ARCHAEOLOGICAL IDENTIFICATION OF KIN GROUPS USING MORTUARY AND BIOLOGICAL DATA: AN EXAMPLE FROM THE AMERICAN SOUTHWEST

Todd L. Howell and Keith W. Kintigh

Despite the central role that kinship plays in key anthropological arguments, recent archaeological efforts to detect kinship have been notably scarce. Here, age and sex distributions and dental morphology traits that reflect genetic affinity are used to argue that specific kin groups were buried in formal, spatially discrete cemeteries in the ancestral Zuni settlement of Hawikku. The inferred kin groups are then used to investigate Hawikku political structure. Results show that community leaders, identified on the basis of mortuary treatments and grave offerings, were selected from a small number of kin groups, suggesting an ascriptive element to leadership selection.

A pesar de que el parentesco es un tema central en argumentos antropológicos, esfuerzos arqueológicos recientes enfocados en la identificación de parentesco han sido notablemente escasos. En este artículo presentamos distribuciones de sexo y edad y rasgos de morfología dental que reflejan afinidad genética para inferir que específicos grupos de parentesco fueron enterrados en cementerios formales y espacialmente discretos en Hawikku, un asentamiento ancestral Zuni. Los grupos de parentesco así identificados se incorporan en la investigación de la estructura política de Hawikku. Los resultados demuestran que los líderes de la comunidad, identificados en base a tratamiento mortuorio y ofrendas funerarias, fueron seleccionados de entre un reducido número de grupos de parentesco, lo cual sugiere un elemento adscrito en la selección de liderazgo.

Attempts by archaeologists to identify aspects of social structure, such as descent rules and residence patterns, began during the initial enthusiasm of the “new archaeology” in the 1960s and 1970s (Hill 1966, 1970; Longacre 1964, 1966). These studies in “anthropological archaeology” relied on assumptions concerning relationships between ceramic design and social organization. Despite shortcomings in both method and theory, these studies remain important in the intellectual history of the discipline. The major contribution lies not in their specific results but in the consequences of the ensuing debates: attention to formation processes, more sophisticated use of ethnographic data and statistical methods, and a refining of the archaeological method and theory we use to understand social organization (Allen and Richardson 1971; Friedrich 1962; Lischka 1975; Plog 1978; Stanislawski 1973; Watson 1977).

Since these initial attempts and their subsequent critiques, many archaeologists apparently heeded the advice of Allen and Richardson that: “kinship is best left to the ethnographer” (1971:51). However, kinship is such an important structuring force, particularly in non-state societies, that it is impossible to ignore. During the 1970s, the significance of kinship was recognized by those archaeologists who were beginning to articulate a framework of method and theory designed to identify kin groups (i.e., clans or lineages) by using mortuary data (Goldstein 1976; Saxe 1970). These analyses were based on a cross-cultural regularity that links formal, spatially discrete cemeteries with specific kin groups.

In this paper, age and sex distributions and dental morphology traits that reflect genetic affinity are used to argue that specific kin groups were buried in spatially discrete cemeteries at the ancestral Zuni settlement of Hawikku. The inferred kin groups are then used to investigate Hawikku political structure. Community leaders are identified and their distribution among kin-based cemeteries is examined. Results show that

Todd L. Howell and Keith W. Kintigh • Department of Anthropology, Arizona State University, Box 872402, Tempe, AZ 85287-2402

leaders were selected from a small number of kin groups, suggesting an ascriptive element to leadership selection.

**Burials and Spatial Structure**

Starting from ethnographic patterns, Saxe (1970) and Goldstein (1976) developed theoretical arguments linking specific mortuary practices with social variables. Saxe (1970:119) developed a hypothesis based on observations made by Meggitt regarding the Mae-Enga, a horticultural, highland New Guinea group. Meggitt (1965:131) argued that pressure on agricultural land was linked to a greater importance of descent groups, who held use rights to high quality agricultural land. The importance of this argument for mortuary studies lies in the fact that living descent group members would seek to affirm their descent group membership (hence, access to land) through rituals that connected them to descent group ancestors:

"[T]he relative scarcity of arable land among the Mae is a significant determinant of the rigidity of their lineage structure, and that the people emphasize the importance of the continuity of solidary descent groups which can assert clear titles to the highly valued land. The popular religion is well designed to support these ends. On the one hand, rituals regularly reaffirm the cohesion and continuity of the patrilineal group; on the other, the dogma in itself implies title to land by relating living members of the group to a founding ancestor who is believed to have first selected that locality for settlement. [Meggitt 1965:131]."

Saxe modified Meggitt's original argument to make it more widely applicable by replacing "agricultural land" with "crucial and restricted resource(s)" and "patrilineal" with "lineal descent." Saxe's hypothesis states:

To the degree that corporate group rights to use and/or control critical but restricted resources are attained and/or legitimized by means of lineal descent from the dead (i.e., lineal ties to ancestors), such groups will maintain formal disposal areas for the exclusive disposal of their dead. [Saxe 1970:119]

Goldstein was also interested in the use of spatial referents as symbols of social structure. She tested Saxe's hypothesis on a worldwide sample of 30 well-known ethnographic societies at varying levels of complexity and engaging in different subsistence practices (1976:48–54). Her results strongly confirmed most of Saxe's original hypothesis:

All groups who buried their dead in formal cemeteries were agricultural with lineal corporate group rights over land, or with long traditions of the same land within one family. In the latter case, the cemetery is usually divided into "family plots." In the former, there are either clan or lineage cemeteries, or lineage subdivisions within the cemetery. [Goldstein 1976:49]

These results indicate a strong association between the presence of spatially discrete cemeteries and their exclusive use by specific kin groups. However, Goldstein (1976:58) also found that lineal corporate groups who controlled critical resources did not always use formal, spatially discrete disposal areas for their dead. She concluded that several ritual behaviors are used by lineal descent group members to establish or legitimize ties to important ancestors, one of which is to establish formal cemeteries for the exclusive disposal of the group's dead. Goldstein's results suggest the narrower hypothesis examined here: whenever burials are spatially arranged in a formal manner, such as spatially discrete clusters, the presence of distinct descent groups is indicated.

The social meaning of this behavior, linked originally by Saxe to inheritance practices (including land tenure), is more poorly understood. Morris (1991) tested the hypothesized connection between property transmission and formal cemeteries by using ethnographic and archaeological data and found mixed support. Morris (1991:153–154) suggested that the link between inheritance and formal cemeteries is often part of a culture's ideology but that survivors use mortuary ritual to symbolize conflicting messages.

Over the past 25 years, the narrower hypothesis developed by Saxe and Goldstein to infer group membership from mortuary remains has been employed (sometimes implicitly) in a variety of mortuary studies (Anderson 1986; Effland
In building these arguments, age and sex distributions, spatial information, and occasionally other data have been used. Here we take a step beyond recent studies by coupling age and sex compositions, spatial information, and biological measures of genetic distance (dental morphology) to examine kin group membership.

**The Kinship Basis of Cemeteries at Hawikku**

Hawikku (or Hawikuh), located 24 km southwest of modern Zuni pueblo in west-central New Mexico (Figure 1), was occupied for about 340 years and is notable as the place of first contact between the Spanish and Puebloan peoples in 1539 and 1540 (Hodge 1937). Under the direction of Frederick Webb Hodge, the Hendricks-Hodge expedition of the Museum of the American Indian, Heye Foundation excavated about 1000 burials at Hawikku between 1917 and 1923 (Smith et al. 1966). Burials at Hawikku are distributed in spatially discrete clusters, or cemeteries (Figure 2).

Before proceeding, however, we must be sure that these spatial clusters are real and not a result of the excavation strategy employed. The excavation strategy used at Hawikku was almost certainly the one used by the Clarke expedition in its 1922 excavation of the nearby pueblo of Kechiba:wa
Figure 2. Map of Hawikku. Each dot represents a burial.
(which is contemporaneous with Hawikku). The two expeditions cooperated closely and shared a field camp. Furthermore, the Museum of the American Indian supplied U.S. Government permission for their excavation and two supervisory staff to the Clarke expedition under a contract (1923 Agreement between the Museum of the American Indian, Heye Foundation and Louis C. G. Clarke, April 5, 1923. National Museum of the American Indian Archives, OC 124#31). Notes from the Clarke expedition indicate that in pursuing trench excavations targeting burials, excavation continued in an area as long as burials continued to be encountered in a given direction (Lothrop 1923:entry for August 4, 1922). Although all edge areas of each cemetery probably were not fully examined, excavations were terminated in areas lacking burials. Thus, it appears that at Hawikku and also at Kechiba:wa the apparent clusters of burials are real spatial phenomena.

It is important to this and subsequent arguments to show that cemeteries (i.e., spatial clusters of graves) were used for a considerable period of time (Howell 1994:54). A total of 386 (40 percent) of the burials could be confidently assigned to one of three time periods, based on associated ceramic types and the presence of historic artifacts. The Pre-Matsaki period (about A.D. 1300–1375) includes burials for which the latest ceramic type was one of the following: Heshotauuthla Polychrome, Kechipawan Polychrome, Gila Polychrome, Tonto Polychrome, Pinnawa types, unnamed red-on-buff, and Kwakina Polychrome. Fifty-six burials (15 percent) date to the Pre-Matsaki period. The Matsaki period (ca. A.D. 1350–1630) includes burials for which the latest ceramic type was either Matsaki or Hopi types. Two hundred and sixty (67 percent) of the burials date to the Matsaki period. Burials were dated to the Historic period (ca. A.D. 1630–1680) if historic artifacts were found or if the latest ceramic type was one of the Hawikuh or historic Zuni types. Seventy (18 percent) burials date to the Historic period. All cemeteries contain individuals dating to two of the three periods; eight contain individuals from all three periods. Bearing in mind that more than one-half of the burials could not be dated, it appears that most, if not all, cemeteries were used for a long period of time.

The specific hypothesis to be tested here is that the location of a grave within a spatial cluster of graves (cemetary) at Hawikku indicates kin group membership. Although each cemetery may have been used by a lineage, extended family, or clan, depending on cultural rules for interment and the social structure of Hawikku society, the key argument is that the cemeteries are kin-based.

Burials at Hawikku are located in spatially discrete cemeteries around the main pueblo. In Figure 2, each cemetery is numbered (following Smith et al. 1966) and each dot represents a burial. A small proportion of burials were located below room floors (n = 63) and from a historic church (n = 41), but only cemetery burials are considered here (n = 873). Of these, 572 were inhumations and 300 were cremations (for 1 burial, type is unknown). Eleven cemeteries have been identified at Hawikku (Cemetery 11, not present in Figure 2, is located an unknown distance north of the pueblo). These cemeteries vary considerably in size, as might be expected if they were used by specific lineages or clans, which historically vary dramatically in size.

If specific kin groups used separate cemeteries, each cemetery should contain both males and females in roughly consistent proportions. Each cemetery should also contain all age groups in approximately natural proportions (that is, about one-half 12 years old or younger and one-half over the age of 12 years). Finally, if each cemetery represents a specific kin group, then, in general, individuals buried within one cemetery should be more biologically similar to one another than to individuals buried in other cemeteries. Nonmetric dental morphological data, available from a subset of the Hawikku burial population, were used to assess genetic affinity.

Sex and Age Distributions

Although Hawikku burials were “aged” and “sexed” in the field, a small sample of the skeletal remains is held by the Smithsonian Institution and was later studied by Hrdlicka (1931; Smith et al. 1966:179). Data recorded by Hrdlicka are used here; for burials not examined by Hrdlicka, field
Table 1. Distribution of Males and Females by Cemetery.

<table>
<thead>
<tr>
<th>Cemetery</th>
<th>Male</th>
<th>Female</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>14</td>
<td>83</td>
<td>106</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>10</td>
<td>64</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>10</td>
<td>51</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>2</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>4</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>31</td>
<td>44</td>
<td>226</td>
<td>301</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2</td>
<td>223</td>
<td>226</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Totals</td>
<td>55</td>
<td>89</td>
<td>729</td>
<td>873</td>
</tr>
</tbody>
</table>

Although there are significantly fewer males (38 percent) than would be expected from an even sex ratio (binomial $p < .01$), this proportion appears to be relatively consistent across the cemeteries. The observed counts of males and females in all cemeteries are quite likely, given an expectation of 38 percent males (binomial probabilities for the nine cemeteries with sexed burials range from .31 to .67).

Age identifications were made for 82 percent of the burials (92 percent of the inhumations and 41 percent of the cremations). Table 2 shows that most cemeteries contain a wide range of age classes. Ten of 11 cemeteries contain the basic categories of infant, child, and adult. Two small cemeteries, 7 and 8, appear somewhat unusual in their age distributions. Nonetheless, combining infant and child into a subadult category and grouping together the adult classes, a chi-square test does not reveal a significant deviation from the expected counts across the 11 cemeteries ($\chi^2 = .14$, $df = 10$). There is no suggestion that burial locations are strongly age dependent. With the exception of a consistent underrepresentation of infants, the observed age distributions are consistent with an interpretation of each cemetery representing a normal death profile.

Dental Trait Distributions

If placement of an individual in a particular cemetery is wholly or partially a consequence of kin group membership, then we would expect a tendency for individuals within a cemetery to have stronger biological relationships with others in

Table 2. Distribution of Age Classes by Cemetery.

<table>
<thead>
<tr>
<th>Cemetery</th>
<th>Infant/Fetus</th>
<th>Child</th>
<th>Young Adult</th>
<th>Adult</th>
<th>Elderly</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>23</td>
<td>11</td>
<td>42</td>
<td>4</td>
<td>9</td>
<td>106</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>15</td>
<td>8</td>
<td>36</td>
<td>1</td>
<td>7</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>14</td>
<td>5</td>
<td>32</td>
<td>3</td>
<td>1</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>10</td>
<td>1</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>44</td>
<td>54</td>
<td>15</td>
<td>113</td>
<td>16</td>
<td>59</td>
<td>301</td>
</tr>
<tr>
<td>10</td>
<td>13</td>
<td>54</td>
<td>30</td>
<td>54</td>
<td>0</td>
<td>75</td>
<td>226</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Totals</td>
<td>114</td>
<td>179</td>
<td>73</td>
<td>314</td>
<td>28</td>
<td>165</td>
<td>873</td>
</tr>
</tbody>
</table>
the same cemetery than with individuals in other cemeteries. Dental traits are used here to assess biological affinity (Alt and Vach 1990 also used dental attributes to assess genetic affinity).

Even if kinship dictated the cemetery in which one was buried, a number of factors would be expected to obscure spatial patterning in the dental trait distributions. However, if spatial patterning is observed, we see no way to account for it except with reference to genetic affinity and sampling error. Factors that would tend to obscure patterning, even if the hypothesized relationship between kin groups and cemeteries holds, are discussed in the following paragraphs.

A result of the probabilistic component of genetic transmission is that some closely related individuals will have dissimilar dental trait expressions. The precise models of dental trait inheritance are less well understood than those of major gene traits, but most analysts indicate polygenic inheritance of dental traits (Scott and Turner 1988). Most dental traits seem to be polygenic quasicontinuous threshold mechanisms (meaning several loci contribute to phenotypic expression). Polygenic traits are characterized by a range of variability in expression. Thus, inherent variability in the expression of polygenic traits would serve to obscure genetic similarity among siblings and between parents and offspring.

The degree of genetic homogeneity of the population is an additional factor that could obscure expected patterning. If the population is relatively isolated, with little new genetic material being added to the gene pool, it may be difficult to detect genetic affinity. Over time, the gene pool would tend to become homogenized, especially if (kin-based) subgroups practiced exogamous marriage within the population.

Marriage and residence practices (and how they structure burial location) could also disrupt dental patterning. If husbands and wives, who do not share as much genetic material as biological kin, are buried in the same cemetery, a cemetery's genetic homogeneity would tend to decrease. If specific cemeteries are utilized by clans (composed of several lineages) rather than a single lineage, measures of genetic homogeneity will be lower, reflecting the heterogeneous nature of a cemetery's gene pool.

Rules defining kinship, and the degree to which they are observed, also could obscure dental trait patterning. For example, adoption of nonbiological kin and their subsequent burial in the cemetery used by the adoptive group could introduce dental traits uncommon in the adoptive group. Like other social rules (Allen and Richardson 1971), prescriptions concerning where an individual is buried may be somewhat flexible. For example, if an individual should be buried in the cemetery used by his or her mother's clan, but some individuals "break" the rule and are instead buried in another cemetery, it would work to obscure patterning in dental attributes.

It is also possible that smaller cemeteries would, over time, merge as available space is used up. It may be the case that large cemeteries, like Cemetery 9 at Hawikku, actually represent the burial locations of more than one kin group whose original areas merged. If this were the case, dental patterning would be weakened.

Despite these expectable and possible reasons for considerable variability in dental morphology within cemeteries, if kin group membership determines, in some way, which cemetery is used, we may still be able to detect greater than chance associations within cemeteries of individuals with similar dental characteristics. Given all these potentially disruptive effects, any statistically significant patterning of dental traits by cemetery can be taken as support that cemeteries were used by specific kin groups.

Finally, because there is some evidence that migration may have been common during the period that Hawikku was occupied (Ferguson 1981:341), we should consider its effects. Inmigration of genetically dissimilar groups could produce spatial patterning of dental traits in two different ways. First, if kin-based groups of migrants maintained a group identity (as they apparently did at Point of Pines; Haury 1986) after coming to Hawikku, or if they joined a limited number of extant Hawikku clans that tended to bury their dead in restricted areas, then dental trait distributions should reflect a kinship basis
for the placement of an individual in a cemetery, as they would for other Hawikku groups.

Alternatively, if there were one or more episodes of substantial migration into Hawikku, and if some cemeteries were used for only a short time, and if burial location were truly independent of kinship, then cemeteries that fell out of use prior to the migration would be more homogeneous genetically than expected because of their lack of genetically distinct migrants. Under these conditions, patterning would reflect temporal differences in the overall genetic population and not a kinship basis for burial placement. However, as discussed earlier, all cemeteries were used for long periods of time. It also seems unlikely, given the sizes of the available samples, that this effect would be detectable in the data unless there was a very high level of migration.

Apparently, only well-preserved skeletal remains (n = 227) were retained for further study.

In our analysis, we are able to use only the 156 sets of individual remains that have retained their exact provenience. Turner (1985) has selected 30 nonmetric morphological traits (Table 3) for study because they exhibit evolutionary stability, no (or slight) sexual dimorphism, and presumably a high genetic component in their expression (Turner et al. 1991 provide a discussion of the traits and coding system used in the collection of these data, which were collected by Turner). These traits are recorded as either present or absent, on an ordinal scale, or as count data (for root and cusp number). The ordinal scale traits are coded on a gradual scale of trait expression; lower scores indicate slight expression, whereas higher scores reflect marked expression. First, the ordinal scale traits were transformed into presence/absence form (based on methods described by Turner 1985:67–74). Then, the frequency of trait expression is calculated for each cemetery for which there were available data. Next, binomial probabilities are calculated for 24 nonmetric traits in seven cemeteries. Only those traits that exhibited variability in this sample were used.

The sample of 156 burials with known provenience was used to calculate the population parameter (the proportion of individuals that scored present) for each trait. With these population parameters, the binomial distribution (Davis 1986:13–19) can assess whether a given cemetery has a nonrandom concentration of particular (dichotomous) dental traits. If cemeteries are kin-based, we would expect individual cemeteries to vary occasionally from the overall population in having a nonrandom selection of individuals with a particular value (present or absent) of a trait.

For example, suppose we wanted to determine whether trait X is randomly distributed in a cemetery, and let us further suppose that, in the population (all recorded individuals at the site), trait X is present 50 percent of the time. Suppose that trait X is present in 8 of 10 (80 percent) individuals in a particular cemetery. We can use the binomial distribution to determine the likelihood of obtaining this (or a more extreme) outcome by chance. In this case, the probability of 8 or more of 10 individuals exhibiting trait X is .05. It is unlikely that this trait would be so concentrated in
Table 4. Dental Trait Distributions by Cemetery.

<table>
<thead>
<tr>
<th>Trait (Occurrence/No. of Valid Observations, Population %)</th>
<th>Cemetery (Occurrence/No. of Valid Observations)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Double shoveling (37/49, 75.5%)</td>
<td>9/10</td>
</tr>
<tr>
<td>Interruption groove (30/59, 50.8%)</td>
<td>5/14</td>
</tr>
<tr>
<td>(p = .03)</td>
<td></td>
</tr>
<tr>
<td>Canine distal accessory ridge (13/19, 68.4%)</td>
<td>3/3</td>
</tr>
<tr>
<td>(p = .03)</td>
<td></td>
</tr>
<tr>
<td>Hypocone (38/49, 77.6%)</td>
<td>8/13</td>
</tr>
<tr>
<td>(p = .08)</td>
<td></td>
</tr>
<tr>
<td>Enamel extension (41/79, 51.9%)</td>
<td>8/17</td>
</tr>
<tr>
<td>(p = .14)</td>
<td></td>
</tr>
<tr>
<td>Peg-shaped/reduced (5/67, 7.5%)</td>
<td>1/14</td>
</tr>
<tr>
<td>Premolar lingual cusp variation (5/54, 9.3%)</td>
<td>0/12</td>
</tr>
<tr>
<td>(p = .09)</td>
<td></td>
</tr>
<tr>
<td>Cusp number, lower 1st molar (16/43, 37.2%)b</td>
<td>3/9</td>
</tr>
<tr>
<td>Cusp number, lower 2nd molar (9/56, 16.1%)b</td>
<td>2/11</td>
</tr>
<tr>
<td>(p = .04)</td>
<td></td>
</tr>
<tr>
<td>Deflecting wrinkle (4/27, 14.8%)</td>
<td>2/8</td>
</tr>
<tr>
<td>Cusp 7 (2/65, 3.1%)</td>
<td>1/14</td>
</tr>
<tr>
<td>Root number, lower 2nd molar (20/66, 30.3%)c</td>
<td>3/13</td>
</tr>
<tr>
<td>(p = .03)</td>
<td></td>
</tr>
<tr>
<td>Groove pattern (4/70, 5.7%)d</td>
<td>2/15</td>
</tr>
<tr>
<td>Tuberculum dentale (14/61, 23%)</td>
<td>5/13</td>
</tr>
<tr>
<td>(p = .11)</td>
<td>(p = .05)</td>
</tr>
<tr>
<td>Carabelli's trait (10/30, 33.3%)</td>
<td>2/6</td>
</tr>
<tr>
<td>Parastyle (5/48, 10.4%)</td>
<td>2/12</td>
</tr>
<tr>
<td>Root number, upper 1st premolar (5/70, 7.1%)c</td>
<td>0/13</td>
</tr>
<tr>
<td>(p = .14)</td>
<td></td>
</tr>
<tr>
<td>Root number, upper 2nd molar (7/57, 12.3%)d</td>
<td>1/11</td>
</tr>
<tr>
<td>(p = .10)</td>
<td></td>
</tr>
<tr>
<td>Congenital absence, 3rd molar (10/81, 12.3%)</td>
<td>4/15</td>
</tr>
<tr>
<td>Root number, lower 1st molar (4/79, 5.1%)b</td>
<td>1/14</td>
</tr>
<tr>
<td>Protostylid (11/59, 18.6%)</td>
<td>1/12</td>
</tr>
<tr>
<td>Distal trigonid crest (5/50, 10%)</td>
<td>2/11</td>
</tr>
<tr>
<td>Shoveling (47/61, 77%)</td>
<td>11/13</td>
</tr>
<tr>
<td>Winging (25/41, 41%)</td>
<td>4/14</td>
</tr>
<tr>
<td>(p = .04)</td>
<td>(p = .09)</td>
</tr>
<tr>
<td>Cemetery sample size</td>
<td>20</td>
</tr>
</tbody>
</table>

\[a\] Cusp frequency is based on six cusps.  
\[b\] Cusp frequency is based on four cusps.  
\[c\] Frequency provided is for one root.  
\[d\] Frequency provided is for "Y" pattern.  
\[e\] Frequency based on two roots.  
\[f\] Frequency based on two roots.  
\[g\] Frequency based on three roots.

one cemetery by chance. In contrast, suppose 6 of 10 cemetery members exhibit trait X. The binomial probability of 6 or more of the 10 individuals displaying the trait is .38, a result likely to occur by chance.

For dental traits such as cusp number and root number, the binomial probability was calculated based on the most infrequent expression of the trait. For example, upper first premolars could have one to three roots. In this population, two roots was the least common (7.1 percent). Therefore, the binomial probability used the population frequency (7.1 percent) to determine whether the proportion of individuals with two-rooted first premolars from each cemetery was random or patterned. Groove pattern, cusp number, and root number variables all have more than two possible outcomes; each was treated in this fashion.
Figure 3. Map of Hawikku showing dental trait cluster assignments.
Individual cemeteries were then examined to determine whether they exhibited dental trait proportions different from what might be expected if traits were randomly distributed. Table 4 lists the dental traits examined, sample sizes for each trait and cemetery, and the statistical probability of individual trait proportions if less than .15.

Three traits have low binomial probabilities for two cemeteries: enamel extension, tuberculum dentale, and winging. These traits appear to have been nonrandomly distributed in this population. Every cemetery for which there are available data, except Cemetery 2, exhibits at least one trait with a relatively low binomial probability, suggesting an unequal distribution of some traits. Cemeteries 3 and 6 each have three traits with probabilities below .1. Cemeteries 1 and 9 exhibit two traits with a probability near .1. Cemeteries 10 and 11 each exhibit a trait with a probability at or below .05.

Although several individual probabilities are quite low, it is difficult to assess the overall statistical significance of these results, because 24 traits were examined. By simultaneously examining several traits across several cemeteries, as done here, the likelihood of obtaining low probabilities by chance is increased simply because there are more chances to identify a nonrandom distribution of traits. While not conclusive, these binomial probabilities suggest there may be some nonrandom distributions of particular dental traits, particularly in Cemetery 3.

Cluster Analysis of Dental Traits. Dental morphological data were also cluster analyzed in order to determine whether individuals buried in the same cemetery also would cluster together based on dental similarities. The quality of dental trait data was highly variable. The collection and analysis of dental morphological data is often complicated by marked tooth wear and the amount of pre- and postmortem tooth loss resulting in considerable missing data. Only 54 individuals for whom 50 percent or more of the dental morphological data were nonmissing and for which cemetery assignment is known were included in the cluster analysis. The cluster analyses were based on a matrix of Gower coefficients (transformed into a distance measure; Shennan 1988). The Gower coefficient was selected because it is designed to deal with both presence/absence and nominal data and can accommodate missing data. This similarity measure is calculated as the number of attributes for which two cases have identical values divided by the number of attributes for which both cases have valid data. For instance, given the following two cases: 0, 0, 1, 5, 1, 1 and 0, 0, 1, 4, 3, (last two missing), where 0s and 1s are presence/absence data for specific traits and larger numbers refer to cusp or root numbers, the Gower coefficient would be 3/4 or .75 (three matches out of four valid comparisons).

Several hierarchical clustering algorithms were executed using the Gower coefficients. Although there were differences between the results of the various methods, certain cases always clustered together. The results from the six-cluster solution using Ward’s method are presented here. In Figure 3, the 54 individuals used in the cluster analysis are plotted in their actual spatial locations; letters represent dental trait clusters A–F. The only exceptions are Cemetery 11 burials, which are located an unknown distance north of the pueblo. Therefore, Cemetery 11 burials are simply plotted together at the top of the figure. In addition, Burial 184 is located in Cemetery 9, but precise spatial information is lacking; it is not included in Figure 3 (it was assigned to Cluster A).

At first glance, it might appear that specific clusters (sets of burials with similar dental characteristics) are not strongly associated with individual cemeteries. However, such a result is expectable given the potentially disruptive factors discussed above. The most obvious patterning occurs in Cemetery 3, where six of nine members (67 percent) belong to Cluster A. Following the binomial logic used above, the likelihood of obtaining six or more Cluster A members from the nine individuals in Cemetery 3 is .04. A similarly low probability is obtained for Cluster F members in Cemetery 10 (p = .05).

Additional patterning can be found within certain cemeteries. If each cemetery was used by a kin group such as a clan, composed of a number of smaller units, such as lineages or families, small groups of individuals within cemeteries sharing
cluster membership might be expected (this tendency is described by Goldstein [1976]). For example, Cemetery 10 contains only a small number of inhumations (the remainder are cremations), restricted to the eastern portion of the cemetery. If these inhumations represent a lineage within a larger clan, it might explain the unlikely concentration of Cluster F members. There are several other instances of within-cemetery clusters. In Cemetery 1, four Cluster A members are localized in the south-central portion of the cemetery. In the northern portion of Cemetery 9 are a group of four Cluster C and three Cluster A members.

At an even finer level of analysis, there are a number of instances in which two or more individuals that share cluster membership are interred very close to one another. Several multiple burials occur at Hawikku; often they are composed of an adult female and child or two or more children. These cases seem to indicate that families used specific places within cemeteries to inter their dead. Pairs of burials in close proximity that share cluster membership (but do not actually share a grave) also may reflect this behavior. In the center of Cemetery 1, there are three such pairs (from Clusters A, F, and C); Cemetery 9 contains two pairs of Cluster A members—one in the south-central and another in the east-central portion of the cemetery. Of the six Cluster A members in Cemetery 3, two inhumations are immediately adjacent to each other at the northwest corner of the cemetery.

These results are consistent with what might be expected if exogamous clans (which are characteristic of ethnographic Zuni) used specific cemeteries. The number of instances in which more than one individual with the same dental trait-based cluster membership were buried very close together suggests that small kin-based units, perhaps matrilines (also characteristic of ethnographic Zuni), used a section of a larger cemetery. The dominance of Cluster A members in Cemetery 3 and the spatial positioning of small groups of burials that share cluster membership supports the hypothesis that each cemetery was used by one or a limited number of kin groups.

However, the dominance of Cluster A members in two different cemeteries (3 and 9) implies genetic similarities between the two, a result that would not necessarily be expected if each cemetery was used by a single kin group. This pattern might result from a prolific founding descent group that had split into two groups, perhaps clans. Although cluster analysis is generally an exploratory, not confirmatory, technique, we can rigorously measure the homogeneity of cluster membership.

Testing for Cluster Dominance. If the rationale for the burial of an individual in a particular cemetery was not at least partly kinship based, then there should be no relationship between the cemetery in which an individual was buried and his or her genetically based dental characteristics. If there is some kinship basis for burial placement, individual cemeteries should contain unusual concentrations of individuals associated with one or a few dental trait clusters (indicative of their genetic affinity). Although the binomial tests address this question on a cluster by cluster and cemetery by cemetery basis, it is possible to test this proposition directly by using an idea proposed by Koetje (1987:44–47).

We first need to measure the degree to which a single cemetery is dominated by members of one or a few dental trait clusters. For this purpose, we use Simpson’s C, a measure of concentration (Pielou 1975: 8–9) that is defined as the sum of the squares of the proportions of species in a community (in this case, dental clusters in a cemetery). The higher the value of C, the more a cemetery is dominated by members of a few clusters; with lower values of C, the dental clusters are more evenly represented within the cemetery. If all individuals in a cemetery were in the same dental cluster, the C value would be 1.0; if they were evenly divided among k clusters, C would approach 1/k, in this case 1/6 = .166. A second value, C+, provides an overall measure of dominance for the entire site. C+ is calculated as the average of the values of C for the cemeteries weighted by the number of burials in each.

Based on the values in Table 5, for Hawikku, C+ is .33. This is somewhat higher than we would expect by chance. That is, consistent with our expectations, dental trait clusters are nonrandomly concentrated in spatially distinct cemeter-
Table 5. Distribution of Cemetery Members by Cluster (Ward’s Method), Associated C Values, and Probabilities.

<table>
<thead>
<tr>
<th>Cemetery</th>
<th>Cluster</th>
<th>Total</th>
<th>C Score</th>
<th>Estimated Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A 4</td>
<td>B 1</td>
<td>C 3</td>
<td>D 2</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>8</td>
<td>12</td>
<td>4</td>
</tr>
</tbody>
</table>

ies. In deriving this result a Monte Carlo analysis was used to estimate the $C'$ that would be expected if there were no relationship between the cemetery and the dental cluster assignment of a burial. This analysis holds constant the number of burials within each dental trait cluster (18 in A, 8 in B, etc.) and the number of (analyzed) burials within each cemetery. Then it randomly associates dental cluster assignments with graves, producing a new table that has the form of Table 5 and maintains the same marginal totals. That is, the same number of graves is in each cemetery and the same number of individuals is assigned to each of the six dental trait clusters, but, by design, there is no association between cemetery and dental cluster. Thus, $C'$ calculated for this new table is the result of a truly random process in which there is no relationship between cluster and cemetery. Because any single random configuration might, by chance, show a high or low concentration, we repeat this process many times. An average $C'$ over 100,000 such trials is .30. Values of $C'$ as high as the observed .33 occurred in only 8 percent of the random trials, suggesting some relationship between dental characteristics and the cemetery in which an individual was buried. A relationship this strong is unlikely (although not terribly so) to have occurred by chance ($p = .08$).

We should not be surprised that the relationship is weak, given the sparse nature of the data matrix being analyzed (54 burials distributed among 6 dental trait clusters and 7 cemeteries) and given the factors that mitigate against observing a patterned distribution, even where the proposed relationship actually holds.

The probabilities for individual clusters (Table 5) generally confirm some of the impressions one receives from an examination of the spatial distribution of cluster membership. Probabilities of .03 and .08, for Cemeteries 3 and 9, respectively, reflect a nonrandom distribution of cluster members. Cemetery 3 is dominated by Cluster A members, and Cemetery 9 is dominated by Cluster A and C members, as discussed above. (Recall that Cemetery 3 showed, by far, the strongest patterning in the binomial analysis with probabilities of occurrence for three traits below .05.)

Overall, this nonrandom patterning of genetic markers suggests that there is a genetic component to cemetery membership. If one considers the factors that can work to obscure spatial patterning (e.g., processes of genetic inheritance, degree of genetic homogeneity, social rule flexibility, possible merging of cemeteries) and the strong ethnographic pattern of spatially discrete cemetery use by kin groups, these results are consistent with the hypothesis that each cemetery was used by one or a limited number of kin groups. Furthermore, this genetic component of cemetery membership is difficult to explain without reference to some kind of kin group organization.

**Kinship and Political Organization at Hawikku**

The identification of kin groups is not an end in itself but rather can be used to study several kinds of problems, such as differences in wealth, access to certain goods or burial treatments, or health and diet. One of us has used this identification of cemeteries with kin groups to explore political structure (Howell 1994:84–103 provides a more detailed account of this analysis). By identifying
community leaders and assessing their distribution among kin groups, the structure of decision making, as well as the means of leadership selection, can be examined.

In most societies leaders maintain a larger number of social roles than ordinary citizens. We use the term social role to refer to what Goodenough has called a social identity, that is, a social category that determines “how one’s rights and duties distribute to specific others” (1965:3). Every social relationship defines an expected set of rights and responsibilities between two people. “Leader” is used to refer to individuals at the apex of the decision-making structure that make community (or intercommunity) decisions. Leaders wear many “hats,” reflecting roles such as war leader, dispute arbitrer, ambassador, moral role model, ceremonialisnt, or controller of trade (Feinman and Neitzel 1984:52–53). Zuni ethnography provides an example of the tendency for leaders to hold a large number of social roles.

Membership in the council of priests, the principal decision-making body described around 1900 at Zuni, was based on other important positions such as priesthood membership or head of the Bow society. Each of these positions, in turn, was based on other achieved and ascribed roles (Eggan 1950). The death of a community leader, because of the greater number of social roles (relationships) held in life, means a greater community involvement than the death of a nonleader; more of the population recognizes some kind of responsibility to a leader at death (Binford 1971:17).

If we are to use the number of roles to indicate leadership, the methodological challenge is to use mortuary remains to measure the number of social roles held in life. Grave goods and special body and grave preparations are potential symbols of social roles. Thus, a rough index of the number of social roles held in life, for each individual, is a count of the number of different types of grave goods, special body preparations, and grave attributes. This diversity score focuses on qualitative differences in mortuary treatment because it is the presence, not the quantity, of mortuary treatments and offerings that appears to symbolize a social role (Braun 1979:67; cf. Ravesloot 1988). Leaders are argued to be those individuals in the burial population who exhibit high diversity scores.

The use of this measure is not without its potential problems. Not all treatments or artifact classes are equal in their use as mortuary symbols. For example, the inclusion of corn may reflect a world view that prescribes a need for food in the afterlife. World view, however, should be consistently held by all, limiting differential treatment. Some social roles may be redundantly symbolized; that is, more than one grave good or grave or body treatment may be used in concert to symbolize a particular social role (resulting in inflated diversity scores). Some ritual behaviors intended to symbolize social roles are not archaeologically visible. Dancing, praying, and washing the deceased are a few possible examples. Aside from social roles, other aspects of life could also be symbolized, including idiosyncratic personality traits, circumstances of death, kin group mem-
bership, age, sex, and economic roles. However, these "other" aspects of life (and death) provide far fewer opportunities to symbolize than the vast number of potential social roles in society. Each of these factors could work to undermine an archaeological attempt to measure social roles from mortuary remains. However, they are probably not serious enough to render the diversity approach unusable. Although diversity scores may be somewhat inflated or depressed for some burials, the diversity score should provide a reasonable relative measure of the number of social roles held in life.

Seventy-six grave goods, four grave preparations, and one body preparation were coded from the burial excavation notes as present or absent for 955 of the Hawikku burials. This number includes all cemetery burials (n = 873), sub-floor burials (n = 63), and burials without specific provenience information (n = 19). For grave goods, classes of objects were coded as present or absent; no detailed typologies were used. The only material type that was treated slightly differently was ceramic vessels, for which the following variables were used: utility ceramic, decorated jar, decorated bowl, and ladle (because each had a different use and hence potentially different symbolic meanings). Figure 4 is a histogram of diversity scores. Over one-half of the individuals had a diversity score of zero or one, and the number of burials with higher diversity scores progressively decreases. The highest diversity score in the sample is 36. There is a continuous distribution of scores to 16; only four burials scored higher. Because individuals with a high diversity score were probable leaders, the four highest diversity burials are the most likely candidates. We might expect additional leaders to have burial treatments similar to these four. Cluster and correspondence analysis (Howell 1994:88–108) identified an additional seven individuals, all with high diversity scores, that, along with the four highest diversity burials, likely functioned as community leaders. These high diversity graves tended to contain rare artifact classes that likely symbolized leadership roles; some of these classes were found exclusively with these 11 burials. It is also interesting to note that whereas most artifact classes occurred in small numbers in graves, the 11 high diversity graves tended to contain large numbers of certain classes (especially ceramic vessels).

Eight of these burials were adult males; half were treated very similarly and were interpreted to have held the same leadership position. A war club, bow, and arrow likely represented a "badge of office" exhibited by these males (all four had a bow and three of four exhibited a war club and arrows). War clubs were found exclusively with these burials, whereas bows and arrows were slightly more common (in 6 [.06 percent] and 10 [.1 percent] graves, respectively). One member of this group had the only occurrence of a human scalp. Warfare, or village defense, appears to have been a prime responsibility. Two other burials in the group of eight had bows and arrows and appear to have been an earlier version of the warfare position (all the burials that reflect warfare positions share some symbols of the Zuni Bow Priesthood and are similar to Bow Priest burials, recorded around the turn of the century [Stevenson 1904:288, 583, 585]). The last two male burials seemed to have leadership positions concerned with ritual and ceremony.

Three of the high diversity burials were female (they include three of the four highest diversity graves); they exhibit a great deal of similarities. All three exhibit the following grave goods: corn, squash, utility ceramic, decorated bowl, mano, metate, basket, and shaped wood. Two of the three had paint-grinding stones, antler tool, gourd, decorated jar, feather, and human hair. There appears to be an emphasis on domestic items used in household food preparation, storage, and serving and on ritual items, such as paint-grinding stones, gourd (possible rattle), feather, and human hair. Human hair occurs as an offering in fewer than .5 percent (4 of 955) of Hawikku graves. In the grave pit of one of these women a shrine, composed of shaped and painted wood, string, and feathers, was erected (the only such occurrence at Hawikku). Given the lack of an historical analog of female leadership, it is difficult to interpret the possible function of the role(s) indicated here. One of us has argued that these three women held two roles—one that is analogous to the head of a matriline or some equivalent role, and a second,
less-well defined leadership role associated with ritual (Howell 1995:142–143).

The kin groups, as indicated by cemetery, can be used to determine whether leaders were selected ascriptively, that is, whether one or a limited number of kin groups furnished leaders. Eight leaders were buried in Cemetery 9, and three were buried in Cemetery 1. Although these two are among the largest three cemeteries, it is unlikely that by chance eight leaders would be among the 301 burials in Cemetery 9 (p = .03) or that no leaders would be found among the 226 in Cemetery 10 (p = .06; binomial probabilities based on an overall .013 = 11/873 proportion of leaders). This concentration of leadership roles in only 2 of 11 kin-based cemeteries suggests that leadership was based, in part, on kin group membership. There seems to have been an ascriptive element to leadership selection at Hawikku.

Discussion and Conclusions

Among cemeteries at Hawikku, age and sex composition and the distribution of dental morphological traits suggest that spatially distinct cemeteries at Hawikku represent kin groups. These results support the observations of Saxe and Goldstein regarding the importance of mortuary spatial patterning for understanding social structure. The use of a specific area by a kin group to bury their dead may be a remarkably widespread phenomenon; more investigation is required to assess the extent of this cultural practice.

The analysis of leadership roles provides just one possible avenue of inquiry that can be undertaken once kin groups are identified. We have shown how an attempt to identify kin groups by using mortuary data is greatly enhanced by bridging subdisciplinary boundaries and making use of one or more biological measures of genetic distance as an independent measure. Given the primacy of kinship as an organizing principle in nonstate societies, this approach, or similar ones that utilize both spatial information and biological measures of genetic distance, hold great potential for understanding many aspects of social structure.

Acknowledgments. We thank Brenda Shears for access to the remarkable mortuary data set from Hawikku, provided with the cooperation of the National Museum of the American Indian and the Arizona State Museum Archives. Shears directed a National Endowment for the Humanities-funded documentation grant that codified and made readily usable the extensive notes and other documentation of the Hendricks-Hodge expedition. We are grateful to Christy Turner for generously making available his Hawikku dental trait data. Dr. Turner’s collection of the dental data was funded, in part, by a National Geographic Society grant. Bernardo Arriaza, Vicki Cassman, George Cowgill, James Hill, John O’Shea, Brenda Shears, Christy Turner, and an anonymous reviewer provided comments on previous drafts of this paper that have improved its clarity.

References Cited

Allen, W. L., and J. B. Richardson III

Alt, K. W., and W. Vach

Anderson, K. M.

Binford, L. R.

Braun, D. P.

Davis, J. C.

Effland, R. W., Jr.

Eggan, F.

Feinman, G., and J. Neitzel

Ferguson, T. J.
1981 The Emergence of Modern Zuni Culture and

Friedrich, M. H.

Goldstein, L.

Goodenough, W. H.

Haury, E. W.

Hill, J. N.


Hodge, F. W.
1937 The History of Hawikuh, New Mexico. One of the (So-Called) Cities of Cibola. Southwest Museum, Los Angeles.

Howell, T. L.


Hrdlicka, A.

Koetje, T.

Larson, L. H.

Lischka, J. J.

Longacre, W.


Lothrop, S. K.

Meggitt, M. J.

Mitchell, D. R., T. M. Fink, and W. Allen

Morris, I.

O’Shea, J. M.

O’Shea, J., and M. Zvelebil

Pielou, E. C.

Plog, S.

Ravesloot, J. C.

Saxe, A. A.

Scott, R. G., and C. Turner II

Shennan, S.

Smith, W., R. B. Woodbury, and N. F. S. Woodbury

Stanislawski, M.

Stevenson, M. C.
1904 The Zuni Indians: Their Mythology, Esoteric Fraternities, and Ceremonies. In Twenty-third Annual
Tainter, J. A.

Turner, C. G. II

Turner, C. G. II, C. R. Nichol, and R. G. Scott

Watson, P. J.

Received April 14, 1995; accepted October 4, 1995.