions of the Human Skeletal Remains at Liyupo

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The state of preservation of 40 skeletal individuals from 39 burials excavated within the 2008 trenches at Liyupo are described below, together with sex and age determination and morphological notes. The best-preserved skull and appendicular bones are displayed in the following photographic figures (Appendix Figure 10-A). Age estimates were made based on the tooth eruption phase, extent of tooth attrition, cranial suture closure, postcranial epiphyseal unions, pubic symphyseal face morphology, sequential changes of sternal rib ends, and the severity of osteoarthritis. Age classes for adult individuals were assigned as follows:

Young adult (20–29 years)
Middle-aged adult (30–49 years)
Old adult (over 50 years old)

For recording occlusal surface wear of the dentition, simple five-phase scheme of Broca[1] was adopted. Sex determination was based on pelvic indicators, cranial morphology, and epiphyseal size of the long-bones. As far as the permanent dentition is concerned, the tooth presence and condition is recorded via standard recording protocols, as per the following example.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | M2 | M1 | P2 | P1 | C | X | I1 | I1 | X | C | P1 | P2 | M1 | M2 | M3 |
| M3 | M2 | M1 | P2 | P1 | C | / | X | X | / | C | P1 | P2 | M1 | M2 | △ |

I: incisor, C: canine, P: premolar, M: molar
0: tooth missing but socket present, △: only tooth root remaining
X: socket closed, /: socket broken and tooth missing

### M1
Age: middle mature; Sex: female
Remarks:
The fragmented cranial remains are present. The limb bones are in partially good condition, in particular the left arm and both femurs. The vertebrae and ribs are also par-

tially well preserved. The limber vertebrae have strong lipping. The cranial sutures are not fused on either side. The femoral head is small, indicating a female.

### M2

Age: adult young or middle mature; Sex: female
Remarks:
The skull is fragmented and the cranial vault alone remains intact. The mastoid process is very small. The nuchal plane is smooth. The cranial sutures are not fused on either side. Limbs are in partially good condition, small, and gracile. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | / | △ | ○ | ○ | ○ | ○ | I1 | I2 | ○ | P1 | P2 | / | / | / |
| M3 | M2 | M1 | P2 | P1 | C | I2 | / | I1 | I2 | / | / | / | / | / | / |

### M3

Age: adult; Sex: female
Remarks:
Only the right arm bones are well preserved. The narrow femoral condyles show female features. The humeral and femoral shafts are gracile and slender.

### M4

Age: adult; Sex: unknown
Remarks:
Only the tibial shafts remain.

### M5-1

Age: adult middle mature; Sex: male
Remarks:
The preservation of cranium includes the frontal bone and the mandible. The postcranial bones are highly fragmented. The protruding glabella of frontal bone, the backwards-leaning forehead, and the very high mandible symphysis indicate that this individual was male. The cranial sutures around the bregma point, coronoid and sagittal sutures around the bregma point, are fused on the inner surface. The teeth are severely worn to Broca 3rd or 4th grade. The following teeth are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | / | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |
| M3 | × | × | P2 | P1 | C | I2 | / | / | △ | △ | P1 | P2 | M1 | M2 | M3 |

### M5-2

Age: child; Sex: unknown
Remarks:

Only a few tooth fragments remain.

**M6**
Age: young mature; Sex: male
Remarks:
The cranium is fragmented, while the mandible is well preserved. The upper limb bones are in good condition. The humeral condyles are very wide in the size range of males, but the limb robustness is weak for a male. Tooth wear corresponds to Broca 2nd grade, exposing the pits of dentine. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | M1 | / | P1 | C | I2 | / | / | / | ○ | P1 | P2 | ○ | M2 | / |
| M3 | M2 | M1 | P2 | P1 | ○ | ○ | ○ | ○ | ○ | ○ | P1 | P2 | M1 | M2 | M3 |

**M7**
Age: adult middle mature; Sex: female
Remarks:
The lower limbs are well preserved, and the shafts are relatively slender and gracile.

**M8**
Age: adult young or middle mature; Sex: female
Remarks:
The vault of the skull is well preserved, while the lower limbs are excellently preserved. The cranial sutures are not fused on either side. The great sciatic notch of pelvis is wide, indicating a female. The femoral and tibial shafts are long slender with moderately developed muscle attachment areas. The mandible remains without teeth, in which only the following tooth sockets can be identified.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |
| × | × | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | / | / | / | × | × | × |

**M10**
Age: unknown; Sex: unknown
Remarks:
There are only small amount of bone fragments.

**M11**
Age: adult; Sex: female
Remarks:
Only a small quantity of fragments remains. The limbs are small and gracile, probably female.

## M12

Age: adult late middle mature; Sex: male

Remarks:

The calvaria and mandible are well preserved. This skull is small, but the strongly backwards-leaning frontal bone and well-ridged glabella indicate that it is a male. Most of the postcranial bones are missing. Only fragments of the clavicle and pelvis are present. The following teeth remain.

| / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * | △ | M1 | P2 | P1 | C | ○ | ○ | ○ | ○ | C | P1 | P2 | × | × | △ |

## M13

Age: adult; Sex: male

Remarks:

There are only a small number of skull and postcranial fragments. The great sciatic notch of pelvis is narrow and in the size range of a typical male.

## M14

Age: adult old mature; Sex: male

Remarks:

The cranial remains consist of a small number of fragments. The major sutures are nearly fused on the inner surface. The pelvis and forelimbs are in good or excellent condition. The great sciatic notch of ilium is narrow, indicating a male. The limbs are long and slender with moderately developed muscle attachment areas. Some degree of bone diffusion is present on the posterior side on the lumber vertebra. It appears that this anomaly is similar to diffuse idiopathic skeletal hyperostosis (DISH), but the diagnosis is uncertain (see Chapter 11). The mandibular body is preserved, in which most of the molars were missing ante mortem. The tooth wear is Broca 4th grade, and the following teeth remain.

| / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| × | △ | × | × | ○ | ○ | ○ | ○ | / | / | C | / | / | ○ | M2 | × |

## M15

Age: adult middle mature; Sex: female

Remarks:

The cranium is crushed. The cranial sutures are not fused, and the tooth wear is a severe grade of Broca 4th. The lower extremities are in relatively good condition. The pelvis shows the female characteristic of a wide great sciatic notch. The femoral and tibial shafts are slender and gracile. The following teeth are identified with their crown surfaces worn out at the level of Broca 2nd grade at the anterior teeth, and 4th grade at the posterior teeth.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ○ | △ | M1 | △ | △ | C | I2 | I1 | I1 | I2 | / | / | / | M1 | M2 | M3 |
| / | / | / | P2 | P1 | C | I2 | I1 | I1 | I2 | C | / | / | / | / | / |

**M16**
Age: adult middle mature; Sex: female
Remarks:
As for the skull, only the calvaria and jaws are in relatively good condition. The cranial sutures are partially closed on the inner surface. The limb bones and pelvis are in partially good condition. The great sciatic notch of ilium shows wide female features. Several vertebral fragments are detected, and the thoracic vertebrae have lipping. The following teeth, worn to the Broca 3rd grade, are remaining.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | / | P2 | ○ | C | ○ | ○ | ○ | ○ | ○ | ○ | ○ | M1 | M2 | M3 |
| M3 | M2 | △ | P2 | ○ | / | / | ○ | ○ | ○ | ○ | △ | P2 | M1 | M2 | M3 |

**M17**
Age: adult young mature; Sex: female
Remarks:
The skull is preserved but skewed by soil pressure. The cranial features and limbs are that of a gracile female. The vertebrae are well preserved; lipping is not present. The individual was young as also indicated by tooth wear in the Broca grade 1st or 2nd. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ○ | M2 | ○ | / | / | / | / | / | / | / | / | / | / | / | / | / |
| / | ○ | M1 | P2 | P1 | C | I2 | / | / | / | / | / | / | / | / | / |

**M18**
Age: child; Sex: unknown
Remarks:
Both the skull and postcranial bones are partially remaining in good condition. The first permanent molar is completely erupted, indicating an age over 6 years.

**M19**
Age: adult young mature; Sex: male
Remarks:
The cranium shows good preservation. Morphologically, this individual appears to be a robust male, possessing a strongly ridged glabella, large mastoid process, and rugged nuchal plane. The pelvic sciatic notch is opening to a narrow angle, also indicating a male. The humerus has a strong muscle attachment area. The following teeth are remaining with a wear level of Broca 2nd grade, indicating a young mature individual.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | △ | ○ | ○ | ○ | / | / | / | P1 | P2 | M1 | M2 | M3 |
| △ | M2 | M1 | P2 | P1 | C | △ | △ | I1 | △ | △ | P1 | P2 | M1 | M2 | M3 |

**M21**
Age: child 6 years; Sex: unknown
Remarks:
The cranial vault is in partially good condition. The limb bones are remaining only for the upper extremities. The permanent first molars had completely erupted in the jaw, and the milk teeth still remain.

**M22**
Age: adult middle mature; Sex: female
Remarks:
The skull shows a very good state of preservation. The flat glabella and small mastoid process, as well the compact mandible, show female features. The pelvic sciatic notch confirms the sex as female with a wide opening angulate. The cranial sutures are partially fused on the outer surface. The limbs are small and compact. The following teeth are remaining with severe attrition at the level of Broca 4th grade.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | P2 | P1 | C | I2 | / | I1 | × | △ | P1 | P2 | M1 | M2 | △ |
| ○ | ○ | × | P2 | P1 | C | △ | / | / | △ | C | P1 | P2 | × | M2 | M3 |

**M23**
Age: adult young mature; Sex: female
Remarks:
The skull is excellently preserved. The cranial and mandibular morphology is gracile, including a flat glabella, very smooth nuchal plane, quite small mastoid process, and smooth mandibular chin. The great sciatic notch angulates widely, possessing an apparent female feature. The lumber vertebrae have moderate lipping on the body margins. The dental wear is of the Broca 1st or 2nd grade and the fresh third molars are present, allowing an age estimate of around 20 years old. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |

**M24**
Age: adult middle mature; Sex: male
Remarks:
All of the limbs and vertebrae are excellently preserved. The pelvis is also complete, and the great sciatic notch is narrow like a male. The limb shafts are slender with moderate length and weak muscle attachments. The lumber vertebrae have weak lipping.

**M25**

Age: child; Sex: unknown
Remarks:
The left lower limb is missing. Other bones are not well preserved.

**M26**

Age: adult; Sex: male
Remarks:
Only the right side of upper and lower limbs are in good condition, while others are absent. The great sciatic notch of pelvis shows a narrow angle consistent with a male. The limb size and robustness are moderate for a male.

**M27**

Age: adult; Sex: male
Remarks:
The left side upper limb and left femur are missing, while others are well preserved. The humeral condyle is very wide and robust, indicating a male. The length and muscle developments are moderately strong.

**M28**

Age: adult middle mature; Sex: female
Remarks:
The cranium is preserved, but the facial skeleton is vertically compressed by soil pressure. The pelvis sciatic notch is moderately angulated with an angle between male and female. The cranial morphology shows female characteristics, with an elevated frontal bone, a flat glabella, and an occipital bone possessing a smooth nuchal plane. The limbs are well preserved, and the shafts are long and slender with moderately developed muscle attachments. The following teeth are present with dental wear consistent with Broca 3rd grade.

| / | M2 | / | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | / | / | / | / |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | × | / | △ | P1 | C | I2 | △ | I1 | / | C | P1 | P2 | × | △ | △ |

**M29**

Age: adult young mature; Sex: male
Remarks:
Only the calvaria of the cranium is well preserved. The pelvis sciatic notch displays a narrow angle consistent with male features. As for the limbs, only the humerus is in good condition, while others represented by a small number of fragments. The humeral and femoral heads, and the humeral condyles are large and in the range of male characteristics. The cranial sutures are not fused, and dental wear is at the Broca 2nd level, allowing for an age estimate of young mature.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | M2 | M1 | P2 | P1 | C | I2 | △ | I1 | I2 | C | P1 | P2 | / | / | / |
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | I1 | I2 | C | P1 | P2 | M1 | M2 | M3 |

**M30**
Age: adult middle mature; Sex: female
Remarks:
The skull is highly fragmented. The sagittal suture is not fused on either side. The mandibular first molars remain, having a crown surface worn to the Broca 3rd grade. The upper limbs are nearly complete. The size and robustness are moderate for a female. The lower extremities are partially well preserved. The femoral head and condyles are large, but in range of typical female sizes. The pelvis sciatic notch shows a wide female angle.

**M31**
Age: child approximately 5 years old; Sex: unknown
Remarks:
All of the skeleton is highly fragmented. The cervical vertebral bodies and deciduous teeth show that this individual was still a young child.

**M32**
Age: adult; Sex: female
Remarks:
Only the pelvis, right femur, and tibia survive. The sciatic notch shows a wide female angle. The limb size is compact.

**M33**
Age: unknown; Sex: absent
Remarks:
Only small fragments were detected.

**M34**
Age: adult middle mature; Sex: male
Remarks:
The cranium is in partially good condition. The right parietal, temporal sphenoid bones, including cranial base and the left facial skeleton, are heavily damaged. The teeth are worn to the Broca 3rd grade. The cranial sutures are partially fused on the outer surface. The pelvis is well preserved with the shape and sciatic notches showing typical male characteristics. The limbs size is moderate with moderately developed muscle attachments. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | / | M1 | P2 | P1 | C | I2 | I1 | / | / | C | P1 | / | / | M2 | / |
| ○ | △ | M1 | ○ | P1 | △ | △ | ○ | ○ | / | / | P1 | / | / | / | / |

### M35

Age: adult young mature; Sex: male

Remarks:

The skull, including the mandible, is well preserved, although the cranial base is broken. The right frontal region is damaged, due to burning and cracking during a later period. The mastoid process of the temporal bone is very large, while the overall cranial robustness is moderate for a male. The postcranial skeleton is in an excellent state of preservation. The great sciatic notch possesses male features with narrow angulation. The upper limbs possess very strong muscles, especially strong deltoid muscles on the humerus. The lower limbs are long and slender with moderately developed muscle attachment areas. The vertebrate bodies have no lipping. The following teeth are remaining and all of the crowns are the level of Broca 2nd or partial 3rd grade.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | I2 | I1 | ○ | I2 | C | P1 | P2 | M1 | M2 | ○ |
| M3 | M2 | M1 | P2 | P1 | C | I2 | △ | △ | △ | △ | ○ | P2 | M1 | M2 | M3 |

### M36

Age: adult; Sex: male

Remarks:

The pelvis, femur, and tibia are well preserved and other bones are missing. The sciatic notch is narrow in keeping with a male pelvis. The limb size is compact with moderately developed muscle attachment areas.

### M37

Age: adult late middle mature; Sex: female

Remarks:

A fragmented cranium with the mandible, the right pelvis, femur, tibia, and small parts of upper limbs are preserved. The mandibular teeth show a severe level of attrition at Broca 3rd or 4th grade. The mastoid process is large at the temporal bone. The pelvis sciatic notch indicates narrow angle, evidently of a male. The limb size is compact for a male with moderately developed muscle attachment joints. The following teeth are present.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / | × | ○ | × | × | ○ | ○ | ○ | / | / | / | / | / | / | / | / |
| △ | M2 | × | P2 | ○ | ○ | / | / | / | / | / | / | × | × | × | ○ |

### M38

Age: adult young mature; Sex: female

Remarks:

The skull is in relatively good condition, but the reconstruction was difficult due to damaged temporal and sphenoid bones. The gracile cranial morphology, as well as the pelvis shape, indicate that this individual was female. The cranial sutures are not fused on the outer surface, and the inner surface is not observable due to a hard soil covering. The teeth are worn to the Broca 1st or 2nd grade, allowing for an age estimate of young adult. The lower limbs are slender with weak muscle attachment areas.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M3 | M2 | M1 | P2 | P1 | C | ○ | ○ | ○ | △ | ○ | P1 | P2 | M1 | M2 | M3 |
| △ | M2 | M1 | P2 | P1 | C | ○ | ○ | / | / | / | P1 | P2 | M1 | M2 | M3 |

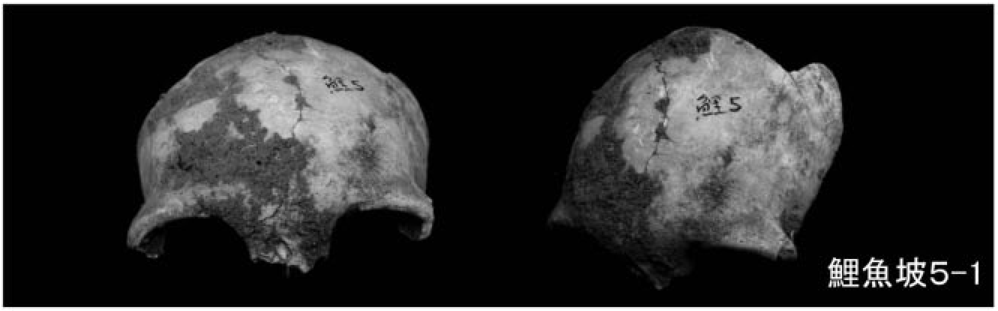
**M39**
Age: adult; Sex: female
Remarks:
Only the lower limbs are preserved in excellent condition. The femoral and tibial shafts are long and slender with weak muscle attachment areas.

## LITERATURE CITED

[1] Acsádi G, Nemeskéri J. History of Human Life Span and Mortality. Akadémiai Kiadó, Budapest, 1970.

## APPENDIX FIGURES 10-A




鯉魚坡5-1


鯉魚坡6


鯉魚坡7

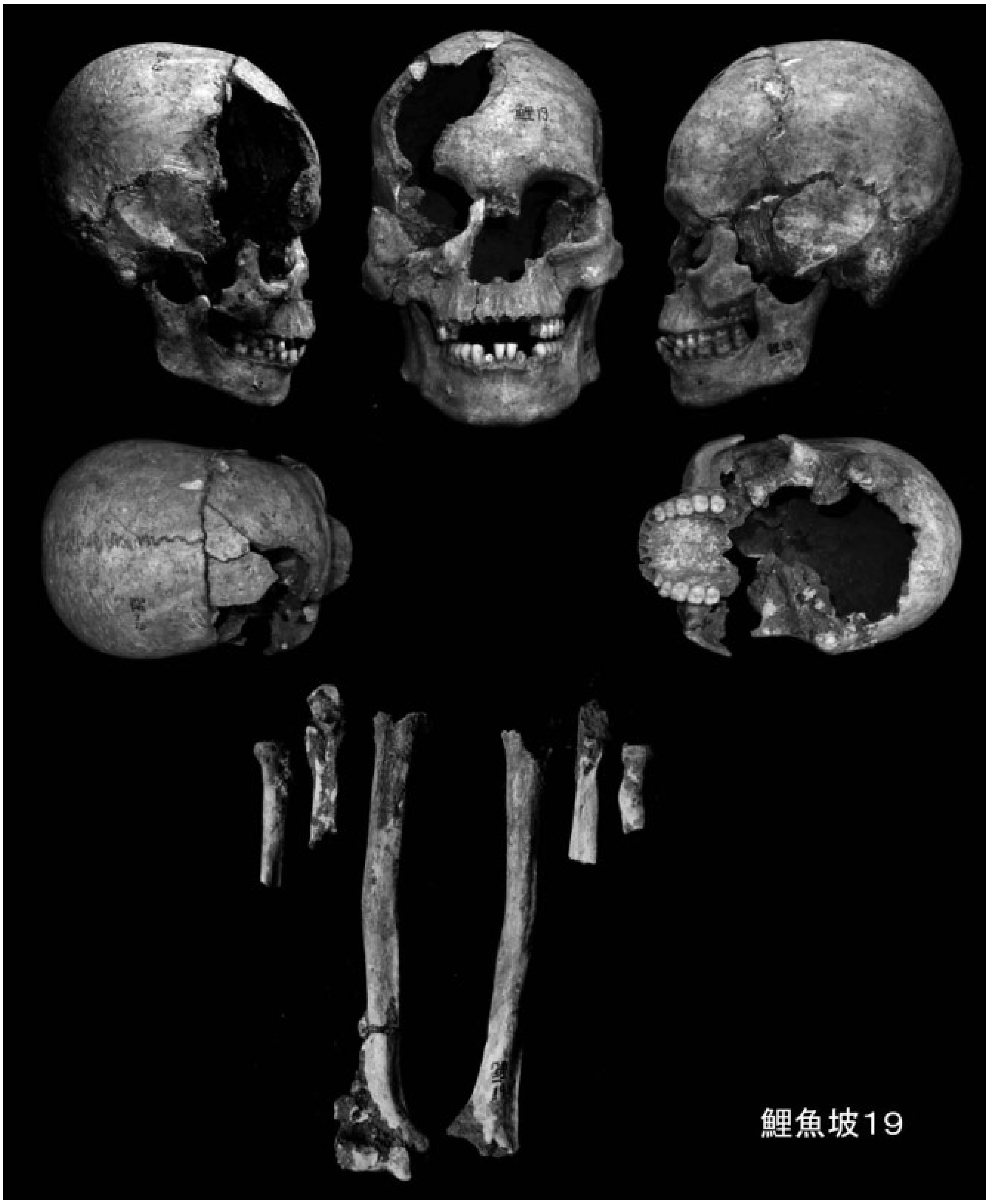

鯉魚坡8


鯉魚坡12


鯉魚坡15

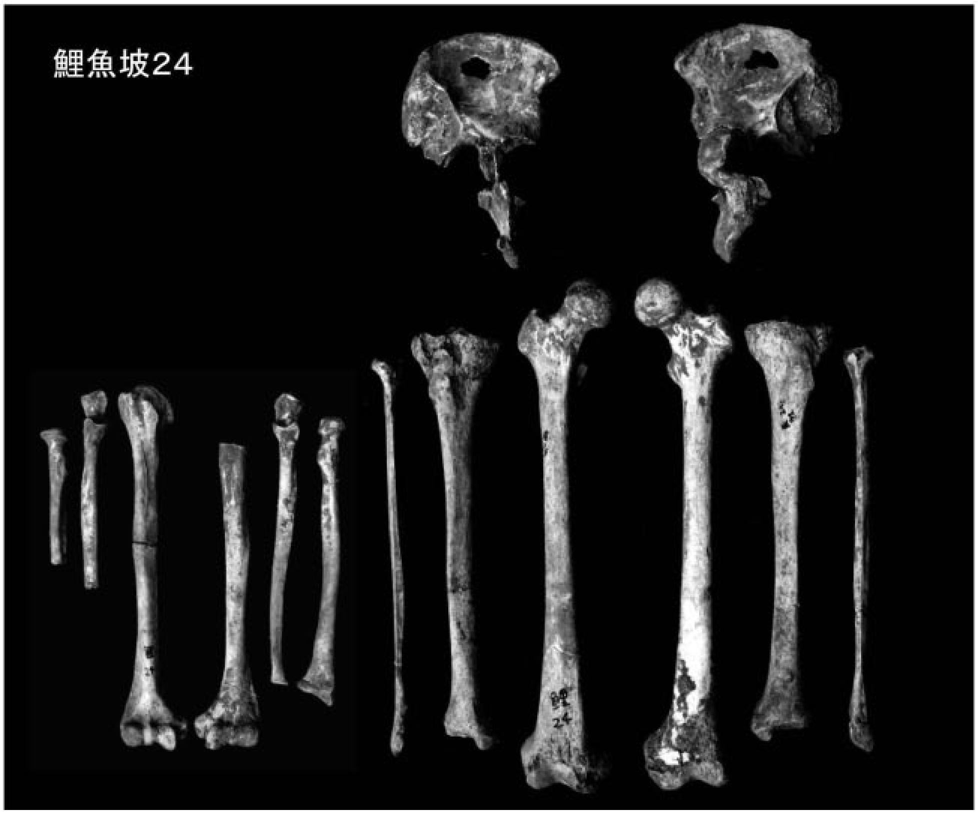

鯉魚坡16


鯉魚坡17


鯉魚坡19

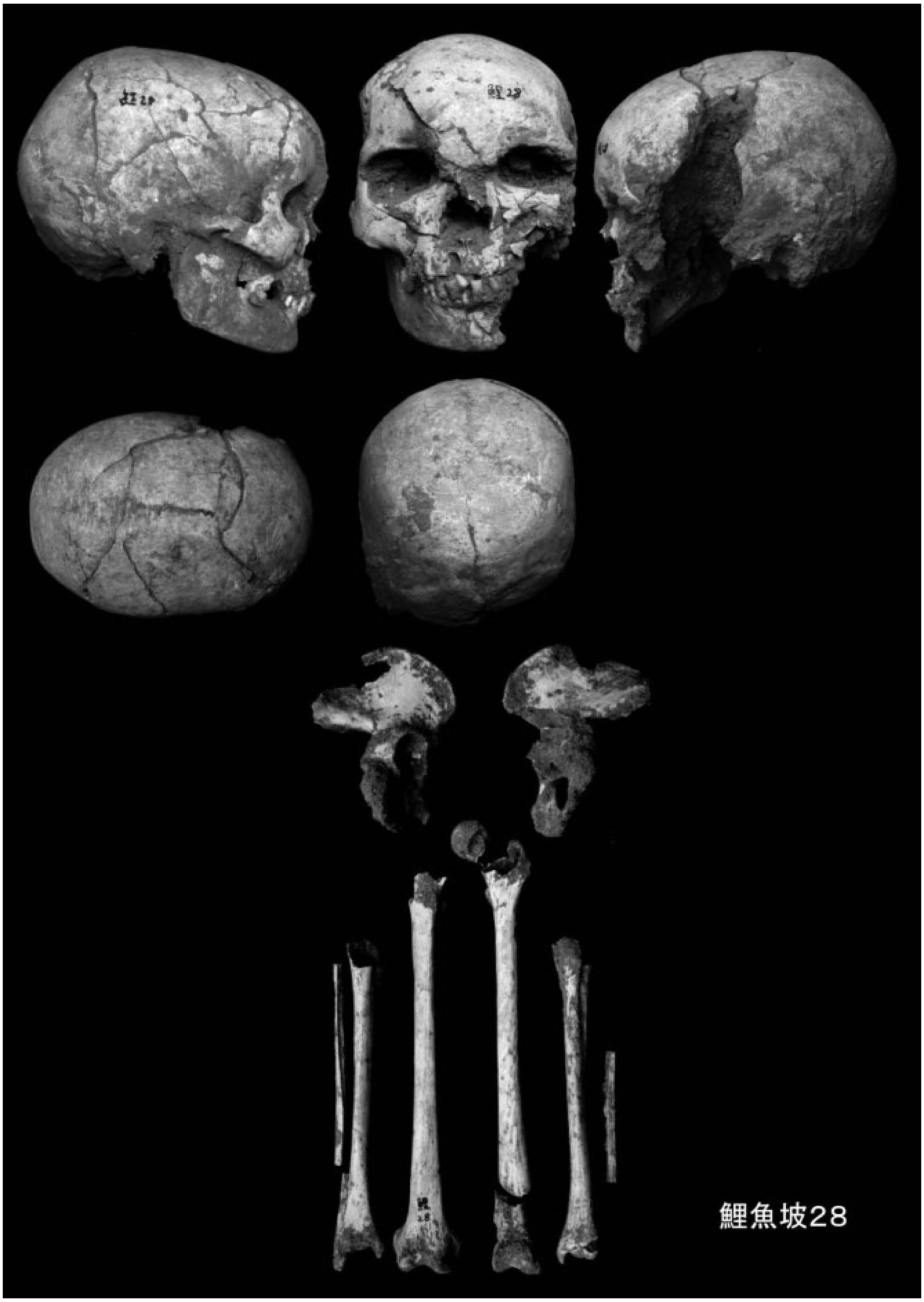

鯉魚坡22


鯉魚坡23


鯉魚坡24


鯉魚坡26


鯉魚坡27


鯉魚坡28


鯉魚坡29


鯉魚坡30


鯉魚坡36


鯉魚坡38


鯉魚坡39

# 11
# Paleopathological Description of the Liyupo Human Remains

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## INTRODUCTION

The fundamental paleopathological findings of the 37 burials and several scattered or intermixed human remains from the Liyupo site are described in this section. Our approaches were similar to those of the Huiyaotian burials (see chapter 5).

## PATHOLOGICAL DESCRIPTION

The frequencies of the pathological features are shown in Tables 11-1–11-4. The individual paleopathological information is listed below. The abbreviations used for the tooth types are the same as those in the Huiyaotian paleopathological report. The occurrence of each pathological condition is summarized in the supplementary tables (Tables 11-S1–11-S5).

### M1, adult middle mature, female

One linear enamel hypoplasia (LEH) line was found in the right LI1. The left LI1 was lost postmortem. Severe caries was found in the left UP2, in which enamel had disappeared, and a cervical caries was found on the distal side of the right LI1. A mild degree of vertebral osteophyte was observed in one lumbar vertebra.

### M2, adult young or middle mature, female

One LEH line was found in the left LI1 and in the right LC. The right LI1 and left LC were lost postmortem. Moderate cribra orbitalia (CO) was observed in the right orbital roof; the left roof was absent. Many caries were found in this burial, including fissure caries in the right UM2, right LM1, right LM2, and right LM3; a smooth surface caries on the mesial side of the left UP1; cervical caries on the mesial side of the left UP2 and right LM1; and a cervical caries on the distal side of the right LP2. Periodontitis was observed in the region of the right LM1 and LM2.

### M3, adult, female

Mild vertebral osteophytes were observed in one cervical vertebra and two lower thoracic vertebrae.

Table 11-1. Frequencies of stress markers and oral health indicators

| | CO[1] | LEH[2] | | | | Dental caries[2] | Periodontitis[3] | AMTL[3] |
|---|---|---|---|---|---|---|---|---|
| | | UI1 | UC | LI1 | LC | | | |
| N | 2/13 | 5/6 | 9/10 | 3/6 | 10/14 | 34/272 | 8/446 | 31/446 |
| % | 15.4 | 83.3 | 90.0 | 50.0 | 71.4 | 12.5 | 1.8 | 7.0 |

[1] Number of orbital roofs with CO/Total number of orbital roofs remains. The left and right were combined.
[2] Number of teeth with LEH/Total number of teeth remains. Abbreviations for tooth type are as follows: U is upper, L is lower, I is incisor, and C is canine.
[3] Number of teeth lost antemortem/Total number of sockets in maxilla and mandible remains.

Table 11-2. Vertebral osteophytes and OALL

| | Vertebral osteophyte | | | OALL[1] |
|---|---|---|---|---|
| | Cervical | Thoracic | Lumbar | |
| N | 1/52 | 2/106 | 4/47 | 2/205 |
| % | 1.9 | 1.9 | 8.5 | 1.0 |

[1] Number of OALL/Total number of vertebrae remains.

Table 11-3. Frequencies of periostitis[1]

| | Humerus | Radius | Ulna | Femur | Tibia | Fibula |
|---|---|---|---|---|---|---|
| N | 0/28 | 0/19 | 0/15 | 0/35 | 2/31 | 0/24 |
| % | 0.0 | 0.0 | 0.0 | 0.0 | 6.5 | 0.0 |

[1] The left and right were combined.

Table 11-4. Frequencies of limb arthritis[1]

| | Scapula glenoid cavity | Humerus proximal | Humerus distal | Radius proximal | Radius distal |
|---|---|---|---|---|---|
| N | 0/9 | 0/19 | 0/27 | 0/25 | 0/16 |
| % | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | Ulna trochlear notch | Os Coxae acetabular | Femur proximal | Femur distal | Patella |
|---|---|---|---|---|---|
| N | 0/26 | 0/21 | 0/26 | 0/28 | 2/23 |
| % | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 |

| | Tibia proximal | Tibia distal | Fibula distal | Talus subtalar | Calcaneus talar |
|---|---|---|---|---|---|
| N | 0/21 | 0/26 | 0/18 | 0/18 | 0/14 |
| % | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

[1] The left and right were combined.

Two adult mandibles were intermixed with the burial remains of M3. Since individual recognition was difficult, they were assigned the numbers mandible 3-1 and 3-2 for descriptive purposes. Mandible 3-1 had fissure caries in the right LP1. The left LC, LP1, P2, LM1, LM2, and LM3 of mandible 3-2 were lost antemortem (AMTL) (Figure 11-1).

### M4, adult, sex unknown

No abnormal pathological traits were found.

### M5-1, adult middle mature, male

One LEH line was found in the right LC. The crown of the left LC was damaged. The right UM1 and UM2 were lost antemortem. It is interesting that the attritions of the upper anterior teeth were severe (7 or 8 degrees in Molnar's attrition scoring system[1]), although those of the lower anterior teeth were fairly mild (3 or 4 degrees in Molnar's system [1]).

### M5-2, child 6 years, sex unknown

Three LEH lines were found in the left UC. The right LC was lost postmortem. Two LEH lines were found in both LCs.

### M6, adult young mature, male

One LEH line was found in the right UC. The left UC was lost postmortem.

### M7, adult, female

Mild periostitis was observed in both tibiae diaphyses.

### M8, adult young or middle mature, female

Periodontitis was observed in the regions of the right LC and LP1. The left LM1, both LM2s, and both LM3s were lost antemortem. Small bone erosion due to arthritis was found in the articular facet of the left patella.

### M10, adult, sex unknown

No abnormal pathological traits were found.

### M11, adult, female

No abnormal pathological traits were found.

### M12, adult late middle mature, male

One LEH line was found in both LCs. The left LM1 and LM2 were lost antemortem.

### M13, adult, male

Mild CO was observed in the left orbital roof (Figure 11-1). The right roof was absent.

The left maxilla and mandible of another individual (6-year-old child, sex unknown)

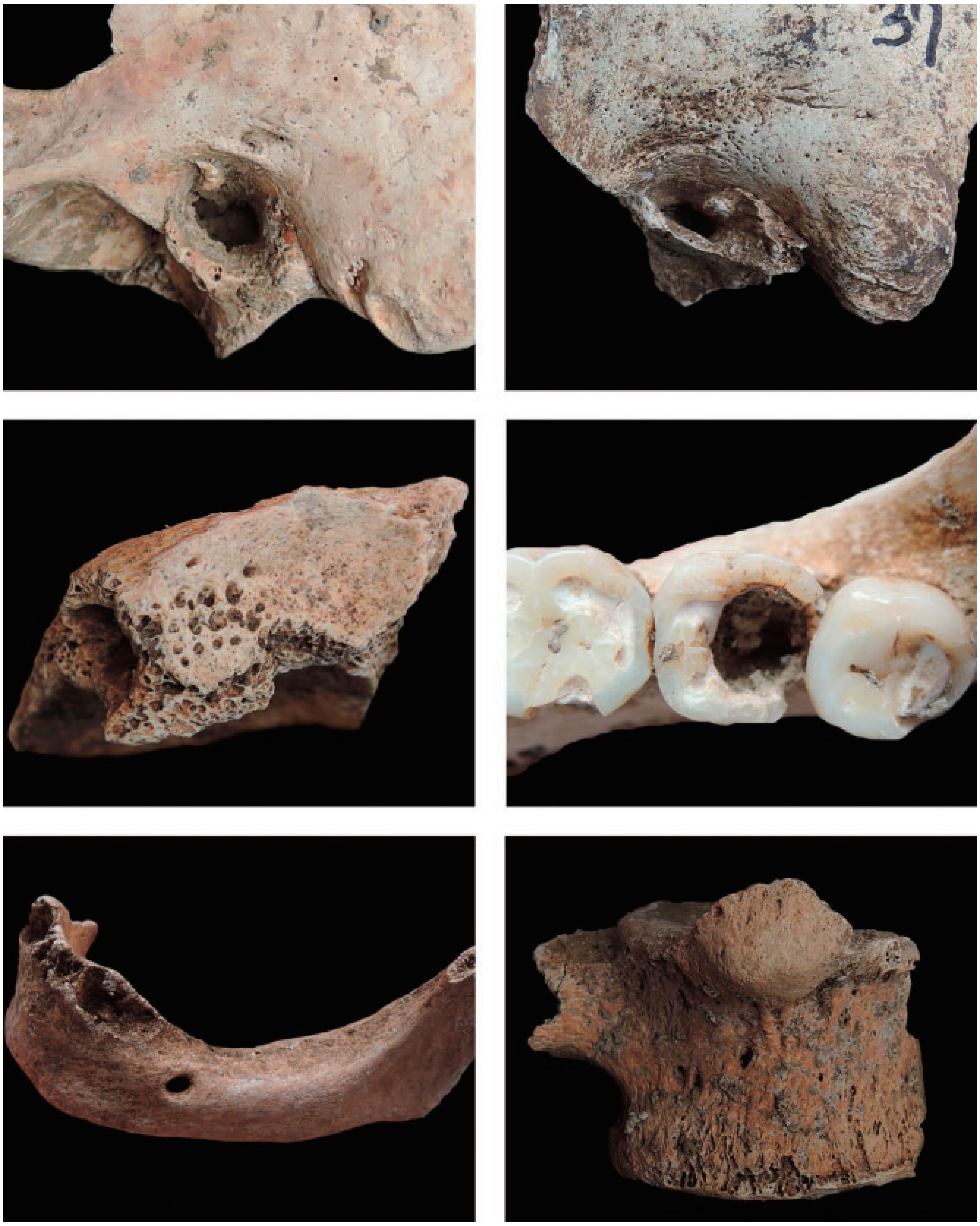

Figure 11-1. EAEs, CO, dental caries, AMTL, and OALL in the Liyupo human remains.
(The upper left and right are the EAEs in the burials of M18 and M37, respectively; the middle left is the CO in the burial of M14; the middle right is the caries in the right LM2 of the burial of M35; the lower left is the AMTL in the burial of M3-2; the lower right is the OALL in the lumbar vertebra of the burial of M14.

were intermixed with the burial remains of M13. No abnormal pathological traits were found in them.

### M14, adult old mature, male

A fissure caries was found in the left LM2 (Figure 11-1). The right LP2, right LM1, and both LM3s were lost antemortem. A possible case of ossification of anterior longitudinal ligament (OALL) was observed in one lumbar vertebra (Figure 11-1). Small abnormal osteophytosis was observed on the anterior surface around the left symphysis pubis.

### M15, adult middle mature, female

Fissure caries were found in the left UM1 and UM2, and a cervical caries was found on the distal side of the left UM2. Periodontitis was observed in the right UM2 region.

### M16, adult middle mature, female

Three LEH lines were found in the left UC. The right UC was lost postmortem. Periodontitis was observed in the region of the right LM2.

### M17, adult young mature, female

Two LEH lines were found in the right LC. The left LC was lost postmortem.

### M18, child, sex unknown

A possible case of mild external auditory exostosis (EAE) was observed in the left ear canal (Figure 11-1).

### M19, adult young mature, male

One LEH line was found in the right LC. The left LC was damaged. Fissure caries were found in the left LM2 and LM3.

### M20, child 4 years, sex unknown

No abnormal pathological traits were found.

### M21, child 6 years, sex unknown

Two LEH lines were found in the right UC, which had not erupted, but its broken alveolar made observation possible.

### M22, adult middle mature, female

One LEH line was found in the right UI1. The left UI1 was lost postmortem. Smooth surface caries were found on the distal side of the right UP2, mesial side of the right UM1, distal side of the left UP1, and mesial side of the left UP2. Periodontitis was observed in the right LM2 region. The left UI2 and both LM1s were lost antemortem.

### M23, adult young mature, female

Two LEH lines were found in both UI1s, both UCs, and both LCs, and one LEH line was found in both LI1s. Fissure caries were found in the left UM3 and LM3.

### M24, adult middle mature, male

Several mild or medium vertebral osteophytes were observed in the third, fourth, and fifth lumbar vertebrae. A possible case of OALL was observed in the fourth lumbar vertebra.

### M25, child 4–6 years, sex unknown

No abnormal pathological traits were found.

### M26, adult, male

No abnormal pathological traits were found.

### M27, adult, male

The right femoral neck was twisted, which indicated the possibility of a healed femoral neck fracture.

### M28, adult, female

The left LM1 and right LM2 were lost antemortem. Small bone erosion due to arthritis was found in the articular facet of the left patella. A mild bony lipping formation was also observed at the medial margin of the same patella.

### M29, adult young mature, male

One LEH line was found in the left UI1 and both UCs, respectively. The right UI1 was damaged. A fissure caries was found in the left LM1, and smooth surface caries were found on the distal side of the left UP1, mesial side of the left UP2, and lingual side of the right LM1.

### M30, adult middle mature, female

No abnormal pathological traits were found.

The mandible of another individual (adult, sex unknown) was intermixed with the burial remains of M30. A fissure caries was found in the left LM1 of the mandible.

### M31, child, sex unknown

No abnormal pathological traits were found.

### M32, adult, female

No abnormal pathological traits were found.

### M34, adult middle mature, male

One LEH line was found in the right UI1. The left UI1 was lost postmortem. Two LEH lines were found in both UCs. Fissure caries were found in the right UP1, right

UP2, and right LM1. A smooth surface caries was found on the mesial side of the left UC.

The mandible of another individual (adult, sex unknown) was intermixed with the burial remains of M34. Two LEH lines were found in the left LC of the mandible.

### M35, adult young mature, male

One LEH line was found in the right UI1, right LC, and both UCs. The left UI1 was lost postmortem, and the left LC was damaged. Fissure caries were found in the right UM2, right UM3, and right LM2 (Figure 11-1). Periodontitis was observed in the right LM2 region. A mild EAE was observed in the left ear canal.

### M36, adult, male

No abnormal pathological traits were found.

### M37, adult middle mature, male

A fissure caries was found in the right LM2. Periodontitis was observed in the regions of the right UM1, right UM2, left LP2, right LM1, left LM1, and left LM2. The right UP1, right UP2, right UM2, left LP2, right LM1, left LM1, and left LM2 were lost antemortem. A moderate EAE was observed in the left ear canal (Figure 11-1).

### M38, adult young mature, female

One LEH line was found in the right UC and LC. The left UC and LC were lost postmortem.

### M39, adult, female

No abnormal pathological traits were found.

## DISCUSSION AND CONCLUSION

It is noteworthy that EAE was observed in two adult males and one child. This osseous proliferation in the auditory canal tended to appear in the populations living between latitudes 30°–45° north and south, where the water temperatures were lower than 19°C [2]. The prevalence of EAE is also higher in coastal inhabitants than in inland groups [3]. Therefore, EAE may be a owing to continuous exposure to cold-water activities such as habitual fishing in the ocean. However, the Liyupo site was located at an inland region more than 100 km from the current coastline and at a latitude of 22° north. To clarify whether individuals with EAE in the Liyupo site performed activities in the inland cold-water area, whether a coastline existed near the Liyupo site at that time, or for any other reasons, further studies such as environmental archaeological research and diet analysis should be conducted.

The occurrences and frequencies of the other pathological traits were as follows:

1) Stress markers (CO and LEH): The frequencies of CO based on the number of orbits, of LEH in UI1 based on the number of UI1, of LEH in UC based on the number of UC, of LEH in LI1 based on the number of LI1, and of LEH in LC based on the

number of LC were 15.4% (2/13), 83.3% (5/6), 90.0% (9/10), 50.0% (3/6), and 71.4% (10/14), respectively.

2) Oral health indicators (dental caries, periodontitis, and AMTL): The frequencies of dental caries based on the number of permanent teeth, periodontitis based on the number of sockets, and AMTL based on the number of sockets were 12.5% (34/272), 1.8% (8/446), and 7.0% (31/446), respectively.

3) Vertebrae lesions: The frequencies of cervical osteophyte based on the number of cervical vertebrae, of thoracic osteophyte based on the number of thoracic vertebrae, of lumbar osteophyte based on the number of lumbar vertebrae, and of OALL based on the number of all vertebrae were 1.9% (1/52), 1.9% (2/106), 8.5% (4/47), and 1.0% (2/205), respectively.

4) Periostitis: The frequency of periostitis in the tibia based on the number of tibiae was 6.5% (2/31). No periostitis was found in the other limb long bones.

5) Limb arthritis: The frequency of arthritis in the patella was 8.7% (2/23). No arthritis was found in the other limb bones.

## REFERENCES

[1] Molnar S. Human Tooth Wear, Tooth Function and Cultural Variability. American Journal of Physical Anthropology, 1971, 34: 175–189.

[2] Kennedy GY. The Relationship between Auditory Exostoses and Cold Water: A Latitudinal Analysis. American Journal of Physical Anthropology, 1986, 71: 401–415.

[3] Standen VG, Arriaza BT, Santoro CM. External Auditory Exostosis in Prehistoric Chilean Populations: A Test of the Cold Water Hypothesis. American Journal of Physical Anthropology, 1997, 103: 119–129.

Table 11-S1. Occurrence of CO, LEH, and dental caries

| Burial | CO[1] | | LEH[1,2] | | | | Dental caries | |
|---|---|---|---|---|---|---|---|---|
| | L | R | UI1 | UC | LI1 | LC | N[3] | tooth type[2] |
| M1 | | | | | + | | 2/2 | UP2 (L), LI1 (R) |
| M2 | − | + (medium) | − | | + | + | 7/14 | UP1-2 (L), UM2(R), LP2 (R), LM1-3 (R) |
| M3-1 | | | | | | | 1/2 | LP1 (R) |
| M5-1 | − | − | | | | + | 0/25 | |
| M5-2 | | | | + | | + | 0/4 | |
| M6 | | | | + | | | 0/17 | |
| M12 | | | | | | + | 0/7 | |
| M13 | + (mild) | | | | | | 0/ | |
| M13 intermix | | | | − | | | 0/2 | |
| M14 | | | | | | − | 1/2 | LM2 (L) |
| M15 | | | | | | | 2/9 | UM1-2 (L) |
| M16 | | | | + | | | 0/12 | |
| M17 | | − | | | | + | 0/6 | |
| M18 | | | | | | | 0/1 | |
| M19 | − | | | | − | + | 2/20 | LM2-3 (L) |
| M21 | | | | + | | | 0/4 | |
| M22 | − | | + | | | − | 4/19 | UP2 (LR), UM1 (LR) |
| M23 | − | − | + | + | + | + | 2/32 | UM3 (L), LM3 (L) |
| M28 | | | | | − | − | 0/2 | |
| M29 | − | | + | + | − | − | 4/27 | UP1-2 (L), LM1 (LR) |
| M30 intermix | | | | | | | 1/1 | LM1 (L) |
| M34 | | | + | + | | | 4/12 | UC (L), UP1-2 (R), LM1 (R) |
| M34 intermix | | | | | | + | 0/5 | |
| M35 | − | | + | + | | + | 3/25 | UM2-3 (R), LM2 (R) |
| M37 | | | | | | | 1/2 | LM2 (R) |
| M38 | − | | | + | | + | 0/20 | |

[1] Symbol "+" indicates CO/LEH presence, and "−" indicates CO/LEH absence.
[2] Abbreviations for tooth type are as follows: U is upper, L is lower, I is incisor, C is canine, P is premolar, and M is molar.
[3] Number of caries teeth/Total number of teeth remains.

Table 11-S2. Occurrence of periodontitis and AMTL

| Burial | Number of sockets | Periodontitis | | AMTL | |
|---|---|---|---|---|---|
| | | N | Region | N | Tooth type |
| M1 | 6 | 0 | | 0 | |
| M2 | 15 | 2 | LM1-2 (R) | 0 | |
| M3-1 | 12 | 0 | | 0 | |
| M3-2 | 12 | 0 | | 6 | LC (L), LP1-2 (L), LM1-3 (L) |
| M5-1 | 29 | 0 | | 2 | LM1-2 (R) |
| M5-2 | 4 | 0 | | 0 | |
| M6 | 21 | 0 | | 0 | |
| M8 | 13 | 0 | | 5 | LM1-3 (LR) |
| M12 | 15 | 0 | | 2 | LM1-2 (L) |
| M13 intermix | 2 | 0 | | 0 | |
| M14 | 11 | 0 | | 4 | LP2 (R), LM1 (R), LM3 (LR) |
| M15 | 18 | 1 | UM2 (R) | 0 | |
| M16 | 27 | 1 | LM2 (R) | 0 | |
| M17 | 9 | 0 | | 0 | |
| M18 | 1 | 0 | | 0 | |
| M19 | 29 | 0 | | 0 | |
| M21 | 4 | 0 | | 0 | |
| M22 | 28 | 0 | | 3 | UI2 (L), LM1 (LR) |
| M23 | 32 | 0 | | 0 | |
| M28 | 24 | 0 | | 2 | LM1 (L), LM2 (R) |
| M29 | 28 | 0 | | 0 | |
| M30 | 2 | 0 | | 0 | |
| M30 intermix | 5 | 0 | | 0 | |
| M34 | 14 | 0 | | 0 | |
| M34 intermix | 8 | 0 | | 0 | |
| M35 | 32 | 1 | LM2 (R) | 0 | |
| M37 | 17 | 3 | UP1-2 (R), UM2 (R), LP2 (L), LM1 (LR), LM2 (L) | 7 | UM1-2 (R), LM1 (R) |
| M38 | 28 | 0 | | 0 | |

Table 11-S3. Occurrence of osteophyte and OALL

| Burial | Vertebral osteophyte[1] | | | OALL |
|---|---|---|---|---|
| | Cervical | Thoracic | Lumbar | |
| M1 | | 0/7 | 1/4 | |
| M2 | 0/2 | | | |
| M3 | 1/1 | 2/8 | 0/1 | |
| M6 | 0/7 | | | |
| M8 | | 0/3 | | |
| M13 | | | 0/2 | |
| M14 | | | 0/1 | Lumbar |
| M15 | 0/5 | 0/3 | | |
| M17 | | 0/8 | 0/5 | |
| M19 | 0/6 | 0/6 | | |
| M20 | 0/4 | | | |
| M22 | | 0/2 | 0/5 | |
| M23 | 0/7 | 0/12 | 0/5 | |
| M24 | | 0/12 | 3/5 | 4th lumbar |
| M25 | | 0/8 | | |
| M26 | | | 0/3 | |
| M29 | 0/6 | 0/2 | | |
| M30 | | 0/3 | | |
| M31 | 0/2 | 0/5 | 0/4 | |
| M34 | | 0/2 | 0/5 | |
| M35 | 0/7 | 0/12 | 0/5 | |
| M36 | | | 0/2 | |
| M37 | | 0/1 | | |
| M38 | 0/5 | 0/12 | | |

[1] Number of osteophyte vertebrae/Total number of vertebrae remains.

Table 11-S4. Occurrence of periostitis[1]

| Burial | Humerus | | Radius | | Ulna | | Femur | | Tibia | | Fibula | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | R | L | R | L | R | L | R | L | R | L | R |
| M1 | − | | − | | − | | − | − | | | | |
| M2 | − | | − | − | | | | − | | | | − |
| M3 | | − | | − | | − | − | | − | | − | |
| M4 | | | | | | | | | − | | | |
| M6 | − | − | − | − | − | − | | | | | | |
| M7 | | | − | | − | | − | − | + | + | | − |
| M8 | | | − | | | | − | − | − | | − | − |
| M14 | − | | | − | | − | − | − | − | | − | |
| M15 | | | | | | | − | − | − | − | | − |
| M16 | − | − | − | − | | | | − | − | | | − |
| M17 | − | | | | | | | | | | | |
| M19 | − | − | | | | | − | − | | − | | |
| M22 | − | − | − | | | | − | | | − | | |
| M23 | − | − | − | | − | | − | − | − | − | − | − |
| M24 | − | − | − | | − | − | − | − | − | − | − | − |
| M26 | − | | | | | | − | | − | | − | |
| M27 | | − | − | − | − | − | | − | − | − | − | − |
| M28 | | − | | | | | | − | | − | | − |
| M29 | − | − | | | | | | | | | | |
| M30 | − | − | | | | | − | | − | | − | |
| M32 | | | | | | | | − | | − | | |
| M34 | | − | | | − | | − | − | − | − | − | − |
| M35 | − | − | − | − | − | − | − | − | − | − | − | − |
| M36 | | | | | | | − | − | − | | | |
| M37 | | | | | | | − | | − | | | |
| M38 | | − | | − | | − | − | − | − | − | − | − |
| M39 | | | | | | | − | | − | − | − | |

[1] Symbol “+” indicates periostitis presence, and “−” indicates periostitis absence.

Table 11-S5. Occurrence of limb arthritis[1]

| Burial | Scapula | | Humerus | | | | Radius | | | | Ulna | | Os Coxae | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | glenoid cavity | | proximal | | distal | | proximal | | distal | | trochlear notch | | acetabulum | |
| | L | R | L | R | L | R | L | R | L | R | L | R | L | R |
| M1 | | | – | | – | | – | | | | – | | | |
| M2 | | | – | | – | | | | | – | – | | | |
| M3 | | | | – | | – | | – | | – | | | | |
| M4 | | | | | | | | | | | | | | |
| M5-1 | | | | | | | | | | | | | | |
| M6 | | | | | – | – | – | – | – | | – | – | | |
| M7 | | | | | | | – | | | | – | – | | |
| M8 | – | | | | | | | | | | | – | | |
| M11 | | | | | | | | – | | | | | | |
| M13 | | | | | | | | | | | | – | – | |
| M14 | | | – | | – | – | – | – | | – | | – | – | – |
| M14 intermix | | | | | | | | | | | | | | |
| M15 | | | | | | | | | | | | | – | – |
| M16 | | | – | | | | – | | – | – | | | | |
| M17 | | | – | | – | | | | | | – | | – | – |
| M19 | | | | | – | | – | – | | – | | – | | |
| M22 | – | | – | – | – | – | – | | | | – | – | | – |
| M23 | – | – | | – | – | – | – | | – | | – | | – | – |
| M24 | | | | – | – | – | – | – | – | | – | – | – | – |
| M26 | | | – | | – | | | | | – | | | | – |
| M27 | | | | | | – | – | – | – | – | | – | | |
| M28 | | | – | – | | – | | | | | | | | – |
| M29 | – | – | – | | – | | – | | | | – | | | |
| M30 | | | – | – | – | – | – | | | | – | – | | |
| M32 | | | | | | | | | | | | | | |
| M34 | | | | | – | – | | – | | | – | | – | |
| M35 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| M36 | | | | | | | | | | | | | – | – |
| M37 | | | | | – | | – | – | | | – | – | | |
| M38 | – | | | – | | – | | – | – | – | | – | – | – |
| M39 | | | | | | | | | | | | | | |

Table 11-S5. (continued)

| Burial | Femur proximal L | Femur proximal R | Femur distal L | Femur distal R | Patella L | Patella R | Tibia proximal L | Tibia proximal R | Tibia distal L | Tibia distal R | Fibula distal L | Fibula distal R | Talus subtalar L | Talus subtalar R | Calcaneus talar L | Calcaneus talar R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M1 | − | | | | | | | | | | | | | | | |
| M2 | | | | | − | − | | | | | | − | | | | |
| M3 | | | − | | | | | | − | | − | | | | | |
| M4 | | | | | | | | | | | − | | | | − | |
| M5-1 | | | | | − | | | | | | | | | | | |
| M6 | | | | | | | | | | | | | | | | |
| M7 | − | | − | − | − | − | − | − | | − | | − | | | | |
| M8 | − | − | − | − | + | | | − | − | | | − | | | | |
| M11 | | | | | | | | | | | | | | | | |
| M13 | | | | | | | | | | | | | | | | |
| M14 | − | − | − | | − | | − | | − | − | − | | − | | | |
| M14 intermix | | | | | − | − | | | | | | | | | − | |
| M15 | − | − | | − | | | | − | − | − | | | | | | |
| M16 | | | − | − | | − | − | | | | | | | | | |
| M17 | − | | | | | | | | | | | | | | | |
| M19 | | − | − | − | | | − | | | | | − | | | | |
| M22 | − | | − | | | | | | − | − | | | − | | − | |
| M23 | − | − | − | − | − | | − | − | − | − | − | | − | − | − | |
| M24 | − | − | − | − | − | | − | − | − | − | − | − | | − | | − |
| M26 | − | | | | | | | | − | | | | − | | − | |
| M27 | | | − | − | | | − | − | | − | | − | | − | | |
| M28 | | | − | − | + | | | | − | − | | − | | | | |
| M29 | | | | | | | | | | | | | | | | |
| M30 | | − | − | − | − | − | | | | − | | − | | − | | − |
| M32 | | | | | | − | | | | | − | | | | | |
| M34 | − | − | | | | − | | − | | − | | − | − | − | − | − |
| M35 | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − |
| M36 | − | − | | | | − | | − | − | | | | | | | |
| M37 | | | | | | | | | | | | | − | − | | |
| M38 | − | − | − | − | | − | − | − | − | − | − | | − | − | − | |
| M39 | − | | − | − | − | − | − | − | − | − | | | − | − | − | − |

[1] Symbol "+" indicates arthritis presence, and "−" indicates arthritis absence.

# 12
# Morphometric Records of the Liyupo Human Skulls

Hirofumi Matsumura[1] and Nguyen Lan Cuong[2]

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Of the 60 burials excavated at Liyupo during the 2008 season, skull measurements were taken for 13 adult males and 9 adult females following Martin's measurement definitions (Bräuer[1]). The recorded data set consists of 32 cranial measurements and representative cranial indices. In the case of incomplete preservation, when half of a portion was complete, some measurements were estimated by doubling the value. The measurements are given in Table 12-1.

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Table 12-1. Cranial and mandibular measurements (mm) and indices for the Liyupo.

| Martin's No. | M5-1 | M6 | M12 | M17 | M19 | M22 | M23 | M28 | M29 | M34 | M35 | M38 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex (M=male, F=female) | M | M | M | F | M | F | F | F | M | M | M | F |
| 1 Maximam cranial length | — | — | 179 | — | 192 | 179 | 180 | 194 | — | 191 | 187 | — |
| 5 Basion-nasion length | — | — | — | — | — | 100 | 97 | 107 | — | — | — | — |
| 8 Maximam cranial breadth | — | — | 130 | — | 138 | 130 | 132 | 138 | — | 136 | 140 | — |
| 9 Minimum frontal breadth | 92 | — | 92 | 96 | 102 | 100 | 94 | 102 | 96 | 96 | 106 | — |
| 10 Maximaum frontal breadth | 112 | — | — | — | 119 | 116 | 107 | 114 | 114 | — | 114 | — |
| 12 Maximum occipital breadth | — | — | 115 | — | 112 | 103 | 106 | 116 | 108 | — | 115 | — |
| 17 Basion-bregma height | — | — | — | — | *138* | 138 | 127 | 132 | — | — | | — |
| 29 Frontal chord | — | — | — | — | 117 | 109 | 101 | 111 | — | — | 106 | — |
| 30 Parietal chord | — | — | — | — | 131 | — | 110 | 121 | — | — | 114 | — |
| 31 Occipital chord | — | — | — | — | — | — | 104 | 110 | 92 | 89 | 109 | — |
| 40 Basion-prostion breadth | — | — | — | — | — | 95 | 102 | 102 | — | — | | — |
| 43 Upper facial breadth | 114 | — | — | 110 | 114 | 110 | 106 | 113 | 108 | — | 112 | — |
| 45 Bizigomatic breadth | — | — | — | — | 142 | — | 126 | 137 | — | — | 143 | — |
| 46 Bimaxillary breadth | — | — | — | — | 105 | 108 | 99 | 103 | — | 105 | 107 | 94 |
| 48 Upper facial height | — | — | — | — | 68 | 64 | 61 | — | — | 63 | 66 | 61 |
| 51 Orbital breadth | — | — | — | 39.6 | 44 | 42 | 40 | — | — | 43 | 43 | — |
| 52 Orbital height | — | — | 32 | 32 | 37 | 35 | 34 | — | — | 33 | 32 | — |
| 54 Nasal breadth | — | — | — | — | 33 | 28 | 28 | 26 | 24 | 28 | 27 | 24 |
| 55 Nasal height | — | — | — | — | 48 | 48 | 45 | — | — | 46 | 46 | 44 |
| 60 Upper alveolar length | — | — | — | — | 59 | 56 | 53 | — | — | — | 58 | — |
| 61 Upper alveolar breadth | — | — | — | — | 70 | 62 | 64 | — | — | — | 70 | — |
| 8:1 Cranial index | — | — | 72.6 | — | 71.9 | 72.6 | 73.3 | 71.1 | — | 71.2 | 74.9 | — |
| 48:45 Upper facial index | — | — | — | — | 48.2 | — | 48.3 | — | — | — | 46.3 | — |
| 43(1) Frontal chord | 100 | — | — | — | 104 | 103 | 98 | — | — | 99 | 103 | — |
| 43c Frontal subtense | 6.4 | — | — | — | 24.4 | 12.5 | 25.8 | — | — | 8.9 | 19.9 | — |
| 57 Simotic chord | — | — | — | — | — | 10.4 | 10.4 | — | — | — | 6.3 | — |
| 57a Simotic subtense | — | — | — | — | — | 3.9 | 3.9 | — | — | — | 2.4 | — |
| 46b Zygomaxillary chord | — | — | — | — | 104 | 108 | 97 | — | — | 95 | 107 | 94 |
| 46c Zygomaxillary subtense | — | — | — | — | 27.3 | 30.5 | 21.9 | — | — | 17.1 | 17.2 | — |
| 43c: 43(1) Frontal index | 6.4 | — | — | — | 23.4 | 12.2 | 26.3 | — | — | 9.0 | 19.3 | — |
| 57a: 57 Simotic index | — | — | — | — | | 37.5 | 37.5 | — | — | — | 38.8 | — |
| 46c: 46b Zygomaxillary index | — | — | — | — | 26.3 | 28.2 | 22.6 | — | — | 18.0 | 16 | — |
| 66 Bigonial breadth | — | — | — | — | 111 | 100 | 94 | — | — | — | 108 | — |
| 68 Mandibuler length | — | — | — | — | 80 | 81 | 81 | — | 78 | — | 85 | — |
| 69 Symphyseal height | 39 | — | 36 | — | 36 | 32 | 26 | 31 | 31 | — | 34 | — |
| 70 Ramus height | 60 | — | — | — | 63 | | 57 | — | — | — | 62 | — |
| 71 Ramus breadth | 39 | 41 | 36 | — | 34 | 38 | 34 | 36 | 34 | — | 43 | — |

# 13
# Morphometric Records of the Liyupo Human Teeth

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Metric dental traits, except for the third molars, were represented by the mesiodistal and buccolingual crown diameters. The measurements were taken according to the system of Fujita[1]. The dental measurements and observations were made on the right teeth when available. Twenty-one nonmetric dental traits were scored using protocols and criteria given by Matsumura[2] and in Table 13-1 and. All traits were scored for both sexes on the basis of presence/absence to facilitate statistical comparisons. The recorded crown measurements and nonmetric scores are given in Table 13-2.

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Table 13-1. Criteria for presence in the 21 nonmetric dental characteristics.

| Trait | Tooth | Description | Critera | Presence |
|---|---|---|---|---|
| Shoveling | UI1, UI2 | Hanihara *et al.*, 1970[3] | Depth of Lingual Fossa (DFL) | DLF>=0.5 mm |
| double shoveling | UI, UI2 | Suzuki and Sakai, 1973[4] | 3=+++(strong), 2=++(moderate), 1=+(weak)) | 2–3 |
| dental tubercle | UI, UI2 | Turner II *et al.*, 1991[5] | 0=none, 1=faint, 2=trace, 3 (strong ridging)–6 (strong cusp) | 3–6 |
| Spine | UI1 | 0:none 1:present | 1=single, 2=double, 3=triple | 1 |
| interruption groove | UI2 | Turner II *et al.*, 1991[5] | 0=none, 1=M (mesial), 2=Med (central), 3=d (distal) | 1–3 |
| winging (bilateral) | UI1 | Enoki and Dahlberg, 1958[6] | 0=straight, 1=counter wing, 2=bilateral wing, 3=uni-counter wing, 4=uni-lateral wing | 1 |
| De Terra's tubercle | UP1 | Saheki, 1958[7] | 0=none, 1=+(faint ridging), 2=++(small cusp), 3=+++(large cusp) | +, ++, +++ |
| double roots | UP1, UP2 | Turner II *et al.*, 1991[5] | 1=single, 2=double, 3=triple | 2–3 |
| Carabelli's trait | UM1 | Dahlberg's P-plaque | 0=a (none), 1=b, 2=c, 3=d, 4=e, 5=f, 6=g | d–g |
| hypocone reduction | UM2 | Dahlberg's P-plaque | 0=3 (none), 1=3+(faint hyp cusp), 2=4-(small hyp cusp), 3=4-(large hyp cusp) 4=4 (full size hyp cusp) | 3+ |
| sixth cusp | LM1 | Turner II *et al.*, 1991[5] | 0=none, 1 (much small cusp)–5 (much larger cusp) | 1–5 |
| seventh cusp | LM1 | Turner II *et al.*, 1991[5] | 0=none, 1 (faint)–4 (large) | 2–4 |
| Protostylid | LM1 | Dahlberg's P-plaque | 0=none, 1=pit, 2=curved groove, 3 (secondary grrove)–5 (free apex) | 3–5 |
| deflecting wrinkle | LM1 | Turner II *et al.*, 1991[5] | 0=none, 1=faint, 2=moderately deflect, 3=L-shape | 2–3 |
| groove pattern Y | LM1 | Jørgensen, 1955[8] | 1=Y, 2=+, 3=X | Y |
| groove pattern X | LM2 | Jørgensen, 1955[8] | 1=Y, 2=+, 3=X | X |
| number of cusps (hypoconulid reduction) | LM2 | Turner II *et al.*, 1991[5] | 4=0 (no hyld), 5=1 (small hyld)–5 (very large hyld), 6=with cusp 6 | 4 (4 cusps molar) |

U: Upper, L: Lower, I: Incisor, C: Canine, P: Premolar, M: Molar.

Table 13-2. Dental crown measurements (mm) and the presence of nonmtric tooth traits of the Liyupo.

| Sample Number | | M2 | M4 | M5 | M6 | M12 | M13 | M14 | M16 | M17 | M18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | | F | ? | ? | M | M | M | M | F | F | ? |
| Mesiodistal diameters (mm) | | | | | | | | | | | |
| | UI1 | — | — | — | — | — | — | — | — | — | — |
| | UI2 | — | — | — | — | — | — | — | — | — | — |
| | UC | 8.22 | — | — | — | — | — | — | 8.06 | — | — |
| | UP1 | — | — | — | 7.41 | — | — | — | — | — | — |
| | UP2 | 6.79 | — | — | 7.74 | — | — | — | 6.96 | — | — |
| | UM1 | 10.66 | 10.33 | 11.35 | 11.78 | — | — | — | 10.57 | — | — |
| | UM2 | 10.04 | — | 10.01 | 10.33 | — | — | — | 10.23 | 10.01 | — |
| | LI1 | — | — | — | — | — | — | — | — | — | — |
| | LI2 | 6.22 | — | 6.25 | — | — | — | — | — | 6.18 | — |
| | LC | 7.38 | — | 7.57 | — | — | — | 7.93 | — | 6.66 | — |
| | LP1 | 7.56 | — | 6.65 | 6.65 | 7.41 | — | — | — | 7.15 | — |
| | LP2 | 7.46 | — | 7.59 | 7.43 | 8.11 | — | — | 7.86 | 6.87 | — |
| | LM1 | — | — | — | 12.16 | 12.54 | — | — | 11.33 | 11.45 | — |
| | LM2 | 11.82 | — | — | 11.09 | — | — | — | 10.16 | — | — |
| Buccolingual diameters (mm) | | | | | | | | | | | |
| | UI1 | — | — | — | — | — | — | — | — | — | — |
| | UI2 | — | — | — | — | — | — | — | — | — | — |
| | UC | 8.46 | — | — | 8.89 | — | — | — | 7.79 | — | — |
| | UP1 | 10.12 | — | — | 9.22 | — | — | — | — | — | — |
| | UP2 | 9.44 | — | — | 9.43 | — | — | — | 9.25 | — | — |
| | UM1 | 11.81 | 11.88 | 12.05 | 12.57 | — | — | — | 11.51 | — | — |
| | UM2 | 12.17 | — | 12.09 | 11.79 | — | — | — | 11.28 | 11.08 | — |
| | LI1 | 5.45 | — | — | — | — | — | — | — | — | — |
| | LI2 | 6.12 | — | 7.04 | — | — | — | — | — | 6.05 | — |
| | LC | 8.12 | — | 8.5 | — | — | — | 7.68 | — | 7.11 | — |
| | LP1 | 8.92 | — | 8.81 | 8.32 | 8.79 | — | — | — | 7.96 | — |
| | LP2 | 8.63 | — | 8.93 | 8.14 | 9.31 | — | — | 8.46 | 8.6 | — |
| | LM1 | — | — | — | 11.41 | 12.18 | — | — | 10.56 | 10.69 | — |
| | LM2 | 11.13 | — | — | 10.47 | — | — | — | 10.28 | — | — |
| shovelling | UI1 | — | — | — | — | — | — | — | — | — | — |
| shovelling | UI2 | — | — | — | — | — | 0.2 | — | — | — | — |
| double shovelling | UI1 | — | — | — | — | — | — | — | — | — | — |
| double shovelling | UI2 | — | — | — | — | — | 0 | — | — | — | — |
| dental tubercle | UI1 | — | — | — | — | — | — | — | — | — | — |
| dental tubercle | UI2 | — | — | — | — | — | 0 | — | — | — | — |
| spine | UI1 | — | — | — | — | — | — | — | — | — | — |
| interruption groove | UI2 | — | — | — | — | — | 0 | — | — | — | — |
| winging (bilateral) | UI1 | — | — | — | — | — | — | — | 0 | — | — |
| De Terra's tubercle | UP1 | — | — | — | — | — | — | — | — | — | — |
| double rooted | UP1 | — | — | — | 2 | — | — | — | — | — | — |
| double rooted | UP2 | — | — | — | 1 | — | — | — | 2 | — | — |
| Carabelli's trait | UM1 | — | — | — | 0 | — | — | — | 0 | — | — |
| hypocone reduction | UM2 | — | — | — | — | — | — | — | 3 | — | — |
| sixth cusp | LM1 | — | — | — | 2 | 2 | 0 | — | — | — | 0 |
| seventh cusp | LM1 | — | — | — | 0 | 0 | 0 | — | — | — | 0 |
| protostylid | LM1 | — | — | — | 1 | 0 | 3 | — | — | — | 0 |
| deflecting wrinkle | LM1 | — | — | — | — | — | 1 | — | — | — | 2 |
| groove pattern Y | LM1 | — | — | — | 1 | — | 1 | — | — | — | 1 |
| groove pattern X | LM2 | — | — | 2 | 3 | — | — | — | — | — | — |
| number of cusps | LM2 | — | — | 5 | 6 | — | — | — | — | — | 5 |

U: Upper, L: Lower, I: Incisor, C: Canine, P: Premolar, M: Moler

Table 13-2 (continued).

| Sample Number | | M19 | M21 | M22 | M23 | M28 | M29 | M34 | M35 | M37 | M38 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | | M | ? | F | F | F | M | M | M | M | F |
| Mesiodistal diameters (mm) | | | | | | | | | | | |
| | UI1 | — | — | — | 9.02 | — | 8.86 | — | 8.90 | — | — |
| | UI2 | — | — | — | 7.62 | — | 8.11 | — | 7.03 | — | — |
| | UC | — | — | — | 8.16 | — | 7.90 | 8.49 | 8.08 | — | 7.67 |
| | UP1 | 7.17 | — | — | 7.26 | — | 7.31 | 7.47 | — | — | 6.90 |
| | UP2 | 6.55 | — | — | 7.61 | — | 6.99 | 7.38 | — | — | 6.29 |
| | UM1 | 10.49 | — | — | 10.80 | — | 11.23 | 11.11 | — | 10.94 | 10.22 |
| | UM2 | 10.36 | — | — | 9.95 | — | 10.39 | — | — | — | 9.37 |
| | LI1 | 5.34 | — | — | 6.07 | 5.88 | 5.67 | — | — | — | — |
| | LI2 | — | — | — | 6.44 | 6.1 | 6.57 | 6.61 | 6.23 | — | — |
| | LC | 7.22 | — | 7.39 | 7.16 | 7.17 | 6.96 | 6.90 | 7.33 | 8.33 | 6.95 |
| | LP1 | 7.15 | — | — | 6.78 | — | 7.68 | — | 7.75 | 7.99 | 7.60 |
| | LP2 | 7.29 | — | — | 7.22 | — | 7.56 | — | 8.24 | 8.26 | 7.11 |
| | LM1 | 11.47 | — | — | 11.99 | — | 11.05 | — | 12.78 | — | 11.41 |
| | LM2 | 10.84 | — | — | 11.58 | — | 10.97 | — | 12.06 | — | 10.77 |
| Buccolingual diameters (mm) | | | | | | | | | | | |
| | UI1 | — | — | 7.85 | 7.97 | — | 7.77 | — | — | — | — |
| | UI2 | — | — | — | 6.99 | — | 6.90 | — | — | — | — |
| | UC | — | — | — | 9.07 | — | 8.39 | 8.45 | 8.58 | — | 7.23 |
| | UP1 | 9.86 | — | — | 9.50 | — | 9.58 | 9.79 | — | — | 8.85 |
| | UP2 | 10.06 | — | — | 9.37 | — | 9.38 | 10.01 | 9.01 | — | 9.11 |
| | UM1 | 11.65 | — | — | 12.66 | — | 12.57 | 12.35 | 12.44 | 12.24 | 11.86 |
| | UM2 | 11.84 | — | — | 12.97 | — | 12.51 | — | 12.97 | — | 11.71 |
| | LI1 | 6.09 | — | — | 5.97 | — | 6.21 | — | — | — | — |
| | LI2 | — | — | — | 6.44 | — | 7.04 | 6.24 | 6.30 | — | 5.34 |
| | LC | 8.04 | — | — | 8.01 | — | 7.87 | 7.56 | 8.28 | 8.89 | 7.38 |
| | LP1 | 8.53 | — | 9.79 | 7.93 | — | 8.22 | 8.40 | 8.29 | 10.17 | 7.57 |
| | LP2 | 8.82 | — | 10.30 | 8.03 | — | 8.71 | 9.37 | 8.09 | 10.43 | 8.23 |
| | LM1 | 11.03 | — | — | 10.94 | — | 10.94 | 11.28 | 12.23 | 12.10 | 9.95 |
| | LM2 | 11.18 | — | — | 10.97 | — | 10.23 | 11.16 | 12.25 | 12.10 | 10.56 |
| shovelling | UI1 | — | 0.2 | — | 0.69 | — | 0.2 | — | — | — | — |
| shovelling | UI2 | — | 0.4 | — | 0.4 | — | 0.2 | — | — | — | — |
| double shovelling | UI1 | — | 0 | — | 0 | — | 0 | — | 0 | — | — |
| double shovelling | UI2 | — | 0 | — | 0 | — | 0 | — | 0 | — | — |
| dental tubercle | UI1 | — | — | — | 0 | — | — | — | — | — | — |
| dental tubercle | UI2 | — | 0 | — | 0 | — | 0 | — | — | — | — |
| spine | UI1 | — | — | — | 0 | — | — | — | — | — | — |
| interruption groove | UI2 | — | 0 | — | 0 | — | — | — | — | — | — |
| winging (bilateral) | UI1 | 0 | — | — | 2 | — | 2 | — | 1 | — | — |
| De Terra's tubercle | UP1 | 0 | — | — | 0 | — | 0 | — | — | — | 0 |
| double rooted | UP1 | — | — | — | — | — | — | — | — | — | — |
| double rooted | UP2 | — | — | — | — | — | 1 | — | — | — | — |
| Carabelli's trait | UM1 | 0 | 0 | — | 0 | — | 0 | 0 | — | — | 0 |
| hypocone reduction | UM2 | 2 | — | — | 3 | — | 2 | — | 2 | — | 0 |
| sixth cusp | LM1 | 0 | 0 | — | 0 | — | 0 | — | — | — | 1 |
| seventh cusp | LM1 | 0 | 0 | — | 0 | — | — | — | — | — | 0 |
| protostylid | LM1 | 0 | 0 | — | 0 | — | — | — | 0 | — | 0 |
| deflecting wrinkle | LM1 | — | 2 | — | — | — | — | — | — | — | 0 |
| groove pattern Y | LM1 | — | 5 | — | 2 | — | — | — | — | — | — |
| groove pattern X | LM2 | — | — | — | 2 | — | 3 | — | — | — | 2 |
| number of cusps | LM2 | 5 | — | — | 5 | — | — | — | — | — | 6 |

U: Upper, L: Lower, I: Incisor, C: Canine, P: Premolar, M: Moler

# 14
# Morphometric Records of the Liyupo Human Limb Bones

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This chapter provides the metric data of the major long bones of upper and lower limbs, together with shaft diameter indices and proportions of long bone lengths of the Liyupo people.

The skeletal measurements were taken from six segments of long bones, consisting of the humerus, radius, ulna, femur, tibia, and fibula following the method of Martin and Saller[1]. The measurements were recorded for only one side per segment. Regarding incomplete long bones, when a certain part of the proximal and/or distal end was missing, the maximum length was estimated using the formulae of Wright and Vasquez[2], regression equations based specific landmarks, to estimate total lengths of long bones. The measurements are given in Tables 14-1 and 14-2.

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Table 14-1. Upper limb bone measurements (mm) recorded for the Liyupo series.

| Sample No. | M1 | M2 | M3 | M6 | M7 | M8 | M16 | M17 | M19 | M22 | M23 | M24 | M26 | M27 | M28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | F | F | F | M | F | F | F | F | M | F | F | M | M | M | F |
| Humerus | L | L | R | L | — | — | L | L | R | L | L | R | L | R | R |
| 1. Max. length | — | — | — | — | — | — | *296* | 285 | — | 266 | — | 303 | 315 | — | — |
| 2. Total length | — | — | — | — | — | — | — | 283 | — | 264 | — | 297 | 310 | — | — |
| 4. Bi-epicondylar width | 56 | 51 | — | 58 | — | — | — | 54 | — | 51 | 49 | 59 | 57 | 63 | 56 |
| 5. Max. mid-shaft diameter | — | 18 | 20 | 23 | — | — | 22 | 20 | 23 | 18 | 18 | 21 | 22 | — | — |
| 6. Min. mid-shaft diameter | — | 16 | 15 | 17 | — | — | 15 | 14 | 16 | 13 | 13 | 15 | 15 | — | — |
| 9. Transv. head diameter | — | — | — | — | — | — | 40 | 35 | — | 34 | — | 39 | 39 | — | 39 |
| 10. Max. sagittal head diameter | — | — | 40 | — | — | — | 43 | 38 | — | 38 | — | 41 | 43 | — | 38 |
| 6/5. Mid-shaft cross-section index | — | 88.9 | 75.0 | 73.9 | — | — | 68.2 | 70.0 | 69.6 | 72.2 | 72.2 | 71.4 | 68.2 | — | — |
| 9/10. Head cross-section index | — | — | — | — | — | — | 93.0 | 92.1 | — | 89.5 | — | 95.1 | 90.7 | — | 102.6 |
| Radius | L | — | R | R | — | L | R | — | — | — | — | L | — | R | — |
| 1. Max. length | — | — | — | — | — | — | — | — | — | — | — | 238 | — | 242 | — |
| 4. Max. Transv. shaft diameter | 14 | — | 14 | 12 | — | 17 | 15 | — | — | — | — | 16 | — | 17 | — |
| 5. Sagittal shaft diameter | 12 | — | 11 | 10 | — | 12 | 11 | — | — | — | — | 11 | — | 11 | — |
| 5/4. Mid-shaft cross-section index | 85.7 | — | 78.6 | 83.3 | — | 70.6 | 73.3 | — | — | — | — | 68.8 | — | 64.7 | — |
| Ulna | L | L | R | R | L | — | R | L | R | — | R | L | — | R | — |
| 1. Max. length | — | — | — | 259 | — | — | — | — | — | — | — | — | — | — | — |
| 2. Physiological length | — | — | — | 227 | — | — | — | — | — | — | — | — | — | — | — |
| 6. Olecranon breadth | 24 | 23 | — | 26 | — | — | — | 20 | 25 | — | 22 | 24 | — | 28 | — |
| 11. Dorso-ventral shaft diameter | 13 | 12 | 11 | 14 | 12 | — | 11 | — | — | — | — | 10 | — | 12 | — |
| 12. Transv. shaft diameter | 14 | 14 | 13 | 15 | 13 | — | 14 | — | — | — | — | 12 | — | 14 | — |
| 11/12. Shaft cross-section index | 92.9 | 85.7 | 84.6 | 93.3 | 92.3 | — | 78.6 | — | — | — | — | 83.3 | — | 85.7 | — |

*Italic:* estimated value via formulae from Wright and Vasquez (2003), (M16: H0–H6: 282 mm)

M=Male, F=Female, R=Right, L=Left

Table 14-1 (continued).

| Sample No. | M29 | M30 | M34 | M35 | M37 | M38 | Liyupo Average | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | M | F | M | M | M | F | Males | | | Females | | |
| Humerus | L | L | R | L | L | R | n | Mean | SD | n | Mean | SD |
| 1. Max. length | 298 | 304 | — | 318 | — | 279 | 4 | 308.5 | 9.5 | 5 | 286.0 | 14.8 |
| 2. Total length | 293 | 299 | — | 312 | — | 274 | 4 | 303.0 | 9.4 | 4 | 280.0 | 14.9 |
| 4. Bi-epicondylar width | 54 | 57 | 59 | 62 | 56 | — | 8 | 58.5 | 3.0 | 7 | 53.4 | 3.1 |
| 5. Max. mid-shaft diameter | 19 | 21 | 23 | 20 | — | 17 | 7 | 21.6 | 7.8 | 8 | 19.3 | 1.8 |
| 6. Min. mid-shaft diameter | 17 | 17 | 16 | 18 | — | 12 | 7 | 16.3 | 1.1 | 8 | 14.4 | 1.7 |
| 9. Transv. head diameter | 40 | 39 | — | 41 | — | 36 | 4 | 39.8 | 1.0 | 6 | 37.2 | 2.5 |
| 10. Max. sagittal head diameter | 42 | 40 | — | 44 | — | — | 4 | 42.5 | 1.3 | 6 | 39.5 | 2.0 |
| 6/5. Mid-shaft cross-section index | 89.5 | 81.0 | 69.6 | 90.0 | — | 70.6 | 7 | 76.0 | 9.5 | 8 | 74.8 | 6.9 |
| 9/10. Head cross-section index | 95.2 | 97.5 | — | 93.2 | — | — | 4 | 93.6 | 2.1 | 5 | 94.9 | 5.2 |
| Radius | L | — | R | L | — | R | n | Mean | SD | n | Mean | SD |
| 1. Max. length | — | — | — | 251 | — | 219 | 3 | 243.7 | 6.7 | 1 | 219.0 | — |
| 4. Max. Transv. shaft diameter | 15 | — | 12 | 17 | — | 12 | 6 | 14.8 | 2.3 | 5 | 14.4 | 1.8 |
| 5. Sagittal shaft diameter | 10 | — | 10 | 13 | — | 8 | 6 | 10.8 | 1.2 | 5 | 10.8 | 1.6 |
| 5/4. Mid-shaft cross-section index | 66.7 | — | 83.3 | 76.5 | — | 66.7 | 6 | 73.9 | 8.3 | 5 | 75.0 | 7.4 |
| Ulna | L | L | R | L | L | — | n | Mean | SD | n | Mean | SD |
| 1. Max. length | — | — | — | — | — | — | 1 | 259.0 | — | 0 | — | — |
| 2. Physiological length | — | — | — | 240 | — | — | 2 | 233.5 | 9.2 | 0 | — | — |
| 6. Olecranon breadth | 25 | 25 | 26 | 26 | 23 | — | 8 | 25.4 | 1.5 | 5 | 22.8 | 1.9 |
| 11. Dorso-ventral shaft diameter | — | 13 | 12 | 14 | — | — | 5 | 12.4 | 1.7 | 6 | 12.0 | 0.9 |
| 12. Transv. shaft diameter | — | 14 | 16 | 17 | — | — | 5 | 14.8 | 1.9 | 6 | 13.7 | 0.5 |
| 11/12. Shaft cross-section index | — | 92.9 | 75.0 | 82.4 | — | — | 5 | 83.9 | 6.6 | 6 | 87.8 | 5.9 |

M=Male, F=Female, R=Right, L=Left

Table 14-2. Lower limb bone measurements (mm) and indicies recorded for the Liyupo series.

| Sample No. | M1 | M2 | M3 | M7 | M8 | M15 | M16 | M17 | M22 | M24 | M26 | M27 | M28 | M30 | M32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | F | F | F | F | F | F | F | F | F | M | M | M | F | F | F |
| Femur | R | R | L | L | L | R | L | L | L | L | L | R | R | R | R |
| 1. Max. length | — | — | — | 415 | 432 | 405 | — | — | — | 407 | — | *395* | *456* | — | — |
| 2. Physiological length | — | — | — | 415 | 430 | 404 | — | — | — | 406 | — | — | — | — | — |
| 6. Sagittal mid-shaft diameter | 27 | 26 | 25 | 29 | 27 | 28 | 26 | — | 24 | 28 | 31 | 28 | 27 | 29 | 28 |
| 7. Transv. mid-shaft diameter | 23 | 24 | 22 | 24 | 25 | 22 | 24 | — | 23 | 24 | 23 | 26 | 22 | 26 | 23 |
| 9. Transv. proximal shaft diameter | 28 | 28 | 27 | 28 | 31 | 27 | — | 29 | 26 | 28 | 28 | 29 | 30 | — | — |
| 10. Sagittal proximal shaft diameter | 22 | 22 | 22 | 21 | 24 | 22 | — | 23 | 21 | 22 | 23 | 26 | 21 | — | — |
| 18. Vertical head diameter | — | — | — | 43 | 45 | 38 | — | 40 | 38 | 44 | 43 | — | 42 | 43 | — |
| 19. Sagittal head diameter | — | — | — | — | 44 | 38 | — | 40 | 38 | 43 | 43 | — | 41 | 43 | — |
| 21. Bicondylar width | — | — | — | — | — | 68 | 71 | — | — | 74 | — | — | — | 72 | — |
| 6/7. Mid-shaft cross-section index (Pilastric) | 117 | 108 | 114 | 121 | 108 | 127 | 108 | — | 104 | 117 | 135 | 108 | 123 | 112 | 122 |
| 9/10. Prox. shaft cross-section index (Platymeric) | 127 | 127 | 123 | 133 | 129 | 123 | — | 126 | 124 | 127 | 122 | 112 | 143 | — | — |
| 19/18. Head cross-section index | — | — | — | — | 98 | 100 | — | 100 | 100 | 98 | 100 | — | 98 | 100 | — |
| Tibia | — | R | R | R | L | R | L | — | L | L | L | R | R | L | R |
| 1. Total length | — | — | — | *337* | — | 341 | — | — | — | 338 | — | 345 | — | — | — |
| 1a. Max. length | — | — | — | — | — | 335 | — | — | — | 332 | — | 338 | — | — | — |
| 3. Epicondylar breadth | — | — | — | — | — | 65 | — | — | — | 71 | — | — | — | — | — |
| 8. Max. sagittal mid-shaft diameter | — | — | — | 27 | 30 | 25 | 25 | — | 25 | 26 | 27 | 29 | 26 | — | — |
| 9′. Transv. mid-shaft diameter | — | — | — | 17 | 21 | 19 | 20 | — | 18 | 18 | 18 | 24 | 18 | — | — |
| 8a. Max. sagit. Diam. at nutrient foramen | — | 31 | — | 33 | 35 | 37 | 28 | — | — | 31 | — | 31 | 30 | 29 | 30 |
| 9a′. Transv. diameter at nutrient foramen | — | 21 | 20 | 22 | 23 | 21 | 20 | — | — | 22 | — | 23 | 23 | 22 | 24 |
| 9′/8. Mid-shaft cross-section index | — | — | — | 63 | 70 | 76 | 80 | — | 72 | 69 | 67 | 83 | 69 | — | — |
| 9a′/8a. Shaft cross-section index | — | 68 | — | 67 | 66 | 57 | 71 | — | — | 71 | — | 74 | 77 | 76 | 80 |
| Fibula | — | — | ? | R | R | ? | L | — | — | R | — | — | — | — | — |
| 1. Max. length | — | — | — | — | — | — | — | — | — | 330 | — | — | — | — | — |
| 2. Max. mid-shaft diameter | — | — | 16 | 18 | 18 | 13 | 13 | — | — | 15 | — | — | — | — | — |
| 3. Min. mid-shaft diameter | — | — | 10 | 11 | 14 | 9 | 9 | — | — | 11 | — | — | — | — | — |
| 3/2. Mid-shaft cross-section index | — | — | 63 | 61 | 78 | 69 | 69 | — | — | 73 | — | — | — | — | — |

*Italic:* estimated values via formulae from Wright and Vasquez (2003), (M7: T1–T6: 305 mm, M27: F2–F6: 323 mm, M28: F2–F6: 376 mm)
M=Male, F=Female, R=Right, L=Left

Table 14-2 (continued).

| Sample No. | M34 | M35 | M36 | M37 | M38 | M39 | Li Yu Po Average | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | M | M | M | M | F | F | | Males | | | Females | |
| Femur | R | R | L | L | L | L | n | Mean | SD | n | Mean | SD |
| 1. Max. length | — | 443 | — | — | 400 | 421 | 3 | 414.9 | 25.5 | 6 | 421.5 | 12.7 |
| 2. Physiological length | — | 440 | — | — | 399 | 416 | 2 | 423.0 | 24.0 | 5 | 412.8 | 12.0 |
| 6. Sagittal mid-shaft diameter | 29 | 29 | 28 | 29 | 21 | 26 | 7 | 28.9 | 1.1 | 13 | 26.4 | 2.2 |
| 7. Transv. mid-shaft diameter | 23 | 26 | 23 | 25 | 21 | 24 | 7 | 24.3 | 1.4 | 13 | 23.3 | 1.4 |
| 9. Transv. proximal shaft diameter | 30 | 30 | 27 | 28 | 28 | 29 | 7 | 28.6 | 1.1 | 11 | 28.3 | 1.4 |
| 10. Sagittal proximal shaft diameter | 23 | 23 | 23 | 22 | 21 | 22 | 7 | 23.1 | 1.3 | 11 | 21.9 | 0.9 |
| 18. Vertical head diameter | 43 | 46 | 42 | — | 40 | 41 | 5 | 43.6 | 1.5 | 9 | 41.1 | 2.4 |
| 19. Sagittal head diameter | 44 | 46 | 41 | — | 39 | 41 | 5 | 43.4 | 1.8 | 8 | 40.5 | 2.2 |
| 21. Bicondylar width | — | 82 | — | — | 66 | 71 | 2 | 78.0 | 5.7 | 5 | 69.6 | 2.5 |
| 6/7. Mid-shaft cross-section index (Pilastric) | 126 | 112 | 122 | 116 | 100 | 108 | 7 | 119.2 | 9.2 | 13 | 113.3 | 8.1 |
| 9/10. Prox. shaft cross-section index (Platymeric) | 130 | 130 | 117 | 127 | 133 | 132 | 7 | 123.7 | 7.2 | 11 | 129.1 | 6.0 |
| 19/18. Head cross-section index | 102 | 100 | 98 | — | 98 | 100 | 5 | 99.5 | 1.9 | 8 | 99.1 | 1.2 |
| Tibia | R | L | L | L | L | L | n | Mean | SD | n | Mean | SD |
| 1. Total length | — | 361 | — | — | 327 | 343 | 3 | 348.0 | 11.8 | 4 | 337.0 | 7.1 |
| 1a. Max. length | — | 357 | — | — | 321 | 346 | 3 | 342.3 | 13.1 | 3 | 334.0 | 12.5 |
| 3. Epicondylar breadth | 74 | 79 | 67 | — | 64 | 66 | 4 | 72.8 | 5.1 | 3 | 65.0 | 1.0 |
| 8. Max. sagittal mid-shaft diameter | — | 30 | 27 | — | 21 | 28 | 5 | 27.8 | 1.6 | 8 | 25.9 | 2.6 |
| 9′. Transv. mid-shaft diameter | — | 22 | 19 | — | 16 | 17 | 5 | 20.2 | 2.7 | 8 | 18.3 | 1.7 |
| 8a. Max. sagit. Diam. at nutrient foramen | 35 | 33 | 28 | 31 | 24 | 33 | 6 | 31.5 | 2.3 | 10 | 31.0 | 3.7 |
| 9a′. Transv. diameter at nutrient foramen | 21 | 25 | 20 | 25 | 18 | 19 | 6 | 22.7 | 2.1 | 11 | 21.2 | 1.8 |
| 9′/8. Mid-shaft cross-section index | — | 73 | 70 | — | 76 | 61 | 5 | 72.5 | 6.2 | 8 | 70.9 | 6.6 |
| 9a′/8a. Shaft cross-section index | 60 | 76 | 71 | 81 | 75 | 58 | 6 | 72.2 | 6.9 | 10 | 69.3 | 7.9 |
| Fibula | R | R | — | — | L | ? | n | Mean | SD | n | Mean | SD |
| 1. Max. length | 336 | — | — | — | — | — | 2 | 333.0 | 4.2 | 0 | — | — |
| 2. Max. mid-shaft diameter | 17 | 17 | — | — | 12 | 17 | 3 | 16.3 | 1.2 | 7 | 15.3 | 2.6 |
| 3. Min. mid-shaft diameter | 10 | 12 | — | — | 8 | 9 | 3 | 11.0 | 1.0 | 7 | 10.0 | 2.0 |
| 3/2. Mid-shaft cross-section index | 59 | 71 | — | — | 67 | 53 | 3 | 67.6 | 7.7 | 7 | 65.6 | 7.8 |

M=Male, F=Female, R=Right, L=Left

# 15
# The Origin of Early Holocene Hunter-Gatherers at Huiyaotian and Liyupo in Guangxi, Southern China: Craniometric Perspective

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The aim of this chapter is to record the quantitative morphology of the cranial series from Huiyaotian and Liyupo as represented by cranial measurements and to explore their biological relationships to surrounding populations from prehistoric to modern times. An assessment of the morphometric affinities presented here addresses the issue of the origin of the prehistoric hunter-gatherers who settled in Guangxi Province, Southern China.

## MATERIALS AND METHODS

Of the 58 burials excavated from Huiyaotian and the 39 from Liyupo during the 2008 and 2013 seasons, the skulls of 34 adult individuals are in relatively good condition and were utilized for cranio-metric analysis. Cranial and mandibular measurements were taken for these individuals (Huiyaotian: 13 males, 9 females; Liyupo: 7 males, 5 females), following Martin's measurement definitions (Bräuer[1]) (row data given in Chapters 6 and 12). Representative male skulls are exhibited in Figures 15-1 and 15-2. Table 15-1 gives the average data sets for the Huiyaotian and Liyupo series, generated from basic statistics of the cranial and mandibular measurements and indices. In order to utilize the greatest number of individual specimens under conditions of variable preservation, sixteen male cranial measurements (Martin's: M1, M8, M9, M17, M43(1), M43c, M45, M46b, M46c, M57, M57a, M48, M51, M52, M54, M55) were selected for calculating the Q-mode correlation coefficient (Sneath and Sokal[2] ). The compared samples are listed in Table 15-2, which includes both archaeological populations and modern samples from East/Southeast Asia and the Pacific. To aid in the interpretation of phenotypic affinities between the samples, un-rooted tree diagrams were created using the Neighbor Joining method (Saitou and Nei[32]) applied to the distance (1-r) matrix of the Q-mode correlation coefficients (r). This procedure was undertaken using the software package "Splits Tree Version 4.0" provided by Huson and

Figure 15-1. Views of the representative skulls from Huiyaotian.

Figure 15-2. Views of the representative skulls from Liyupo.

Bryant[33]).

## RESULTS

Table 15-3 gives the distance matrix (1-r) transformed from the Q-mode correlation coefficients (r) computed using sixteen male cranial data sets. Figure 15-3 depicts the results from the neighbor-joining method applied to the distances of this distance

Table 15-1. Cranial and mandibular measurements (mm) and indices for the Huiyaotian and Liyupo series.

| Martin's No and measurement | Huiyaotian (males) | | | Huiyaotian (females) | | | Liyupo (males) | | | Liyupo (females) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | M | SD | n | M | SD | n | M | SD | n | M | SD |
| 1 Max. cranial length | 8 | 196.6 | 8.4 | 5 | 202.2 | 8.8 | 4 | 187.3 | 5.9 | 3 | 184.3 | 8.4 |
| 5 Basion-nasion length | 2 | 105.0 | 4.2 | 2 | 99.0 | 1.4 | — | — | — | 3 | 101.3 | 5.1 |
| 8 Max. cranial breadth | 7 | 137.3 | 7.4 | 2 | 135.0 | 7.1 | 4 | 136.0 | 4.3 | 3 | 133.3 | 4.2 |
| 9 Min. frontal breadth | 5 | 97.6 | 5.8 | 5 | 97.2 | 5.3 | 6 | 97.4 | 5.7 | 4 | 98.1 | 3.5 |
| 10 Max. frontal breadth | 3 | 116.1 | 3.0 | 2 | 114.5 | 3.5 | 4 | 114.9 | 3.0 | 3 | 112.3 | 4.9 |
| 12 Max. occipital breadth | 2 | 112.0 | 1.4 | 0 | — | — | 4 | 112.5 | 3.3 | 3 | 108.5 | 6.7 |
| 17 Basion-bregma height | 2 | 138.5 | 4.9 | 3 | 143.0 | 10.6 | 0 | — | — | 3 | 132.3 | 5.5 |
| 29 Frontal chord | 3 | 108.9 | 19.1 | 2 | 108.6 | 2.3 | 2 | 111.5 | 8.4 | 3 | 107.1 | 5.3 |
| 30 Parietal chord | 1 | 122.0 | — | 2 | 124.1 | 2.6 | 2 | 122.3 | 12.3 | 2 | 115.8 | 7.5 |
| 31 Occipital chord | 1 | 99.0 | — | 1 | 100.3 | — | 3 | 96.5 | 10.5 | 2 | 106.9 | 4.5 |
| 40 Basion-prosthion length | 2 | 100.9 | 0.2 | 1 | 102.0 | — | 0 | — | — | 3 | 99.7 | 4.0 |
| 43 Upper facial breadth | 4 | 112.2 | 1.7 | 5 | 111.0 | 6.9 | 4 | 112.0 | 2.8 | 4 | 109.9 | 2.9 |
| 45 Bizygomatic breadth | 3 | 142.3 | 2.1 | 4 | 142.0 | 2.8 | 2 | 142.4 | 0.5 | 2 | 131.6 | 7.6 |
| 46 Bimaxillary breadth | 4 | 104.2 | 3.4 | 4 | 105.5 | 2.5 | 3 | 105.8 | 1.0 | 4 | 101.2 | 6.0 |
| 48 Upper facial height | 4 | 66.5 | 1.6 | 6 | 66.9 | 4.2 | 3 | 65.8 | 2.7 | 3 | 62.0 | 1.8 |
| 51 Orbital breadth | 7 | 43.9 | 1.5 | 4 | 42.5 | 2.8 | 3 | 43.3 | 0.5 | 3 | 40.7 | 1.2 |
| 52 Orbital height | 7 | 34.2 | 2.1 | 5 | 33.8 | 3.6 | 4 | 33.5 | 2.2 | 3 | 33.8 | 1.3 |
| 54 Nasal breadth | 7 | 29.6 | 2.1 | 6 | 28.0 | 1.4 | 4 | 27.9 | 3.6 | 4 | 26.6 | 2.0 |
| 55 Nasal height | 5 | 50.2 | 1.8 | 5 | 50.8 | 1.6 | 3 | 46.8 | 1.1 | 3 | 45.7 | 2.1 |
| 60 Upper alveolar length | 1 | 51.0 | — | 2 | 60.8 | 0.3 | 2 | 58.3 | 0.4 | 2 | 54.5 | 1.5 |
| 61 Upper alveolar breadth | 2 | 64.8 | 1.1 | 2 | 65.9 | 1.5 | 2 | 69.7 | 0.2 | 2 | 63.0 | 1.4 |
| 8:1 Cranial index | 6 | 70.9 | 4.8 | 1 | 67.3 | — | 4 | 72.6 | 1.6 | 3 | 72.4 | 1.1 |
| 48:45 Upper facial index | 3 | 47.0 | 1.8 | 4 | 48.6 | 1.7 | 2 | 47.2 | 1.3 | 1 | 48.3 | — |
| 43(1) Frontal chord | 5 | 102.2 | 3.7 | 3 | 100.1 | 5.4 | 4 | 101.5 | 2.4 | 2 | 100.5 | 3.6 |
| 43c Frontal subtense | 5 | 19.6 | 4.8 | 3 | 12.1 | 6.9 | 4 | 14.9 | 8.6 | 2 | 19.2 | 9.4 |
| 57 Simotic chord | 8 | 9.7 | 1.2 | 3 | 11.3 | 1.6 | 1 | 6.3 | — | 2 | 10.4 | 0.0 |
| 57a Simotic subtense | 8 | 3.0 | 1.2 | 3 | 2.7 | 0.3 | 1 | 2.4 | — | 2 | 3.9 | 0.0 |
| 46b Zygomaxillary chord | 3 | 102.9 | 3.0 | 3 | 104.4 | 3.9 | 3 | 102.1 | 6.4 | 3 | 99.6 | 7.4 |
| 46c Zygomaxillary subtense | 3 | 22.0 | 5.6 | 3 | 21.6 | 12.9 | 3 | 20.5 | 5.9 | 2 | 26.2 | 6.1 |
| 43c:43(1) Frontal index | 5 | 19.2 | 4.9 | 3 | 12.1 | 6.8 | 4 | 14.6 | 8.1 | 2 | 19.2 | 10.0 |
| 57a:57 Simotic index | 8 | 30.9 | 11.3 | 3 | 24.7 | 5.9 | 1 | 38.8 | — | 2 | 37.5 | 0.0 |
| 46c:46b Zygomaxillary index | 3 | 21.5 | 6.1 | 3 | 20.4 | 11.8 | 3 | 20.1 | 5.5 | 3 | 16.9 | 14.9 |
| 66 Bigonial breadth | 4 | 105.9 | 11.7 | 2 | 97.5 | 3.0 | 2 | 109.7 | 2.0 | 2 | 97.0 | 4.2 |
| 68 Mandibular length | 5 | 86.0 | 1.8 | 3 | 85.4 | 4.4 | 3 | 80.9 | 3.5 | 2 | 81.1 | 0.1 |
| 69 Symphyseal height | 7 | 35.6 | 2.6 | 4 | 34.9 | 1.8 | 5 | 35.2 | 3.0 | 3 | 29.5 | 3.4 |
| 70 Ramus height | 3 | 64.8 | 3.7 | 3 | 60.8 | 3.5 | 3 | 61.5 | 1.8 | 1 | 57.5 | — |
| 71 Ramus breadth | 6 | 40.7 | 3.3 | 4 | 41.7 | 5.7 | 6 | 38.0 | 3.7 | 3 | 35.9 | 1.6 |

Table 15-2. Comparative cranial samples from Northeast/Southeast Asia and Oceania.

| | Locality | Period | Data Source | Storage | Remark |
|---|---|---|---|---|---|
| ***Pre-Neolithic*** | | | | | |
| Liujinag | China | Late Pleistocene | Woo[3] | | M43(1),43c,46b,46c,57,57a (cast). by H.M. |
| Zengpiyan | China | Mesolithic c. 8000BP | IACAS, ATGZM, ZM, and ATGC[4] | | Guilin, Guangxi Region |
| Hoabinhian Vietnam | Vietnam | Late Pleistocene-Early Holocene | H.M. | IAH<br>MHO | Sites of Mai Da Nuoc, Mai Da Dieu, Lang Gao, Lang Bon in northern Vietnam (Cuong[5][6]) |
| Bac Son | Vietnam | Early Holocene (c. 8,000-7,000 BP) | H.M. | MHO | Sites of Pho Binh Gia, Lang Cuom, Cua Gi, Dong Thuoc in northern Vietnam |
| Con Co Ngua | Vietnam | Da But Culture (c.5,000-6,000 BP) | Cuong[7] | IAH<br>MHO | Than Hoa Prov. northern Vietnam; M43(1),43c,46b,46c,57,57a by H.M. |
| Gua Cha | Malaysia | Hoabinhian (c.8,000-6,000 BP) | H.M. | UCB | Site in Kelantan Prov., Malaysia; specimen No. H12; Sieveking[8] |
| ***Neolithic*** | | | | | |
| Baligan 八里崗 | China | Neolithic (c.7,000-5,000 BP), Yangshao (仰韶) Culture | H.M. | PKU | Site in Henan Prov. 河南省 |
| Weidun 圩墩 | China | Neolithic (c.7,000-5,000 BP), Majiabang (馬家浜) Culture | Nakahashi and Li[9] | | Sites in Jiangsu Prov. 江蘇省 |
| Jiahu 賈湖 | China | Neolithic (c. 8,000 BP) | H.M. | HEPICA | Site in Henan Prov. 河南省 (HPIAC[10][11]) |
| Xipo 西坡 | China | Neolithic (c. 5,300 BP), Yangshao (仰韶) Culture | H.M. | HEPICA | Site in Henan Prov. 河南省 Central China (IACAS and HPIAC[12]) |
| Hemudu 河姆渡 | China | Neolithic (c. 6,300 BP), Hemudu (河姆渡) Culture | H.M. | HEMSM | Site in Zhejiang Province 浙江省, Yangzi Delta region (ZCARI[13]) |
| Man Bac 1 | Vietnam | Late Neolithic (c. 3800-3500 BP) | H.M. | IAH | Ninh Binh Province; see text for additional discussion |
| Man Bac 2 | Vietnam | Same as above | Same as above | IAH | Same as above |
| Ban Chiang | Thai | Neolithic-Bronze Age (c. 3,500-1,800 BP) | Pietrusewsky and Douglas[14] | UHW<br>SAC | Site in Udon Thani Prov., Thailand; M51by Hanihara[15]; M43(1),43c,46b,46c,57,57a by H.M. |
| An Son | | Late Neolithic (c.3800 BP) | H.M. | LAPM | Long An Province; Cuong[16] |
| Jomon | Japan | Neolithic (c. 5,000-2,300 BP) | Hanihara[15][17] | | Sites in Japan; Yamaguchi[18] |
| Neolithic Baikal | Russia | Ishida[19] | Neolithic | | |

Storage: institutions whose materials were studied by Matsumura for unpublished data: AST=Academia Sinica of the Republic of China in Taipei; BMNH=Department of Paleontology, Natural History Museum, London; CAM=Department of Biological Anthropology, University of Cambridge; CSPH=Center for South East Asian Prehistory, Hanoi; HEMSM=Hemudu Site Museum; HEPICA=Henan Provincial Institute of Cultural Relics and Archaeology; IAH=Department of Anthropology, Institute of Archaeology, Hanoi; LAPM=Long An Provincial Museum, Vietnam; MHO=Laboratoire d'Anthropologie Biologique, Musée de l'Homme, Paris; NMP=Department of Archaeology, National Museum of the Philippines, Manila; NTW=Department of Anatomy, National Taiwan University; SAC=Princess Maha Chakri Sirindhorn Anthropology Centre, Bangkok; UHW=Department of Anthropology, University of Hawaii, UNLV: Department of Anthropology, University of Nevada, USA. USYD: Department of Anatomy, University of Sydney

Table 15-2 (continued).

| | Locality | Period | Data Source | Storage | Remark |
|---|---|---|---|---|---|
| ***Bronze and Iron Age*** | | | | | |
| Yayoi | Japan | Yayoi Period (c. 800 BC–AD 300) | Nakahashi[20] | | Various sites in Northern Kyushu and Yamaguchi Districts |
| Jiangnan | China | Eastern Zhou–Former Han Periods (770 BC–AD 8) | Nakahashi and Li[9] | | Sites in Jiangnan Province along Lower Basin of Yangtze River, Sothern China |
| Jindushan 早都山 | China | Spring/Autumn Period (c.500 BC) | Beijing Cultural Relic Institute[21] | | Site in Yanqing Prefecture near Beijing |
| Dong Son | Vietnam | Early Metal Age (3,000–1,700 BP) | Cuong[22] and H.M. | IAH, CSPH | Sites of Vinh Quang, Chau Son, Doi Son, Quy Chu, Thieu Duong, Nui Nap, Dong Mom, Minh Duc, Dong Xa |
| Anyang | China | Bronze–Iron Age (c. 3,300 BP) | IHIA[23] 1982; Han & Qi[24] | AST | M43(1), 43c, 46b, 46c, 57, 57a by H.M. |
| ***more Modern*** | | | | | |
| Laos | | Modern | Cuong[20] | MHO | M43(1), 43c, 46b, 46c, 57, 57a by H.M. |
| Thai | | Modern | Sangvichien[25]; Hanihara[17] | MUB | |
| Myanmar | | Modern | Pietrusewsky[26]; Hanihara[17] | BMNH | M17, 45, 48, 51 by H.M. |
| Philippines | | Modern | Suzuki *et al.*[27] | NMP | M43(1), 43c, 46b, 46c, 57, 57a by H.M. |
| Hainan | | Modern | Howells[28] | NTW | M43(1), 43c, 46b, 46c, 48, 51, 55, 57, 57a by H.M |
| North China | | Modern | Hanihara[15][17] | | |
| South China (Hong Kong) | | Modern | H.M. | CAM | |
| Japan | | Modern | Hanihara[15][17] | | |
| Seman Negrito (Malaysia) | | Modern | H.M. | BMNH | |
| Australia | | | Hanihara[15] | BMNH | M43(1), 43c, 46b, 46c, 57, 57a by H.M. |
| Melanesia | | Modern | Hanihara[15][17] | | |
| Loyalty, New Britain, New Guinea Tolai, Veddah, Nicobal | | Modern | H.M. | CAM, USYD, MHO | |
| Cambodia, Vietnam | | Modern | Matsumura *et al.*[29] | | |
| Celebes, Java, Myanmar, South Moluccas, Sumatra | | Modern | Pietrusewsky[26], Hanihara[17] | BMNH, CAM | M17, 45, 48, 51 by H.M. |
| Seman Negrito (Malaysia) | | Modern | H.M. | BMNH | |
| Okhotsk | | AD c.400–1,000 | Ishida[30] | | |
| Aleut, Asian Eskimo, Buryat, Chukchi, Evenki, Hokkaido Ainu, Mongol, Nanay, Negidal, Nivkh, Troitskoe, Ulch, Yakut, Yukagir | | Modern | Ishida[19][31] | | |


Figure 15-3. A un-rooted tree of Neighbor Joining analysis applied to the distances of Q-mode correlation coefficients, between the Huiyaotian, Liyupo and comparative samples, based on 16 cranial measurements (males).

matrix. A non-rooted tree in this figure represents an apparent divergence into two major clusters at the top and bottom. These clusters are East Asians and many Southeast Asians ranging from the late Neolithic to modern times at the top and Australo-Melanesians and early Holocene Southeast Asians, including the Hoabinhian, at the bottom. Both the Huiyaotian and Liyupo are tightly connected with the early Vietnamese samples, including the Mesolithic Hoabinhian, Bac Son, and the Con Co Ngua of the Da But Culture. These samples form a mega cluster together with the Australo-Melanesian, Gua Cha Malay (Hoabinhian), and Neolithic Jomon (Japan) samples.

The majority of those Huiyaotian and Liyupo cranial specimens are characterized by a dolichocephalic cranium with a prominent glabella, straight orbital margins at the superior line, a concave nasal root (Figures 15-1 and 15-2), and a low wide face. These features differ significantly from the typical features of people in present day China who possess relatively narrow and flat faces with round orbits.

## DISCUSSION

Archaeological and linguistic research has linked the dispersal of Austronesian and Austroasiatic language families with the demographic expansion of rice cultivating people during the Neolithic period, and have sought the ultimate origin of these language and population dispersals in southern China and Taiwan (Renfrew;[34][35][36] Bellwood[37][38][39][40]; Bellwood, *et al.* [41]; Blust[42][43]; Glover and Higham[44]; Higham[45][46]; Bellwood and Renfrew[47]; Diamond and Bellwood[48]; and Zhang and Hung[49]). Based upon data from prehistoric human remains, the "Two Layer" model, has been supported as a scenario to understand the population history of mainland Southeast Asia (e.g., Callenfels[50]; Mijsberg[51]; Von Koenigswald[52]; Coon[53]; Jacob[54]; Brace, *et al.* [55]; Matsumura and Hudson[56]; and Matsumura[57]). It has been hypothesized that Southeast Asia was initially occupied by indigenous people related to present-day Australo-Melanesians and later exchanged or admixed genes with immigrants from North and/or East Asia, leading to the formation of present-day Southeast Asian populations.

Regarding cranial morphometric features, the pre-Neolithic Hoabinhian and Bac Son individuals, and the early Neolithic Da But individuals share dolichocephalic calvaria, large zygomatic bones, a remarkably prominent glabella, a concave nasal root and a low and wide face with prominent prognathism. On the other hand, the majority of later Neolithic and Metal Period people tend to possess an array of distinctive cranial features represented by relatively narrow and long faces, flat glabella and nasal roots, and round orbits. Such large discontinuity in cranial morphology between the pre-historic and early historic populations implies that the late Neolithic period may be regarded as a transition phase in terms of the micro-evolutionary history of mainland East/Southeast Asia. Multivariate analysis using the quantitative cranial morphology data set supports the view that the Bac Son and Con Co Ngua people are direct descendants of Hoabinhian settlers. The early hunter-gatherers who settled in northern Vietnam are contemporary with the Huiyaotian and Liyupo people in Guangxi, China. The Con Co Ngua site belongs to Da But Culture. Furthermore, the Huiyaotian and the Con Co Ngua shared common burial practices, represented by flexed "squatting" or so-called "seated" style and similar types of associated pottery. It is noteworthy that both the Huiyaotian and Liyupo bear cranial features in common with the Con Co Ngua and Da But Cultural people, exhibiting characteristics potentially inherited from the earlier Hoabinhian indigenous inhabitants. Taking this cranial affinity into consideration, it may be concluded that the Huiyaotian and Liyupo people were less affected by the substantial gene flow via diffusion of Northeast Asians from northern or eastern peripheral areas than by other contemporary Neolithic Chinese, such as the Jiahu (賈湖), Xipo (西坡) and Hemudu (河姆渡) peoples. The Huiyaotian and Liyupo specimens lend strong support to the "Two Layer" model, in which these early hunter-gatherers whose locality was more in northern (East Asia) than in mainland Southeast Asia, are the members of the first layer.

## SUMMARY

This chapter describes the morphometric affinities of the cranial series from Huiyaotian and Liyupo. Multivariate comparisons using cranial metrics demonstrate that the Huiyaotian and Liyupo series closely resemble the contemporary or earlier pre-Neolithic settlers of mainland Southeast Asia represented by Da But Cultural people of the Con Co Ngua and Hoabinhian Cultural people in Vietnam, and are dissimilar to the later Neolithic farming population in East Asia, which includes the majority of people in modern China. These early hunter-gatherers in Guangxi Province are regarded as members of first settlers of Homo sapiens akin to present-day Austro-Melanesians.

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Appendix Table. Distance (1-r) matricies of Q-mode correlation coefficients (r), based on 16 cranial measurements.

| | | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] | [11] | [12] | [13] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [1] | An Son | | | | | | | | | | | | | |
| [2] | Anyang | 0.555 | | | | | | | | | | | | |
| [3] | Australia | 1.608 | 1.628 | | | | | | | | | | | |
| [4] | Bac Son | 1.130 | 1.230 | 0.969 | | | | | | | | | | |
| [5] | Ban Chiang | 0.358 | 0.653 | 1.514 | 0.945 | | | | | | | | | |
| [6] | Cambodia | 1.209 | 0.949 | 1.305 | 1.359 | 1.176 | | | | | | | | |
| [7] | Celebes | 0.901 | 0.517 | 1.359 | 1.644 | 1.026 | 0.408 | | | | | | | |
| [8] | Con Co Ngua | 0.942 | 1.424 | 0.957 | 0.214 | 0.628 | 1.378 | 1.718 | | | | | | |
| [9] | Dong Son | 0.600 | 0.870 | 1.338 | 1.105 | 0.764 | 0.995 | 0.761 | 1.039 | | | | | |
| [10] | Gua Cha H12 | 1.562 | 1.377 | 0.442 | 0.628 | 1.271 | 1.337 | 1.672 | 0.737 | 1.298 | | | | |
| [11] | Hainan | 1.012 | 0.537 | 1.251 | 1.478 | 1.232 | 0.431 | 0.214 | 1.614 | 0.745 | 1.560 | | | |
| [12] | Hoabinhian | 1.248 | 0.993 | 0.930 | 0.186 | 1.118 | 1.504 | 1.576 | 0.596 | 1.171 | 0.453 | 1.467 | | |
| [13] | Japan | 0.907 | 0.358 | 1.322 | 1.324 | 0.842 | 0.659 | 0.318 | 1.486 | 1.130 | 1.403 | 0.334 | 1.267 | |
| [14] | Java | 0.953 | 0.705 | 1.284 | 1.501 | 1.063 | 0.400 | 0.097 | 1.547 | 0.894 | 1.687 | 0.321 | 1.567 | 0.335 |
| [15] | 前漢 Jiangnan | 0.675 | 0.426 | 1.425 | 1.388 | 0.999 | 0.513 | 0.254 | 1.484 | 0.874 | 1.708 | 0.156 | 1.466 | 0.306 |
| [16] | Jomon Japan | 0.855 | 1.047 | 1.085 | 1.085 | 0.764 | 1.204 | 1.203 | 0.839 | 1.029 | 0.718 | 1.589 | 1.004 | 1.407 |
| [17] | Lang Bon | 1.637 | 1.323 | 0.721 | 0.474 | 1.529 | 0.925 | 1.204 | 0.937 | 1.152 | 0.577 | 1.144 | 0.359 | 1.186 |
| [18] | Lang Gao | 1.163 | 0.826 | 0.979 | 0.447 | 0.881 | 1.417 | 1.345 | 0.712 | 1.094 | 0.675 | 1.164 | 0.334 | 0.839 |
| [19] | Laos | 1.171 | 1.220 | 1.066 | 1.479 | 1.339 | 0.408 | 0.591 | 1.354 | 1.237 | 1.368 | 0.835 | 1.498 | 1.106 |
| [20] | Liujiang | 1.384 | 1.273 | 0.903 | 0.829 | 1.190 | 1.104 | 1.306 | 0.722 | 1.077 | 0.516 | 1.407 | 0.769 | 1.465 |
| [21] | Loyalty | 1.380 | 1.263 | 0.498 | 0.666 | 1.415 | 1.482 | 1.372 | 0.863 | 1.273 | 0.602 | 1.112 | 0.586 | 0.945 |
| [22] | Mai Da Dieu 16 | 0.888 | 1.168 | 0.876 | 0.724 | 1.075 | 1.146 | 1.112 | 0.669 | 1.126 | 1.172 | 1.108 | 0.935 | 1.307 |
| [23] | Mai Da Nuoc | 1.129 | 1.304 | 0.625 | 0.865 | 1.013 | 1.486 | 1.667 | 0.808 | 1.035 | 0.326 | 1.672 | 0.630 | 1.693 |
| [24] | Man Bac 1 | 0.305 | 0.805 | 1.673 | 1.024 | 0.385 | 0.874 | 1.013 | 0.784 | 0.556 | 1.378 | 1.110 | 1.202 | 1.171 |
| [25] | Man Bac 2 | 1.188 | 1.034 | 1.117 | 0.655 | 0.687 | 0.995 | 1.337 | 0.538 | 0.879 | 0.514 | 1.432 | 0.716 | 1.306 |
| [26] | Melanesia | 1.577 | 1.342 | 0.345 | 0.773 | 1.499 | 1.167 | 1.178 | 0.975 | 1.495 | 0.682 | 0.972 | 0.769 | 0.811 |
| [27] | Myanmer | 1.117 | 0.679 | 1.237 | 1.612 | 1.120 | 0.424 | 0.109 | 1.655 | 0.834 | 1.531 | 0.217 | 1.556 | 0.275 |
| [28] | New Guinea Tolai | 1.635 | 1.408 | 0.232 | 1.043 | 1.638 | 1.229 | 1.274 | 1.047 | 1.557 | 0.546 | 1.053 | 0.921 | 1.187 |
| [29] | New Britain | 1.678 | 1.457 | 0.260 | 0.765 | 1.479 | 1.154 | 1.426 | 0.816 | 1.716 | 0.451 | 1.199 | 0.761 | 1.129 |
| [30] | Nicobar | 0.942 | 1.141 | 0.628 | 1.216 | 0.886 | 1.427 | 1.251 | 1.035 | 0.990 | 0.862 | 1.175 | 1.056 | 1.298 |
| [31] | Philippines | 0.952 | 0.778 | 1.171 | 1.543 | 1.252 | 0.601 | 0.441 | 1.598 | 1.018 | 1.234 | 0.705 | 1.359 | 0.879 |
| [32] | S.Moluccas | 1.074 | 0.760 | 0.960 | 1.378 | 1.129 | 0.902 | 0.358 | 1.425 | 0.702 | 1.265 | 0.447 | 1.311 | 0.538 |
| [33] | Semang Negritos | 1.226 | 1.216 | 0.686 | 1.036 | 1.240 | 0.551 | 0.788 | 1.016 | 1.342 | 1.120 | 0.791 | 1.353 | 0.747 |
| [34] | South | 0.392 | 0.177 | 1.617 | 1.529 | 0.676 | 0.801 | 0.349 | 1.598 | 0.792 | 1.587 | 0.441 | 1.355 | 0.351 |
| [35] | Sumatra | 1.246 | 0.928 | 0.998 | 1.182 | 1.359 | 0.738 | 0.420 | 1.418 | 0.701 | 1.362 | 0.368 | 1.125 | 0.588 |
| [36] | Thai | 0.842 | 0.428 | 1.540 | 1.589 | 1.034 | 0.231 | 0.161 | 1.676 | 0.959 | 1.616 | 0.214 | 1.541 | 0.334 |
| [37] | Veddah | 1.793 | 1.669 | 0.187 | 0.960 | 1.739 | 1.056 | 1.239 | 0.972 | 1.346 | 0.577 | 1.052 | 0.954 | 1.288 |
| [38] | Vietnam | 0.489 | 0.739 | 1.744 | 1.241 | 0.695 | 0.432 | 0.442 | 1.177 | 0.373 | 1.644 | 0.595 | 1.436 | 0.777 |
| [39] | 圩墩(常州) Weidun | 0.808 | 0.413 | 1.548 | 1.126 | 0.543 | 0.592 | 0.464 | 1.230 | 0.659 | 1.355 | 0.534 | 1.109 | 0.452 |
| [40] | Yayoi Japan | 0.472 | 0.359 | 1.554 | 0.973 | 0.283 | 1.001 | 0.651 | 0.911 | 0.734 | 1.410 | 0.779 | 1.097 | 0.473 |
| [41] | Nanay | 0.436 | 0.233 | 1.390 | 1.182 | 0.504 | 1.060 | 0.571 | 1.224 | 0.951 | 1.525 | 0.574 | 1.182 | 0.293 |
| [42] | Negidal | 0.359 | 0.356 | 1.541 | 1.041 | 0.474 | 0.871 | 0.563 | 1.043 | 0.780 | 1.587 | 0.666 | 1.206 | 0.515 |
| [43] | Oroch | 0.614 | 0.313 | 1.661 | 1.041 | 0.683 | 0.714 | 0.409 | 1.166 | 1.040 | 1.582 | 0.583 | 1.108 | 0.314 |
| [44] | Aleut | 0.544 | 0.655 | 1.405 | 1.034 | 0.718 | 0.935 | 0.652 | 1.020 | 1.049 | 1.442 | 0.899 | 1.171 | 0.613 |
| [45] | Asian Eskimo | 0.530 | 0.503 | 1.269 | 1.302 | 0.519 | 1.032 | 0.535 | 1.155 | 0.974 | 1.525 | 0.661 | 1.417 | 0.292 |
| [46] | Buryat | 0.533 | 0.410 | 1.570 | 1.216 | 0.667 | 0.704 | 0.433 | 1.230 | 0.867 | 1.560 | 0.599 | 1.291 | 0.474 |
| [47] | Chukchi | 0.478 | 0.467 | 1.367 | 1.242 | 0.511 | 1.035 | 0.521 | 1.124 | 0.934 | 1.560 | 0.691 | 1.358 | 0.329 |
| [48] | Evenki | 0.406 | 0.361 | 1.457 | 1.009 | 0.621 | 1.047 | 0.683 | 1.036 | 0.829 | 1.485 | 0.774 | 1.081 | 0.693 |
| [49] | Hokkaido Ainu | 1.239 | 1.050 | 0.832 | 1.017 | 1.215 | 1.256 | 0.871 | 1.042 | 1.102 | 0.925 | 1.011 | 0.938 | 0.793 |
| [50] | Mongol | 0.463 | 0.373 | 1.496 | 1.161 | 0.616 | 0.817 | 0.496 | 1.166 | 0.864 | 1.549 | 0.582 | 1.284 | 0.409 |
| [51] | Nivkh | 0.536 | 0.359 | 1.528 | 1.207 | 0.550 | 0.741 | 0.404 | 1.144 | 0.954 | 1.596 | 0.556 | 1.359 | 0.324 |
| [52] | Northern Chinese | 0.612 | 0.348 | 1.376 | 1.375 | 0.769 | 0.897 | 0.354 | 1.445 | 0.995 | 1.634 | 0.360 | 1.340 | 0.119 |
| [53] | Troitskoe | 0.306 | 0.225 | 1.669 | 1.000 | 0.403 | 0.927 | 0.676 | 1.037 | 0.967 | 1.534 | 0.775 | 1.085 | 0.458 |
| [54] | Ulch | 0.457 | 0.319 | 1.402 | 1.151 | 0.547 | 0.959 | 0.501 | 1.181 | 0.897 | 1.548 | 0.551 | 1.248 | 0.261 |
| [55] | Yakut | 0.461 | 0.259 | 1.514 | 1.145 | 0.521 | 0.920 | 0.511 | 1.144 | 0.856 | 1.558 | 0.614 | 1.223 | 0.385 |
| [56] | Yukagir | 0.473 | 0.322 | 1.519 | 1.032 | 0.479 | 0.976 | 0.603 | 0.999 | 0.782 | 1.490 | 0.681 | 1.136 | 0.543 |
| [57] | Neolithic Baikal | 0.593 | 0.405 | 1.272 | 1.035 | 0.721 | 1.222 | 0.685 | 1.076 | 0.828 | 1.370 | 0.756 | 1.021 | 0.631 |
| [58] | Okhotsk | 0.377 | 0.203 | 1.622 | 1.030 | 0.475 | 1.086 | 0.572 | 1.089 | 0.755 | 1.582 | 0.636 | 1.062 | 0.379 |
| [59] | 甑皮岩Zengpiyan | 1.079 | 0.870 | 0.978 | 0.606 | 1.034 | 1.184 | 1.230 | 0.787 | 1.668 | 1.010 | 1.048 | 0.616 | 0.756 |
| [60] | 西坡（河南）Xipo | 0.370 | 0.518 | 1.769 | 0.900 | 0.401 | 0.957 | 1.038 | 0.799 | 0.441 | 1.186 | 1.002 | 0.971 | 1.031 |
| [61] | 河姆渡Hemudu | 0.630 | 0.455 | 1.539 | 0.672 | 0.387 | 1.293 | 1.071 | 0.768 | 0.685 | 1.107 | 1.108 | 0.562 | 0.942 |
| [62] | 賈湖Jiahu | 0.345 | 0.215 | 1.682 | 1.301 | 0.614 | 0.808 | 0.473 | 1.405 | 0.558 | 1.567 | 0.441 | 1.258 | 0.359 |
| [63] | 早都山Jindushan | 0.339 | 0.220 | 1.713 | 1.232 | 0.538 | 0.975 | 0.657 | 1.255 | 0.866 | 1.554 | 0.558 | 1.160 | 0.390 |
| [64] | 八里崗 Baligan | 0.231 | 0.280 | 1.817 | 1.034 | 0.317 | 1.099 | 0.764 | 1.021 | 0.716 | 1.468 | 0.835 | 1.007 | 0.575 |
| [65] | 灰窯田 Huiyaotian | 1.417 | 1.315 | 0.507 | 0.394 | 1.364 | 1.388 | 1.445 | 0.642 | 0.803 | 0.400 | 1.208 | 0.411 | 1.317 |
| [66] | 鯉魚坡 Liyupo | 0.995 | 1.003 | 0.931 | 0.491 | 0.725 | 1.316 | 1.459 | 0.418 | 0.983 | 0.475 | 1.333 | 0.677 | 1.029 |

Appendix Table (continued 1).

| | | [14] | [15] | [16] | [17] | [18] | [19] | [20] | [21] | [22] | [23] | [24] | [25] | [26] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [15] | 前漢 Jiangnan | 0.355 | | | | | | | | | | | | |
| [16] | Jomon Japan | 1.230 | 1.479 | | | | | | | | | | | |
| [17] | Lang Bon | 1.118 | 1.299 | 1.219 | | | | | | | | | | |
| [18] | Lang Gao | 1.275 | 1.352 | 1.177 | 0.652 | | | | | | | | | |
| [19] | Laos | 0.566 | 0.828 | 0.787 | 1.025 | 1.625 | | | | | | | | |
| [20] | Liujiang | 1.240 | 1.516 | 0.325 | 0.787 | 1.048 | 0.829 | | | | | | | |
| [21] | Loyalty | 1.206 | 1.255 | 1.352 | 0.709 | 0.548 | 1.446 | 0.952 | | | | | | |
| [22] | Mai Da Dieu 16 | 1.061 | 0.915 | 0.875 | 0.936 | 1.114 | 0.782 | 0.908 | 1.265 | | | | | |
| [23] | Mai Da Nuoc | 1.809 | 1.701 | 0.646 | 0.928 | 1.011 | 1.220 | 0.736 | 0.914 | 1.198 | | | | |
| [24] | Man Bac 1 | 0.998 | 0.924 | 0.810 | 1.376 | 1.238 | 1.007 | 1.046 | 1.588 | 0.972 | 0.982 | | | |
| [25] | Man Bac 2 | 1.317 | 1.503 | 0.450 | 0.914 | 0.844 | 1.221 | 0.357 | 1.172 | 1.207 | 0.649 | 0.779 | | |
| [26] | Melanesia | 0.979 | 1.187 | 1.420 | 0.623 | 0.495 | 1.167 | 1.143 | 0.249 | 1.005 | 1.159 | 1.756 | 1.307 | |
| [27] | Myanmer | 0.113 | 0.414 | 1.282 | 1.104 | 1.136 | 0.659 | 1.180 | 1.091 | 1.292 | 1.720 | 1.159 | 1.301 | 0.915 |
| [28] | New Guinea Tolai | 1.245 | 1.194 | 1.131 | 0.875 | 1.076 | 0.897 | 0.758 | 0.430 | 0.886 | 0.724 | 1.674 | 1.201 | 0.419 |
| [29] | New Britain | 1.269 | 1.296 | 1.227 | 0.703 | 0.867 | 1.048 | 0.828 | 0.422 | 0.892 | 0.774 | 1.547 | 1.038 | 0.309 |
| [30] | Nicobar | 1.477 | 1.210 | 1.114 | 1.317 | 1.079 | 1.139 | 1.326 | 0.986 | 1.032 | 0.387 | 1.071 | 1.262 | 1.015 |
| [31] | Philippines | 0.543 | 0.706 | 0.767 | 1.206 | 1.465 | 0.434 | 0.989 | 1.451 | 0.883 | 1.126 | 0.886 | 1.189 | 1.235 |
| [32] | S.Moluccas | 0.476 | 0.477 | 1.207 | 1.160 | 1.331 | 1.028 | 1.065 | 0.849 | 1.190 | 1.324 | 1.308 | 1.184 | 1.031 |
| [33] | Semang Negritos | 0.574 | 0.676 | 1.176 | 0.916 | 1.317 | 0.744 | 1.123 | 0.961 | 0.812 | 1.448 | 1.293 | 1.076 | 0.672 |
| [34] | South | 0.562 | 0.304 | 1.109 | 1.515 | 1.097 | 0.975 | 1.538 | 1.414 | 1.130 | 1.382 | 0.719 | 1.395 | 1.368 |
| [35] | Sumatra | 0.428 | 0.675 | 1.451 | 0.721 | 0.751 | 0.864 | 1.256 | 0.841 | 1.039 | 1.596 | 1.409 | 1.434 | 0.606 |
| [36] | Thai | 0.269 | 0.211 | 1.212 | 1.238 | 1.308 | 0.518 | 1.338 | 1.501 | 1.107 | 1.639 | 0.864 | 1.307 | 1.243 |
| [37] | Veddah | 1.103 | 1.343 | 1.149 | 0.632 | 1.003 | 0.801 | 0.674 | 0.397 | 0.974 | 0.854 | 1.723 | 1.083 | 0.311 |
| [38] | Vietnam | 0.461 | 0.496 | 1.039 | 1.204 | 1.405 | 0.766 | 1.176 | 1.558 | 1.132 | 1.460 | 0.339 | 0.991 | 1.639 |
| [39] | 圩墩(常州) Weidun | 0.688 | 0.527 | 1.275 | 1.149 | 0.924 | 1.144 | 1.470 | 1.428 | 1.355 | 1.257 | 0.816 | 0.888 | 1.342 |
| [40] | Yayoi Japan | 0.688 | 0.561 | 0.946 | 1.294 | 0.850 | 1.341 | 1.164 | 1.372 | 0.857 | 1.480 | 0.612 | 0.852 | 1.384 |
| [41] | Nanay | 0.678 | 0.313 | 1.255 | 1.415 | 0.916 | 1.304 | 1.570 | 1.170 | 0.945 | 1.460 | 0.894 | 1.313 | 1.164 |
| [42] | Negidal | 0.603 | 0.369 | 1.014 | 1.317 | 1.029 | 1.125 | 1.365 | 1.504 | 0.627 | 1.576 | 0.623 | 1.107 | 1.373 |
| [43] | Oroch | 0.395 | 0.348 | 0.989 | 1.167 | 0.939 | 0.899 | 1.164 | 1.324 | 0.777 | 1.771 | 0.839 | 1.113 | 1.198 |
| [44] | Aleut | 0.551 | 0.584 | 0.744 | 1.131 | 1.086 | 0.869 | 0.976 | 1.280 | 0.552 | 1.635 | 0.807 | 1.158 | 1.194 |
| [45] | Asian Eskimo | 0.456 | 0.509 | 1.041 | 1.485 | 0.898 | 1.160 | 1.313 | 1.054 | 0.955 | 1.659 | 0.928 | 1.245 | 0.968 |
| [46] | Buryat | 0.438 | 0.430 | 0.870 | 1.220 | 1.012 | 0.855 | 1.139 | 1.535 | 0.634 | 1.707 | 0.688 | 1.141 | 1.295 |
| [47] | Chukchi | 0.441 | 0.501 | 0.962 | 1.451 | 0.915 | 1.126 | 1.240 | 1.107 | 0.887 | 1.686 | 0.870 | 1.205 | 1.054 |
| [48] | Evenki | 0.733 | 0.507 | 0.823 | 1.273 | 0.974 | 1.072 | 1.147 | 1.449 | 0.483 | 1.470 | 0.728 | 1.075 | 1.348 |
| [49] | Hokkaido Ainu | 0.757 | 1.127 | 0.730 | 0.912 | 0.741 | 0.982 | 0.579 | 0.522 | 1.024 | 1.316 | 1.547 | 1.008 | 0.591 |
| [50] | Mongol | 0.492 | 0.381 | 0.968 | 1.307 | 0.948 | 1.042 | 1.267 | 1.405 | 0.659 | 1.713 | 0.752 | 1.176 | 1.202 |
| [51] | Nivkh | 0.390 | 0.322 | 0.954 | 1.390 | 1.073 | 0.965 | 1.189 | 1.403 | 0.738 | 1.749 | 0.765 | 1.084 | 1.253 |
| [52] | Northern Chinese | 0.367 | 0.256 | 1.383 | 1.352 | 0.903 | 1.090 | 1.520 | 0.957 | 1.085 | 1.727 | 1.034 | 1.543 | 0.915 |
| [53] | Troitskoe | 0.699 | 0.429 | 0.986 | 1.377 | 0.932 | 1.170 | 1.369 | 1.401 | 0.845 | 1.468 | 0.575 | 1.045 | 1.379 |
| [54] | Ulch | 0.517 | 0.310 | 1.177 | 1.351 | 0.914 | 1.253 | 1.458 | 1.182 | 0.852 | 1.659 | 0.879 | 1.265 | 1.107 |
| [55] | Yakut | 0.500 | 0.399 | 0.970 | 1.351 | 0.943 | 1.147 | 1.208 | 1.314 | 0.816 | 1.626 | 0.737 | 1.034 | 1.272 |
| [56] | Yukagir | 0.640 | 0.507 | 0.895 | 1.331 | 0.850 | 1.164 | 1.143 | 1.449 | 0.596 | 1.568 | 0.675 | 0.977 | 1.310 |
| [57] | Neolithic Baikal | 0.709 | 0.634 | 0.831 | 1.203 | 0.771 | 1.186 | 1.017 | 1.178 | 0.570 | 1.492 | 0.977 | 1.081 | 1.110 |
| [58] | Okhotsk | 0.570 | 0.418 | 1.112 | 1.381 | 0.852 | 1.332 | 1.282 | 1.103 | 1.019 | 1.534 | 0.674 | 1.060 | 1.282 |
| [59] | 甑皮岩Zengpiyan | 1.125 | 0.888 | 1.431 | 0.953 | 0.669 | 1.152 | 1.311 | 0.578 | 0.920 | 1.080 | 1.209 | 1.270 | 0.559 |
| [60] | 西坡(河南)Xipo | 1.152 | 0.868 | 0.791 | 1.350 | 1.025 | 1.309 | 0.950 | 1.426 | 1.225 | 0.922 | 0.218 | 0.540 | 1.773 |
| [61] | 河姆渡Hemudu | 1.206 | 1.014 | 1.035 | 1.099 | 0.655 | 1.500 | 1.112 | 1.165 | 1.181 | 0.799 | 0.533 | 0.654 | 1.452 |
| [62] | 賈湖Jiahu | 0.558 | 0.355 | 1.220 | 1.351 | 0.915 | 1.245 | 1.480 | 1.263 | 1.245 | 1.493 | 0.579 | 1.210 | 1.344 |
| [63] | 早都山Jindushan | 0.753 | 0.413 | 1.264 | 1.499 | 0.840 | 1.214 | 1.483 | 1.162 | 1.168 | 1.394 | 0.569 | 1.328 | 1.282 |
| [64] | 八里崗 Baligan | 0.864 | 0.617 | 0.976 | 1.430 | 0.798 | 1.290 | 1.299 | 1.337 | 1.023 | 1.297 | 0.387 | 1.083 | 1.484 |
| [65] | 灰窯田 Huiyaotian | 1.385 | 1.408 | 1.070 | 0.443 | 0.537 | 1.556 | 0.711 | 0.463 | 0.911 | 0.782 | 1.426 | 0.696 | 0.568 |
| [66] | 鯉魚坡 Liyupo | 1.379 | 1.274 | 0.717 | 1.052 | 0.648 | 1.658 | 0.646 | 0.722 | 1.047 | 0.889 | 1.025 | 0.372 | 0.912 |

Appendix Table (continued 2).

| | [27] | [28] | [29] | [30] | [31] | [32] | [33] | [34] | [35] | [36] | [37] | [38] | [39] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [28] New Guinea Tolai | 1.141 | | | | | | | | | | | | |
| [29] New Britain | 1.261 | 0.136 | | | | | | | | | | | |
| [30] Nicobar | 1.338 | 0.652 | 0.822 | | | | | | | | | | |
| [31] Philippines | 0.661 | 0.984 | 1.140 | 1.025 | | | | | | | | | |
| [32] S.Moluccas | 0.408 | 0.859 | 1.117 | 1.041 | 0.808 | | | | | | | | |
| [33] Semang Negritos | 0.795 | 0.837 | 0.681 | 1.439 | 1.021 | 0.833 | | | | | | | |
| [34] South | 0.543 | 1.454 | 1.586 | 0.957 | 0.542 | 0.746 | 1.211 | | | | | | |
| [35] Sumatra | 0.284 | 1.074 | 1.213 | 1.210 | 0.912 | 0.611 | 0.964 | 0.805 | | | | | |
| [36] Thai | 0.265 | 1.315 | 1.387 | 1.306 | 0.425 | 0.738 | 0.801 | 0.261 | 0.622 | | | | |
| [37] Veddah | 0.995 | 0.172 | 0.267 | 0.909 | 1.140 | 0.898 | 0.690 | 1.704 | 0.779 | 1.363 | | | |
| [38] Vietnam | 0.568 | 1.768 | 1.775 | 1.422 | 0.737 | 0.784 | 0.972 | 0.553 | 0.812 | 0.437 | 1.596 | | |
| [39] 圩墩(常州) Weidun | 0.610 | 1.568 | 1.519 | 0.986 | 0.922 | 0.704 | 1.109 | 0.424 | 0.757 | 0.462 | 1.579 | 0.520 | |
| [40] Yayoi Japan | 0.762 | 1.616 | 1.495 | 1.307 | 1.137 | 0.779 | 0.972 | 0.500 | 0.999 | 0.721 | 1.716 | 0.599 | 0.502 |
| [41] Nanay | 0.725 | 1.357 | 1.348 | 1.022 | 1.095 | 0.690 | 0.886 | 0.279 | 0.927 | 0.584 | 1.599 | 0.806 | 0.501 |
| [42] Negidal | 0.797 | 1.615 | 1.533 | 1.319 | 0.923 | 0.866 | 0.782 | 0.379 | 0.952 | 0.545 | 1.725 | 0.535 | 0.564 |
| [43] Oroch | 0.537 | 1.489 | 1.430 | 1.582 | 0.769 | 0.773 | 0.803 | 0.379 | 0.765 | 0.370 | 1.574 | 0.559 | 0.573 |
| [44] Aleut | 0.748 | 1.413 | 1.371 | 1.583 | 0.896 | 0.891 | 0.710 | 0.634 | 0.927 | 0.682 | 1.447 | 0.651 | 1.025 |
| [45] Asian Eskimo | 0.506 | 1.318 | 1.292 | 1.262 | 1.078 | 0.690 | 0.743 | 0.472 | 0.784 | 0.654 | 1.378 | 0.789 | 0.795 |
| [46] Buryat | 0.559 | 1.563 | 1.526 | 1.499 | 0.703 | 0.923 | 0.849 | 0.367 | 0.759 | 0.377 | 1.606 | 0.514 | 0.709 |
| [47] Chukchi | 0.528 | 1.392 | 1.375 | 1.354 | 1.032 | 0.690 | 0.774 | 0.459 | 0.793 | 0.644 | 1.445 | 0.716 | 0.798 |
| [48] Evenki | 0.914 | 1.481 | 1.492 | 1.320 | 0.896 | 0.947 | 0.879 | 0.461 | 0.967 | 0.657 | 1.605 | 0.713 | 0.791 |
| [49] Hokkaido Ainu | 0.643 | 0.788 | 0.960 | 1.377 | 1.118 | 0.639 | 0.928 | 1.149 | 0.563 | 1.129 | 0.620 | 1.219 | 1.303 |
| [50] Mongol | 0.620 | 1.528 | 1.479 | 1.448 | 0.847 | 0.873 | 0.762 | 0.357 | 0.789 | 0.453 | 1.597 | 0.589 | 0.695 |
| [51] Nivkh | 0.530 | 1.452 | 1.403 | 1.462 | 0.821 | 0.703 | 0.691 | 0.388 | 0.868 | 0.414 | 1.563 | 0.569 | 0.618 |
| [52] Northern Chinese | 0.341 | 1.228 | 1.278 | 1.185 | 0.935 | 0.559 | 0.885 | 0.267 | 0.572 | 0.414 | 1.366 | 0.738 | 0.637 |
| [53] Troitskoe | 0.886 | 1.613 | 1.485 | 1.316 | 0.962 | 1.002 | 0.882 | 0.321 | 1.136 | 0.546 | 1.805 | 0.604 | 0.546 |
| [54] Ulch | 0.613 | 1.438 | 1.390 | 1.290 | 1.046 | 0.671 | 0.733 | 0.341 | 0.813 | 0.550 | 1.567 | 0.686 | 0.589 |
| [55] Yakut | 0.635 | 1.505 | 1.453 | 1.431 | 0.976 | 0.755 | 0.775 | 0.401 | 0.905 | 0.538 | 1.600 | 0.629 | 0.646 |
| [56] Yukagir | 0.756 | 1.520 | 1.470 | 1.324 | 0.912 | 0.888 | 0.950 | 0.432 | 0.889 | 0.605 | 1.636 | 0.673 | 0.643 |
| [57] Neolithic Baikal | 0.778 | 1.310 | 1.379 | 1.315 | 1.016 | 0.805 | 0.951 | 0.568 | 0.763 | 0.790 | 1.378 | 0.911 | 0.908 |
| [58] Okhotsk | 0.686 | 1.510 | 1.476 | 1.328 | 1.042 | 0.658 | 1.003 | 0.372 | 0.919 | 0.647 | 1.649 | 0.596 | 0.574 |
| [59] 甑皮岩Zengpiyan | 1.222 | 0.651 | 0.464 | 0.882 | 1.136 | 1.192 | 0.933 | 0.994 | 1.176 | 1.057 | 0.925 | 1.429 | 1.027 |
| [60] 西坡(河南)Xipo | 1.162 | 1.695 | 1.654 | 1.158 | 1.079 | 1.115 | 1.385 | 0.645 | 1.356 | 0.867 | 1.754 | 0.400 | 0.574 |
| [61] 河姆渡Hemudu | 1.218 | 1.456 | 1.348 | 0.836 | 1.164 | 1.021 | 1.575 | 0.726 | 1.233 | 1.093 | 1.626 | 0.831 | 0.460 |
| [62] 賈湖Jiahu | 0.553 | 1.671 | 1.675 | 1.275 | 0.905 | 0.802 | 1.094 | 0.179 | 0.757 | 0.398 | 1.725 | 0.387 | 0.466 |
| [63] 旱都山Jindushan | 0.709 | 1.435 | 1.442 | 1.012 | 0.917 | 0.959 | 1.324 | 0.168 | 0.942 | 0.473 | 1.700 | 0.630 | 0.559 |
| [64] 八里崗 Baligan | 0.881 | 1.667 | 1.625 | 1.085 | 0.931 | 1.037 | 1.455 | 0.254 | 1.055 | 0.653 | 1.890 | 0.531 | 0.542 |
| [65] 灰窯田 Huiyaotian | 1.328 | 0.762 | 0.715 | 1.138 | 1.419 | 0.949 | 0.945 | 1.583 | 0.835 | 1.610 | 0.556 | 1.370 | 1.264 |
| [66] 鯉魚坡 Liyupo | 1.367 | 1.023 | 0.857 | 1.279 | 1.424 | 1.024 | 0.875 | 1.291 | 1.364 | 1.443 | 1.036 | 1.184 | 1.069 |

Appendix Table (continued 3).

| | [40] | [41] | [42] | [43] | [44] | [45] | [46] | [47] | [48] | [49] | [50] | [51] | [52] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [41] Nanay | 0.216 | | | | | | | | | | | | |
| [42] Negidal | 0.125 | 0.178 | | | | | | | | | | | |
| [43] Oroch | 0.257 | 0.316 | 0.189 | | | | | | | | | | |
| [44] Aleut | 0.318 | 0.463 | 0.239 | 0.191 | | | | | | | | | |
| [45] Asian Eskimo | 0.249 | 0.216 | 0.295 | 0.324 | 0.294 | | | | | | | | |
| [46] Buryat | 0.238 | 0.380 | 0.132 | 0.130 | 0.145 | 0.299 | | | | | | | |
| [47] Chukchi | 0.205 | 0.224 | 0.237 | 0.238 | 0.204 | 0.016 | 0.230 | | | | | | |
| [48] Evenki | 0.230 | 0.278 | 0.074 | 0.236 | 0.218 | 0.373 | 0.146 | 0.291 | | | | | |
| [49] Hokkaido Ainu | 0.964 | 1.037 | 1.109 | 0.780 | 0.654 | 0.635 | 0.882 | 0.605 | 0.948 | | | | |
| [50] Mongol | 0.184 | 0.243 | 0.069 | 0.142 | 0.158 | 0.195 | 0.040 | 0.148 | 0.101 | 0.877 | | | |
| [51] Nivkh | 0.143 | 0.226 | 0.102 | 0.088 | 0.174 | 0.164 | 0.096 | 0.117 | 0.177 | 0.842 | 0.063 | | |
| [52] Northern Chinese | 0.404 | 0.175 | 0.393 | 0.289 | 0.448 | 0.152 | 0.370 | 0.170 | 0.499 | 0.739 | 0.292 | 0.261 | |
| [53] Troitskoe | 0.179 | 0.153 | 0.088 | 0.175 | 0.318 | 0.326 | 0.235 | 0.270 | 0.160 | 1.148 | 0.163 | 0.161 | 0.372 |
| [54] Ulch | 0.146 | 0.065 | 0.099 | 0.201 | 0.266 | 0.110 | 0.214 | 0.097 | 0.199 | 0.874 | 0.095 | 0.099 | 0.154 |
| [55] Yakut | 0.113 | 0.159 | 0.086 | 0.160 | 0.233 | 0.161 | 0.152 | 0.115 | 0.115 | 0.862 | 0.082 | 0.065 | 0.274 |
| [56] Yukagir | 0.106 | 0.261 | 0.076 | 0.195 | 0.267 | 0.274 | 0.108 | 0.215 | 0.072 | 0.932 | 0.073 | 0.101 | 0.413 |
| [57] Neolithic Baikal | 0.260 | 0.323 | 0.223 | 0.308 | 0.258 | 0.278 | 0.218 | 0.217 | 0.093 | 0.616 | 0.161 | 0.235 | 0.424 |
| [58] Okhotsk | 0.173 | 0.169 | 0.214 | 0.228 | 0.410 | 0.248 | 0.358 | 0.195 | 0.276 | 0.882 | 0.264 | 0.207 | 0.248 |
| [59] 甑皮岩Zengpiyan | 1.096 | 0.795 | 1.049 | 0.848 | 1.095 | 1.001 | 1.182 | 1.024 | 1.086 | 1.121 | 1.100 | 1.011 | 0.797 |
| [60] 西坡（河南）Xipo | 0.515 | 0.754 | 0.606 | 0.763 | 0.901 | 0.941 | 0.749 | 0.873 | 0.666 | 1.369 | 0.743 | 0.747 | 0.992 |
| [61] 河姆渡Hemudu | 0.527 | 0.660 | 0.723 | 0.801 | 1.103 | 0.993 | 0.959 | 0.944 | 0.781 | 1.329 | 0.944 | 0.880 | 0.933 |
| [62] 賈湖Jiahu | 0.344 | 0.270 | 0.297 | 0.382 | 0.564 | 0.377 | 0.336 | 0.358 | 0.408 | 1.099 | 0.277 | 0.356 | 0.268 |
| [63] 早都山Jindushan | 0.445 | 0.280 | 0.443 | 0.418 | 0.671 | 0.442 | 0.471 | 0.437 | 0.535 | 1.161 | 0.425 | 0.441 | 0.246 |
| [64] 八里崗 Baligan | 0.276 | 0.351 | 0.338 | 0.366 | 0.519 | 0.475 | 0.373 | 0.419 | 0.418 | 1.137 | 0.368 | 0.398 | 0.419 |
| [65] 灰窯田 Huiyaotian | 1.176 | 1.320 | 1.253 | 1.348 | 1.235 | 1.302 | 1.344 | 1.294 | 1.142 | 0.718 | 1.251 | 1.370 | 1.399 |
| [66] 鯉魚坡 Liyupo | 0.696 | 0.967 | 0.895 | 0.974 | 0.895 | 0.867 | 1.035 | 0.857 | 0.888 | 0.775 | 0.895 | 0.881 | 1.166 |

Appendix Table (continued 4).

| | [53] | [54] | [55] | [56] | [57] | [58] | [59] | [60] | [61] | [62] | [63] | [64] | [65] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [54] Ulch | 0.145 | | | | | | | | | | | | |
| [55] Yakut | 0.109 | 0.073 | | | | | | | | | | | |
| [56] Yukagir | 0.170 | 0.162 | 0.081 | | | | | | | | | | |
| [57] Neolithic Baikal | 0.334 | 0.220 | 0.143 | 0.111 | | | | | | | | | |
| [58] Okhotsk | 0.145 | 0.150 | 0.105 | 0.218 | 0.288 | | | | | | | | |
| [59] 甑皮岩Zengpiyan | 0.810 | 0.937 | 1.034 | 1.077 | 1.133 | 0.854 | | | | | | | |
| [60] 西坡（河南）Xipo | 0.496 | 0.787 | 0.645 | 0.622 | 0.852 | 0.516 | 1.229 | | | | | | |
| [61] 河姆渡Hemudu | 0.573 | 0.826 | 0.735 | 0.676 | 0.850 | 0.476 | 0.785 | 0.350 | | | | | |
| [62] 賈湖Jiahu | 0.256 | 0.245 | 0.260 | 0.361 | 0.476 | 0.216 | 1.137 | 0.433 | 0.671 | | | | |
| [63] 早都山Jindushan | 0.283 | 0.361 | 0.403 | 0.445 | 0.609 | 0.266 | 0.723 | 0.496 | 0.547 | 0.175 | | | |
| [64] 八里崗 Baligan | 0.232 | 0.375 | 0.371 | 0.320 | 0.517 | 0.251 | 0.904 | 0.338 | 0.387 | 0.235 | 0.114 | | |
| [65] 灰窯田 Huiyaotian | 1.390 | 1.227 | 1.247 | 1.174 | 0.958 | 1.219 | 1.129 | 1.153 | 1.053 | 1.302 | 1.533 | 1.430 | |
| [66] 鯉魚坡 Liyupo | 0.873 | 0.859 | 0.845 | 0.814 | 0.824 | 0.838 | 1.013 | 0.695 | 0.865 | 1.036 | 1.119 | 0.950 | 0.442 |

# 16
# The Origin of Early Holocene Hunter-Gatherers at Huiyaotian and Liyupo in Guangxi, Southern China: Odontometric Perspective

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The study of the dental characteristics of the Huiyaotian and Liyupo skeletal series focuses on the micro regional population history of mainland China, allowing for a discussion of whether or not these prehistoric Guangxi people were the direct ancestors of the current East Asians, including the Chinese. Another purpose of this study, following the results of the micro regional analysis presented here, is to challenge the currently dominant hypothesis of the population history of East/Southeast Asia from a macro regional perspective. Since early in the last century, it has been argued that Southeast Asia was initially settled by people akin to the modern "Australo-Melanesian" population that, in the later Neolithic period, underwent substantial genetic modification due to expansion of immigrants associated with the spread of rice farming agriculture from Southern China. This model is currently referred to as the "Two Layer hypothesis" or the "Immigration" model (Callenfels[1]; Mijsberg[2]; Barth[3]; von Koenigswald[4]; Coon[5]; Thomas[6]; Jacob[7][8]; Brace[9]; Howells[10]; and Brace, *et al.*[11]). A number of recent reviews of archeological studies conclude that a rice farming people and their associated Neolithic material culture spread south from the Yangtze River Basin to mainland and island Southeast Asia (Bellwood[12][13]; Spriggs[14]; Glover and Higham[15]; and Bellwood, *et al.* [16]). In order to further support or reject this scenario of the expansion of East Asian farming populations into southward, the focus needs to be placed more on the biological relationships between the Neolithic and pre-Neolithic occupants across East and Southeast Asia. Given these perspectives, the Huiyaotian and Liyupo skeletons, which are of pre-farming hunter-gatherers adjacent to mainland Southeast Asia, are crucial materials to assess the "Two Layer hypothesis," and challenge this model expanding into East Asia.

Along with the above-mentioned aims, this paper presents results pertaining to population affinities of the Guangxi skeletal sequence compared to early and modern population samples from the area covering East/Southeast Asia and the West Pacific regions based on dental metric data. Dental morphology often has been used as one of the most reliable methods for reconstructing population movement, because the heritability of phenotypical dental morphology is more strongly controlled by genetics than skeletal features are, with the exception of some nonmetric cranial traits. Accordingly, the dental data of the Huiyaotian and Liyupo specimens can provide substantial clues

Table 16-1. Comparative prehistoric dental samples from East/Southeast Asia

| | Locality | Period | Remark | Dental metrics |
|---|---|---|---|---|
| ***Pre-Neolithic*** | | | | |
| Hoabinhian Vietnam | Vietnam | Late Pleistocene - Early Holocene (Hoabinhian Culture) | Sites of Mai Da Nuoc, Mai Da Dieu, Dong Truong, Du Sang and Lan Bon | H.M. |
| Bac Son | Northern Vietnam | Early Holocene (Bac Son Culture c. 8,000-7,000 BP) | Sites of Pho Binh Gia, Lang Cuom, and Cua Gi | Matsumura and Hudson[17] |
| Guar Kepah | mainland Penang, Malaysia | Early Holocene (Hoabinhian Culture) | Callenfels, 1936; Mijsberg, 1940 | Matsumura and Hudson[17] |
| Mesolithic Flores | Flores Island | Early Holocene (Meso-lithic, c.7,000-4,000 BP) | Sites of Liang Momer, Linag Toge, Liang X, Gua Alo, Aimere, Sampung and Gua Nempong (Jacob, 1967) | Matsumura and Pookajorn[18] |
| Early Laos Tam Hang | Northern Laos | Early Holocene | Mansuy and Colani, 1925; Huard and Saurin, 1938 | H.M. |
| Da But Con Co Ngua | Than Hoa Prov., Nth Vietnam | Da But Culture, sample dated to c.5,000 BP | Patte, 1965; Bui, 1991 | Matsumura *et al.*[19] |
| Gua Cha | Kelantan, Malaysia | Hoabinhian-Neolithic (c.8,000-3,000 BP) | Sieveking, 1954; Bulbeck, 2000a | Matsumura and Hudson[17] |
| Niah Cave | Borneo Island | Mesolithic and Neolithic | Harison, 1996; Barker *et al.*, 2007 | H.M. |
| ***Neolithic*** | | | | |
| 圩墩Weidun | Jiangsu Prov., Sth China | Neolithic (Majiabang Culture, c.7,000-5,000 BP) | Chang, 1986; Nakahashi and Li, 2002; teeth includes Songze series | Matsumura[20] |
| Jomon | Japan | Neolithic (Middle-Latest Jomon Culture, c. 5,000-2,300 BP) | Akazawa and Aikens, 1986 | Matsumura[21] |
| Khok Phanom Di | Chon Buri Prov.,Thailand | Neolithic (c. 4,000-3,500BP) | e.g. Higham and Ban-nanurag, 1990 | Tyles[22] |
| Man Bac | Ninh Binh Prov., Nth Vietnam | Late Neolithic (c. 3,800-3,500 BP) | Matsumura *et al.*, 2008; Oxenham *et al.* 2011 | H.M. |
| Non Nok Tha | Khok Kaen Prov., Thailand | Neolithic-Bronze Age (c. 3,500-3,000 BP) | Bayard, 1971 | H.M. |
| ***Bronze and Iron Age*** | | | | |
| 安阳Anyang | Henan Prov., China | Bronze - Iron Age (c. 3,300 BP) | IHIA and CASS, 1982 | H.M. |
| Hoa Diem | "Khanh Hoa Prov., Sth Vietnam" | Early Metal age (c.2,000 BP) | — | unpublished |
| Dong Son | Northern Vietnam | Early Metal Age (Dong Son Culture, 3,000-1,700 BP) | Cuong, 1996 | Matsumura *et al.*[19] |
| Go Ochua | Long An Prov., Sth Vietnam | Iron Age | Site in Long An Prov., Southern Vietnam | Cuong in press |
| Yayoi | Western Japan | Yayoi Period (c. 800 BC - AD 300) | Sites of Doigahama, Nakanohama, Kanenokuma and others in Northern Kyushu and Yamaguchi Districts | Matsumura[23] |
| 江南Jiangnan | Jiangnan Prov., Sth China | Zhou-Western Han (2,770-1,992 BP) | Nakahashi and Li, 2002 | Matsumura[20] |
| Gion Ca Vo | Ho Chi Minh Dist., Sth Vietnam | Iron Age (c. 300-0 BC) | Site in Ho Chi Minh | H.M. |
| Phum Snay | Preah Neat Orey Dist., Cambodia | Iron Age (c. 350 BC-200 AD) | Site of Phum Snay in Preah Neat Orey District, West Cambodia | Matsumura *et al.*[24] |

towards the understanding of the population history of this region. This study does not address nonmetric traits due to the small sample size.

Table 16-1. (continued)

| | Locality | Period | Remark | Dental metrics |
|---|---|---|---|---|
| ***more Modern*** | | | | |
| Australian aborigines | Australia | Modern | — | Matsumura and Hudson[17] |
| Dayak | Sarawak, Malaysia | Modern | — | Matsumura and Hudson[17] |
| Java & Timor Islanders | Sulawesi, Timor and Java | Modern | — | Matsumura and Hudson[17] |
| Loyalty Islanders | Loyalty Islands | Modern | — | Matsumura and Hudson[17] |
| Andaman Islanders | Andaman Islands | Modern | — | Matsumura and Hudson[17] |
| New Britain Islanders | New Britain Island | Modern | — | Matsumura[25] |
| Philippines | Luzon, Philippines | Modern | — | Matsumura and Hudson[17] |
| Malay | Penang and Malay Peninsula, Malaysia | Modern | — | Matsumura and Hudson[17] |
| Thai | Bangkok, Thailand | Modern | — | Matsumura[23] |
| Thai Chinese | Bangkok, Thailand | Modern | — | Matsumura[23] |
| Vietnamese | Northern Vietnam | Modern | — | Matsumura and Hudson[17] |
| Myanmar | Myanmar | Modern | — | Matsumura *et al.*[26] |
| Laotians | Laos | Modern | — | Matsumura and Hudson[17] |
| Atayal | Taiwan | Modern | samples in National Taiwan Univ. | unpublished |
| 海南Hainan | Hainan Island in Sth. China | Modern | samples in National Taiwan Univ. | unpublished |
| Ainu Hokkaido | Hokkaido, Japan | Modern | — | Matsumura[21] |
| Japan | Kanto, Japan | Modern | — | Matsumura[21] |
| Ban Na Di | | | | H.M. |
| Sumatra & Mentawi | | | | H.M. |
| Bunun | | | | H.M. |

## MATERIALS

Well-preserved teeth of male individuals from a total of forty-three prehistoric and historic/modern samples from Huiyaotian and Liyupo have been used for this study. The prehistoric samples include Hoabinhian and Mesolithic series from Southeast Asia and China and the Neolithic and Metal Age series from Eastern Asia. The historic/modern samples are from a wider area of eastern Asia, including India, as well as near Oceania (Australia and New Guinea). These comparative samples are listed in Table 16-1. The average metric data for each sample was used for the present analyses.

## RECORDING SYSTEM OF DENTAL MORPHOLOGY

Metric dental traits were represented by the mesiodistal and buccolingual crown diameters of all teeth except for the third molars. The measurements were taken as maximum diameters according to Fujita's[27] system. Crown measurements and observations of nonmetric traits were undertaken for teeth on the right side. Antimere substitutions were made when necessary.

## STATISTICAL PROCEDURES

Dental metric comparisons were made using the mesiodistal and buccolingual crown diameters. The multi-variate comparative analyses were made between the Huiyaotian samples, Liyupo samples, and other population samples on a global scale using male permanent tooth data. Similarities in odontometric proportions were estimated by Q-mode correlation coefficients (Sneath and Sokal[28]). Then, the measurement data were standardized using grand mean values of all comparative samples.

Only male samples were used for the dental metric data analysis because most of the comparative datasets are exclusively male.

Statistically, population comparisons using frequency data require larger sample sizes than dental metric comparisons. The sample sizes of the nonmetric dental data from Huiyaotian and Liyupo are very small and would skew the frequency data, therefore they were excluded from the analysis.

## RESULTS

Table 16-2 gives basic statistics for the mesiodistal and buccolingual diameters of the Huiyaotian and Liyupo series. Figure 16-1 presents the results of the Net Split analysis applied to the distances of the Q-mode correlation coefficients (Table 16-3) based on the fourteen dental measurements taken from the 43 population samples. The unrooted network trees resulting from these analyses branch into two major clusters at

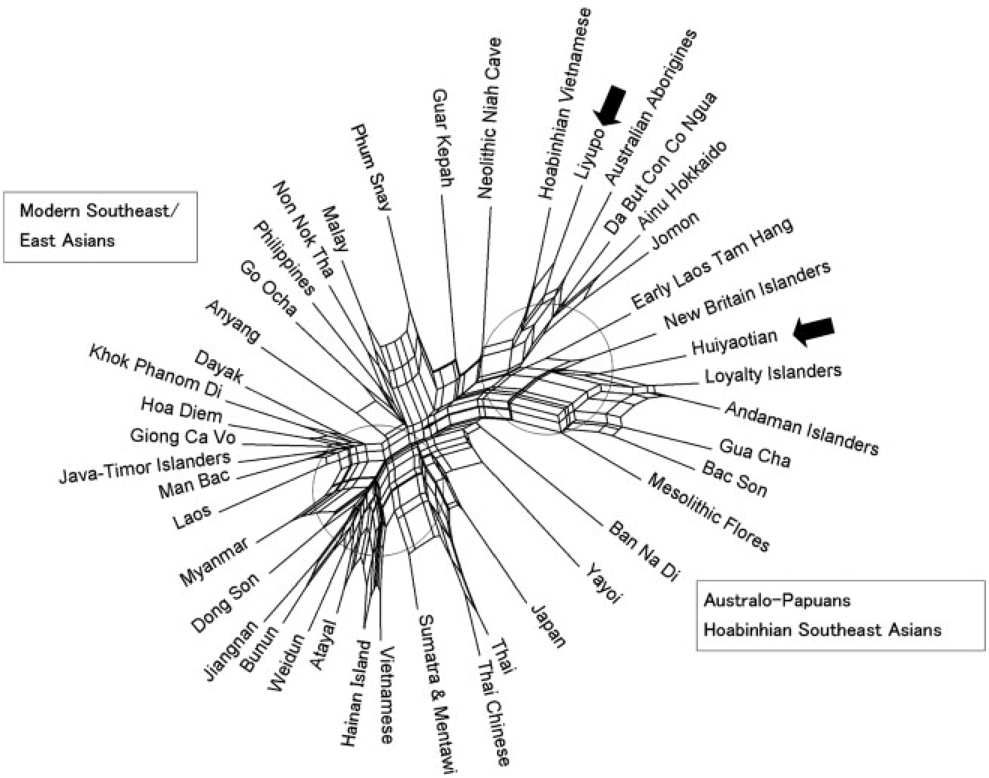


Figure 16-1. A Net Split tree generated on the basis of Q-mode correlation of 28 crown diameters.

Table 16-2. Basic statistical values of mesiodistal and buccolingual crown diameters of the Huiyaotian and Liyupo permanent dentition.

| | Huiyaotian | | | | | | Liyupo | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | Males | | | Females | | |
| | n | Mean | SD | n | Mean | SD | n | Mean | SD | n | Mean | SD |
| Mesiodistal diameters (mm) | | | | | | | | | | | | |
| UI1 | 4 | 8.69 | 0.47 | 2 | 8.98 | 0.96 | 2 | 8.88 | 0.03 | 1 | 9.02 | — |
| UI2 | 4 | 7.50 | 0.54 | 2 | 7.87 | 1.29 | 2 | 7.57 | 0.76 | 1 | 7.62 | — |
| UC | 4 | 8.24 | 0.21 | 2 | 8.15 | 0.52 | 3 | 8.16 | 0.30 | 4 | 8.03 | 0.25 |
| UP1 | 3 | 7.71 | 0.39 | 2 | 6.34 | 0.37 | 4 | 7.34 | 0.13 | 2 | 7.08 | 0.25 |
| UP2 | 3 | 7.08 | 0.41 | 2 | 6.94 | 0.15 | 4 | 7.17 | 0.51 | 4 | 6.91 | 0.55 |
| UM1 | 2 | 10.88 | 0.47 | 1 | 10.25 | — | 5 | 11.11 | 0.47 | 4 | 10.56 | 0.25 |
| UM2 | 4 | 10.16 | 0.49 | 2 | 10.26 | 1.05 | 3 | 10.36 | 0.03 | 5 | 9.92 | 0.32 |
| LI1 | 6 | 5.37 | 0.36 | 3 | 5.26 | 0.16 | 2 | 5.51 | 0.23 | 2 | 5.98 | 0.13 |
| LI2 | 6 | 5.91 | 0.45 | 3 | 5.88 | 0.27 | 3 | 6.47 | 0.21 | 4 | 6.24 | 0.15 |
| LC | 8 | 7.31 | 0.66 | 3 | 7.20 | 0.58 | 6 | 7.45 | 0.57 | 6 | 7.12 | 0.28 |
| LP1 | 8 | 7.26 | 0.63 | 3 | 6.91 | 0.41 | 6 | 7.44 | 0.48 | 4 | 7.27 | 0.39 |
| LP2 | 8 | 7.37 | 0.50 | 1 | 6.41 | — | 6 | 7.82 | 0.44 | 5 | 7.30 | 0.38 |
| LM1 | 6 | 11.89 | 0.53 | 0 | — | — | 5 | 12.00 | 0.73 | 4 | 11.55 | 0.30 |
| LM2 | 6 | 11.60 | 0.67 | 1 | 11.29 | — | 4 | 11.24 | 0.56 | 4 | 11.08 | 0.76 |
| Buccolingual diameters (mm) | | | | | | | | | | | | |
| UI1 | 4 | 7.44 | 0.57 | 2 | 7.40 | 1.05 | 1 | 7.77 | — | 2 | 7.91 | 0.08 |
| UI2 | 4 | 7.04 | 0.34 | 2 | 6.46 | 0.59 | 1 | 6.90 | — | 1 | 6.99 | — |
| UC | 4 | 8.42 | 0.44 | 2 | 8.18 | 1.07 | 4 | 8.58 | 0.22 | 4 | 8.14 | 0.80 |
| UP1 | 2 | 10.53 | 0.54 | 2 | 9.47 | 0.90 | 4 | 9.61 | 0.29 | 3 | 9.49 | 0.64 |
| UP2 | 3 | 9.79 | 0.53 | 2 | 9.04 | 0.40 | 5 | 9.58 | 0.45 | 4 | 9.29 | 0.14 |
| UM1 | 4 | 12.35 | 0.66 | 1 | 11.52 | — | 6 | 12.30 | 0.34 | 4 | 11.96 | 0.49 |
| UM2 | 6 | 12.14 | 0.68 | 2 | 12.11 | 0.45 | 4 | 12.28 | 0.57 | 5 | 11.84 | 0.76 |
| LI1 | 8 | 6.22 | 0.76 | 3 | 6.13 | 0.37 | 2 | 6.15 | 0.08 | 2 | 5.71 | 0.37 |
| LI2 | 9 | 6.60 | 0.81 | 6 | 6.63 | 0.45 | 3 | 6.53 | 0.45 | 4 | 5.99 | 0.46 |
| LC | 9 | 7.93 | 0.88 | 5 | 7.94 | 0.58 | 6 | 8.05 | 0.48 | 4 | 7.66 | 0.49 |
| LP1 | 9 | 8.45 | 0.39 | 3 | 8.16 | 0.48 | 7 | 8.67 | 0.69 | 5 | 8.43 | 0.91 |
| LP2 | 9 | 8.48 | 0.53 | 2 | 9.02 | 1.32 | 7 | 8.98 | 0.81 | 6 | 8.71 | 0.81 |
| LM1 | 8 | 11.36 | 0.51 | 3 | 11.43 | 1.00 | 7 | 11.60 | 0.56 | 4 | 10.54 | 0.42 |
| LM2 | 8 | 11.00 | 0.38 | 4 | 10.65 | 0.76 | 6 | 11.23 | 0.82 | 4 | 10.74 | 0.39 |

the top and bottom: (1) Northeast and East Asians, and several sets of Southeast Asians ranging from Late Neolithic to modern times; and (2) Australo–Melanesians and early Holocene Southeast Asians, including Hoabinhian and early Neolithic, respectively. The people represented in several present-day Southeast Asian sample sets occupy an intermediate position between these two major groupings. Essentially, this figure shows a relatively straightforward dichotomization of the dataset into a group that includes early Holocene Southeast Asians and Australo–Melanesian forms and another group that includes the more modern Northeast Asian and Southeast Asian morphology (for the most part Neolithic and post-Neolithic populations). As far as Huiyaotian and Liyupo are concerned, they are classified into the former group.

Table 16-3. Distance (1-r) transformed from q-mode correlation coefficients, on the bases of 28 male crowm diamaters.

| | | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] | [11] | [12] | [13] | [14] | [15] | [16] | [17] | [18] | [19] | [20] | [21] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [1] | Mesolithic Flores | | | | | | | | | | | | | | | | | | | | | |
| [2] | Guar Kepah | 0.88 | | | | | | | | | | | | | | | | | | | | |
| [3] | Gua Cha | 0.64 | 0.76 | | | | | | | | | | | | | | | | | | | |
| [4] | Malay | 1.06 | 1.03 | 1.49 | | | | | | | | | | | | | | | | | | |
| [5] | Dayak | 1.37 | 1.09 | 1.37 | 0.57 | | | | | | | | | | | | | | | | | |
| [6] | Andaman Islanders | 0.55 | 0.99 | 0.50 | 1.32 | 1.60 | | | | | | | | | | | | | | | | |
| [7] | Early Laos Tam Han | 0.90 | 1.05 | 0.87 | 1.15 | 0.94 | 0.82 | | | | | | | | | | | | | | | |
| [8] | Bac Son | 0.62 | 1.29 | 0.52 | 1.17 | 1.51 | 0.49 | 0.89 | | | | | | | | | | | | | | |
| [9] | Vietnamese | 0.95 | 1.04 | 1.20 | 0.89 | 0.87 | 1.22 | 1.39 | 1.25 | | | | | | | | | | | | | |
| [10] | Myanmar | 1.07 | 1.12 | 1.32 | 0.90 | 0.60 | 1.61 | 0.96 | 1.33 | 0.65 | | | | | | | | | | | | |
| [11] | Java-Timor Islanders | 1.11 | 1.15 | 1.35 | 0.81 | 0.70 | 1.08 | 0.59 | 1.36 | 0.76 | 0.55 | | | | | | | | | | | |
| [12] | Sumatra & Mentawi | 0.93 | 1.23 | 1.14 | 0.73 | 0.50 | 1.29 | 0.96 | 1.01 | 0.77 | 0.62 | 0.54 | | | | | | | | | | |
| [13] | Laos | 1.15 | 1.00 | 1.16 | 1.05 | 0.61 | 1.25 | 0.90 | 1.43 | 0.94 | 0.66 | 0.69 | 0.78 | | | | | | | | | |
| [14] | Loyalty Islanders | 0.52 | 1.06 | 0.64 | 1.28 | 1.55 | 0.27 | 0.64 | 0.52 | 1.11 | 1.44 | 0.93 | 1.27 | 1.37 | | | | | | | | |
| [15] | Philippines | 0.81 | 1.13 | 1.32 | 0.62 | 0.73 | 1.29 | 0.92 | 0.91 | 0.89 | 1.05 | 0.98 | 0.56 | 1.34 | 0.96 | | | | | | | |
| [16] | Khok Phanom Di | 1.20 | 0.86 | 1.50 | 0.55 | 0.53 | 1.47 | 1.01 | 1.51 | 0.70 | 0.65 | 0.87 | 0.99 | 1.00 | 1.29 | 0.81 | | | | | | |
| [17] | Hoa Diem | 1.12 | 0.95 | 1.40 | 0.72 | 0.60 | 1.38 | 0.74 | 1.34 | 0.78 | 0.58 | 0.52 | 0.79 | 0.89 | 1.15 | 0.84 | 0.49 | | | | | |
| [18] | Neolithic Niah Cave | 1.19 | 1.00 | 0.91 | 1.20 | 0.83 | 1.00 | 1.02 | 1.08 | 1.26 | 1.37 | 1.06 | 0.89 | 1.17 | 0.87 | 0.85 | 1.11 | 0.99 | | | | |
| [19] | Non Nok Tha | 0.88 | 1.11 | 1.34 | 0.52 | 0.69 | 1.11 | 1.06 | 1.12 | 0.96 | 0.81 | 0.73 | 0.60 | 0.90 | 1.16 | 0.58 | 0.88 | 0.80 | 1.21 | | | |
| [20] | Phum Snay | 0.92 | 0.80 | 0.78 | 0.59 | 0.95 | 1.05 | 1.21 | 1.04 | 0.97 | 1.19 | 1.01 | 0.98 | 1.12 | 1.03 | 0.93 | 1.16 | 0.95 | 0.83 | 0.75 | | |
| [21] | Hoabinhian Vietnamese | 1.07 | 1.25 | 1.07 | 1.08 | 1.29 | 0.87 | 0.68 | 0.84 | 1.21 | 1.20 | 0.94 | 1.28 | 1.28 | 0.69 | 0.98 | 0.94 | 1.21 | 0.76 | 1.32 | 1.05 | |
| [22] | Dong Son | 0.88 | 0.82 | 1.08 | 1.30 | 0.86 | 1.38 | 1.11 | 1.20 | 0.60 | 0.45 | 0.91 | 0.75 | 1.04 | 1.24 | 0.82 | 0.78 | 0.71 | 1.02 | 0.99 | 1.21 | 1.21 |
| [23] | Da But Con Co Ngua | 0.87 | 1.16 | 1.23 | 1.00 | 1.05 | 0.83 | 0.69 | 1.16 | 1.32 | 1.10 | 0.90 | 1.34 | 0.87 | 0.69 | 1.03 | 0.80 | 0.93 | 0.97 | 0.92 | 1.20 | 0.71 |
| [24] | Man Bac | 1.13 | 1.31 | 1.43 | 0.81 | 0.44 | 1.39 | 0.89 | 1.41 | 1.02 | 0.65 | 0.65 | 0.43 | 0.55 | 1.44 | 0.72 | 0.81 | 0.73 | 0.87 | 0.62 | 1.24 | 1.21 |
| [25] | Giong Ca Vo | 0.96 | 1.15 | 1.39 | 0.84 | 0.56 | 1.46 | 0.69 | 1.43 | 0.71 | 0.46 | 0.50 | 0.70 | 0.62 | 1.21 | 0.73 | 0.53 | 0.51 | 1.19 | 0.86 | 1.19 | 1.05 |
| [26] | Atayal | 1.03 | 0.92 | 1.33 | 0.58 | 0.34 | 1.52 | 1.15 | 1.35 | 0.56 | 0.43 | 0.76 | 0.63 | 0.72 | 1.43 | 0.78 | 0.44 | 0.64 | 1.27 | 0.63 | 0.98 | 1.43 |
| [27] | Bunun | 0.89 | 0.91 | 1.01 | 0.92 | 0.84 | 1.16 | 1.25 | 1.01 | 0.73 | 0.77 | 1.10 | 0.98 | 0.99 | 1.27 | 0.88 | 1.05 | 1.26 | 1.29 | 0.85 | 0.84 | 1.15 |
| [28] | 海南 Hainan | 1.09 | 1.10 | 1.28 | 0.69 | 0.49 | 1.40 | 1.23 | 1.23 | 0.23 | 0.65 | 0.65 | 0.56 | 0.86 | 1.15 | 0.61 | 0.67 | 0.76 | 1.13 | 0.76 | 0.93 | 1.30 |
| [29] | 安陽 Anyang | 1.03 | 1.64 | 1.18 | 1.12 | 0.80 | 1.20 | 0.76 | 0.73 | 0.89 | 0.59 | 0.91 | 0.77 | 1.11 | 0.99 | 0.75 | 0.88 | 1.00 | 1.16 | 1.10 | 1.48 | 0.78 |
| [30] | Go Ocha | 0.78 | 1.44 | 1.15 | 0.95 | 0.91 | 1.01 | 0.60 | 0.81 | 1.11 | 0.79 | 0.62 | 0.56 | 1.01 | 0.70 | 0.64 | 1.06 | 0.62 | 1.00 | 0.63 | 1.07 | 0.98 |
| [31] | Australian Aborigines | 0.98 | 0.88 | 0.88 | 1.20 | 1.33 | 0.65 | 0.71 | 0.90 | 1.45 | 1.59 | 1.28 | 1.64 | 1.27 | 0.47 | 1.05 | 1.17 | 1.30 | 0.70 | 1.37 | 0.97 | 0.57 |
| [32] | Ban Na Di | 0.85 | 1.08 | 1.25 | 0.92 | 1.10 | 1.11 | 0.81 | 1.03 | 1.31 | 0.94 | 1.13 | 1.08 | 0.97 | 1.25 | 0.79 | 1.00 | 1.13 | 1.28 | 0.76 | 1.16 | 0.92 |
| [33] | 圩墩 Weidun | 1.19 | 1.15 | 1.13 | 0.88 | 0.51 | 1.38 | 1.15 | 1.11 | 1.00 | 0.62 | 0.91 | 0.52 | 0.77 | 1.60 | 0.95 | 1.01 | 1.10 | 1.05 | 0.87 | 1.13 | 1.21 |
| [34] | Jomon | 1.11 | 0.75 | 1.06 | 1.25 | 0.97 | 0.89 | 0.99 | 1.41 | 1.20 | 1.18 | 1.17 | 1.47 | 0.96 | 1.15 | 1.34 | 0.76 | 0.91 | 0.74 | 1.25 | 1.25 | 0.97 |
| [35] | New Britain Islanders | 0.64 | 1.23 | 1.04 | 1.01 | 1.18 | 0.58 | 0.49 | 0.84 | 1.24 | 1.30 | 0.79 | 1.06 | 0.93 | 0.46 | 0.84 | 1.16 | 1.15 | 0.96 | 1.07 | 1.14 | 0.69 |
| [36] | Thai | 1.23 | 1.18 | 1.06 | 0.89 | 0.79 | 1.25 | 1.32 | 0.99 | 0.73 | 0.84 | 0.82 | 0.43 | 0.80 | 1.22 | 0.87 | 1.27 | 0.97 | 0.93 | 0.72 | 0.80 | 1.30 |
| [37] | Thai Chinese | 1.19 | 1.17 | 0.93 | 0.99 | 1.11 | 0.91 | 1.30 | 0.80 | 0.71 | 1.00 | 0.80 | 0.58 | 0.77 | 1.11 | 1.17 | 1.40 | 1.31 | 1.13 | 0.94 | 0.95 | 1.10 |
| [38] | Yayoi | 0.86 | 1.18 | 1.21 | 1.11 | 1.27 | 1.03 | 1.33 | 1.06 | 0.71 | 0.83 | 1.14 | 1.06 | 1.13 | 1.11 | 1.06 | 0.90 | 0.88 | 1.25 | 0.99 | 1.20 | 1.16 |
| [39] | Japan | 1.25 | 1.10 | 1.19 | 0.66 | 0.91 | 1.35 | 1.14 | 0.96 | 0.91 | 0.62 | 0.93 | 0.81 | 1.14 | 1.24 | 0.88 | 0.89 | 0.85 | 1.16 | 0.77 | 0.82 | 1.06 |
| [40] | Ainu Hokkaido | 1.19 | 1.06 | 1.22 | 1.31 | 1.23 | 0.89 | 0.86 | 1.16 | 1.46 | 1.08 | 1.10 | 1.42 | 1.00 | 0.99 | 1.25 | 1.05 | 0.96 | 0.86 | 1.07 | 1.33 | 0.84 |
| [41] | 江南 Jiangnan | 1.05 | 0.83 | 0.71 | 1.14 | 0.77 | 1.18 | 1.21 | 1.10 | 0.80 | 0.90 | 1.31 | 1.15 | 1.05 | 1.21 | 1.08 | 0.87 | 1.23 | 0.87 | 1.27 | 0.86 | 1.01 |
| [42] | 灰窯田 Huiyaotian | 0.87 | 1.11 | 0.66 | 1.46 | 1.19 | 0.43 | 0.74 | 0.79 | 1.31 | 1.42 | 1.08 | 1.07 | 1.13 | 0.54 | 1.02 | 1.27 | 1.26 | 0.74 | 1.11 | 1.30 | 0.98 |
| [43] | 鯉魚坡 Liyupo | 1.14 | 0.88 | 1.01 | 1.24 | 1.40 | 0.98 | 1.00 | 1.21 | 1.14 | 1.11 | 1.14 | 1.58 | 0.97 | 0.93 | 1.41 | 0.85 | 1.04 | 0.97 | 1.43 | 1.06 | 0.48 |

## DISCUSSION AND CONCLUSIONS

The “Two Layer” model, also known as the “Immigration” hypothesis, is an important scenario put forth to understand the population history of Southeast Asia and has been supported by a wide array of archaeological, historical, linguistic, and genetic studies, as mentioned at the beginning of this chapter. These studies have shown that the prehistoric expansion of language families, specifically the Austronesian and Austroasiatic families, can often be linked with the Neolithic dispersal of rice farming populations (Renfrew[29][30][31]; Bellwood[32][33][34]; Hudson [35][36][37]; Higham[38][39]; Hill[40]; Bellwood and Renfrew[41]; and Diamond and Bellwood[42]). Regarding human skeletal remains, there have been long-term debates on this issue (for a review see Oxenham and Tayles[43]). The Guangxi Region in southern China is on the corridor of the Neo-

Table 16-3. (continued)

| | | [22] | [23] | [24] | [25] | [26] | [27] | [28] | [29] | [30] | [31] | [32] | [33] | [34] | [35] | [36] | [37] | [38] | [39] | [40] | [41] | [42] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [23] | Da But Con Co Ngua | 1.39 | | | | | | | | | | | | | | | | | | | | |
| [24] | Man Bac | 0.92 | 0.92 | | | | | | | | | | | | | | | | | | | |
| [25] | Giong Ca Vo | 0.61 | 0.85 | 0.49 | | | | | | | | | | | | | | | | | | |
| [26] | Atayal | 0.57 | 1.28 | 0.69 | 0.39 | | | | | | | | | | | | | | | | | |
| [27] | Bunun | 0.59 | 1.43 | 1.12 | 0.79 | 0.47 | | | | | | | | | | | | | | | | |
| [28] | 海南 Hainan | 0.69 | 1.27 | 0.90 | 0.56 | 0.31 | 0.63 | | | | | | | | | | | | | | | |
| [29] | 安陽 Anyang | 0.64 | 1.00 | 0.89 | 0.63 | 0.78 | 0.80 | 0.75 | | | | | | | | | | | | | | |
| [30] | Go Ocha | 0.90 | 0.82 | 0.76 | 0.81 | 1.05 | 1.39 | 0.97 | 0.61 | | | | | | | | | | | | | |
| [31] | Australian Aborigines | 1.49 | 0.49 | 1.42 | 1.36 | 1.55 | 1.23 | 1.41 | 1.17 | 1.15 | | | | | | | | | | | | |
| [32] | Ban Na Di | 1.04 | 0.78 | 0.58 | 0.77 | 1.02 | 0.80 | 1.37 | 0.95 | 1.13 | 0.93 | | | | | | | | | | | |
| [33] | 圩墩 Weidun | 0.65 | 1.45 | 0.70 | 0.72 | 0.49 | 0.50 | 0.71 | 0.62 | 1.01 | 1.54 | 1.00 | | | | | | | | | | |
| [34] | Jomon | 0.98 | 0.63 | 0.87 | 0.97 | 1.10 | 1.14 | 1.37 | 1.25 | 1.43 | 0.72 | 0.77 | 1.10 | | | | | | | | | |
| [35] | New Britain Islanders | 1.31 | 0.62 | 0.87 | 0.70 | 1.14 | 0.98 | 1.15 | 0.89 | 0.85 | 0.56 | 0.67 | 1.21 | 0.96 | | | | | | | | |
| [36] | Thai | 0.94 | 1.51 | 0.76 | 1.21 | 0.96 | 1.11 | 0.68 | 1.07 | 0.63 | 1.49 | 1.38 | 0.79 | 1.59 | 1.40 | | | | | | | |
| [37] | Thai Chinese | 1.14 | 1.55 | 0.94 | 1.31 | 1.06 | 0.97 | 0.78 | 1.11 | 1.02 | 1.43 | 1.24 | 0.81 | 1.52 | 1.18 | 0.26 | | | | | | |
| [38] | Yayoi | 0.72 | 0.97 | 0.88 | 1.04 | 1.12 | 1.24 | 1.15 | 0.86 | 0.79 | 1.23 | 0.86 | 1.21 | 0.82 | 1.24 | 0.90 | 1.02 | | | | | |
| [39] | Japan | 1.06 | 1.12 | 0.95 | 1.27 | 1.02 | 1.12 | 0.96 | 1.00 | 0.90 | 1.15 | 0.97 | 1.18 | 1.34 | 1.40 | 0.62 | 0.75 | 0.79 | | | | |
| [40] | Ainu Hokkaido | 1.13 | 0.44 | 0.83 | 1.22 | 1.54 | 1.46 | 1.66 | 1.10 | 0.96 | 0.61 | 0.61 | 1.39 | 0.41 | 0.96 | 1.26 | 1.33 | 0.61 | 0.84 | | | |
| [41] | 江南 Jiangnan | 0.64 | 1.30 | 1.19 | 0.81 | 0.62 | 0.37 | 0.75 | 0.81 | 1.54 | 1.07 | 1.09 | 0.67 | 0.87 | 1.16 | 1.31 | 1.25 | 1.27 | 1.30 | 1.39 | | |
| [42] | 灰窯田 Huiyaotian | 0.95 | 0.85 | 0.98 | 1.11 | 1.38 | 1.19 | 1.30 | 0.83 | 0.77 | 0.84 | 1.08 | 1.11 | 0.81 | 0.68 | 1.12 | 1.11 | 0.93 | 1.41 | 0.73 | 1.00 | |
| [43] | 鯉魚坡 Liyupo | 1.22 | 0.68 | 1.13 | 1.14 | 1.45 | 1.41 | 1.48 | 1.29 | 1.18 | 0.65 | 0.92 | 1.49 | 0.68 | 1.02 | 1.17 | 1.08 | 0.76 | 0.94 | 0.55 | 1.21 | 1.12 |

lithic farming dispersal from East Asia to Southeast Asia. Given this location, in order to develop a comprehensive interpretation of early Guangxi population affinities, this study has undertaken multivariable comparisons of Huiyaotian and Liyupo samples and a data set from East/Southeast Asia and the Pacific, using dental metric data and encompassing ethnologically and chronologically different population samples.

The early Holocene Hoabinhian populations, which occupied mainland Southeast Asia, share a common ancestry with present-day Australian Aboriginal and Melanesian people, suggesting that Australo-Melanesians are descended from the first Homo sapiens colonizers of these regions. In Vietnam, as demonstrated in other studies (Matsumura and Oxenham[44]; Matsumura, *et al.*[45]), some cranial and dental traits characterizing the early populations were retained through the subsequent Bac Son Culture (c. 7,000 BP) until the pre-Neolithic Da But Culture (c. 6,000 BP). The Huiyaotian and Liyupo series are contemporary with the post-Hoabinhian Da But cultural phase in northern Vietnam. The odontometric analysis demonstrate that both the Huiyaotian and Liyupo samples have close affinities with the samples from Con Co Ngua of the Da But Culture, suggesting that pre-agricultural foraging communities in Sothern China are akin to the linage through Hoabinhian and Da But foragers in northern Vietnam.

Both regions are geographically separated by the mountains such as Shi wan da shan mountains, but there are many similarities in the shape and making technique of pottery, burial custom and shell utilization. These archeological facts are also good examples of cultural interaction between Northern Vietnam and Southern China.

Furthermore, from the macro-regional perspective, both the Huiyaotian and Liyupo, as well as the early Vietnamese samples, are closely clustered with Australo-Melanesains. As stated earlier, with respect to the origins of modern non-Australo-Melanesian Southeast Asians, the "Two Layer" hypothesis posits that they arose through a greater or lesser degree of genetic exchange between the original indigenous populations (first layer) and immigrants (second layer) from North and/or East Asia. In this respect, the

Huiyaotian and Liyupo people are distinctively assigned as members of the "first layer" in "Two Layer" model.

## SUMMARY

The dental morphology of early Holocene hunter-gatherer Huiyaotian and the Liyupo people in Guangxi Province were investigated and compared with the specimens from surrounding Northeast and Southeast Asia, including the Australians and the Melanesians. In their odontometric traits, these early Holocene hunter-gatherers in Southern China had features similar to Mesolithic Hoabinhian foragers in mainland Southeast Asia and far remote Australo-Melanesians, which are distinctively differentiated from the Northeast Asian features widely dispersed in current China. The dental remains of Huiyaotian and Liyupo people are regionally key specimens to consider the expansion northward into East Asia, to debate the "Two Layer" model, and to understand population history of Southeast Asia.

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# 17
# Comparative Study of the Limb Bones at Huiyaotian and Liyupo

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This chapter assesses the robustness and proportion of upper and lower limb bones and statures estimated via limb bone length for the Huiyaotian (灰窑田) and Liyupo (鲤鱼坡) people. The size and proportion of the appendicular long bones, morphologically formed as a result of physical activities, nutritional condition, and genetic contributions, provide significant information in the understanding of the ante-mortem lifestyle and lineage of buried individuals.

## MATERIALS AND METHODS

The limb bone measurements and indices, followed by Martin's[1] definitions, for the individual specimens from Huiyaotian and Liyupo are given in Chapters 8 and 14 respectively. The comparisons were made in regards to cross sectional indices of limb shafts, limb proportions evaluated using brachial and crural indices, and statures estimated using limb length.

The brachial index is the length ratio of the fore-arm (radius) to upper arm (humerus), and the crural index indicates the tibial-femoral length ratio expressing the proportion of the lower leg length to thigh length.

Stature estimations were made using several regression formulae derived from different East Asian population samples and based on the maximum length of long bones. Those formulae adopted for the Huiyaotian and Liyupo specimens were the regression equations of Stevenson[2] derived from Northern Chinese samples, those of Trotter and Gleser[3] derived from Asian Americans, those of Mo[4] derived from Southern Chinese samples, those of Fujii [5] derived from Japanese samples, those of Sangvichien *et al.*[6] derived from Thai/Chinese samples, and those of Sjøvold[7] derived from nonspecific ethnic populations. Among these, only Fujii and Sangvichien *et al.* provided sex specific equations. In order to assess the most suitable stature estimation equations for the Huiyaotian and Liyupo series, this study compared estimated statures calculated using different kinds of long bones (femur and tibia) and assessed the discrepancies among the different regression equations. Then, the regression equation set, which indicated the smallest discrepancy between estimated statures based on different long bones, was taken as the most appropriate formula to estimate the statures of the target populations.

## RESULTS

Table 17-1 gives basic statistics for the cross-sectional indices of limb shafts recorded for Huiyaotian and Liyupo specimens. The indices of several prehistoric samples in China (cited from Zengpiyan 甑皮岩[8]; Weidun 圩墩[9]; Jiangnan 江南series from Spring-Autumn to Western Han Periods consisting of the site of Fuquanshan 福泉山, Maqiao 马桥, Tashan 塔山, Huating 华庭[9] and Neolithic Man Bac Vietnamese[10] are shown in this table as reference values.

Table 17-1. Comparison of upper limb bones with Huiyaotian, Liyupo and other sites.

| Site | Huiyaotian | | | | | | Liyupo | | | | | | Zengpiyan* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | Males | | | Females | | | Males | | | Females | | | Males | | | Females | | |
| | n | Mean | SD | n | Mean | SD | n | Mean | SD | n | Mean | SD | n | Mean | SD | n | Mean | SD |
| Humerus | | | | | | | | | | | | | | | | | | |
| 6/5. Mid-shaft cross-section index | 8 | 70.7 | 4.4 | 6 | 74.2 | 6.6 | 7 | 76.0 | 9.5 | 8 | 74.8 | 6.9 | 3 | 87.3 | 8.0 | 4 | 80.9 | 10.4 |
| Radius | | | | | | | | | | | | | | | | | | |
| 5/4. Mid-shaft cross-section index | 10 | 74.2 | 11.4 | 9 | 65.3 | 27.2 | 6 | 73.9 | 8.3 | 5 | 75.0 | 7.4 | — | — | — | — | — | — |
| Ulna | | | | | | | | | | | | | | | | | | |
| 11/12. Shaft cross-section index | 8 | 93.4 | 8.9 | 6 | 87.9 | 15.7 | 5 | 83.9 | 6.6 | 6 | 87.8 | 5.9 | — | — | — | — | — | — |
| Femur | | | | | | | | | | | | | | | | | | |
| 6/7. Mid-shaft cross-section index (Pilastric) | 11 | 107.3 | 7.0 | 7 | 113.4 | 6.7 | 7 | 119.2 | 9.2 | 13 | 113.3 | 8.1 | 3 | 112.2 | 6.3 | 4 | 113.6 | — |
| 9/10. Prox. shaft cross-section index (Platymeric) | 12 | 75.5 | 6.6 | 9 | 79.8 | 5.6 | 7 | 81.1 | 4.9 | 11 | 77.6 | 3.5 | 3 | 73.4 | 5.5 | 4 | 74.5 | — |
| Tibia | | | | | | | | | | | | | | | | | | |
| 9’/8. Mid-shaft cross-section index | 5 | 73.5 | 4.2 | 3 | 70.9 | 4.7 | 5 | 72.5 | 6.2 | 8 | 70.9 | 6.6 | — | — | — | — | — | — |
| 9a’/8a. Shaft cross-section index | 8 | 67.6 | 5.4 | 5 | 65.5 | 4.0 | 6 | 72.2 | 6.9 | 10 | 69.3 | 7.9 | 4 | 63.4 | 1.6 | 2 | 64.2 | 0.6 |
| Fibula | | | | | | | | | | | | | | | | | | |
| 3/2. Mid-shaft cross-section index | 7 | 73.6 | 14.8 | 3 | 67.6 | 9.3 | 3 | 67.6 | 7.7 | 7 | 65.6 | 7.8 | 0 | — | — | — | — | — |
| Brachial index (Rad.1/Hum.1) based on average lengths | | 77.3 | | | 83.4 | | | 79.0 | | | 76.6 | | | | | | | |
| Crural index (Tib.1a/Fem.1) based on average lengths | | 81.1 | | | | | | 82.5 | | | 80.9 | | | | | | | |

| Site | Weidun** | | | | | | Man Bac**** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | Males | | | Females | | | Males | | | Females | | |
| | n | Mean | SD | n | Mean | SD | n | Mean | SD | n | Mean | SD |
| Humerus | | | | | | | | | | | | |
| 6/5. Mid-shaft cross-section index | 14 | 76.8 | 5.6 | 12 | 75.8 | 5.3 | 14 | 78.4 | 9.7 | 7 | 72.3 | 5.1 |
| Radius | | | | | | | | | | | | |
| 5/4. Mid-shaft cross-section index | 9 | 71.4 | 5.7 | 6 | 69.6 | 5.4 | 14 | 71.5 | 6.1 | 7 | 72.1 | 5.5 |
| Ulna | | | | | | | | | | | | |
| 11/12. Shaft cross-section index | 6 | 81.0 | 3.6 | 2 | 89.3 | 5.1 | 14 | 88.9 | 20.5 | 7 | 85.8 | 17.2 |
| Femur | | | | | | | | | | | | |
| 6/7. Mid-shaft cross-section index (Pilastric) | 24 | 111.5 | 11.2 | 15 | 98.9 | 6.1 | 15 | 108.2 | 12.2 | 7 | 104.1 | 5.7 |
| 9/10. Prox. shaft cross-section index (Platymeric) | 23 | 82.5 | 6.2 | 13 | 80.9 | 4.0 | 15 | 77.6 | 8.6 | 6 | 77.1 | 8.9 |
| Tibia | | | | | | | | | | | | |
| 9’/8. Mid-shaft cross-section index | 21 | 69.1 | 5.9 | 13 | 74.2 | 4.9 | 12 | 66.3 | 5.4 | 6 | 68.5 | 1.6 |
| 9a’/8a. Shaft cross-section index | 18 | 66.4 | 6.2 | 13 | 71.2 | 5.0 | 12 | 66.0 | 9.9 | 6 | 67.4 | 4.3 |
| Fibula | | | | | | | | | | | | |
| 3/2. Mid-shaft cross-section index | 5 | 77.6 | 10.5 | 6 | 65.2 | 7.4 | 12 | 66.3 | 10.7 | 6 | 66.7 | 5.9 |
| Brachial index (Rad.1/Hum.1) based on average lengths | | 80.3 | | | 79.2 | | | 81.0 | | | 79.2 | |
| Crural index (Tib.1a/Fem.1) based on average lengths | | 82.4 | | | 79.9 | | | 85.6 | | | 84.2 | |

*Institute of Archaeology (CASS) *et al.*[8], **Wakebe 2002[9], ***Matsumura *et al.* 2008[10]

## Limb shaft cross-section index

The mid-shaft cross-section index of the humerus (6/5=minimum mid-shaft diameter/maximum mid-shaft diameter) of the Huiyaotian are slightly greater in the female (74.2) than the male (70.7), indicating more rounded robust humeral shaft for the females of Huiyaotian. The sexual difference in Liyupo is smaller (males=76.0, females=74.8), due to the females also possessing robust humeri. The humeral shafts of either sex of the two sites are categorized into moderate roundness so-called "eurybrachia" of the cross section at the humeral mid-shaft.

The mid-shaft cross-section index of the radius (5/4=sagittal shaft diameter/maximum transversal diameter) of the Huiyaotian is considerably greater in males (74.2) than in females (65.3). On the other hand, the sexual discrepancy in the Liyupo is quite small (females=75.0, males=73.9), indicating that the females carry robust radial shafts in comparison to the males. These values of both sites are, although males are slightly greater, in range of moderate level.

As for the ulnal shafts, the cross-section index (11/12=dorso-ventral shaft diameter/transversal shaft diameter) of Huiyaotian males is particularly large (93.4), indicating a very robust ulnal shape.

The mid-shaft cross-section index of the femur (6/7=transverse mid-shaft shaft diameter/sagittal mid-shaft diameter), the "pilastric index," relates to the degree of development of the linear aspera. The index of the Huiyaotian females (107.3) is comparable to that of the males (113.3), indicating that even females have robust pilastric forms associated with well-developed linea aspera. Liyupo males (119.2) are characterized by more robust femoral shafts than the others.

The proximal shaft cross-section index (9/10=transverse proximal shaft diameter/sagittal proximal shaft diameter), the "platymeric index," reflects the degree of flatness of the upper portion of the femoral shaft. Among the Huiyaotian people, females (79.8) have a flatter upper shaft than males (75.5); however, among the Liyupo people, the males (81.1) have upper shafts that are flatter than that of females (77.6). These specimens, as well as other comparative samples, are classified as having moderate flatness.

The shaft cross-section index of tibia (9a'/8a.=maximum transverse diameter/maximum sagittal diameter) evaluates the transversal flatness or sagittal thickness of the tibial shaft at the level of the nutrient foramen. The Liyupo males (72.2) show particularly greater values, indicating a very transversely flat shaft and sagittally wide robustness.

## Brachial and crural indices

The brachial index (Rad.1/Hum.1=maximum length of radius/maximum length of humerus) and crural index (Tib.1a/Fem.1=maximum length of tibia/maximum length of femur), which evaluate the limb length proportions within the upper limbs and lower limbs respectively, are shown in Table 17-1. Figure 17-1 schematizes these two indices of Huiyaotian and Liyupo males together with other representative population samples, that is the Neolithic Ban Chiang in Thailand (Pietrusewsky and Douglas[11]), Dayak in Borneo (Yokoh[12]), Japanese and Neolithic Jomon in Japan (Takigawa[13]), Tasmanian (Roth[14]), Chinese (Olivier[15]), Iron Age Yayoi Japanese (Wakebe[9]), Australian Aborigines and Hawaiians (Olivier[15]), Han Chinese, and Neolithic Weidun Southern

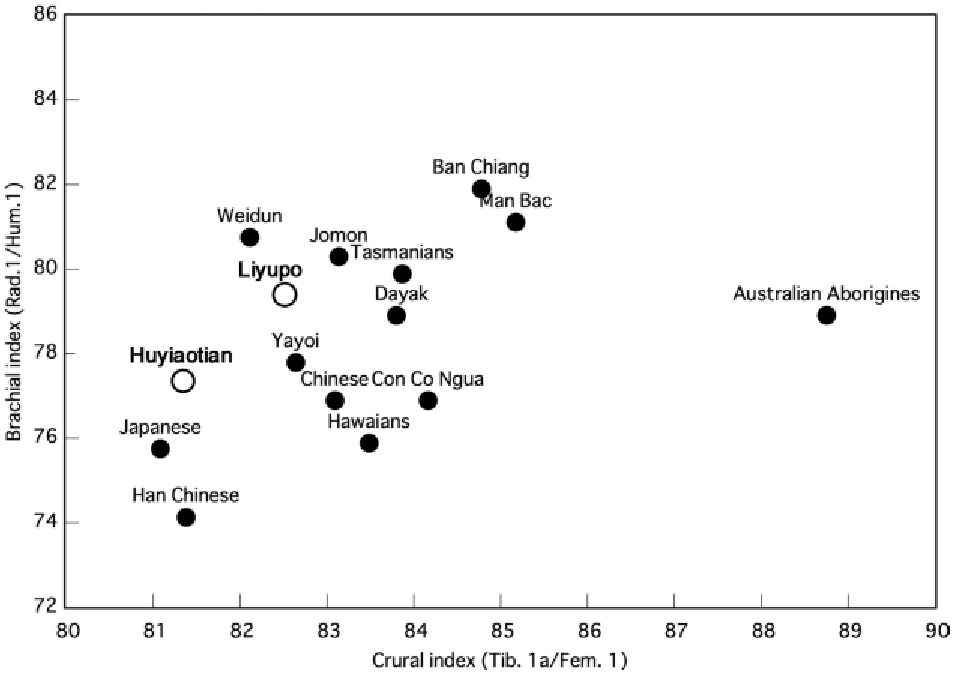


Figure 17-1. Crural and brachial indices for the comparative samples.

Chinese (Wakebe[9]). Both the Huiyaotian and Liyupo are characterized by proportionality almost the same in range of other East and Southeast Asian samples, except Japanese and Han Chinese who poses relatively shorter fore arms and fore legs.

## Stature estimation

Tables 17-2 and 17-3 give the results of estimated statures for Huiyaotian and Liyupo individuals, respectively. The stature estimations were performed using several sets of regression equations on the basis of long bone lengths. The estimated statures varied with the formulae used, as well as with the bone segments used. This fluctuation was caused by the differences in body proportion among the original population samples used to provide the regression equations for stature estimations. In order to assess the most suitable set of equations for the Huiyaotian and Liyupo specimens, the consistency of estimated statures was compared amongst the regression formulae. Therefore, Tables 17-2 and 17-3 show the differences in stature estimation based on the femoral and tibial lengths. Consequently, the smallest discrepancies were given in estimations using Sangvichien, *et al.*'s equations for Huiyaotian and Trotter and Gleser's formulae for Liyupo.

The average estimated statures are 164.6 cm by femoral length and 160.2 cm by tibial length for Huiyaotian males and 161.6 cm (femur) and 156.7 cm (tibia) for the females. Liyupo males are 163.3cm and 161cm for the females. As compared with mean estimated statures of four comparative samples (Table 17-4), the statures of Huiyaotian and Liyupo males are moderate. The females are relatively high among the reference samples, and the both Huiyaotian and Liyupo people are characterized by small

Table 17-2. Estimated statures (cm) of Huiyaotian series.

| Sample No. | M5 | M7 | M8 | M10 | M14 | M16 | M19 | M20 | M29 | M43 | M46-2 | M56 | Huiyaotian Averages | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | M | F | M | M | M | F | F | F | F | M | F | M | Males | | | Females | | |
| Stature estimation | | | | | | | | | | | | | n | Mean | SD | n | Mean | SD |
| Stevenson (1929): northern Chinese (femur) | — | — | 167.8 | — | — | 173.9 | — | 164.1 | — | — | 158.0 | 171.2 | 2 | 169.5 | 2.4 | 3 | 165.3 | 8.0 |
| Stevenson (1929): northern Chinese (tibia) | — | — | — | 170.3 | 161.8 | — | — | — | 162.1 | 159.1 | — | 172.7 | 4 | 166.0 | 6.5 | 1 | 162.1 | — |
| Stevenson (1929): northern Chinese (humerus) | 175.2 | 163.1 | 168.7 | — | 172.8 | — | 156.1 | — | — | — | 160.3 | — | 3 | 172.3 | 3.3 | 3 | 159.8 | 3.5 |
| Trotter & Gleser (1958): USA Asians (femur) | — | — | 165.9 | — | — | 171.4 | — | 162.7 | — | — | 157.2 | 169.2 | 2 | 167.6 | 2.3 | 3 | 163.8 | 7.1 |
| Trotter & Gleser (1958): USA Asians (tibia) | — | — | — | 169.2 | 162.5 | — | — | — | 162.8 | 160.4 | — | 171.0 | 4 | 165.8 | 5.1 | 1 | 162.8 | — |
| Mo (1983): southern Chinese (femur) | — | — | 162.1 | — | — | 167.8 | — | 158.7 | — | — | 153.1 | 165.3 | 2 | 163.7 | 2.3 | 3 | 159.9 | 7.4 |
| Mo (1983): southern Chinese (tibia) | — | — | — | 164.6 | 156.2 | — | — | — | 156.5 | 153.5 | — | 167.0 | 4 | 160.3 | 6.5 | 1 | 156.5 | — |
| Fujii (1960) Japanese (femur) | — | — | 162.3 | — | — | 168.5 | — | 158.6 | — | — | 152.5 | 165.8 | 2 | 164.1 | 2.4 | 3 | 159.9 | 8.1 |
| Fujii (1960) Japanese (tibia) | — | — | — | 164.6 | 157.7 | — | — | — | 158.0 | 155.5 | — | 166.6 | 4 | 161.1 | 5.3 | 1 | 158.0 | — |
| Fujii (1960) Japanese (humerus) | 166.1 | 154.2 | 159.7 | — | 163.8 | — | 147.2 | — | — | — | 151.4 | — | 3 | 163.2 | 3.2 | 3 | 150.9 | 3.5 |
| Sangvichien *et al.* (1985) Thai/Chinese (femur) | — | — | 163.3 | — | — | 167.7 | — | 160.7 | — | — | 156.4 | 165.8 | **2** | **164.6** | **1.7** | **3** | **161.6** | **5.7** |
| Sangvichien *et al.* (1985) Thai/Chinese (tibia) | — | — | — | 164.1 | 156.4 | — | — | — | 156.7 | 153.9 | — | 166.3 | **4** | **160.2** | **6.0** | **1** | **156.7** | — |
| Sjøvold (1990): nonspecific population (femur) | — | — | 163.7 | — | — | 170.5 | — | 159.7 | — | — | 152.9 | 167.5 | 2 | 165.6 | 2.7 | 3 | 161.0 | 8.9 |
| Sjøvold (1990): nonspecific population (tibia) | — | — | — | 168.1 | 158.9 | — | — | — | 159.2 | 155.9 | — | 170.7 | 4 | 163.4 | 7.1 | 1 | 159.2 | — |
| Sjøvold (1990): nonspecific population (humerus) | 163.8 | 144.0 | 153.2 | — | 160.0 | — | 132.4 | — | — | — | 139.4 | — | 3 | 159.0 | 5.4 | 3 | 138.6 | 5.8 |
| Difference of stature estimation based on comparisons between femoral and tibial lengths | | | | | | | | | | | | | | | | | | |
| Stevenson (1929) | — | — | — | — | — | — | — | — | — | — | — | 1.5 | | 1.5 | | | | |
| Trotter & Gleser (1958) | — | — | — | — | — | — | — | — | — | — | — | 5.7 | | 5.7 | | | | |
| Mo (1983) | — | — | — | — | — | — | — | — | — | — | — | 1.7 | | 1.7 | | | | |
| Fujii (1960) | — | — | — | — | — | — | — | — | — | — | — | 0.8 | | 0.8 | | | | |
| Sangvichien *et al.* (1985) | — | — | — | — | — | — | — | — | — | — | — | 0.5 | | **0.5** | | | | |
| Sjøvold (1990) | — | — | — | — | — | — | — | — | — | — | — | 3.2 | | 3.2 | | | | |

bold: stature estimation regarded as most adequate for Huiyaotian series.

Table 17-3. Estimated statures (cm) of Liyupo series.

| Sample No. | M7 | M8 | M15 | M16 | M17 | M22 | M24 | M26 | M27 | M28 | M29 | M30 | M35 | M38 | M39 | Liyupu Averages | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | F | F | F | F | F | F | M | M | M | F | M | F | M | F | F | Males | | | Females | | |
| Stature estimation | | | | | | | | | | | | | | | | | | | | | |
| Stevenson (1929): northern Chinese (femur) | 162.9 | 167.0 | 160.5 | — | — | — | 160.9 | — | 158.0 | 172.8 | — | — | 169.7 | 159.2 | 164.4 | 3 | 162.9 | 6.1 | 6 | 164.5 | 5.4 |
| Stevenson (1929): northern Chinese (tibia) | 161.2 | — | 162.4 | — | — | — | 161.5 | — | 163.6 | — | — | — | 168.5 | 158.2 | 163.0 | 3 | 164.5 | 3.6 | 4 | 161.2 | 2.6 |
| Stevenson (1929): northern Chinese (humerus) | — | — | — | 164.8 | 161.7 | 156.4 | 166.8 | 170.1 | — | — | 165.4 | 167.1 | 171.0 | 160.0 | — | 4 | 168.3 | 2.7 | 5 | 162.0 | 3.7 |
| Trotter & Gleser (1958): USA Asians (femur) | 161.6 | 164.9 | 159.2 | — | — | — | 159.6 | — | — | — | — | — | 167.0 | 158.1 | 161.8 | **2** | **163.3** | **5.2** | **5** | **161.1** | **1.8** |
| Trotter & Gleser (1958): USA Asians (tibia) | — | — | 161.6 | — | — | — | 160.9 | — | 162.3 | — | — | — | 166.8 | 158.3 | 164.2 | **3** | **163.3** | **2.7** | **3** | **161.4** | **2.0** |
| Mo (1983): southern Chinese (femur) | 157.6 | 161.4 | 155.3 | — | — | — | 155.8 | — | 153.0 | 166.8 | — | — | 163.9 | 154.2 | 158.9 | 3 | 157.6 | 5.7 | 6 | 159.1 | 5.6 |
| Mo (1983): southern Chinese (tibia) | 155.5 | — | 156.8 | — | — | — | 155.9 | — | 158.0 | — | — | — | 162.8 | 152.6 | 157.4 | 3 | 158.9 | 3.5 | 4 | 155.6 | 2.7 |
| Fujii (1960) Japanese (femur) | 157.4 | 161.6 | 154.9 | — | — | — | 155.4 | — | 152.4 | 167.5 | — | — | 164.3 | 153.7 | 158.9 | 3 | 157.4 | 6.2 | 6 | 159.0 | 5.4 |
| Fujii (1960) Japanese (tibia) | 157.2 | — | 158.2 | — | — | — | 157.5 | — | 159.2 | — | — | — | 163.2 | 154.8 | 158.7 | 3 | 160.0 | 2.9 | 4 | 157.2 | 1.8 |
| Fujii (1960) Japanese (humerus) | — | — | — | 155.8 | 152.8 | 147.5 | 157.8 | 161.1 | — | — | 156.4 | 158.1 | 162.0 | 151.1 | — | 4 | 159.3 | 2.7 | 5 | 153.0 | 4.4 |
| Sangvichien *et al.* (1985) Thai/Chinese (femur) | 159.9 | 162.8 | 158.2 | — | — | — | 158.5 | — | 156.4 | 166.9 | — | — | 164.7 | 157.3 | 160.9 | 3 | 159.9 | 4.3 | 6 | 161.0 | 4.4 |
| Sangvichien *et al.* (1985) Thai/Chinese (tibia) | 155.8 | — | 156.9 | — | — | — | 156.1 | — | 158.0 | — | — | — | 162.5 | 153.1 | 157.5 | 3 | 158.9 | 3.3 | 4 | 155.8 | 3.3 |
| Sjøvold (1990): nonspecific population (femur) | 158.3 | 162.9 | 155.6 | — | — | — | 156.2 | — | 152.9 | 169.4 | — | — | 165.9 | 154.3 | 160.0 | 3 | 158.3 | 6.8 | 6 | 160.1 | 6.0 |
| Sjøveled (1990): nonspecific population (tibia) | 158.2 | — | 159.5 | — | — | — | 158.5 | — | 160.8 | — | — | — | 166.1 | 154.9 | 160.2 | 3 | 161.8 | 3.9 | 4 | 158.2 | 2.3 |
| Sjøveled (1990): nonspecific population (humerus) | — | — | — | 146.8 | 141.7 | 132.9 | 150.0 | 155.5 | — | — | 147.7 | 150.4 | 156.9 | 138.9 | — | 4 | 152.5 | 4.4 | 5 | 142.1 | 9.6 |
| Difference of stature estimation based on comparisons between femoral and tibial lengths | | | | | | | | | | | | | | | | | | | | | |
| Stevenson (1929) | 1.7 | — | 2.0 | — | — | — | 0.6 | — | 5.7 | — | — | — | 1.2 | 1.0 | 1.3 | 1.9 | | | | | |
| Trotter & Gleser (1958) | — | — | 2.4 | — | — | — | 1.3 | — | — | — | — | — | 0.2 | 0.2 | 2.4 | **1.3** | | | | | |
| Mo (1983) | 2.1 | — | 1.4 | — | — | — | 0.1 | — | 5.0 | — | — | — | 1.1 | 1.6 | 1.6 | 1.8 | | | | | |
| Fujii (1960) | 0.2 | — | 3.3 | — | — | — | 2.1 | — | 6.8 | — | — | — | 1.2 | 1.1 | 0.2 | 2.1 | | | | | |
| Sangvichien *et al.* (1985) | 4.1 | — | 1.2 | — | — | — | 2.4 | — | 1.7 | — | — | — | 2.3 | 4.2 | 3.4 | 2.7 | | | | | |
| Sjøveled (1990) | 0.2 | — | 3.9 | — | — | — | 2.4 | — | 8.0 | — | — | — | 0.2 | 0.7 | 0.2 | 2.2 | | | | | |

bold: stature estimation regarded as most adequate for Huiyaotian series.

Table 17-4. Estimated statures (cm) at comparative sites.

| Site | Zengpiyan* | | | | | | Weidun** | | | | | | Jiangnan** | | | | | | Man Bac*** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | males | | | females | | | males | | | females | | | males | | | females | | | males | | | females | | |
| Stature estimation | | | | | | | | | | | | | | | | | | | | | | | | |
| Stevenson (1929): northern Chinese (femur) | 4 | 168.4 | 3.3 | 4 | 169.7 | 3.4 | **20** | **168.1** | **3.6** | **11** | **159.9** | **2.3** | 9 | 168.7 | 2.1 | 1 | 161.4 | — | 13 | 164.5 | 7.5 | 6 | 160.3 | 3.7 |
| Stevenson (1929): northern Chinese (tibia) | 3 | 166.1 | 3.7 | 4 | 171.6 | 1.8 | **18** | **177.5** | **3.6** | **9** | **156.7** | **3.7** | 3 | 165.3 | 4.2 | 0 | — | — | 11 | 168.3 | 9.4 | 5 | 160.1 | 3.5 |
| Stevenson (1929): northern Chinese (humerus) | 4 | 172.3 | 2.5 | 5 | 167.4 | 4.3 | 15 | 169.8 | 2.1 | 8 | 160.3 | 2.5 | 3 | 172.0 | 2.0 | 0 | — | — | 12 | 166.6 | 6.4 | 3 | 161.0 | 3.3 |
| Trotter & Gleser (1958): USA Asians (femur) | **3** | **164.7** | **3.2** | **4** | **166.7** | **6.3** | 20 | 165.4 | 3 | 11 | 158.0 | 2.2 | 10 | 166.0 | 1.7 | 1 | 160.1 | — | 13 | 163.2 | 6.6 | 6 | 159.5 | 3.3 |
| Trotter & Gleser (1958): USA Asians (tibia) | **3** | **165.9** | **2.9** | **4** | **170.2** | **1.4** | 18 | 176.8 | 2.8 | 9 | 158.5 | 2.9 | 3 | 165.3 | 3.3 | 0 | — | — | 11 | 167.7 | 7.5 | 4 | 162.2 | 3.6 |
| Mo (1983): southern Chinese (femur) | 4 | 162.7 | 3.1 | 4 | 163.9 | 6.5 | 20 | 162.4 | 3.3 | 11 | 154.9 | 2.2 | 9 | 162.9 | 2.0 | 1 | 156.2 | — | 13 | 159.1 | 7.0 | 6 | 155.2 | 3.4 |
| Mo (1983): southern Chinese (tibia) | 0 | — | — | 0 | — | — | 18 | 169.8 | 3.7 | 9 | 150.2 | 3.8 | 3 | 158.1 | 4.6 | 0 | — | — | 11 | 162.8 | 9.5 | 4 | 155.8 | 4.5 |
| Fujii (1960) Japanese (femur) | 4 | 163.0 | 3.4 | 4 | 164.3 | 7.1 | 20 | 162.7 | 3.6 | 11 | 154.4 | 2.4 | **9** | **163.3** | **2.1** | **1** | **155.9** | **—** | 13 | 159.1 | 7.6 | 6 | 151.6 | 3.4 |
| Fujii (1960) Japanese (tibia) | 0 | — | — | 0 | — | — | 18 | 170.6 | 3.1 | 9 | 152.8 | 3.2 | **3** | **159.3** | **3.7** | **0** | — | — | 11 | 163.2 | 7.8 | 4 | 153.6 | 6.0 |
| Fujii (1960) Japanese (humerus) | 4 | 163.2 | 2.5 | 5 | 158.4 | 4.3 | 15 | 160.8 | 2.1 | 8 | 151.4 | 2.5 | 3 | 163.0 | 2.0 | 0 | — | — | 12 | 157.7 | 6.4 | 3 | 148.6 | 2.8 |
| Sangvichien *et al.* (1985) Thai/Chinese (femur) | 4 | 163.8 | 2.4 | 4 | 164.7 | 5.0 | 20 | 163.6 | 2.5 | 11 | 157.8 | 1.7 | 9 | 164.0 | 1.5 | 1 | 158.8 | — | **13** | **162.2** | **5.3** | **6** | **156.2** | **3.9** |
| Sangvichien *et al.* (1985) Thai/Chinese (tibia) | 0 | — | — | 0 | — | — | 18 | 169.6 | 3.4 | 9 | 150.9 | 3.5 | 3 | 158.1 | 4.2 | 0 | — | — | **11** | **163.8** | **8.7** | **4** | **155.5** | **4.5** |
| Sjøvold (1990): nonspecific population (femur) | 4 | 164.5 | 3.7 | 4 | 165.8 | 7.8 | 20 | 164.2 | 4 | 11 | 155.0 | 2.6 | 9 | 164.7 | 2.3 | 1 | 156.7 | — | 13 | 160.1 | 8.4 | 6 | 155.4 | 4.1 |
| Sjøveled (1990): nonspecific population (tibia) | 0 | — | — | 0 | — | — | 18 | 173.1 | 4.1 | 9 | 152.4 | 4.2 | 3 | 161.0 | 5.0 | 0 | — | — | 11 | 166.1 | 10.3 | 4 | 158.5 | 5.0 |
| Sjøveled (1990): nonspecific population (humerus) | 4 | 159.0 | 4.1 | 5 | 151.0 | 7.1 | 15 | 155 | 3.5 | 8 | 139.4 | 4.1 | 3 | 158.6 | 3.3 | 0 | — | — | 12 | 158.8 | 10.6 | 3 | 149.6 | 5.4 |

| Site | Zengpiyan* | Weidun** | Jiangnan** | Man Bac*** |
|---|---|---|---|---|
| Difference of stature estimation based on comparisons between humeral and femoral lengths | | | | |
| Stevenson (1929) | 3.8 | 2.8 | 2.5 | 2.7 |
| Fujii (1960) | 4.9 | 2.9 | 1.2 | 2.7 |
| Sjøveled (1990) | 11.0 | 10.6 | 7.1 | 3.5 |
| Difference of stature estimation based on comparisons between femoral and tibial lengths | | | | |
| Stevenson (1929) | 2.2 | **1.8** | 0.7 | 2.6 |
| Trotter & Gleser (1958) | **2.0** | 2.0 | 1.8 | 3.9 |
| Mo (1983) | — | 2.5 | 0.8 | 2.8 |
| Fujii (1960) | — | 1.9 | **0.4** | 3.4 |
| Sangvichien *et al.* (1985) | — | 3.8 | 2.3 | **0.6** |
| Sjøveled (1990) | — | 2.0 | 0.7 | 5.1 |

bold: stature estimation regarded as most adequate for each series.
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sexual differences in terms of stature.

## SUMMARY

This chapter describes quantitative morphology, as represented by skeletal measurements of the upper and lower limb bones of the Huiyaotian and Liyupo populations. In comparisons with surrounding prehistoric samples from China and Vietnam, both sets of limb bones are neither highly robust, nor gracile, but moderate.

The brachial and crural indices are considered to be important to evaluate ethnic features in respect to body proportion. A low value, reflecting shorter forearms or forelegs, relates to cold climate adaptation, as was seen in Northeast Asians. In comparison to several population samples, both the Huiyaotian and Liyupo do not have proportionally long forelegs, like Australian aborigines, while their forearms are not specifically short, like the Han Chinese and Japanese, but proportionally moderate.

The statures were estimated using several different sets of regression equations, and the consistency of estimated values using different limb segments was tested between the equations by the different providers. Consequently, computation using Sangvichien, *et al.*'s formulae derived from Thai/Chinese cadavers was regarded as the most appropriate procedure to estimate the statures of the Huiyaotian people. Meanwhile, Trotter and Gleser's formulae derived from American Asians was selected for the Liyupo people as the most appropriate model to estimate stature. The calculated average male statures for Huiyaotian and Liyupo using femoral or tibial length data are given in the range of 160–165 cm, and the females of these two sites as 156–162 cm. Male height is moderate among the comparative population samples, and the females are relatively tall.

Though the analysis of limb bone measurements in this chapter is preliminary, the recorded data provided here would be useful on a more extensive study addressing ante-mortem physical activity, nutritional conditions, and genetic relationships with other populations.

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# 18
# Health Profiles of the Huiyaotian and Liyupo Hunter-Gatherers

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The living environment and health conditions of prehistoric hunter-gatherers in the southern region of China, before the start of agriculture, remains poorly understood (cf. Zhang and Hung)[1]. Here, we provide a closer look at the appearance of paleopathological characteristics in the Huiyaotian and Liyupo hunter-gatherers, and compare our findings to those of human remains from the late Neolithic Man Bac site (ca. 3,800-3,500 years ago) in northern Vietnam[2], which is located close to the Huiyaotian and Liyupo sites of southern China.

## MATERIALS AND METHODS

This chapter assesses the occurrence ratio of cribra orbitalia (CO), linear enamel hypoplasia (LEH) in the upper first incisor (UI1) and lower canine (LC), dental caries, periodontitis, antemortem tooth loss (AMTL), external auditory exostosis (EAE), vertebral osteophyte, periostitis, and limb arthritis.

For the Huiyaotian and Liyupo human remains, the paleopathological data reported in Chapter 5 and 11 of this monograph were used. During the analyses of stress markers (e.g., CO and LEH), oral health indicators (e.g., dental caries, periodontitis, and AMTL), and EAE comparisons were made against the human remains found at the Man Bac. Occurrences of LEH and EAE in the Man Bac human remains were observed and recorded by author (J. S.), while the other paleopathological data for the Man Bac remains were excerpted from Oxenham and Domett[3].

## RESULTS

The occurrence frequencies of paleopathological characteristics are summarized in Table 18-1. Results from comparing the Huiyaotian, Liyupo, and Man Bac human remains groups according to each paleopathological characteristic are as follows.

### Stress markers (CO and LEH)

The rates of CO occurrence, LEH occurrence in the UI1s, and LEH occurrence in the LCs are summarized in Figures 18-1, 18-2, and 18-3, respectively. Both CO and LEH in the LCs tended to be most frequent in the Man Bac and the least in the Huiyaotian remains.

We used Fisher's exact test to examine the differences among the populations with regard to the rate of occurrence of each stress marker. As such, a significant difference

Table 18-1. Frequencies of paleopathological characteristics in the Huiyaotian, Liyupo and Man Bac human remains

| | Huiyaotian | | Liyupo | | Man Bac | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Cribra orbitalia (CO)[1] | 1/14 | 7.1 | 2/10 | 20.0 | 19/26 | 73.1 |
| Linear enamel hypoplasia (LEH) in UI1[2, 3] | 9/13 | 69.2 | 5/6 | 83.3 | 22/31 | 71.0 |
| Linear enamel hypoplasia (LEH) in LC[2, 4] | 10/26 | 38.5 | 10/14 | 71.4 | 24/29 | 82.8 |
| Dental caries[2] | 11/548 | 2.0 | 34/272 | 12.5 | 64/581 | 11.0 |
| Periodontitis[5] | 10/687 | 1.5 | 8/446 | 1.8 | 13/727 | 1.8 |
| Antemortem tooth loss (AMTL)[5] | 23/687 | 3.3 | 31/446 | 7.0 | 19/727 | 2.6 |
| Cervical vertebral osteophyte | 3/43 | 7.0 | 1/52 | 1.9 | — | — |
| Thoracic vertebral osteophyte | 4/74 | 5.4 | 2/106 | 1.9 | — | — |
| Lumbar vertebral osteophyte | 5/23 | 21.7 | 4/47 | 8.5 | — | — |
| Periostitis of the humerus[6] | 1/35 | 2.9 | 0/28 | 0.0 | — | — |
| Periostitis of the radius[6] | 1/25 | 4.0 | 0/19 | 0.0 | — | — |
| Periostitis of the ulna[6] | 0/25 | 0.0 | 0/15 | 0.0 | — | — |
| Periostitis of the femur[6] | 0/41 | 0.0 | 0/35 | 0.0 | — | — |
| Periostitis of the tibia[6] | 2/40 | 5.0 | 2/31 | 6.5 | — | — |
| Periostitis of the fibula[6] | 1/23 | 4.3 | 0/24 | 0.0 | — | — |
| Arthritis of the scapula glenoid cavity[6] | 1/19 | 5.3 | 0/9 | 0.0 | — | — |
| Arthritis of the humerus proximal end[6] | 0/13 | 0.0 | 0/19 | 0.0 | — | — |
| Arthritis of the humerus distal end[6] | 0/33 | 0.0 | 0/27 | 0.0 | — | — |
| Arthritis of the radius proximall end[6] | 0/25 | 0.0 | 0/25 | 0.0 | — | — |
| Arthritis of the radius distal end[6] | 1/27 | 4.0 | 0/16 | 0.0 | — | — |
| Arthritis of the ulna trochlear notch[6] | 0/37 | 0.0 | 0/26 | 0.0 | — | — |
| Arthritis of the os coxae acetabular fossa[6] | 0/5 | 0.0 | 0/21 | 0.0 | — | — |
| Arthritis of the femur proximall end[6] | 0/28 | 0.0 | 0/26 | 0.0 | — | — |
| Arthritis of the femur distal end[6] | 0/10 | 0.0 | 0/28 | 0.0 | — | — |
| Arthritis of the patella[6] | 4/20 | 20.0 | 2/23 | 8.7 | — | — |
| Arthritis of the tibia proximall end[6] | 0/3 | 0.0 | 0/21 | 0.0 | — | — |
| Arthritis of the tibia distal end[6] | 0/20 | 0.0 | 0/26 | 0.0 | — | — |
| Arthritis of the fibula distal end[6] | 0/20 | 0.0 | 0/18 | 0.0 | — | — |
| Arthritis of the talus (subtalar joint)[6] | 1/36 | 2.8 | 0/18 | 0.0 | — | — |
| Arthritis of the calcaneus (talar joint)[6] | 1/22 | 4.5 | 0/14 | 0.0 | — | — |

[1] Number of individuals with CO/Total number of individuals.
[2] Number of teeth with LEH/Total number of teeth remains.
[3] UI1: upper first incisor.
[4] LC: lower canine.
[5] Number of teeth lost antemortem/Total number of sockets in maxilla and mandible remains.
[6] The left and right were combined.

at the 0.01 level in the rate of CO occurrence was observed between the Huiyaotian and Man Bac human remains groups and the Liyupo and Man Bac human remains groups. Regarding the rate of LEH occurrence in the LCs, a significant difference at the 0.01 level was observed between the Huiyaotian and Man Bac human remains groups. No significant difference was observed in the rate of LEH occurrence in the UI1s among the human remains groups at the 0.05 significance level.

**Oral health indicators (dental caries, periodontitis, and AMTL)**

In juvenile specimens, no instances of dental caries in permanent teeth, periodontitis, or AMTL were observed. As such, the rate of occurrence in adult permanent teeth of dental caries is summarized in Figure 18-4, the rate of occurrence of periodontitis is shown in Figure 18-5, and the rate of occurrence of AMTL is shown in Figure 18-6. Both dental caries and AMTL tended to be most frequent in the Liyupo human remains

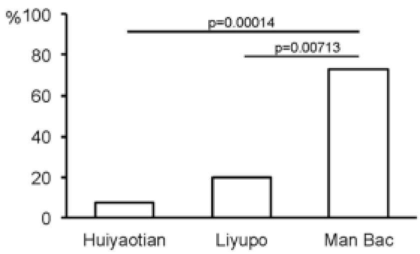


Figure 18-1. Occurrence rates of CO. (P values were computed by Fisher's exact test.)

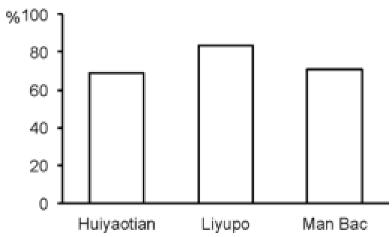


Figure 18-2. Occurrence rates of LEH in the UI1.

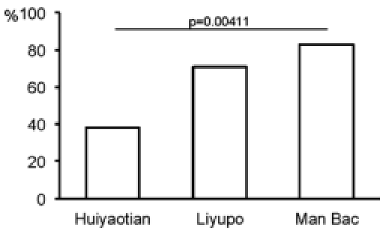


Figure 18-3. Occurrence rates of LEH in the LC. (P value was computed by Fisher's exact test.)

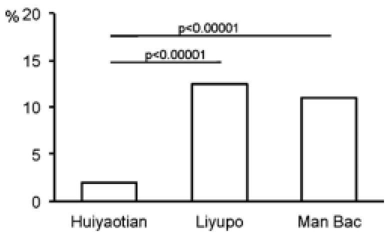


Figure 18-4. Occurrence rates of dental caries. (P values were computed by Fisher's exact test.)

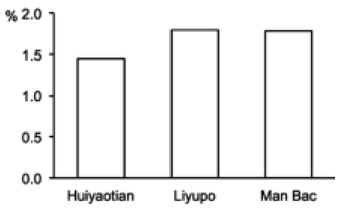


Figure 18-5. Occurrence rates of periodontitis.

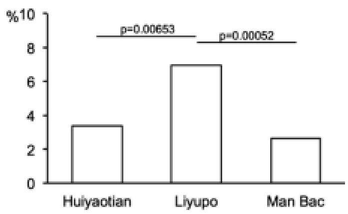


Figure 18-6. Occurrence rates of AMTL. (P values were computed by Fisher's exact test.)

group.

When examining the differences in rates of pathological characteristic occurrence among the groups using Fisher's exact test, a significant difference at the 0.001 level was observed between the Huiyaotian and Liyupo human remains groups and the Huiyaotian and Man Bac human remains groups with regard to occurrence of dental caries. Regarding the rate of AMTL occurrence, a significant difference was observed between the Huiyaotian and Liyupo human remains groups and the Liyupo and Man Bac human remains groups at the 0.01 significance level. However, no significant difference in the

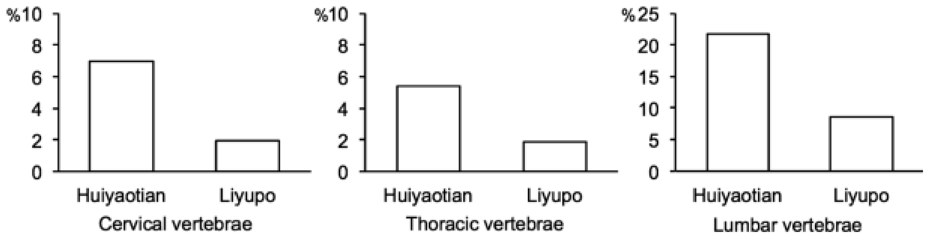


Figure 18-7. Occurrence rates of vertebral osteophyte.

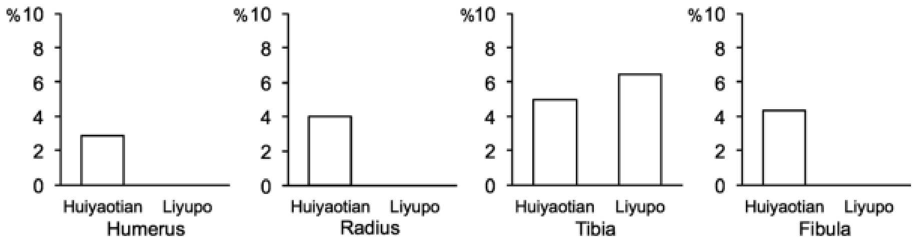


Figure 18-8. Occurrence rates of periostitis in limb bones.

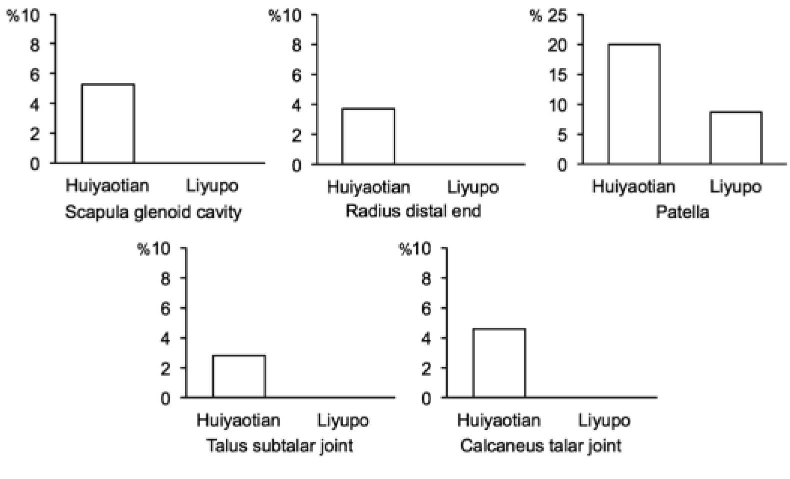


Figure 18-9. Occurrence rates of limb arthritis. (No arthritis was found in the limb joints other than the articular surface shown in this figure.)

rate of periodontitis occurrence was observed among the human remains groups at the 0.05 significance level.

**EAE**

In the Liyupo human remains group, EAE was observed in three specimens, but was not observed in any specimen in the Huiyaotian and Man Bac human remains groups.

**Postcranial pathological characteristics (vertebral osteophytes, periostitis, and limb arthritis)**

The rate of vertebral osteophyte occurrence in adult vertebrae is summarized in Figure 18-7, the rate of arthritis occurrence in adult limb joints is summarized in Figure 18-8, and the rate of occurrence of periostitis in adult limb bones is summarized in Figure 18-9. The rate of occurrence for almost all of these characteristics was found to be higher in the Huiyaotian human remains group compared to the Liyupo human remains group, although no significant difference was observed between these groups at the 0.05 significance level in Fisher's exact test.

## DISCUSSION

Despite the geographical and periodical proximity of Huiyaotian and Liyupo sites, the rate of occurrence of multiple paleopathological characteristics differed between these two human remains groups. This suggests that the living environments and health conditions of the various pre-agriculture hunter-gatherer communities in southern China were not homogeneous.

The main causes of CO are iron-deficiency anemia and vitamin $B_{12}$ deficiency during the developmental period [4, 5, 6], and the main causes of LEH in permanent teeth are systemic stresses such as conditions associated with nutritional deficiencies and metabolic abnormality during the tooth crown enamel formation period of infancy and early childhood [7, 8]. The occurrences of both CO and LEH in the Liyupo human remains group were higher than those in the Huiyaotian human remains group, which indicates that the nutritional and health conditions during Liyupo inhabitants' childhood development were poorer than those for the Huiyaotian inhabitants.

In addition, the rates of CO and LEH occurrence in the late Neolithic human remains from the Man Bac site were higher than those observed in both the Huiyaotian and Liyupo hunter-gatherers' remains. During prehistoric times in North America and the Levant region, the rates of occurrence of stress markers increased when subsistence shifted from hunting and gathering to agriculture, because the early farmers depended on one primary type of food resource (i.e., seasonal deficiencies in food supply may have led to a decline in living conditions) [7, 8, 9, 10]. Oxenham and colleagues [11, 12] revealed that similar health changes occurred in Vietnam, Southeast Asia. The results of our study showed that there were cases in which health conditions of the Huiyaotian and Liyupo hunter-gatherers were better than those of the late Neolithic Man Bac early farmers, which is consistent with the findings of Oxenham and colleagues [11, 12], reinforcing their view.

The rates of occurrence of oral pathological traits such as dental caries, periodontitis, and AMTL observed in the Liyupo human remains group were higher than those seen in the Huiyaotian human remains group. Such traits reflect the overall quality of oral hygiene [13]. In general, the caries rate of hunter-gatherers around the world is as low as a few percent [10, 14, 15], so the caries rate exceeding 10% in the Liyupo remains is somewhat significant. Regarding the lifestyle habits related to oral hygiene and whether Liyupo inhabitants ingested larger amounts of carbohydrate foods (often associated with the development of caries) compared to the Huiyaotian inhabitants, a stable isotope analysis of human remains and zooarcheological and plant archeological studies of the Liyupo and Huiyaotian will be necessary to conduct more detailed examinations and analyses of dietary habits.

The main causes of vertebral osteophyte formation and arthritis of limb joints are aging and long-term burdens [13, 16]. In addition, the main causes of periostitis of limb bones are excessive physical activity that directly impacts bones and/or infections [13]. The rates of occurrence of postcranial pathological characteristics in the Huiyaotian human remains group were higher than those in the Liyupo human remains group, which suggests that the Huiyaotian inhabitants were subjected to lifestyles involving frequent heavy loads placed on the postcranial bones. Vertebral osteophyte and limb arthritis tend to increase with age; however, since both Huiyaotian and Liyupo human remains include few elderly individuals (see Chapter 3 and 10), it is unlikely that the difference in the occurrence rates of osteophyte and arthritis between both groups is attributable to differences in age.

## CONCLUSION

The occurrence rates of stress markers, oral health indicators, and EAEs in the Liyupo human remains group were higher than those in the Huiyaotian human remains group; conversely, the occurrence rates of most postcranial pathological characteristics such as vertebral osteophytes, periostitis, and limb arthritis were higher in the Huiyaotian human remains group. These findings suggest that the status of paleohealth and living environments—including the nutritional and health conditions during childhood, the quality of oral hygiene, and physical activity of the pre-agriculture hunter-gatherer communities of southern China—were not homogeneous.

The rates of occurrence of stress markers in the prehistoric hunter-gatherers who lived at the Huiyaotian and Liyupo sites were lower when compared to the rates observed in the late Neolitchic inhabitants of the Man Bac site. As such, the overall health condition and living status seems to have not immediately improved with the introduction of agriculture in the southeastern corner of the Eurasian continent.

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# 19
# Mitochondrial DNA Analysis of the Human Remains Excavated from Huiyaotian and Liyupo

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Advances in molecular biological techniques have facilitated the recovery and analysis of DNA from ancient materials, thereby enabling an objective approach to studying the genetic composition of past populations. Studies are taking place currently to elucidate how groups have formed by investigating, how the structures of genes change over time based on analysis of the DNA found in archaeological human remains. To understand the origin of a past population, DNA analysis of ancient human remains is effective, because it provides the genetic characteristics of these people. To clarify the genetic characteristics of Huiyaotian and Liyupo in southern China, ancient DNA analysis was conducted on human skeletal remains excavated from both prehistoric hunter-gatherer's sites.

## MATERIALS AND METHODS

(Archeological specimens)

Tooth enamel forms a natural barrier to exogenous DNA contamination. Furthermore, the DNA recovered from teeth appears to lack most of the inhibitors of the enzymatic amplification of ancient DNA[1]. Therefore, tooth samples were used in the present analysis. A total of 41 well-preserved tooth samples (25 from Huiyaotian and 16 from Liyupo) were selected for DNA analysis. In addition, because recent research reveals that the temporal bone is a good region from which to analyze aDNA[2], tooth and temporal bone samples that excavated at 2016 were added in this analysis. A list of all samples used in this study is presented in Tables 19-1 and 19-2.

(Authentication methods and extraction of DNA)

DNA analyses were performed at the National Museum of Nature and Science and at Yamanashi University, which have dedicated laboratories for ancient DNA analysis. Standard precautions were taken to avoid contamination, e.g., separation of pre- and post-PCR experimental areas, use of disposable laboratory ware and filter-plugged pipette tips, treatment with DNA contamination removal solution (DNA Away; Molecular Bio Products, San Diego, CA, USA), UV irradiation of equipment and benches, and negative extraction and PCR controls[3].

First, exact replicas of each tooth were prepared for the other morphological studies.

Table 19-1. Samples used for DNA extraction and the results from Huiyaotian.

| No. | Sample code | portion | PCR | APLP |
|---|---|---|---|---|
| 1 | T1003 M5 | Maxilla, Right, M3 | Negative | Negative |
| 2 | T1003 M7 | Mandible, Right, M3 | Negative | Negative |
| 3 | T1003 M9 | Mandible, Left, M1 | Negative | Negative |
| 4 | T1003 M18 | Mandible, Right, M2 | Negative | Negative |
| 5 | T1003 M19 | Maxilla, Right, M2 | Negative | Negative |
| 6 | T1003 M25 | Mandible, Left, M3 | Negative | Negative |
| 7 | T1003 M27 | Mandible, Left, M2 | Negative | Negative |
| 8 | T1003 M36-1 | Maxilla, Left, M3 | Negative | Negative |
| 9 | T1003 M37 | Maxilla, Right, PM1 | Negative | Negative |
| 10 | T1003 M38 | Mandible, Left, M2 | Negative | Negative |
| 11 | T1003 M43 | Maxilla, Left, M2 | Negative | Negative |
| 12 | T1003 M45 | Mandible, Right, M3 | Negative | Negative |
| 13 | T1003 M46 | Mandible, Left, M3 | Negative | Negative |
| 14 | T1003 M51 | Maxilla, Left, M3 | Negative | Negative |
| 15 | T1003 M54 | Maxilla, Right, M3 | Negative | Negative |
| 16 | T1003 M57 | Maxilla, Right, M2 | Negative | Negative |
| 17 | T1003 M8 | Maxilla, Left, M2 | Negative | Negative |
| 18 | T1003 M29 | Mandible, Right, M3 | Negative | Negative |
| 19 | T1004 M20 | Mandible, Right, M3 | Negative | Negative |
| 20 | T1004 M28 | Mandible, Right, M3 | Negative | Negative |
| 21 | T1009, M1 | Unknown | Negative | Negative |
| 22 | T1009, M2 | Unknown | Negative | Negative |
| 23 | T1003 M17 | Temporal bone | Not experimented | M7* |
| 24 | T1003 M45 | Temporal bone | Not experimented | Negative |
| 25 | T1009 No.98 | Mandible, Left, M1 | Not experimented | Negative |

To prevent contamination from post-excavation handling, the tooth samples were rinsed with DNA-decontamination agents and then washed thoroughly with distilled water before drying. Next, the samples were encased in silicone rubber (Provil novo Heraeus Kulzer GmbH, Hanau, Germany). The tip of the root of the tooth sample was removed by a horizontal cut using a cutting disk, and the dentin around cavities and dental pulp were powdered and removed through the root tip by using a dental drill as described by Gilbert, *et al.*[4]. The powdered samples were decalcified with 0.5 M EDTA (pH 8.0) (Invitrogen, Carlsbad, CA, U.S.A.) at room temperature overnight. Then, the EDTA buffer was replaced by fresh buffer, and samples were decalcified for a further 48 hours. Decalcified samples were lysed in 500 $\mu$l of Fast Lyse (Genetic ID, Fairfield, IA, U.S.A.) with 30 $\mu$l of 20 mg/ml Proteinase K (Invitrogen) at 60℃ for 4 hours. DNA was extracted from the lysate using a FAST ID DNA Extraction Kit (Genetic ID) in accordance with the technical manual.

A segment of hypervariable region (HVR) 1 (nucleotide positions 16121 to 16238 and 16209 to 16402, relative to the revised Cambridge reference sequence[5] were amplified all samples except samples excavated at 2016. Only APLP analysis was done

Table 19-2. Samples used for DNA extraction and the results of the analyses from Liyupo.

| No. | Sample code | portion | PCR | APLP |
|---|---|---|---|---|
| 1 | M2 | Maxilla, Right, M3 | Negative | Negative |
| 2 | M3 | Mandible, Left, M1 | Negative | Negative |
| 13 | M3 | Mandible, Left, M3 | Negative | Negative |
| 3 | M6 | Maxilla, Left, M1 | Negative | Negative |
| 4 | M7 | Mandible, Left, M1 | Negative | (R) |
| 5 | M8 | Maxilla, Left, M2 | Negative | Negative |
| 6 | M10 | Maxilla, Right, C | Negative | Negative |
| 7 | M12 | Mandible, Right, M2 | Negative | Negative |
| 8 | M14 | Maxilla. Right, M1 | Negative | Negative |
| 9 | M16 | Maxilla, Right, PM1 | Negative | Negative |
| 10 | M17 | Maxilla, Left, M3 | Negative | Negative |
| 11 | M22 | Maxilla, Left, M3 | Negative | Negative |
| 12 | M29 | Maxilla, Left, M3 | Negative | Negative |
| 14 | M37 | Mandible, Right, M2 | Negative | Negative |
| 16 | M35 | Temporal bone | Not experimented | Negative |
| 15 | M17 | Temporal bone | Not experimented | D4a4 |

in these samples. Two-microliter aliquots of the extracts were used as the templates for PCR. Amplifications were carried out in a total reaction volume of 25 $\mu$l containing one unit of Taq DNA polymerase (HotStarTaqTM DNA polymerase; QIAGEN), 0.1 $\mu$M of each primer, and 100 $\mu$M of dNTPs in 1× PCR buffer provided by the manufacture. The conditions for PCR were as follows: incubation at 95˚C for 15 min; 40 cycles at 94˚C for 20 s, 50˚C −56˚C for 20 s, 72˚C for 15 s; and final extension at 72˚C for 1 min. The primers used to amplify the regions described above are same as used by Shinoda, *et al.*[6]. The PCR products were recovered from 1.5% agarose gel using a QIAEX II Agarose Gel Extraction kit (Qiagen, Germany).

Mitochondrial DNA SNPs were detected using the amplified product length polymorphism (APLP) method[7][8]. This method has been applied to ancient DNA analyses and has yielded convincing results[3][9]. In this study, 11 SNPs in the coding region and a 9-bp pair repeat variation in the non-coding cytochrome oxidase II/tRNALys intergenic region were analyzed by the multiplex APLP method using the primer sets described by Adachi, *et al.*[10]. The polymorphic sites examined in this study have been proved to cover most of the haplogroup-defining mutations in East Asian mtDNAs. The constitution of the PCR reaction mixture, thermal conditions, and the method for separating and detecting PCR products were the same as described by Adachi, *et al.*[11].

## RESULTS AND DISCUSSION

The primary objective of the present experiment was to verify whether DNA was retained in analyzable conditions within the human skeletal remains excavated from these sites. However, a product failed to yield in PCR amplification in all samples except 2016 excavated samles. Table 19-1, Table 19-2, and Figure 19-1 show the

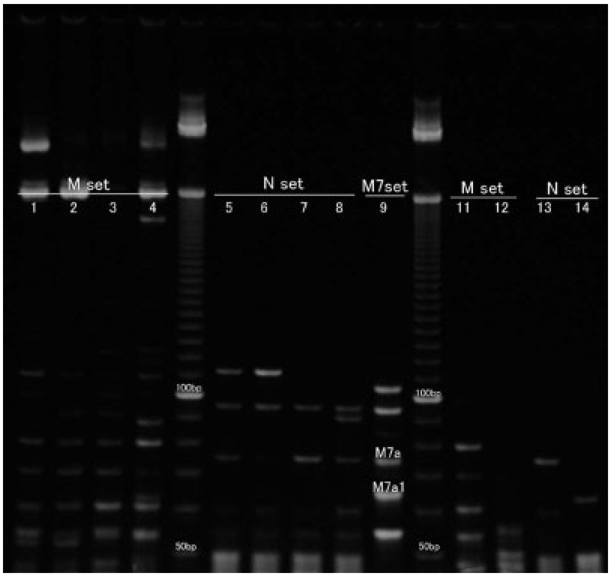


Figure 19-1. An example of the APLP analysis of a single Liyupo sample.
1; T11M3, 2; T11M6, 3; T11M8, 4; T11, M12, Lane 5; Ladder marker, 5; T11M3, 6; T11M6, 7; T11M8, 8; T11M12, 9: Positive control (Japanese sample that haplogroup is M7a1), Lane 11; Ladder marker, 11; Negative control, 12; Blank control, 13; Negative control, 14; Blank control. In this analysis, primers set M distinguish haplogroup M7, M8, G, D and D4. Primers set N distinguish haplogroup N, B, R, F, N9 and A.

results of PCR amplification of HVR1 and the genotyping of coding regions by APLP methods. Among the 41 individuals considered in this study, an mtDNA haplogroup was successfully assigned for only two samples on the basis of APLP analysis. Moreover, data was extracted only from the temporal bone samples. Every primer that is used in the multiplex PCR produces 50 to 100 base pair amplified products. Therefore, it is safely said that most of samples have DNA segment remains that are over 50 base pairs.

The number of samples for which DNA sequences could be determined was small in the present analysis, so unfortunately, very little could be concluded based on the results. However, the present experiment proved that sufficient amounts of DNA are retained in temporal bone samples, even though the efficiency of analysis may be poor. Thus, we believe that there is significance in continuing the experiments to obtain more detailed data on the human skeletal remains from these sites.

Since hot and humid conditions are unfavorable to the preservation of DNA in human remains, the possibilities are low for finding well-preserved DNA in a tropical region like South China. However, the establishment of kinship among numerous individuals buried at a single burial site may provide us with extremely valuable pieces of information regarding the social structure of the time. Furthermore, if it were possible to collect DNA data of the people inhabiting a single region over a prolonged period, it may be possible to deduce the movement of groups and the population dynamics in the region. Recent advances in the next generation of sequencing procedures enable us to analyze the small pieces of DNA fragments[12]. Therefore, it will be worth the effort to study these samples again using improved techniques.

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from the Funadomari site, Hokkaido, and its implication for the origin of Native Americans. American Journal of Physical Anthropology, 2009, 138: 255–265.

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# 20
# Neolithic Transition in Guangxi: a Long Development of Hunting-Gathering Society in Southern China

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## INTRODUCTION

Since the early 20th Century, it has been argued that Southeast Asia was occupied initially by an Australo-Melanesian population that later underwent substantial genetic admixture with East Asian immigrants associated with the spread of agriculture from the Neolithic period onwards. This model currently is known as the *Two-Layer Hypothesis*. Through multivariate comparisons, using cranial and dental metrics, several previous studies concluded the Two-Layer formation of prehistoric populations in Southeast Asia (e.g. Matsumura and Zuraina[1]; Matsumura and Pookajorn[2]; Matsumura[3]; Matsumura *et al.*[4][5][6]). This hypothesis has been confirmed by genetic study in northern Vietnam (e.g. Shinoda[7]). A key focus of this research in this volume is to understand the ancient population formation especially during the late Pleistocene and middle Holocene in southern China.

Southern China played an important role in the origins of farming for neighboring regions especially Taiwan, Hainan, and Mainland/Island Southeast Asia. Guangxi is located at a strategic position, between the Yangtze River and Mainland Southeast Asia, and thus it is ideal for investigating the issue of Neolithic transition, including the complicated involvements of varied populations, subsistence, plants, animals, and cultural practices in the transition process. For example, did two or more layers of human populations inhabit ancient Guangxi, especially during the period from the late Palaeolithic to early Neolithic phases? When did the major movements occur? How did these movements relate with plants, animals, and material culture? Based on the research questions mentioned here, this chapter first will review archaeological chronology and regional culture phases in Guangxi. Secondly, the cultural characteristics and the results from physical anthropology studies will be incorporated in order to clarify the formation of regional culture and people in Guangxi. Finally, Guangxi will be placed in the larger geographical context of southern China and Southeast Asia for interpreting its long process of Neolithic transition.

## A BRIEF SUMMARY OF GUANGXI PREHISTORY

The world's oldest pottery so far has been discovered in southern China, dated to 18,000 BC in Xianrendong Cave of Hunan Province (Boaretto *et al.*[8]; Wu *et al.*[9]), 12,000 BC in Zengpiyan Cave in Guangxi (Institute of Archaeology, Chinese Academy of Social Science *et al.*[10]), and 11,000–10,000 BC in Chihedong Cave in Fujian of southeast China (Fan[11]). The earliest Guangxi pottery so far is recorded in Zengpiyan and several other nearby caves.

No evidence of agriculture was associated with these earliest pottery assemblages in southern China. Farther to the north, the emergence of rice farming can be traced back to 7,000–6,000 BC in a core region including the Hui River (between Yellow and Yangtze Rivers), the middle Yangtze, and the lower Yangtze Valley. It became well developed ca. 5,000 BC especially in the noted core region. Rice farming did not occur in most areas of southern China, such as Fujian, Guangdong, Guangxi, and Yunnan, until 3,000–2,500 BC (Zhang and Hung[12]). When rice cultivation began in the core region ca. 7,000 BC, hunter-gathers in Guangxi and other provinces of southern China left their cave shelters, and then they occupied large open settlements on river terraces (Zhang and Hung[13]).

Since the early Holocene, some hunter-gatherer groups co-existed with early rice cultivators in China, thus indicating that a variety of mixed economies co-existed for several thousand years in the broad areas of southern China. In our previous study (Zhang and Hung[13]), we defined three types of subsistence strategy during the long-term cultural development in the Lingnan-Fujian region from the late Pleistocene to middle Holocene, referring to the provinces of Guangdong, Guangxi, and Fujian (Table 20-1):

1. Pleistocene hunting-gathering, documented mostly in caves;
2. More complex hunting-gathering in the terminal Pleistocene and early Holocene, in both caves and open settlements, with pottery and large cemeteries; and
3. The development of farming during the middle Holocene.

The Guangxi region supported varied types of prehistoric sites from the late Pleistocene through middle Holocene, such as at large caves, rockshelters, shell middens, the so-called "large stone shovel" sites, burial caves, and open settlements. The chronology and relations between different types of sites were not clear until very recently. Based on our previous work and the present study, a brief outline can be proposed of three major cultural phases in Guangxi.

### 1. Hunter-gatherers in caves, from the terminal Pleistocene to early Holocene

In Guangxi, one of the most earliest modern human remains is the Liujiang series unearthed from Liuzhou region (Figure 20-1). A study suggested the fossils would date at least as early as ～68 ka, but more likely it was ～139–111 ka or perhaps even older

Table 20-1. Chronological contexts of southern Chinese Neolithic cultures, both of farmers and of complex hunter-gatherers (the latter in italics).

| Region | | *Yangtz Alluvial Plain* | | | | | | *South of the Nanling Mountains* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Hubei & Xia-Jiang** | | **Dongting Lake Region** | **Southern Hunan** | **Gan-Bo Region** | **Jiang-Zhe Region** | **Guangxi** | **Guangdong** | **Fujian** | **Taiwan** |
| Age | Phase | Xia-Jiang region: Three Gorges | Hubei region | Dongting Lake Plain | Yuanshui River Region | Gan Valley Poyang-Lake | Yangtze Delta | | | | |
| 18000-7000 BC | Late Palaeolithic to Early Neolithic | | | *Yuchanyan Cave* | | *Xianrendong & Diaotonghuan Caves* | | *Dayan, Miaoyan & Zengpiyan Caves* | *Niulandong Cave* | | |
| | | | | | | | Shangshan Culture | | | | |
| 7000-5000 BC | Middle Neolithic | | Pengtoushan Culture | Pengtoushan Culture | | | Xiaohuangshan-Kuahuqiao Culture | *Dingsishan Culture* | | | |
| | | *Xia-Jiang variant of the Chengbeixi Culture* | Chengbeixi Culture | Zaoshi culture | *Gaomiao variant* | | | | | | |
| 5000-3000 BC | Early Phase of Late Neolithic | *Xia-Jiang variant of the Daxi Culture* | Daxi Culture | Daxi Culture | *Late Gaomiao* | Shiniianshan Culture | Hemudu Culture | *Dingsishan Culture* | *Xiantouling Culture*** | | |
| | | | | | Yuanshui variant of the Daxi Culture* | | Majiabang Culture | | | *Keqiutou & Fuguodun Culture* | |
| | | | | | | | Early Songze Culture | | | | *Early Dabenkeng Culture* |
| | | *Yuxiping variant* | | | | | Late Songze Culture | | | | |
| 3000-2100 BC | Late Phase of Late Neolithic | Qujialing Culture | Qujialing Culture | Qujialing Culture | Qujialing Culture | Early Fanchengdui | Liangzhu Culture | *Dingsishan Culture?* | Shixia Culture | Tanshisan Culture | Late Dabenkeng Fine Cord-Marked Pottery Culture |
| | | Early Shijiahe Culture | Early Shijiahe Culture | Early Shijiahe Culture | Early Shijiahe Culture | Late Fanchengdui Culture and Shanbei Culture | | | | | |
| | | Middle Shijiahe Culture | Middle Shijiahe Culture | Middle Shijiahe Culture | Middle Shijiahe Culture | | | | | | |
| 2100-1800 BC | Terminal Neolithic | Late Shijiahe Culture | | Late Shijiahe Culture | Late Shijiahe Culture | | Nandang Culture | Dingsishan Phase 4 | | | |

* or called Songxikou Culture.

** or called Lingnan variant of the Daxi Culture.

Figure 20-1. The Tongtiandong Cave of Liujiang skeletons in Liuzhou of Guangxi (Photo by HC Hung in 2010).

than ~153 ka (Shen *et al.*[14]). However, the date of Liujiang specimens is still in debate, especially now with a new study of cranial morphology suggesting the age of the Liujiang series should be younger than the Upper Cave series in Beijing (Liu *et al.*[15]), thus indicating a context that was younger than 30,000–16,000 BC.

Similar to other areas of southern China during this time, *c.*18,000–7,000 cal. BC, caves with large quantities of shell midden have been also found in Guangxi, for example in Zengpiyan, Miaoyan, and Dayan Caves of Guilin, and in Bailiandong and Liyuzui Caves of Liuzhou (Figures 20-2 and 20-3). Similar cave deposits occur in northern Vietnam during this time. The stone technologies and assemblages from these Guangxi caves are similar to those of the Hoabinhian sites in Southeast Asia. Very importantly, several cave sites in the late Pleistocene of Guangxi have produced pottery. Coarse pottery with temper of quartz grit was found in some cave sites, such as Dayan, Miaoyan, and Zengpiyan Caves.

In Guangxi, Zengpiyan Cave has produced so far the province's earliest pottery, dated more than 10,000 years old since the site's earliest cultural phase. The cultural sequence in Zengpiyan can be distinguished in 5 phases: ca. 10,000–9,000 BC for Phase 1, ca. 9,000–8,000 BC for Phase 2, ca. 8,000–7,000 BC for Phase 3, ca. 7,000–6,000 BC for Phase 4, and ca. 6,000–5,000 BC for Phase 5. At Zengpiyan Cave, so far 27 human individuals have been excavated since the 1970s. Among 15 of the better preserved burials unearthed in 1973 and 2001, 12 are in squatted (crouched) position, and 3 are in flexed position (Institute of Archaeology, Chinese Academy of Social Science *et al.*[16]).

Over time at the cave sites from 10,000 BC through 5,000 BC, the number of exploited animal species apparently increased. Generally, about 20–30 kinds of animal, especially deer, are reported from these caves. The aquatic animals primarily are shellfish, fish, and turtles. Additionally, bird bones were reported in Zengpiyan. Plant macro-remains recovered from Zengpiyan and the contemporaraneous Yuchanyan Site in Hunan include Chinese gooseberries, wild grapes, plums, Chinese hackberries, hickory nuts, and many other edible plant seeds. Also in Zengpiyan, unidentified charred


Figure 20-2. Bailiandong Cave in Liuzhou of Guangxi (Photo by HC Hung in 2010).


Figure 20-3. Zengpiyan Cave in Guilin of Guangxi (Photo by HC Hung in 2010).

tubers possibly were *Dioscorea* sp. and *Colocasia* sp. (Yuan[17]; Institute of Archaeology, Chinese Academy of Social Science *et al.*[18]).

The main lithic industry found in Bailiandong Cave and Liyuzui Rockshelter during this phase included chert and quartz scrapers, pointed tools, other small flake tools and pebble tools. The cultural deposit in Bailiandong can be identified in 5 cultural phases. In phase 1 (ca. 34,000–24,000 BC), the stone tools are mainly small chert tools (94%) with small amounts of larger pebble tools. In phase 2 (ca. 24,000–18,000 BC), the number of pebble tools increased, and then in the following phase (phase 3, ca. 18,000–10,000 BC), pebble tools became the dominant. The phase 4 (9,000–7,000 BC) of Bailiandong was characterized by shell midden. Pebble tools still were the most popular artifacts, while small numbers of chert flakes and polished stone tools also appeared. Some potsherds have been discovered from phase 5 (ca. 5,000 BC), with small numbers of chert tools (Jiang[19]).

At Liyuzui Rockshelter in Dalongtan of Liuzhou, four discovered human skeletons (ca. 9,000 BC) are in flexed position (Liu *et al.*[20]; Jiang[21]). In the previous study, although it was concluded that both the Zengpiyan and Liyuzui people were of North-east Asian (Mongoloid) type, nonetheless some Negroid type features were recorded. Moreover, it has been suggested that both Zengpiyan and Liyuzui individuals shared certain cranial characteristics with the Liujiang series, as mentioned above (e.g. Institute of Archaeology, Chinese Academy of Social Science *et al.*[22]; Liu *et al.*[20]; Zhou and Zhang[23]). A re-examination of the cranial affinitions has been conducted by this project, which will be discussed later.

## 2. Hunter-gatherers in open sites, from the early to middle Holocene

From *c*. 7,000 BC onwards, open settlements began to appear on river terraces in Guangxi. One of the best known hunter-gather societies is named as the Dingsishan Culture. Dingsishan Cultural shell middens are widely distributed in Guangxi, western Guangdong and northern Vietnam *c.* 7,000–3,000 BC. Most of them are located on the terraces of the Zuojiang, Youjiang, and Yongjiang rivers near Nanning, in southern Guangxi. So far, more than 40 shell midden sites of Dingsishan association have been reported. As discussed, the Dingsishan Culture shared very similar characteristics representing a strong link with the Da But Cultural group in northern Vietnam (Zhang and Hung[13]).

The Dingsishan Culture is represented by phases 2 and 3 of the Dingsishan Site itself. According to the excavators, the cultural deposit of this site was divided in 4 cultural phases, including phase 1 as the pre-Dingsishan Cultural Period (8,000–7,000 BC), phases 2–3 as Dingsishan Culture (7,000–6,000 BC for Phase 2, and 6,000–5,000BC for phase 3), and phase 4 as early agriculture (~4,000 BC) (see Fu[29]). The size of the Dingsishan shell midden is around 5,000 $m^2$, and excavation has revealed the existence of separate living areas, a cemetery, and areas for dumping refuse. Sixteen burials have been excavated from phase 2 and 133 from phase 3, within a 500 $m^2$ excavated area. These cemeteries included flexed, squatted, and even dismembered burials, all without grave goods (Guangxi Team, Institute of Archaeology of Chinese Academy of Social Science, *et al.*[24]; Fu[25][26]). A pottery manufacturing workshop of this culture has been reported from Baozitou shell midden (Guangxi Team, Institute of Archaeology of Chinese Academy of Social Science, *et al.*[27]). The evidence for workshops and cemeteries suggests that the shell middens could have been occupied through a long period.

The artifacts found in the Dingsishan shell middens (phases 1 through 3) include polished stone axes and adzes (made of stone and bone), arrowheads, awls, needles, spears, and hooks (all made of bone), shell tools, and pottery. The most common shell tools are perforated so-called *fish-headed* knives. The pottery was grayish brown in color with coarse quartz or sand temper. Pottery surfaces are parallel ribbed or cord marked. At both Dingsishan and Baozitou, the pottery assemblages can be divided in two cultural phases: an earlier phase contained pottery distinguished with quartz temper and parallel ribbing, and a later phase contained pottery featuring sand or crushed shell and cord-marked decoration. Large quantities of aquatic and terrestrial animal bones have been discovered in Dingsishan sites.

No evidence has been found of rice phytoliths until Dingsishan phase 4 at the Dingsishan Site (Zhao *et al.*[28]). As mentioned, the excavator suggested the age of phases 2–3 (the formally defined Dingsishan Culture) is around 7,000–5,000 BC (Fu[25][26][29]). Others proposed a different chronology for the Dingsishan Site, for example including Chen's suggestion of 8,000 BC for Dingsishan phase 1 and 2, and 7,000 BC (or even later) for Dingsishan phase 3 (Chen[30]).

One of the major aims of our project is to clarify the chronology, physical affiliation, and cultural characteristics of the early Holocene hunter-gather sites in Guangxi, especially as related to the Dingsishan Culture. Our research project has been concentrated at two shell midden sites in Guangxi related with the Dingsishan Culture. These two sites, Huiyaotian (see Chapter 2) and Liyupo (see Chapter 9), both are Dingsishan cemetery sites with dense concentrations of human burials. Previously, both were thought to be contemporary with phase 3 of the Dingsishan Site, given a suggested date of ca. 5,000–4,000 BC (Li and Huang[31]).

According to our new AMS dating results and cross-regional comparisons of the pottery findings, we learned that these two sites represent two components within the long-term development of the Dingsishan Culture, as outlined here.

**(1) Huiyaotian in Nanning:** The AMS dating of Huiyaotian from this study is ca. 7,000–6,300 cal. BC (see Chapter 2). The pottery vessels and other findings from Huiyaotian are very similar to those from Phase 4 of the Zengpiyan Cave and from Phases 2–3 of the Dingsishan Site. Furthermore, the C14 dates from Huiyaotian and from the Phase 4 of Zengpiyan Cave are equivalent ca. 7,000–6,000 BC. Importantly, similar pottery vessels appeared in the early phase of the Pengtoushan Site in Hunan of the middle Yangtze Valley, dated to the same age of ca. 7,000–6,000 cal. BC (Hunan Provincial Institute of Cultural Relics and Archaeology[32]) (Figure 20-4). The dating


Figure 20-4. Identical pottery jars from three contemporary sites in southern China. 1. Huiyaotian in southern Guangxi (this study), 2. Zengpiyan (Phase 4) in northern Guangxi (Institute of Archaeology, Chinese Academy of Social Science *et al.*[10]: color plate 10-4), 3. Pengtoushan in Hunan (Hunan Provincial Institute of Cultural Relics and Archaeology[32]: B/W plate 7-4).

Table 20-2. Examples of archaeological sites with human skeletons in squatted or flexed position in southern China, Taiwan, and Southeast Asia during the late Pleistocene and middle Holocene. Many of the listed remains have been confirmed as Australo-Melanesian populations by Matsumura and the authors.

| Region | Site Name |
|---|---|
| Guangxi Prov., Mainland China | 1. Cave sites:<br>(1). Zengpiyan 甑皮岩 in Guilin space between Guilin and 桂林 (the same for many English and Chinese characters in this table, they need to have space in between) 桂林 (Institute of Archaeology, Chinese Academy of Social Science *et al.*[16]);<br>(2). Miaoyan 廟岩 in Guilin 桂林 (Chen[49]);<br>(3). Jiaoziyan 轎子岩 in Guilin 桂林 (Yang[50]);<br>(4). Dayan 大岩 in Lingui 臨桂 (Fu[51]);<br>(5). Liyuzui 鯉魚嘴 in Liuzhou 柳州 (Liu *et al.*[20]; Jiang[19]; Zhou and Zhang[23]).<br><br>2. Para-Neolithic (early to middle Holocene) open-air shell middens:<br>(1). Huiyaotian 灰窑田 in Nanning 南寧 (this study);<br>(2). Dingsishan 頂螄山 in Nanning 南寧 (Guangxi Team, Institute of Archaeology of Chinese Academy of Social Science, *et al.*[24]; Fu[25][26][29]);<br>(3). Qingshan 青山 in Nanning 南寧 (Archaeology Training Program of the Guangxi Zhuang Autonomous Region *et al.*[52]);<br>(4). Changtang 長塘 in Nanning 南寧 (Archaeology Training Program of the Guangxi Zhuang Autonomous Region *et al.*[52]);<br>(5). Liyupo 鯉魚坡 in Longan 隆安 (this study);<br>(6). Ganzao 敢造 in Fusui 扶綏 (Archaeology Training Program of the Guangxi Zhuang Autonomous Region *et al.*[52]);<br>(7). Baxun 岜勛 in Wuming 武鳴 (Archaeology Training Program of the Guangxi Zhuang Autonomous Region *et al.*[52]);<br>(8). Xijin 西津 in Hengxian 橫縣 (Archaeology Training Program of the Guangxi Zhuang Autonomous Region[52]);<br>(9). Qiujiang 秋江 in Hengxian 橫縣 (Archaeological Team of the Guangxi Zhuang Autonomous Region, and Hengxian Museum[53]);<br>(10). Hecun 何村 in Chongzuo 崇左 (He *et al.*[54]);<br>(11). Jiangbian 江邊 in Chongzuo 崇左 (He *et al.*[54]);<br>(12). Chongtang 沖塘 in Chongzuo 崇左 (He *et al.*[54]);<br><br>3. Lithic workshop sites:<br>(1). Gexinqiao 革新橋 in Baise 百色 (Guangxi Institute of Cultural Relics and Archaeology[55]);<br>(2). Baida 百達 in Baise 百色 (Xie *et al.*[56]);<br>(3). Beidaling 北大嶺 in Duan 都安 (Lin *et al.*[57]). |
| Guangdong Prov., Mainland China | 1. Xiankezhou 蚬壳洲 shell midden in Zhaoqing 肇慶 (Guangdong Province Museum[58])<br>2. Liyudun 鯉魚墩 shell midden in Zhanjiang 湛江 (Li *et al.*[59][60]) |

Table 20-2. (Continued)

| Region | Site Name |
|---|---|
| Fujian Prov., Mainland China | Chihedong Cave 奇和洞 in Longyan 龍巖 (Fan[11]) |
| Hunan Prov., Mainland China | Gaomiao 高廟 shell midden in Hongjiang 洪江 (He[61][62]; Zhang and Hung[13]; Matsumura *et al.*[63]) |
| Guizhou Prov., Mainland China | Niupodong 牛坡洞 Cave in the new area between Guiyang and Anshun 貴安新區 (Institute of Archaeology, Chinese Academy of Social Science[43]) |
| Beijing City, Mainland China | Donghulin 東胡林 in Beijing 北京 (School of Archaeology and Museology in Peking University *et al.*[42]) |
| Mazu Island, Taiwan Strait | Daowei I 島尾 I shell midden on Liangdao Island 亮島 (Chen[64][65]; Chen and Chiu[66]) |
| Hainan Island | Yingdun 英墩 shell midden in Sanya 三亞 (Fu Xianguo personal communication on 24 April, 2017) |
| Taiwan | Xiaoma 小馬 Cave in Taidong 台東 (Huang and Chen[67]) |
| Vietnam | 1. Hoabinhian caves in northern Vietnam, such as Hang Chao Cave (Matsumura *et al.*[5]), Hang Dang Cave and Moc Long Cave (Higham[48])<br>2. Da But culture sites in Thanh Hoa Province and in Ninh Binh Prov., such as Da But and Con Co Ngua (Patte[68]; Bui[69]; Nguyen[70]; Nguyen[71] Oxenham *et al.*[88])<br>3. The lower layer of Man Bac Site in Ninh Binh province (4,000-3,600 BP) (Matsumura *et al.*[4]; Oxenham *et al.*[88])<br>4. Quynh Van cultural sites in Nghe An and Ha Tinh provinces, such as Quynh Van (Nguyen *et al.*[73])<br>5. Bau Du shell midden in Quang Nam province (Ha[74]) |
| Laos | Pha Phen Rockshelter, northeast Laos (Tayles *et al.*[75]) |
| Thailand | 1. Tham Lod Rockshelter in Mae Hong Son Province (Shoocongdej[76])<br>2. Ban Rai Rockshelter in Mae Hong Son Province (Treerayapiwat[77]; Higham[48])<br>3. Nong Nor in Chonburi Province (Higham[48])<br>4. Moh Khiew Cave in Krabi Province (Pookajorn[78]; Matsumura and Pookajorn[79]) |
| Malaysia | 1. Niah Cave in Sarawak (Rabett *et al.*[80])<br>2. Gua Cha Rockshelter in Ulu Kelantan, West Malaysia (Taha[81])<br>3. Gua Gunung Runtuh Cave, Perak, West Malaysia (Zuraina[82]; Matsumura and Zuraina[1])<br>4. Gua Teluk Kelawar Cave, Perak, West Malaysia (Zuraina *et al.*[83])<br>5. Gua Kerbau , Perak, West Malaysia (Khong[84])<br>6. Guar Kepah shell midden in Penang (Mok[85]) |
| Philippines | Mindoro Island? |
| Indonesia | Gua Harimau Cave, south Sumatra (Simanjuntak[86]) |


Figure 20-5. Important prehistoric hunter-gatherer sites related with this study, all with squatted (crouched) or flexed human burials (details can be found in Table 20-2), and the distributions of modern Australo-Melanesia populations in Southeast Asia.

Site names (white round markers): Guangxi sites (1–11): 1. Zengpiyan 甑皮岩, Miaoyan 廟岩 and Jiaoziyan 轎子岩; 2. Dayan 大岩; 3. Liyuzui 鯉魚嘴; 4. Xijin 西津 and Qiujiang 秋江; 5. Beidaling 北大嶺; 6. Baxun 岜勛; 7. Huiyaotian 灰窑田; Dingsishan 頂螄山; Qingshan 青山 and Changtang 長塘; 8. Ganzao 敢造; 9. Liyupo 鯉魚坡; 10. Hecun 何村，Jiangbian 江邊 and Chongtang 沖塘; 11. Gexinqiao 革新橋 and Baida 百達; 12. Gaomiao 高廟; 13. Chihedong Cave 奇和洞; 14. Daowei I 島尾 I; 15. Xiaoma Cave 小馬洞; 16. Xiankezhou 蜆壳洲; 17. Liyudun 鯉魚墩; 18. Yingdun 英墩; 19. Niupodon Cave 牛坡洞; 20. Classic area of Hoabinhian ites in northern Vietnam; 21. Man Bac (the lower layer); 22. Da But, and Con Co Ngua; 23.Quynh Van; 24.Bau Du; 25. Pha Phen; 26.Tham Lod and Ban Rai; 27. Nong Nor; 28. Moh Khiew; 29. Guar Kepah; 30. Gua Gunung Runtuh and Gua Teluk Kelawar; 31. Gua Cha; 32. Gua Kerbau; 33. Gua Harimau; 34. Niah Cave. The modern Australo-Melanesian populations (Negrito) in Southeast Asia (see Higham[87]) include Andamanese in the Andaman Islands (see red color zone in the map), Mani (green zone), and Semang (orange zone) in Thailand and the Malaysian Peninsula, and Aeta in northern Luzon of the Philippines (pink zone).

results and the pottery forms are consistent through cross-regional comparison between sites in northern Guangxi, southern Guangxi, and Hunan. The distances between those sites are rather far, measured as more than 700 km between Pengtoushan and Zengpiyan, and as more than 1,000 km between Pengtoushan and Huiyaotian. The similar pottery style in multiple locations at the same time could suggest long-distance contacts between hunter-gather societies and between farmers and hunter-gathers over rather far distances.

Before this study, the chronology and dating results from Dingsishan Cultural sites were uncertain. Now Huiyaotian can be regarded as one of the type sites for the early phase of Dingsishan Culture. During this stage, many of the burial features still exhibited a preference for the squatted position like those in cave sites such as Zengpiyan.

As noted in Chapter 3, the author Matsumura described two unique inhumation styles of burial position. One is partially mismatched anatomical position of cadavers, and the other case is of tightly bundled long bones. According to these bone arrange-


Figure 20-6. Examples of flexed burials discovered in hunter-gather sites in southern China. 1. Dingsishan Site in Yongning, Guangxi (Courtesy: Fu Xianguo); 2. Huiyaotian Site in Yongning, Guangxi; 3. Gaomiao Site in Hongjiang, Hunan (Courtesy: He Gang); 4. Chongtan Site in Chongzu, Guangxi (source: Xinhua.com, news on December 2, 2007)

ments, the strongest possibility is to assume that the cadaver was primarily under aerial sepulture elsewhere, afterwards mummifying when people transported the cadaver with wrapping, or often bundling long bones, to this site for secondary inhumation. Due to the condition of mummifying, some portions were accidentally moved at the articular joints, and people anatomically misplaced it when burying. This burial practice might be, if this assumption is correct, shared among early Holocene hunter-gatherers in this region. For example, the Dingsishan cultural group in Guangxi and the Con Co Ngua cultural group in Vietnam might have been involved in such customs. Thus, we ideally can develop a comparative observation for cemetery sites with such burial practice cross-regionally.

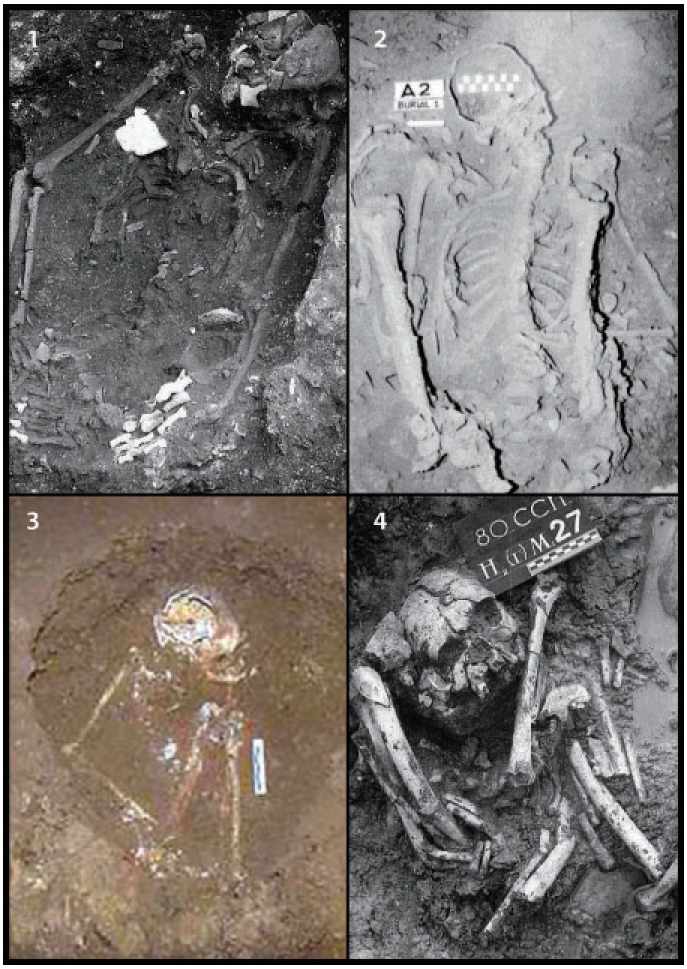


Figure 20-7. Examples of flexed burials discovered in hunter-gather sites in Southeast Asia. 1. Hang Cho Cave in Hoa Binh Province, Vietnam (Matsumura *et al.*[46][47]); 2. Gua Gunung Runtuh Cave in Malaysia (Zuraina[82]); 3. Ban Rai Rockshelter in Thailand (Higham[48]); 4. Con Co Ngua Site of Du But Culture (Courtesy: Nguyen Kim Dung).

**(2) Liyupo in Longan:** This site represents a younger stage than Huiyaotian. The C14 dating of the Liyupo Site is ca. 5,600–5,000 cal. BC (see Chapter 9). At this stage, the squatted burials and dismembered burials are nearly absent, and almost all of them are in flexed position. Many burials have been placed either under or near a large rock. For unknown reasons, the finding of pottery is rare at this stage, not only at Liyupo, but also at other contemporary sites, such as Hecun and Chongtang. New items first appeared at this time, such as waisted stone pestles. Overall, the development of hunting-gathering society in Guangxi was a slow and long process, and minor variations appeared through time.

Similar burial practice like these found in Zengpiyan, Liyuzui, Huiyaotian, and

Liyupo during this time, from the late Pleistocene through middle Holocene, as well as in other sites of pre-farming contexts in southern China, Taiwan, and Southeast Asia (see Table 20-2; Figures 20-5, 20-6, 20-7). As mentioned, several sets of human remains from the above sites have been confirmed as possessing physical characteristics of Australo-Melanesian populations, such as in the previous studies from Zengpiyan, Liyuzui, and Liyudun, and again in our recent study at Gaomiao in Hunan Province (see Table 20-1). This type of burial practice can be recognized as an important marker of a particular time period and population. The population formation and cultural transition in Guangxi can be understood more clearly with an examination of the findings from the next time period during the beginning of farming contexts.

## 3. The arrival of early farmers in the middle Holocene

Still uncertain is the timing of when the hunting-gathering Dingsishan people underwent a fundamental change of their society caused by intrusive farmers. Previous study indicated that rice phytoliths appeared in Phase 4 of the Dingsishan Site, estimated as early as 4,000 BC (Guangxi Team, Institute of Archaeology of Chinese Academy of Social Science, *et al.*[24]). However, there was no available C14 dating result to clarify the exact age for Dingsishan Phase 4. Based on the comparisons of pottery vessels and other cultural remains between the Dingsishan Phase 4 and other sites in Guangxi, we proposed the Dingsishan Phase 4 was probably equal with the same cultural period as Bawang and Nongshan cave burial sites, and the established dating of Bawang and Nongshan was around 2,300 BC (Li[33]2011: 160). Other available evidence suggested farming likely occurred in Guangxi about 4,500 years ago (Zhang and Hung 2010[12]).

The so-called "large stone shovel" sites should be mentioned, as they are reported widely in Guangxi during this time. The actual function of the "large stone shovel" so far has not been resolved, but generally it is regarded as related with the emergence of rice agriculture in this region. The shovel-shaped objects most often were beautifully carved and polished from hard stone, sometimes they were decorated with fine incision patterns. So far, these artifacts have been found at more than 150 sites in Guangxi, and some have been reported in Guangdong, Hainan, and northern Vietnam. In total, about 100 large stone shovels sites are concentrated in Nanning and its neighboring areas. Overall, Guangxi holds the densest distribution of this type of artifact. In some of the reported burial cave sites, such as at Nongshan as mentioned above, large stone shovels were used as burial goods (Li 2011[33]). The newest dating results have shown that these sites with large stone shovels are mostly around 2,000 BC. By association, these findings indicate the emergence of agriculture in Guangxi in the time range of ca. 2,500–2,000 BC.

Currently, early Neolithic settlements contemporary to Dingsishan Phase 4 are almost absent in Guangxi. The only way to understand material culture and other aspects of this period is through sites such as Bawang and Nongshan. Bawang and Nongshan both are cave burials sites. Varied forms, styles, and decorations of pottery vessels and stone tools appeared at Bawang and Nongshan, which were not available in the earlier shell midden sites. New items such as spindle whorls, jade ornaments, and jade tools also occurred (Archaeological Team of the Guangxi Zhuang Autonomous

Region, Nanning Museum and Wuming Institute of Culture and Relics[34]; Institute of Archaeology, Guangxi and Nanning City Museum[35]). A new material culture inventory appeared suddenly in Guangxi during this time. This key stage of sites will need more study in the future.

## CROSS-REGIONAL COMPARISON FOR UNDERSTANDING THE NEOLITHIC TRANSITION IN GUANGXI

Archaeological evidence indicates that around 2,500–2,000 BC, Guangxi witnessed a remarkable cultural transition. This transition involved a fundamental change in multiple aspects of material culture, subsistence pattern, and burial practice. Our research now can consider if these changes were caused by human migration with their domestic crops (e.g. rice or millet) and animals (e.g. pigs), or simply cultural influence, or perhaps technique transfer from other regions.

In terms of cultural perspective, hunter-gatherer sites in Guangxi have shown numerous cultural characteristics different from those seen in contemporaneous farming sites located farther north such as in the middle and lower Yangtze Valley. For example, the hunter-gatherer burials mostly are in flexed or squatted position, and the farmer burials mostly are in extended supine position. The hunter-gatherer burials contained no burial goods at all, but the farmer burials always contained different amounts of sacrificial goods (e.g. pottery vessels, jade ornaments, or stone tools). To understand the biological foundation of the hunter-gatherers and famers in Guangxi, human skeletal remains can provide the most direct answer.

In this study (see Chapter 15), besides Huiyaotian and Liyupo, cranial morphology data were collected from several hunter-gatherer sites in southern China, including the Liujiang series, and human remains from Zengpiyan (Guilin, Guangxi), and Gaomiao (Hunan). Several representative early farming sites from other regions in southern China were selected for comparison study, including Jiahu (Henan), Xipo (Henan), Baligang (Henan), and Hemudu (Zhejiang). (Chapter 15: Table 15-2, Figure 15-3).

1. Jiahu is located in the Huai Valley in Wuyang of Henan province. It most significantly has revealed one of the earliest documented instances of domesticated rice in China, dated as early as 6,700 BC. One complete human skull dated to 6,500-6,000 BC has been examined through this project for comparison. This individual belonged to the Jiahu Phase 1 (Zhang[36;] Zhang and Hung[37]). At Jiahu, 148 excavated structures were recorded in Phase 1, including circular or oval sunken house floors ringed with posts for roof support, burial pits, and storage pits. The Jiahu Phase 1 graves contained mostly extended supine skeletons. Burial goods included pottery *hu* placed near the head of the deceased, with stone and bone tools placed elsewhere.
2. The human remains from Xipo and Baligang of the Yangshao Cultural phases (ca. 5,000–3,000 BC) were included to be examined in this study. Yangshao is known as a highly developed farming society. Millet was the major cultivated crop, but rice was cultivated in some parts of the Yangshao Cultural region. Xipo located in

Liangbao of Henan province, represents the Miaodigou period of the Yangshao Culture (ca. 3,300–3,000 BC). This site covers an area of 40 ha and represents the most significant of the over twenty Miaodigou settlements in the highland region. Two large semi-subterranean houses were found in the center of the settlement during 2000–2004, and 34 burials were recovered in 2005–2006. Most of the skeletons were found in the extended supine position with the head to the west. Pottery vessels, jade or stone *yue* axes, jade or ivory bracelets, and bone hair pins had been offered as burials goods. Analysis of stable isotope ratios in the skeletons indicates that C4 plants, mainly millet, were the main staple food of the Xipo people (Institute of Archaeology, Chinese Academy of Social Science and Henan Provincial Institute of Archaeology and Cultural Relics[38]).

3. Baligang, located on a terrace of the Tuan River, a tributary of the middle Hanshui Valley (Archaeological Field School of Peking University[39]), is about 50,000 $m^2$ (5 ha) in area, and its cultural layers are about 3–4 m in depth. It contains several important cultural layers, commencing with the pre-Yangshao (corresponding to Jiahu 1; see Zhang and Hung[37]) and continuing through Yangshao, Qujialing, Shijiahe, Longshan, Shang, Zhou, Han, and post-Han dynasties. The human remains examined during this project are from the Yangshao Cultural phase, estimated about 5,000–3,000 BC.
4. Located in the lower Yangtze Valley, Hemudu Culture is one of the most important Neolithic rice farming groups in prehistoric China, ca. 5,050–3,350 BC (Sun[40]). The Hemudu Cultural sites are distributed primarily in the Ningbo-Shaoxing Plain in the northeast part of Zhejiang province. So far, more than 50 Hemudu Cultural sites have been discovered. The Hemudu Site itself is a waterlogged site, with excellent preservation of organic remains included rice grains, straw, chaff, wooden components, pieces of wood, reeds, reed matting, ropes, fruits, and the leaves and stems of various plants. The excavation of Hemudu, an area 2,000 sq m in size, uncovered a living area with wooden structures, fences, burials, storage pits, and numerous craft goods (Sun[40]).

Based on the cross-regional comparison of artifact assemblages, subsistence pattern, and cranial morphology from several key sites, we can discern two major different populations that co-existed in prehistoric southern China, namely the Australo-Melanesian as the later hunter-gatherers, and the Northeast Asians (Mongoloids) as the early farmers (See Chapter 15: Figure 15-3). Those early farming sites in China, such as Jiahu, Xipo, Baligang, and Hemudu mentioned above, contain skeletal remains that belong to the Northeast Asian (classic term: Mongoloid) type. On the other hand, those earlier or contemporaneous discoveries in sites without any evidence of farming, such as Liujiang, Zhenpiyang, Huiyaotian, Liyupo, and Gaomiao contain skeletal remains that belong to the Australo-Melanesian type.

## CONCLUSION AND FUTURE RESEARCH QUESTIONS

In essence, we can distinguish two groups of population in the late Pleistocene and middle Holocene in Guangxi and southern China, including the Northeast Asian (clas-

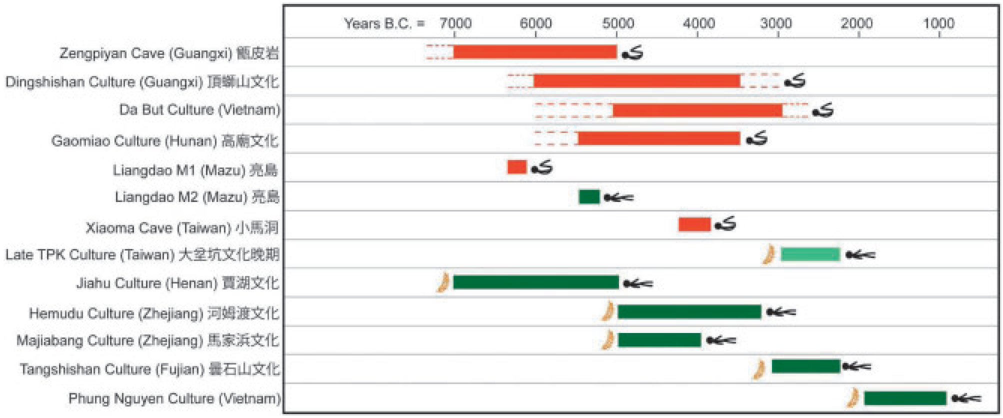


Figure 20-8. Preliminary results of the present study, coordinating burial formats with physical anthropological findings and subsistence practice. The two major populations (Australo-Melanesian in red, and Northeast Asian/Mongoloid in green) are represented from archaeological sites between the Hai River in Central China and northern Vietnam. Light green = presumably Northeast Asian/Mongoloid, pending future confirmation. The symbol of yellow spike of rice = site with rice farming. Two burial positions show flexed burials associated with Australo-Melanesians and extend burials associated with Northeast Asian/Mongoloid populations. The two major groups (Australo-Melanesian/hunter-gathers/flexed burials vs. Northeast Asians (Mongoloid) / farming / extended burials) co-existed in Southern China and northern Vietnam in the late Pleistocene and continuing at least until the middle Holocene.

Figure 20-9. Modern hunter-gatherers Aeta in northern Luzon of the Philippines (Photo by HC Hung in 2003).

sic term: Mongoloid)/farming/extended burial group as compared to the Australo-Melanesian/hunting-gathering/flexed burial group (Figure 20-8). The two groups are culturally and physically different. This result is consistent with previous findings from Southeast Asia, but importantly it opens a new understanding and set of research questions for Chinese prehistory. Although small populations of Australo-Melanesian peo-

Figure 20-10. Modern hunter-gatherers Aeta in northern Luzon of the Philippines (Photo by HC Hung in 2003).

ple still live in parts of Southeast Asia today (Figures 20-5, 20-9, 20-10), none are known currently in China. Thus, the discovery of an ancient Australo-Melanesian population in China has raised a question about the long-term population formation.

However, regarding the existence of an ancient Australo-Melanesian population in China, this topic has received only limited attention in the past by anthropologists or historians, and it has been largely untouched by archaeologists until now. According to Chinese ancient documents, black men or small "Negritos" were recorded as early as the Han Dynasty until the Ming Dynasty. One of the ancient documents specifically mentioned the small black man "Mu-k'eh" in Southern China (Ling[41]), including in the Guangxi region discussed in this chapter.

Current data are unclear about the origins, migration routes, and distribution areas of these two groups now known as Australo-Melanesian and Northeast Asian (classic term: Mongoloid), especially during the late Pleistocene and early Holocene in East Asia. Several previous studies have confirmed that Australo-Melanesian populations occupied the broad region from Southeast Asia through Australia. This study confirmed at least a late Pleistocene age of when the Australo-Melanesian people lived in the region between Hunan and Guangxi provinces of China in the south of Yangtze River. Beyond Hunan, how far north did the modern human Australo-Melanesian population live? If the early Australo-Melanesians came to China through a route along India-Southeast Asia and then entering southern China, then where was the origin of the earliest modern human Northeast Asians (Mongoloid) population, and by which route did they migrate into China? Was it from somewhere near Siberia in north Asia?

In Beijing city of northern China, several sets of human remains have been recovered from Donghulin, including one in flexed position dated about 8,000 BC. In addition to several human remains of different burial positions, Donghulin has produced abundant artifacts such as early pottery, grinding stones, shell necklaces, and microblades, as well as extended burials (School of Archaeology and Museology in Peking University *et al.*[42]). In Niupodong Cave of Guizhou in western China, recent excavation has found several human remains with flexed position from its Phase 2, dated to

8,200–6,700 BC, associated with pebble tools and small chert flakes (Institute of Archaeology, Chinese Academy of Social Science[43]). Sites in different areas of China, such as Donghulin (in northern China) and Niupodong (in western China) different cultural remains can help us to obtain more knowledge of the early encounters between Northeast Asian (Mongoloid) and Australo-Melanesian populations in East Asia.

Based on the archaeological record, two lithic tool assemblages existed in China after 25 kya, including a microblade tradition in the north and a pebble tool tradition in the south (Wang[44]). Similar microblade assemblages occurred across the northeast Asian region, including in the Russian Far East, the Korean peninsula, Japan, and farther into Alaska and western Canada. In southern China, the pebble tool assemblages are mostly located in caves, and this tradition is related to contemporary so-called "Hoabinhian" assemblages in Southeast Asia (Zhang[45]). The modern human replacement model proposes that the microblade assemblages of northern China originated in the Lake Baikal and Altai regions of central Asia, and that the pebble tool tradition was introduced into southern China from Southeast Asia, in both cases by populations of modern *Homo sapiens*. If we incorporate the current human skeletal data, then we might ask whether or not these two lithic traditions corresponded with the Northeast Asian group, who had morphologically adapted to cold climate, and the southern Australo-Melanesian group of modern humans in China during the late Pleistocene and early Holocene.

The trajectory of prehistory in Guangxi provides an excellent example of long-term development from hunter-gathering lifestyles into farming society. Through this study, we can observe different populations inter-relating in variable ways over the Paleolithic to Neolithic transition in a rather large geographic area in East Asia. To understand the complete picture of Neolithic transition in the broader region, we need to incorporate the data from human remains, artifacts, subsistence, and cultural context together.

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