4

CRANIA

Osteological description

The total cranium sample includes nineteen essentially intact crania and twenty incomplete ones. The subsample of intact crania was used to define the types or breeds. It was possible to assign the cranial fragments to a type category after the analysis of the intact crania was complete, creating a total classified sample of thirty-nine. Photographs of selected crania are presented in Figures 4-1 through 4-9.

Anomalies of the total cranium sample (intact & fragmented) were recorded. They include nine specimens which exhibit moderately severe to extreme tooth wear (after G.R.Clark 1995) and ten specimens which have various deformations in the frontal and/or sagittal crest area (Table 4-1).

The frontal and sagittal crest anomalies are particularly interesting. A few have clear indications of healed sinus infections, a condition characterized by one or several holes (with slightly thickened edges) in the orbital sockets. These holes probably represent an infected sinus exploding through the frontal bone. (L. Bixby, DVM, Victoria B.C. pers.comm.). After an infection had subsided, the hole in the bone would heal over to some extent. Specimen 0925 has this type of anomaly (Fig. 4-6). Whether such an

Table 4-1. Cranial pathologies and extremes of tooth wear, by type.

Specime	Type	Description of pathology/tooth wear
1016	?	Possible healed impact scar at nasal/premaxilla suture (cranium fragmented)
0339	1	Green impact scars, both frontals (left most severe)* (cranium fragmented)
0801	1	Healed impact scars on ectorbitales & nasals, bregma thickened
0803	1	Healed impact scars on premaxillas, frontal area thickened
0813	1	Healed impact scar, left frontal
2400	1	Bregma thickened & possible small healed impact scars on both frontals
0201	2	Possible healed impact scars, both frontals (slight) (cranium fragmented)
0300	2	Heal sinus infection with deformed crest formation, right frontal
0925	2	Bregma thickened & sagital crest deformed, no obvious specific trauma
3019	2	Green impact scar on right frontal; healed impact scar on left frontal; green impact scar on left ectorbitale (slight)
0801	1	Tooth wear extreme**
0803	1	Tooth wear moderate
0813	1	Tooth wear extreme
2400	1	Tooth wear moderate
0201	2	Tooth wear extreme on all teeth, canines flattened; left canine broken
0300	2	Tooth wear extreme on all teeth, canines flattened
0360	2	Tooth wear moderate to extreme
0812	2	Tooth wear extreme
0925	2	Tooth wear extreme

* "green" indicates an unhealed trauma to the bone

** "extreme tooth wear" indicates major exposure of dentine, bulk of tooth eroded to a smooth surface (after G.R. Clark 1995).

Crania

Table 4-2a. Univariate statistics of cranium sample, division at the mean (1); measurements #1 - 17A and results of multivariate crossvalidation of type classification.

			** % Probability of		Measurement code numbers										
Specimen	Sex	Type	group membership	(1)	2	3	12	13	15	15B	15C	15D	16	17	17A
0804	F	1	-	146.3			59.3	72.8	47.8	76.0	47.8	38.6	17.9	36.4	36.9
0805	F	1	100.0	153.1	145.4	135.8	65.6	77.5	56.9	83.0	52.3	41.4	17.7	44.4	40.9
3002	F	1	99.8	161.4	158.3	149.0	70.9	80.3	57.0	84.4	51.4	40.4	18.6	44.4	39.8
2400	M	1	96.3	162.0	148.2	140.7	65.2	78.4	53.2	78.0	47.7	37.5	17.0	40.6	35.0
0580	M	1	-	162.2	152.0	144.3	66.3	81.7	55.2	82.5	50.5	39.4	16.0	43.0	38.4
0301	M	1	98.4	164.1	156.2	148.3	69.1	82.3	50.8	83.4	50.8	39.1	15.6	39.0	38.8
3001	M	1	98.2	164.5	155.0	145.7	69.9	82.1	52.3	83.9	52.3	41.1	18.6	40.3	40.3
0813	F	1	99.9	164.5	156.7	149.0	72.6	85.7		87.7	54.0	43.4	17.9		39.4
0801	F	1	95.9	169.0	157.6	150.0	71.5	85.6	52.3	86.2	52.3	41.3	17.8		39.6
0803	M	1	80.0	173.3	162.1	153.5	75.0	88.4	53.7	88.5	53.7	43.0	17.5	41.4	41.7
0300	M	2	-		164.0	156.0	76.8		60.4	87.8	54.1	42.1	16.3	46.5	41.1
3019	M	2	2.7*	176.0	164.4	154.3	76.0	88.7	56.3	89.1	56.3	44.3	19.0	43.4	43.6
3000	M	2	-	180.7	166.4	156.8	74.8		57.0	86.4	51.7	41.5	15.6	44.1	38.9
0812	M	2	59.0	181.5	169.0	160.0	76.3			92.3	55.7	44.2	16.6		41.4
0925	M	2	96.7	185.0	175.0	166.5	77.0	93.5		90.2	55.2	43.4	19.0		41.2
1400	M	2	99.3	188.7	172.1	163.5	81.3	91.7	63.5	91.7	54.8	42.7	17.2	50.3	41.9
2011	M	2	99.9	191.5	177.8	168.1	81.3	93.0	63.4	93.7	55.0	44.1	17.5	51.0	42.8
0109	M	2	100.0	202.0	188.4	177.1	87.4	98.2	66.4	99.0	58.8	46.2	19.5	51.9	44.9
2009	M	2	-	203.0			84.6		57.6	97.0	57.6	45.0		45.0	44.8

Statistics		Measurement code numbers									
	(1)	2	3	12	13	15	15B	15C	15D	16	17	17A
total count	18	17	17	19	15	16	19	19	19	18	15	19
total mean	173.8	162.9	154.0	73.7	85.3	56.5	87.4	53.3	42.0	17.5	44.1	40.6
total std	15.5	10.8	10.3	6.9	6.7	4.8	5.7	2.9	2.3	1.1	4.3	2.4
total min.	146.3	145.4	135.8	59.3	72.8	47.8	76.0	47.7	37.5	15.6	36.4	35.0
total max.	203.0	188.4	177.1	87.4	98.2	66.4	99.0	58.8	46.2	19.5	51.9	44.9
total CV	8.92	6.65	6.67	9.37	7.88	8.57	6.56	5.42	5.40	6.54	9.69	6.02
type 1 count	10	9	9	10	10	9	10	10	10	10	8	10
type 1 mean	162.0	154.6	146.3	68.5	81.5	53.2	83.3	51.3	40.5	17.5	41.2	39.1
type 1 std	7.2	4.9	5.1	4.3	4.3	2.8	3.7	2.0	1.8	1.0	2.6	1.9
type 1 min.	146.3	145.4	135.8	59.3	72.8	47.8	76.0	47.7	37.5	15.6	36.4	35.0
type 1 max.	173.3	162.1	153.5	75.0	88.4	57.0	88.5	54.0	43.4	18.6	44.4	41.7
type 1 CV	4.45	3.19	3.46	6.28	5.30	5.18	4.48	3.98	4.43	5.45	6.23	4.75
type 2 count	8	8	8	9	5	7	9	9	9	8	7	9
type 2 mean	188.6	172.1	162.8	79.5	93.0	60.7	91.9	55.5	43.7	17.6	47.4	42.3
type 2 std	9.2	7.7	7.2	4.1	3.1	3.6	3.9	1.9	1.4	1.3	3.3	1.8
type 2 min.	176.0	164.0	154.3	74.8	88.7	56.3	86.4	51.7	41.5	15.6	43.4	38.9
type 2 max.	203.0	188.4	177.1	87.4	98.2	66.4	99.0	58.8	46.2	19.5	51.9	44.9
type 1 CV	4.89	4.47	4.39	5.18	3.33	5.90	4.27	3.46	3.16	7.65	6.89	4.33

* starred values are misclassified, at < 5% probability of group membership.

** this is the probability of membership in the "type" group as initially classified, based on multivariate analysis using variables 1, 12, 23, 34 together.

Table 4-2b. Univariate statistics of cranium sample, division at the mean (1); measurements #19-36.

			Measurement code number												
Specimen	**Sex**	**Type**	**19**	**22A**	**23**	**25**	**25A**	**27**	**29**	**30**	**31**	**32**	**34**	**35**	**36**
0804	F	1	16.6						51.9		34.4	45.5			
0805	F	1	18.5	14.6	59.4	35.2	32.2	19.1	52.4		34.2		58.9	32.7	36.1
3002	F	1	17.2	16.5	61.8	35.3	31.0	16.9	50.7	89.4	31.4	42.1	58.5	33.1	34.1
2400	M	1	17.6	12.0	60.8	31.7	28.6	16.2	51.0	99.0	34.2	50.5	60.8	31.9	35.3
0580	M	1	16.4	12.4	56.0	30.0	27.8	16.0	57.5	93.5	38.3	44.5	57.8		33.0
0301	M	1	17.0	15.1	59.4	33.1	30.2	18.3	51.0	96.0	33.6	46.0	56.4	29.8	
3001	M	1	17.3	15.3	61.2	34.3	30.5	18.4	52.2	93.9	31.0	48.2	56.9	30.9	33.5
0813	F	1		15.1	59.5	33.0	30.0	17.6	52.0		36.8		60.5	31.5	34.7
0801	F	1	17.3	13.4	62.0	36.5	32.0	18.1	52.0	101.9	34.3	52.8	60.9	34.3	38.5
0803	M	1	19.0	16.0	62.5	34.5	30.5	18.3	51.5		37.8	54.2	63.6	37.8	40.7
0300	M	2	16.5		61.0	32.5	28.6	17.5		106.6		45.1	60.4	32.5	37.1
3019	M	2	19.0	17.0	62.0	35.8	31.4	19.6	51.1	87.8	32.5		59.0	33.0	34.5
3000	M	2	16.6	17.9	64.2	36.3	31.9	18.9	52.6	94.0	35.0	49.9		34.2	34.7
0812	M	2	16.9	17.0	66.6	37.1	33.8	19.3		110.6		56.9	67.0	38.2	39.8
0925	M	2	18.8	16.9	68.0	38.4	35.2	19.7	56.0		35.5	53.8	66.6	39.5	44.2
1400	M	2	17.6	16.7	66.0	33.7	29.9	17.8				48.8	59.2	31.2	34.2
2011	M	2	19.0	18.7	70.5	40.6	36.2	20.4	56.4	102.0	36.6	53.0	62.4	36.5	39.4
0109	M	2	19.6	19.3	71.2	40.9	36.8	21.2	58.3	110.0	36.0		69.0	39.5	41.2
2009	M	2								108.0	34.2	57.4		21.0	

Statistics	Measurement code numbers												
	19	**22A**	**23**	**25**	**25A**	**27**	**29**	**30**	**31**	**32**	**34**	**35**	**36**
total count	17	16	17	17	17	17	15	13	16	15	16	17	16
total mean	17.7	15.9	63.1	35.2	31.6	18.4	53.1	99.4	34.7	49.9	61.1	33.4	36.9
total std	1.0	2.0	4.0	2.9	2.5	1.4	2.5	7.4	2.0	4.5	3.6	4.3	3.2
total min.	16.4	12.0	56.0	30.0	27.8	16.0	50.7	87.8	31.0	42.1	56.4	21.0	33.0
total max.	19.6	19.3	71.2	40.9	36.8	21.2	58.3	110.6	38.3	57.4	69.0	39.5	44.2
total CV	5.78	12.64	6.39	8.10	8.04	7.40	4.67	7.46	5.80	9.10	5.89	12.86	8.69
type 1 count	9	9	9	9	9	9	10	6	10	8	9	8	8
type 1 mean	17.4	14.5	60.3	33.7	30.3	17.6	52.2	95.6	34.6	48.0	59.4	32.7	35.7
type 1 std	0.8	1.5	1.9	1.9	1.4	1.0	1.8	4.0	2.3	4.0	2.2	2.3	2.5
type 1 min.	16.4	12.0	56.0	30.0	27.8	16.0	50.7	89.4	31.0	42.1	56.4	29.8	33.0
type 1 max.	19.0	16.5	62.5	36.5	32.2	19.1	57.5	101.9	38.3	54.2	63.6	37.8	40.7
type 1 CV	4.52	10.15	3.12	5.60	4.46	5.71	3.53	4.20	6.70	8.25	3.65	7.08	6.97
type 2 count	8	7	8	8	8	8	5	7	6	7	7	9	8
type 2 mean	18.0	17.6	66.2	36.9	33.0	19.3	54.9	102.7	34.9	52.1	63.4	33.9	38.1
type 2 std	1.2	0.9	3.5	2.8	2.8	1.2	2.6	8.1	1.3	4.1	3.8	5.4	3.4
type 2 min.	16.5	16.7	61.0	32.5	28.6	17.5	51.1	87.8	32.5	45.1	59.0	21.0	34.2
type 2 max.	19.6	19.3	71.2	40.9	36.8	21.2	58.3	110.6	36.6	57.4	69.0	39.5	44.2
type 1 CV	6.46	5.26	5.23	7.65	8.50	6.01	4.80	7.87	3.81	7.93	6.01	15.96	8.90

infection could affect normal bone formation in the frontal and sagittal crest areas is unclear, but frontal bone and sagittal crest anomalies were seen along with these healed holes on several occasions.

Most of the frontal bone deformations, however, appear to be healed or fresh impact scars. Two specimens (3019 & 0339) exhibit what appear to be "green" or unhealed impact breakage on the frontal bone, which may have been severe enough to cause death. Several other specimens have healed scars from less severe impact injuries, principally on the flat area of the frontal between or in front of the *ectorbitales* and on at least one specimen, on the nasal area of the facial slope. In several instances, normal sagittal crest formation appears to have been affected, causing the bregma and temporal lines to become thickened and warped. In a few cases the sagittal crest is clearly deformed (Figure 4-2).

The cause of these injuries is undoubtedly a blow to the head, often several blows. By whom and for what reason is of course not discernible from the injuries themselves, but a blow to the head may have been a common method of subduing any dog. Alternatively, these scars may result from falls and/or other accidents or possibly, kicks from deer or elk. Lawrence (1968) illustrates a cranium from Jaguar Cave, Idaho that seems to show a similar scar on the left frontal.

Sex determination and sex ratios

The sex of individual crania was determined based on the non-metric characteristics described in Chapter 2. The distribution of the assigned sexes within the total intact cranium sample is quite unequal (14 males/5 females).

The inequality of the sexes represented in the cranium sample could be explained in several ways. Differential burial practices for males and females and/or the two dog types may have biased preservation and thus the sample of recovered remains. Alternatively, it is probable that some measures would have been taken by First Nations people to control their dog population to sustainable levels, as suggested by Gleeson (1970). This may have been accomplished most easily by limiting the absolute number of females, a method which has been described for some Inuit groups (Dr. D. Moyer, Anthropology Department, University of Victoria, B.C., pers. comm.). This method naturally limits the number of offspring produced but is also said to be preferred because it minimizes fighting amongst males for access to females in season.

Photographs of intact crania published in several reports of prehistoric dogs (from North American and Hungary) are clear enough that the sex of the specimens can be provisionally determined by the methods used in this analysis. The preponderance of putative males suggests that other samples of adult dogs may also contain many more males than females (Walker & Frison 1982; Bokonyi 1984). In addition, in two studies which have explicitly addressed sexual dimorphism (from Japan and Australia) there is also an apparent sexual bias in favour of males (Shigehara & Onodera 1984; Gollan 1982). In contrast, however, Brothwell et.al. (1979) found no apparent sexual bias in their sample of Peruvian prehistoric dogs, although this may be more a reflection of the reliability of the method chosen to determine sex than of the true distribution of the sexes in the population.

The possibility that a culturally-instigated pattern of sexual bias favouring males may be quite general in adult prehistoric dog populations is intriguing. If it becomes possible to sex crania of young juvenile individuals, we might find that the high incidence of young dogs (less than 6 months old) reported from many sites (Gleeson 1970; Montgomery 1979; Bernick 1983; Hamblin 1984; Wapnish & Hesse 1993) reflects the culling of young bitches before their first season. This is completely speculative, of course, but probably deserves further investigation. If a high ratio of males to females is the general pattern to be expected for most prehistoric adult dog populations, deviations from this ratio may be especially significant.

A marked deviation from such an "expected" ratio of male to females is demonstrated by this sample. When the sample of intact crania in this study is divided into two subsamples according to type, the difference in distribution of sexes is striking: the sample of small dogs contains *equal numbers of males and females*, while the sample of large dogs contains *only males*. For the sample of fragmented crania that could be assigned to either sex, three of the four specimens classified as type 1 (small dog) are female while only three out of the ten specimens classified as type 2 (large dog) are female. This leaves an overall ratio of six males:eight females (or 0.75) for the small dog (type 1) and eight males:three females (or 6.0) for the large dog (type 2), out of a total sample of thirty-five cranial specimens.

Since the ethnohistoric reports state that there was a specific economic use for by-products from the wool dog (as compared to being a general utility/companion animal, as the village dog reportedly was), this difference in sex ratios may be an indication of deliberate husbandry of the small dog type. Individual village dogs that were trained for hunting may have been valued highly for their particular skills, but *all* wool dogs would presumably have been equally valuable. This would suggest that the production of offspring from wool dogs may have been maximized rather than minimized, within the limits imposed by practical management considerations.

In order to increase the number of offspring produced, more breeding-age female wool dogs would need to be maintained. This could account for the greater number of adult female crania recovered of the small type. This equal representation of both sexes lends considerable support to the suggestion that the small, "type 1" dog actually represents the wool dog, because it implies deliberate breeding (i.e. true "husbandry") of this breed.

Sexual bias in an adult skeletal sample as a consequence of husbandry has been proposed by Klein and Cruz-Uribe (1984) for a sample of prehistoric domestic sheep, where animals apparently chosen for butchering were predominantly young males. The sample of recovered sheep skeletal material thus represented many young juvenile males (presumably culled), a few old females and no adult males. However, I have found no comparable samples reported in the literature which reflect, or even suggest, deliberate husbandry of dogs.

Type classification

Table 4-2a and 4-2b list the results of splitting the sample of intact crania at the mean of the greatest length (173.8 mm), as a method of defining the two breeds. The subsample

Table 4-3. Cranium fragments, type classification

			Measurement code number									
Specimen	Sex	Type	13	15B	23	25	27	29	31	32	34	35
0500	M	1				32.0	16.3					
0520	F	1							32.0	43.2		
1517	F	1			57.4	30.2	15.3	51.4	31.7			
0339	F	1			59.0	34.3	17.7	51.2	32.5			
0449	?	2				37.2	18.9					
0360	?	2				37.6	19.9					
3018	M	2				38.2	18.9		36.7	55.4	67.4	
2017	?	2									68.6	
3003	M	2			63.1	33.3	16.5	50.3	31.4	42.3	59.9	
1442	M	2			64.4	34.2	17.8	52.7	28.9	44.8	59.0	
1000	F	2			66.2	36.0	19.7	55.9	33.1			39.5
1203	F	2			67.2	38.9	18.0	56.3				33.6
1001	M	2			68.8	37.6	20.1	56.8	36.6			
5001	F	2			68.9	37.5	19.9	54.6				
2010	M	2			72.9	39.8	19.1	55.2	35.9	59.3	73.2	
2219	M	2			74.1	42.5	19.5		35.6			28.4
1018	?	2	89.6	90.7								34.2
0201	M	2		91.0					34.5	52.4		
1015	?	2		95.5								
2042	?	2		97.2								

comprising type 1 dogs has a mean total length of 162.0 mm and that of type 2 dogs, 188.6 mm.

Figures 4-10 through 4-13 are graphic representations of the relationships between several cranial dimensions used in this analysis: in particular, note the distribution of points where the carnassial tooth alveola measurement (#19) is used compared to other measurements. As described in Chapter 1, this pattern reflects the loose allometric relationship between tooth size and cranium size and illustrates why teeth should not be used exclusively in classification schemes.

Incomplete and fragmentary cranial remains were assigned to type by comparison to the intact sample and the results presented in Table 4-3. Fragmentary material was assigned to type conservatively. Specimens were classified as belonging to type 1 only if the available measurements for the fragment fell within the reported range for type 1 without being in the range of measurements which overlapped with those classified as type 2. This was necessary because apart from measurements #1, #2, and #3, the range of measurements for all other cranial dimensions overlapped to some degree for the two types. Similarly, specimens were assigned to type 2 if the available measurements fell within the reported range for type 2 without being in the range of overlap of type 1 measurements. If most of several available values were in the range of overlap but one or more values clearly fell within the range of one distinct type, the specimen was classified as belonging to that type. The amount of "range of overlap" was different for each variable and some fragmentary specimens could not be confidently assigned to either type. These specimens (that were measured as part of the study but ultimately not classifiable) are not included in Table 4-3.

Discriminant function analysis

Discriminant analysis of the intact cranium sample was undertaken after designation of breed types, using the *crossvalidation* function to examine the relationship between length and breadth dimensions. This multivariate procedure used length variables #1 and #12, and breadth variables #23 and #34 (total length, snout length, mastoid breadth, and palate breadth, respectively). Only one specimen (3019) was considered incorrectly classified according to this analysis: it was given less than a 5% probability of actually belonging in the type 2 group. Examination of the measurements indicates this cranium is particularly narrow for its length (i.e. it is a gracile large specimen).

Previously reported Northwest Coast material: type classification

Gleeson (1970) reports only one intact cranium from the historic strata at Ozette and as such is not directly comparable to this study. The possibility of interbreeding of indigenous dogs with dogs of European ancestry during the historic period must be considered and this potential for mixed ancestry adds another unquantifiable dimension to a study of size variability within the Ozette dog population. However, according to the criteria of this study, this cranium is clearly not as small as a wool dog type, being classified as a smallish individual of the large dog type.

Montgomery (1979) reports two intact crania from Semiahmoo Spit, both clearly of the small Northwest Coast type as defined by this analysis. Both show congenital absence of premolar 1. The differences in cranium shape which Montgomery describes in some detail (which she thought might represent breed differences) are undoubtedly the result of sexual differences: the small individual is almost certainly female, the larger one male. The comparable measurements for these and for the Ozette cranium described above are presented in Table 4-4.

Comparison to other data sets

An additional discriminant analysis compares the two types defined from this sample to samples of prehistoric dog remains from two other Pacific Rim sites for which raw data have been reported in the literature. One of the samples is a set of eleven dogs recovered from Jomon-period Japanese sites (Shigehara & Onodera 1984; Shigehara 1994). These remains date from approximately 10,000 to 2,300 bp and were chosen because the mean and range of total cranium length (measurement #1) were similar to that of small, type 1 dogs from the Northwest Coast.

The other sample is a set of nineteen prehistoric dog crania recovered from St. Lawrence Island, Alaska, excavated between 1927 and 1935 and reported by Haag (1948:159-162). This St. Lawrence Island sample is reported to date from "ca. 200 B.C. to ca. 200 years bp" and the mean and range of the total cranium length (measurement #1) of these specimens is similar to that of the large, type 2 Northwest Coast dogs. I used a subsample only of the total published St. Lawrence Island dog sample, comprised of all specimens for which measurements #1, #12, #23 and #34 were available.

A discriminant analysis compared both type 1 and type 2 Northwest Coast samples to the Jomon and St. Lawrence Island groups together in one discriminant analysis. The objective of this analysis was to determine whether either of the apparently similarly-sized dogs could be distinguished from each other using only the four variables and also, to see if the particular kinds of errors in classification which occurred could tell us anything more about the sample.

The results of this procedure are summarized in Table 4-5 (where group 1 = NWC small dog; group 2 = NWC large dog; group 3 = small Jomon period dogs; group 4 = large St. Lawrence Island dogs. As expected, the misclassification that most often occurred was from one similar size group to the other (e.g. group 1 to group 3 or group 2 to group 4). Somewhat unexpectedly, all of the St. Lawrence Island dogs were correctly classified

Table 4-4. Selected measurements and classification of previously reported Northwest Coast crania, from Ozette Village and Semiahmoo Spit, Washington State (Fig. 1-1).

		Measurement code numbers*									
		1	**2**	**3**	**12**	**13**	**23**	**25**	**30**	**32**	**34**
Specimen	**Type**	**(1)**	**(3)**	**(2)**	**(12)**	**(4)**	**(7)**	**(8)**	**(9)**	**(13)**	**(5)**
Semiahmoo 1	1	155.6	148.0	140.7	66.9	77.0	56.8	30.7	-	43.3	53.6
Semiahmoo 12	1	168.5	156.5	150.5	75.0	84.6	60.0	31.8	-	45.6	-
Ozette A7/IV/3	2	177.0	162.0	154.0	73.7	86.4	67.8	36.5	100.4	-	58.0

* numbers in brackets on second line are the measurement numbers used by the original authors.

Table 4-5. Classification results of a discriminant analysis using cranium measurements 1, 12, 23 & 34 comparing the two Northwest Coast groups to Japanese Jomon dogs & St. Lawrence Island (Bering Sea) dogs.

	Classified by analysis into group:					**% correctly**
Known group	**1**	**2**	**3**	**4**	**Total**	**classified**
1	5*	0	2	0	7	71
2	0	2*	1	4	7	29
3	1	0	10*	0	11	91
4	0	0	0	19*	19	100

group 1 NWC small **group 3 Jomon small**
group 2 NWC large **group 4 St.Lawrence Island large** * correctly classified

Table 4-6. Measurements of intact puppy skulls, 2-4 months old.

	Measurement code numbers						**deciduous**	**deciduous**
Specimen	**1**	**2**	**3**	**7**	**12**	**34**	**carnassial**	**molar**
Crania								
Little Qualicum #2418	105.1	96.3	90.0		38.0	43.2	10.3	8.0
Ozette #3020	89.9	83.5	78.4		32.2	43.0	10.6	8.7
Mandible								
Little Qualicum #2418	77.0	74.4	72.9	29.5			10.4	

suggesting that this is a very homogeneous population with a unique osteometric "signature" as compared to the other samples. Although the means of total cranial length (187.4 vs. 188.6 mm)as well as snout length were almost identical in each of the samples, the mean of the mastoid breadth and palate breadth values for St. Lawrence Island dogs were appreciably larger than those from Northwest Coast large dogs. St. Lawrence Island dogs had distinctly broad skulls.

By contrast, the Northwest Coast large dog sample had the highest misclassification rate of all four groups: only two out of the seven specimens were correctly classified (29%) when compared to the three other regional samples. One was incorrectly assigned to the Jomon dog group and four were misclassified as St. Lawrence Island dogs. This result suggests that the sample of crania from the Northwest Coast large dog group is not a particularly homogeneous group with respect to these four dimensions. In other words, the Northwest Coast large dog sample included those with broad as well as narrow skulls.

Northwest Coast small dogs were correctly assigned a fairly high proportion of the time (71%) and when they were not, grouped with small Jomon dogs. Jomon dogs were almost always correctly assigned (91%) and when they were not, grouped with small Northwest Coast dogs. This relatively low error rate of classification indicates there is enough regional difference to distinguish with some confidence between the two groups. Overall, Jomon dog crania had narrower palates but greater mastoid breadths than Northwest Coast small dogs.

Again, this analysis is not meant to imply evidence for a direct relationship between any of these groups but is presented as additional support for the assumption that this analysis has defined at least one distinct, fairly homogeneous Northwest Coast dog population. The sample of Northwest Coast small dogs used in this analysis is not as homogeneous as either Jomon or St. Lawrence Island dogs, but the relatively small size of the sample may have contributed significantly to such a result. In contrast, the Northwest Coast large dog sample appears to be fairly heterogeneous, at least according to the criteria used in this analysis.

Intact puppy crania

Two completely intact crania of young puppies were recovered from different water-logged Northwest Coast site deposits: Little Qualicum River (DiSc 1) and Ozette Village (45CA24). While these specimens could not be included in the osteometric analysis because of their immaturity, a discussion of the two crania is included because of the rarity of such material (Figures 4-14 to 4-17). Preservation in both crania is remarkable, despite the unfused cranial sutures and porous texture, which allowed several measurements to be taken .

The deciduous dentition on both is fully erupted, with no permanent teeth showing above the alveolae. The age of both puppies at death, based on tooth eruption, is estimated from two to four months (Andersen 1970; Miller 1965).

The Little Qualicum specimen (#2418) is slightly older than the Ozette individual (closer to four months), having somewhat greater development of the underlying permanent dentition and a little wear on the deciduous molars. The deciduous incisors are not present and it is not clear whether they had been naturally shed or lost due to natural taphonomic (depositional) factors. The permanent incisors and canines are visible in their alveolae, although none have erupted through the gum line. Both mandibles associated with this specimen were also available and measurements for the right side are included in Table 4-6.

There were no mandibles associated with specimen #3020 from Ozette. All incisors in this cranium are fully erupted and still in place, with a slight amount of wear discernible on them. The underlying permanent second molar is barely formed beneath the maxillary bone. Tooth eruption patterns suggest this specimen may have been slightly younger than the Little Qualicum individual, perhaps closer to two months than to four.

A specimen with which these remains can be compared is the puppy skeleton associated with a human burial at the Natufian site in Israel dated at 10,000 to 12,000 bp reported by Davis and Valla (1978). While the authors could not determine conclusively based on morphology whether this puppy was a dog or wolf, it is estimated to have been 4-5 months old. The length of the lower deciduous carnassial is reported as 13.3 mm (cf. 10.4 mm for specimen #2418) and to show extensive wear, suggesting a slightly greater age and larger initial size than the Northwest Coast specimens described here. Additional reported measurements of deciduous dentition of prehistoric dogs may ultimately aid in the species determination of such taxonomically ambiguous material.

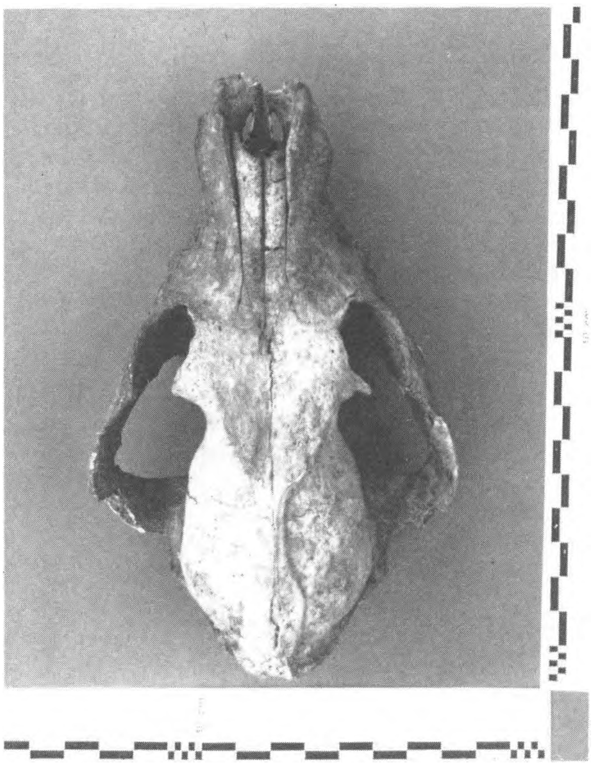

Figure 4-1. Photo (dorsal view), type 1 female cranium, specimen #0801.

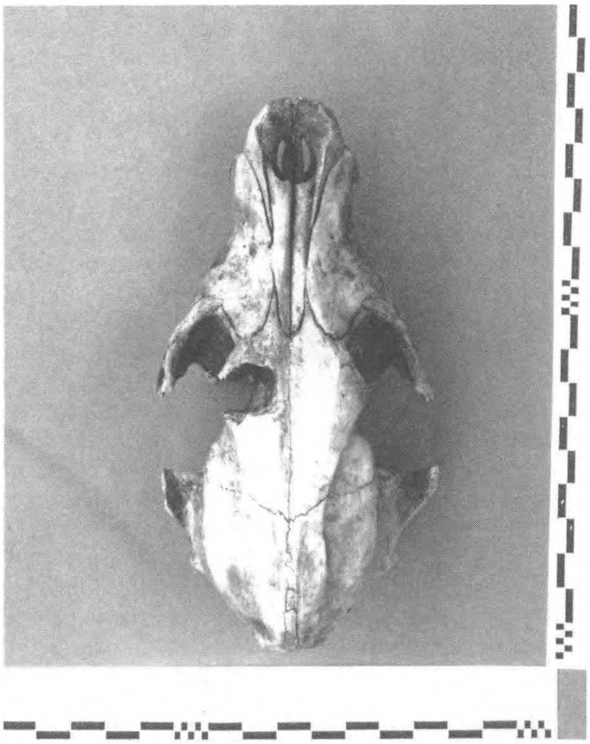

Figure 4-2 Photo (dorsal view), type 1 female cranium, specimen #0805.

Crania

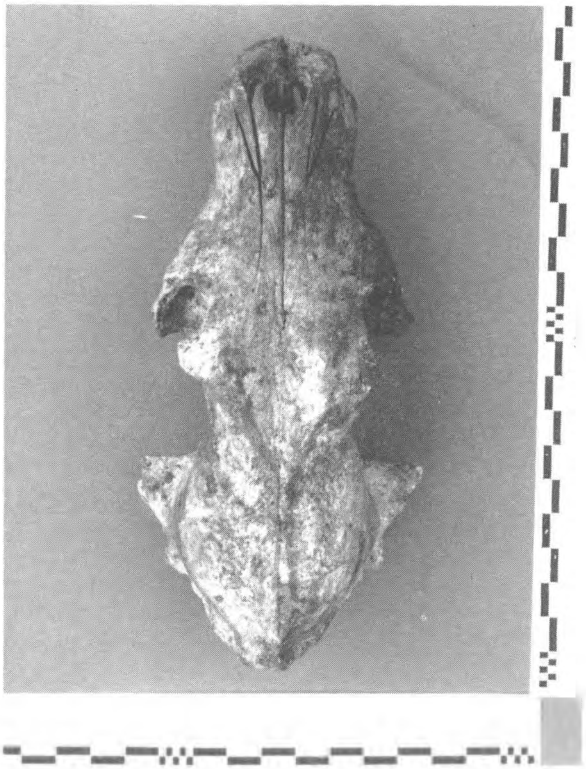

Figure 4-3. Photo (dorsal view), type 1 male cranium, specimen #0803.

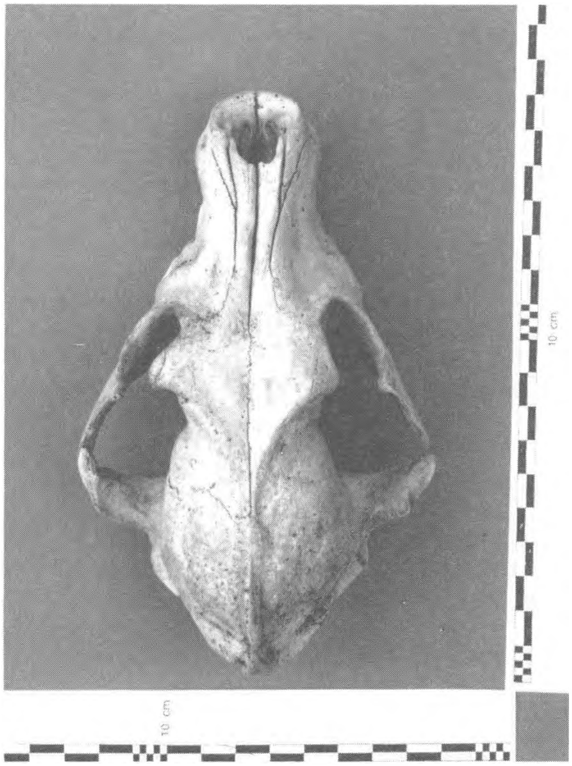

Figure 4-4. Photo (dorsal view), type 1 male cranium, specimen #2400.

Crania

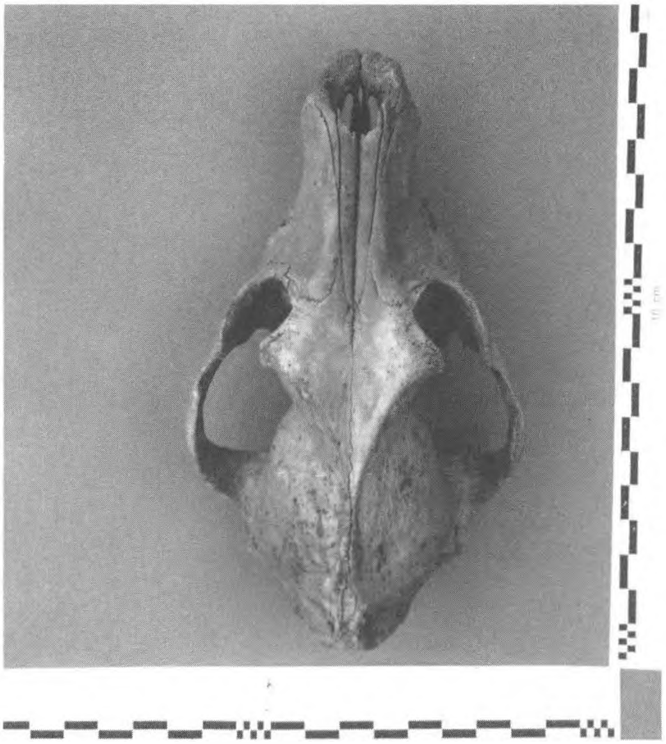

Figure 4-5. Photo (dorsal view), type 1 male cranium, specimen #3001.

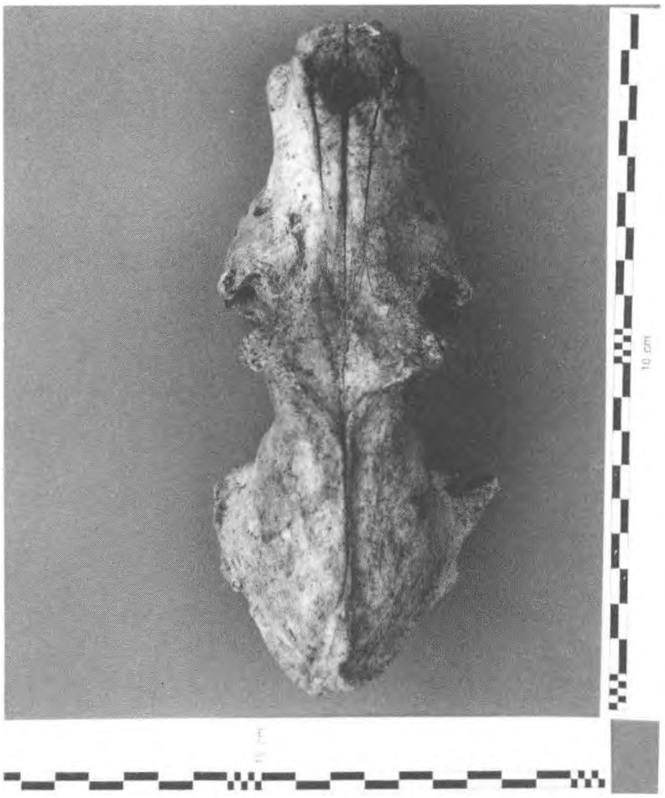

Figure 4-6. Photo (dorsal view), type 2 male cranium, specimen #0925.

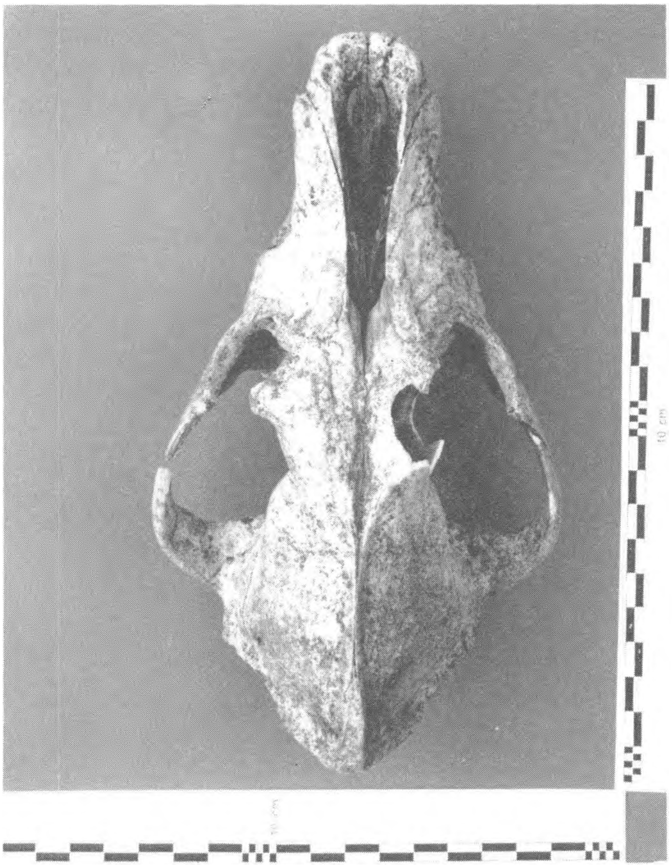

Figure 4-7. Photo (dorsal view), type 2 male cranium, specimen #0109.

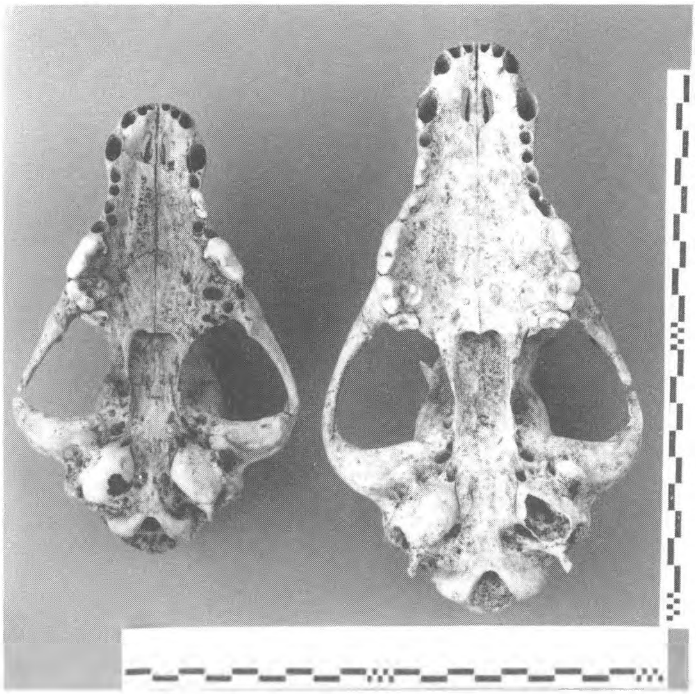

Figure 4-8. Photo, type 2 male cranium, specimen #0109 (on right) vs. type 1 male, specimen #2400 (on left), ventral view.

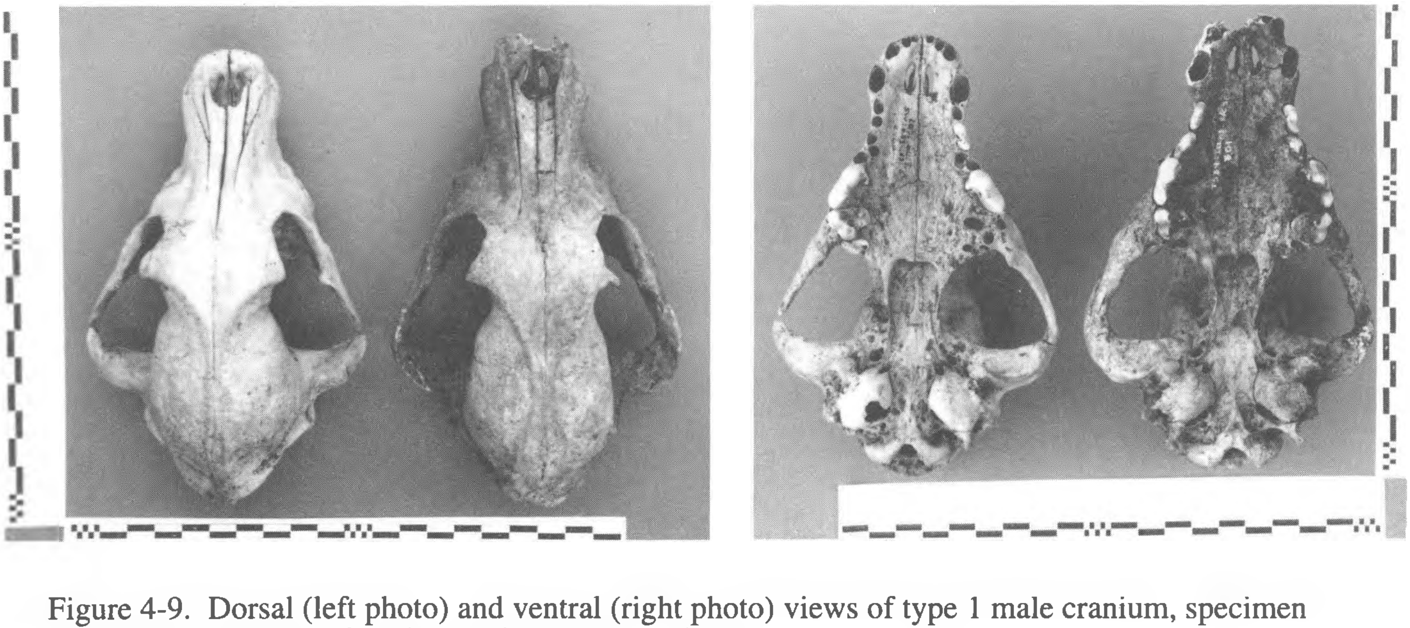

Figure 4-9. Dorsal (left photo) and ventral (right photo) views of type 1 male cranium, specimen #2400 (left) vs. type 1 female, specimen #0801 (right).

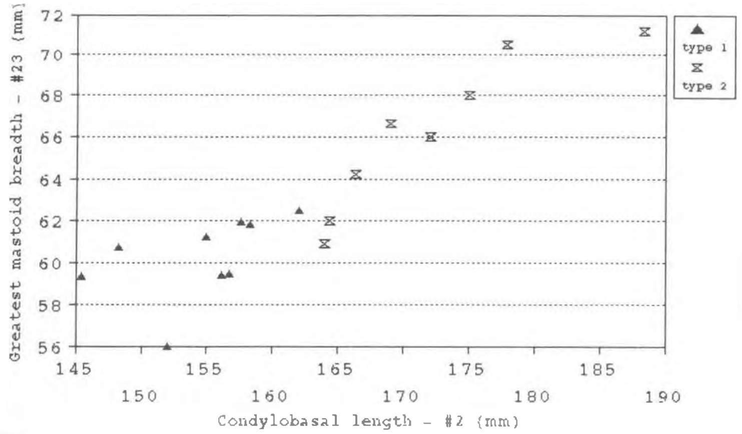

Figure 4-10. Plot of cranial measurement #2 (condylobasal length) vs. #23 (greatest mastoid breadth).

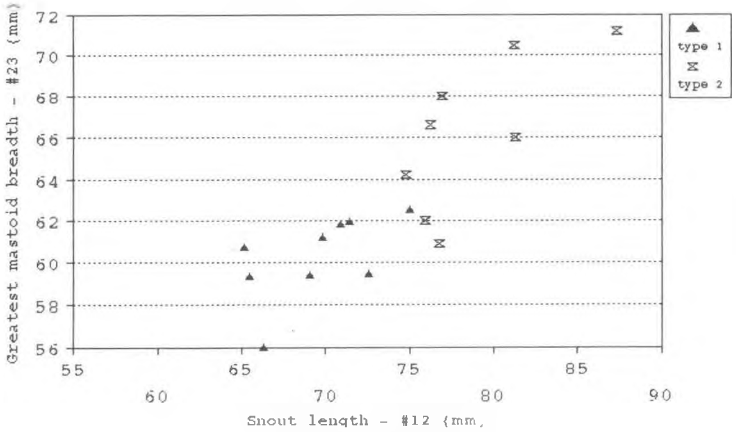

Figure 4-11. Plot of cranial measurement #12 (snout length) vs. #23 (greatest mastoid breadth).

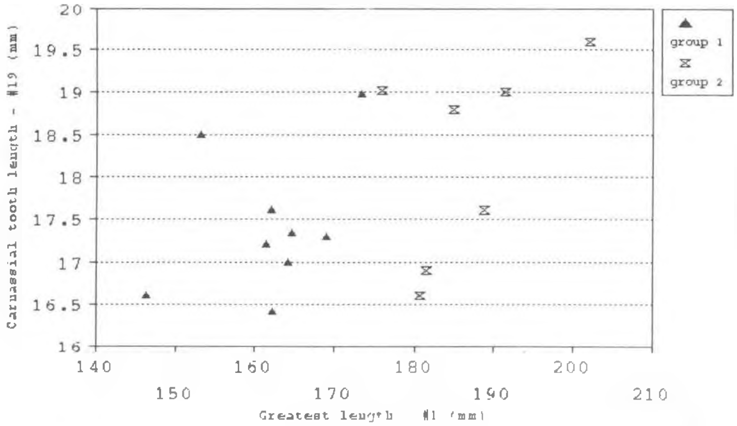

Figure 4-12. Plot of cranial measurement #1 (greatest length) vs. #19 (carnassial alveolus length).

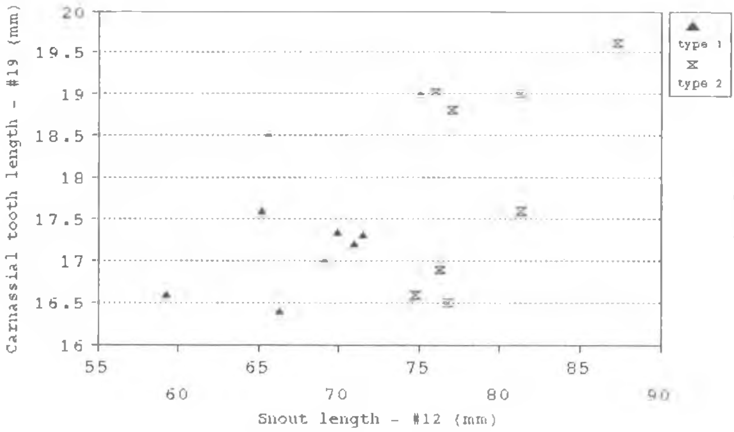

Figure 4-13. Plot of cranial measurement #12 (snout length) vs. #19 (carnassial alveolus length).

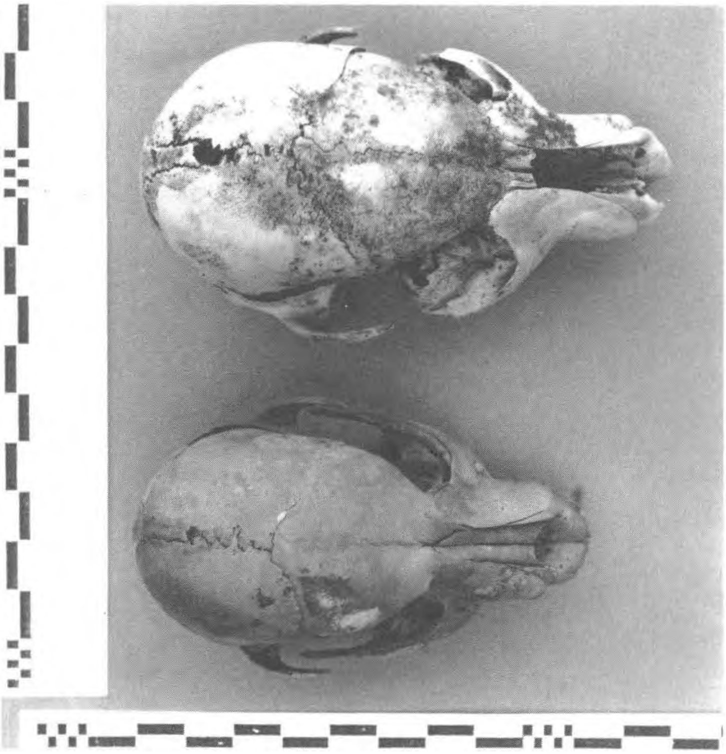

Figure 4-14. Photos of puppy crania, specimen #2418 (top) and specimen #3020 (bottom), dorsal view.

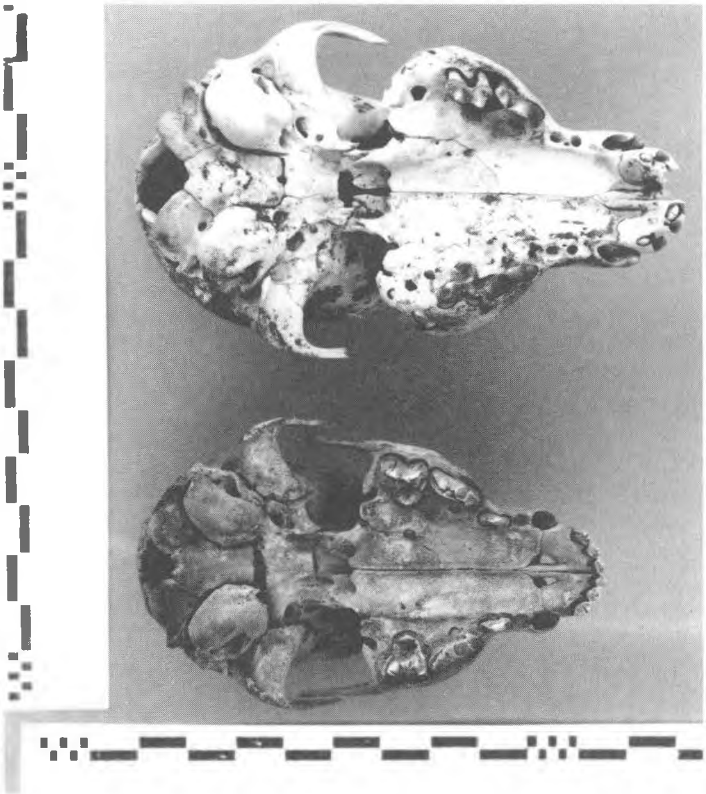

Figure 4-15. Photos of puppy crania, specimen #2418 (top) and specimen #3020 (bottom), ventral view.

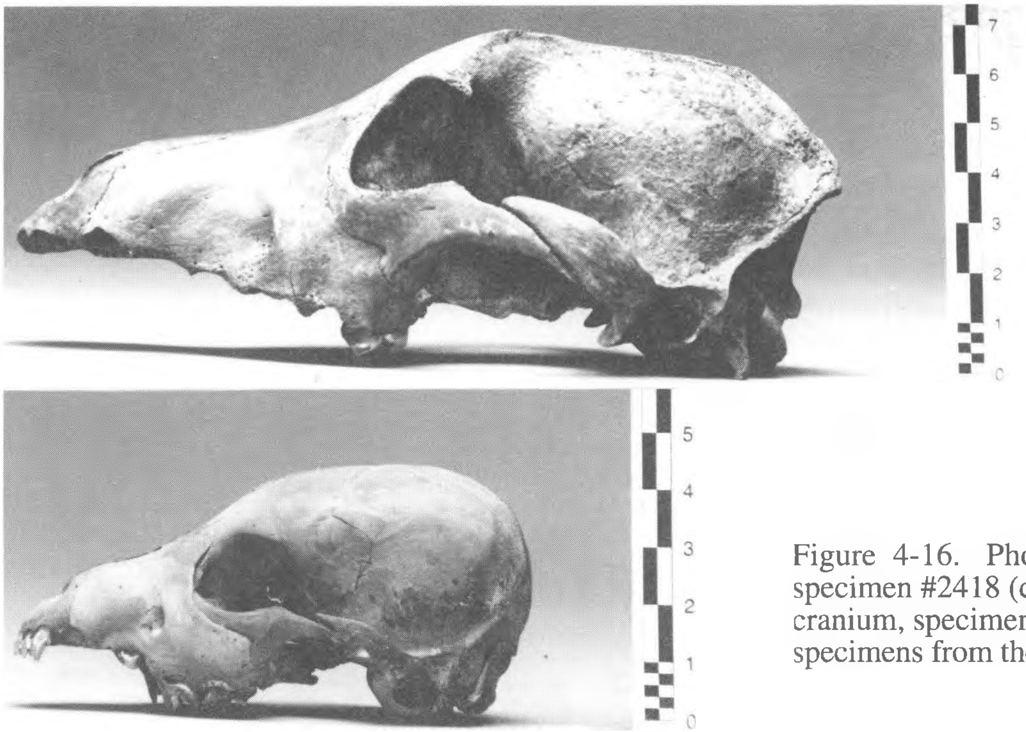

Figure 4-16. Photos of puppy cranium, specimen #2418 (ca. 3-4 months) and adult dog cranium, specimen #2400, lateral view. Both specimens from the Little Qualicum site, DiSc1.

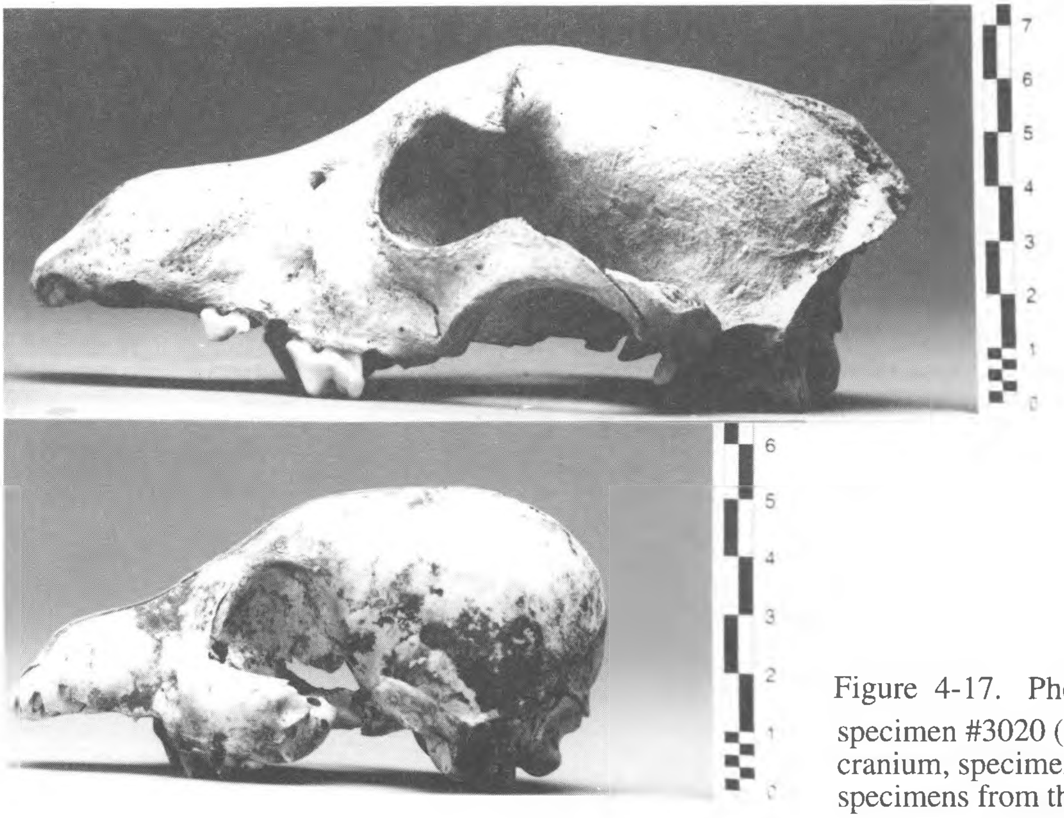

Figure 4-17. Photos of puppy cranium, specimen #3020 (ca. 2-3 months) and adult do cranium, specimen #3001, lateral view. Both specimens from the Ozette site, 45CA24.

Crania

Measurement Number **Definition of cranial measurement codes**

#1........ Total length: Akrokranion (A) to prosthion (P)
#2........ Condylobasal length: Aboral border of occipital condyles to prosthion (P)
#3........ Basal length: Basion (B) to prosthion (B)
#12...... Snout length: Oral border of orbits (median) to prosthion (P)
#13...... Median palatal length: Staphylion (St) to prosthion (P)
#15...... Length of cheektooth row: from P1 to M2 along alveoli of buccal side
#15B*. Length of entire tooth row: Prosthion (P) to aboral alveolus of M2
#15C*. Length of cheektooth row: from P2 to M2, along alveoli of buccal side; where P1 is missing
#16...... Length of molar row: from M1 to M2 along alveoli of buccal side
#17...... Length of premolar row: from P1 to P4, along alveoli of buccal side
#17A* Length of premolar row: from P2 to P4, along alveoli of buccal side; where P1 is missing
#19...... Length of carnassial (P4) alveolus
#22A* Shortest distance between auditory bullae
#23...... Greatest mastoid breadth: Otion (Ot) to otion (Ot) (greatest breadth of occipital triangle)
#25...... Greatest breadth of occipital condyles
#27...... Greatest breadth of foramen magnum
#29...... Greatest neurocranium breadth: Euryon (Eu) to euryon (Eu) (greatest breadth of braincase)
#30...... Zygomatic breadth: Zygion (Z) to zygion (Z)
#31...... Least breadth of cranium: breadth at postorbital constriction, aboral of ectorbitales (Ect)
#32...... Greatest frontal breadth: Ectorbitale (Ect) to ectorbitale (Ect)
#34...... Greatest palatal breadth: measured across outer borders of alveoli of M1
#35...... Least palatal breadth: measured behind canines
#36...... Maximum breadth of palate at canine alveoli: from buccal side of canines

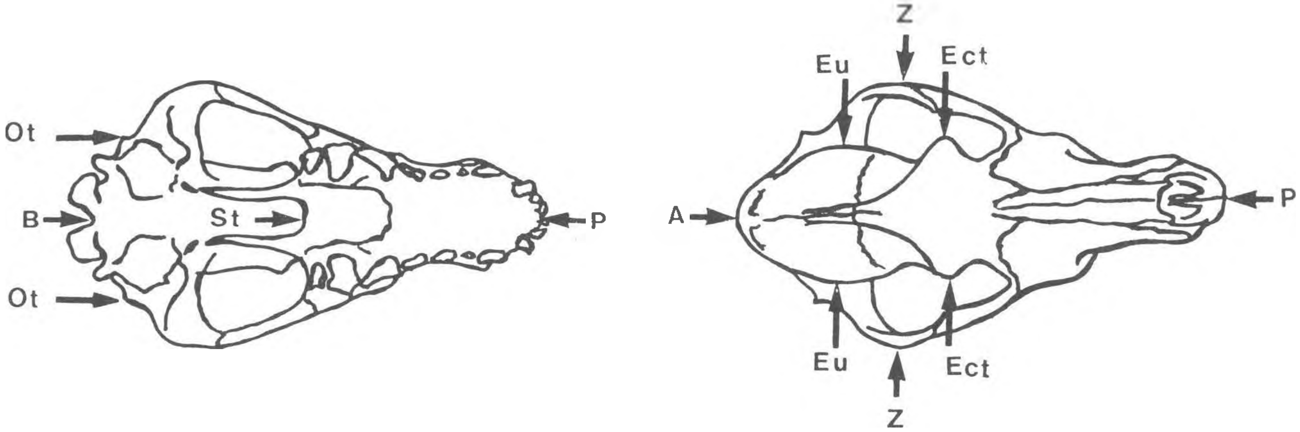

Figure 4-18. Cranial diagram, marked with reference points used in measurement descriptions. Ect=ectorbitale; Eu=euryon; A=akrokranion; P=prosthion; B=basion; Z=zygion; St=staphylion. Ot=otion