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The Identification of Polynesian Head Hair

The major genetic population, or race, of most skeletal remains can be determined by an experienced forensic physical anthropologist if the skull is relatively intact [*1,2*]. However, if the skull is missing or seriously damaged, the determination of race is much more difficult or impossible. Even if the skull is intact, racial determination may be a problem if the individual was of mixed genetic origin [*3*].

The Polynesians of the Pacific islands are a population not easily classified among the major races of the world. Although their genetic origins are not clearly understood, it seems probable that they represent an old admixture of at least two and perhaps several major races. In Hawaii there are many people who have little or no known genetic interruption of a direct line of Polynesian ancestry. They are often referred to as the "Old Hawaiians" and many can trace their pedigrees back for quite a few generations. While there are many people in Hawaii who have varying degrees of admixture of Oriental, European, and sometimes African genes, these "Old Hawaiians" have remained as a physically and genetically distinctive eastern extension of the Polynesians.

In an era of burgeoning air travel between the Pacific islands, Hawaii, and the continental mainlands, the identification of the remains of Polynesians is likely to be of increasing forensic importance. Unfortunately, the Polynesians cannot be placed easily into any of the traditional major racial classifications, yet they have few distinctive skeletal features that enable the anthropologist to identify their remains as being of Polynesian origin. One of the features that can be helpful in the identification of Polynesian remains is the so-called "rocker jaw," with its convex curve to the bottom that causes it to rock back and forth when placed on a flat surface. This can be helpful in identification, but it is not strictly limited to Polynesians nor found in all of them.

Not infrequently, remnants of head hair are found with skeletal remains, particularly the remains of recently deceased individuals. When this occurs, the head hair can be useful in determining racial affinities [*4,5*]. Variations in head hair should be used as an additional parameter for determining race, however, rather than as a positive indication; and several hairs from an individual should be used rather than one or two.

Materials and Methods

The late Professor Charles E. Snow of the University of Kentucky made available to the authors samples of head hair that he had collected from Old Hawaiians with varying degrees of genetic admixture with other racial populations. The total sample of head hair from Old Hawaiians without any record of admixture with other genetic populations was 79. An additional 27 were between 76 and 99 percent Old Hawaiian, and there were 30 with between 50 and 75 percent Old Hawaiian ancestry. Comparisons with the pub-

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TABLE 1—*Cross-sectional area and hair index.*

Population	Area	S.E.	Index	S.E.	Reference
Dutch	2411.0	24.0			[7]
American Negroid	3300.0		55.0		[8]
Australian	3633.3		68.0		[9]
West Europeans	3786.9	185.9	71.2	1.41	[5]
Hopi	4508.0	50.0	80.9		[7]
Negroids	4648.9	255.8	60.0	1.07	[5]
Thai	5200.0		81.8		[8]
Chinese	5816.9	407.2	82.6	1.17	[5]
Hawaiian	6380.7	211.6	74.0	0.27	

lished data for other races utilized only those Old Hawaiians who were classified as 100 percent (Table 1).

Each sample consisted of a tuft of hair that had been cut close to the scalp near the vertex of the head. These hairs were embedded in EPON plastic (Fisher Scientific) by the method previously described by Rosen and Kerley [6] for embedding hairs in plastic along a straight axis parallel to each other. The plastic block and the hairs it contained were then sectioned on a standard rotary microtome at a thickness of 3 microns. The resulting disk was mounted on a slide, and the hairs were examined and measured at a standard magnification of 430× using an ocular micrometer that had been calibrated in tenths of a millimeter and converted to microns by use of a stage micrometer. The major and minor diameters of each cross section were measured, and the hair index was calculated by dividing the minor diameter by the major and multiplying by 100. The area of each cross section was calculated by using the formula for the area of an ellipse:

$$\frac{D_1 \times D_2}{4} \times \pi$$

In addition to the cross sections, longitudinal hair mounts and cuticle scale impressions were examined, but neither proved to be particularly useful in distinguishing the hair of any one population from that of the others.

Results

When the average area of Hawaiian head hair cross sections is compared with cross-sectional areas for the hair of other racial populations (Table 1) it is apparent that the Old Hawaiian head hair has the largest average area of any major population reported to date. It exceeds even the Mongoloid Chinese cross-sectional area, which is the next largest. Although the large variability in Hawaiian Hair, as demonstrated by the standard deviation, leads to quite a bit of overlap between the two populations, the hair index of the Old Hawaiians is closer to that of the Caucasoid Europeans. As might be expected, the larger the cross-sectional area is, the larger is the standard deviation. The hair index, however, has a rather small standard deviation (2.4), suggesting that the Old Hawaiians are much more homogeneous with regard to hair shape than hair size.

Table 2 shows the effect on cross-sectional area of the introduction of genes from other populations. Those individuals who were 100 percent Old Hawaiian had the largest cross-sectional areas of any group. There was a reduction in area in the 76–99 and 51–75 percent groups. In individuals who were less than 50 percent Hawaiian, the average area dropped into the ranges of other racial groups. It is unlikely that age exerted much effect, as the average age for all of the Hawaiian sample was 37.9 and for the 100 percent Old

TABLE 2—*Hawaiian head hair.*

Population	Area	S.D.	Index	S.D.	Number
26–50% Hawaiian	5521.7	1808.8	72.7	11.1	22
51–75% Hawaiian	6024.5	1559.0	69.6	9.4	30
76–99% Hawaiian	6084.5	1600.0	71.9	9.9	27
100% Hawaiian	6380.7	1881.0	74.0	2.4	79
Total Sample	6057.4	1815.6	71.5	9.7	158

Hawaiians 42.5 years. The hair index, on the other hand, showed no correlation with the degree of admixture and remained in the general range of the Caucasoid Western Europeans. The size of the hair shaft, as seen by the cross-section area, appears to be under distinct genetic influence, even though the mechanism of heredity may be complex and not well understood at present.

Discussion

The area of cross sections of the head hair of Old Hawaiians was greater, on the average, than that of any other racial population reported so far. At the same time, there is a large range of overlap between various racial populations when a range of two standard deviations (95 percent of each population) is used (Fig. 1). Even though this overlap is extensive in some cases, the hair index may help in identifying the head hair of Old Hawaiians. The combination of large cross-sectional area and moderate (69–79) hair index range will exclude many of the Caucasoids and virtually all of the Negroids. The waviness of Old Hawaiian hair should help to distinguish it from the straight hair of Mongoloids.

Any criterion for determining racial affinity must be applied to individual cases with considerable caution. This is particularly true of any measurements. Almost no population of man is homogeneous for any racial trait, and there is a wide range of variation within each genetic population. On the other hand, most metric traits are continuous from one population to another, decreasing in frequency or degree with genetic admixture between populations. The result may be a wide range of overlap among various populations, producing ranges in which given values cannot be assigned to any one population with any degree of reliability. That is certainly the case with head hair cross-sectional area measurements, which have rather large standard deviations and quite a range of variation within a sample from a single individual.

The data presented here will be of most help in identifying the head hair of Old Hawaiians who have no genetic admixture, or the 100 percent Hawaiians of this sample. The difference between the average area of the cross sections of their hair (6380.7) and the group with the next largest area, the Chinese (5816.9), is a significant one, and if two standard deviations from the mean are used as the range of variability for each population the greatest overlap will be between the Old Hawaiians and the Mongoloids (see Fig. 1). There is still quite a bit of overlap with the Negroid range of cross-sectional area and, to a lesser degree, with the Caucasoid. When one adds the use of the ± 2 sigma range of hair index, however, over half of the Mongoloids can be excluded, as can virtually all of the Negroids. Since the area and index figures for the American Blacks are both lower than for the African Negroids, the hair index should be even more helpful in distinguishing them from the Old Hawaiians. This leaves the Caucasoids with the greatest overlap of hair index range with that of the Old Hawaiians, but with the least overlap in the ranges of the area.

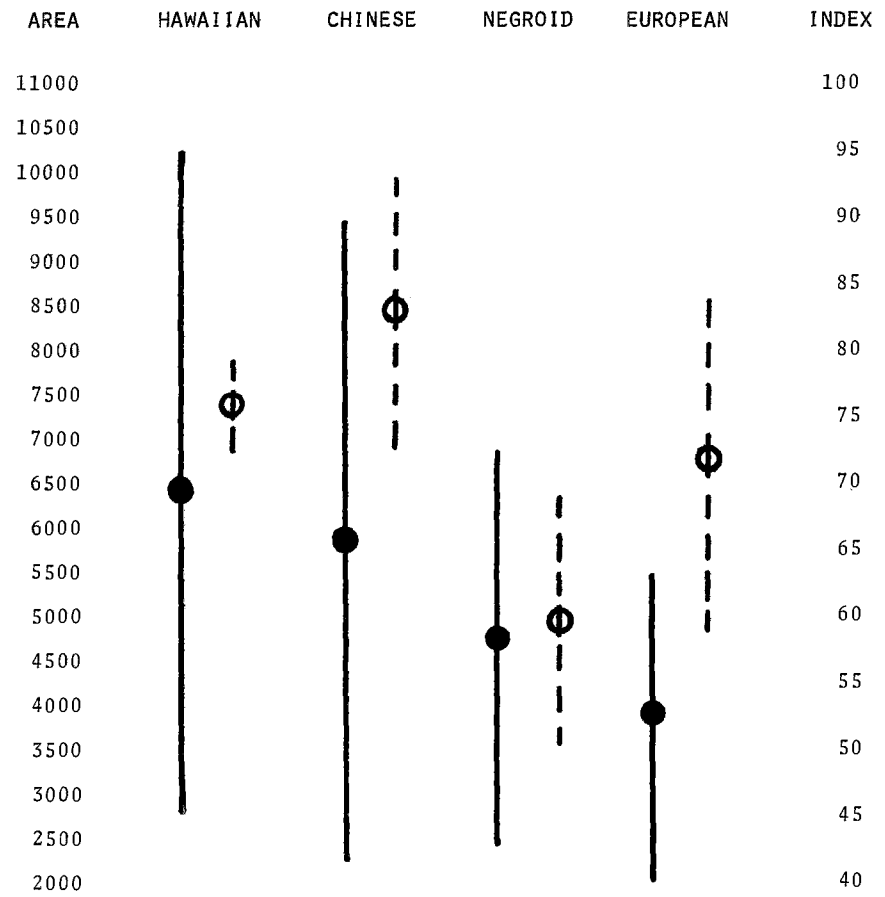

FIG. 1—*The statistical mean (circles) and a range of two standard deviations for the cross-sectional area (solid lines) and the hair index (broken lines).*

Consequently, it should be possible to assume with a high degree of reliability (95 percent) that anyone with an average cross-sectional area of over 7000 μ^2 is either Hawaiian or Mongoloid, but if the hair index is over 79, all populations have been excluded except Mongoloid. On the other hand, an average cross-sectional area of under 2600 μ^2 would exclude the Old Hawaiians. Since an average area of over 5500 μ^2 would eliminate most Caucasoids of European origin, the total overlap of hair index is not critical in differentiating them from Old Hawaiians.

The large ranges of overlap among the major races of man in terms of hair index and cross-sectional area makes it impossible to determine the racial affinities of many people by the microscopic size or shape of the hair. That is not to say, however, that there are not many others whose hair can be identified by a process of exclusion based on the ranges of index and area.

Summary

1. Samples of head hair from 79 Old Hawaiians with no record of any genetic admixture with other populations were measured through a standard binocular microscope using

an ocular micrometer, and the hair indices and areas of cross-sections were calculated and compared with published data for other racial populations.

2. The mean cross-sectional area of the Old Hawaiians (6380.7) is larger than that for any other major human population that has been reported so far. The next largest is the Chinese (5816.9), followed by other Mongoloid populations.

3. Cross sections of the head hair of Polynesians, as represented by the Old Hawaiians, are characterized by large areas of the cut surface combined with intermediate hair indices (69–79).

4. The use of the range of ± two standard deviations from the mean as a range for hair index and cross-sectional area in combination makes it possible to identify the racial affinity of many individuals, including Old Hawaiians, by their head hair. Where the ranges overlap for both factors, there will be also many individuals whose racial affinities cannot be determined by the hair.

Acknowledgments

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