Dental Variation of the Polynesian Populations

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Abstract  Metric and nonmetric dental variation was studied for several samples from Polynesia and Southeast Asia. Within the Polynesian samples, the Tonga sample aligns with a sample from Marquesas. A few Hawaiian samples form a relatively tight cluster. The sample from the Society Islands shows a dispersed arrangement. Extending the comparisons to include the Polynesian and Southeast Asian samples affirms the existence of a relatively homogeneous Polynesian dental morphological pattern. Among the Polynesian samples, Tonga shows the closest affinity to the early Thailand sample. This finding supports the orthodox view for the initial settlement of ancestral Polynesians in Tonga and Samoa from somewhere in Southeast Asia. Moreover, the metric dental affinity of Marquesans with Tongans is compatible with the hypothesis that the Marquesas Islands may have been initially colonized in eastern Polynesia.

Key Words  Polynesians, Tonga, Marquesas, Dentition, Southeast Asia

Introduction  Oceania comprises the geographical areas of Melanesia, Micronesia, and Polynesia. Of all the Oceanic peoples, Polynesians are culturally, linguistically, and physical anthropologically the most homogeneous. They stem probably from the Tonga-Samoa Islands in the late second millennium B.C. (HOWELLS, 1970, 1979; GROUBE, 1971; PIETRUSEWSKY, 1971, 1984; BELLWOOD, 1975, 1978; KIRCH et al., 1989). By 3,600 years B.P., Austronesian-speaking people arrived in eastern Melanesia. Some of them travelled east to Fiji and western Polynesia as far as Samoa carrying Lapita-style pottery (BELLWOOD, 1975, 1978; GREEN, 1979; PIETRUSEWSKY, 1985; KIRCH, 1986; KIRCH et al., 1989). Over the ensuing 1,500 years, there were no further attempts at eastward colonization (BELLWOOD, 1975; JENNINGS, 1979; KIRCH, 1986). Between 1,700 and 2,000 years B.P., a few settlers in the Tonga-Samoa region colonized the Marquesas Islands before dispersing to the Society Islands, Easter Island, Hawaiian Islands, and New Zealand (SINOTO, 1970; BELLWOOD, 1975; JENNINGS, 1979; KIRCH, 1986).

The origin and migration of peoples within the great Polynesian triangle have long been matters for speculation. Physical anthropologists and related scientists have tried and are still trying to get at the facts, but even now a number of matters remain unexplained (MARSHALL, 1956; BELLWOOD, 1975, 1978; PIETRUSEWSKY, 1971, 1984; HEYERDAHL, 1978; KIRCH et al., 1989). Archaeological findings, together with linguistic
studies, suggest that the origins of the Polynesians are in the western Pacific. The Lapita Cultural Complex is regarded on archaeological grounds to include the common ancestral cultures of eastern Melanesia, somewhere in the Bismark Archipelago region or the New Britain – New Ireland area, and western Polynesia, Tonga and Samoa (BELLWOOD, 1975, 1978; GREEN, 1979; KIRCH, 1982, 1986; PIETRUSEWSKY, 1985; KIRCH et al., 1989). This raises the fundamental problem of why the eastern Melanesians and Polynesians, who form a linguistic and to a lesser extent a cultural continuum, should be physically so different (HOWELLS, 1973, 1979; TURNER and SCOTT, 1977; SERJEANTSON, 1984; PIETRUSEWSKY, 1985; KIRCH et al., 1989). Physical anthropological findings based on dental and cranial morphology as well as human genetics have made it possible to say with some certainty that the first settlements were made by migrants from Southeast Asia (RIESENFELD, 1956; COON, 1962; SIMMONS, 1962; BRUES, 1977; TURNER and SCOTT, 1977; HOWELLS, 1979; PIETRUSEWSKY, 1984, 1985, 1990; KIRCH, 1986; TURNER, 1987; KIRCH et al., 1989).

In my previous studies, it was pointed out that the aboriginal populations in Southeast Asia with lesser admixture with Chinese shared common dental and craniofacial morphology and probably common gene pool with not only modern Southeast Asians but also the Pacific populations (western Micronesians and Polynesians), the Neolithic Jomon people and the successors in Japan (HANIHARA, 1990a, b, 1991a, b, c, 1992a, b, c, d). Based on such findings, the present study focuses on the dental variation of several Polynesian populations and the assessment of the dental relationships between Polynesians and Southeast Asians.

Materials and Methods

The dental materials consist of prehistoric and near contemporary samples from Polynesia and Southeast Asia. Table 1 indicates the provenience of the samples investigated, and Fig. 1 shows the map of the Polynesian triangle. The detailed information for the items measured, discrete traits observed, and the criteria for classification is given elsewhere (HANIHARA, 1989a, b, 1990a, b, c, 1991a, b, c, 1992a, b, c, d).

The statistical methods applied are also the same as those used in the previous studies (e.g. HANIHARA, 1990a, 1991a, b, c, c, d). Results

The first analysis is based on the discrete tooth

Table 1. Polynesian samples used in the metric analysis

| Population | Provenience |
|------------|-------------|
| Tonga      | Seven individuals from Tonga Island including a few individuals from Samoa |
| Marquesas  | Twenty one Prehistoric Marquesan samples, Hane Dune site (MUH-1), Uahuka, 2,000-1,700 years B.P. |
| Society    | Twenty individuals from Society Islands including small numbers of specimens from Gambier and Tuamotu Islands |
| Hawaii     | Altogether 69 individuals from Hawaii, Maui, Lanai, and Molokai Islands |
| Oahu       | Specimens from Hawaii Islands are excavated from South Point, Hawaii Islands |
| Kauai      | Mokapu series (84 individuals) |
|            | Twenty-five individuals from Kauai Island |

Almost all specimens are housed in B.P. BISHOP Museum, Honolulu. Numbers of samples used in discrete traits are shown in Table 2.
Fig. 1. Map of Polynesian triangle. Samples used in the present study are shown in capital letters.
Fig. 2. Clustering by group average method. B-square distance matrix based on 9 nonmetric crown traits was applied.

Table 2. Frequency distributions of nonmetric crown traits in each sample (in %, parenthesis; number of teeth)

| Sample                  | Shovel (U11) | CARABELLI (UM1) | Hypocone (UM2) |
|-------------------------|--------------|-----------------|----------------|
|                         | + +          | +               | +              |
|                         | -            | -               | -              |
| Eastern Polynesia       | 16.7 (24)    | 13.3 (45)       | 95.1 (41)      |
| Hawaii                  | 5.5 (55)     | 13.2 (121)      | 85.3 (102)     |
| Oahu                    | 16.5 (127)   | 18.4 (179)      | 90.8 (152)     |

| 6th cusp (LM1) | 7th cusp (LM1) | Deflecting wrinkle (LM1) |
|----------------|----------------|--------------------------|
| +              | +              | +                        |
| 38.9 (36)      | 2.4 (41)       | 28.6 (35)                |
| 45.5 (101)     | 3.5 (113)      | 33.3 (90)                |
| 43.2 (132)     | 6.9 (144)      | 37.3 (118)               |

| Dist. trig. crest (LM1) | Protostyloid (LM1) | 4 cusp pattern (LM2) |
|-------------------------|--------------------|----------------------|
| 2                       | +                  | +                    |
| 5.1                     | 94.9 (39)          | 33.3 (36)            |
| 13.0                    | 87.0 (100)         | 46.0 (113)           |
| 13.7                    | 86.3 (131)         | 45.8 (142)           |

1) Shovel: + + ≥ 1.0mm; + ≥ 0.5mm; < 0.5mm in depth.
2) Including samples from Marquesas, Society, Gambier, and Tuamotu Islands.
Fig. 3. Cluster analysis applied to Q-mode correlation coefficients based on 14 mesiodistal crown diameters.

Fig. 4. Two dimensional expression of multidimensional scaling method (MDS) applied to the same distance matrix used in Fig. 3, accounting for 99.3% of total variance.
crown characters. The frequencies of nine nonmetric crown traits for Polynesian samples are given in Table 2. Based on this table, B-square distance analysis was applied. The dendrogram resulting from the group average clustering technique is shown in Fig. 2.

In this figure, the Polynesian samples form a tight cluster, which links with the early Thailand sample. Within this cluster, the Hawaii and Oahu samples show close association with each other. The affinities of the samples shown in this figure are almost the same as those obtained in the previous studies (HANIHARA, 1990a, b, 1991a, b, 1992a, b, c, d).

Next, distance measures based on Q-mode correlation coefficients were applied to the measurements recorded for six Polynesian male samples. A dendrogram and a two dimensional scattergram were made with the group average cluster analysis and multidimensional scaling method, respectively (Figs. 3 and 4). Using the first two dimensions, 99.3% of total variance is expressed in Fig. 4.

A close relationship is found between Tonga and Marquesas. Smaller subgrouping within this cluster reveals a tie between Oahu and Kauai. The Society Islands and Hawaii construct a second large cluster. In Fig. 4, the Society sample is the most isolated of all groups included in this comparison.

The same statistical procedures were applied to dental measurements of 6 Polynesian and 4 Southeast Asian samples (Table 3, Figs. 5 and 6a, b). In Fig. 5, the early Thailand sample is found to cluster with the Tonga – Marquesas group. This cluster falls within a major constellation which contains all of the samples from Polynesia. A second major cluster consists of the three recent Southeast Asians. In Fig. 6a, the three groups from the Hawaiian Islands are plotted around the Tonga – Marquesas group. The most peripherally positioned sample is the Society Islands. On the other hand, the three Hawaiian samples show relatively close affinities to the Society Islands in Fig. 6b. In this figure, the Tonga and Marquesas samples are situated close to the early Thailand sample. As shown on the distance matrix (Table 3), moreover, the early Thailand sample is more closely related to Tonga than to Marquesas.

These findings suggest that the samples from the Hawaiian Islands have dental similarity with not only those from Tonga and Marquesas but also from the Society Islands.

Table 3. Distance matrix based on Q-mode correlation coefficients

| Sample name  | 1  | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|--------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Tonga        |    |     |     |     |     |     |     |     |     |     |
| Marquesas    | 0.400 |  |     |     |     |     |     |     |     |     |
| Societies    | 1.257 | 1.182 | |     |     |     |     |     |     |     |
| Hawaii       | 1.004 | 0.917 | 0.489 | |     |     |     |     |     |     |
| Oahu         | 0.837 | 0.749 | 1.546 | 0.791 | |     |     |     |     |     |
| Kauai        | 0.907 | 0.891 | 1.365 | 0.625 | 0.447 | |     |     |     |     |
| Negrito      | 1.161 | 1.066 | 1.222 | 1.614 | 1.135 | 1.438 | |     |     |     |
| Filipino     | 1.125 | 1.276 | 1.356 | 1.286 | 1.010 | 0.942 | 0.677 | |     |     |
| Dajak        | 1.593 | 1.469 | 1.271 | 1.425 | 0.952 | 1.273 | 0.835 | 1.021 | |     |
| Early Thailand | 0.646 | 0.970 | 0.970 | 1.199 | 1.422 | 0.945 | 1.242 | 0.014 | 1.431 | |
Fig. 5. Group average cluster analysis applied to Q-mode correlation based on mesiodistal crown diameters.

Discussion

The results obtained in this study allow a few tentative conclusions regarding biological relationships and possible origin and affinities of Polynesian people.

Concerning the initial peopling of the Polynesia, the west Polynesian Archipelagoes of Tonga and Samoa along with certain of the small islands such as Futuna and Niuatoputapu were colonized about 3,000–3,600 years B.P. by those members of the Lapita Cultural Complex who had physical affinities with Southeast Asians (GOLDMAN, 1970; GROUBE, 1971; BELLWOOD, 1975, 1978; GREEN, 1979, 1981; KIRCH, 1982, 1986; PIETRUSEWSKY, 1985; PAWLEY and GREEN, 1986; KIRCH et al., 1989). Among the Polynesian samples treated here, the distance between Tongans and early Thailand people is the smallest. This finding is not inconsistent with the view that the colonization of the Tonga-Samoa area preceded the final populating of the Polynesian triangle. It is probable, moreover, that the ancestors of Polynesians may have linked with prehistoric Southeast Asians with lesser admixture with Chinese.

As regards the initial settlement and colonization of Polynesian triangle, the Marquesas Islands seem to have served as a major dispersal center to the Society, Hawaiian, Easter, and New Zealand Islands based on archeological evidence (SUGGS, 1961; SINOTO, 1968, 1970, 1983). The Society Islands served, moreover, as a secondary dispersal center to Hawaii and New Zealand (JENNINGS, 1979). This dispersal reconstruction has been supported from linguistic analysis (GREEN, 1966). On the other hand, KIRCH (1986) has rejected these hypotheses as being inaccurate or not useful models of eastern Polynesian settlement. He regards the available evidence as being insufficient (KIRCH, 1986). Some minor criticism for the view described above has also been offered by BELLWOOD (1975) and BIGGS (1972).

The relationships found in this study may be in part parallel to the ordered stages of Polynesian prehistory (SUGGS, 1961; SINOTO, 1968; JENNINGS, 1979). (1) Settlement of the Marquesas Islands from Tonga-Samoa: As far as metric dental traits are concerned, the results
obtained in the present study suggest that the sample from Marquesas shows close affinities to that from Tonga. This supports the hypothesis for the colonization of the Marquesas Islands from western Polynesia (Figs. 3, 4, 5, and 6a, b).

(2) Settlement of the Society Islands from Marquesas: In the metric dental analyses, the Society Islands tend to form a single branch separated from the division containing the other Polynesian samples. The sample from Hawaii is most closely related to that of the Society Islands. Society is slightly more like Marquesas than like Tonga, Oahu, and Kauai on the basis of dental measurements (Table 3). (3) Initial colonization of the Hawaiian Islands from the Marquesas Islands and secondary settlement from the Society Islands: The metric dental characters of the samples from the Hawaiian Islands have something in common with those of the Tonga-Marquesas group and Society one. This indicates that the Hawaiian Island group has a probability of being both Tonga-Marquesas and Society related (Figs. 4, 5, and 6a, b).

However, all lines of dental evidence presented here do not necessarily provide further support for the ordered stage of colonization within Polynesia proposed by SINOTO (1968), JENNINGS (1979), and others. It can be said with some certainty that the dental comparisons presented here provide further assessment for the relative homogeneity within the Polynesian populations.
Fig. 6b. Two dimensional expression using first and third axes in the same analysis as in Fig. 6a, where 65.6% of total variance is accounted for. Using first 3 axes (Figs. 6a and 6b), 95.4% of total variance is expressed.

In either case, reconstruction of the population history involves a variety of complicated problems so that it is necessary to analyze not only the dental traits but also several other characteristics such as the cranial morphology, human genetics, and others in order to increase the reliability of analysis.

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抄録
ポリネシア集団の歯の変異について

塚原恒彦

ポリネシアにおける集団の拡散過程については、考古学をはじめ、言語学、形質人類学等から様々な仮説が提唱されている。比較的オーソドックスな仮説は本文に記載したが、今日それが広く受け入れられているわけではない。本研究ではポリネシア諸集団の歯冠形質について、その集団間変異を明らかにするとともに彼らの拡散過程を検討した。

トンガ、マルケサス、ソサイアティ、ハワイ、オアフ、カウアイ集団を比較対象とし、歯冠の計測データ、非計測データを多変量解析法により分析した。計測値による分析では、トンガとマルケサス集団が類似性を示し、またハワイ諸島の3集団も相互に類似する。また、これら3集団はトンガ、マルケサス集団とソサイアティ集団の双方に共通した歯冠形質の特徴を有する。ソサイアティ集団は上記6集団の中では、ハワイ島集団と類似するが、かなり異なった歯冠形態を示す。ポリネシア集団との関係が最も重要視されている東南アジア集団を含めた分析では、先史タイ集団がよりともに類似し、中でもトンガ集団に類似する。非計測的形質による分析では、ポリネシア集団は相互に非常に類似する。さらに彼らと最も類似する集団はやはり先史タイ集団である。

以上の結果から次のようなことがポリネシア集団の歯冠形質について指摘できる。①ポリネシア諸集団は歯冠形質についても比較的ホモジニア的な集団である。②ポリネシアの祖先集団は、西ポリネシアに最初に移住し、その後、マルケサス諸島へと拡散していったと仮説は歯の形態からも支持される。③マルケサス諸島がハワイ諸島、ソサイアティ諸島への最初の拡散中心となり、その後、ソサイアティ諸島が第二の拡散中心となったとする仮説については本研究結果からは検証できない。④ハワイ諸島の集団に関してはマルケサス諸島、ソサイアティ諸島の双方から移住があったと考えても分析結果とは矛盾しない。⑤歯の形態のみに関しては、ポリネシア集団の起源は東南アジアの基層的集団、つまり中国人の南下による混血をあまり受けていない集団である可能性が追跡された。

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