

# 4

## Qualitative Cranio-Morphology at Man Bac

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Cranial nonmetric traits are widely accepted to be effective for reconstructing population histories, not only within limited regions but also globally (Ossenberg, 1986, 1994; Dodo and Ishida, 1990; Dodo and Kawakubo, 2002; Hanihara et al., 2003; Dodo and Sawada, 2010). In this chapter, the occurrence of cranial nonmetric traits is assessed for the Man Bac series, and the origins and affinities of the Man Bac people are discussed in the context of local and regional populations in East and Southeast Asia.

### **MATERIALS AND METHODS**

The presence/absence of 22 nonmetric traits was examined for 33 adult and near-adult crania from the Man Bac site: 4 from the 1999-2001 season, 11 from the 2005 season, and 18 from the 2007 season. The criteria employed here for scoring nonmetric traits are given in Dodo (1974) and Dodo and Ishida (1990). The following 6 traits were used for comparison of the frequencies among cranial samples:

- Supraorbital foramen (SOF)
- Hypoglossal canal bridging (HGCB)
- Transverse zygomatic suture vestige (TZS)
- Ossicle at the lambda (OL)
- Mylohyoid nerve groove bridging (MHB)
- Medial palatine canal (MPC)

These 6 nonmetric traits are little affected by interobserver error in scoring (Ishida and Dodo, 1990) and have been noted as good measures for population relationships in the Japanese Islands (Dodo and Ishida, 1990). Furthermore, the supraorbital foramen and hypoglossal canal bridging are believed to be highly effective in discriminating amongst major human groupings globally (Dodo, 1986; Dodo and Sawada, 2010).

Table 4.1 provides summary information on the 6 cranial samples compared: Neolithic Weidun and early historic Eastern Zhou/Western Han on the lower reaches of the Yangtze River, Jiangsu, southern China; modern mainland Southeast Asians including inhabitants of Vietnam, Laos, Cambodia, and Thailand; modern southern Chinese derived from south of the Yangtze River; and modern Australian

## Aborigines.

Biological distances among the samples were assessed via Smith's Mean Measure of Divergence statistic (MMD) defined as follows:

$$\text{MMD} = 1/r \sum [ (\theta_1 - \theta_2)^2 - (1/n_1 + 1/n_2) ]$$

where  $r$  is the number of traits;  $\theta_1$  and  $\theta_2$  are angular transformations in radian of the trait frequencies  $p_1$  and  $p_2$  in two samples, obtained by the formula  $\theta = \arcsine(1 - 2p)$ ; and  $n_1$  and  $n_2$  are the numbers of observations in the two samples (Sjøvold, 1973).

Two statistical methods for graphic representation were applied to the matrix of MMDs to depict the relationships of the samples. One is group average clustering analysis and the other is the multi-dimensional scaling method. The procedures of these statistical analyses were kindly carried out by Professor H. Matsumura of Sapporo Medical University, using data analysis software "STATISTICA Version 06J" produced by StatSoft Japan Inc., Tokyo.

Table 4.1 Cranial samples used for nonmetric analyses.

Sample name	Provenance	Period	Reference
Man Bac	Ninh Binh, northern Vietnam	neolithic (3,300 - 3,500 uncal.BP)	Present study
Weidun	Lower reaches of the Yangtze River, Jiangsu, China	Neolithic (6,000 - 5,000 BP)	Wakebe, 2002
Zhou/Han (Eastern Zhou-Western Han)	Lower reaches of the Yangtze River, Jiangsu, China	Early Historic (2,800 -2,000 BP)	Wakebe, 2002
SE-Asia (Mainland Southeast Asians)	Vietnam, Laos, Cambodia, and Thailand	Modern	Hanihara and Ishida, 2001a,b,c,d,e
S China (Southern Chinese)	South of the Yangtze River, China	Modern	Hanihara and Ishida, 2001a,b,c,d,e
Australia (Australian Aborigines)	New South Wales, Queensland, and Victoria	Modern	Hanihara and Ishida, 2001a,b,c,d,e

Table 4.2 Comparison of side-incidences of 6 cranial nonmetric traits.

Trait	Man Bac		Weidun		Zhou/Han	
	z	p	n	p	n	p
1 SOF	57	0.439	69	0.406	52	0.519
2 HGCB	32	0.156	45	0.044	44	0.136
3 TZS	39	0.026	37	0.081	42	0.006*
4 OL	24	0.010*	22	0.045	23	0.217
5 MHB	57	0.070	81	0.099	44	0.023
6 MPC	50	0.020	74	0.041	50	0.060

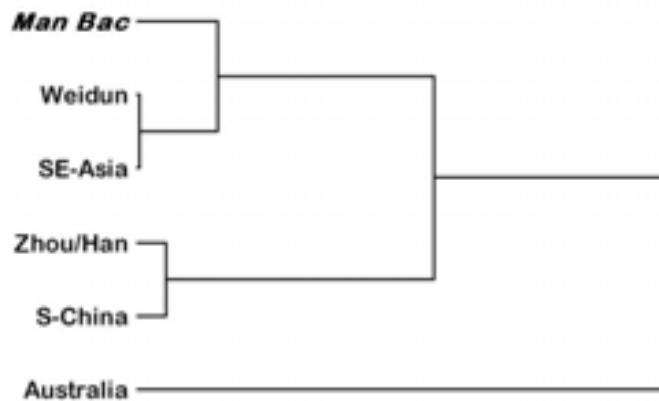
\* 1/4n (Bartlett's adjustment)

## RESULTS

The presence/absence of the 22 nonmetric traits in each cranium of the Man Bac series is shown in the Appendix of this chapter. In Table 4.2, sex- and side-pooled incidences of the 6 nonmetric traits are given for the 6 cranial samples, with the zero proportions being replaced by 1/4n as recommended by Bartlett (Snedecor and Cochran, 1980). Although an anthroposcopic impression suggested the mingling of two types of crania in the Man Bac series (see Chapter 3), i.e., a gracile one and a

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robust one, no such distinction was noticed in the patterning of cranial nonmetric traits. For this reason the Man Bac individuals were treated here as a single



**Figure 4.1 Dendrogram of a cluster analysis applied to the MMDs among the samples from mainland Southeast Asia, southern China, and Australia.**

Table 4.3 MMDs among the 6 cranial samples compared.

	Man Bac	Weidun	Zhou/Han	SE-Asia	S China	Australia
Man Bac		0.0016	0.0735	0.0270	0.0959	0.1068
Weidun	0.0016		0.0778	0.0005	0.0359	0.0652
Zhou/Han	0.0735	0.0778		0.0233	0.0052	0.1476
SE-Asia	0.0270	0.0005	0.0233		0.0084	0.0614
S China	0.0959	0.0359	0.0052	0.0084		0.0880
Australia	0.1068	0.0652	0.1476	0.0614	0.0880	

population sample. Table 4.3 gives MMDs based on the frequencies of the 6 nonmetric traits among the 6 cranial samples compared.

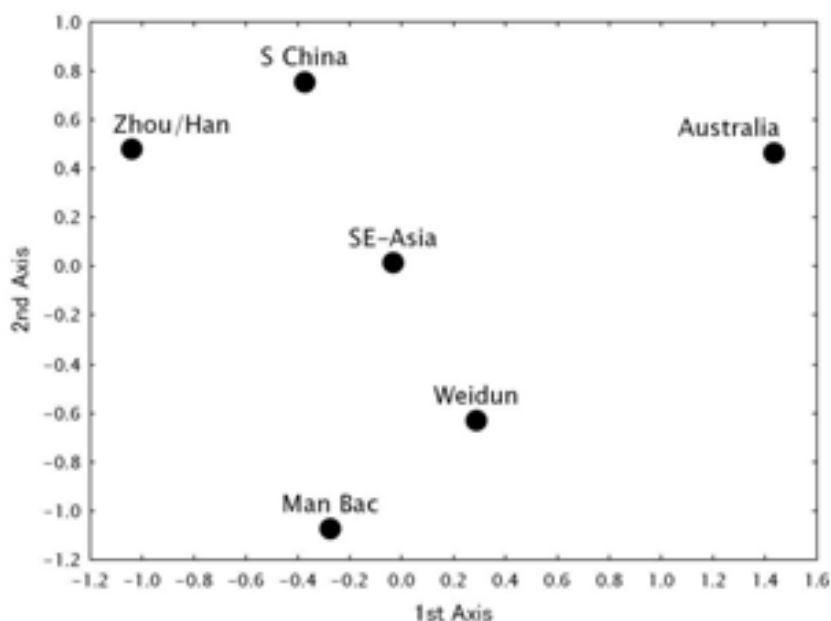
The Man Bac cranial series (3800–3500 years BP) was compared with that of the Neolithic Weidun site (6,000–5,000 years BP) and that of the early historic Eastern Zhou/Western Han (2,800–2,000 years BP) in the Yangtze Basin, southern China. Moreover, comparisons were made with modern cranial samples from mainland Southeast Asia and southern China. Australian aboriginal crania were also used for comparison.

In the MMD matrix of Table 4.3, the closest sample to the Man Bac population is the Neolithic Weidun series from in the Yangtze Basin, and the next closest are modern mainland Southeast Asians. The Australian aboriginal population is the furthest away, and the samples of Eastern Zhou/Western Han and southern Chinese are in-between.

A dendrogram of cluster analysis and a two-dimensional display of multidimensional scaling are depicted in Figure 4.1 and Figure 4.2, respectively. Both figures show a relatively tight cluster of Man Bac, Weidun, and mainland Southeast Asians. Another cluster is seen between the Eastern Zhou/Western Han and southern Chinese.

## DISCUSSION

It was noticed that there is a close relationship between Man Bac and the Weidun sample, and that these two series are also close to the crania of mainland Southeast Asians (Table 4.3, Figures 4.1 and 4.2). The cranial and dental metric study of the Man Bac specimens from the 1999-2001 and 2004-2005



**Figure 4.2** Two-dimensional display of the multidimensional scaling method applied to the MMDs among the samples from mainland Southeast Asia, southern China and Australia.

seasons revealed that the Man Bac sample is grouped with the early Metal Age to modern East/Southeast Asian and the Neolithic Weidun people (Matsumura et al., 2008a). Taking into account the findings of the cranial nonmetric and cranial/dental metric analyses, it can be postulated that the inhabitants of Man Bac from northern Vietnam were closely related to the Neolithic Weidun people, essentially a rice-farming culture on the lower reaches of the Yangtze River, and the following schema of population history can be outlined: Neolithic Weidun→neolithic Man Bac→early Iron Age Dong Son→modern mainland Southeast Asians.

Recent studies have disclosed that the late Pleistocene and early Holocene human remains from Southeast Asia, such as Gua Gunung Runtuh in Peninsular Malaysia and Mai Da Nuoc, Mai Da Dieu, and Hang Cho in northern Vietnam, exhibit osteological characteristics shared with 'Australo-Melanesians' (Matsumura and Zuraina, 1999; Cuong, 1986; Matsumura et al., 2008b). These researchers have argued that Southeast Asia was first occupied by an indigenous population, sometimes referred to as 'Australo-Melanesian', before immigrants from East Asia dispersed widely into this region (Matsumura and Hudson, 2005; Matsumura et al., 2008a).

The results of the present nonmetric analysis, however, revealed little affiliation between the Man Bac inhabitants and the Australian aboriginal sample, as shown in Table 4.3 and Figures 4.1-4.2. Most likely, the prototype population ancestral to modern mainland Southeast Asians, which would appear to be quite different to 'Australo-Melanesians', was already established by the time of the neolithic in

northern Vietnam.

In order to reconstruct the population history in Vietnam more systematically, samples of the Early to Middle Holocene Hoabinhian, Bacsonian, and Da But cultures, as well as the Early Metal Age Dong Son culture, need to be investigated in terms of cranial nonmetric variation.

#### **SUMMARY**

The presence/absence of 22 nonmetric traits was examined for 33 adult and near-adult crania from the Man Bac site. The frequencies of the 6 traits, which are little affected by interobserver error in scoring, were used for comparison among the 6 neolithic to modern cranial samples from mainland Southeast Asia, southern China, and Australia. Biological distances assessed by Smith's Mean Measure of Divergence indicated that the Man Bac series is closest to Neolithic Weidun in the Yangtze Basin in southern China, and next closest to modern mainland Southeast Asians. From these findings, it was inferred that the Man Bac people, genetically influenced by those represented by the Neolithic Weidun rice-farming people in the Yangtze Basin, are a prototype population ancestral to modern mainland Southeast Asians.

#### **ACKNOWLEDGMENTS**

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Appendix 4.1 Presence or absence of cranial nonmetric traits in each cranium of the Man Bac series (\* median trait; 1 present; 0 absent; / unobservable).

No. Age/Sex	MB99M2		MB01M5		MB01M9		MB01M10		MB05M29		MB05M31		MB05M32		MB05M34		MB07H1M04	
	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male
1 Metopism*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Supraorbital nerve groove	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
3 Supraorbital foramen	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0	0
4 Ossicle at lambda*	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Biasterionic suture (10mm-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Asterionic bone	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
7 Occipitomastoid bone	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Parietal notch bone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Condylar canal	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Precondylar tubercle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Paracondylar process	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Hypoglossal canal bridging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Foramen of Huschke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Ovale-spinosum open	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Foramen of Vesalius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Pterygospinous foramen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Medial palatine canal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Transv. zygomatic suture (5mm-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jugular foramen bridging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Sagittal sinus groove left*	1	/	/	/	0	0	/	/	/	/	1	0	0	0	0	0	0	0
21 Clinoid bridging	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
22 Mylohyoid bridging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 4.1 (continued 1).

No.	MB07H1M05		MB07H1M08		MB07H1M09		MB07H1M10		MB07H1M11		MB07H2M01		MB07H1M04		MB07H1M05		MB07H1M08	
	adult/male	L	adult/male	L	adult/male	L	adult/female	L	adult/female	L	adult/male	L	adult/male	L	adult/male	L	adult/male	L
1 Metopism*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Supraorbital nerve groove	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
3 Supraorbital foramen	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
4 Ossicle at lambda*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Biasterionic suture (10mm-)	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
6 Asterionic bone	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
7 Occipitomastoid bone	/	/	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
8 Parietal notch bone	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
9 Condylar canal	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Precondylar tubercle	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Paracondylar process	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Hypoglossal canal bridging	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Foramen of Huschke	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Ovale-spinosum open	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Foramen of Vesalius	/	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Pterygospinous foramen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Medial palatine canal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Transv. zygomatic suture (5mm-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jugular foramen bridging	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Sagittal sinus groove left*	/	/	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Clinoid bridging	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Mylohyoid bridging	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0



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Appendix 4.1 (continued 2).

No.	MB07H1M09		MB07H1M10		MB07H1M11		MB07H2M01		MB07H2M02		MB07H2M05		MB07H2M10		MB07H2M12		MB07H2M18	
	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	adult/male	subadult/female	subadult/male	adult/male	adult/female	adult/male	adult/female	adult/male	adult/female	subadult/male	subadult/male	subadult/male
1 Metopism*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Supraorbital nerve groove	0	0	0	0	0	0	1	/	0	/	/	/	0	0	0	0	0	0
3 Supraorbital foramen	/	1	/	0	0	1	0	1	1	0	/	0	0	0	1	1	1	0
4 Ossicle at lambda*	0	/	/	0	/	0	/	/	/	0	0	0	0	0	0	0	0	0
5 Blastertonic suture (10mm-)	1	1	/	/	0	1	0	/	0	0	0	0	0	1	0	0	0	0
6 Asterionic bone	0	/	/	/	/	/	1	/	0	0	0	0	0	0	0	0	0	0
7 Occipitomastoid bone	1	/	/	/	/	/	0	/	/	/	/	0	0	0	/	/	0	0
8 Parietal notch bone	0	0	/	/	1	0	0	/	0	0	0	0	0	0	0	0	0	0
9 Condylar canal	/	/	/	/	/	/	/	/	/	/	/	/	/	0	/	/	/	/
10 Precondylar tubercle	/	/	/	/	/	/	/	/	/	/	0	0	1	1	/	/	0	0
11 Paracondylar process	/	/	/	/	/	/	/	/	/	/	0	0	0	0	/	/	0	0
12 Hypoglossal canal bridging	/	/	/	/	/	/	/	/	/	/	0	0	0	0	/	/	0	0
13 Foramen of Huschke	0	/	/	/	0	1	/	/	0	0	0	0	0	0	/	0	0	0
14 Ovale-spinosum open	/	0	/	/	0	/	0	/	/	/	1	0	1	0	0	0	0	0
15 Foramen of Vesalius	/	0	/	/	0	/	/	/	/	/	0	0	/	/	/	/	/	/
16 Pterygospinous foramen	0	0	/	/	0	0	0	/	/	/	0	0	0	0	0	0	0	0
17 Medial palatine canal	0	/	0	/	0	0	1	/	/	/	0	0	0	0	0	0	0	0
18 Transv. zygomatic suture (5mm-)	0	/	/	/	0	0	/	/	/	/	/	/	/	0	0	0	0	0
19 Jugular foramen bridging	/	/	/	/	/	/	/	/	/	/	/	/	/	0	0	0	0	0
20 Sagittal sinus groove left*	1	/	0	/	/	/	/	/	/	/	0	0	0	0	0	0	0	0
21 Clinoid bridging	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
22 Mylohyoid bridging	0	0	0	0	0	0	0	/	/	/	0	0	0	0	0	1	0	0

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Appendix 4.1 (continued 3).

No. Age/Sex	MB07H2M19		MB07H2M22		MB07H2M24		MB07H2M27		MB07H2M30		MB07H2M32	
	adult/male		adult/female		adult/female		adult/male		adult/male		adult/male	
	R	L	R	L	R	L	R	L	R	L	R	L
1 Metopism*	/		0		0		0		0		0	
2 Supraorbital nerve groove	/	/	1	1	0	0	0	0	0	0	0	0
3 Supraorbital foramen	/	/	0	0	0	0	1	1	0	1	1	1
4 Ossicle at lambda*	/		0		0		0		0		0	
5 Biasterionic suture (10mm- )	/	/	0	0	0	0	0	0	0	0	0	/
6 Asterionic bone	/	/	0	0	/	0	0	0	/	/	0	0
7 Occipitomastoid bone	/	/	0	0	/	0	0	0	/	/	/	0
8 Parietal notch bone	/	/	0	0	0	0	0	0	0	0	0	0
9 Condylar canal	/	/	/	/	/	/	/	/	1	/	1	/
10 Precondylar tubercle	/	/	0	0	/	/	0	0	/	0	0	0
11 Paracondylar process	/	/	0	/	/	/	/	/	/	/	/	/
12 Hypoglossal canal bridging	/	/	0	1	/	/	0	0	0	0	1	0
13 Foramen of Huschke	/	/	0	0	0	0	0	0	0	0	1	/
14 Ovale-spinosum open	/	/	0	0	/	/	1	0	/	0	0	/
15 Foramen of Vesalius	/	/	/	/	/	/	/	/	/	/	/	/
16 Pterygospinous foramen	/	/	0	0	/	/	0	0	/	0	0	/
17 Medial palatine canal	/	/	0	0	0	/	0	0	0	0	/	0
18 Transv. zygomatic suture (5mm- )	/	/	0	0	/	/	0	0	0	/	0	0
19 Jugular foramen bridging	/	/	0	0	/	/	/	0	/	/	/	/
20 Sagittal sinus groove left*	/		/		0		/		0		0	
21 Clinoid bridging	/	/	/	/	/	/	/	/	/	/	/	/
22 Mylohyoid bridging	0	0	0	0	/	/	0	/	1	0	0	0