5
Quantitative and Qualitative Dental-Morphology at Man Bac

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The aim of this chapter is to explore the local population history of northern Vietnam, specifically the relationship between the Man Bac sample and mid-Holocene Da But (represented by the cemetery site Con Co Ngua) and late Pleistocene/early Holocene Bac Son/Hoabinhian communities. Additionally, any potential relationship with Metal period Dong Son and present-day Vietnamese is explored. Moreover, this study will also provide a test of the "Two-layer" hypothesis. For nearly a century it has been argued that Southeast Asia was initially settled by people akin to present-day Australo-Melanesians that, in the later neolithic, underwent substantial genetic modification due to the influx of immigrants associated with the spread of agriculture from southern China (Callenfels, 1936; Mijsberg, 1940; Barth, 1952; von Koenigswald, 1952; Coon, 1962; Thoma, 1964; Jacob, 1967, 1975; Brace, 1976; Howells, 1976; Brace et al., 1991). A number of recent archaeological reviews conclude that food producing communities spread south from the Yangtze Basin into mainland and island Southeast Asia (Bellwood, 1987, 1997; Spriggs, 1989; Glover and Higham, 1996; Bellwood et al., 1992). In order to test this scenario, the biological relationships between neolithic and pre-neolithic communities throughout Southeast Asia need to be examined in more detail. The Man Bac sample provides a crucial data set in such an examination (see also Chapter 3). Along with the above-mentioned aims, this chapter compares Man Bac metric and non-metric dental data with early and modern samples from East/Southeast Asia and the west Pacific.

MATERIALS AND METHODS

Man Bac Specimens and Comparative Samples

The dental sample derives from all four seasons of excavation at Man Bac. This is the only study in this monograph to estimate the sex of subadult individuals, in this instance using Schutkowski's (1993) protocols based on mandibular morphology.

Some 41 adult and subadult individuals contributed to the permanent tooth sample, while 17 subadults contributed to the deciduous tooth sample. Multivariable statistical procedures were undertaken to assess the population affinities between Man Bac and the comparative samples (see Table 5.1) including:

Vietnam, Laos, Thailand, Malaysia, Indonesia, China and Japan, as well as modern samples from East/Southeast Asia and the Pacific. All comparative data are from males for the odontometric analysis and from a sex-combined sample for the nonmetric trait comparisons.

Crown measurements and observations of non-metric traits were undertaken for teeth on the right side, or antimere substitutions, where necessary. Odontometric data and the presence of nonmetric traits recorded for the Man Bac individuals are given in Appendix 5.1 and 5.2 (this chapter), combining all four season's datasets.

Recording System of Quantitative and Qualitative Dental Morphology

Quantitative dental morphological data was represented by tooth crown diameters, which were recorded as maximum diameters according to the Fujita (1949) system. Measurements of the permanent dentition were only undertaken for sex-identified individuals. Due to difficulties in estimating the sex of subadults, crown diameters of deciduous teeth were recorded for all available specimens regardless of sex.

Qualitative dental morphology was recorded for 21 nonmetric dental traits of the permanent dentition, which were scored using protocols and criteria given in Matsumura (1995, see also Table 5.2). All traits were scored for both sexes on the basis of presence/absence to facilitate statistical comparisons, although males and females were combined given the low to minimal sexual dimorphism expected for these traits (Turner et al., 1991).

Statistical Procedures

Dental metric comparisons were made using mesiodistal and buccolingual crown diameters. In the first step, both the metric and nonmetric data recorded for the Man Bac specimens were compared with those of present-day Vietnamese. In univariate comparisons, Student's t-test and chi-square tests were employed to assess any significant differences in tooth dimensions and the frequency of the presence of nonmetric traits, respectively. In order to compare the magnitude of intra-group odontometric variation, coefficients of variation (CV = SD / M X 100: SD = standard deviation, M = mean value) were calculated for each measurement.

The next step included multivariate comparative analyses between Man Bac and other samples using male permanent tooth data. Similarities in odontometric proportions were estimated by Q-mode correlation coefficients based on odontometric data sets. Following this, measurement data were standardised using grand mean values of all comparative samples and standard deviations of the modern Vietnamese sample.

Population affinities, based on odontometric proportions, were estimated by calculating Q-mode correlation coefficients on the basis of full sets of 28 crown diameters. To aid in the interpretation of the matrix of inter-population phonetic distances, the Neighbour Joining method of Saitou and Nei (1987) was applied to the distance matrix (1-r) transformed from Q-mode correlation coefficients (r), using the software package "Splits Tree Version 4.0" provided by Huson and Bryant (2006).

Table 5.1 Comparative population samples, providing permanent dental data, from mainland East/Southeast Asia and the west Pacific.

Sample	Locality	Sample Period	Remarks	Metric Data	Non-metric Data
Early Holocene Vietnam & Laos	Northern Vietnam and Laos	Early Holocene (Hoabinhian-Neolithic)	Bac Son and Da But Cultural sites in Vietnam, Tam Hang and Tam Pong sites in Laos (Mansuy and Colani, 1925; Huard and Saurin, 1938)	-	Matsumura and Hudson, 2005
Hoabinhian	Vietnam	Hoabinhian Culture (c. 11,000 - 8,000 BP)	Sites of Mai Da Nuoc, Mai Da Dieu (Cuong, 1986), Dong Truong, Du Sang and Lan Bon	Matsumura and Hudson, 2005	-
Bac Son	Northern Vietnam	Bac Son Culture (c.8,000 BP)	Sites of Pho Binh Gia, Lang Cuom, and Cua Gi	Matsumura and Hudson, 2005	-
Con Co Ngua	Site in Thanh Hoa Prov., Nrt. Vietnam	Da But Culture (c.5,000 BP)	Patte, 1965; Duy, 1967; Bui, 1991; Thuy, 1990	Matsumura et al., 2001	-
An Son	Site in Long An Prov., Sth Vietnam	Late Neolithic (c.3,800 BP)	samples in Long An Museum, Vietnam (Cuong, 2006)	unpublished	-
Dong Son	Northern Vietnam	Early Iron age (c. 3,000-1,700 BP)	Sites of Vinh Quang, Chau Son, Doi Son, Nui Nap, Minh Duc, Dong Xa (Thuy, 1993 Cuong, 1996)	Matsumura et al., 2001	Matsumura et al., 2001
Hoa Diem	Site in Khanh Hoa Prov., Sth Vietnam	Early Metal age (c.2,000 BP)		unpublished	-
Gua Cha	Kelantan, Malaysia	Late Pleistocene - Early Holocene (Hoabinhian and Neolithic Culture)	Sieveking, 1954; Bulbeck 2000	Matsumura and Hudson, 2005	-
Mesolithic Flores	Flores Island	Early Holocene (c.7,000-4,000 BP)	Sites of Liang Momer, Linag Toge, Liang X, Gua Alo, Aimere, Sampung and Gua Nempong (Verhoeven, 1958; Jacob, 1967)	Matsumura and Pookajorn, 2005	-
Early Flores and Malay	Malay and Flores Island	Hoabinhian-Neolithic	Gua Cha, Guar Kepah Sites and Mesolithic sites in Flores (Jacob, 1967)	-	Matsumura and Hudson, 2005
Khok Phanom Di	Chonburi Prov., Thai	Late Neolithic (c. 4,000-3,500 BP)		Tayles, 1999	-
Weidun & Songze	Sites in Jiangsu Prov., Sth China	Neolithic Majiabang Culture (c.5,000 BP)	Chang, 1986; Nakahashi and Li, 2002	Matsumura 2002	-
Anyang (Yin-Shang)	Henan Province, China	Bronze age (c. 3,300BP)	IHIA, and CASS, 1982, samples in Academia Sinica, Taipei	unpublished	unpublished
Jiangnan	Yangtze River region	Zhou and Western Han periods (c. 2,770-1,992 BP)	Nakahashi and Li, 2002	Matsumura 2002	-
Jomon	Japan	Late Jomon (c.5,000-2,300 BP)	Akazawa and Aikens, 1986	Matsumura 1989	Matsumura1995
Yayoi	Western Japan	Early Metal age (c.2,000 BP)	Kanaseki et al., 1960; Nakahashi, 1989; Hudson, 1990	Matsumura and 1994	Matsumura1995
Australia	Australian aborigines	Modern		Matsumura and Hudson, 2005	Matsumura and Hudson, 2005
New Britain Islanders	New Britain Island	Modern		Matsumura 1995	Matsumura1995
Loyalty	Loyalty Islands	Modern		Matsumura and Hudson, 2005	Matsumura and Hudson, 2005
Andaman	Andaman Islands	Modern		Matsumura and Hudson, 2005	Matsumura and Hudson, 2005
Malay	Mainland Malay	Modern		Matsumura and Hudson, 2005	-
Dayak	Sarawak, Malaysia	Modern		Matsumura and Hudson, 2005	Matsumura and Hudson, 2005
Lesser Sunda	Sulawesi, Timor and Java	Modern		Matsumura and Hudson, 2005	Matsumura and Hudson, 2005
Vietnam	Vietnam	Modern		Matsumura et al., 2010	Matsumura et al., 2010
Laos	Laos	Modern		Matsumura et al, 2010	-
Thai	Bangkok, Thailand	Modern		Matsumura 1994	Matsumura1995
Myanmar	Myanmar	Modern		Matsumura et al., 2010	Matsumura et al., 2010
Atayal	Taiwan	Modern	samples in National Taiwan Univ.	unpublished	unpublished
Hainan	Hainan Island in Sth. China	Modern	samples in National Taiwan Univ.	unpublished	unpublished

Table 5.2 Criteria for scoring presence of the 21 non-metric dental traits.

Trait	Tooth	Description	Criteria	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 groove) - 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.

In the odontometric analyses, mean values obtained from small sample sizes were utilised for statistical procedures, but for the nonmetric trait comparisons small sample sizes skew the frequency data. Statistically, population comparisons using frequency data require larger sample sizes in each sub-sample than the odontometric comparisons. For this reason some population samples with small sample size were combined or excluded from the non-metric comparisons, as summarised in Table 5.1. C.A.B. Smith's distances (Berry and Berry, 1967), often referred to as "mean measure of divergence" values, were calculated to evaluate population affinities based on the presence/absence frequencies of the 21 non-metric traits. Finally, the Neighbour Joining analysis was applied to the Smith's distance matrix in order to provide a summarised pattern of population affinities in the non-metric trait battery.

RESULTS

Quantitative Data Comparisons

Summary Man Bac and modern Vietnamese permanent and deciduous odontometric statistics are presented in Tables 5.3 and 5.4. Buccolingual diameters of deciduous teeth were not measured for the modern Vietnamese specimens as the material used was plaster casts taken from living residents in which the maximum diameter point at the crown was covered by gingiva. Significant differences were found only in a few measurements for the deciduous teeth between the Man Bac and modern Vietnamese. The former sample possesses larger anterior teeth as compared to modern Vietnamese.

In comparing the permanent dentition, only four male crown diameters are statistically significantly different to those of the modern Vietnamese sample, in each case the Man Bac diameter is smaller. Regarding females, only a single statistically significant difference was found between Man Bac and modern Vietnamese crown diameters, in this case Man Bac UM1 BL diameters are larger.

When comparing the coefficients of variation (CV) between the Man Bac and modern Vietnamese series, no specific pattern of variability in either the permanent or deciduous dentition was observed.

Table 5.5 gives the distance matrix (1-r) transformed from the Q-mode correlation coefficients (r). Figure 5.1 displays the results of the Neighbour Joining analysis applied to the distance matrix of Table 5.5. The Man Bac sample is quite close to present-day populations from Laos, Thailand and Malaysia. The modern samples from Myanmar, Vietnam and the Metal Period Dong Son Vietnamese, as well as the contemporaneous series Khok Phanom Di from Thailand and the Neolithic southern Chinese from Weidun and Songze, are clustered in a second degree of proximity to Man Bac. In contrast, mid-Holocene samples, such as Con Co Ngua (representative of Da But communities) and late Pleistocene/early Holocene Bac Son and Hoabinhian series are grouped in the other major cluster, consisting of Australo-Melanesians, Andaman Islanders, and early Malay and Flores samples (including Gua Cha). Two late samples from Jomon (Japan) and one from neolithic An Son (southern Vietnam) are located intermediately within this schema.

Table 5.3 Summary statistics of mesiodistal and buccolingual crown diameters of Man Bac and present-day Vietnamese.

	Man Bac								Vietnamese									
	Males				Females				Males					Females				
	n	Mean	SD	CV	n	Mean	SD	CV	n	Mean	SD	CV	t-value	n	Mean	SD	CV	t-value
Mesiodistal diameters (mm)																		
UI1	17	8.51	0.52	6.1	11	8.53	0.66	7.8	19	8.73	0.44	5.1	1.37	8	8.35	0.33	3.9	0.71
UI2	6	7.24	0.44	6.0	4	7.11	1.29	18.1	18	7.14	0.50	7.0	0.44	8	6.64	0.41	6.2	0.98
UC	17	7.96	0.46	5.8	10	7.70	0.33	4.3	21	8.08	0.39	4.8	0.87	8	7.90	0.24	3.1	1.43
UP1	15	7.24	0.49	6.7	7	7.35	0.78	10.6	32	7.54	0.52	6.9	1.88	8	7.42	0.32	4.3	0.23
UP2	18	6.80	0.67	9.8	8	6.95	0.49	7.1	31	7.19	0.74	10.3	1.84	8	6.98	0.28	4.0	0.15
UM1	17	10.42	0.49	4.7	8	10.44	0.68	6.5	48	10.53	0.46	4.4	0.83	9	10.05	0.34	3.4	1.52
UM2	18	9.27	0.68	7.3	9	9.44	0.68	7.2	40	9.58	0.51	5.3	1.93	6	9.29	0.31	3.3	0.50
LI1	12	5.50	0.33	6.0	7	5.34	0.63	11.9	19	5.49	0.32	5.8	0.08	8	5.33	0.16	3.0	0.04
LI2	12	6.12	0.29	4.7	7	5.90	0.64	10.8	23	6.07	0.34	5.6	0.43	8	5.92	0.20	3.5	0.08
LC	17	6.95	0.49	7.0	9	6.79	0.62	9.1	25	7.14	0.38	5.4	1.41	8	6.76	0.20	3.0	0.13
LP1	16	7.06	0.55	7.8	7	6.75	0.50	7.5	26	7.43	0.47	6.3	2.32 *	8	7.08	0.34	4.7	1.51
LP2	16	7.02	0.58	8.2	10	6.98	0.48	6.9	24	7.61	0.43	5.7	3.70 ***	8	7.12	0.24	3.4	0.75
LM1	17	11.72	0.46	3.9	8	11.37	0.75	6.6	31	11.63	0.45	3.9	0.66	8	11.04	0.27	2.5	1.17
LM2	18	10.61	0.73	6.9	8	10.54	0.96	9.1	25	10.98	0.84	7.6	1.50	6	10.02	0.44	4.4	1.22
Buccolingual diameters (mm)																		
UI1	17	7.20	0.35	4.8	11	7.02	0.45	6.4	4	7.86	0.21	2.7	3.58 ***	2	7.75	0.36	4.7	2.15
UI2	6	6.73	0.32	4.7	4	6.34	0.82	12.9	4	7.07	0.42	6.0	1.46	2	6.49	0.33	5.1	0.24
UC	18	8.21	0.65	8.0	10	7.73	0.65	8.4	11	8.55	0.58	6.8	1.42	3	7.69	0.07	0.9	0.10
UP1	15	9.58	0.50	5.2	12	9.20	0.56	6.1	18	9.62	0.61	6.4	0.20	8	9.35	0.45	4.8	0.63
UP2	18	9.38	0.47	5.1	13	9.10	0.57	6.2	17	9.40	0.63	6.7	0.11	8	9.15	0.44	4.8	0.21
UM1	20	11.80	0.77	6.5	9	12.06	0.78	6.5	35	11.71	0.59	5.1	0.49	9	11.02	0.50	4.5	3.37 ***
UM2	17	11.30	0.71	6.3	10	11.08	1.00	9.1	30	11.64	0.69	5.9	1.61	7	10.79	0.39	3.6	0.72
LI1	12	5.82	0.42	7.2	7	5.67	0.56	9.8	9	5.93	0.51	8.5	0.54	5	5.94	0.25	4.2	1.00
LI2	12	6.16	0.33	5.4	7	5.97	0.58	9.7	12	6.30	0.49	7.8	0.82	5	6.30	0.32	5.1	1.14
LC	18	7.56	0.55	7.3	12	7.24	0.61	8.4	12	8.35	0.44	5.2	4.16 ***	3	6.97	0.28	4.1	0.73
LP1	18	8.08	0.63	7.8	12	7.63	0.44	5.8	25	8.25	0.55	6.7	0.94	8	7.88	0.52	6.6	1.16
LP2	18	8.36	0.53	6.4	12	7.97	0.56	7.0	24	8.66	0.48	5.6	1.92	8	8.22	0.53	6.4	1.00
LM1	19	10.93	0.70	6.4	10	10.57	0.61	5.8	33	10.87	0.57	5.2	0.34	8	10.32	0.47	4.6	0.95
LM2	18	10.20	0.69	6.8	9	9.89	0.81	8.2	29	10.38	0.63	6.1	0.92	5	10.20	0.43	4.2	0.79

CV=Coefficient of variation, ***: significance level at 0.5%, **: 1%, and *: 5%by t-test.

Table 5.4 Summary statistics of mesiodistal and buccolingual crown diameters of Man Bac and present-day Vietnamese.

	Man Bac				Vietnamese				
	n	Mean	SD	CV	n	Mean	SD	CV	t-value
Mesiodistal diameters (mm)									
udi1	11	7.04	0.37	5.2	15	6.62	0.29	4.4	3.207 ***
udi2	14	5.92	0.32	5.4	15	5.58	0.38	6.8	2.652 *
udc	15	7.04	0.21	3.0	15	6.68	0.40	6.1	3.021 **
udm1	13	7.30	0.37	5.0	15	7.48	0.36	4.9	1.275
udm2	13	9.14	0.67	7.4	15	9.15	0.56	6.2	0.052
ldi1	9	4.51	0.29	6.3	15	4.26	0.34	7.9	1.860
ldi2	10	5.04	0.22	4.3	15	4.78	0.38	7.9	1.914
ldc	12	5.99	0.19	3.1	15	5.90	0.30	5.1	0.897
ldm1	14	8.47	0.45	5.3	15	8.28	0.60	7.2	0.960
ldm2	15	10.50	0.35	3.3	15	10.44	0.50	4.8	0.365
Buccolingual diameter (mm)									
udi1	9	4.96	0.32	6.4					
udi2	13	4.87	0.34	7.0					
udc	14	5.96	0.30	5.1					
udm1	12	8.97	0.45	5.1		no data			
udm2	11	10.16	0.35	3.4					
ldi1	8	3.74	0.11	2.9					
ldi2	10	4.34	0.35	8.2					
ldc	11	5.53	0.45	8.1					
ldm1	13	7.06	0.34	4.8					
ldm2	14	8.77	0.43	4.9					

u: upper, l:lower, d:deciduous, i:incisor, c:canine, m:molar, CV=Coefficient of variation, significance level at ***: 0.5%, **: 1%, and *: 5% by t-test.

Figure 5.1 An un-rooted tree of neighbour joining analysis applied to the distance matrix of Q-mode correlation coefficients in Table 5.5, using 28 crown diameters of the male permanent dentition.

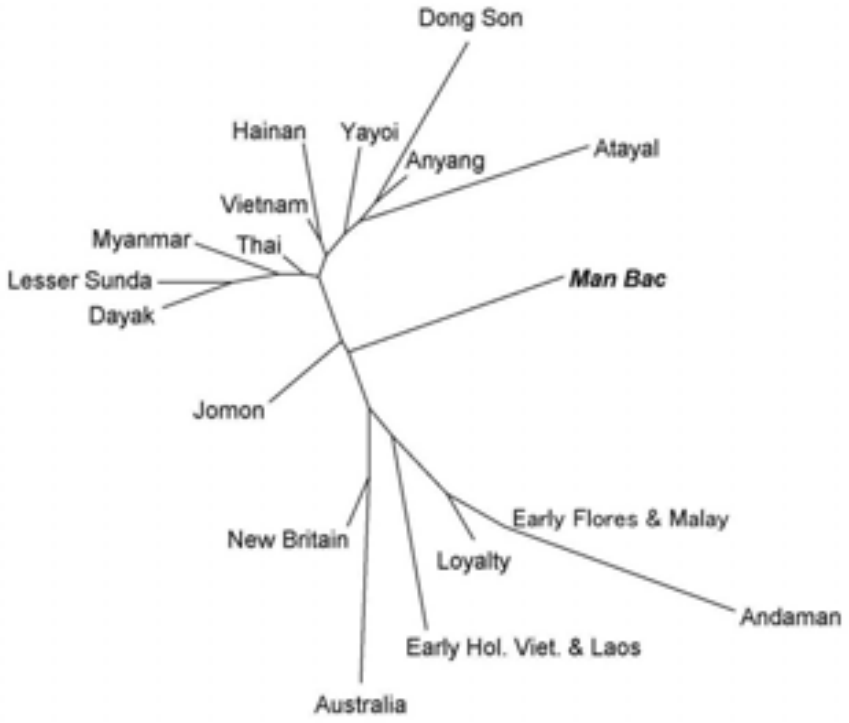

Figure 5.2 An un-rooted tree of neighbour joining analysis applied to Smith's distance matrix of Table 5.7, using frequency data of 21 nonmetric dental traits in the permanent dentition (sexes combined).

Qualitative Data Comparisons

Table 5.6 provides the frequency of the 21 non-metric dental traits recorded for the Man Bac and present-day Vietnamese assemblages. Statistically significant differences were detected in four of the 21 traits. The Man Bac sample shows higher occurrences of UI1 dental tubercle and LM1 seventh cusp, with lower frequencies of UI1 shoveling and UP1 De Terra's tubercle, as compared with modern Vietnamese.

Smith's distances computed using the 21 trait frequencies are presented in Table 5.7. An un-rooted tree of the Neighbour Joining analysis applied to the Smith's distance matrix is depicted in Figure 5.2. The samples compared are clearly divided into two major clusters. The first consists of early and modern East Asian samples and a sub-cluster of modern mainland and island Southeast Asians. The Metal Period Dong Son branches off from this assemblage. The other major cluster encompasses the remaining Hoabinhian-Neolithic Malay, Australian Aborigines, Melanesians and Andaman Islanders. The early Vietnamese series, consisting of the Bac Son and Da But (Con Co Ngua) series, also branch off from this assemblage. Man Bac, as well as the Jomon series, are positioned intermediately between the two major clusters.

DISCUSSION AND CONCLUSIONS

The 'Two Layer' model, or 'Immigration' hypothesis, supported by a wide array of archaeological, historical linguistic and genetic studies, is important for our understanding of the complexities of the population history of Southeast Asia. The prehistoric expansion of language families, specifically the Austronesian and Austroasiatic, can be correlated with the Neolithic dispersal of food producing populations (Renfrew, 1987, 1989, 1992; Bellwood, 1991, 1993, 1997; Hudson, 1994, 1999, 2003; Higham 1998, 2001; Hill, 2001; Bellwood and Renfrew, 2003; Diamond and Bellwood, 2003). In regards to the contributions of studies of human skeletal remains, there have been long term debates on this issue (for review see also Oxenham and Tayles, 2006). In contrast to the traditional "Two Layer" model, some recent cranial and dental studies (eg. Turner 1989, 1990, 1992, Hanihara, 1993, 1994, Pietrusewsky 1992, 1994, 1999) propose that the evolution of many present-day Southeast Asians was by local adaptation, and not by significant admixture with new food producing communities expanding from a source somewhere in mainland East Asia. In terms of craniodental morphology a difficulty arises in distinguishing between *in situ* local modernisation and gene flow mediated change (so-called "Mongoloidisation" by Bulbeck, 1982). Although regional population groupings such as those sometimes termed "Mongoloid" and "Australo-Melanesian" cannot be seen as modernisation in the sense of monophyletic groups, such a conundrum nevertheless remains central to the interpretation of the data analysed, including the Man Bac series. A dental morphological approach may help shed light on the debate given the generally accepted better heritability of dental traits in comparison to cranial morphology.

Previous dental analyses (Matsumura et al. 2001) demonstrated a large morphological gap between later Dong Son and early Holocene samples represented by Bac Son and Da But (Con Co Ngua) people. It was argued that the discontinuity

Table 5.5 Distance (1-r) transformed from q-mode correlation coefficients, on the bases of 28 crown diameters of the male permanent dentition.

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
[1]	Andaman																											
[2]	Yayoi	1.02																										
[3]	Khok Phanom Di	1.52	0.79																									
[4]	Malay	1.22	1.19	0.77																								
[5]	An Son	0.85	1.41	1.23	1.06																							
[6]	Anyang	1.21	0.89	0.90	1.09	1.55																						
[7]	Atayal	1.53	1.12	0.52	0.72	1.08	0.99																					
[8]	Australia	0.71	0.92	1.18	1.26	0.85	1.29	1.54																				
[9]	Bac Son	0.55	0.96	1.50	1.12	1.17	0.66	1.38	0.81																			
[10]	Con Co Ngua	0.78	0.96	0.93	1.22	0.79	1.19	1.35	0.50	1.19																		
[11]	Dayak	1.56	1.31	0.64	0.73	0.75	1.05	0.40	1.31	1.60	1.11																	
[12]	Dong Son	1.41	0.59	0.68	1.28	1.25	0.72	0.61	1.40	1.15	1.42	0.96																
[13]	Gua Cha	0.56	1.04	1.49	1.41	0.83	1.32	1.23	0.72	0.56	1.10	1.27	1.08															
[14]	Hainan	1.37	1.16	0.63	0.62	1.39	0.85	0.33	1.36	1.26	1.37	0.60	0.71	1.28														
[15]	Hoabinhian Vietnam	0.86	1.02	1.03	1.17	1.18	0.80	1.62	0.52	0.72	0.84	1.45	1.22	1.02	1.33													
[16]	Lesser Sunda	1.11	1.23	0.86	0.85	1.10	0.99	0.77	1.33	1.43	1.02	0.78	0.92	1.37	0.68	1.07												
[17]	Jiangnan	1.20	1.05	0.90	1.02	1.13	1.04	0.62	1.05	1.05	1.34	0.78	0.69	0.61	0.64	1.11	1.22											
[18]	Jomon	0.78	0.74	0.81	1.21	0.71	1.31	1.16	0.85	1.42	0.60	0.88	1.01	1.11	1.33	1.05	1.07	1.10										
[19]	Laos	1.13	1.22	0.97	0.98	0.75	1.27	0.66	1.31	1.53	0.80	0.50	1.12	1.15	0.90	1.43	0.68	1.04	0.76									
[20]	Loyalty	0.32	1.04	1.34	1.40	1.07	1.06	1.48	0.40	0.52	0.71	1.65	1.23	0.59	1.20	0.63	1.06	1.12	1.14	1.40								
[21]	Mesolithic Flores	0.66	0.86	1.37	1.34	1.02	1.25	1.05	0.86	0.64	0.93	1.53	0.87	0.48	1.18	1.16	1.33	0.93	1.18	1.18	0.57							
[22]	Myanmar	1.66	0.75	0.64	0.96	1.29	0.75	0.44	1.48	1.21	1.20	0.75	0.45	1.17	0.71	1.33	0.62	0.88	1.34	0.86	1.42	0.96						
[23]	New Britain	0.65	1.21	1.28	1.30	0.90	1.16	1.24	0.44	0.87	0.63	1.36	1.36	0.93	1.27	0.72	1.02	1.14	0.95	1.00	0.47	0.68	1.33					
[24]	Thai	1.17	0.94	1.11	0.69	1.01	1.00	0.93	1.35	1.07	1.50	0.71	0.92	1.09	0.73	1.18	0.89	1.10	1.28	0.81	1.29	1.35	0.91	1.58				
[25]	Vietnam	1.26	0.68	0.60	0.85	1.61	0.91	0.54	1.27	1.18	1.35	0.96	0.53	1.14	0.22	1.17	0.78	0.62	1.21	1.07	1.07	0.91	0.59	1.20	0.85			
[26]	Weidun & Songze	1.43	1.07	0.96	0.93	0.86	0.84	0.49	1.41	1.12	1.41	0.53	0.68	1.04	0.81	1.28	0.95	0.73	1.09	0.81	1.6	1.13	0.59	1.24	0.8	0.99		
[27]	Hoa Diem	1.07	1.01	1.11	0.77	1.05	0.82	0.94	1.14	1.06	1.01	1.02	0.96	1.36	0.93	0.99	0.90	1.14	1.17	1.05	0.96	0.95	0.93	0.85	0.84	0.98	0.93	
[28]	Man Bac	1.30	1.09	0.82	0.84	0.85	0.92	0.78	1.58	1.51	1.07	0.53	1.01	1.58	1.00	1.34	0.82	1.28	0.65	0.53	1.64	1.45	0.94	1.23	0.77	1.15	0.83	0.85

Table 5.6 Frequencies of 21 non-metric dental traits: Man Bac and modern Vietnamese permanent teeth.

		Man Bac			Vietnamese				
		O	A	Freq.	O	A	Freq.	chi-value	
shoveling	UI1	29	18	62.1	41	34	82.9	3.869	*
shoveling	UI2	12	4	33.3	39	19	48.7	0.877	
double shoveling	UI1	33	5	15.2	41	6	14.6	0.004	
double shoveling	UI2	15	0	0.0	40	1	2.5	0.382	
dental tubercle	UI1	33	8	24.2	38	1	2.6	7.452	**
dental tubercle	UI2	14	1	7.1	36	2	5.6	0.045	
spine	UI1	30	8	26.7	40	10	25.0	0.025	
interruption groove	UI2	14	4	28.6	29	5	17.2	0.732	
winging (bilateral)	UI1	29	0	0.0	41	4	9.8	3.001	
De Terra's tubercle	UP1	12	0	0.0	60	16	26.7	4.114	*
double rooted	UP1	11	4	36.4	50	25	50.0	0.672	
double rooted	UP2	11	0	0.0	49	3	6.1	0.709	
Carabelli's trait	UM1	23	10	43.5	92	26	28.3	1.981	
hypocone reduction	UM2	31	6	19.4	75	15	20.0	0.006	
sixth cusp	LM1	20	6	30.0	63	15	23.8	0.308	
seventh cusp	LM1	25	4	16.0	66	2	3.0	4.952	*
protostylid	LM1	19	0	0.0	65	1	1.5	0.296	
deflecting wrinkle	LM1	18	3	16.7	53	19	35.8	2.312	
groove pattern Y	LM1	23	16	69.6	57	43	75.4	0.292	
groove pattern X	LM2	29	6	20.7	65	21	32.3	1.322	
hypoconulid reduction	LM2	25	15	60.0	66	25	37.9	3.602	

O: observed numbers of dentitions, A: affected numbers of dentitions, Freq: frequency (%).
significance level at 5%, and **: 1% by chi-square test.

between early and later Holocene populations was due to considerable levels of gene flow into what is now northern Vietnam from migrants moving in from the northern or eastern peripheral areas. Subsequent studies, using the early Hoabinhian Hang Cho specimen, and Man Bac remains excavated from 1999-2005, reconfirmed the large morphological discontinuity between these two sequences (Matsumura et al., 2008a and 2008b). The Hang Cho specimen was posited as representing an ancestral population of subsequent early to mid Holocene people, whereas the majority of the Man Bac assemblage (1999-2005 series), as well as the later Dong Son and modern Vietnamese, were thought to have closer genetic ties with immigrants from the northern peripheral area of what is now Vietnam and southern China.

In order to develop a more comprehensive interpretation of Man Bac population affinities this study has utilised a wide range of dental data and employed a geographically large and temporally deep comparative data set. This analysis has demonstrated that: (1) Man Bac odontometric variance is greater than that of modern Vietnamese; (2) in terms of odontometric proportions, the Man Bac sample has a closer affinity with modern Vietnamese than the earlier late Pleistocene/early to mid Holocene series (e.g. Con Co Ngua (Da But), Bac Son and Hoabinhian), who are in turn phenotypically akin to Australo-Melanesian populations; (3) with respect to non-metric dental traits, the Man Bac series is situated midway between earlier groups (e.g. Bac Son and Con Co Ngua (Da But) and modern Vietnamese. Inconsistencies in the results exhibited by the metric and non-metric data might

Table 5.7 Smith's distances based on 21 non-metric dental traits of the permanent dentition (sexes combined).

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]
[1]	Andaman																	
[2]	Dayak	0.33																
[3]	Early Flores & Malay	0.13	0.18															
[4]	Lesser Sunda	0.33	0.08	0.19														
[5]	E-Hol. Viet. & Laos	0.20	0.20	0.20	0.17													
[6]	Loyalty	0.14	0.21	0.13	0.21	0.23												
[7]	Jomon	0.30	0.15	0.17	0.14	0.23	0.16											
[8]	Yayoi	0.50	0.20	0.30	0.17	0.33	0.31	0.12										
[9]	Thai	0.35	0.08	0.21	0.08	0.21	0.20	0.10	0.07									
[10]	Australia	0.38	0.27	0.20	0.29	0.26	0.35	0.27	0.25	0.23								
[11]	New Britain	0.20	0.15	0.10	0.18	0.23	0.15	0.17	0.21	0.11	0.14							
[12]	Vietnam	0.37	0.10	0.20	0.12	0.21	0.19	0.15	0.10	0.07	0.23	0.18						
[13]	Dong Son	0.48	0.28	0.25	0.26	0.29	0.29	0.20	0.20	0.20	0.26	0.31	0.13					
[14]	Myanmar	0.42	0.10	0.22	0.13	0.29	0.25	0.22	0.15	0.09	0.29	0.19	0.08	0.24				
[15]	Atayal	0.44	0.28	0.39	0.32	0.41	0.28	0.26	0.18	0.18	0.41	0.29	0.18	0.26	0.29			
[16]	Hainan	0.49	0.17	0.34	0.16	0.33	0.22	0.17	0.14	0.10	0.40	0.29	0.07	0.21	0.13	0.20		
[17]	Anyang	0.55	0.20	0.34	0.21	0.38	0.28	0.19	0.09	0.11	0.31	0.28	0.07	0.12	0.11	0.15	0.10	
[18]	Man Bac	0.32	0.24	0.23	0.21	0.25	0.16	0.18	0.30	0.24	0.39	0.25	0.18	0.24	0.30	0.32	0.18	0.30

reflect sample bias or perhaps different patterns of genetic inheritance. Nevertheless, it can be concluded that the dental affinities of the Man Bac people indicate a considerable level of gene flow from Neolithic East Asia. Similarities between late Pleistocene and early to mid Holocene series and Man Bac, in terms of nonmetric dental morphology, suggest Man Bac was a population in genetic transition.

SUMMARY

This chapter provides quantitative (metric) and qualitative (non-metric) dental data recorded for the Man Bac series. It presents results of analyses using batteries of tooth traits useful for assessing biological affinities. Multivariate comparisons using odontometric data sets revealed the closer affinity of the Man Bac people to later Metal Age Dong Son and present-day Southeast Asians than to earlier populations such as the Con Co Ngua (Da But) and Bac Son/Hoabinhian series, who are in turn phenotypically more akin to Australo-Melanesian populations. Although the analysis of the non-metric trait battery suggests that Man Bac people still partially preserved genetic features of earlier indigenous populations, this study concludes that the population structure of Man Bac was affected by major gene flow that can likely be sourced to new immigrants from peripheral northern or eastern areas of East Asia, including southern China.

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Appendix 5.1 Crown measurements (mm) and the presence of non-metric dental traits of the permanent dentition of the Man Bac series.

Sample Number		99M2	99M3	01M1	01M5	01M9	01M10	05M9	05M10	05M11
Sex		Female	Male	Unknown	Male	Male	Male	Female	Male	Male
Mesiodistal	UI1	7.95	8.18		8.22	8.35	8.48	8.34	9.15	
diameters (mm)	UI2	6.78				6.75			7.87	
	UC	7.30	7.35		7.82	7.61	7.50	7.44		8.83
	UP1	6.81	7.27			7.11				7.41
	UP2	6.85	7.02		6.53	5.60	6.42			7.11
	UM1	9.73	9.93		10.23	10.75			10.68	10.93
	UM2	8.78	8.35		9.57	9.11	9.15	9.98	9.81	10.20
	LI1	4.94	5.40		5.65		4.98	4.93	5.92	5.62
	LI2	5.45	5.96		5.83		6.08	5.33	6.33	6.42
	LC	6.32	6.56		6.51	6.90	6.94	6.87		7.84
	LP1	6.42	7.53		6.23		7.02			7.64
	LP2	6.33	7.53		6.52			7.22		7.53
	LM1	11.11	11.82		11.24			11.23	12.18	12.11
	LM2	9.53	10.29		10.12		10.18	11.04		11.61
Buccolingual	UI1	6.56	6.53		6.98	7.53	7.42	7.01	7.13	
diameters (mm)	UI2	5.74				6.82			6.80	
	UC	6.88	7.51		7.52	7.72	6.62	8.01		8.49
	UP1	8.30	9.13			9.60		9.43		9.62
	UP2	8.38	9.37		8.86	8.91	9.18	8.85		9.39
	UM1	11.06	11.46		11.40	11.51	11.37	11.77	11.37	12.47
	UM2	10.04	10.81		10.94	11.64	11.39	11.73		12.24
	LI1	4.81	5.42		5.58		5.20	5.65	6.01	5.73
	LI2	5.31	5.78		6.29		5.82	6.10	6.07	6.34
	LC	6.68	6.87		7.20	8.04	7.17	7.25		7.80
	LP1	6.85	7.82		7.28		8.24	7.97		8.47
	LP2	6.78	8.00		7.81		8.06	8.50		8.56
	LM1	9.67	10.04		10.65		10.19	10.32	10.67	11.75
	LM2	8.67	9.28		9.64		9.41	9.98		11.02
shoveling	UI1	-	+	-	+	-	+		+	
shoveling	UI2	-				-			+	
double shoveling	UI1	-	-	-	+	-	+	-	-	
double shoveling	UI2	-		-		-			-	
dental tubercle	UI1	-	-	-	-	-	-	-	-	
dental tubercle	UI2	-				-			-	
spine	UI1	-	-	-	-	-	-		-	
interruption groove	UI2	-				-			+	
winging (bilateral)	UI1	-	-	-	-	-		-	-	
De Terra's tubercle	UP1	-	+			+				
double rooted	UP1	-			-	+				-
double rooted	UP2	-	-		-	-	-			-
Carabelli's trait	UM1	-	+	-	+	-			-	
hypocone reduction	UM2	+	-	-	-	-	-	-	-	+
sixth cusp	LM1	-	+	-					-	+
seventh cusp	LM1	-	+	-					-	-
protostylid	LM1	-	-	-					-	-
deflecting wrinkle	LM1	-	-	+					-	-
groove pattern Y	LM1	+	+	+	+				+	-
groove pattern X	LM2	-	-	-	-		-	-	-	-
number of cusps	LM2	+	+				-	-	-	-

U:Upper, L:Lower, I:Incisor, C:Canine, P:Premolar, M:Moler, +: present, -: absent

Appendix 5.1 (Continued 1).

Sample Number		05M13	05M15	05M20	05M24	05M25	05M28	05M29	05M31	05M32
Sex		Unknown	Female	Male	Unknown	Unknown	Female	Male	Male	Male
Mesiodistal	UI1	8.44		8.15	8.25		8.49	8.64		9.10
diameters (mm)	UI2	7.23						6.85		
	UC	7.79	8.36	7.86			7.48	8.19	8.70	
	UP1	7.32	7.98				7.29	7.39	7.28	8.27
	UP2	7.33	7.36	7.07			7.46	6.92	7.14	8.64
	UM1	10.64	10.73	10.43	11.53		10.53	10.59	9.66	11.32
	UM2	9.29	9.04	9.44			9.73	10.20	9.17	
	LI1	5.39	5.62	5.21	5.23			5.70		6.12
	LI2	5.98	6.54	6.34				6.27		
	LC	6.66	7.12	7.30				7.20	7.45	
	LP1	7.04	7.31	7.09				7.17	7.69	7.83
	LP2	7.26	7.10	7.14				7.13	7.47	7.71
	LM1	11.15	12.23	11.39	12.00			12.31	11.21	12.17
	LM2	11.03	9.82	9.38	6.06		10.63	11.16	10.66	12.02
Buccolingual	UI1	8.03		6.83	6.89		6.70	7.86		7.46
diameters (mm)	UI2	7.10						7.29		
	UC	9.09	8.48	7.64			7.77	8.84	8.74	
	UP1	9.51	9.64				9.33	10.36	9.78	9.34
	UP2	9.75	9.53	9.49			9.65	10.05	9.59	9.81
	UM1	11.41	12.91	11.55	11.87			13.24	11.69	11.87
	UM2	11.73	10.29	11.21			11.57	12.50	11.96	
	LI1	5.95	5.77	5.59				6.60		6.49
	LI2	6.82	5.88	6.12				6.80		
	LC	7.69	7.81	7.20				8.37	8.00	
	LP1	8.38	7.97	7.97				9.48	8.54	8.60
	LP2	9.04	8.03	7.91				9.17	8.41	8.24
	LM1	10.77	11.21	10.46	10.79			12.11	10.99	10.91
	LM2	9.99	10.08	9.94			10.03	11.13	10.54	10.80
shoveling	UI1	+		-	+					+
shoveling	UI2	-			+					
double shoveling	UI1	-		+	+		-	-		-
double shoveling	UI2	-			-			-		
dental tubercle	UI1	-		-	-		-	-		+
dental tubercle	UI2	-			-			-		
spine	UI1	-		-	-		-			+
interruption groove	UI2	-			-			+		
winging (bilateral)	UI1	-		-	-			-		
De Terra's tubercle	UP1	-	-							
double rooted	UP1		+	-						-
double rooted	UP2		-						-	
Carabelli's trait	UM1	+	-	-	+					+
hypocone reduction	UM2	-	-	-			-	-	-	
sixth cusp	LM1	-	-	-	-	-				-
seventh cusp	LM1	+	-	-	+	-			-	-
protostylid	LM1	-	-	-	-					-
deflecting wrinkle	LM1	-	+		-	-				
groove pattern Y	LM1	-	+	-	+	-				+
groove pattern X	LM2	+	-	+			-		-	-
number of cusps	LM2	+	-	+			+		+	

U:Upper, L:Lower, I:Incisor, C:Canine, P:Premolar, M:Moler, +: present, -: absent

Appendix 5.1 (Continued 2).

Sample Number		05M34	07H1M1	07H1M3	07H1M4	07H1M5	07H1M8	07H1M9	07H1M10	07H1M11
Sex		Female	Unknown	Female	Female	Male	Male	Male	Female	Female
Mesiodistal	UI1	8.52		7.83	8.24	9.10	7.80	8.19	9.58	8.48
diameters (mm)	UI2			6.01				7.52		
	UC	7.73		7.36	7.68	8.23	8.00	8.47	7.94	
	UP1	7.05		6.67		7.36	7.29	7.48		
	UP2	6.68		6.56		6.09	6.76	7.17		
	UM1	10.18		9.75		10.97	10.11	10.46	10.75	
	UM2			9.21		9.42	7.59	9.70	9.64	8.67
	LI1			4.69			5.23		5.98	
	LI2			5.31			5.75	6.57	5.92	
	LC	6.86		6.24			6.69	7.41	6.77	6.45
	LP1	6.51		6.21			6.80	7.15		6.59
	LP2	7.56		6.46			6.53	7.11	7.48	6.85
	LM1			10.68			11.04	11.49		10.94
	LM2	10.58		9.82		11.04	9.83	10.63		
Buccolingual	UI1	7.14		6.85	6.73	7.22	7.34	6.91	6.97	7.49
diameters (mm)	UI2			5.82				6.47		
	UC	7.54		7.13	7.67	8.53	8.05	8.79	7.67	
	UP1	9.21		8.90	9.64	9.62	9.70	9.56	9.20	9.21
	UP2	9.05		8.63	9.37	9.62	9.37	9.09	9.16	9.52
	UM1	12.35		11.27		11.93	12.21	11.36	12.17	12.20
	UM2			10.72		11.63	10.50	11.73	11.28	10.78
	LI1			5.33			5.81		6.00	
	LI2			5.63			5.80	6.39	6.12	
	LC	7.52		6.82	6.98	8.05	6.26	7.64	7.30	7.47
	LP1	7.80		7.18	7.75	8.78	7.50	7.99	7.28	8.10
	LP2	8.00		7.49	8.47	9.28	8.06	7.77	7.39	8.19
	LM1			9.84	10.10	11.48	10.81	11.08		10.80
	LM2	10.91		8.82		10.79	10.76	10.36		
shoveling	UI1	+	+	+	-	-	-	+	+	+
shoveling	UI2		-	-				-		
double shoveling	UI1	-	-	-	-	-	-	-	-	-
double shoveling	UI2		-	-				-		
dental tubercle	UI1	+	+	-	-	+	-	-	-	+
dental tubercle	UI2		+	-				-		
spine	UI1	+	-	-	-	-	-	-	-	-
interruption groove	UI2		-	-				+		
winging (bilateral)	UI1	-	-	-	-	-	-	-	-	-
De Terra's tubercle	UP1		+	-				+		
double rooted	UP1									+
double rooted	UP2				-					
Carabelli's trait	UM1	+	-	-				-		
hypocone reduction	UM2		-	-		-	-	+	-	-
sixth cusp	LM1		-	-						
seventh cusp	LM1		-	-			-	-		
protostylid	LM1		-	-				-		
deflecting wrinkle	LM1		-	-				-		
groove pattern Y	LM1		+	+				-		
groove pattern X	LM2	-	-	+			+	+		
number of cusps	LM2	+	-	-		-		-		

U:Upper, L:Lower, I:Incisor, C:Canine, P:Premolar, M:Moler, +: present, -: absent

Appendix 5.1 (Continued 3).

Sample Number		07H2M1	07H2M2	07H2M10	07H2M12	07H2M13	07H2M15	07H2M17	07H2M18	07H2M19
Sex		Male	Female	Male	Female	Unknown	Unknown	Unknown	Male	Male
Mesiodistal	UI1	7.76	9.98						8.67	7.92
diameters (mm)	UI2		8.97	7.01					7.43	
	UC	7.25	8.04	7.51					7.74	
	UP1	5.86	8.80	7.26					7.16	
	UP2	5.63	7.68	6.69	6.32				7.13	
	UM1	10.06	11.79	10.04					9.66	
	UM2	8.53	10.81	9.75					9.03	8.67
	LI1		6.32	5.43					5.57	
	LI2		6.97	6.26					6.00	
	LC	6.17	8.22	6.98					6.41	6.20
	LP1	5.80	7.59	7.54					6.64	
	LP2	5.60	7.61	7.77	6.46				6.55	6.58
	LM1	11.29	12.81	11.55	10.78				11.13	11.80
	LM2	9.94	12.56	10.90					10.05	9.62
Buccolingual	UI1	7.02	8.15						6.86	6.99
diameters (mm)	UI2		7.51	6.60					6.42	
	UC	8.25	9.00	8.39					7.66	8.35
	UP1	8.44	10.27	9.38	8.26				9.64	
	UP2	8.11	10.18	9.73	8.07				9.39	
	UM1	11.98	13.44	11.65					11.38	10.69
	UM2	11.13	13.47	11.79					10.36	10.23
	LI1		6.60	5.74					5.54	
	LI2		7.12	6.11					5.83	
	LC	7.39	8.72	7.75	7.07				7.06	7.89
	LP1	6.68	8.27	8.21	7.31				7.67	8.26
	LP2	7.53	8.83	8.93	7.69				7.99	8.50
	LM1	10.47	11.67	10.63	10.59				10.30	10.43
	LM2	9.17	11.08	10.38					8.99	10.00
shoveling	UI1	+	+					+	-	-
shoveling	UI2		+	+				-	-	
double shoveling	UI1	-	+					-	-	-
double shoveling	UI2		-	-				-	-	
dental tubercle	UI1	-	+					-	-	-
dental tubercle	UI2		-	-				-	-	
spine	UI1	-	+					-	-	-
interruption groove	UI2		+	-				-	-	
winging (bilateral)	UI1	-	-					-	-	-
De Terra's tubercle	UP1		-					-	-	
double rooted	UP1				-				+	
double rooted	UP2				-					
Carabelli's trait	UM1		+	-			+	+	-	-
hypocone reduction	UM2	-	-	-				-	+	-
sixth cusp	LM1		+		+	-		+	-	
seventh cusp	LM1		-		-	-		-	-	-
protostylid	LM1		-		-	-		-	-	
deflecting wrinkle	LM1		-		-	-		+	-	
groove pattern Y	LM1	+	+		-	+		+	+	
groove pattern X	LM2		-	-				-	-	+
number of cusps	LM2	+	-	+				+	+	+

U:Upper, L:Lower, I:Incisor, C:Canine, P:Premolar, M:Moler, +: present, -: absent

Appendix 5.1 (Continued 4).

Sample Number		07H2M22	07H2M24	07H2M27	07H2M30	07H2M32
Sex		Female	Female	Male	Male	Male
Mesiodistal	UI1	8.35	8.08	9.47	8.48	9.09
diameters (mm)	UI2	6.68				
	UC	7.64		7.88	8.01	8.39
	UP1	6.83		6.84	7.15	7.42
	UP2	6.65		6.60	6.89	7.01
	UM1	10.04		10.28		11.05
	UM2	9.07		9.13		10.02
	LI1	4.88			5.15	
	LI2	5.76			5.66	
	LC	6.27		6.92	7.60	7.11
	LP1	6.60		6.56	7.05	7.19
	LP2	6.74		6.61	7.33	7.14
	LM1	11.20		11.90	12.25	12.43
	LM2	10.35		10.82	11.16	11.51
Buccolingual	UI1	6.76	6.86	7.11	7.55	7.67
diameters (mm)	UI2	6.30				
	UC	7.11		8.75	9.31	8.58
	UP1	8.97		9.03	10.17	10.34
	UP2	9.07	8.81	9.06	10.12	9.64
	UM1	11.38		10.87	14.06	11.84
	UM2	10.57	10.39	10.15		11.82
	LI1	5.53			6.15	
	LI2	5.65			6.58	
	LC	6.49	6.76	7.19	8.04	8.18
	LP1	7.24	7.83	7.53	8.38	8.02
	LP2	8.10	8.15	8.29	9.28	8.66
	LM1	10.66	10.79	10.63	12.78	11.37
	LM2	9.56	9.90	10.06	11.18	10.13
shoveling	UI1		+	-	-	+
shoveling	UI2					
double shoveling	UI1	-	-	-	-	-
double shoveling	UI2	-				
dental tubercle	UI1	-	+	-	+	-
dental tubercle	UI2	-				
spine	UI1	-	-	-		-
interruption groove	UI2	-				
winging (bilateral)	UI1	-		-	-	-
De Terra's tubercle	UP1					-
double rooted	UP1		-			
double rooted	UP2				-	
Carabelli's trait	UM1				+	-
hypocone reduction	UM2	+		+		-
sixth cusp	LM1			-		+
seventh cusp	LM1			-	+	-
protostylid	LM1					-
deflecting wrinkle	LM1					-
groove pattern Y	LM1			+		+
groove pattern X	LM2	-	-	-	-	-
number of cusps	LM2	+			+	+

U:Upper, L:Lower, I:Incisor, C:Canine, P:Premolar, M:Moler, +: present, -: absent

Appendix 5.2 Crown measurements (mm) of the deciduous dentition of the Man Bac series (sex unknown).

	05M1	05M3	05M5	05M10	05M12	05M14	05M18	05M24	05M25
Mesiodistal diameters (mm)									
udi1	7.32				6.64	7.33			
udi2	6.55	5.75			5.65	6.17	6.28		5.60
udc			6.93	6.99	7.12	6.68	6.88	7.12	7.14
udm1	7.31			7.30	6.54	6.75	7.36	7.04	7.87
udm2	9.06			9.12	8.22	8.96		9.25	9.01
ldi1			4.52		4.28	4.93	4.51		
ldi2	5.25		4.88		4.91	5.25	5.19		
ldc			5.72	5.94	5.82	6.07		5.81	6.35
ldm1	7.66		9.14	8.18	7.78	9.01	8.22	8.17	8.71
ldm2	10.03		10.28	10.48	9.88	10.75	10.41	10.46	10.71
Buccolingual diameter (mm)									
udi1					5.12	5.18			
udi2	4.70	5.53			5.04	4.90	4.86		4.96
udc			5.56	6.14	6.18	6.12	5.67	6.11	6.45
udm1	9.34			9.31	8.91	9.07	9.35	8.49	8.78
udm2	9.66			9.87	9.64	10.64		9.98	10.28
ldi1			3.89		3.58	3.76	3.65		
ldi2	4.64		4.10		4.20	4.54	5.06		
ldc			6.64	5.54	5.42	5.69		5.72	5.72
ldm1	7.09			7.56	6.92	7.34	6.88	7.63	7.24
ldm2	8.56			8.98	8.67	9.04	8.75	9.56	8.98

	05M30	07H2M6	07H2M7	07H2M13	07H2M15	07H2M16	07H2M26	07H2M31
Mesiodistal diameters (mm)								
udi1	7.40	6.53	6.81	7.27	6.46	7.47	7.08	7.08
udi2	6.07	6.16	5.90	5.68	5.39	6.16	5.80	5.75
udc	7.08	6.82	6.92	7.03	6.84	7.39	7.46	7.16
udm1	7.61		7.33	7.65	7.16	7.57		7.43
udm2	9.44		9.32	9.78	7.69	9.14	10.50	9.31
ldi1	4.95	4.19		4.52	4.15			4.51
ldi2			4.78	5.00	4.68	5.12		5.31
ldc		6.16	5.96	5.85	6.16	5.91		6.14
ldm1			8.17	8.60	8.56	8.79	8.93	8.71
ldm2		10.20	10.37	10.85	10.46	10.94	11.20	10.45
Buccolingual diameter (mm)								
udi1		5.10	4.63	4.94	4.38	5.42	4.78	5.12
udi2		4.90	4.42	4.55	4.49	5.38	4.50	5.10
udc		5.72	5.35	6.01	6.30	6.05	5.85	5.95
udm1			8.21	8.35	9.75	9.09		9.01
udm2				10.52	10.33	10.02	10.35	10.52
ldi1		3.83		3.70	3.65			3.84
ldi2			3.93	3.93	4.14	4.51		4.34
ldc			4.90	5.10	5.39	5.44		5.29
ldm1			6.64	6.64	6.82	6.83	7.40	6.81
ldm2		8.85	7.74	8.72	8.60	8.79	9.27	8.27

u: upper, l:lower, d:deciduous, l:incisor, c:canine, m:moler