Archaic Native Americans.

This set of hypotheses allowed us to examine the possibility that the remains are unlike modern American Indians, yet similar to temporally adjacent Archaic populations in the New World. To test the null hypothesis, we collected craniometric data for 13 skeletal series dating to the Archaic period (8,000 - 1,900 yr B.P.) in North America. One caveat should be noted: even if there is a strong similarity of between Archaic groups and the Kennewick remains, this does not necessarily provide evidence to support or refute a connection to later American Indian populations. Only a time series analysis of populations from the Plateau region, extending from earliest occupation to the historic period, can provide a statistically valid means of assessing morphometric continuity of populations through time. Data for performing such an analysis are currently unavailable.

Craniometric Analyses:
The first analysis of craniometric data utilized the primary variable set of 52 dimensions (Table 2). In the canonical discriminant analysis of the primary variables, Kennewick falls between modern Amerindians and southeast Asian groups (Figure 2), a pattern noted for other ancient North American remains by Steele and Powell (1992, 1994). When the size-corrected data are used to generate posterior probabilities of group membership, the Kennewick individual has the greatest probability of inclusion in the South Japan sample ($p_{posterior}$ = 0.9861), followed by the South Pacific Moriori ($p_{posterior}$ = 0.0081) and North American Arikara ($p_{posterior}$ = 0.0021) samples. If the chronometric age of the Kennewick remains is correct, it is unlikely that the Kennewick skeleton belongs within any modern population, so that a typicality probability is the better assessment of group membership. Typicality probabilities were all $p_{typicality} < 0.00000001$ for all population comparisons using all combinations of the original size-corrected variables.

The first three principal components from the principal components analysis of all 52 variables account for only 39.22% of the total size-corrected variation in the data. The PCA plot (Figure 3) places the Kennewick individual as an outlier compared to full Howells data (N = 22 populations). Using the principal component scores to generate inter-individual distances (Van Vark and Schaafsma 1991), the Kennewick individual is closest to south Pacific (Moriori, Easter Island) and the Ainu of Japan. The typicality probabilities for the PC reduced data, which are the least conservative estimates of group membership, all indicate that the Kennewick cranium is not morphologically similar to any modern human population (Table 7). No modern Native American group is included as a close neighbor in the least conservative approach, which strongly suggests that they bear no morphological resemblance to the Kennewick remains. Furthermore, while the inclusion of the Ainu as a nearest group could be interpreted as a possible "Caucasoid" morphology for the Kennewick remains if one considers modern Ainu to be "Caucasoids" (see Jantz and Owsley 1997); we view this as a reflection of the southern Asian/south Pacific morphology of the Kennewick skull given that most researchers tend to associate Ainu groups with earlier population originating in southern Asia (Brace and Hunt 1990; Turner 1985, 1990).

While the above results are interesting, they include a number of variables that tend to exhibit a high degree of intra- and inter-observer error (see Table 2). After removing variables that were univariately non-normal in the comparative data, or that exhibited low repeatability or high inter-observer error, the above analyses were repeated using the best variable set. This variable set contained 45 dimensions of the face and neurocranium, including several radii (Table 2), and was compared to over 2,000 males in the Howells (1989) data

The canonical variates analysis places Kennewick closer to southern Asians, and nearly equidistant to modern Native Americans and Polynesians (Figure 4). The discriminant analysis based on the 45 best variables is highest for South Japan ($p_{posterior}$ = 0.9007), followed by Moriori ($p_{posterior}$ = 0.0765), and Ainu ($p_{posterior}$ = 0.03115). Typicality probabilities were all zero for the Howells comparative samples, suggesting again that the Kennewick skeleton morphologically is unlike any modern human population. A plot of the principal component scores places Kennewick in a peripheral position relative to the bulk of Polynesians and southern Asians, as well as to the Ainu sample (Figure 5). The first three components account for 38.54% of the size-corrected craniometric variation in the Howells data set. Based on inter-individual Mahalanobis' distances, the most proximate group to Kennewick was Moriori, which produced one of the largest typicality probabilities observed ($p_{typicality}$ = 0.1338). Other "neighbors" to Kennewick included northern and southern Moriori, Ainu, and the Arikara sample (Table 8).

Because the Howells (1989) data contain only three Native American populations, the potential biological affinity, or lack thereof, between Kennewick and recent American Indians cannot be fully assessed without addition of other American Indian samples. A larger comparative data set for world-wide populations, generously provided by Dr. T. Hanihara (1996), was used to examine the relationship between Kennewick and late Holocene populations in North and South America. This data set, which contains 48 cranial dimensions for 296 populations (N = 6,310 individuals), was used to generate both principal components and discriminant scores for the Kennewick remains.

Because the Hanihara data contain some variables that are defined differently than those in Howells, only dimensions that were defined and measured in the same way as Howells (1989) were used: GOL, XCB, XFB, BNL, ASB, BPL, NLH, NLB, MAB, OBH, FRC, PAC, and OCC. These 13 variables were size-corrected as before, and used to generate principal components, canonical variates, and linear discriminant functions. Due to missing data for many observations, only 183 populations (N = 4,179) were used for comparison, including 19 North and South American populations. Prehistoric groups from the states of Washington and Oregon were included, as were populations from Alaska and British Columbia.

In the canonical variates analysis (Figure 6), the Kennewick skeleton was separated from other modern populations on all three canonical axes, though it fell closest to the south Pacific samples. The four largest posterior probabilities of group membership, using 13 size-corrected variables were: Moriori ($p_{posterior}$ = 0.2757) Papua New Guinea ($p_{posterior}$ = 0.0848), Marquesas ($p_{posterior}$ = 0.0753), and California ($p_{posterior}$ = 0.0657). Mahalanobis distances between Kennewick and other group centroids produced low typicality probabilities (Table 9).

The principal components analysis (Figure 7) shows that Kennewick falls within the range of other modern groups for the first two components, but away from modern populations on the third component. The first three components account for 50.84% of the total craniometric variation present. When Mahalanobis distances were computed from PC scores, the Kennewick individual was closest to the Moriori sample ($p_{posterior}$ = 0.3954), followed by Society Islands ($p_{posterior}$ = 0.0945) and Sakhalin ($p_{posterior}$ = 0.0616). Mahalanobis distances for the PC data are provided in Table 10. The five closest groups included Polynesian and northeast Asian populations, while the five most distant groups included Africans, Europeans, and the prehistoric Tennessee samples. Typicality probabilities for all groups were less than 0.10 (Table 10).

A final point of concern involved the reconstruction of the Kennewick skull used for the above analyses. The differences between the measurements taken on the Kennewick Man cast and the Powell/Odegaard reconstruction were statistically significant, suggesting that some reconstruction differences were present in the data analyzed above. Although the fit of pieces was firm, with no observable gaps, it is possible, if unlikely, that the results obtained above are the result of an artifact of the reconstruction. In order to avoid reconstruction bias, multivariate analyses were performed using only those dimensions that were not affected by the reconstruction of the complete skull. Variables deleted were those involving prosthion, subspinale, zygomaxillare, zygoorbitale, and ectoconchion, as well as those already removed because of potential inter- and intra-observer error. This variable set should be the most conservative and, potentially, most accurate of those generated in the Kennewick Phase I study.

The canonical variates analysis for the 33 variable data set placed clearly within the cluster of Polynesian samples, and far from the three American Indian groups (Figure 8). The discriminant analysis of the 33 size-corrected original variables place Kennewick within the South Japan sample ($p_{posterior}$ = 0.9425), followed by Moriori ($p_{posterior}$ = 0.0173) and Ainu ($p_{posterior}$ = 0.0096) samples. None of the typicality probabilities for the Howells populations were greater than zero.

The first three principal components derived from these data accounted for 41.63% of the total size-corrected variation. The PC plot (Figure 9), places Kennewick near the periphery of modern samples, but closest to two northern Asian populations. The inter-individual distances were smallest for the Ainu, Moriori, South Japan, Zalavar, and Easter Island groups, and largest for Berg, Tolai, Tasmania, Australia, Bushmen samples (Table 11). None of the typicality probabilities were greater than 13%, suggesting that with the less conservative PC data, Kennewick could not be attributed with certainty to any of the modern samples. One additional point to note is that with the non-reconstructed variables, two so-called "Caucasoid" groups-- Ainu and Zalavar-- were indicated as most similar to Kennewick in multivariate space, while none of the American Indian samples were close to the Kennewick skeleton. This is not to say that the Kennewick remains are those of a "Caucasoid" individual. It does, however, confirm the work of other researchers (Steele and Powell 1992, 1994; Jantz and Owsley 1997, in press) which indicate that early New World populations have some features shared by some modern Polynesian and European groups. The cranial nonmetric and dental data confirm the Polynesian morphology of the Kennewick skeleton, but do not suggest a morphological similarity of this individual to modern populations of Europe.

To assess the relationship between the Kennewick skeleton and Archaic North American groups, we selected ten variables common to the Howells, Hanihara, and Archaic data, excluding variables with different landmark definitions, for analysis. The pooled modern samples (N=7,142, 277 groups) were corrected for size and tested for interobserver effects. Mahalanobis distances for these samples were used to generate typicality probabilities for these data; the PCA and canonical plots contained too many individual populations to be of any utility. Results are presented in Table 12. Based on the 277 prehistoric and modern reference samples, the five closest populations included Eskimo, Northeast Asians, and Polynesian groups, while the five furthest samples included the majority of Archaic groups and one Near Eastern sample (Table 12). Typicality probabilities were high, with Kennewick exhibiting a 91% probability of having been drawn from the sample of Chukchi from Siberia. Typicality probabilities for the remaining proximate samples were in the range of 0.7339 to 0.8658 (Table 12). Archaic samples from Plains, southeast U.S. and Florida were distant from the Kennewick individual, with zero probability of Kennewick having been drawn from these groups. The Kennewick individual was much closer ($D^2 = 5.37$; $p_{typicality} = 0.865132$) to Archaic individuals from the northern Great Basin.

Initially, the above results would suggest rejection of the second null hypothesis. On removal of some of the smaller samples (those with n < 5) in the Hanihara data set, we observed that the set of population relationships changed considerably, and suggested that the results presented in Table 12 may be an artifact of pooling the within-group covariances of these many small samples. When the pooled within-groups covariance matrix in the Mahalanobis distance is computed, samples with deviant covariances may skew the resulting distances. To examine this possibility, the Howells-Hanihara reference data were tested for univariate and multivariate normality. The results indicated that 10 of 14 variables were not univariate normal, and the pooled data were not multivariate normally distributed. Thus the previous results (Table 12) are somewhat suspect.

In order to minimize the effect of outlying populations on the pooled within-groups covariance matrix, we elected to combine the 277 individual samples into eight major geographic groups: Africa, Europe, the Near East, Northeast Asia, Southeast Asia, the Americas, Australia, and Polynesia. A combined Ainu/Jomon sample was retained separately. The resulting regional data were univariate normally distributed (but exhibited some multivariate leptokurtosis) and appear to provide a better overall approximation of world-wide craniometric variation than the use of individual modern samples. Because sample sizes for some of the Archaic reference data were small, we utilized the pooled within-group covariance matrix derived from eight modern regional samples to calculate Mahalanobis distances for Kennewick and all Archaic populations, following the suggestion of Jantz and Owsley (1997) and Van Vark and Schaafsma (1992). This avoided the possibility that the small Archaic samples would also skew the results. Table 13 provides the resulting typicality probabilities for the ten size-corrected variables. In this analysis, the Kennewick individual is most similar to the Archaic sample from Indian Knoll, Kentucky, followed by the Ainu/Jomon pooled sample, an Amerindian pooled sample, Northeast Asians, and Southeast Asians (Table 13). Once multivariate normality in the reference data was established, the morphological similarity between Kennewick and Archaic groups is stronger. The typicality probability of Kennewick having been drawn from either middle Holocene sample from the eastern U.S. ($p_{typicality} = 0.873325$) is high, followed by the Ainu/Jomon groups of east Asia ($p_{typicality} = 0.476220$) and the pooled hemispheric American Indian sample ($p_{typicality} = 0.450143$). Other Archaic groups not shown in Table 13 also exhibit higher typicality probabilities (0.5999 to 0.1369); the seven remaining modern regional samples exhibit lower typicalities, in the range of 0.0040 to 0.1734. These results support the contention that there is at least some morphological similarity between Kennewick and Archaic groups, although the Archaic samples from the southeastern U.S. are clearly distinct. Based on these results, it is not possible to reject the second null hypothesis.

In addition to multivariate craniometric analysis, we also performed a set of bivariate analyses that utilize naso-orbital indices derived by Gill (1984) for discriminating American Whites from Plains Indians and American Blacks. The Kennewick remains produced a maxillofrontal index of 46.9, a zygoorbital index of 30.9, and an alpha index of 72.7. Based on these data, two of Kennewick's indices (maxillofrontal and alpha) fall above the non-white/white cutoff point, suggesting that Kennewick's nasal and orbital configurations for those dimensions are most similar to Gill's (1984) American White sample. The third index (zygoorbital) is well within the Plains Indian/Black range and suggests that Kennewick's zygoorbital breadth and naso-zygoorbital subtense are more similar to Gill's Plains/Black samples.

Odontometric Analyses

Because of excessive dental wear, maximum crown diameter data for Kennewick were limited to seven buccolingual crown diameters: UI1, UC, UM3, LC, LM1, LM2, and LM3. However, because of large numbers of missing variables, only seven of the 14 Wolpoff (1971) samples (N=42) could be used. These data were employed in principal components and discriminant analysis procedures. The first three principal components encompass 69.82% of the total buccolingual variation present in these limited comparative data, and place Kennewick at the margin of prehistoric Amerindians and southeast Asian individuals (Figure 10). The canonical variates was analysis was not significant (p = 0.0561) and will not be presented. The posterior probabilities derived from size-corrected data (not PCA scores) indicated that Kennewick would be classified as part of the largest sample, prehistoric Amerindians from Dickson Mound ($p_{posterior}$ = 0.4584); typicality probabilities were highest for Dickson Mound, followed by Europeans and Southeast Asians (Table 14). Typicality probabilities for including with other prehistoric Amerindians (a composite sample from several North American sites) were low ($p_{typicality}$ = 0.1711).

Discrete Trait Analysis:
Cranial and dental discrete traits presented a difficulty in analysis. These features could only be scored as "present" or "absent" in Kennewick, while they are recorded as a percentage of "presence" or "absence" in comparative samples. In order to statistically assess the Kennewick discrete data, we elected to follow a procedure outlined in Powell (1993) for converting frequency data to presence/absence form in statistical analyses. All comparative sample frequencies were converted to a set of ones or zeros following Powell (1993), and these data were then used to generate posterior probabilities of group membership for an unknown sample using logistical discrimination (Jobson 1982). Typicality probabilities were not generated for these analysis, though such an approach would be possible.

Cranial discrete data for eight variables in 20 world-wide samples provided a statistically significant discrimination (log-likelihood chi-square 24.93 at 7 d.f., p = 0.0008) of samples into "Amerindian" and "Non-Amerindian" groups. Under this method, Kennewick had a probability of 0.0000 for membership in Amerindians and 0.9998 for membership in Non-Amerindians. The procedure was repeated using dichotomized dental data. In this analysis, 44 samples were divided into Sinodont (including American Indians) and Sundadont groups. The discriminatory power of this method was significant (log-likelihood chi-square 43.360 with 7 d.f, p = 0.0001) for the dental data. Kennewick had a probability of 0.48460 for membership in the Sinodont group, 0.93769 for membership in the Sundadont group. The analysis was repeated using a third group, composed of Paleoindian and middle Holocene samples, in addition to the Sinodont and Sundadont populations. Early Holocene American samples were separated from the main east Asian dental patterns because they exhibit a mixture of features that occur in high frequency in both Sinodonts and Sundadonts (see Powell in press and Powell 1995). Based on this analysis, the Kennewick specimen had a posterior probability of 0.0055 for membership in Sinodonts, 0.5940 for membership in Sundadonts, and 0.4005 for membership in the early Holocene group.

Anthroposcopic Trait Analysis:
Analysis of Kennewick's craniofacial features proceeded as in other forensic cases examined by Rose and Powell. Kennewick was scored for a number of anthroposcopic features, following Rhine (1990), Napoli and Birkby (1990), Brues (1990), Gill and Gilbert (1990), and Brooks et al. (1990).

The craniofacial appearance of Kennewick contains a mix of features observed in both Amerindian and American White populations from forensic contexts. Kennewick's more European/Caucasoid features included cranial sutures of medium complexity (where observable), no wormian bones (where observable), no *os japonicum*, a large nasal spine, slanting ascending ramus profile, and an undulating horizontal ramus border. Native American/Mongoloid features included a large malar tubercle, blurred nasal sill, zygomatic posterior tubercle, slight nasal depression, moderate prognathism, elliptical dental arcade, straight palatine suture, and what appeared to be an angled zygomaticomaxillary suture (though much of this was obliterated by sutural fusion and damage). Kennewick also exhibits forward facing frontal processes of the Maxilla (Gill and Gilbert 1990) typical of modern American Indians. The Kennewick facial skeleton also exhibited features that occur in several modern non-Amerindian populations, including a nasal bone configuration intermediate between towered and tented forms, a medium nasal opening, vertical zygomatic bones, a somewhat rhomboid orbital shape. Many of these features are typical of Polynesian groups. Kennewick lacked the projecting and bilobate chin of Europeans.

The midfacial profile of Kennewick was examined following Brooks et al. (1990). Kennewick exhibits a slight concavity below the prominent anterior nasal spine, followed by minimal prognathism and a more vertical outline approaching infradentale superior. This condition is intermediate between the American Whites, which tend to have a less prognathic profile and a much shorter outline, and the North American Indian profiles (particularly those from the northern Great Basin such as Brooks et al. 1990 Figure 3a), which tend to be concavoconvex (Brooks et al. 1990).

Based on CT data, the oval window of the external auditory meatus is partially visible, a condition that occurs in only 6% of Caucasoids (American Whites), but occurs in 34% of Mongoloid (Native American) and 32% of admixed (Hispanic/Mestizo) individuals. The posterior wall morphology of the external auditory meatus is convex, which is found in 82% of Caucasoids (American Whites), and in 44% and 73% of Mongoloid and admixed populations (Napoli and Birkby 1990). The temporopetrous angle of inclination in Kennewick was significantly smaller (19°) than that of Caucasoids (32.07°) and admixed (32.44°) groups.

Overall, the anthroposcopic data indicate that the Kennewick skeleton contains a mix of features seen in modern groups, including East Asians, American Indians, and Europeans. The skull lacks features associated with African populations. Gill (1986) presented a list of features for geographic races, and noted that the Polynesian sample (primarily from Easter Island) exhibited a wide range of features like those in Kennewick. Such a finding corresponds to the stronger south Pacific and Polynesian morphometric appearance the Kennewick skull noted in the craniometric analyses.

Summary

The Kennewick skeleton is a male who died between 45 and 50 years of age. He was approximately 175 cm (5' 9") tall, based on an average of all stature estimates. The morphology of the humeri and muscle marking of all arm bones indicate that he was well-muscled and engaged in rigorous activity employing his arms. The left elbow joint reaction area is also associated with this rigorous activity. All evidence for arthritis is minor and all joints are in excellent shape for a man of his age. He most likely would not have experienced any pain or problems with any of his joints. Many years prior to death he had broken two right ribs which did not heal together and formed pseudoarthroses (false joints). These false joints would not have caused any disability or pain. Possibly at the same age he also suffered a fracture of the right humerus. This healed well and would have caused no disability. Many years before death and probably when he was a teenager (and at the same time as the other trauma), an accident or conflict occurred which resulted in a projectile point being embedded within the right iliac blade of the pelvis. Recovery from this wound was complete; there was no infection of the bone, and there was no disability associated with this injury. The small defect of the frontal bone of the skull would have occurred just before death. This defect is obscured by matrix both within the depression and the inner surface of the skull that makes definitive interpretation impossible. However, there is no evidence for a depressed fracture and this is most likely a minor traumatic event.

Taphonomically, the Kennewick remains represent a single individual who was most probably interred rather than left to decompose on the surface. The completeness of the remains, the lack of carnivore damage to the remains, and presence of rodent gnawing on several elements are all typical of the pattern seen in intentional modern and prehistoric burials. In fact, the Kennewick remains could not be statistically distinguished from intentionally buried remains, but could be distinguished from human remains in other post-depositional contexts (Table 4). The red staining of some bones ***may*** be cultural in origin, suggesting application of red ochre pigment to the skin of the individual prior to interment. This determination will require confirmation of iron oxide levels in the matrix adhering to the bone, and possibly chemical analysis of the bone itself. Algal staining on some elements is probably due to exposure of the remains in shallow water just prior to their recovery in along the Columbia River.

Like other early American skeletons, the Kennewick remains exhibit a number of morphological features that are not found in modern populations. For all craniometric dimensions, the typicality probabilities of membership in modern populations were zero, indicating that Kennewick is unlike any of the reference samples used. Even when the least-conservative inter-individual distances are used to construct typicality probabilities, Kennewick has a low probability of membership in any of the late Holocene reference samples. Similar results were obtained by Ozolins et al. (1997) for Upper Paleolithic samples from Asia, Africa, and Europe and Paleoindian groups, and are not surprising considering that Kennewick is separated by roughly 8,000 years from most of the reference samples in Howells (1989) and Hanihara (1996). The most craniometrically similar samples appeared to be those from the south Pacific and Polynesia as well as the Ainu of Japan, a pattern observed in other studies of early American crania from North and South America (Steele and Powell 1992, 1994; Jantz and Owsley 1997).

Only in three cases, including two analyses based on the least-conservative inter-individual distances, was a Native American included in the five closest samples to Kennewick. The Hanihara craniometrics and the cranial discrete traits both failed to find an association between Kennewick and modern Indian groups, despite the fact that these data sets included populations from the Northwest Coast and Interior Plateau regions of North America. Only the odontometric data suggested a connection between Kennewick and modern American Indians, but the typicality probabilities for this analysis were all very low. Clearly the Kennewick individual is unique relative to recent American Indians, and finds its closest association with groups of Polynesia and the Ainu of Japan.

The question of "Caucasoid" affinities for the Kennewick remains can be addressed, depending on how the term "Caucasoid" is defined. In the strictest sense, this refers to populations of western and southwest Eurasia-- peoples that live or lived in what is now Europe, the near East, and India. When defined in this way, Kennewick is clearly not a Caucasoid. Although one European group, Zalavar (1/25 = 4%) was included among the five nearest "neighbors" to Kennewick (Tables 7 - 12), the majority of nearest neighbors are from Polynesia (16/25 = 64%) and east Asia (24%). The Ainu, which we have described as "east Asian", occur as a nearest neighbor three times (12%), while Native Americans occur as neighbors just twice

DOI 05885

(8%). Although Kennewick exhibits some features that typically (but not exclusively) occur in modern American Whites (Caucasoids), these same features also occur in moderate to high frequency among Polynesian populations (Gill 1986). If the Ainu are considered to be "Caucasoids," as they were first described in 19th-century anthropological literature, this might explain reports of "Caucasoid" features in the Kennewick skull. However, we follow Brace and Hunt (1990) and Turner (1990) in viewing the Ainu as a southeast Asian population derived from early Jomon peoples of Japan, who have their closest biological affinity with south Asians rather than western Eurasian peoples. Thus Kennewick appears to have strongest morphological affinities with populations in Polynesia and southern Asia, and not with American Indians or Europeans in the reference samples.

Going back to the original null hypothesis, we can reject this hypothesis for the craniometric data, for cranial discrete traits, and for dental discrete traits. The data are inconclusive for anthroposcopic traits, and the null hypothesis cannot be rejected for the odontometric data. The Kennewick skeleton can be excluded, on the basis of dental and cranial morphology, from recent American Indians. More importantly, it can be excluded (on the basis of typicality probabilities) from ***all*** late Holocene human groups. There are indications, however, that the Kennewick cranium is morphologically similar to Archaic populations from the northern Great Basin region, and to large Archaic populations in the eastern woodlands. While these data raise a number of interesting questions, only a regional time series analysis of a sequence of well-dated human remains from east-central Washington spanning the past 9,000 can provide direct evidence of biological continuity between Kennewick and modern American Indian tribes.

Table of Contents | References Cited

EXPLORE | CONSERVE | PEOPLES & CULTURES | COMPUTE | IN THE PARKS

Home | Publications | Laws | Search | E-mail | Links to the Past

Last Modified: Wed, Nov 17 1999 12:23:38 pm EDT

MJB

ParkNet
National Park Service