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Biological Relationships among Southeast Asians, Jomonese, and the Pacific Populations as Viewed from Dental Characters: The Basic Populations in East Asia, X

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Abstract Morphological patterns of similarity and difference derived from an assessment of metric and non-metric dental characters in a series of Jomonese and their lineage in Japan, Southeast Asians, Micronesians, and Polynesians were presented. Despite the marked difference of phenotypic features, the dentitions of Negritos, Dajaks, and Filipinos show close resemblance to each other. The original dental traits of Southeast Asians may have occurred by the result of convergent microevolution under the similar environmental condition such as tropical rain-forest. Diachronic comparison of Southeast Asian dental samples supports the local evolution hypothesis for modern Southeast Asian dental characters. Dental traits of Micronesians and Polynesians are more like those of Southeast Asians than those of Jomonese and their lineage. The present findings do not favor the Neolithic Jomonese as the most likely source for the present people in Micronesia and Polynesia. Jomonese may be linked with the Pacific populations through the common gene pool derived from somewhere in Southeast Asia.

Key Words: Southeast Asia, Pacific, Jomonese, Dentition, Biological relationships

Introduction

The problem of origins and affinities for the people of Southeast Asia and the Pacific is once again a matter for debate. The orthodox view is that the present inhabitants of Southeast Asia originated somewhere in South China, absorbing and replacing the aboriginal Southeast Asians after a series of migration within the past 2,000–4,000 years (COON, 1962; BRUES, 1977; BELLWOOD, 1978, 1985). However, some physical anthropologists present another viewpoint of recent Chinese expansion and replacement, and it is now time to turn to another view which may be correct in part and which may necessitate modification of basic replacement theories (BELLWOOD, 1985, p.95). TURNER (1987, 1990a) first pointed out that the dental morphology of the present Southeast Asians could have evolved within Southeast Asia or Sundaland from the late Pleistocene onwards. PIETRUSEWSKY (1988) compared the craniofacial morphology of near contemporary Southeast Asians with that of the Neolithic ones and suggested that the populations of Southeast Asia

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were undergoing similar trends in terms of the modernization or gracilization of craniofacial form throughout the late Pleistocene and into Holocene.

Negritos, very short in stature, dark skinned, and with frizzly hair, are quite different from the other Southeast Asians who now predominate in this part of the world. They have been regarded as people with lesser admixture with the East Asian migrants from the north, and have been the best known of the "Australoids" in modern times in Southeast Asia (COON, 1962; HOWELLS, 1976; JACOB, 1976; BIRDSELL, 1977; BRUES, 1977; BELLWOOD, 1978, 1985; KENNEDY, 1979). However, as far as human genetics as well as dental and craniofacial morphology is concerned, there is no necessary connection of Negritos with Australians and Melanesians, despite their phenotypic resemblance (OMOTO, 1984; HANIHARA, 1989c, 1990a, b, 1991a, b).

The similarities of dental and craniofacial features between Negritos and adjacent Southeast Asians pointed out by the present author (HANIHARA, 1991a, b) are supportive of the local evolution hypothesis for modern Southeast Asian phenotype. However, diachronic comparison of Southeast Asian samples is indispensable to confirm this hypothesis. In the present study, one early Southeast Asian sample excavated from Ban Chiang site, north Thailand, is included for comparison.

Although all lines of evidence provided by physical anthropological studies support a non-Melanesian source of Micronesians and Polynesians, the origins and migrations of people within the Micronesia and Polynesia have long been matters for speculation. In physical anthropological field, the work by PIETRUSEWSKY (1976, 1977, 1984a, 1985, 1988, 1990a, b) is one of the most extensive survey of the Pacific populations ever made. Based on metric and non-metric craniofacial traits, his findings indicate close ties among Micronesians, Polynesians, and Southeast Asians. HOWELLS (1973, 1979, 1989, 1990) also provided convincing evidence of biological relationship between Micronesian-Polynesian group and Southeast Asians. Using several crown and root traits of teeth, TURNER and colleagues attributed the possible ancestors of Micronesians and Polynesians to the inhabitants of the Island Southeast Asia (HARRIS *et al.*, 1975; TURNER and SCOTT, 1977; TURNER and SWINDLER, 1978; TURNER, 1989, 1990b; KIRCH *et al.*, 1989). On the other hand, BRACE and colleagues (BRACE *et al.*, 1989, 1990; BRACE and HUNT, 1990; YONGYI *et al.*, 1991) as well as KATAYAMA (1990) described that the prehistoric Jomonese in Japan should have colonized Micronesia and Polynesia through the Nansei island chain.

The second purpose of the present study is to present a dentally oriented perspective in the affinities and possible origins for the Pacific populations on the basis of studies which were pioneered by W.W. HOWELLS, M. PIETRUSEWSKY, C.G. TURNER II, C.L. BRACE, *etc.*

Materials and Methods

The materials consist of 6 prehistoric and 9 near contemporary samples from Southeast Asia, the Japanese Archipelago, Micronesia, and Polynesia as shown in Table 1. The detailed provenience of all the samples except for early Thailand sample is given elsewhere (HANIHARA, 1989a, b, c, 1990a, b, c, 1991a, b, c, d). The early Thailand materials, excavated from Ban Chiang site in north Thailand (dated to *ca.* 3,000–6,000 years B.P.) are housed at Department of Anthropology, University of Hawaii. The archaeological and other detailed information is given by PIETRUSEWSKY (1978, 1981, 1982, 1984b). The dental data were obtained from 37 male, 24 female and 14 sex-unknown skulls. The metric

Table 1. Sample names and the brief information

Population label	Information
Japan	
Jomonese (106)	Middle, late and the latest Neolithic Jomon period (*ca.* 2,300–5,300 years B.P.) Excavated from Honshu, Japan
Hirota (21)	Aeneolithic Yayoi period (1,700–2,300 years B.P.) Hirota site, Tanegashima island, northern island of the Nansei island chain
Amami islands (122)	Recent inhabitants of Amami islands Amamioshima-, Kikai-, Yoro-, Yoron-, Okinoerabu-, Tokunoshima-island
Okinawa islands (34)	Recent and modern inhabitants of Okinawa islands
Sakishima islands (39)	Recent inhabitants of Sakishima islands, southwestern part of the Nansei island chain Miyako-, Ishigaki-, Hateruma-, Yonaguni-island
Southeast Asia	
Filipino (14)	Modern Filipino, Marcows village, the Philippines
Negrito (21)	Modern Negritos, Aeta tribe, Bataan Peninsula, Luzon, the Philippines
Dajak (13)	Recent inhabitants of Borneo Pontianak, Kapuas River
Early Thailand (37)	Early metal age of Thailand (*ca.* 3,000–6,000 years B.P.) Ban Chiang site, Nong Han district of Udon Thani province in Northeast Thailand
Micronesia	
Guam (52)	Chamorros from Guam island, Pre-historic (pre-Spanish epoch)
Tinian (15)	Recent Chamorros from Tinian island
Ponape (14)	Recent inhabitants of Ponape island including a few specimens from Truk islands
Polynesia	
Tonga (7)	Tonga island including a few specimens from Samoa
Hawaii (84)	Pre-historic (pre-contact) inhabitants of Oahu, Mokapu site (*ca.* 500–600 years B.P.)
Marquesas (21)	Pre-historic (pre-contact) Marquesans (*ca.* 1,700–2,000 years B.P.) Hane Dune site (MUH-1), Uahuka, Marquesas islands

Parenthesis: numbers of male samples; those of male and female combined are given elsewhere (HANIHARA, 1990b, c, 1991a, b, d)

data used were recorded on male specimens. The mesiodistal crown diameters were measured on all the teeth except for the maxillary and mandibular third molars (Table 2). The discrete crown traits were recorded on both male and female specimens since sexual dimorphism was insignificant in most of the samples investigated. The traits observed are: shovelling (U-I1); CARABELLI's cusp (U-M1); hypocone (U-M2); 6th cusp, 7th cusp, deflecting wrinkle, distal trigonid

Table 2. Means and standard deviations of mesio-distal crown diameters in early Thailand sample from Ban Chiang Site

Tooth	N	Mean	S.D.
U-I1	16	8.39	0.5714
U-I2	15	7.01	0.4474
U-C	16	7.48	0.5360
U-P3	20	7.06	0.4852
U-P4	19	6.59	0.4895
U-M1	23	10.40	0.5573
U-M2	20	9.62	0.6841
L-I1	18	5.11	0.3874
L-I2	16	5.72	0.3860
L-C	24	6.84	0.4288
L-P3	27	7.04	0.3972
L-P4	26	7.07	0.4940
L-M1	25	11.22	0.5887
L-M2	24	10.54	0.7474

crest, and protostylid (L-M1); and 4 cusp pattern (L-M2) (Table 3). The detailed information of the criteria for classification of non-metric characters was given elsewhere (HANIHARA, 1989b, 1991a, b, n.d. a). Metric and non-metric traits were scored per individual, not per side.

Distance analysis based on Q-mode correlation coefficients between every pair of samples was applied to the dental measurements. B-square distance analysis developed by BALAKRISHNAN and SANGHVI (1968) was applied to the discrete crown characters. Distance matrices obtained are presented as a dendrogram using group average clustering technique, and a two-dimensional scattergram using multidimensional scaling method.

Results

In the first analysis, inter-group relationships among samples from Southeast Asia, Micronesia, Polynesia, the Nansei island chain, and Jomonese were analyzed. All the prehistoric and near contemporary samples from the Nansei island chain are considered to be of the "Jomon lineage" (HANIHARA, K., 1987, 1991; DODO and ISHIDA, 1990; KOZINTSEV, 1990; HANIHARA, 1991a, b, d). In Fig. 1, a principal division occurs between the Micronesian-Polynesian constellation and one containing Jomonese and their lineage, and Southeast Asian samples. The samples from early Thailand is attracted to the Jomonese-Hirota cluster. With the exception of the Ponape sample, Polynesian and Micronesian samples form their own branch.

Fig. 2a is a plot of 15 samples on the first and second axes and Fig. 2b is that on the first and third ones obtained by multidimensional scaling method, accounting for 79.3% and 68.2% of total variance, respectively. A clear separation between the Jomonese-Nansei islander group and the Micronesian-Polynesian group is evident. The Southeast Asian samples occupy an intermediate position between the two groups on the first axis. In the four Southeast Asian groups, early Thailand sample occupies an isolated position on the second axis, suggesting a temporal difference. However, this sample is linked with the two samples of indigenous inhabitants of Southeast Asia, or Negritos and Dajaks, on the first and third axes.

Since the analyses described include both recent and earlier samples, secular change in morphology may bias the results of comparison. In the next analysis of dental measurements, therefore, the prehistoric samples, except for recent Negritos and Dajaks, are compared. A dendrogram based on Q-mode correlation coefficients (Fig. 3) shows 2 large clusters with 2 sub-clusters. Here again, the Guamanian, Hawaiian, and Marquesan samples are closely related to those of island Southeast Asians than to the Jomonese and early Thailand samples. Fig. 4 displays a two dimensional expression obtained by multidimensional scaling method, accounting for 81.4% of total variance. In this figure, the

Table 3. Frequency distributions of discrete crown traits in early Thailand sample from Ban Chiang site (in %; parenthesis, the numbers of teeth observed)

Traits	++	+	−
Shovel (UI1)	7.7	65.4	26.9 (26)
CARABELLI (UM1)	18.6		81.4 (43)
Hypocone (UM2)	86.4		13.6 (44)
6th cusp (LM1)	22.5		77.5 (40)
7th cusp (LM1)	0.0		100.0 (49)
Deflecting wrinkle (LM1)	42.9		57.1 (27)
Distal trigonid crest (LM1)	6.9		93.1 (29)
Protostylid (LM1)	3.1		96.9 (32)
4-cusp pattern (LM2)	57.1		42.9 (42)

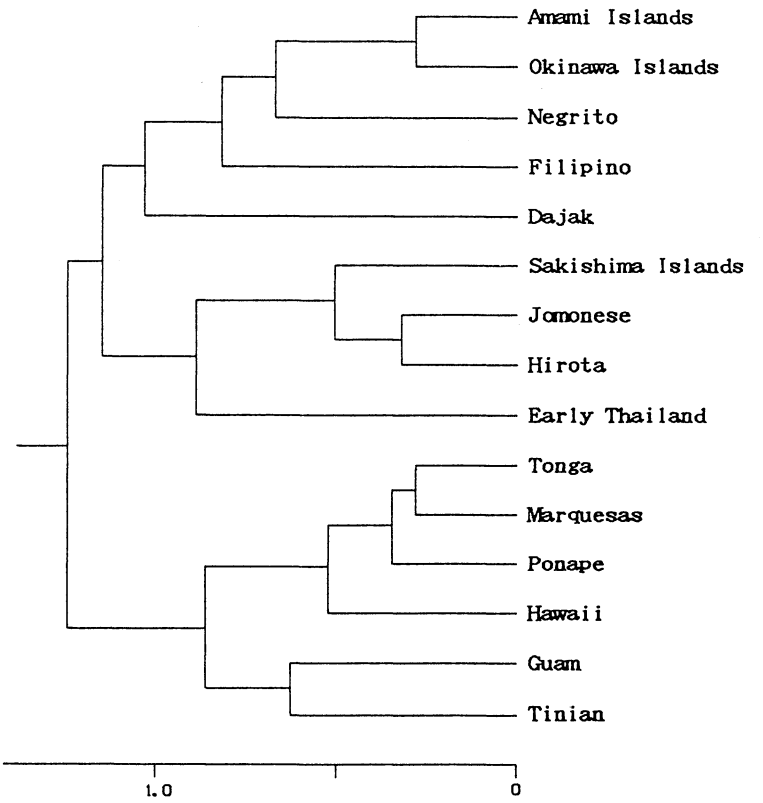

Fig. 1. Clustering by group average method. Distance matrix transformed from Q-mode correlation coefficients based on 14 mesiodistal crown diameters was applied.

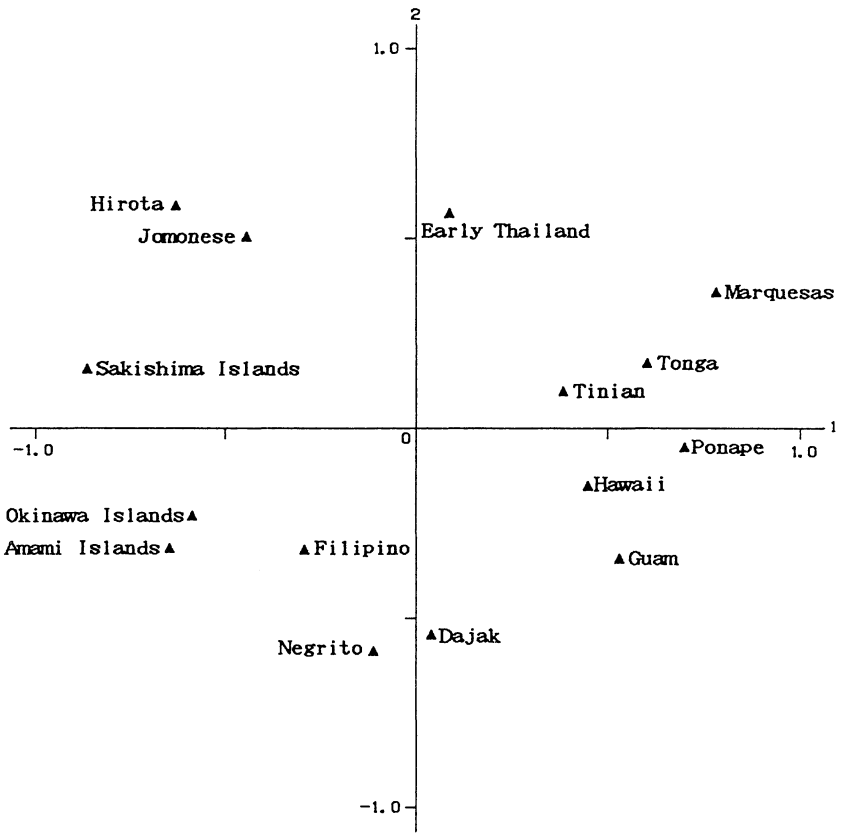

Fig. 2a. Two dimensional graph of multidimensional scaling (MDS) applied to the same distance matrix used in Fig. 1. Using first two axes, 79.3% of total variance is expressed.

early Thailand sample occupies an intermediate position between the Jomonese-Hirota samples and Micronesian-Polynesian ones. The Negrito-Dajak group falls into the Micronesian-Polynesian cluster on the first axis and the Jomonese-Hirota cluster on the second axis.

The analysis of the discrete tooth crown traits is based on the prehistoric samples from Southeast Asia, Japan, Micronesia, and Polynesia, except for recent Negrito sample. A dendrogram based on B-square distance coefficients (Fig. 5) is roughly divided into 2 major clusters represented by the Jomonese-Hirota and the Pacific samples. The Negrito sample falls within the Jomonese sub-branch, and the sample of early Thailand links to the Pacific samples.

Discussion

As described previously, sufficient congruency between the results from metric and non-metric triats suggests biological relationships among populations in the Japanese Archipelago, Southeast Asia, and the Pacific. Dental features common to Southeast Asians, Jomonese and their lineage, as well as the Pacific populations are clues to the racial origins of the Pacific Basin and Rim populations.

In the previous studies, it is pointed out that

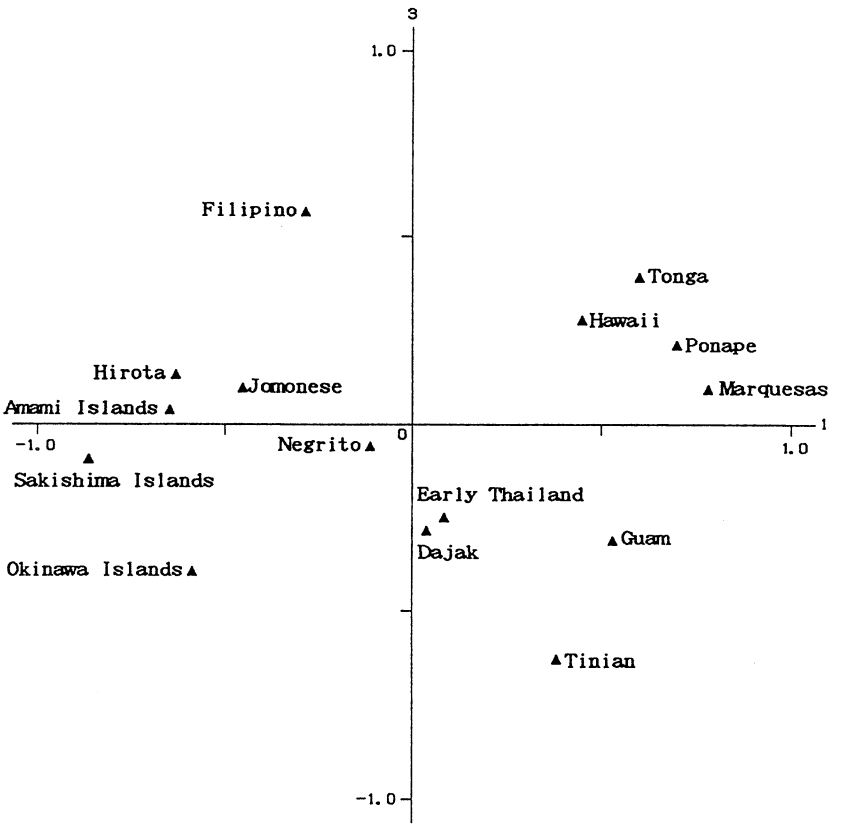

Fig. 2b. Two dimensional expression using first and third axes in the same analysis in Fig. 2. 68.2% of total variance is accounted for.

Negritos may be one possible representative of the aboriginal population of Southeast Asia, or the generalized Asiatic populations, who have undergone *in situ* evolution in mountainous tropical rain-forest environments through the time as long as 20,000–30,000 years (HANIHARA, 1991a, b, c). Negritos are traditionally forest hunters and gatherers. The phenotype of them is, as described previously, characterized by short stature, dark skin, and frizzly hair (COON, 1962; BRUES, 1977; GLINKA, 1981; OMOTO, 1984; BELLWOOD, 1985). On the other hand, Dajaks, an aboriginal population in Borneo, are agriculturists or horticulturists. They are not so short in stature as Negritos, yellowish or brown-skinned, mostly straight-haired, and with features of a general Southeast Asian cast (COON, 1962; RIPLEY, 1971). Despite the difference in phenotypic appearance between Negritos and Dajaks, and also Filipinos, they show close resemblance not only in dental features but also in the craniofacial morphology (HANIHARA, 1991a, b, n.d. a, b). These findings suggest that the similarities they share may be explained by the results of adaptation to similar environmental condition such as tropical rain-forest or convergent microevolution. OMOTO (1984) hypothesized that the formation of

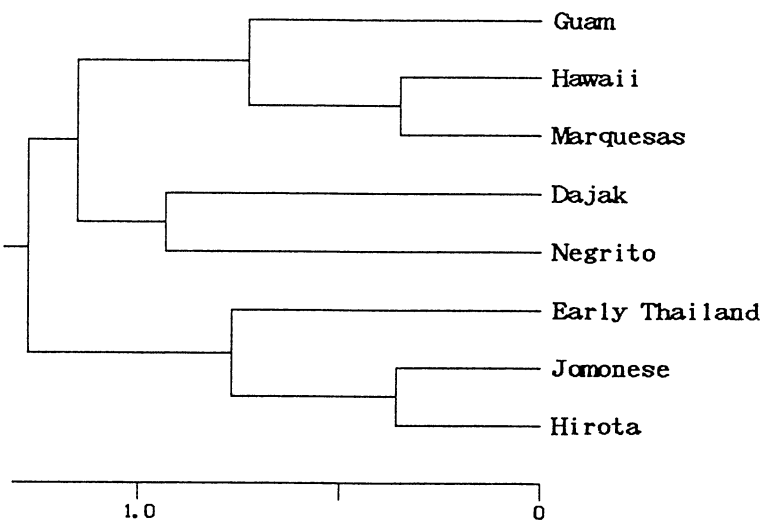

Fig. 3. Cluster analysis applied to Q-mode correlation coefficients between every pair of samples.

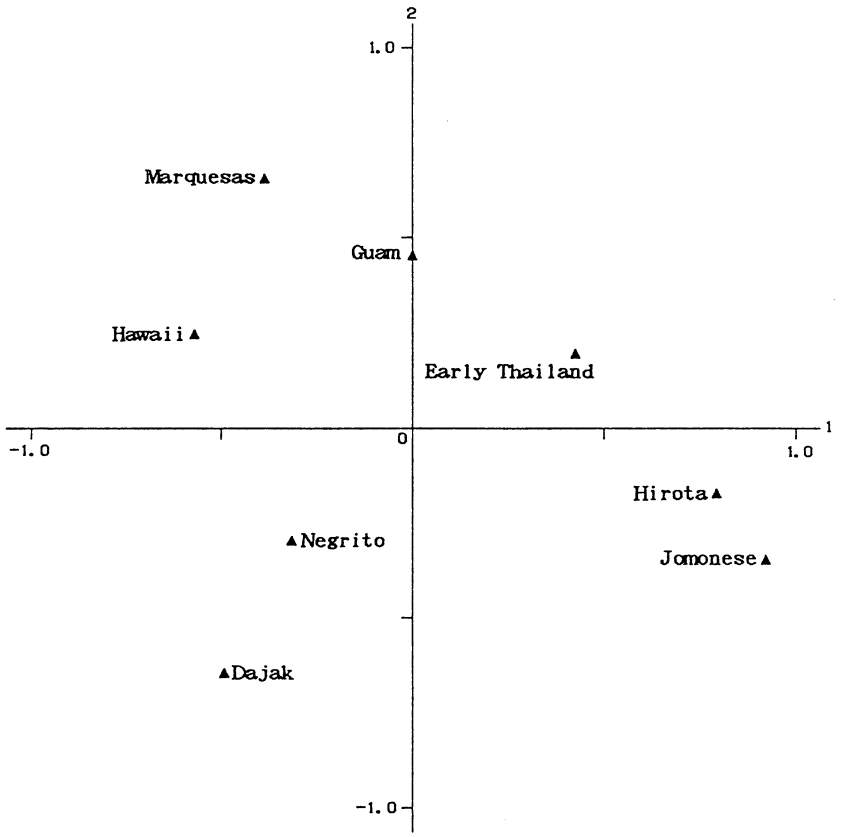

Fig. 4. Two dimensional scattergram of MDS applied to the same distance matrix used in Fig. 3, expressing 81.4% of total variance.

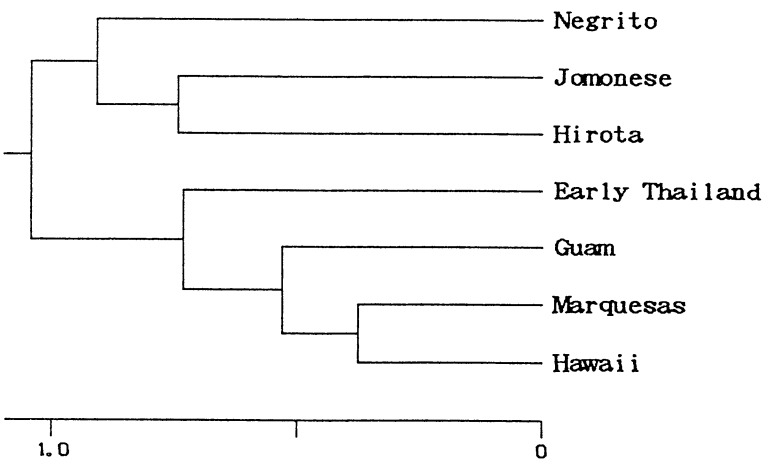

Fig. 5. Group average cluster analysis applied to B-square distance coefficients based on 9 discrete crown traits.

Negrito-like feature may have occurred in this kind of environmental condition and a sufficient time-depth, say, 20,000 years or so. In the present study, I will not dispute that intense East Asian (probably Chinese) gene flow into Southeast Asian region has taken place in historic or even prehistoric times. However, diachronic comparison suggests that the original Southeast Asian dental pattern may have evolved in Southeast Asia, not formed by the replacement of the invaders from the north, as pointed out by TURNER (1987, 1990a).

PIETRUSEWSKY (1988) suggested that the original cranial features of Southeast Asians may have also evolved in Southeast Asia. He analyzed the cranial data by applying MAHALANOBIS' generalized distance and stepwise discriminant function analysis. Using the published cranial data by PIETRUSEWSKY (1974, 1981, 1984a, 1988), the pattern of cranial "shape" of Southeast Asians and circum-Southeast Asians was reanalyzed by applying Q-mode correlation coefficients (Figs. 6, 7). In Fig. 6, two Neolithic samples from Vietnam cluster with Australian group. This may not be inconsistent with the orthodox view that the Australian Aborigines whose ancestors originally migrated into Sahulland from Sundaland via the WALLACE Line by at least 40,000 years ago may have shared the common gene stock with the indigenous inhabitants of Southeast Asia (COON, 1962; HOWELLS, 1976; BRUES, 1977; BELLWOOD, 1978; and others). However, all the early Southeast Asian samples occupy a central position between Australian-Melanesian and Southeast Asian constellations in Fig. 7. Moreover, a greater number of the prehistoric Southeast Asians overlap with recent Southeast Asians than with Australomelanesian complex in these representations. This may allow to suppose that the early Southeast Asians without intensive admixture with Chinese can be regarded as morphological members having recent Southeast Asian cranial features. The original form may have still retained to a certain extent in part of the inhabitants of island Southeast Asia. At the same time, the Chinese expansion from mainland to island Southeast Asia is evidently suggested.

For Micronesians, HOWELLS (1973) and PIETRUSEWSKY (1990b) note a marked separa-

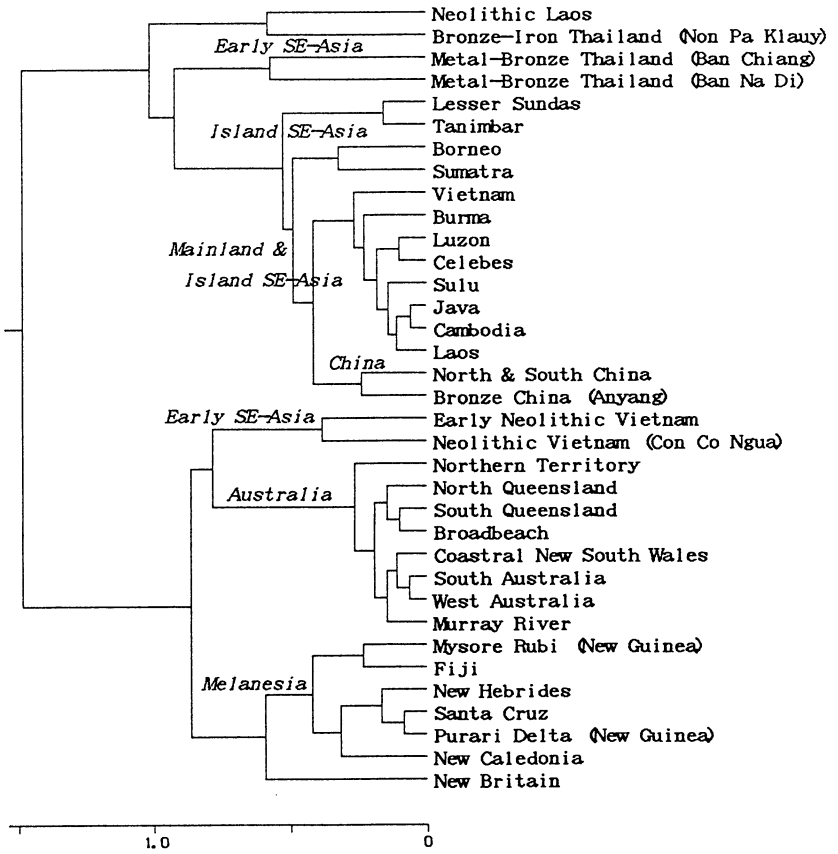

Fig. 6. Cluster analysis applied to Q-mode correlation coefficients based on 13 cranial measurements published by PIETRUSEWSKY (1981, 1984a, 1988). The items are: Maximum cranial length (M-1); Nasio-occipital length (M-1d); Maximum cranial breadth (M-8); Minimum frontal breadth (M-9); Maximum frontal breadth (M-10); Biauricular breadth (M-11b); Biasterionic breadth (M-12); Nasion-bregma chord (M-29); Bregma-lambda chord (M-30); Bifrontal breadth (M-43); Interorbital breadth (M-49a); Mastoid height (H-MDH); and Mastoid width (H-MDB).

tion between western Micronesia (the Marianas, Palau, and Yap) and eastern as well as central Micronesia, or the so-called nuclear Micronesia (*e.g.* Truk, Ponape, Kosrae, Marshalls, and Gilberts). Archaeological records and the linguistic evidence substantiate the east-west division (BENDER, 1971; BELLWOOD, 1975, 1978; CRAIB, 1983). The association of Ponapeans with Polynesians shown in Figs. 1 and 2 shows an east-west dichotomy within Micronesia. Based on linguistic studies, BELLWOOD (1979) suggested that the nuclear Micronesians were close cousins to Polynesians, while PIETRUSEWSKY (1990a, b) confirmed Ponape – eastern Melanesian association.

The present findings do not favor the Jomonese as the most likely racial source and the Nansei island chain as the geographical route for

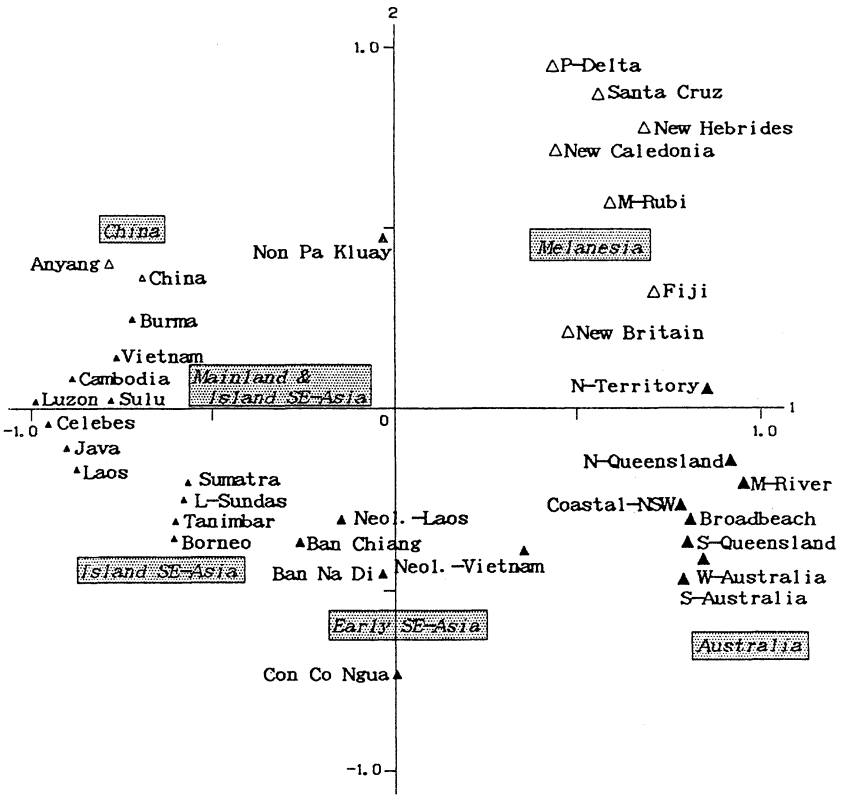

Fig. 7. Two dimensional graph of MDS applied to the same distance matrix used in Fig. 6, expressing 70.0% of total variance.

the peopling of Micronesia and Polynesia proposed by BRACE and colleagues (BRACE *et al.*, 1989, 1990; BRACE and HUNT, 1990), and KATAYAMA (1990). The findings presented here are consistent with those reported by TURNER, (1987, 1989, 1990a, b), PIETRUSEWSKY (1990a, b), HOWELLS (1990), *etc.* All the evidence obtained indicates that the Micronesians, Polynesians, and Jomonese share the common gene pool which can be traced back to Southeast Asians, most likely the generalized Asian populations from dental morphological viewpoints. This finding supports TURNER's dental hypothesis stating that the sundadont ancestors of Jomonese could have arrived from Southeast Asia, or Sundaland, via the now-submerged East Asian continental shelf in the late Pleistocene and early Holocene times, and could have colonized Pacific Basin in the late Holocene times (TURNER, 1987, 1989, 1990a, b). It is worth noting that HORAI *et al.* (1989) succeeded to amplify mtDNA extracted from a Jomonese skull dated to about 6,000 years B.P., and determined a 190-bp nucleotide sequence of part of the major non-coding region. Comparing the sequence from this Jomonese skull with those of 107 modern humans, he found the complete identity with two Southeast Asians (a Malay and an Indonesian).

According to TURNER (1990b), W.G. SOLHEIM II suggested that people like those

possessing the Southeast Asian boat cultures are good candidates for the pioneer colonist of Pacific Basin and Rim. Such people may have similar dental characters to those of the generalized Asian populations. In addition, it should be kept in mind that there is no evidence of sailing technique in the Jomon age of Japan.

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抄　　録

縄文人，東南アジア，太平洋地域集団の系統関係

埴 原 恒 彦

現在の東南アジア集団の表現型は，いわゆる置換説によって説明されるのが最も一般的である．すなわち，約2,000年から4,000年前の時期に中国から南下してきた集団が，先住民を吸収していったとする説である．ネグリトはこのような混血から免れた集団の代表としてよく知られているが，多くの成書には，彼らは東南アジアにおけるオーストラロイド集団として記載されている．筆者は，ネグリトの研究から，彼らの歯冠及び頭骨形態は，オーストラリア原住民，あるいはメラネシア諸集団よりも，むしろ東南アジア，特にその島嶼部の集団に類似することを指摘した．このことは，現在の東南アジアの集団の原型が，この地域における集団の小進化によって形成されたのではないか，ということを示唆する．一方，東南アジア集団の形質的特徴は，太平洋民族，縄文人の起源に関する研究においても無視することはできない．本研究では，歯冠形態に基づいて東南アジア集団の小進化を考察すると共に，彼らと太平洋民族ならびに縄文人との関係を再検討した．

比較分析は，東南アジア4集団，縄文人，南西諸島4集団，ミクロネシア3集団，ポリネシア3集団の計15集団を対象とした．結果は，東南アジアの4集団，すなわちネグリト，ダヤク，フィリピン人，先史タイ人（3千～6千年前）が相互に類似性を示した．ネグリトの形質的特徴は，熱帯降雨林という環境と2～3万年にわたる時間によって形成されたであろうことは，すでに尾本恵市教授によって指摘されているが，今回得られた結果も，この仮説を支持するものと考えられる．その根拠は，ネグリトとはその表現型が異なるボルネオ島の原住民ダヤク（前者は低身長，黒い皮膚色，縮毛等によって特徴づけられ，後者は，比較的高身長，褐色の皮膚，直毛であり，大多数の東南アジア諸集団と共通の特徴を示す），あるいはフィリピン人が，歯冠形質ではネグリトに類似するということによる．すなわち，彼らは，熱帯降雨林という環境を共有し，このような環境に対する適応が彼ら

の形態的類似性をもたらしたであろうことは十分考えられるからである．さらに，このような形態的特徴が東南アジア大陸部の先史集団とも類似するという事実は，歯冠形質に関する限り，その原型が東南アジア地域で小進化したという可能性を示していると思われる．

上記の東南アジア集団は，縄文人や太平洋民族に共通した歯冠の形態的特徴を持つことが追証された．このことは，従来のもっともオーソドックスな主張通り，縄文人，太平洋民族の起源を東南アジア集団に求め得ることを示している．最近提唱された，太平洋民族（ポリネシア人，ミクロネシア人）が南西諸島にその地理的ルートをもつとする縄文人起源説は，今回得られたどの分析結果をとってみても支持されない．縄文人と太平洋民族との類似性は，東南アジアを介して，共通の祖先を持つことによると考えられる．

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