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Frequency variations of discrete cranial traits in major human populations. II. Hypostotic variations

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ABSTRACT

Five discrete hypostotic cranial traits, tympanic dehiscence, ovale-spinosum confluence, metopism, transverse zygomatic suture vestige, and biasterionic suture, were investigated in 81 human population samples. Except for ovale-spinosum confluence, marked asymmetric occurrences of the bilateral traits were not detected in the majority of the samples. Significant intertrait association was observed mainly between the biasterionic suture and other sutural variations including accessory ossicles. The traits showing relatively consistent sex differences across diverse populations were tympanic dehiscence, which is predominant in females, and biasterionic suture in males. On a world scale, the 5 hypostotic cranial traits showed distinctive patterns of geographical variation. Different clinal variations within and between macrogeographical areas such as western and eastern parts of the Old World were found for the frequencies of the traits. The Ainu may be the most distinct outlier in the eastern Asian region on the basis of the incidence of the traits, especially the transverse zygomatic suture vestige. The interregional variation without reasonable adaptive value and nonadaptive shift of the possible outliers presented in this study suggest that the genetic background for the occurrence of these traits cannot be excluded completely.

Key words: Osteology; arrested ossification; sutural variation; cranial variants; geographic variation.

INTRODUCTION

After Berry & Berry (1967), the use of discrete cranial traits in ethnic anthropology and palaeoanthropology has increased in frequency (Ossenberg, 1969; Pietrusewaky, 1971, 1984; Corruccini, 1974; Dodo, 1974, 1980; Hauser & De Stefano, 1989; Pardoe, 1991; Kozintsev, 1992; Manzi et al. 1996, 2000; and others). These investigations may have been based on the hypothesis that these discrete skeletal traits are highly genetic as shown by pedigree studies (Torgersen, 1950, 1951*a*, *b*; Grünberg, 1963; Berry, 1968; Lane, 1978). Several investigators, moreover, have paid attention to the extent of their hereditary determination and developmental mechanisms through embryological and developmental studies as well as through intertrait correlations, asymmetry, and dependence on sex and age (Corruccini, 1974; Berry, 1975; Mouri, 1976; Trinkaus, 1978; Perizonius, 1979; Dodo, 1980, 1986; Česnys, 1982). Recently, the features of minor discrete cranial traits have received attention in the study of fossil hominids (e.g. Manzi et al. 1996, 2000). The occurrence of these traits in fossil hominids suggests their potential significance for the investigation of the origin and diversification of anatomically modern humans.

The purpose of the present study, together with the previous study (Hanihara & Ishida, 2001*b*), was to examine cranial variation in recent populations in the world that can help to disclose the evolutionary pathways of morphological diversification. Generally, interpretations of the morphological variation of craniofacial traits and relationships between geographical groups depend on whether founder effects, genetic drift and population structure or local adaptation are assumed. The findings of the occurrence of traits at different frequencies in human population groups of different genetic constitutions, clinal vari-

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ation with or without an identifiable adaptation value, and change in frequencies in a population with time and space may provide supposition of not only the genetic background of the traits but also the evolution of modern human diversity.

In the present study, 5 discrete cranial hypostotic traits, tympanic dehiscence, ovale-spinosum confluence, metopism, transverse zygomatic suture vestige, and biasterionic suture, are examined. The hypostotic variations within and between populations are discussed comprehensively in the literature (Berry & Berry, 1967; De Villiers, 1968; Ossenberg, 1969; Corruccini, 1974; Hauser & De Stefano, 1989; and others).

Several investigators have suggested that the condition of hypostosis is related to mechanical stress affecting the cranial vault during the early stages of growth and development (Ossenberg, 1970; Pucciarelli, 1974; Gottlieb, 1978; Konigsberg et al. 1993; Manzi et al. 2000). However, more importantly for the focus of this study, the variations observed in different geographical groups from around the world affect interpretations of the peculiarities of trait expression.

With these considerations in mind, we hope that the present study will be useful in the following 3 respects: (1) investigation of geographical variation of the hypostotic cranial traits; (2) possible interpretation of the variations found; and (3) implications for the evolutionary significance of modern human diversity.

MATERIALS AND METHODS

The data from 10 samples mainly from Asian and Pacific regions as shown in the Table are added to our previous database (Hanihara & Ishida, 2001*a*). All additional data are from the Australian Museum, the South Australian Museum, and the University of Sydney, examined by T.H. A complete list of the samples used and further information are given in our previous study (Hanihara & Ishida, 2001*a*).

In the present study, the following 5 hypostotic traits were examined with respect to sex, side, intertrait association, and frequency distributions in a series of approximately 10000 undeformed skulls representing major human populations in the world (Fig. 1).

1. *Tympanic dehiscence* (TD): foramen acusticum Huschkei, foramen of Huschke, foramen tympanicum. This is a dehiscence occurring in the medial third of the tympanic plate. Following Dodo's (1974) method, pinhole size apertures to large defects are recorded as positive.

2. *Ovale-spinosum confluence* (OSC): confluent foramen ovale and spinosum; common oval-spinous foramen. Communication of the foramen ovale with the foramen spinosum is recorded as positive (Dodo, 1974).

3. *Metopism* (MET): metopic suture, sutura metopica, sutura frontalis persistens, sutura interfrontalis, sutura frontalis. An individual with a completely persisting metopic suture is recorded as positive.

4. *Transverse zygomatic suture vestige* (TZS): a partial horizontal division of the zygomatic bone observed at the temporal process of the zygomatic bone. This variation is often regarded as os japonicum trace or incomplete expression of a bipartite zygomatic bone (Ossenberg, 1969, 1970). According to Bharagava et al. (1960), Jeyasingh et al. (1982), and Hauser & De Stefano (1989), on the other hand, the expression of a suture limited to the temporal surface does not represent the remnant of a bipartite zygomatic bone but is due to an extension of the zygomatic process of the temporal bone. Moreover, subdivisions of the zygomatic bone do not correspond to developmental arrest of a primary anlage, but are modifications of the secondary appositions from which the definitive zygomatic bone develops (Hauser & De Stefano, 1989). Thus this trait may not be a precise hypostotic character. In this study, therefore, it is only tentatively included in the hypostotic category. A suture longer than 2 mm was scored as positive by Ossenberg (1970) and Kozintsev (1990, 1992). Dodo (1974) recorded a suture longer than 5 mm as positive. In this study, results based on both definitions are presented. For the os japonicum, details have been reported previously (Hanihara et al. 1998*a*).

5. *Biasterionic suture* (BAS): sutura mendosa, mendosal suture. The portion of the occipital squama inferior to the highest nuchal line is ossified in cartilage, the superior portion in membrane. When the parts fail to unite and remain separated by the biasterionic suture, the upper portion is known as the os Incae (Ossenberg, 1969). On the other hand, Aichel (1914) and Davida (1914) pointed out that a transverse occipital suture dividing the Inca bone differs from a biasterionic suture, which originates mostly from the asterion and never bisects the occipital squama totally into upper and lower parts (Hauser & De Stefano, 1989). In the present study, we follow Ossenberg's (1969) definition. In fact, a suture originating from the asterion is very rare and, if present, is usually above, although sometimes below it. Concerning the scoring procedure, Dodo (1974) scored it as present if its

Table. *Material added to those previously reported*

Sample name	Brief description
Southeast Asians	
Mainland SE Asians	Recent inhabitants in Thailand (University of Sydney)
Borneans	Native inhabitants of Borneo, Dayaks (University of Sydney, South Australian Museum)
Polynesians	
Maori	Recent aboriginal populations from New Zealand (Australian Museum, University of Sydney, South Australian Museum)
Moriori	Recent aboriginal populations from Chatham Island (Australian Museum, University of Sydney, South Australian Museum)
Melanesians	
Papua New Guinea	Purari River delta, Fly River delta, Sepik River delta, and other regions (Australian Museum, University of Sydney, South Australian Museum)
North Melanesians	Recent indigenous inhabitants from New Ireland, New Britain, Solomon and Santa Cruz Islands (Australian Museum, University of Sydney, South Australian Museum)
South Melanesians	Recent indigenous inhabitants from New Caledonia, Vanuatu, and Fiji Islands (Australian Museum, University of Sydney, South Australian Museum)
Australians	
East Australians	New South Wales (Australian Museum)
Southwest Australians	Prehistoric Australians from the Roonka site, Murray River basin, South Australia, and recent Australians from near Adelaide (South Australian Museum)
Europeans	
Eastern Europe	Recent Czechoslovakians, mainly from central Moravia (South Australian Museum)

Australian Museum: Sydney, Australia
University of Sydney: Sydney, Australia
South Australian Museum: Adelaide, Australia

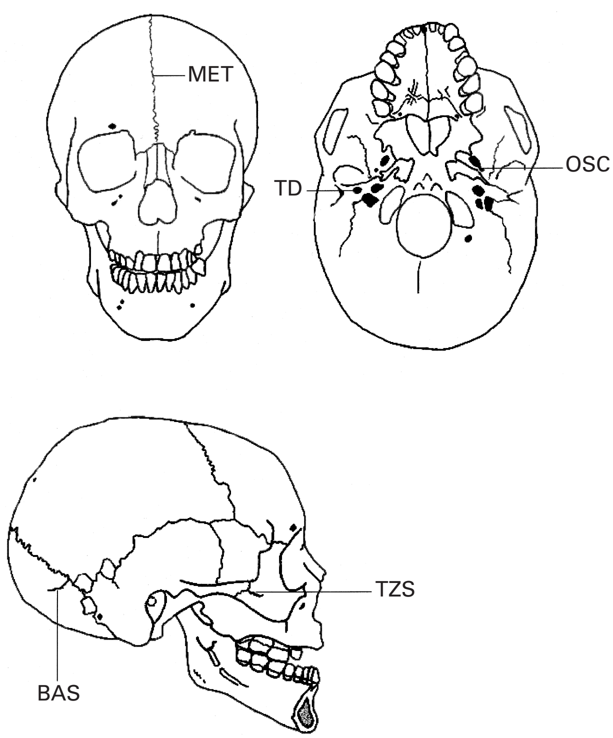

Fig. 1. A diagram of the skull with the 5 hypostotic variations. TD, tympanic dehiscence; OSC, ovale-spinosum confluence; MET, metopism; TZS, transverse zygomatic suture vestige; BAS, biasterionic suture.

length exceeded 10 mm, but here it is recorded in more detail with respect to its length: (1) 2 mm or more; and (2) 10 mm or more. In the present study, the os Incae was not scored separately because it has been described elsewhere (Hanihara & Ishida, 2001*a*).

The material examined, as well as the statistical procedures employed are the same as those adopted in our previous study (Hanihara & Ishida, 2001*b*).

RESULTS

Within population variations

The results of phi coefficients, Yule's coefficients of association (4-fold point correlation coefficients), and Fisher's exact probability test for side differences applied to the samples of the large geographical groups are given in Appendix 1. The predominant symmetric occurrence of the traits may allow us to perform further tests for their incidence per cranium (individual).

Appendix 2 shows the relative level of intertrait association represented by phi coefficients and with absolute significance as ascertained by Fisher's exact probability test. Appendix 3 summarises the significant intertrait correlations between the traits treated herein and the incidence of 4 supernumerary ossicles, i.e. the ossicle at the lambda (OL), the parietal notch bone (PNB), the asterionic bone (ASB) and the occipitomastoid bone (OMB), which are sometimes classified as hypostotic characters (Ossenberg, 1969, 1970; Corruccini, 1974). In several of the samples, the occurrence of metopism and/or a biasterionic suture are related to those of the supernumerary ossicles.

The incidence of the traits in the male and female samples and the results of Fisher's exact probability test for sex differences are given in Appendix 4. In the present study, 10 out of the 20 macrogeographical samples showed a significantly higher incidence for tympanic dehiscence in females. With the exception of the biasterionic suture, the present results indicate a tendency for higher frequencies of the hypostotic variants in females than in males that in some samples reached a significant level. The different geographical groups differed in pattern of sex differences as well as in extent.

Between population variations

As in our previous study (Hanihara & Ishida, 2001*b*), the combined-sex frequency distributions of each trait for all samples have been calculated. Appendix 5 summarises the incidence of the 5 hypostotic traits for the 81 samples. Figures 2–6 illustrate the incidences of tympanic dehiscence, ovale-spinosum confluence, metopism, a transverse zygomatic suture vestige, and a biasterionic suture, respectively. The frequency variations of the traits on the large geographical samples summarised in Appendix 6 are shown as bar plots in Figures 7 and 8.

Figures 2 and 7 give the frequencies of tympanic dehiscence. At the low end, we find the Polynesian and the Australian samples. With some minor exceptions, the East/Northeast Asian and the Arctic samples show higher frequencies than the Oceanian samples. The New World samples are aligned with the Arctic and Northeast Asian samples. A temporal shift is evident in Northeast Asia. The Neolithic Baikalian sample shows a lower frequency, comparable with the Ainu, the Bornean, and the Melanesian samples. The Southeast Asian samples are intermediate, favouring rough clinality. With the distinct exception of the Russian sample, the incidence of tympanic dehiscence is relatively low in the western part of the Old World. Except for the South African sample, the Subsaharan African samples show higher frequencies of this trait than the North African and European samples.

Figures 3 and 7 illustrate the world frequency variation for ovale-spinosum confluence. The Melanesian samples have, on average, the world's highest frequencies. In the eastern Asian region, a rough clinality exists from south to north. The New World samples resemble the Northeast Asian more closely than the Arctic series. The 2 Ainu samples from Sakhalin and Hokkaido do not fall within the range of the neighbouring East Asian samples, instead being like southern Asian populations. With a few exceptions, Central, South, and West Asian samples as well as the European samples fall in the low frequency cluster. The Medieval English sample from the Ensay site in Scotland has considerably higher frequencies than the other samples from UK, suggesting long-term isolation and subsequent genetic drift. Along with the Melanesian samples, the Subsaharan African samples other than the Khoisan sample show the highest frequencies of ovale-spinosum confluence.

Figures 4 and 8 show the frequency variation for the metopic suture. This character is most common in the European samples, especially those from the UK, distinguishing the samples in this area from those of many other populations. The Subsaharan African samples, along with the Australian and the Pacific samples, by contrast, seldom exhibit a metopic suture. With the exception of those for the Ainu, the East Asian samples, together with the Tibetan/Nepalese and the Assam/Sikkim samples, show somewhat higher frequencies of this trait than the neighbouring population samples. Temporal and regional shifts are again detectable in Northeast Asia. The Neolithic Baikalian sample is aligned with the Amur basin and the Ainu samples. The very high frequencies for the Morocco sample should not be taken seriously because of the small sample size.

Figures 5 and 8 give the incidence of the transverse zygomatic suture vestige. In Figure 5 the total length of bar indicates the frequencies of a suture longer than 2 mm and dense bar shows those more than 5 mm long. In the eastern part of the Old World, this trait is less frequent in the Oceanian and Pacific samples than in any other samples. The East and Northeast Asian samples have a much higher incidence than the Southeast Asian samples, favouring clinality from south to north. The Arctic and the New World samples except for the Aleut break away from the Northeast Asian samples and align closer to those of Southeast Asia. The 2 Ainu samples are the most obvious outliers in East/Northeast Asia. The Tibetan/Nepalese samples along with the Assam/Sikkim samples are more like the East Asian samples than those of the neighbouring populations. The variations of the transverse zygomatic suture vestige do not clearly distinguish the samples from the western part of the Old World.

As for the previously described trait, the total length of the bars in Figure 6 represents the

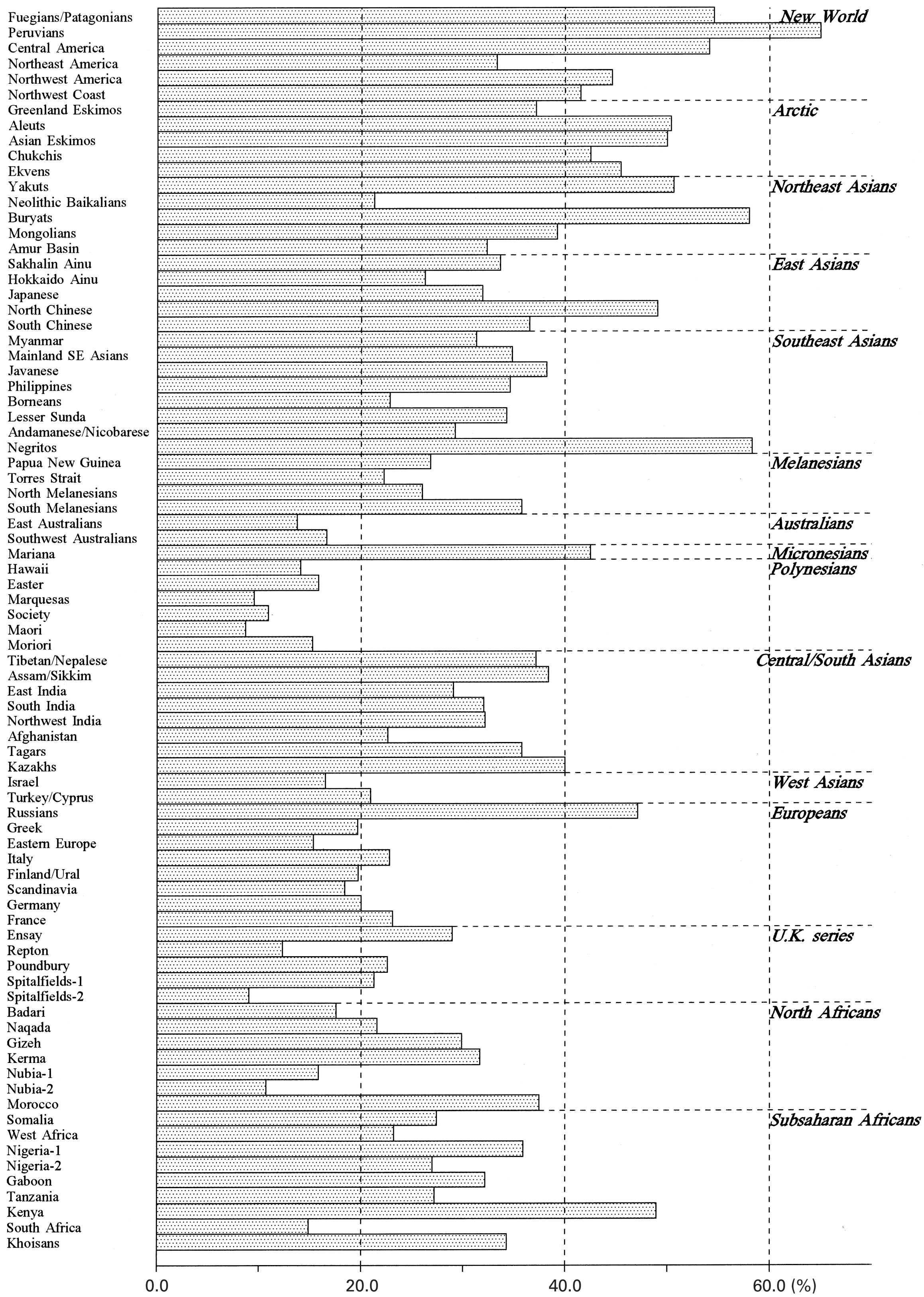

Fig. 2. Frequency variation in the tympanic dehiscence among 81 major human population samples.

frequencies for a biasterionic suture of between 2 and 10 mm and the dense dot bar more than 10 mm in length. As can be seen in Figures 6 and 8, the biasterionic suture is least common in the Subsaharan African samples and to a lesser extent the Central Asian Tagar and Kazakh samples. In the eastern Asian and the Pacific regions, there is a decisive division between south and north. The Melanesian,

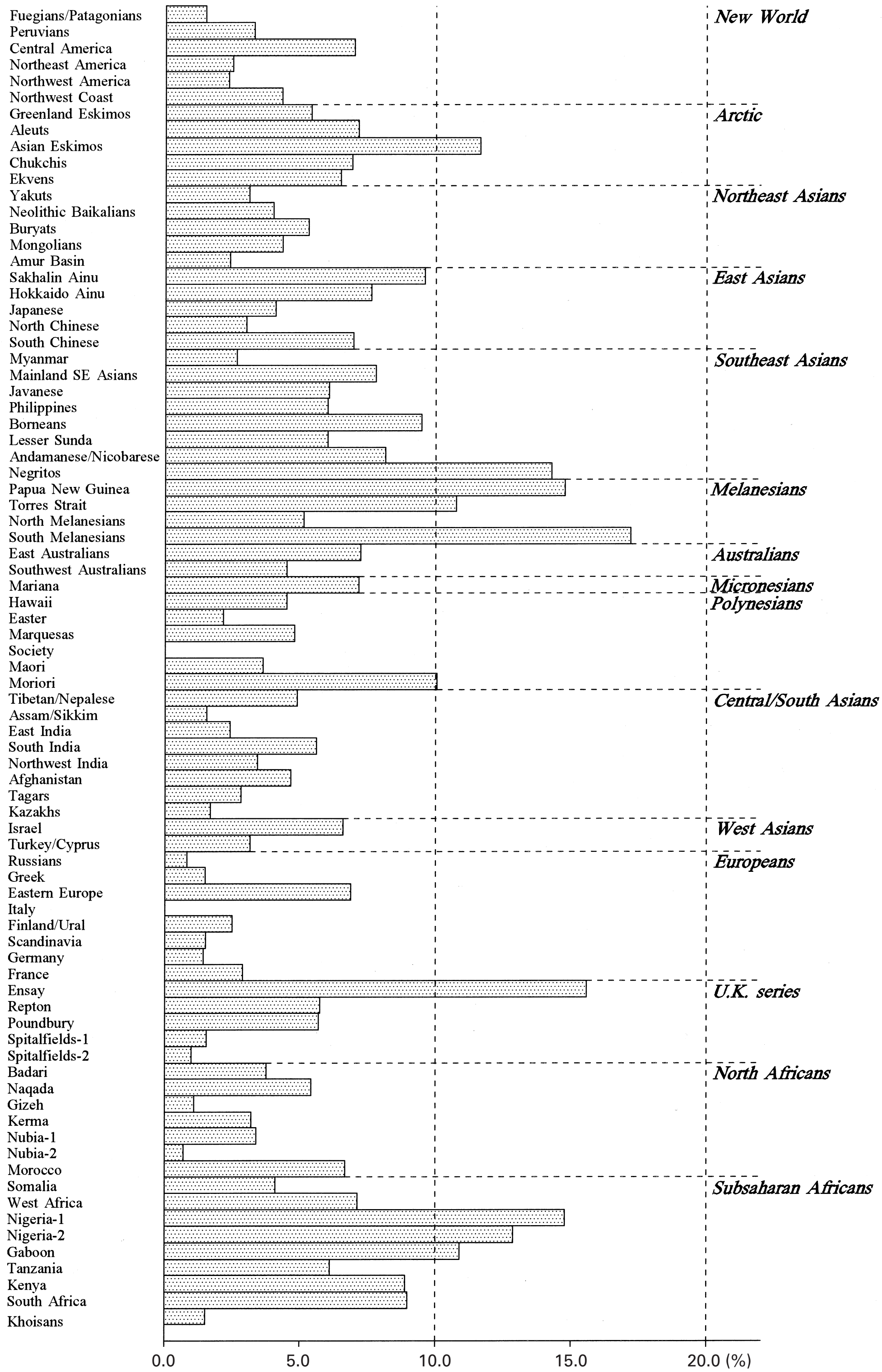

Fig. 3. Frequency of ovale-spinosum confluence among 81 human population samples.

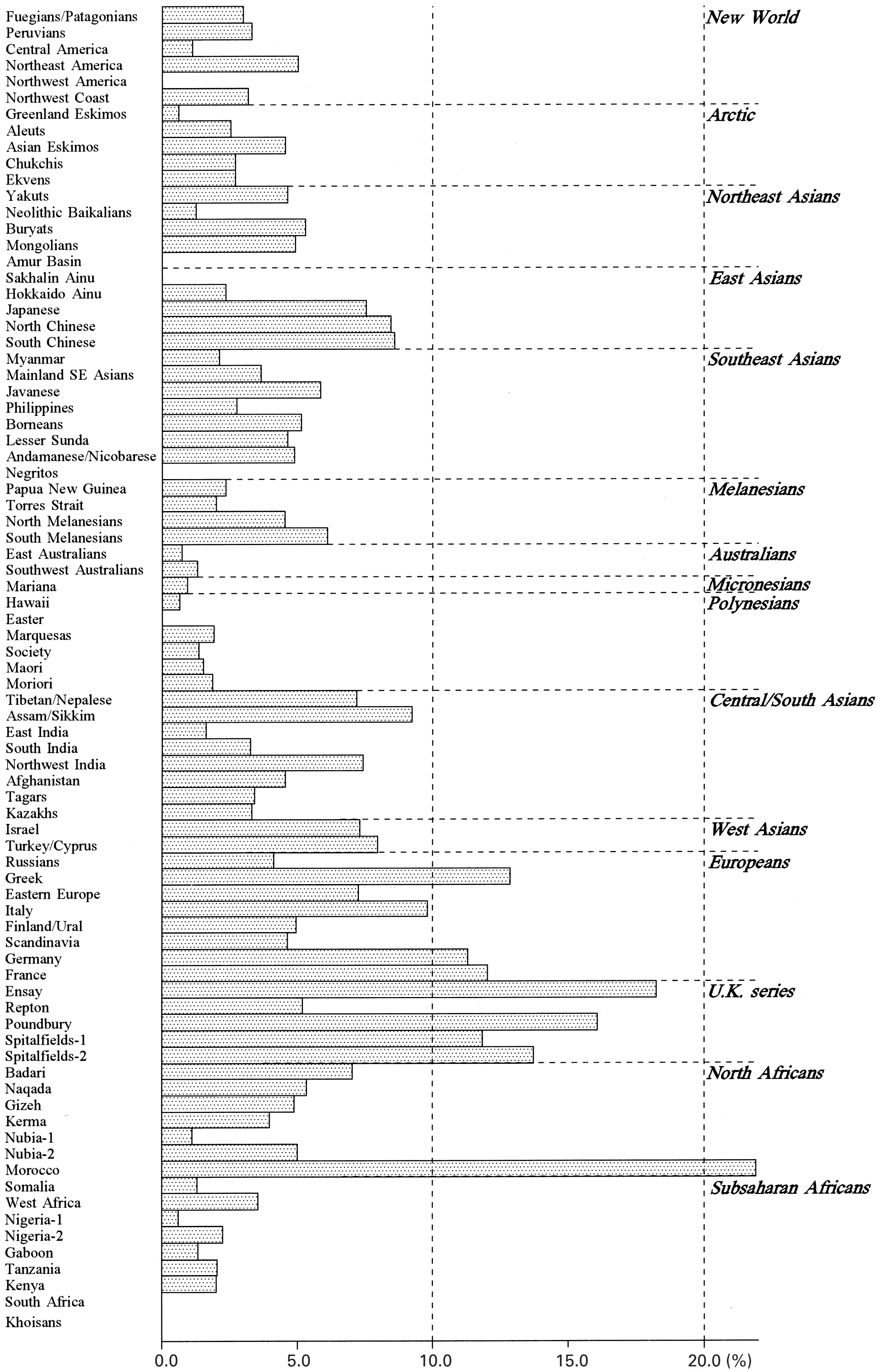

Fig. 4. Frequency of metopism among 81 human population samples.

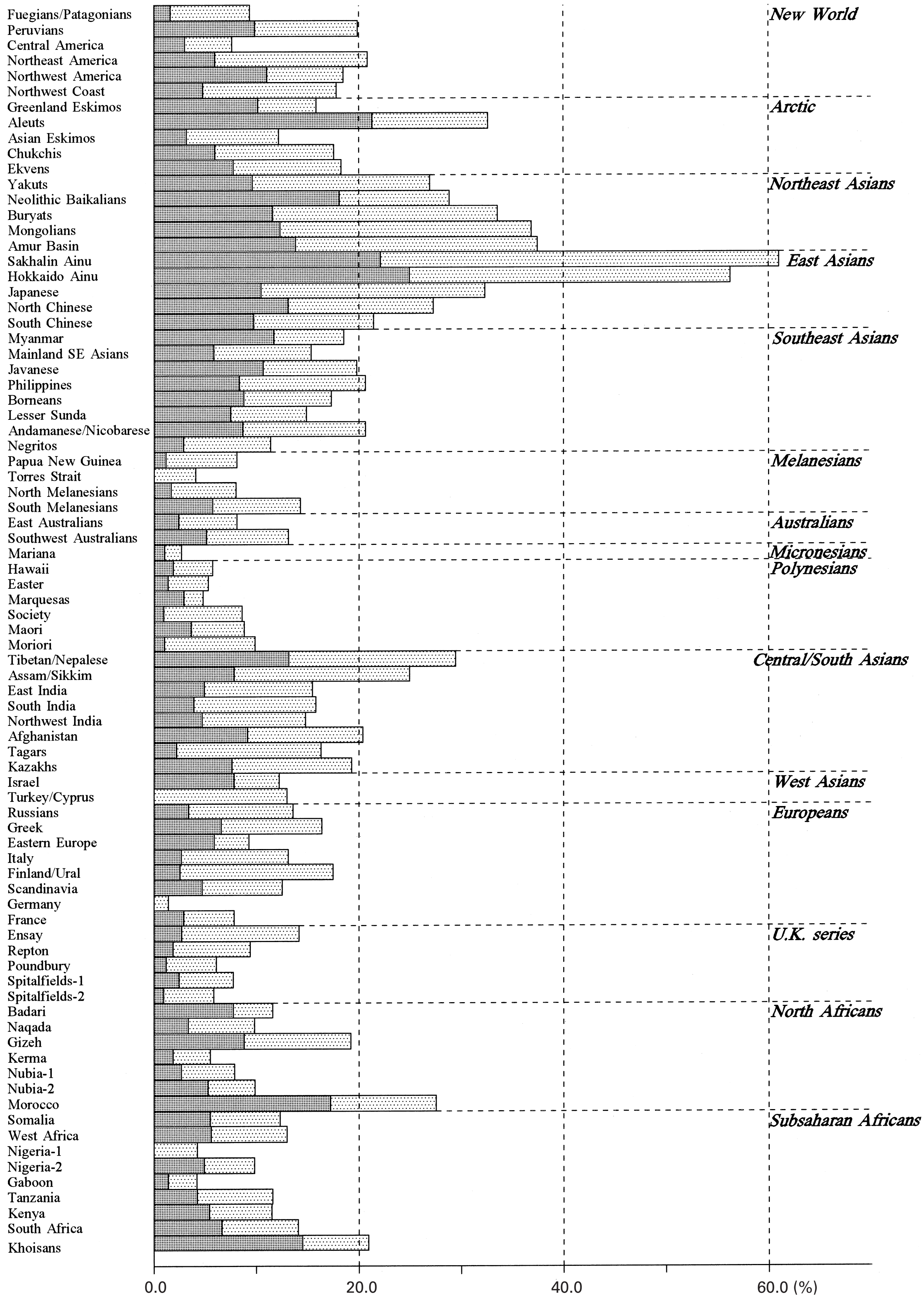

Fig. 5. Frequency of the transverse zygomatic suture vestige among 81 human population samples.

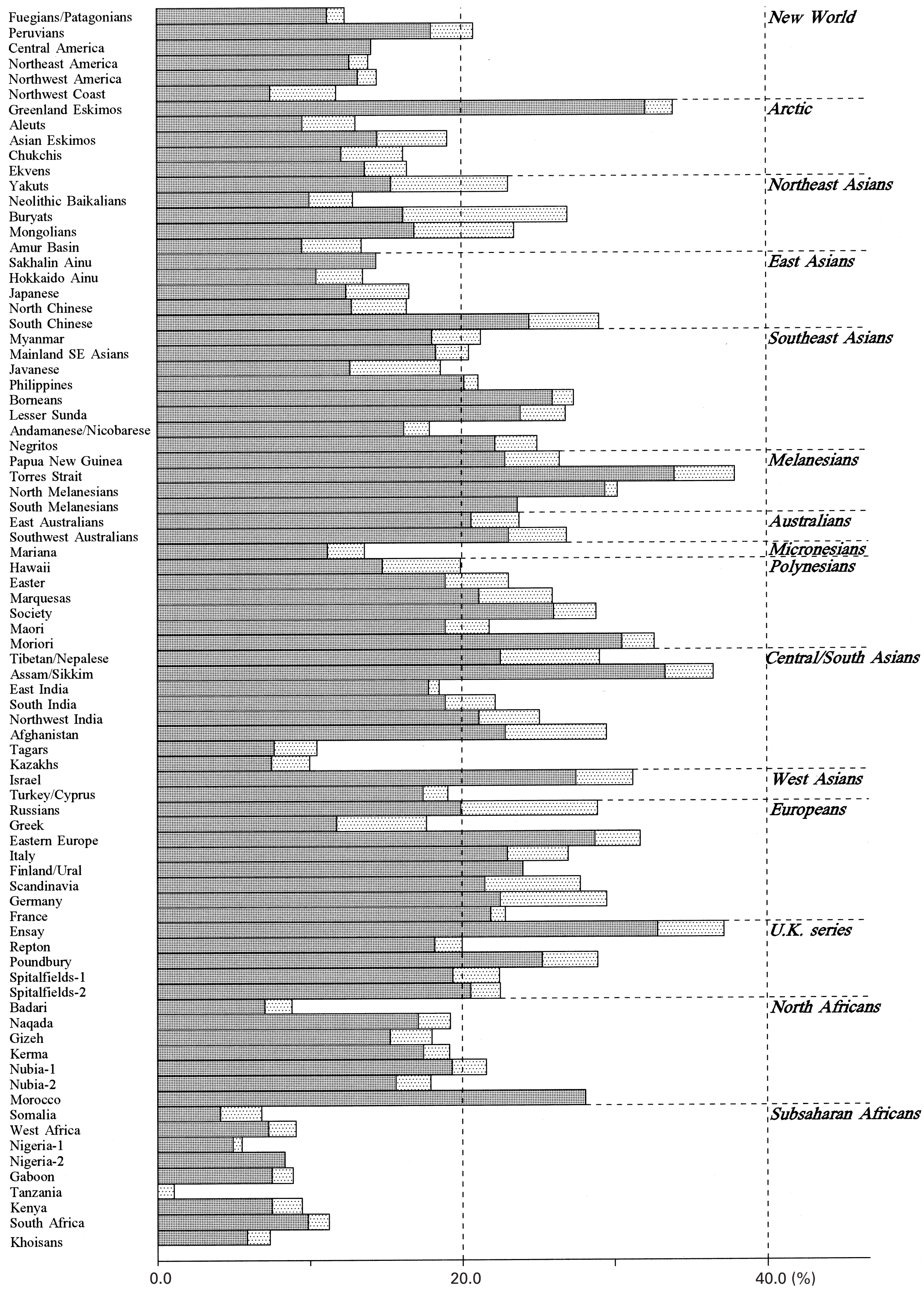

Fig. 6. Frequency of the biasterionic suture among 81 human population samples.

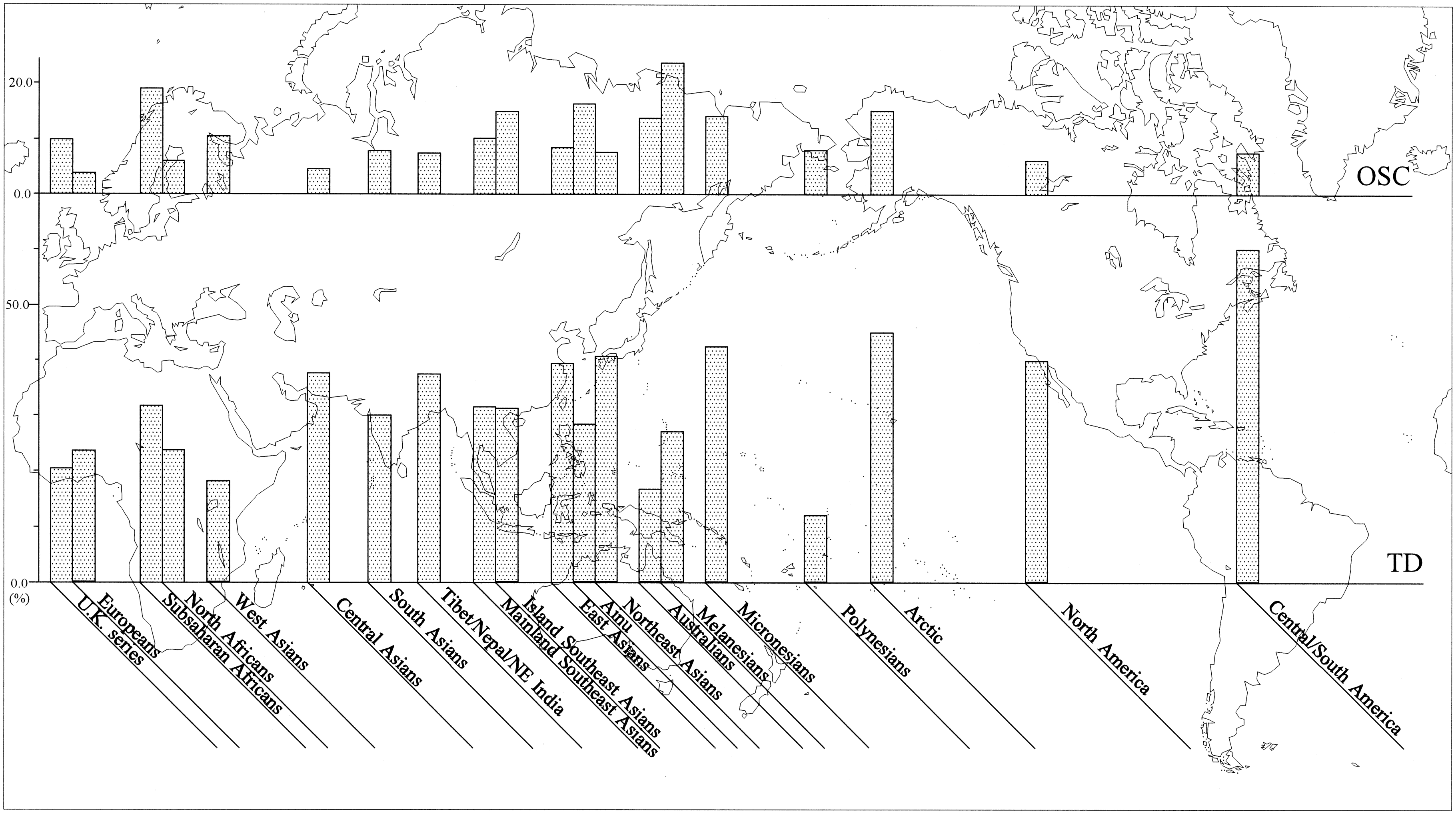

Fig. 7. Frequency variations in tympanic dehiscence (TD) and ovale-spinosum confluence (OSC) based on the large geographical samples given on the world map.

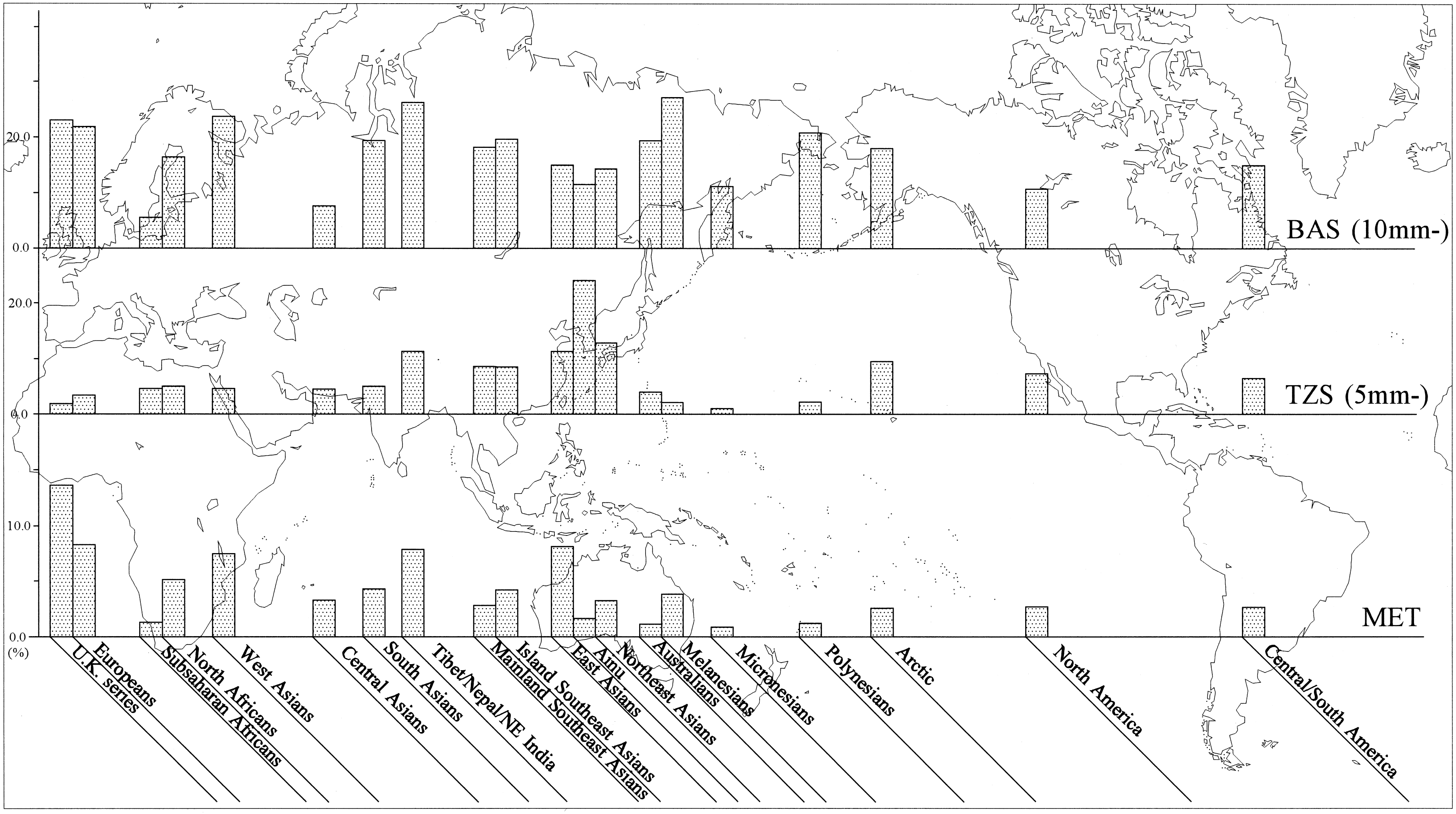

Fig. 8. Frequency variations in the 3 sutural variants, metopism (MET), transverse zygomatic suture vestige (TZS), the biasterionic suture (BAS).

and to a lesser degree, the Polynesian samples, have higher frequencies for the biasterionic suture than the East Asian samples. The Australian and the Southeast Asian samples are intermediate, suggesting clinality. The Micronesian sample goes against regional trends, showing exceptionally low frequencies for this trait. With the exception of the Greenland Eskimo sample, those from the New World and the Arctic region share similar frequencies for this trait. The Northeast Asian samples show slightly higher incidences than the East Asian samples except for the Neolithic Baikalian and the Amur basin samples. The Assam/Sikkim and to a lesser degree the Tibetan/Nepalese samples show higher incidences than those of the neighbouring Indian subcontinent. In the West Asian and European regions, the retention of the biasterionic suture does not exhibit a pattern of geographic variation that clearly differentiates the regional samples. The North African samples show lower frequencies than the West Asian and the European samples but distinctively higher than the Subsaharan African samples.

DISCUSSION

Except for the ovale-spinosum confluence, the bilateral traits examined in this study do not show significant side differences. A predominantly asymmetric occurrence of ovale-spinosum confluence is seen in 4 out of 20 population groups. Such asymmetric occurrence of a bilateral trait is often regarded as a fluctuating asymmetry characterising a trait that is normally symmetric but exhibits occasional side differences with no left or right side preference (Van Valen, 1962; Soule & Cuzin-Roudy, 1982; Clarke, 1995; Livshits et al. 1998). According to Česnys (1982), the unilateral expression of a paired trait with no identifiable adaptation value means an incomplete realisation of its genetic mechanism.

There are some indications for the existence of an association between morphogenetically close traits such as hypostotic or hyperostotic characters, suggesting a common underlying process for their occurrence (Berry & Berry, 1967; Hertzog, 1968; Ossenberg, 1969, 1970; Corruccini, 1974; Hauser & De Stefano, 1989). The present findings show that the pairs of traits with significant association are not necessarily consistent across a diverse array of population groups. This indicates that while there may exist a common underlying process for their occurrence, the possibility of other modifying factors may exist.

Appendix 3 shows that the occurrence of the metopic and biasterionic sutures is linked to the occurrence of the accessory ossicles in several population groups. According to Ossenberg (1969, 1970), groups practicing cranial deformation not only have a higher incidence of wormian bones, but also in general a slower rate of suture closure. She went further to say that wormian bones and metopism are more common in crania with an Inca bone (and therefore the biasterionic suture) than in crania without. The association between sutural variants such as metopism and/or a biasterionic suture and the accessory ossicles presented here may shed light on the hypothesis that sutural variants are not under direct genetic control but are secondary characteristics brought about by 'ontogenetic stress' including artificial cranial deformation (Oetteking, 1930; Hess, 1946; Benett, 1965; Ossenberg, 1969, 1970; Finkel, 1971; Pucciarelli, 1974; Gottlieb, 1978; Konigsberg et al. 1993; Manzi et al. 1996). This hypothesis is, however, not necessarily adequate to account for the variation among populations throughout the world.

Tympanic dehiscence is reported to be predominant in females (Oetteking, 1930; Laughlin & Jörgensen, 1956; Berry, 1975; Cosseddu et al. 1979; Dodo, 1974; Hauser & De Stefano, 1989). In human populations, males and females consistently differ in cranial size, in that males have larger and more robust skulls than females. Such general sexual dimorphism may have had something to do with the differences in the degree of retention of immature features described here in both sexes. If this is true, though far from obvious, the factors controlling the occurrence of some sutural variants such as a biasterionic suture and the accessory ossicles, which show a tendency for a predominant occurrence in males (Hanihara & Ishida, 2001), may at least in part differ from those of other hypostotic traits.

On a world scale, the traits presented in this study show distinctive patterns of geographic variation. Subsaharan Africans occupy an extreme position in the western hemisphere of the Old World for 4 out of 5 traits. They show higher frequencies for tympanic dehiscence and ovale-spinosum confluence, and lower incidences of metopic and biasterionic sutures. These traits are, however, not necessarily distinctive Subsaharan African traits on a world scale.

Except for the transverse zygomatic suture vestige, a rough clinal distribution of the frequencies may be recognised in the western part of the Old World, from Subsaharan Africa to Europe and West Asia through North Africa. The clinal distribution may be also seen in eastern Asian and west Oceanian regions. The frequencies of tympanic dehiscence, ovale-spinosum confluence, and a biasterionic suture become higher from south to north, and those for metopism and a transverse zygomatic suture vestige become lower. With regard to the frequencies of tympanic dehiscence and a biasterionic suture, the direction of clinality is reversed between the western and eastern parts of the Old World. West Asians are in general more European-like than Central and South Asians. The South Asians are roughly intermediate between West Asians/Europeans and Eastern Asians, favouring west-east clinality. The frequency distributions of the traits in the New World populations are in general more similar to those of East/Northeast Asians than to Southeast Asians with the possible exception of the transverse zygomatic suture vestige.

The frequencies of the 5 traits in the possible outlier populations in the eastern Asian and Pacific regions, as represented by Tibetans/Nepalese, Assamese/Sikkim, Negritos, Polynesians, Aleuts, and Ainu fall outside the range of those of the predominant eastern Asians. Among them, the Ainu are the most obvious outliers in East Asian context. They are distinguished not only from other eastern Asian populations (Dodo & Ishida, 1990; Kozintsev, 1990, 1992; Ishida, 1995, 1996; Hanihara et al. 1998*b*; Ishida & Kondo, 1999) but also from other world populations by the transverse zygomatic suture vestige. For the frequencies of the biasterionic bone and the transverse zygomatic suture vestige, Ainu are more northern-like, but they show southward shift for the frequencies of tympanic dehiscence and the ovale-spinosum confluence.

The distinctiveness of such possible outliers or peripheral groups may indicate discontinuities in regional morphology. These intraregional shifts and interregional rough clinality without any identifiable adaptation value, together with the temporal shift observed in Northeast Asia indicate that founder effects, genetic drift, and population structure could have, at least in part, been the underlying cause for the phenotypic variations of the hypostotic cranial traits presented in this study on a world scale.

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Appendix 1. *Phi coefficients, Yule's coefficient associations, and Fischer's exact probability tests (%) between right and left sides for the occurrence of the traits in the major regional pooled samples*

	TD			OSC			TZS (2 mm−)			TZS (5 mm−)			BAS (2 mm−)			BAS (10 mm−)		
Sample name	Phi	Yule	Fisher	Phi	Yule	Fisher	Phi	Yule	Fisher	Phi	Yule	Fisher	Phi	Yule	Fisher	Phi	Yule	Fisher
East Asians	0.6366	0.9182	0.00	0.0863	0.7040	n.s.	0.5122	0.8692	0.00	0.4740	0.9205	0.00	0.4928	0.8940	0.00	0.3862	0.8552	0.00
Ainu	0.5915	0.9127	0.00	0.2122	0.7870	0.48	0.4976	0.7978	0.00	0.4970	0.8673	0.00	0.4912	0.9239	0.00	0.5276	0.9489	0.00
Mainland SEA	0.6371	0.9264	0.00	0.2648	0.8973	0.22	0.6263	0.9526	0.00	0.5788	0.9658	0.00	0.6376	0.9482	0.00	0.5461	0.9220	0.00
Island SEA	0.7331	0.9624	0.00	0.3696	0.9153	0.00	0.5417	0.9183	0.00	0.2927	0.8701	0.00	0.6504	0.9537	0.00	0.5961	0.9369	0.00
NE Asians	0.5132	0.8390	0.00	0.2807	0.9265	0.00	0.4863	0.8307	0.00	0.5882	0.9509	0.00	0.5329	0.9101	0.00	0.5329	0.9414	0.00
Arctic	0.6291	0.9077	0.00	0.4450	0.9456	0.00	0.6191	0.9435	0.00	0.6097	0.9668	0.00	0.6179	0.9389	0.00	0.5464	0.9212	0.00
North America	0.6472	0.9232	0.00	0.2567	0.9504	n.s.	0.5175	0.9050	0.00	0.4852	0.9549	0.00	0.7570	0.9882	0.00	0.6670	0.9809	0.00
C/S America	0.6551	0.9171	0.00	0.4159	0.9664	0.02	0.6415	0.9641	0.00	0.3731	0.9139	0.01	0.6331	0.9533	0.00	0.6626	0.9662	0.00
Micronesians	0.6393	0.9148	0.00	0.2545	0.8507	2.87	0.0162	−1.0000	3.87	0.0065	−1.0000	0.64	0.6136	0.9688	0.00	0.3846	0.8947	1.37
Polynesians	0.5281	0.9398	0.00	0.1047	0.7568	n.s.	0.4387	0.9362	0.00	0.2003	0.9238	0.00	0.5292	0.8963	0.00	0.4802	0.8867	0.00
Melanesians	0.6566	0.9434	0.00	0.4940	0.9279	0.00	0.3293	0.8770	0.00	0.2945	0.9630	0.00	0.6869	0.9539	0.00	0.6127	0.9266	0.00
Australians	0.5638	0.9328	0.00	0.2651	0.8779	0.45	0.5239	0.9409	0.00	0.4659	0.9681	0.00	0.7158	0.9709	0.00	0.6849	0.9671	0.00
Tibet/Nepal/NEI	0.7393	0.9614	0.00	0.4337	0.9672	0.34	0.5650	0.9078	0.00	0.4250	0.9395	0.01	0.5388	0.8795	0.00	0.5748	0.9105	0.00
South Asians	0.6498	0.9387	0.00	0.3545	0.9460	0.00	0.5778	0.9392	0.00	0.3518	0.9343	0.00	0.5661	0.9164	0.00	0.5381	0.9141	0.00
Central Asians	0.5660	0.8808	0.00	0.0099	−1.0000	2.39	0.5396	0.9243	0.00	0.1613	0.8230	n.s.	0.6289	0.9730	0.00	0.6195	0.9829	0.00
West Asians	0.4356	0.8690	0.00	0.0255	−1.0000	n.s.	0.4237	0.9101	0.46	0.7033	1.0000	2.11	0.4741	0.8505	0.00	0.4845	0.8667	0.00
Europeans	0.6235	0.9382	0.00	0.3083	0.9659	0.00	0.4705	0.9200	0.00	0.2345	0.9071	0.00	0.6129	0.9276	0.00	0.5410	0.9050	0.00
United Kingdom	0.5686	0.9222	0.00	0.1865	0.8293	0.00	0.5209	0.9562	0.00	0.4569	0.9862	0.00	0.5548	0.9076	0.00	0.5519	0.9149	0.00
North Africans	0.6199	0.9350	0.00	0.1356	0.8581	0.03	0.5841	0.9573	0.00	0.6200	0.9850	0.00	0.5995	0.9543	0.00	0.5848	0.9589	0.00
Subsaharan Africa	0.6755	0.9445	0.00	0.2798	0.8307	0.00	0.6054	0.9663	0.00	0.5740	0.9825	0.00	0.6260	0.9805	0.00	0.6287	0.9855	0.00

Appendix 2. *Intertrait association based on phi coefficients and Fisher's exact probability test*

	OSC	MET	TZS (5 mm+)	BAS (10 mm+)
TD		0.1118 3.45[2]	0.1085 3.05[2]	0.1066 0.77[4]
OSC		0.1252 0.08[3] 0.1378 0.13[8]	0.2402 0.98[5]	
MET				0.1387 0.80[1] 0.0928 0.99[6] 0.2270 0.41[7]
TZS (5 mm+)				

mm+, greater than the length specified, in mm.
1, East Asians; 2, Mainland SE Asians; 3, Island SE Asians; 4, NE Asians; 5, North America; 6, Polynesians; 7, Tibetans/Nepalese/NE India; 8, South Asians.

Appendix 3. *Yule's coefficients of association and Fisher's exact probability test between the traits treated in this study and those of the accessory ossicles in the major regional pooled samples*

	OL	PNB	ASB	OMB
TD				
OSC			0.1074 1.47[8]	0.1874 2.19[11]
MET	0.1243 1.91[1] 0.1082 1.12[4] 0.1494 0.23[5]	0.1188 1.41[1] 0.1130 0.94[6] 0.1755 1.66[11] 0.1237 0.14[13] 0.0767 4.31[15]		0.1285 0.58[5] 0.0838 1.65[16]
TZS		0.0982 3.71[1] 0.1649 0.00[15]		
BAS	0.1327 0.21[5] 0.1741 2.22[8] 0.1194 0.14[9]	0.1302 0.68[1] 0.2040 0.04[7] 0.1165 4.30[10] 0.1351 4.86[11] 0.0906 1.43[13]	0.1111 2.14[1] 0.1046 4.62[2] 0.2002 0.02[3] 0.0997 0.56[4] 0.0844 1.29[9] 0.2221 0.02[10] 0.0919 2.61[14] 0.1275 0.03[15]	0.1019 3.15[1] 0.1165 0.15[4] 0.0912 2.37[5] 0.0844 3.79[12] 0.0898 1.89[13]

1, East Asians; 2, Ainu; 3, Mainland SEA; 4, Island SEA; 5, NE Asians; 6, Arctic; 7, Central/South America; 8, Micronesians; 9, Polynesians; 10, Australians; 11, Tibetans/Nepalese/NE India; 12, South Asians; 13, Europeans; 14, UK; 15, North Africans; 16, Subsaharan Africans. OL, ossicle at lambda; PNB, parietal notch bone; ASB, asterionic bone, OMB, occipitomastoid bone.

Appendix 4. *Sexual differences in frequency distributions in the major regional pooled samples based on Fisher's exact probability test*

	TD	OSC	MET	TZS		BAS	
				2 mm+	5 mm+	2 mm+	10 mm+
East Asians							
M	0.3792 (327)	0.0436 (321)	0.0793 (328)	0.2658	0.1013 (316)	0.2038	0.1693 (319)
F	0.4356 (101)	0.0396 (101)	0.0891 (101)	0.3100	0.1400 (100)	0.1515	0.0909 (99)
Ainu							
M	0.2315 (216)	0.0853 (211)	0.0237 (211)	0.6075	0.2634 (186)	0.1713*	0.1389 (216)
F	0.3630 (146)**	0.0775 (142)	0.0069 (145)	0.5299	0.2051 (117)	0.0884	0.0816 (147)
Mainland Southeast Asians							
M	0.2971 (276)	0.0455 (264)	0.0181 (276)	0.1569	0.0876 (274)	0.2433**	0.2129** (263)
F	0.4286 (91)*	0.0543 (92)	0.0543 (92)	0.2000	0.1000 (90)	0.1087	0.0870 (92)
Island Southeast Asians							
M	0.3054 (501)	0.0611 (491)	0.0423 (496)	0.1707	0.0894 (492)	0.2454	0.2209 (489)
F	0.4030 (201)*	0.0918 (196)	0.0348 (201)	0.2421*	0.0789 (190)	0.1791	0.1542 (201)
Northeast Asians							
M	0.3627 (397)	0.0382 (393)	0.0302 (398)	0.3405	0.1287 (373)	0.2191	0.1443 (388)
F	0.4813 (241)**	0.0372 (242)	0.0328 (244)	0.3468	0.1306 (222)	0.1765	0.1345 (238)
Arctic							
M	0.4172 (326)	0.0721 (319)	0.0306 (327)	0.1456	0.0777 (309)	0.2615**	0.2215** (325)
F	0.4706 (255)	0.0830 (253)	0.0196 (255)	0.2379**	0.1189 (227)	0.1508	0.1310 (252)
North America							
M	0.3195 (169)	0.0238 (168)	0.0353 (170)	0.1871	0.0710 (155)	0.1775**	0.1479** (169)
F	0.5286 (70)**	0.0429 (70)	0.0143 (70)	0.2000	0.0833 (60)	0.0429	0.0286 (70)
Central/South America							
M	0.5695 (223)	0.0315 (222)	0.0267 (225)	0.1584	0.0743 (202)	0.2273**	0.2000*** (220)
F	0.6489 (94)	0.0638 (94)	0.0213 (94)	0.1325	0.0602 (83)	0.0532	0.0319 (94)
Micronesians							
M	0.3697 (119)	0.0796 (113)	0.0083 (120)	0.0280	0.0093 (107)	0.1949**	0.1525* (118)
F	0.5054 (93)*	0.0625 (80)	0.0109 (92)	0.0244	0.0122 (82)	0.0581	0.0581 (86)
Polynesians							
M	0.1113 (503)	0.0373 (456)	0.0118 (508)	0.0789	0.0283 (494)	0.3043***	0.2702*** (470)
F	0.1338 (269)	0.0361 (249)	0.0111 (270)	0.0736	0.0194 (258)	0.1566	0.1124 (249)
Melanesians							
M	0.2376 (564)	0.1160 (250)	0.0350 (571)	0.0784	0.0205 (536)	0.3399**	0.3083* (253)
F	0.3474 (331)***	0.1313 (160)	0.0473 (338)	0.0960	0.0248 (323)	0.2188	0.2063 (160)
Australians							
M	0.1521 (355)	0.0651 (169)	0.0134 (373)	0.1190	0.0450 (311)	0.3158***	0.2690*** (171)
F	0.1955 (179)	0.0787 (89)	0.0104 (193)	0.0704	0.0211 (142)	0.0778	0.0778 (90)
Tibetans/Nepalese/Northeast India							
M	0.3433 (134)	0.0451 (133)	0.1037 (135)	0.2576	0.0909 (132)	0.3358	0.2761 (134)
F	0.4222 (45)	0.0227 (44)	0.0222 (45)	0.3333	0.1778 (45)	0.2791	0.2326 (43)
South Asians							
M	0.2730 (403)	0.0276 (398)	0.0447 (403)	0.1595	0.0608 (395)	0.2625***	0.2325*** (400)
F	0.3388 (121)	0.0744 (121)*	0.0492 (122)	0.1597	0.0252 (119)	0.1157	0.0826 (121)
Central Asians							
M	0.3311 (148)	0.0204 (147)	0.0338 (148)	0.1844	0.0567 (141)	0.1224	0.0748 (147)
F	0.4359 (117)	0.0261 (115)	0.0336 (119)	0.1681	0.0354 (113)	0.0769	0.0769 (117)
Europeans							
M	0.1988 (669)	0.0155 (647)	0.0773 (673)	0.1058	0.0280 (643)	0.2809*	0.2315 (648)
F	0.3833 (180)	0.0343 (175)	0.1038 (183)	0.1477	0.0625 (176)	0.2000	0.1714 (175)
UK							
M	0.1573 (426)	0.0394 (406)	0.1446 (429)	0.0874	0.0194 (412)	0.3000***	0.2714*** (420)
F	0.2566 (226)**	0.0575 (226)	0.1239 (226)	0.0783	0.0230 (217)	0.1682	0.1364 (220)
North Africans							
M	0.1944 (540)	0.0322 (528)	0.0406 (542)	0.1077	0.0481 (520)	0.2212**	0.1993** (538)
F	0.3017 (348)***	0.0291 (344)	0.0661 (348)	0.1104	0.0521 (326)	0.1370	0.1254 (343)
Subsaharan Africans							
M	0.2776 (634)	0.0844 (628)	0.0125 (639)	0.1092	0.0521 (595)	0.0746	0.0635 (630)
F	0.4007 (302)***	0.1133 (300)	0.0166 (302)	0.0846	0.0404 (272)	0.0661	0.0429 (303)

mm+, longer than the length specified, in mm. *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

Appendix 5. *Frequency distributions for the 5 hypostotic cranial traits based on the components of the major regional pooled samples*

	TD	OSC	MET	TZS		BAS	
				2 mm+	5 mm+	2 mm+	10 mm+
East Asians							
Japanese	0.3198 (172)	0.0407 (172)	0.0756 (172)	0.3232	0.1037 (164)	0.1657	0.1243 (169)
Hokkaido Ainu	0.2636 (258)	0.0763 (249)	0.0237 (253)	0.5625	0.2500 (208)	0.1351	0.1042 (259)
Sakhalin Ainu	0.3365 (104)	0.0962 (104)	0.0000 (103)	0.6105	0.2211 (95)	0.1442	0.1442 (104)
North Chinese	0.4909 (165)	0.0301 (166)	0.0843 (166)	0.2733	0.1304 (161)	0.1636	0.1273 (165)
South Chinese	0.3656 (93)	0.0698 (86)	0.0860 (93)	0.2151	0.0968 (93)	0.2907	0.2442 (86)
Mainland Southeast Asia							
Myanmar	0.3138 (188)	0.0265 (189)	0.0212 (189)	0.1862	0.1170 (188)	0.2128	0.1809 (188)
Mainland SE Asians	0.3490 (192)	0.0778 (180)	0.0365 (192)	0.1534	0.0582 (189)	0.2056	0.1833 (180)
Island Southeast Asia							
Javanese	0.3824 (136)	0.0606 (132)	0.0584 (137)	0.1970	0.1061 (132)	0.1866	0.1269 (134)
Philippines	0.3470 (219)	0.0599 (217)	0.0276 (217)	0.2074	0.0829 (217)	0.2110	0.2018 (218)
Borneans	0.2293 (157)	0.0946 (148)	0.0513 (156)	0.1733	0.0867 (160)	0.2740	0.2603 (146)
Lesser Sunda	0.3433 (67)	0.0597 (67)	0.0462 (65)	0.1493	0.0746 (67)	0.2687	0.2388 (67)
Andamanese/Nicobariese	0.2927 (123)	0.0813 (123)	0.0488 (123)	0.2069	0.0862 (116)	0.1789	0.1626 (123)
Negritoa	0.5833 (36)	0.1429 (35)	0.0000 (36)	0.1143	0.0286 (36)	0.2500	0.2222 (36)
Northeast Asia							
Mongolians	0.3934 (183)	0.0437 (183)	0.0492 (183)	0.3684	0.1228 (171)	0.2350	0.1694 (183)
Buryats	0.5800 (150)	0.0530 (151)	0.0530 (151)	0.3356	0.1164 (146)	0.2703	0.1622 (148)
Amur Basin	0.3232 (164)	0.0241 (166)	0.0000 (166)	0.3750	0.1382 (152)	0.1341	0.1037 (164)
Neolithic Baikalians	0.2126 (80)	0.0405 (74)	0.0123 (81)	0.2879	0.1818 (66)	0.1286	0.1000 (70)
Yakuts	0.5077 (65)	0.0308 (65)	0.0462 (65)	0.2698	0.0952 (63)	0.2308	0.1538 (65)
Arctic							
Ekvens	0.4545 (110)	0.0648 (108)	0.0270 (111)	0.1827	0.0769 (104)	0.1636	0.1364 (110)
Chukchis	0.4247 (73)	0.0694 (72)	0.0270 (74)	0.1765	0.0588 (68)	0.1622	0.1216 (74)
Aleuts	0.5043 (117)	0.0714 (112)	0.0256 (117)	0.3265	0.2143 (98)	0.1304	0.0957 (115)
Asian Eskimos	0.5000 (132)	0.1163 (129)	0.0455 (132)	0.1210	0.0323 (124)	0.1908	0.1450 (131)
Greenland Eskimos	0.3713 (167)	0.0542 (166)	0.0060 (167)	0.1592	0.1019 (157)	0.3394	0.3212 (165)
New World							
Northwest Coast	0.4149 (94)	0.0430 (93)	0.0319 (94)	0.1786	0.0476 (84)	0.1170	0.0745 (94)
Northwest America	0.4471 (85)	0.0238 (84)	0.0000 (85)	0.1852	0.1111 (81)	0.1446	0.1325 (83)
Northeast America	0.3333 (78)	0.0256 (78)	0.0506 (79)	0.2090	0.0597 (67)	0.1392	0.1266 (79)
Central America	0.5402 (87)	0.0698 (86)	0.0114 (88)	0.0725	0.0290 (69)	0.1412	0.1412 (85)
Peruvians	0.6503 (183)	0.0328 (183)	0.0328 (183)	0.1988	0.0994 (171)	0.2077	0.1803 (183)
Fuegians/Patagonians	0.5455 (66)	0.0152 (66)	0.0299 (67)	0.0938	0.0156 (64)	0.1231	0.0769 (65)
Micronesia							
Micronesians	0.4252 (214)	0.0718 (195)	0.0093 (214)	0.0262	0.0105 (191)	0.1359	0.1117 (206)
Polynesia							
Hawaii	0.1410 (156)	0.0449 (156)	0.0064 (156)	0.0577	0.0192 (156)	0.1987	0.1474 (156)
Easter	0.1509 (159)	0.0216 (139)	0.0000 (160)	0.0533	0.0133 (150)	0.2308	0.1888 (143)
Marquesas	0.0952 (105)	0.0481 (104)	0.0189 (106)	0.0476	0.0286 (105)	0.2596	0.2115 (104)
Society	0.1096 (73)	0.0000 (72)	0.0135 (74)	0.0857	0.0143 (70)	0.2877	0.2603 (73)
Maori	0.0859 (198)	0.0364 (165)	0.0151 (199)	0.0876	0.0361 (194)	0.2171	0.1886 (175)
Moriori	0.1524 (105)	0.1064 (94)	0.0185 (108)	0.0980	0.0098 (102)	0.3263	0.3053 (95)
Melanesia							
Papua New Guinea	0.2689 (331)	0.1481 (136)	0.0235 (340)	0.0805	0.0124 (323)	0.2647	0.2279 (136)
Torres Strait	0.2233 (103)	0.1078 (102)	0.0198 (101)	0.0400	0.0000 (100)	0.3786	0.3398 (103)
North Melanesians	0.2614 (306)	0.0513 (117)	0.0453 (309)	0.0803	0.0167 (299)	0.3025	0.2941 (119)
South Melanesians	0.3508 (191)	0.1720 (93)	0.0609 (197)	0.1429	0.0571 (175)	0.2366	0.2366 (93)
Australia							
East Australians	0.1377 (138)	0.0722 (97)	0.0072 (139)	0.0806	0.0242 (124)	0.2371	0.2062 (97)
Southwest Australians	0.1662 (361)	0.0551 (127)	0.0128 (392)	0.1313	0.0505 (297)	0.2692	0.2308 (130)
Central/South Asia							
Tibetans/Nepalese	0.3710 (124)	0.0488 (123)	0.0720 (125)	0.2951	0.1311 (122)	0.2903	0.2258 (124)
Assam/Sikkim	0.3846 (65)	0.0156 (64)	0.0923 (65)	0.2500	0.0781 (64)	0.3651	0.3333 (63)
East Indian	0.2903 (124)	0.0242 (124)	0.0161 (124)	0.1545	0.0488 (123)	0.1855	0.1774 (124)
South India	0.3207 (184)	0.0562 (178)	0.0326 (184)	0.1573	0.0393 (178)	0.2222	0.1889 (180)
Northwest India	0.3218 (174)	0.0343 (175)	0.0743 (175)	0.1479	0.0473 (169)	0.2514	0.2114 (175)
Afghanistans	0.2273 (44)	0.0465 (43)	0.0455 (44)	0.2045	0.0909 (44)	0.2955	0.2273 (44)
Tagars	0.3586 (145)	0.0282 (142)	0.0340 (147)	0.1630	0.0222 (135)	0.1042	0.0764 (144)
Kazakhs	0.4000 (120)	0.0167 (120)	0.0333 (120)	0.1933	0.0756 (119)	0.1000	0.0750 (120)

Appendix 5 (*cont.*)

	TD	OSC	MET	TZS 2 mm+	TZS 5 mm+	BAS 2 mm+	BAS 10 mm+
West Asia							
Israel	0.1651 (109)	0.0660 (106)	0.0727 (110)	0.1222	0.0778 (90)	0.3119	0.2752 (109)
Turkey/Cyprus	0.2097 (62)	0.0317 (63)	0.0794 (63)	0.1296	0.0000 (54)	0.1905	0.1746 (63)
Europe							
Russians	0.4711 (121)	0.0083 (121)	0.0413 (121)	0.1356	0.0339 (118)	0.2893	0.1983 (121)
Greece	0.1970 (66)	0.0149 (67)	0.1286 (70)	0.1639	0.0656 (61)	0.1765	0.1176 (68)
Eastern Europe	0.1532 (124)	0.0693 (101)	0.0726 (124)	0.0924	0.0588 (119)	0.3168	0.2871 (101)
Italy	0.2277 (202)	0.0000 (202)	0.0980 (204)	0.1309	0.0262 (191)	0.2700	0.2300 (200)
Finland/Ural	0.1975 (81)	0.0250 (80)	0.0494 (81)	0.1750	0.0250 (80)	0.2405	0.2405 (79)
Scandinavia	0.1846 (65)	0.0154 (65)	0.0462 (65)	0.1250	0.0469 (64)	0.2769	0.2154 (65)
Germany	0.2000 (70)	0.0143 (70)	0.1127 (71)	0.0141	0.0000 (71)	0.2958	0.2254 (71)
France	0.2315 (108)	0.0288 (104)	0.1204 (108)	0.0784	0.0294 (102)	0.2286	0.2190 (105)
United Kingdom							
Ensay	0.2895 (114)	0.1560 (109)	0.1826 (115)	0.1416	0.0265 (113)	0.3717	0.3274 (113)
Repton	0.1228 (57)	0.0577 (52)	0.0517 (58)	0.0943	0.0189 (53)	0.2000	0.1818 (56)
Poundbury	0.2262 (168)	0.0570 (158)	0.1607 (168)	0.0606	0.0121 (165)	0.2892	0.2530 (166)
Spitalfields-1	0.2137 (262)	0.0156 (257)	0.1183 (262)	0.0776	0.0245 (245)	0.2253	0.1937 (253)
Spitalfields-2	0.0900 (100)	0.0098 (102)	0.1373 (102)	0.0588	0.0098 (102)	0.2255	0.2059 (102)
North Africa							
Badari	0.1754 (57)	0.0377 (53)	0.0702 (57)	0.1154	0.0769 (52)	0.0877	0.0702 (57)
Naqada	0.2162 (185)	0.0543 (184)	0.0535 (187)	0.0984	0.0328 (183)	0.1925	0.1711 (187)
Gizeh	0.2989 (184)	0.0109 (184)	0.0489 (184)	0.1934	0.0884 (181)	0.1803	0.1530 (183)
Kerma	0.3172 (227)	0.0320 (219)	0.0396 (227)	0.0550	0.0183 (218)	0.1920	0.1741 (224)
Nubia-1	0.1591 (88)	0.0341 (88)	0.0114 (88)	0.0789	0.0263 (76)	0.2159	0.1932 (88)
Nubia-2	0.1071 (140)	0.0072 (139)	0.0500 (140)	0.0992	0.0534 (131)	0.1791	0.1567 (134)
Morocco	0.3750 (32)	0.0667 (30)	0.2188 (32)	0.2759	0.1724 (29)	0.2813	0.2813 (32)
Subsaharan Africa							
Somalia	0.2740 (73)	0.0411 (73)	0.0132 (76)	0.1233	0.0548 (73)	0.0685	0.0411 (73)
West Africa	0.2321 (56)	0.0714 (56)	0.0357 (56)	0.1296	0.0556 (54)	0.0909	0.0727 (55)
Nigeria-1	0.3598 (164)	0.1481 (162)	0.0061 (163)	0.0423	0.0000 (142)	0.0552	0.0491 (163)
Nigeria-2	0.2707 (133)	0.1288 (132)	0.0227 (132)	0.0976	0.0488 (123)	0.0833	0.0833 (132)
Gabon	0.3221 (149)	0.1088 (147)	0.0134 (149)	0.0414	0.0138 (145)	0.0884	0.0748 (147)
Tanzania	0.2727 (99)	0.0612 (98)	0.0202 (99)	0.1158	0.0421 (95)	0.0103	0.0000 (97)
Kenya	0.4897 (145)	0.0890 (146)	0.0201 (149)	0.1154	0.0538 (130)	0.0952	0.0748 (147)
South Africa	0.1493 (134)	0.0896 (134)	0.0000 (135)	0.1405	0.0661 (121)	0.1128	0.0977 (133)
Khoisans	0.3433 (67)	0.0152 (66)	0.0000 (68)	0.2097	0.1452 (62)	0.0735	0.0588 (68)

mm+, greater than the length specified, in mm.

Appendix 6. *Frequency distributions for the 5 hypostotic cranial traits based on the major regional pooled samples*

				TZS		BAS	
	TD	OSC	MET	2 mm+	5 mm+	2 mm+	10 mm+
Eastern Asia							
East Asians	0.3953 (430)	0.0425 (424)	0.0812 (431)	0.2799	0.1124 (418)	0.1905	0.1500 (420)
Ainu	0.2845 (362)	0.0822 (353)	0.0169 (356)	0.5776	0.2409 (303)	0.1377	0.1157 (363)
Mainland SE Asians	0.3316 (380)	0.0515 (369)	0.0289 (381)	0.1698	0.0875 (377)	0.2092	0.1821 (368)
Island SE Asians	0.3306 (738)	0.0748 (722)	0.0422 (734)	0.1883	0.0851 (717)	0.2210	0.1975 (724)
Northeast Asians	0.4081 (642)	0.0391 (639)	0.0325 (646)	0.3428	0.1288 (598)	0.2048	0.1413 (630)
Arctic/New World							
Arctic	0.4507 (588)	0.0764 (576)	0.0254 (590)	0.1848	0.0961 (541)	0.2140	0.1815 (584)
North America	0.4008 (257)	0.0314 (255)	0.0271 (258)	0.1897	0.0733 (232)	0.1328	0.1094 (256)
Central/South America	0.6012 (336)	0.0388 (335)	0.0266 (338)	0.1480	0.0658 (304)	0.1742	0.1502 (333)
Pacific/Oceania							
Micronesians	0.4252 (214)	0.0718 (195)	0.0093 (214)	0.0262	0.0105 (191)	0.1359	0.1117 (206)
Polynesians	0.1211 (826)	0.0410 (757)	0.0120 (833)	0.0735	0.0237 (803)	0.2455	0.2093 (774)
Melanesians	0.2782 (931)	0.1186 (447)	0.0380 (947)	0.0881	0.0212 (897)	0.2949	0.2727 (451)
Australians	0.1670 (551)	0.0691 (275)	0.0120 (583)	0.1066	0.0405 (469)	0.2266	0.1942 (278)
Central/South/West Asia							
Tibetan/Nepalese/NE India	0.3757 (189)	0.0374 (187)	0.0789 (190)	0.2796	0.1129 (186)	0.3155	0.2620 (187)
South Asians	0.3007 (552)	0.0403 (546)	0.0434 (553)	0.1630	0.0519 (540)	0.2259	0.1949 (549)
Central Asians	0.3774 (265)	0.0229 (262)	0.0337 (267)	0.1772	0.0472 (254)	0.1023	0.0758 (264)
West Asians	0.1813 (171)	0.0533 (169)	0.0751 (173)	0.1250	0.0486 (144)	0.2674	0.2384 (172)
Europe							
Europeans	0.2373 (864)	0.0191 (837)	0.0827 (871)	0.1142	0.0349 (832)	0.2640	0.2198 (837)
United Kingdom	0.2040 (701)	0.0501 (678)	0.1362 (705)	0.0826	0.0192 (678)	0.2627	0.2308 (689)
Africa							
North Africans	0.2388 (913)	0.0301 (897)	0.0514 (915)	0.1126	0.0506 (870)	0.1867	0.1657 (905)
Subsaharan	0.3184 (1002)	0.0946 (994)	0.0129 (1008)	0.1023	0.0474 (929)	0.0681	0.0561 (998)

mm+, greater than the length specified, in mm.