Chapter 3

Materials And Methods

This chapter describes the methods employed in all four phases of the project: site reconnaissance, excavation, data collection, and analysis.

Site Reconnaissance

Survey Methods

Although our reconnaissance, which took place in autumn of 1989, covered the same 3-km stretch of bluffs that was investigated by Wilson two years earlier, our survey methods were significantly different. Whereas Wilson relied on judgmental survey techniques, focussing on large boulders with prominent, open-mouthed crevices, we attempted total systematic coverage of the study area, examining the perimeter of every boulder for small, hidden crevices that might contain human bone. The reconnaissance was conducted in longitudinal transects oriented parallel to the bluffs, with crew members positioned between five and ten metres apart. The crew maintained constant visual and voice contact to ensure that all boulders and rock outcrops were thoroughly examined on all faces. Since several traverses were necessary to cover the entire rockfall area and bluff face, the crew member at the end of the survey line marked his/her position with red flagging to delineate the edges of the surveyed area for ready identification on the return sweep.

Areas surveyed included the vertical rockfaces exposed at the top of the bluffs; the steep, forested slopes below the rockface which were littered with exfoliated sandstone and conglomerate boulders and marked by occasional bedrock outcrops; and the boulder accumulations along the toes of the slopes. Boulders located at the base of the slopes were often covered with brush piles and logging slash from adjacent cleared fields, which tended to obscure any crannies or declivities beneath or between the rocks. Long sticks were employed to probe through the brush along the base of the boulders; if a cavity or depression was detected between the bottom edge of the boulder and the ground surface, the brush piles were pulled apart or cut away until the area was clear enough for close inspection.

Crevices and crannies were inspected with high-powered flashlights, and wherever the openings were sufficiently large, a crew member would crawl inside to inspect the chamber at close range. In cases where the openings were too narrow to permit entry, flashlights supplemented with mirrors were employed to inspect the interiors. When a feature containing human bone was located, it was flagged with red survey tape labelled with site and feature number, and pertinent information was recorded on a standard Feature Record Form.

Once a section of the bluffs had been surveyed, the provenances of the identified features were recorded. Burial features located in proximity to the Mussel Heights housing development were provenienced with reference to the nearest property pin. Prominent boulders were selected as arbitrary datum points for features not located within convenient distance of a permanent established datum. Given the serious problem of vandalism at some of the burial features, it was necessary that these arbitrary datums be conspicuous enough for easy relocation, but not so conspicuous as to draw the attention of pothunters or vandals to previously undisturbed burials. Datum points were marked with red paint on the selected boulder, and true compass bearings and taped distances measured from this point to the feature in question. The labelled flagging was then taken down and placed in an inconspicuous location within the feature, to avoid drawing unwanted attention to the human remains.

Recognizing that our skills in identifying burial features improved with experience, after the site reconnaissance was completed, the crew re-surveyed the portions of the upper bluffs that had been examined during the first week of field work. Three additional burial features were discovered during this resurvey. Two of these features had previously been inspected: in one case the human bones were newly exposed by animal activities; in the other the bones had been missed during the first inspection. In the third case, the feature entrance was so well concealed that its eventual discovery was surprising.

Recording Procedures

Since many of the features appeared to be associated spatially, it was decided that each crevice or cave containing human remains would not be assigned a separate site number, but that clusters of such features would be considered part of the same burial site. As a result of Wilson's survey, site numbers had already been assigned to three burial areas: DgRw 199, DgRw 204, and DgRw 210. Additional burial features discovered in the vicinity of these previously recorded sites were subsumed under the same site number, but assigned a unique feature number, with Feature 1 at each site reserved for the burials recorded by Wilson (i.e., DgRw 204-F1). Burial features remote from existing sites were assigned a new site number.

In areas of dense boulder concentrations, it was sometimes difficult to determine where one burial feature ended and another began. To facilitate recording it was decided that all caves or crevices located beneath a single capping stone would be considered part of the same feature, and that caves or crevices capped by different boulders would be considered different features regardless of their proximity. The sole exception to this rule was DgRw 199-F1, which, following Wilson's (1987) and Skinner's (1991) previous work, was treated as a single feature despite the fact that the two burial chambers were capped by separate sandstone blocks.

Standardized feature recording forms were completed in the field for each burial feature. The following information was included on each form: **Site Number,** following the Borden (1952) system of site designation; **Feature Number,** assigned sequentially within each site, as new burial features were discovered during the survey; **Location:** legal description of the property on which the feature is located; **Provenience:** true compass bearing and tape distance from site datum or property pin; **Orientation:** direction the cave/crevice opening faces, using true compass bearings; **Feature Type:** the structure of the feature, whether it is formed by a cluster of fallen boulders (Type I), a crevice beneath a single boulder (Type II), a ledge or crevice in the cliff face (Type III), or is located in the open, unassociated with rock formations (Type IV); **Number of Chambers:** if the feature is subdivided internally into two or more sections by component boulders, ceiling extensions, or other structural elements; **Height of Opening:** maximum height of the entrance to the burial cave/crevice, measured with metric tape to the nearest centimetre; **Width of Opening:** maximum diameter of the entrance; **Depth of Chamber:** a measure of approximate chamber size, obtained by extending the tape measure from the feature entrance to the back wall; **Sediments:** a description of the non-cultural materials visible on the floors of the burial features, including leaf litter, sandstone and conglomerate rubble, and animal faeces; **Bones Visible:** a catalogue of all human skeletal remains visible in the feature, with determination of broad age categories (infant, child, adolescent, adult) where possible; **Minimum Number of Individuals:** an estimate of the minimum number of individuals represented in each burial feature, based on visible skeletal elements; **Inclusions:** any materials that may be of cultural origin, such as artifacts, hearth features, midden deposits, or faunal remains; **Disturbance:** any evidence of animal or human intervention that may have affected the integrity of the deposits; **Documentation:** a record of field photographs, field notes, and drawings made of the feature; **Comments:** additional information about the structure of the feature, its setting, and any peculiarities worth noting.

Excavation Methods

Five of the burial features recorded during site reconnaissance were selected for excavation in order to collect a sample of human skeletal remains for analysis. Prior to excavation, the area around each of these features was mapped at a scale of 1:100 to illustrate its location relative to the site datum and to other features in the vicinity. Accumulated brush and leaf litter were cleared away from the perimeters to expose structural details. Plan drawings were made of each floor, indicating the positions of identifiable surface remains, and the features were mapped in cross-section to illustrate the slopes of ceiling and floor. A grid of 1.0 x 1.0 m excavation units (EUs) was then established over the feature floor, augmented by small unit extensions (EXs) of variable size and shape where necessary to ensure complete coverage of the floor. Excavation units and unit extensions were sub-divided into 50 x 50 cm quadrants, and dug by trowel in 5-cm arbitrary levels; excavated sediments were sieved through nested screens of 6-mm and 3-mm mesh. Cultural materials (human bone, vertebrate fauna, and artifacts) collected from the screens were bagged according to three-dimensional provenience (unit/ extension, quadrant, and level). In most cases, floor plans were drawn to scale at the bottom of each excavated level, and the locations of all human elements discovered *in situ* plotted on the plan. This was not possible at DgRw 199-F1 due to the high density of human remains in this feature. All human bone clusters encountered during excavation were examined for possible anatomical articulations between elements before removal.

Excavation continued until culturally sterile deposits were encountered, or until further excavation was blocked by the presence of large immovable boulders. Stratigraphic profiles were drawn of the walls of one or more excavation units to illustrate the natural layers comprising the cultural deposits. Two-litre matrix samples were collected from each natural layer of DgRw 204-F1, and each arbitrary level of DgRw 199-F1 and DgRw 199-F9 to ensure the recovery of microfauna that might be missed during excavation and screening, and to provide quantifiable information on the abundance and species of invertebrate fauna present.

Data Collection

Human Remains Catalogue

Recovered human remains were washed in clear water and air dried for several days before further processing. Since the vertical and horizontal distribution of elements across the burial chamber can provide useful information about burial practices and post-depositional taphonomic processes, specimens were first catalogued according to three-dimensional field provenience before reconstruction was attempted, with one exception: specimens exhibiting recent fractures indicative of recovery/transport damage were reconstructed prior to cataloguing and treated as a single fragment rather than as two conjoined pieces (see below). Bone fragments too small to identify or to carry a catalogue number were counted, bagged by provenience unit, and assigned a single catalogue number.

More detailed information was collected on the remaining specimens. In addition to provenience, twelve categories of information were recorded in the Human Remains Catalogue. The first three categories are concerned with specimen identification: **skeletal element** (e.g., mandible, femur, rib), **side**, and **portion recovered** (e.g., complete, distal third, metaphysis fragment). Long bones shaft fragments that could not be attributed to a specific element were sorted into two groups based on approximate shaft diameter: humerus/tibia/femur and radius/ulna/fibula.

The next two categories (**age** and **sex**) refer to demographic characteristics of the individual from whom the specimen came. Where possible, specimens were assigned to the following age classes: infant (<2 years of age), child (2-10), juvenile/adolescent (11-20), young adult (21-35), middle adult (36-50), and old adult (> 50 years). Subadult age determinations were based on dental development, long bone lengths, and sequence of epiphyseal closure, according to the standards recommended by Buikstra and Ubelaker (1994). Adult ages were estimated from the extent of ectocranial suture closure (Meindl and Lovejoy 1985), progressive degenerative changes in the pubic symphysis (Brooks and Suchey 1990) and auricular surfaces (Lovejoy et al.1985), and degree of dental attrition, using the prehistoric Tsawwassen sample as a standard (Curtin 1991a). In practice, however, very few specimens could be aged with this degree of precision, and in most cases only an adult/subadult differentiation was possible. Sex determinations were even more problematic. With the infrequent exceptions of unusually well-preserved cranial and pelvic elements, only those elements at the morphological extremes of size and robusticity could be assigned a sex attribution with any degree of confidence. Later in the analysis, after the conjoining exercise was completed (see below), age and sex attributions were reassessed for the larger and more complete reconstructed specimens, and in many cases it was possible to refine earlier demographic estimates, or assign values to previously unaged or unsexed elements.

Next, the **condition** of each specimen was subjectively assessed as poor, fair, or good, according to the degree of weathering and/or exfoliation of cortical surfaces, and the preservation and integrity of trabecular bone. Many bone fragments were observed to be coated with an opaque, greyish-white calcareous plaque that was very resistant to removal. Most often this presented as small discontinuous patches, but occasionally it formed a thick, continuous sheet completely encasing the fragment and obscuring the cortical surface. Presence and extent of this **mineral plaque** was also recorded in the Human Remains

Catalogue, in the hopes that the distribution of affected elements throughout the burial chambers would provide clues as to its origin.

The next three data categories (**burning**, **chew marks**, and **tool marks**) record *post mortem* modifications to the specimens. The presence and degree of **burning** was assessed primarily on the basis of bone colouration as follows: (a) absent: no apparent heat-related changes; (b) slight: very light or localized discolouration with reddening or darkening of the bone; (c) moderate: extensive discolouration, dark brown to black charring or "smoking"; or (d) severe: heavily calcined, white, grey, or blue-grey in colour, often exhibiting shrinkage and warping. Once the burnt specimens had been reconstructed (see below), they were reevaluated with reference to patterns of burning damage over skeletal elements and anatomical regions of the body in an attempt to discern the condition of the bones at the time of burning, i.e., fleshed, defleshed but "green", or dry. Although the original state of the bone is only one of several variables that may affect osseous burning patterns (others include length of time in the fire, intensity of heat, and location of the bone relative to the point of oxidation of the flame), experimental studies have shown that it is possible to distinguish between the three states by examining such features as the presence and depth of surficial checking, frequency and orientation of fracture lines, and patterns of burning with reference to soft tissue cover in life (Baby 1954; Binford 1963; Shipman et al. 1984; Buikstra and Swegle 1989). From this information it is possible to infer whether the burning was a product of deliberate cultural practices, such as mortuary ritual (cremation) or food preparation (cannibalism), or the result of accidental exposure to fire, as in a forest fire.

Presence, location, and form of modification resulting from **animal chewing** was recorded as an indicator of post depositional taphonomic processes inside the burial caves. Two main types of chew marks were distinguished: rodent gnaw marks (continuous series of short, shallow, relatively broad grooves along bony ridges and crests, and at the sites of muscle and ligamentous insertions) and carnivore chew marks (conical puncture marks and linear scratches or "scoring", often in association with splintering of thinner cortical areas).

The third category of *post mortem* bone modification recorded is **tool marks**, which are always diagnostic of deliberate human intervention. Tool marks were classified into four types based on morphology and inferred etiology, following White (1992): cutmarks (narrow, linear, v-shaped incisions produced by slicing with a sharp blade); chopmarks (broad, wedge or v-shaped depressed fractures, produced by a striking action with the edge of an implement); scraping marks (clusters of superficial striations across a bone surface, produced by the removal of large segments of soft tissue); and percussion striae (very localized clusters of short, fine striations found in association with percussion fractures). The anatomical location, number, dimensions, and type of all tool marks were recorded.

The final category of information recorded in the Human Remains Catalogue is **pathology**; it includes observations on trauma, degenerative changes, infectious processes, and congenital anomalies, as well as non-specific alterations in bone texture, quantity, or morphology.

Reconstruction and Conjoining

Once all the human remains from a burial feature had been catalogued they were sorted according skeletal element and all fractured edges compared for possible articulation with other fragments. Pieces found to conjoin were reconstructed using water-soluble white glue, and a record was kept of both the number of articulating pieces and the original field provenience of each constituent piece in a conjoined "set". This information was then used to assess the degree of horizontal and vertical dispersal of fragments from a single bone. Conjoined sets whose constituent pieces all came from the same 50 x 50 x 5 cm provenience unit (unit/quadrant/level) were assigned horizontal and vertical dispersal scores of 1 (H=1, V=1); these numbers were summed to provide a total scatter score (TS) of 2. Similarly, sets whose members were found at the same level of two adjacent quadrants were scored H=2, V=1, TS=3, and sets whose members came from 4 levels of the same quadrant were scored H=1, V=4, TS=5. Calculated dispersal scores were then used to evaluate mortuary behaviour and taphonomic processes both within and between burial features.

Dispersal scores are subject to a number of biases, however, and can provide only a rough approximation of the true extent of scattering of bone fragments within burial features. Time constraints were a serious limiting factor during this exercise, allowing only a fraction of potentially conjoinable fragments to be reconstructed. It seems plausible that fragments from the same or adjacent provenience units would be more likely to be successfully conjoined than those from widely dispersed areas, simply because familiarity would enhance the likelihood of pattern recognition. Another potential problem is the lack of equivalency of the horizontal and vertical dispersal scales, although the ones arbitrarily selected may reflect actual dispersal processes more accurately than a strictly equivalent scale.

Data Collection

After the conjoining exercise was completed, age and sex determinations and observations on pathology were reassessed in the light of the more complete reconstructed specimens. Standard osteometric data were collected on the reconstructed elements, following methods described in Buikstra and Ubelaker (1994). It should be emphasized, however, that due to the highly fragmented condition of the remains, these data are very sparse and incomplete. Observations on nonmetric traits of the teeth and infracranial skeleton were also made at this time. Traits recorded include 43 crown and root variants of the permanent dentition (defined in Turner et al. 1991), which were scored using the Arizona State University visual reference plaques to standardize observations, and 54 morphological variants of the infracranial skeleton, following the trait definitions and scoring procedures of Saunders (1978).

Minimum number of individuals (MNI) was then calculated for each skeletal element by subdividing the sample by age (adult/subadult) and by side and counting the number of adult specimens from the same side which exhibited a readily identifiable anatomical landmark, such as radial tuberosity or femoral lesser trochanter. All subadult specimens (both sides) were then seriated according to age (based on relative size) and the minimum number of subadults estimated based on a combination of age/side considerations. The adult and immature MNI estimates were summed to produce a total MNI score for each skeletal element, and the highest MNI derived from a particular skeletal element was accepted as the minimum number of individuals represented in the burial feature.

Upon completion of data collection, selected specimens were photographed and radiographed before the cave/crevice burial collection was returned to the Nanaimo First Nation for reinterment.

Comparative Analysis

To test the relative contributions of biological, chronological, and cultural differences to mortuary variability on Gabriola Island, the inland cave/crevice burials were compared with an existing human skeletal collection from the False Narrows midden, located on the shore approximately 800 m southwest of the inland bluffs.

False Narrows Burial Sample

False Narrows (DgRw 4) is a large (ca. 1,300 x 100 m) shell midden located near the middle of the southern shore of Gabriola Island, opposite Mudge Island. It contains archaeological components dating to the Marpole and Developed Coast Salish periods of coastal prehistory, as well as a more recent occupation identified with the ethnographic Nanaimo village of *Senewélets*, a seasonal clam-gathering location (Burley 1989). The False Narrows midden burial sample was recovered in the course of controlled excavations at DgRw 4 in 1966 and 1967 (Mitchell 1967, 1968; Burley 1989), and analysed by M. Gordon for her 1974 M.A. Thesis. On the basis of their stratigraphic location and associated grave goods, the majority of the recovered burials were assigned to the Marpole component; a smaller group of 4-5 individuals was attributed to the later Developed Coast Salish component.

There is some uncertainty as to the exact number of individuals represented in the False Narrows collection. Based on the sequence of assigned burial numbers, it appears that 53 burials were identified in the field. Gordon's subsequent analysis was based on 49 of the original burials (four could not be relocated); however among these 49 burials, she identified the remains of 82 individuals. Individuals newly identified in the lab were differentiated by lower case letters appended to the original burial number (i.e., Burial 51a, Burial 51b). While it is not uncommon for the more careful and detailed inspection that is possible under lab conditions to result in the identification of individuals not initially recognized in the field, there appear to be other factors operating in the case of the False Narrows burial sample. Re-examination of these remains in the course of the current project demonstrated that many of the "new" individuals defined by Gordon were actually parts of the original 53 burials. For example, the remains designated Burial 51b were found to articulate with elements from Burial 50, and remains designated Burial 30b contained elements from at least three different burials (Burials 19, 22, and 26). Two processes appear to have contributed to this confusion. The first is the prehistoric disturbance of earlier burials by later interments, a common occurrence in cemetery areas that have been repeatedly used over long periods of time. This was clearly a significant problem at False Narrows, where a minimum of 46 burials were recovered from one relatively small 5 x 4 m excavation area (Unit 1). There are also indications that some of the burial remains were inadvertently commingled prior to cataloguing, when the bones were in transit to the University of Calgary for analysis.

Because of the uncertainty of many of the existing burial attributions, the entire sample was reassessed in terms of individuation, age, and sex, before data were collected for use in the current analysis. Methods of age and sex determination followed the recommendations of Buikstra and Ubelaker (1994), with the specific standards employed dependent on the relative age and completeness of each skeleton. Most of the skeletons are relatively incomplete, due in part to the problem of prehistoric burial disturbance, but also as a result of the excavation strategy, which dictated that only those portions of a burial which actually intruded into an excavation unit would be collected. Since many burials were not fully exposed or collected, it was often difficult to differentiate intact primary interments from scattered, disturbed remains both in the field and later in the lab.

Reevaluation of the burial sample resulted in a revised estimate of between 62-64 individuals, including 37 adults (> 20 years of age), 4 late adolescents (15-20 years), 7-8 juveniles (11-15 years), 9-10 children (2-10 years), and 5 infants (< 2 years). The False Narrows collection is remarkable for the unusually high proportion of subadults (41%), which are usually under-represented in Northwest Coast burial sites. No significant sex bias is apparent among adults from the site: 19 were classed as females, 16 as males, and 2 were of indeterminate sex. Due to the incompleteness of most of the skeletons, adults could be aged only within rather broad categories: young adult (approximately 21-35 years), middle adult (36-50 years), and old adult (> 50 years). Adult age determinations are presented in Table 3.1 for the whole sample, and for each sex separately.

Mortuary treatment at False Narrows is similar to that recorded at other prehistoric midden cemeteries: most of the bodies appear to have been placed in a flexed or semi-flexed position in shallow pits dug into the midden matrix. At least 11 of the burials have associated rock features, either one or two boulders or sandstone slabs placed over a portion of the body, or in two cases, a cairn of several large boulders completely covering the skeleton (Burley 1989). One of the cairn features (associated with an adult female/infant double interment) was capped by a cluster of whole horse clam shell valves. Grave goods were found in association with 19 (30%) of the burials (including an adolescent, Burial 52, whose skeleton could not be relocated, and which is not included in the above tabulations or in the comparative analysis). Interestingly, with the exception of infants (none of which had associated artifacts), grave inclusions were more likely to be found with all categories of subadults (child n=4, 42%; juvenile n=3, 40%; adolescent n=2, 40%) than with adults (n=10, 27%). Artifact associations range from very simple (single ornaments or tools) to very elaborate (thousands of beads, elaborately carved pendants, and ceremonial paraphernalia); a complete catalogue of grave goods and associated burials can be found in Burley (1989).

Biological Distance

The biological distance between the two Gabriola Island skeletal samples was assessed through analysis of nonmetric dental and skeletal morphological variants (also known as discrete, epigenetic, or quasi-continuous traits). The genetic basis of such variants and their utility in the elucidation of biological relationships was first demonstrated by the pioneering studies of Grüneberg (1952), Grewal (1962), and Berry (1963, 1964, 1968) on wild populations and inbred strains of mice, and the methodology has since been applied with considerable success to studies of past human populations. Although their precise mode of inheritance is unclear, it is postulated that nonmetric traits are determined by multiple genes with additive effects. The underlying genetic component is continuous in distribution, but the phenotypic expression of the genotype is governed by a threshold effect based on size, such that if the additive effects of the genes involved fall below a critical level, the trait will not be expressed morphologically, but if the additive effects exceed the threshold the trait will be expressed. Theoretically, within a biological breeding population, the probability of offspring having below-threshold or above-threshold gene associations is fixed within limits, so discrete trait frequencies are a real property of that population (Berry 1968).

Nonmetric traits were initially thought to be superior to metric variables in discriminating between populations because they appeared to be less affected by environmental influences, less subject to age and sex bias, free from intervariable correlations, and unambiguous in expression (Howe and Parsons 1967; Berry 1968; Anderson 1968); consequently it was felt that they reflected the underlying genotype more faithfully than did skeletal measurements. More recent research has demonstrated that these assumptions are not necessarily valid for all morphological variants, so some caution is necessary in selecting traits for use in distance studies. One definite advantage of nonmetric traits, however, is that they can be scored on very fragmentary and incomplete skeletal remains giving them a wider applicability than strictly metric analyses.

Studies of biological distance between human populations have relied primarily on cranial and dental traits, probably because the skull is the most intensely studied region of the human skeleton and therefore the most likely to be preserved in museum collections. Cranial variants were deemed inappropriate for this study, however, due to the possible confounding effects of artificial cranial deformation, which is prevalent in the False Narrows midden sample but rare among the cave/crevice burials. Although there is no consensus as to the magnitude of the effect of artificial deformation on cranial trait frequencies, the usual practice is either to exclude deformed skulls from distance analyses altogether (Ossenberg 1970), or to compare them only with other deformed skulls (Konigsberg et al. 1993).

Table 3.1 Adult age distributions, False Narrows burial sample.

Age	Male	%	Female	%	Total	%
Young Adult	7	0.44	11	0.58	20*	0.54
Middle Adult	6	0.38	7	0.37	13	0.35
Old Adult	3	0.19	1	0.05	4	0.11
Total	16	1.00	19	1.00	37	1.00

*Includes two individuals of undetermined sex

Infracranial morphological variants have been used much less frequently in biodistance studies, although in theory they should be analogous to cranial and dental traits in their reflection of underlying biological relationships (Saunders 1978). The validity of any biological distance analysis, whether based on dental, cranial, or infracranial traits is dependent on the selection of appropriate traits for study: those with a strong genetic component, that are unaffected by dietary, pathogenic, functional, or mechanical influences, are independent of sex and age, are not correlated with other traits, occur with variable frequencies in different populations, and can be scored accurately and reliably.

Variants employed in this biodistance analysis are a subset of the dental and infracranial traits described above. Due to the incomplete and fragmented nature of both the False Narrows and the cave/crevice collections, in most cases it was not possible to test the samples directly for intertrait correlations or age and sex bias; therefore traits selected for inclusion were ones that have been demonstrated to be free from such influences in previous studies. Using this criterion, Turner's (1990) 28 key traits recommended for population characterization were chosen from the original suite of 43 dental observations, along with two additional numerical variants, mesiodens and mandibular incisor agenesis. Both of the latter traits have been shown to be controlled primarily by genetic factors, and appear to be inherited as autosomal dominant Mendelian traits (Burzynski and Escobar 1983). Dental trait frequencies were calculated using the individual count method (Turner et al. 1991), and do not include observations on isolated teeth to avoid the possibility of double scoring one individual.

Similarly, a subset of 17 infracranial traits demonstrated to have a substantial genetic component and good reproducibility in scoring (Saunders 1978) was selected for inclusion in the biodistance analysis, along with three additional traits found to occur with variable frequency in the Gabriola Island material: notching of the tibial distal articular surface lateral to the medial malleolus; first metatarsal proximal articular facet double; and cuboid medial facet double. Only observations made on adult specimens were included in the analysis. Infracranial traits frequencies were calculated by side rather than by individual, due to the difficulty in recognizing antimeres in the fragmented and disarticulated cave sample; for each element, the side with the highest number of observations was arbitrarily selected for inclusion in the distance analysis.

Intraobserver consistency was evaluated by scoring a subsample of remains from one burial cave feature (Skinner's 1987 collection from DgRw 199-F1) on two occasions: at the beginning of data collection in 1992, and at the end in 1994; traits that showed significant differences in observations were eliminated from the analysis. Also deleted were traits with very low sample sizes (<10 observations per group), those that did not occur in both groups, traits with very high (>.95) or very low (<.05) frequencies, and those that showed no variability between groups. In order to achieve adequate sample sizes for analysis, data from the two largest burial features (F1 and F9 from DgRw 199) were pooled to form the cave/crevice burial sample; this was considered appropriate since the features are geographically clustered and contemporaneous. The final list of 11 dental and 18 infracranial variants that were used in the distance analysis is presented in Table 3.2, along with the criteria used for dichotomizing multi-state expressions into simple presence/absence scores.

The biological relatedness of the two samples was assessed using the multivariate Mean Measure of Divergence statistic (Sjøvold 1973) with the Freeman-Tukey inverse sine transformation recommended by Green and Suchey (1976) for small sample sizes.

Table 3.2 Trait lists for biodistance analysis.

Dental Trait	Scoring	Infracranial Trait	Scoring
Mesiodens	any expression	Scapula circumflex sulcus	any expression
UI1 winging	any expression	Humerus septal aperture	any expression
UM2 two roots	separate > 1/4 length	Humerus supratrochlear spur	any expression
UM3 reduction	peg-shaped - absent	Ulna trochlear notch bipartite	2 separate facets
LI1 agenesis	tooth absent	Femur third trochanter	any expression
LM1 three roots	any expression	Patella vastus notch	any expression
LM1 enamel extension	expression ≥ 1	Tibia distal articular notch	any expression
LM1 cusp 7	expression ≥ 1	Talus os trigonum	unfused ossicle
LM2 protostylid	expression > 1	Calcaneal anterior/middle facet	separate facets
LM2 cusp 6	expression ≥ 1	Calcaneus secondarius	any expression
LM3 reduction	peg-shaped - absent	Cuboid double medial facet	2 separate facets
		Metatarsal #1 double proximal facet	2 separate facets
		Atlas double condylar facet	2 separate facets
		Atlas bridging	complete bridge
		Axis transverse foramen open	any expression
		Lumbar #5 spina bifida	any expression
		Transitional lumbosacral vertebra	any expression
		Sacral accessory facet	any expression

$$\mathrm{MMD} = \frac{\sum_{i=1}^{t}\left([\theta_{1i} - \theta_{2i}]^2 - \left[\frac{1}{n_{1i} + \frac{1}{2}} + \frac{1}{n_{2i} + \frac{1}{2}}\right]\right)}{t}$$

$$\mathrm{Var}_{\mathrm{MMD}} = \frac{2}{t^2}\sum_{i=1}^{t}\left(\frac{1}{n_{1i} + \frac{1}{2}} + \frac{1}{n_{2i} + \frac{1}{2}}\right)^2$$

where: t = the number of traits employed in the study; n_{1i} and n_{2i} = the number of individuals observed for the i^{th} trait in samples 1 and 2 respectively; and θ_{1i} = the angular transformation of the frequency of the i^{th} trait in population 1, measured in radians, such that:

$$\theta = \frac{1}{2}\sin^{-1}\left(1 - 2\frac{k}{n+1}\right) + \frac{1}{2}\sin^{-1}\left(1 - 2\left[\frac{k+1}{n+1}\right]\right)$$

where: k = the observed frequency of the trait and n = the number of individuals observable for that trait.

The significance of the calculated MMD is evaluated by means of the Chi Square statistic with t degrees of freedom:

$$X^2 = \sum_{i=1}^{t}\left(\frac{(\theta_{1i} - \theta_{2i})^2}{V_i}\right)$$

where:

$$V_i = \left(\frac{1}{n_{1i} + \frac{1}{2}} + \frac{1}{n_{2i} + \frac{1}{2}}\right)^2$$

Diachronic variation

The contemporaneity of the two skeletal samples was assessed by evaluation of several lines of evidence, including radiometric data (where available), stratigraphic interpretations, and cultural associations.

Social differentiation

The theoretical bases for evaluating social differences in burial remains was addressed in Chapter 1. In population.practical terms, differences in social status are usually evaluated on the basis of differential energy expenditure in mortuary programs, including the size and elaboration of the burial enclosure, time investment in body preparation, and amount of wealth invested in the dead (Binford 1972). These variables will be considered in evaluating the hypothesis that the two buria forms represent different social classes within the same population.