I. SJo-68 DENTAL MORPHOLOGY AND ITS BEARING ON THE "DIHYBRID THEORY" OF AMERICAN INDIAN ORIGINS

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ABSTRACT

Despite some two decades of research on the origins of the American Indian, the dihybrid model proposed by Joseph Birdsell (1951) persists as one of the few paradigms couched in an essentially evolutionary framework. Birdsell holds that, in addition to the unquestionable Mongoloid ancestry, there is also a genetic contribution from an archaic Caucasoid (Amurian) element.

This paper presents data on the dental morphology of an Early Horizon Californian skeletal series (San Joaquin-68). This temporally early, geographically peripheral sample fulfills the criteria for analysis of American Indian origins proposed by Birdsell. Incisor labial and lingual shoveling is frequent and often marked in expression, Carabelli's cusp is uncommon, the protostylid complex is in high frequency, as is incisor winging, and 3-rooted mandibular first molars are relatively common. All of these features stand in contrast to the Caucasoid dental plan. The SJo-68 series is compared to samples of archaic and Mediterranean Caucasoids, Asiatic Mongoloids, and American Indians, all of which support the contention that the American Indian is of a uniracial, Mongoloid origin.

INTRODUCTION

The origin of the American Indian has long been of interest to laymen and scholars alike. Substantial evidence indicates that the New World was first populated by migrant hunters from eastern Siberia who crossed the now-submerged Bering Land Bridge, reaching Alaska more than 12,000 years ago (Stewart, 1973). There is less evidence or agreement on the number of migrations and the region within Asia from which these Paleolithic people originated. The biological characteristics and origin of the early Asian geographic race is itself still poorly known. One excellent reason for research on the skeletal and dental variation of native Americans is that it helps to further our understanding of ancient Asian populations whose skeletal remains are less common than those from the Americas, especially North America.

One worker, Joseph B. Birdsell, stands out in his pioneering efforts to unravel the biological history of the American Indian by employing concepts from evolutionary biology rather than continuing to apply the methods of classical taxonomy. Birdsell's review of the racial features of Indians, Asians, and Australians suggested to him that the genetic character of American Indians resulted from a dihybrid mixture in Asia between Mongoloids, who evolved late out of Amurians in cold northeastern Asia, and earlier-evolved eastern Caucasoids, called Amurians by Birdsell.

It is the purpose of this paper to examine this hypothesis in light of an available skeletal series of prehistoric California Indians that conforms to suggestions for analysis set forth by Birdsell. The selection of this series is based on its definite antiquity, its geographic provenience, its large sample size, and the preservation of the dentition, a tissue suggested by Birdsell as valuable for investigating his model.

THE DIHYBRID MODEL

Synoptically, Birdsell's argument rests on two assumptions. First, all evidence indicates that modern man did not originate in northeastern Asia or in the New World. Second, what has become the Mongoloid race was the last of the major groups to differentiate; "Their definitive phase of evolution occurred late in the fourth glacial period as the result of extreme environmental stressing in a dry Arctic environment" (Birdsell,1951:7).

Taking into account the temporal and geographic requirements involved in polyracial theories of American Indian origins, Birdsell convincingly argues that earlier claims of Negritoid, Carpentarian, Melanesian, Australian, and/or Mediterranean Caucasoid contributions to the peopling of the New World are unreasonable given the prescriptions involved in having any of these groups at the right place at the right time for entry into the Americas. Temporal and spatial restrictions allow only two likely sources of New World

Indians: One, the Amurian branch of the "Caucasoid" race and, two, the "newly-evolved" Mongoloid race. The Amurian group is defined as the hypothetical antecedent mainland population located in the Amur River basin, "...a region which must have been occupied by the populations ancestral to ...the living Ainu..." (1951:12).

From these two sources, the American Indian is considered to possess a dihybrid racial origin, and "...the universally admitted Mongoloid element has been adulterated only by an archaic Caucasoid contribution from the Amurians" (Birdsell, 1951:62).

Implicit in this argument is that, since the Amurian peoples were present in the right place (east Asia) at the right time (late Würm glaciation), then, not only could they have contributed to the New World gene pool, but they did in fact do so. Our physical anthropological knowledge for eastern Asia prior to the fourth interglacial has advanced but little in the last two decades, and Birdsell's hypothesis of an archaic Caucasoid group is still tenable.

There is almost no skeletal evidence of early man in eastern Asia between the terminal Pleistocene and the occurrence of wholly modern Mongoloids (i.e. between about 10,000 and 5,000 years ago). Examining the Upper Pleistocene finds in northern Asia, though, the morphological variability in the three adult skeletons from Upper Paleolithic deposits in the Upper Cave at Choukoutien is noteworthy (e.g. Weidenreich, 1939). The male cranium is described as Neanderthaloid with certain Caucasian features. The two female skulls have morphologic similarities with Melanesians and Eskimos respectively. If these skeletons are coeval there is no problem accounting for the morphologic variation in American Indians, even if microevolutionary changes did not occur after entrance into the Americas. W. W. Howells, regarding the Mongoloid features of these skulls, has labelled them "unmigrated American Indians" (1959:300); likewise, Birdsell sees the phylogeny of the American Indian as stemming at least from the morphology of these individuals, especially the male cranium, skull no. 101 (Birdsell, 1951:17). The other Upper Pleistocene finds from Asia, such as those from near Ting T'sun (Movius, 1956), Tzeyang (Pei and Woo, 1957), Changyang (Chia, 1957), and Liukang (Woo, 1959), are each presented by these authors as examples of a primitive Mongoloid stock, and the few available teeth exhibit Mongoloid features.

So too, the candidates for early man in the New World mentioned by Birdsell (Brown's Valley, Punin, Lagoa Santa, and the Paltacalo series) do not support the contention of an archaic Caucasoid element. Temporally more recent New World skeletal evidence is also unconvincing (including finds since Birdsell's paper). Birdsell concluded, "... that the cranial materials offer even less substantiation of the Amurian-Mongoloid hypothesis than do the living peoples" (1951:49).

Birdsell's model provides for two alternatives depending on when the earliest immigrants entered North America:

> If modern man reached the New World as early as during the third interglacial period, it is predicted that this type will be found to be unmixed Amurian in its characteristics. Any group of people migrating across

> Bering Strait in post-glacial times should be dihybrid in origin [1951:63] .

All anthropological and geological information to date supports a terminal or late glacial movement by man into the New World; we may cite Wormington (1964) as the most comprehensive current work (see also Hopkins, 1967; Bryan, 1969; and Borden, 1969). Consequently, Birdsell's model would have the migrants as dihybrid in origin, and, thusly interpreted, the model becomes that of a single migration of indeterminant length and number of immigrants. Implicit in this model is the assumption that admixture occurred between the Amurian and Mongoloid groups prior to their entrance into the New World, and only the resultant hybridized group reached the Americas.

Birdsell provides no explanation as to why or how extensive gene flow would have occurred between Caucasoid and Mongoloid peoples at any point in time (except, of course, along common areal peripheries).

It is not surprising that Birdsell's most substantial evidence among living Indians should come from geographically marginal, relict populations. The Cahuilla of southern California and the Pomo and Yuki of northern California are cited (1951:63) as being the most suggestive of possessing a high frequency of archaic Caucasoid characteristics. It is instructive to note in passing what these characteristics are.

Five "distinctively Caucasoid" traits are listed for these Californian groups: 1) unusually abundant facial hair, 2) early graying of the facial and head hair, 3) concave nasal profile with unusual breadth, 4) greatly developed ear lobes, and 5) a marked tendency towards obesity (1951:36). But the 'propositae' illustrated in the article (see also Birdsell, 1972:492) are not -- with one probable exception -- representative of their groups. There is the assumption that the individuals selected do not possess appreciable post-Columbian White admixture. Not unreasonably, most if not all of these traits would be expected to be possessed by particular individuals within any living New World group due simply to independent assortment and random recombination within a wholly Mongoloid population. Although it is stated that Birdsell's model relies primarily upon natural selection as an evolutionary force (1951:6-7), there is no mention of the likelihood of convergent evolution. It is, of course, the frequency rather than the mere presence of traits which distinguishes between geographic races.

From this critical standpoint, one becomes skeptical of Birdsell's comment that, "This [anthroposcopic] evidence, as slim as it is, is the best testimony for an Amurian element in the Americas" (1951:36). Simply put, there are too many alternative hypotheses to explain the minor, observed variations, but most importantly, claiming features to be markers of an hypothetical population is untestable.

A METHODOLOGICAL APPROACH

Birdsell comments that, "It is believed that the Mongoloid component in the immigrants would increase with the passage of time" (1951:63).

Ideally, then, the detection of a non-Mongoloid component in the New World would derive from 1) the examination of one or more prehistoric series which approximate as closely as possible the earliest immigration into the Americas, 2) samples from refugial areas would provide somewhat of a safeguard against admixture with more recent immigrants, 3) characteristics examined should be under relatively complete genetic control, and the selection of traits should consist of those which will discriminate between the populations in question (in this case between Caucasoid and Mongoloid groups), and 4) a populational rather than a typological approach is requisite.

These requirements are met in the following analysis of the dental morphology of the skeletal series from a Central Californian site, San Joaquin-68, which, although its antiquity is not remarkable (ca. 4,000 years B.P.), it is still the earliest series to meet the demands of sample size, geographically peripheral location, and sufficient preservation to afford the desired examinations. An alternative, the much earlier (pre-Anathermal ?) series from the Tranquillity site (Fre-48), California, reported by Angel (1966) is too small (two fairly complete skeletons and altogether about a dozen individuals represented), and the dentition is in extremely poor condition.

It will be noted that this method of utilizing appropriate skeletal material and traits possessing strong genetic components was proposed by Birdsell as an approach "... pertinent to the solution of American Indian origins" (1951:55). Specifically, Birdsell even lists nine dental characteristics which he notes to be "promising phenotypic traits" (1951:56). The utility of the dentition for the identification of microevolutionary changes has been discussed elsewhere (Turner, 1969).

MATERIAL AND METHODS

SJo-68, the Blossom Site, has been described by R. F. Heizer (1949) and Ragir (1972) as a single-component, Early Horizon habitation site. The low-lying midden is situated on an alluvial plain, south of the Mokelumne River and northwest of the town of Thornton.

Radiocarbon dating of a combined sample of scattered bits of burnt wood screened from the midden (C-440 and C-522) place the occupation of the site at 4052 ± 160 radiocarbon years B.P. A sample of calcined and carbonized human bone (M-647) was radiocarbon dated at 4350 ± 250 years B.P. (Heizer, 1958). More recently, Ragir (1972) has reported dates calculated from human bone collagen. An untreated sample (I-2749a) dates as 3585 ± 110 B.P., and two samples, each treated overnight with two-molar sodium hydroxide, date at 3775 ± 160 B.P. (I-2479b) and 2980 ± 110 B.P. (I-3038).

The first two of these three collagen dates are from four feet below present ground surface while the third is from one foot below the surface (Ragir, 1972:32).

These dates and the associated artifacts (Beardsley, 1948; Ragir, 1972) place SJo-68 in the Windmiller Culture of the Californian Early Horizon. Ragir states that the known Windmiller Culture sites range between three and four thousand years B.P. (1972:121-123) which is more conservative than the earlier estimate of four to seven thousand years ago made by Heizer and Cook (1949).

The data of this report are from 27 individuals out of a total of 188 individuals and at least five cremations (Ragir, 1972:163-166). Selection was based only on the preservation of teeth, and, as is crucial in many prehistoric Californians (see Leigh, 1928; Kennedy, 1960; Molnar, 1971), individuals without extensive pre-mortem tooth loss and/or extreme attrition (which often removes all of the tooth above the cingulum). Table 1 lists the sex and age distribution of the usable sample.

The traits examined and their grading scales are those established in the literature. Data collection was accomplished through visual and hand lens examination of the teeth with constant comparison of the traits against standardized plaques. All observations were made by one of us (CGT). No metrical traits were examined.

Using chi-square analysis none of the traits exhibit sexual dimorphism significant at the 0.05 level. All data are presented with the sexes (male, female and unknown) pooled, and, unless noted, all counts are of teeth, not individuals, a procedure necessitated by the sample's condition.

SJo-68 DENTAL MORPHOLOGY

1. Incisors. A. Hrdlička was the first (1907:55; see also Hrdlička, 1920 and 1921) to comment that the incidence of maxillary incisor lingual shoveling in American Indians, as in Mongoloid populations in general, is essentially unity. Table 2 indicates that shoveling is in high frequency in the SJo-68 series and thus fits the Mongoloid dental plan per this trait. This incidence is close to that of more recent American Indian series such as prehistoric Texas Indians where stronger maxillary central incisor shoveling grades are also 100 per cent (n = 124 individuals) (Goldstein, 1948:70), Indian Knoll's 100 per cent (n = 30 individuals) (Dahlberg and Snow, in Dahlberg, 1951:144), and the Papago of Arizona with 100 per cent shoveling

(n = 198 individuals) (D. H. Morris, 1965:116). In South America the prehistoric Atacama all possessed shoveling (n = 17 individuals) (DeVoto and Arias, 1967:1478), and living Pewenche Indians in Chile have 95 per cent shoveling (n = 60 individuals) (Rothhammer et al. 1968:163).

In the mandible, where the degree of lingual marginal ridging is always less developed than in the maxillary teeth (Carbonell, 1963), the frequency of some shoveling expression for the SJo-68 series is still high, 93.8 per cent (15/16) in the central incisors and 90.0 per cent (18/20) in the laterals.

The degree of lingual shoveling is also noteworthy. In the maxilla, two-thirds (10/16)of the teeth exhibit full shoveling while the other third (6/16) possess semi-shoveling (Table 2). This is in contrast to the distribution in Caucasoids (here an American White [Mediterranean Caucasoid] series described by Hrdlička, 1920:452) where full-shoveling is a mere 1.1 per cent (8/742 individuals) and semi-shoveling is only 5.8 per cent (43/742 individuals). Although a quarter of this White sample (23.7%, 176/742 individuals) has trace shoveling, this still leaves over half (69.4%, 515/742) of these Caucasians with no lingual ridging.

Given the simple models proposed for the inheritance of lingual shoveling (e.g. Abrahams, 1949; Turner, 1969), it seems quite likely that, if present, a genetic contribution from a Caucasoid population would be apparent in a descendant series (e.g. SJo-68) due to random recombination of the alleles for this trait. Nor is the absence of shoveling detectable in the upper central incisors even when larger, though more recent samples of American Indians without European admixture are examined.

Alternatively, if lingual shoveling is a quasi-continuous trait under polygenic control (e.g. Scott, 1972, 1973), then gene flow between Caucasoid and Mongoloid peoples would reflect itself in a lowered incidence of full shoveling in the descendent Mongoloid groups in the Americas. This is not, however, what is observed in the SJo-68 sample.

Campbell notes that shoveling "... is by no means a characteristic of the Australian's teeth" (1925:28). Riesenfeld (1956) found no cases of full shoveling in Australians (n = 47 incisors). Barksdale (1972) did not encounter any cases of full shoveling in his study of six Papuan groups (n = 279 individuals) from New Guinea, and semi-shoveling was consistently less than ten per cent for these Melanesians.

The labial surfaces of the incisors in the SJo-68 series also exhibit marginal ridging (Table 2), a feature seldom seen in Europeans. In the mandible, only the mesial labial borders of the lateral incisors possess this trait (15%, 3/20), but in the maxilla, all of the available teeth possess either labial shoveling of the mesial border (50%, 4/8) or ridging of both the mesial and distal borders (50%, 4/8).

Four grades of medial lingual ridges were tabulated for the incisors (Table 3). Most of the incisors (75%, 39/52) lack lingual ridges. When present, though, they are much more common on central (7/8) than on lateral incisors (1/8) in the maxilla, while the reverse is true for the mandibular incisors. The presence of multiple ridges seems to be confined to the maxillary centrals, but none of the teeth examined have more than two medial lingual ridges. No lingual tubercles were found.

The position of the central incisors could be examined in eight maxillary arcades (Table 4). Incisor winging, the mesial rotation of the incisors (Enoki and Dahlberg, 1958), is 12.5 per cent (1/8 individuals) in this small sample. Dahlberg comments that, "The frequencies [of winging] vary from 22 to 38 per cent among Indian tribes, but drop to 10 per cent for Japanese and to 3 per cent for Chicago Whites" (1963:156, see also Scott, 1973:190). The SJo-68 frequency is closer to the Mongoloid than to the Caucasoid frequencies.

2. Canines. The only trait scored on the canine is the tuberculum dentale. This term is used here in a broad sense to refer to "... any pronounced single or multiple tubercle or cusp with a free apex that occurs on the lingual surface of maxillary incisors and canines" (Turner, 1967:39). In the SJo-68 series (Table 5), the occurrence of such tubercles is similar to that of other American Indians, 20 per cent (9/45). Except for Arctic populations where the incidence of tuberculum dentale is low (less than 10%, Turner, 1967:45; see also Moorrees, 1957:26), this trait does not appear to characterize any particular geographic group; frequencies of the tubercle are generally less than 25 per cent. As in the SJo-68 series, the incidence of tuberculum dentale is typically higher on the canine than on either of the maxillary incisors.

3. Premolars. The features of the mandibular first and second premolars are scored by the criteria of Kraus and Furr (1953) and Ludwig (1957) respectively. No traits were scored on the maxillary premolars.

The modal form of the lower first premolar (Table 6) is: One external lingual groove, an uninterrupted sagittal sulcus with two occlusal pits and an independent apex on the deuteroconid, just one lingual cusp which is situated mesially, and the medial occlusal ridge is not bifurcated.

The second lower premolar (Table 7) has this modal form: Both a mesial and a distal accessory occlusal ridge and a divergent medial-occlusal ridge on the protoconid; the lingual cusp is mesial and independent of the buccal cusp; the sagittal sulcus is interrupted, and the multiple cusp, when present, is distal to the deuteroconid.

There is essentially no comparative data for $P\overline{2}$, but four studies involving five different ethnic and geographic groups have followed Kraus and Furr's scheme for the lower first premolar. D. H. Morris (1965) presents data for the living Papago of Southern Arizona and for the skeletal series from Pecos Pueblo, New Mexico; Turner (1967) studied Eskimo skeletal series (Kodiak Island, Arctic Coast, Sadlermiut, and Greenland), Aleut series, and northern Indians (Southeast Alaska and Arctic Interior); Turner and Scott (1973) describe the premolars of living Easter Islanders, and Harris *et al.* (n.d.) provide data on living Yap Islanders, Micronesia. Although minor variations exist in the number of traits examined, it is of interest that the modal condition for the morphology of P1 in each of these seven series is the same as that stated above for the SJo-68 sample in spite of potential sampling or inter-observer error. All of these seven are Asian or Asian-derived series, though, and it may be this consideration rather than any inherent lack of variation in the lower first premolar that accounts for the lack of discriminatory power for the traits examined. Certainly, much more work needs to be done in dental anthropology on non-Mongoloid populations.

4. *Molars*. Considering the maxillary molars first, the variation in hypocone size is presented in Table 8. The SJo-68 series nicely demonstrates the field effect (*e.g.* Dahlberg, 1951, 1963) for increasing reduction and loss of the hypocone from the first to the third molars. The first molar has an incidence of unity (32/32) for the full-size hypocone (grade 4) while the second molar typically exhibits a reduced hypocone (grade 4-), and the third molar possesses both the smallest hypocones and the greatest variability in types of expression. These general conditions are typical of all human populations, but there is a more than usual retention of the full-size hypocone on the first molar in this sample (*cf.* Scott, 1973:178).

The observed variation in Carabelli's trait is given in Table 9. As is typical of several Mongoloid series studied, and in contrast to Caucasoid samples, the SJo-68 molars do not commonly possess actual cusps, although the frequency of the complete complex is fairly high (80% for M1 and 96% for M2) as with other American Indian series.

The protostylid complex was scored for the lower molars (Table 10). The frequency of this trait (*ca.* 22% for M1) is somewhat higher than for that reported for Southwest Indians (Scott, 1973:206), for Eskimo and Aleut (Turner, 1967), and for Pacific Islanders (*e.g.* Turner and Scott, 1973; Harris *et al.*, n.d.). However, the SJo-68 frequencies for the protostylid complex of the three molars are closer to these Mongoloid groups than for the sketchily known Caucasoid groups.

Lower molar cusp number in this series (Table 11) exhibits the typical influences of the field effect. Retention of five cusps is the mode for the first (96%) and second (82%) molars while the frequency is low in the third molars.

The habitual retention of five cusps on M1 makes this trait of little interest for between-group comparisons, but the variability on the second molar suggests that the SJo-68 series aligns with the Mongoloid in contrast to Caucasoid or Negroid groups. In these latter two geographic races, the incidence of five cusps on M2 is well below one-third (*e.g.* Jørgensen, 1955: Table 5; Scott, 1973:Table 66) while the frequency in Mongoloid groups appears to be over one-half and is commonly in excess of three-fourths of all individuals (or teeth) examined.

Mandibular molar groove pattern likewise exhibits less inter-group variation on the first than on the second or third molar. In the SJo-68 series (Table 12), the Y cusp pattern (occlusal contact between cusps 2 and 3) on M2 and M3 is uncommon. The low frequency is not uncommon in Mongoloid populations, but Caucasoid and, to a lesser extent, Negroid groups typically retain the phylogenetically more ancient Y pattern to a greater degree on these posterior molars.

Scoring the molars for the occurrence of supernumerary cusps, the incidence of cusp 5 on the maxillary molars is 10.5 per cent on $M\underline{1}$ (4/38) and absent on the second (0/24) and third (0/16) molars. Cusp 6, the "entoconulid," on the lower molars is moderately common on the first (8.8%, 3/34) and second (8.7%, 2/23) molars, but was not found on the third molar (0/22). Cusp 7, the "metaconulid," occurs on 5.9 per cent (2/34) of the lower first molars, but not on the second (0/23) or third (0/22).

Molar enamel extensions, the deflection of the enamel border on the buccal aspect of the crown-root junction, are common in the SJo-68 series (Table 13), ranging from 75 per cent ($M\overline{1}$) to unity ($M\underline{2}$). Comparison with Danish series (Pedersen and Thyssen, 1942 cited in Pedersen, 1949; Jørgensen, 1956) and an American White series (Chappel, 1927) suggest that enamel extensions, notably the marked forms, are uncommon in Europeans while being reasonably common in the New World.

5. *Rare morphological variants*. Table 14 presents the incidence of nine features which may be under essentially genetic rather than environmental control. Too little data are available to allow any meaningful comments on their anthropological significance, however.

6. *Root configurations*. Tables 15 and 16 present the root numbers and forms found in the SJo-68 series for the upper and lower arcades respectively. The classification is that originated by Turner (1967:133-152). As defined here, a root is independent of other roots for at least half of its overall length. A radical (or 'partial root') is free for less than half of its total length or may not even possess an independent apex, being recognized only by its elevated contour as seen in cross section. This scoring procedure differs from that used by some (*e.g.* Alexandersen, 1963) which equates root apices with root number.

Because most of the studies have been done on living subjects without benefit of radiography and because most workers dealing with skeletal series or samples of extracted teeth have ignored the roots, this discussion must be essentially descriptive. Some of the exceptions are Pedersen's work on the East Greenland Eskimo (1949), papers by Tratman (1938) and Turner (1971) which are concerned with three-rooted mandibular first molars, and the work by Alexandersen (*e.g.* 1963) on double-rooted lower canines.

One example of a three-rooted mandibular first molar (3RM1) occurs in the SJo-68 series (Table 16) yielding a sample frequency of 4.5 per cent. This incidence compares well with other American Indian samples (mean = 5.9%, excluding Eskimo-Aleuts and Navajos), but stands in contrast to the lower incidence in the Negroid (absent) and Caucasoid (mean = 1.1%) samples studied to date (see Turner, 1971).

No example of two-rooted lower canines was found.

7. Additional observations. The size and incidence of the palatine and mandibular tori were recorded for the SJo-68 series (Tables 17 and 18 respectively). To date, only the high frequency of very pronounced tori among Eskimo groups has been recognized as of discriminatory utility in inter-group studies (*cf*. Hrdlička, 1940; Woo, 1950; N. T. Morris, 1970). As noted by Moorrees, only additional studies (and new techniques or procedures ?) will reveal whether the observed variations are "incidental or part of a geographic pattern" (1957:61).

The incidence of congenital absence of third molars is 3.3 per cent (2/61) as a tooth count and 5.9 per cent (1/17) as an approximate individual count.

No example of cosmetic or craft-related tooth modification was found. As already noted, though, occlusal attrition is severe in this series (*cf*. Leigh, 1928; Molnar, 1971).

PREHISTORIC AFFINITIES

In addition to the remarks on inter-group comparisons in the above descriptions, we have compared the SJo-68 dental series to select groups from the New and Old Worlds in order to estimate morphological relationships with this early New World sample. Two problems occur: Small sample sizes may produce spurious similarities or differences, especially when dealing on a subspecific level, and, two, inter-observer differences caused by the absence of agreed upon standards have often resulted in false interpretations of relationship. Phylogeny is also confounded by genetic adaptation of the individual populations to their specific environments subsequent to their biologic separation from other groups, although this has not yet been demonstrated for the dentition. Table 19 presents dental trait frequencies for seven series in addition to the SJo-68 data.

The Sakhalin Ainu are presented here as a putative example of archaic Caucasoids which emigrated from the Southeast Asian source of this race. The Ainu have been the subject of countless arguments both for and against their archaic Caucasoid affiliation. Birdsell stated that the Ainu are "closely related" to the eastern branch of the Caucasoid race (1951:12), and he has remained firm in this opinion (*e.g*. Birdsell, 1972:499-500). Others have argued that the Ainu are reasonably within the range of Mongoloid variation, and simply evidence extremes for some few traits (*e.g*. facial and body hair). Two studies on the Ainu dental morphology are available, one by Suzuki and Sakai (1957) which is based on a small series of morphologically and culturally pure Ainu, and the second by Hanihara (1973) is an analysis specifically aimed at testing the non-Caucasoid (and non-Amurian) nature of the Ainu.

Relative to the SJo-68 sample, I2 lingual shoveling is more common in the Ainu, although both groups lack examples of trace- and no-shoveling. This grade distribution is in the direction of intensification of this Mongoloid dental feature, which, of course, is most pronounced in certain American Indian groups living today. The Ainu exhibit an intermediate frequency of the cusp of Carabelli (*i.e.* the forms with free apices) on M1 and may lack actual cusps on M2; Hanihara reports a frequency of 9.5 per cent (10/105 individuals) for living Ainu (1973:Table 2). The low but positive incidence of protostylid *tubercles* on M1 conforms to known Mongoloid samples. The Ainu possess a greater incidence of six-cusped M1 than the SJo-68 series, or, for that matter, any of the other groups in Table 19. This is probably not just a function of sample size because Hanihara (1973) reports an incidence of 26.6 per cent (21/79 individuals). Palatine and mandibular tori appear more commonly in the Ainu than in the SJo-68 series. Upper central incisor shoveling and the frequency of large hypocones on M1 are similar to those in SJo-68, but there is a more pronounced trend towards the loss of the hypocone on M2 (as with most groups) among the Ainu than that evidenced in the SJo-68 sample.

The dental plan of the Ainu lends no support to the view that these people are Caucasoid. The problem exists that genetic changes through time may have occurred so that the living Ainu are different (*i.e.* more Mongoloid) in their dental form than their potential archaic ancestors. Examinations of the osteology (Yamaguchi, 1967), dermatoglyphics (Kimura, 1962), and serologic polymorphisms (Omoto, 1972) do not support such an interpretation, however.

Analysis of a larger, prehistoric sample of the Ainu dentition would help to further clarify this problem; there does not appear to be any difficulty distinguishing these people from the present, Japanese inhabitants (Howells, 1966). Now, though, we simply note that the SJo-68 series is similar to the Ainu only insofar as both series reflect Mongoloid dental characteristics, and, interestingly, the differences (*e.g.* I2 shoveling, protostylid tubercles) are due to the Ainu expressing the Mongoloid plan more intensely; hypocone reduction is the only, tentative, exception for the traits examined.

Descendants of the Amurians are represented by the Australian Aborigines. (That is, Birdsell suggested that the Australians are descended in part from the Murrayians who shared a common ancestry with the Amurians.) Both the Australians and the SJo-68 sample appear to have a strong retention of full-size hypocones on M1, a tendency which contrasts with the direction in which American Whites (Mediterranean Caucasoids) have evolved. The Australians are also notable in their retention of the hypocone on M2 and M3, perhaps as a selective response to their need for greater tooth mass (*cf.* Molnar, 1972). As noted below, though, this apparent need for tooth mass is not evidenced in the lower molars where the Australians and some other groups have not retained the hypoconulid, especially on M2. The teeth are large in size, though. The Australian sample is similar to SJo-68 in its low incidence of palatine and mandibular tori, particularly when one considers the larger grades, but is quite distinct in its high frequency of Carabelli's cusp on M1.

Riesenfeld (1956) provides data on maxillary incisor shoveling for Oceanic groups wherein he notes that the Australians have 64 per cent shoveling (51% trace and 13% semi) in a sample of 47 teeth (22I1 + 25 I2). This suggests that the archaic Caucasoids are considerably closer to the Mongoloid pattern of shoveling than to that of the Mediterranean branch, but they are not similar or truly intermediate to the grade distribution in the SJo-68 sample.

Insofar as the Australians are the best example of the archaic Caucasoid branch referred to by Birdsell, it is unfortunate that a more recent study with more comparable analysis is not available for their dental morphology than Campbell's pioneering work (1925). Hanihara's brief analysis (1973) does suggest that the Australians are relatively unlike the Asiatic and New World groups studied to date. It has long been recognized that the Mediterranean Caucasoids have followed a different evolutionary track and are, therefore, not nearly as useful for the purposes of these comparisons (*e.g.* Birdsell, 1951:14).

As the evidence stands, there is no good case for a phylogenetic relationship between the Australian Aborigine and the American Indian. Similar frequencies obtain for the mutual absence of moderate and large grades of mandibular and palatine tori, but the dental evidence provides several distinctions: Australians have almost no incisor shoveling (and no marked examples), Carabelli's cusp is much more common, as is reduction of cusp number on $M\overline{1}$, and there is a greater retention of the hypocone.

The recently studied group of American Whites (Scott, 1973) is the most directly comparable data on the Mediterranean Caucasoids (this particular sample is from California and Arizona). Additional data on a variety of Southeastern European Whites has recently been reported by Kochiyev (1973). The striking differences relative to the SJo-68 series is the absence of moderate and pronounced grades of incisor shoveling, simplification of the Caucasoid maxillary molars evidenced by the reduction of the hypocone on $M\underline{1}$ and $M\underline{2}$, and the *relatively* high incidence of an actual cusp of Carabelli. Although the frequencies for cusp number are close to SJo-68 for $M\overline{1}$, the Whites are noted, as are the Australians, for the absence of the hypoconulid on the lower second molars compared to Mongoloid groups. At least for the first molar, the SJo-68 series exhibits a greater incidence of actual tubercles at the protostylid sites than do the Whites. In all, the Mediterranean Caucasoids are quite distinct, and these comparisons agree with the suggestion by Thoma (1973) that the Mongoloids represent an early separation onto a separate evolutionary track, probably during the Neandertal stage.

The Papago, a Sonoran desert Uto-Aztecan group in Southern Arizona, are presented here as an Indian group which appears to have occupied the same geographic area for several millenia. Compared to this early California series, the Papago possess very similar grade distributions of lingual shoveling in both $I\underline{1}$ and $I\underline{2}$. A different grading procedure for the grade 4 hypocone is responsible for the frequencies being considerably different in these Papago; the biologically similar Pima Indians do not express any notable difference to the SJo-68 sample except for a higher frequency of three-cusped $M\underline{2}$ (19%, 36/182 individuals) when Dahlberg's scale is used (see Dahlberg, 1951:165-166). The Papago exhibit relatively high frequencies of Carabelli's cusp (*i.e.* with a free apex) which is roughly twice that of even the White series, suggesting a possible trend towards increasing tooth mass or complexity. In contrast, there is a reduction in molar size in the Papago as seen in the higher frequency of absence of the fifth and sixth cusps in the Papago $M\overline{1}$ and $M\overline{2}$ relative to SJo-68; in this latter feature, the Papago approximate the Caucasoid condition. The molar groove patterns of the

Papago are more like the SJo-68 condition than like Whites. No protostylid cusps appear to occur in the Papago.

The Hopi are also a Uto-Aztecan group with considerable antiquity in their homeland of Northeastern Arizona (*e.g.* Seltzer, 1944), but these people occupy a higher, wetter and colder ecologic setting than do the Papago. The Hopi exhibit lower incidences of the extreme form of incisor shoveling relative to SJo-68 and other American Indian groups in Table 19, but clearly do not align with the Caucasian examples. Although the distribution of hypocone forms on M1 is similar between the Hopi and SJo-68, M2 exhibits an appreciable reduction in hypocone size relative to SJo-68 and is even more extreme in this respect than the American White series. For the other traits in Table 19, the Hopi series is not readily distinguished from the other samples.

The Navajo represent a recent Athapascan immigration into the American Southwest and possibly are *relatively* recent to the New World. This particular sample was collected at Keams Canyon (Hopi Reservation), Arizona, which, because of admixture, may account for its gross similarity to non-Athapascan Southwest groups. Upper incisor shoveling is clearly Mongoloid, but is not notable relative to other American Indian groups. As seen in the other native groups, the Navajo do not exhibit the strong retention of large hypocones on the molars. The Navajo and Hopi series both indicate somewhat higher frequencies of actual cusps at the Carabelli and protostylid sites than do the Caucasian samples.

The Aleut, along with the Eskimo, are possibly the most recent pre-Columbian immigrants into the New World, and, as such, are suggested to best approximate the nature of Northeastern Siberian dentitions. The Aleuts do not exhibit the high incidence of full shoveling characteristic of American Indians, including SJo-68, but there is also an absence of non-shoveling in these Arctic Mongoloids. The distributions of the hypocone form is similar to SJo-68 for M1 and M3, but cusp four reduction is more pronounced on M2 for the Aleut. Carabelli's cusp is conspicuous by its absence, but the protostylid cuspule is, relatively, not uncommon in this northern series. Cusp number in the Aleuts tends toward increasing (or at least not reducing) tooth mass; possession of five- and six-cusped molars is more common in the Aleut M1, notably so for M2.

The characteristics of Mongoloid and Caucasoid dental features differentiate from one another rather clearly (Table 19), but, since it is the relative proportions within the grade distribution per trait which best distinguishes these groups, rather than specific percentages, it is not possible to state unequivocally that there is no archaic Caucasoid component in the SJo-68 sample, or, by extension, other American Indian groups. By the same token, however, Birdsell's model contends that, if present, a Caucasoid element should manifest itself more clearly in this temporally early, marginal series than in, say, living series of American Indians. Using the approach suggested to be ". . . pertinent to the solution of American Indian origins" (Birdsell, 1951:55), the parsimonious conclusion is that the Asian immigrants into North America were sufficiently within the known range of Mongoloid dental variation to exclude the need for assuming any Caucasoid element.

SUMMARY AND CONCLUSIONS

Temporal and spatial limitations, in addition to the biologic evidence itself, strongly mitigates against the possibility of racial groups other than archaic Caucasoid and Mongoloid immigrating into the New World prehistorically. The Asian origin of the American Indian is without question, but whether there was also a Caucasoid contribution has not been adequately determined. Birdsell's delineation of some somatic traits which are in low frequency in some Indian groups and which are common in modern Caucasian populations has been cited as *a priori* evidence of such a non-Mongoloid component.

The present study describes and compares the dental morphology of an Early Horizon California skeletal series dating *circa* 2,000 B. C. This description is of value in its own right, but, of equal interest, the SJo-68 series does not exhibit any recognizable Caucasoid component.

It may be argued that this series is simply too recent and that the many millenia between the peopling of the New World and the occupation of SJo-68 was more than sufficient to dilute the Amurian characteristics beyond recognition. A review of the dental morphology of the isolated early man finds from both Northeast Asia and from North and South America indicates that this is not the case. Although the details are beyond the scope of this paper, examination of the literature devoted to early man skeletal descriptions (*e.g.* Jenks, 1936; Black and Eyman, 1963; Anderson, 1965; Angel, 1966; Romano, 1970; Breternitz *et al*., 1971) shows that the Mongoloid rather than the Caucasoid dental complex (see Hanihara, 1967) is manifest in all prehistoric American Indians. This is to say that, as in SJo-68, the Mongoloid dental complex has 1) a high frequency of lingual shoveling on $I\underline{1}$ and $I\underline{2}$, 2) a high frequency of the protostylid complex (when all grades are considered), and 3) a low incidence of actual *cusps* of Carabelli. Additionally, the SJo-68 series is characterized by retention of large hypocones on $M\underline{1}$, some protostylid cuspules, relatively common incisor winging, and the occurrence of 3RM1. All of these features stand in significant contrast to the Caucasoid dental plan.

Finally, even though no recognizable Caucasoid element can be found in the SJo-68 dental series, the contention may be made that the authors are "easy evolutionists" (*cf*. Birdsell, 1972:499) in that they rely on a parsimonious interpretation of the data. This is indeed true, and it has already been mentioned that the use of epigenetic traits which vary in proportion instead of simple occurrence prevents absolute proof of a single biologic origin of the American Indian. There are also the questions of how much gene flow from a non-Mongoloid source could have occurred and yet go undetected, and, secondly, what influence the actual movement of people into North America through the so-called "Arctic filter" had on either the diminution or the accentuation of non-Mongoloid characteristics. It is possible, then, that a proportionately insignificant non-Mongoloid genetic contribution, if indeed it existed, will not be found in the New World simply because it was selected out as the aboriginal immigrants crossed the Bering Platform to North America.

In any event, there is no evidence of it either in the subfossil record of modern man in northeastern Asia or in the New World, and the biologic evidence of this early California series points entirely towards an immigration of only Mongoloid peoples.

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Table 1

Distribution of SJo-68 Sample by Age and Sex

Age	Male	Female	Sex uncertain	M+F+? n	%
Infant (x-3 yrs.)	0	0	1	1	3.7
Child (4-6)	1*	0	3	4	14.8
Child (7-12)	0	0	5	5	18.5
Adolescent (13-17)	3	1	3	7	25.9
Subadult (18-20)	0	3	0	3	11.1
Young Adult (21-35)	2	1	0	3	11.1
Middle Aged (36-55)	2	2	0	4	14.8
Totals	8	7	12	27	

*Sex based on very large size of erupting first permanent molars.

Table 2

Incisor Shoveling Variation
(Tooth count, sexes pooled)

	Maxilla				Mandible			
	Central		Lateral		Central		Lateral	
Degree of Shoveling	n	%	n	%	n	%	n	%
Lingual surface*								
None	0/16	0.0	0/15	0.0	1/16	6.2	2/20	10.0
Trace	0/16	0.0	0/15	0.0	12/16	75.0	15/20	75.0
Semi-Shovel	6/16	37.5	8/15	53.3	3/16	18.8	3/20	15.0
Shovel	10/16	62.5	7/15	46.7	0/16	0.0	0/20	0.0
Barrel	0/16	0.0	0/15	0.0	0/16	0.0	0/20	0.0
Labial surface								
Mesial labial Shovel	4/8	50.0	7/9	77.8	0/16	0.0	3/20	15.0
Distal labial Shovel	0/8	0.0	0/9	0.0	0/16	0.0	0/20	0.0
Double Shovel	4/8	50.0	2/9	22.2	0/16	0.0	0/20	0.0

*After A. Hrdlička, 1920

Table 3

Incisor Medial Lingual Ridge Number
(Tooth count, sexes pooled)

Number of Medial Lingual Ridges*	Maxilla						Mandible					
	I1		I2		Total		I1		I2		Total	
	L	R	L	R	(Maxilla)	Percent	L	R	L	R	(Mandible)	Percent
No Lingual Ridges	3	3	7	5	18/26	69.2	6	7	3	5	21/26	80.8
One " "	1	2	0	1	4/26	15.4	0	0	3	2	5/26	19.2
Two " "	2	2	0	0	4/26	15.4	0	0	0	0	0/26	0.0

*After C. Turner, 1967

Table 4

Maxillary Central Incisor Rotation
(Individual count, sexes pooled)

	Individuals	
Form of Winging*	n	%
Bilateral	0	0.0
Unilateral	1	12.5
Straight (none)	7	87.5
Unilateral Counter-winging	0	0.0
Bilateral Counter-winging	0	0.0
Total	8	100.0

*After K. Enoki and A. A. Dahlberg, 1958.

Table 5

Tuberculum Dentale*
(Tooth count, sexes pooled)

Tooth, maxilla	Left	Right	Sides Pooled	Percent
Canine	2	2	4/12	33.3
Lateral incisor	1	2	3/17	17.6
Central incisor	1	1	2/16	12.5

*After C. Turner, 1967.

Table 6

Mandibular First Premolar Variation
(Tooth count, sexes pooled)

Characteristic*	First Left	Premolar Right	Sides Pooled	Percent
1a. No external lingual groove	4	2	6/15	40.0
1b. One external lingual groove	5	4	9/15	60.0
1c. Two external lingual grooves	0	0	0/15	0.0
2a. Interrupted sagittal sulcus	8	8	16/16	100.0
2b. Uninterrupted sagittal sulcus	0	0	0/16	0.0
3a. Lingual cusp is mesial	6	7	13/16	81.2
3b. Lingual cusp is distal	0	0	0/16	0.0
3c. Lingual cusp is medial	2	1	3/16	18.8
4a. One lingual cusp	7	7	14/16	87.5
4b. Two lingual cusps	1	1	2/16	12.5
4c. Three lingual cusps	0	0	0/16	0.0
4d. Four lingual cusps	0	0	0/16	0.0
5a. Single medial occlusal ridge, buccal cusp	3	1	4/4	100.0
5b. Divergent medial occlusal ridge, buccal cusp	0	0	0/4	0.0
6a. One occlusal pit	2	1	3/16	18.8
6b. Two occlusal pits	6	7	13/16	81.2
7a. Fused lingual and buccal cusp	6	8	14/16	87.5
7b. Independent lingual and buccal cusp	2	0	2/16	12.5

*After B. S. Kraus and M. L. Furr, 1953.

Table 7

Mandibular Second Premolar Variation
(Tooth count, sexes pooled)

Characteristic*	Second Premolar Left	Second Premolar Right	Sides Pooled	Percent
1a. One distal accessory ridge, buccal cusp	0	0	0/8	0.0
1b. One mesial accessory ridge, buccal cusp	0	1	1/8	12.5
1c. Mesial and distal accessory ridge	3	4	7/8	87.5
2a. Single occlusal ridge, buccal cusp	0	2	2/6	33.3
2b. Divergent occlusal ridge, buccal cusp	2	2	4/6	66.6
3a. Lingual cusp is medial	0	3	3/13	23.1
3b. Lingual cusp is mesial	5	4	9/13	69.2
3c. Lingual cusp is distal	0	1	1/13	7.7
4a. One lingual cusp	3	3	6/10	60.0
4b. Two lingual cusps	1	3	4/10	40.0
4c. Three lingual cusps	0	0	0/10	0.0
5a. Lingual cusp is independent	4	5	9/10	90.0
5b. Lingual cusp is fused	0	1	1/10	10.0
6a. Multiple lingual cusp is medial	0	0	0/4	0.0
6b. Multiple lingual cusp is distal	1	2	3/4	75.0
6c. Multiple lingual cusp is mesial	0	1	1/4	25.0
7a. Sagittal sulcus is interrupted	2	3	5/9	55.6
7b. Sagittal sulcus is not interrupted	1	3	4/9	44.4

*After F. J. Ludwig, 1957.

Table 8

Maxillary Molar Cusp Patterns
(Tooth count, sexes pooled)

		4		4-		3+		3	
Tooth	Grade*	n	%	n	%	n	%	n	%
M1		32/32	100.0	0/32	0.0	0/32	0.0	0/32	0.0
M2		0/22	0.0	19/22	86.4	3/22	13.6	0/22	0.0
M3		1/14	7.1	1/14	7.1	5/14	35.7	7/14	50.0

*After A. A. Dahlberg, 1951.

Table 9

Carabelli's Trait
(Tooth count, sexes pooled)

	M1		M2	
Form*	n	%	n	%
Smooth	5/25	20.0	23/24	95.8
Furrow	0/25	0.0	0/24	0.0
Pit	10/25	40.0	1/24	4.2
Double Furrow	3/25	12.0	0/24	0.0
"Y" Form	6/25	24.0	0/24	0.0
No Contact with Lining Groove	0/25	0.0	0/24	0.0
Small Contact with Lining Groove	0/25	0.0	0/24	0.0
High Cone	1/25	4.0	0/24	0.0

*After A. A. Dahlberg, 1963, and elsewhere.

Table 10

Protostylid Variation
(Tooth count, sexes pooled)

	M1		M2		M3	
Grade*	n	%	n	%	n	%
No cusp, straight buccal groove	19/28	67.9	17/26	65.4	10/16	62.5
No cusp, pit in buccal groove	8/28	28.6	9/26	34.6	2/16	12.5
No cusp, curved buccal groove	0/28	0.0	0/26	0.0	0/16	0.0
Small cusp, buccal groove just beginning	0/28	0.0	0/26	0.0	0/16	0.0
Slight cusp	1/28	3.5	0/26	0.0	0/16	0.0
Moderate cusp	0/28	0.0	0/26	0.0	0/16	0.0
Strong cusp	0/28	0.0	0/26	0.0	4/16	25.0

*After A. A. Dahlberg, 1963, and elsewhere.

Table 11

Mandibular Molar Cusp Number*
(Tooth count, sexes pooled)

	4		5		6	
Tooth	n	%	n	%	n	%
M1	0/23	0.0	22/23	95.6	1/23	4.4
M2	1/27	3.7	22/27	81.5	4/27	14.8
M3	6/23	26.1	8/23	34.8	9/23	39.1

*Modified after W. K. Gregory, 1916: see C. Turner, 1967 and elsewhere.

Table 12

Mandibular Molar Groove Patterns
(Tooth count, sexes pooled)

		Y		+		X		H	
Tooth	Pattern*	n	%	n	%	n	%	n	%
M1		21/23	91.3	2/23	8.7	0/23	0.0	0/23	0.0
M2		0/27	0.0	10/27	37.0	17/27	63.0	0/27	0.0
M3		0/23	0.0	3/23	13.0	17/23	73.9	3/23	13.0

*After W. K. Gregory, 1916; M. Hellman, 1928; and K. D. Jørgensen, 1955.

Table 13

Molar Enamel Extension Variation
(Tooth count, sexes pooled)

	Maxilla						Mandible					
	M1		M2		M3		M1		M2		M3	
Grade*	n	%	n	%	n	%	n	%	n	%	n	%
No line	4/35	11.4	0/19	0.0	2/9	22.2	6/24	25.0	3/24	12.5	1/12	8.3
Slight	18/35	51.4	2/19	10.5	2/9	22.2	6/24	25.0	7/24	29.2	2/12	16.7
Medium	4/35	11.4	3/19	15.8	1/9	11.1	0/24	0.0	4/24	16.7	3/12	25.0
Marked	9/35	25.7	14/19	73.7	4/9	44.4	12/24	50.0	10/24	41.6	6/12	50.0
Reversed	0/35	0.0	0/19	0.0	0/9	0.0	0/24	0.0	0/24	0.0	0/12	0.0

*After R. W. Leigh, 1930; and G. Lasker, 1950.

Table 14

Rare Morphological Variants
(sexes pooled)

Form of Variant*	Maxilla		Mandible		Pooled
	teeth	individuals	teeth	individuals	(teeth)
Occlusal Pits	8	5	16	8	24
Buccal Pits	0	0	13	6	13
Hypoplasia	0	0	5	3	5
Pegging of incisors	1	1	0	0	1
Supernumerary teeth	1	1	0	0	1
Crown Wrinkling	0	0	0	0	0
Gemmate	0	0	0	0	0
Odontomes	0	0	0	0	0
Triform (Lateral Incisors)	0	0	0	0	0

*After M. Diamond, 1952; P.O. Pedersen, 1949; and J. H. Scott and N.B. Symons, 1958.

Table 15

Maxillary Tooth Root Number and Root Configuration
(Tooth count, sexes pooled)

		I1		I2		C		P1		P2		M1		M2		M3	
Root Number	Configuration*	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	1 root no fusion	8	72.7	9	64.3	2	25.0	2	14.3	0	0.0	0	0.0	0	0.0	0	0.0
2	2 roots no fusion	0	0.0	0	0.0	0	0.0	1	7.1	1	10.0	0	0.0	0	0.0	0	0.0
3	3 roots no fusion	0	0.0	0	0.0	0	0.0	1	7.1	0	0.0	0	0.0	1	8.3	0	0.0
1	2 roots fused into one	1	9.1	2	14.3	3	37.5	8	57.1	8	80.0	0	0.0	0	0.0	0	0.0
1	3 roots fused into one	2	18.2	3	21.4	2	25.0	1	7.1	1	10.0	0	0.0	1	8.3	0	0.0
1	4 roots fused into one	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	0	0.0	3	25.0	2	66.7
2	2 roots fused, one free	0	0.0	0	0.0	0	0.0	1	7.1	0	0.0	0	0.0	1	8.3	0	0.0
3	2 roots fused, two free	-	-	-	-	-	-	-	-	-	-	4	50.0	4	33.3	0	0.0
3	3 roots fused, two free	-	-	-	-	-	-	-	-	-	-	0	0.0	1	8.3	0	0.0
3	2 roots fused, one free, two fused	-	-	-	-	-	-	-	-	-	-	3	37.5	0	0.0	0	0.0
2	2 roots fused, two fused	-	-	-	-	-	-	-	-	-	-	0	0.0	1	8.3	1	33.3
2	4 roots fused, one free	-	-	-	-	-	-	-	-	-	-	1	12.5	0	0.0	0	0.0
	Number of Teeth Examined	11		14		8		14		10		8		12		3	

*After C. Turner, 1967.

Table 16

Mandibular Tooth Root Number and Root Configuration
(Tooth count, sexes pooled)

		I1		I2		C		P1		P2		M1		M2		M3	
ot Number	Configuration*	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	1 root no fusion	10	62.5	0	0.0	0	0.0	0	0.0	10	66.7	0	0.0	0	0.0	0	0.0
1	2 roots fused into one	2	12.5	7	46.7	13	86.7	5	27.8	2	13.3	0	0.0	4	22.2	4	36.4
1	3 roots fused into one	2	12.5	8	53.3	2	13.3	12	66.7	3	20.0	0	0.0	3	16.7	0	0.0
1	4 roots fused into one	2	12.5	0	0.0	0	0.0	1	5.5	0	0.0	0	0.0	4	22.2	0	0.0
2	2 roots fused, one free	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	5.6	0	0.0
3	2 roots fused, one free, two fused	-	-	-	-	-	-	-	-	-	-	1	4.5	0	0.0	0	0.0
2	2 roots fused, two fused	-	-	-	-	-	-	-	-	-	-	14	63.6	6	33.3	7	63.6
2	2 roots fused, three fused	-	-	-	-	-	-	-	-	-	-	7	31.8	0	0.0	0	0.0
	Number of Teeth Examined	16		15		15		18		15		22		18		11	

*After C. Turner, 1967.

Table 17

Palatine Torus in SJo-68 Sample
(Individual count, sexes pooled)

Grade	Individuals n	Individuals %
Absent	15	75.0
Slight	5	25.0
Medium	0	0.0
Large	0	0.0
Very large*	0	0.0
Total	20	100.0

*As in some Eskimo

Table 18

Mandibular Torus
(Individual count, sexes pooled)

Grade*	Individuals n	 %
Absent	17/18	94.5
Very slight	1/18	5.5
Other	0/18	0.0

*After E. A. Hooton, 1918 and
N. T. Morris, 1970.

Caption
TABLE 19

Intergroup comparisons of morphologic dental traits. Trait selection is based on availability of data and between-observer comparability. Group selection is discussed in the text. Sexes are pooled in all samples. The SJo-68, Sakhalin Ainu, and Australian Aborigine series are tooth counts; the others are individual counts; only symmetric individuals are used for the Papago. Data sources: SJo-68 (present study), Sakhalin Ainu (Suzuki and Sakai, 1957), Australian Aborigine (Campbell, 1925), American White (Scott, 1973), Papago (D. H. Morris, 1965), Hopi and Navajo (Harris and Scott, 1972 and Scott, 1973), and Aleut (Turner, 1967). Grading scales: lingual shoveling (Hrdlička, 1920), hypocone size (Dahlberg, 1951), Carabelli's cusp (grades 6 and 7 of Dahlberg, 1963), cusp number (Gregory, 1916, Hellman, 1928 and Jørgensen, 1955), protostylid tubercle (grades 4, 5, and 6 of Dahlberg, 1963), palatine torus (Woo, 1950), mandibular torus (Hooton, 1918 and N. T. Morris, 1970). Frequencies equaling less than 100% indicate that additional variants were scored.

Table 19a

Tooth	Trait/ Grade	SJo-68		Sakhalin Ainu		Australian Aborigines		American Whites		Papago		Hopi		Navajo		Aleut	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
I1	Shoveling																
	absent	(16)	0.0	(17)	0.0	-	-	39	41.5	(184)	0.0	(164)	0.0	(135)	0.0	(48)	0.0
	trace	(16)	0.0	(17)	0.0	-	-	54	57.4	-	-	16	9.8	(135)	0.0	4	8.3
	semi	6	37.5	3	17.7	-	-	1	1.1	71	38.6	94	57.3	64	47.4	30	62.5
	full	10	62.5	14	82.3	-	-	(94)	0.0	113	61.4	54	32.9	71	52.6	14	29.2
I2	Shoveling																
	absent	(15)	0.0	(18)	0.0	-	-	21	40.4	10	6.6	4	2.4	1	0.6	(58)	0.0
	trace	(15)	0.0	(18)	0.0	-	-	31	59.6	-	-	22	13.1	11	6.9	2	3.4
	semi	8	53.3	2	11.1	-	-	(52)	0.0	76	50.0	73	43.5	81	50.9	21	36.2
	full	7	46.7	16	88.9	-	-	(52)	0.0	66	43.4	53	31.5	52	32.7	35	60.3
M1	Hypocone																
	4	32	100.0	23	92.0	83	94.3	97	89.8	46	27.4	155	90.1	140	89.7	80	93.0
	4-	(32)	0.0	2	8.0	5	5.7	11	10.2	122	72.6	16	9.3	14	9.0	6	7.0
	3+	(32)	0.0	(25)	0.0	(88)	0.0	(108)	0.0	(168)	0.0	(172)	0.0	1	0.6	(86)	0.0
	3	(32)	0.0	(25)	0.0	(88)	0.0	(108)	0.0	(168)	0.0	1	0.6	1	0.6	(86)	0.0
M2	Hypocone																
	4	(22)	0.0	1	7.1	200	96.2	12	11.5	(104)	0.0	9	5.5	9	6.0	4	3.6
	4-	19	86.4	8	57.1	8	3.8	58	55.7	33	31.7	83	50.6	54	36.2	16	14.4
	3+	3	13.6	1	7.1	(208)	0.0	5	4.8	41	39.4	39	23.8	51	34.2	56	50.5
	3	(22)	0.0	4	28.6	(208)	0.0	29	27.9	30	28.8	33	20.1	35	23.5	35	31.5
M3	Hypocone																
	4	1	7.1	-	-	111	71.2	-	-	-	-	(34)	0.0	(42)	0.0	(66)	0.0
	4-	1	7.1	-	-	9	5.8*	-	-	-	-	2	5.9	(42)	0.0	8	12.1
	3+	5	35.7	-	-	-	-	-	-	-	-	4	11.8	10	23.8	25	37.9
	3	7	50.0	-	-	36	23.0	-	-	-	-	27	79.4	28	66.7	33	50.0
M1	Carabelli's Cusp	1	4.0	2	13.3	20	33.3	27	24.3	68	42.8	6	4.0	1	0.8	(61)	0.0
M2	Carabelli's Cusp	(24)	0.0	(16)	0.0	-	-	1	1.0	9	6.8	1	0.7	(91)	0.0	(40)	0.0
M3	Carabelli's Cusp	-	-	-	-	-	-	-	-	-	-	(20)	0.0	(10)	0.0	-	-

Tooth	Trait/ Grade	SJo-68 n	SJo-68 %	Sakhalin Ainu n	Sakhalin Ainu %	Australian Aborigines n	Australian Aborigines %	American Whites n	American Whites %	Papago n	Papago %	Hopi n	Hopi %	Navajo n	Navajo %	Aleut n	Aleut %
M$\overline{1}$	Cusp Number																
	6	1	4.4	4	40.0	-	-	-	-	30	19.9	-	-	-	-	29	22.1
	5	22	95.6	5	50.0	83	94.3*	91	95.8*	120	79.5	115	99.1*	169	100.0*	102	77.9
	4	(23)	0.0	1	10.0	5	6.2	4	4.2	1	0.7	1	0.9	(169)	0.0	(131)	0.0
M$\overline{2}$	Cusp Number																
	6	4	14.8	-	-	-	-	-	-	11	10.3	-	-	-	-	25	22.7
	5	22	81.5	-	-	40	32.0*	18	17.8*	47	43.9	-	-	-	-	76	69.7
	4	1	3.7	-	-	85	68.0	83	82.2	49	45.8	-	-	-	-	9	8.2
M$\overline{3}$	Cusp Number																
	6	9	39.1	-	-	80	72.7*	-	-	-	-	-	-	-	-	15	30.0
	5	8	34.8	-	-	30	27.3*	-	-	-	-	-	-	-	-	28	56.0
	4	6	26.1	-	-			-	-	-	-	-	-	-	-	7	14.0
M$\overline{1}$	Groove Pattern																
	Y	21	91.3	6	60.0	-	-	9	81.8	47	92.2	34	75.6	48	78.7	80	64.5
	+	2	8.7	3	30.0	-	-	(11)	0.0	3	5.9	4	8.9	1	1.6	29	23.4
	X	(23)	0.0	1	10.0	-	-	2	18.2	1	2.0	7	15.6	11	18.0	15	12.1
	Hy	(23)	0.0	(10)	0.0	-	-	(11)	0.0	(51)	0.0	-	-	-	-	(124)	0.0
M$\overline{2}$	Groove Pattern																
	Y	(27)	0.0	-	-	-	-	2	10.5	1	3.4	4	11.8	4	6.7	16	13.9
	+	10	37.0	-	-	-	-	3	15.8	15	51.7	8	23.5	21	35.0	53	46.1
	X	17	63.0	-	-	-	-	13	68.4	13	44.8	22	64.7	33	55.0	46	40.0
	Hy	(27)	0.0	-	-	-	-	(18)	0.0	(29)	0.0	-	-	-	-	(115)	0.0
M$\overline{3}$	Groove Pattern																
	Y	(23)	0.0	-	-	-	-	-	-	-	-	1	14.3	3	30.0	4	6.7
	+	3	13.0	-	-	-	-	-	-	-	-	1	14.3	(10)	0.0	26	43.3
	X	17	73.9	-	-	-	-	-	-	-	-	5	71.4	7	70.0	29	48.3
	Hy	3	13.0	-	-	-	-	-	-	-	-	-	-	-	-	1	1.7

Table 19c

Tooth	Trait/ Grade	SJo-68		Sakhalin Ainu		Australian Aborigines		American Whites		Papago		Hopi		Navajo		Aleut	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
M$\overline{1}$	Protostylid Tubercle	1	3.5	1	5.3	-	-	(99)	0.0	(154)	0.0	1	1.1	1	1.2	(65)	0.0
M$\overline{2}$	Protostylid Tubercle	(26)	0.0	-	-	-	-	(96)	0.0	(131)	0.0	(77)	0.0	2	2.7	2	3.8
M$\overline{3}$	Protostylid Tubercle	4	25.0	-	-	-	-	-	-	-	-	-	-	-	-	1	4.5
Palatine Torus																	
	absent	15	75.0	4	36.4	145	80.0	-	-	-	-	-	-	-	-	-	-
	slight	5	25.0	2	18.2	24	13.1	-	-	-	-	-	-	-	-	-	-
	medium	(20)	0.0	2	18.2	9	4.9	-	-	-	-	-	-	-	-	-	-
	large	(20)	0.0	3	27.2	3	1.6	-	-	-	-	-	-	-	-	-	-
	very large	(20)	0.0	(11)	0.0	1	0.5	-	-	-	-	-	-	-	-	-	-
Mandibular Torus																	
	absent	17	94.5	2	18.2	>100	100.0	-	-	-	-	-	-	-	-	-	-
	slight	1	5.5	2	18.2	(>100)	0.0	-	-	-	-	-	-	-	-	-	-
	medium	(18)	0.0	2	18.2	(>100)	0.0	-	-	-	-	-	-	-	-	-	-
	large	(18)	0.0	5	45.5	(>100)	0.0	-	-	-	-	-	-	-	-	-	-
	very large	(18)	0.0	(11)	0.0	(>100)	0.0	-	-	-	-	-	-	-	-	-	-

* = probable over-estimate due to not scoring additional variant forms
\- = data not available or cannot be adapted
n = number possessing trait
(x) = number examined
Hy = hypoplastic