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Sex Determination of Fragmentary Crania by Analysis of the Cranial Base: Applications for Study of an Arikara Skeletal Sample

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To the Graduate Council:

I am submitting herewith a thesis written by Margaret M. Williams entitled "Sex Determination of Fragmentary Crania by Analysis of the Cranial Base: Applications for Study of an Arikara Skeletal Sample." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

William M. Bass, Major Professor

We have read this thesis and recommend its acceptance:

R.L. Jantz, P.S. Willey

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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SEX DETERMINATION OF FRAGMENTARY CRANIA BY ANALYSIS OF THE CRANIAL BASE: APPLICATIONS FOR STUDY OF AN ARIKARA SKELETAL SAMPLE

A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville

Margaret M. Williams
June 1987

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Most of all, though, thanks to my family - you're *the greatest!*

ABSTRACT

A total of 175 adult human crania from an Arikara Indian skeletal sample are used in this evaluation of a discriminant function analysis for determining the sex of fragmentary crania. The method used was developed by Holland (1986b) and employs nine cranial base measurements. Only crania with associated innominates are used for development of the discriminant functions and a total of 26 crania without innominates are used as a test sample.

A test of measurement error indicates an average of 17.5% of variation due to measurement error for all measurements except the Distance between Foramina (DF). Data from the DF measurement indicated as much as 70% of variation between measurements due to measurement error, and thus DF was excluded from all other statistical analyses.

Four discriminant functions were developed that sexed the sample correctly with 73-76% accuracy, and the test sample was correctly classified with only 48-56% accuracy. Holland's discriminant function based on four measurements correctly classified the sample with 52.5% accuracy.

This evaluation supports the argument that discriminant functions should be developed from the population expected to be used, as the discriminants developed in this study are much more appropriate than Holland's for use with the Arikara sample. Although the results may be somewhat useful in sex determination of fragmentary crania, they demonstrate the need to further evaluate

Holland's sex discriminants by testing them on larger, more diverse populations before they can be applied with accuracy to forensic cases.

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CHAPTER I

INTRODUCTION

Anthropologists have long been interested in techniques for sexing the human skeleton, the cranium in particular. Many early studies involved visual assessments of the skeleton, with sex determination based on the generally smaller, more infantile characteristics of the female skeleton, and the generally larger, more muscular appearance of males.

Hrdlicka (1920) claimed an 80% accuracy in sexing adult human crania based on size differences of the supra-orbital ridges, the mastoid process, the occipital crest, the mandible, and the base of the skull. Martin-Saller (1957) made similar visual observations of crania, and included the size of the foramen magnum and the length of the basilar process among the differences they found between males and females, noting a generally longer foramen magnum and longer basilar process as characteristic of males.

Keen (1950), in a study of crania from the Cape Coloured skeletal population, reported an 85% accuracy in determining sex by visual methods. Krogman (1962) conducted a similar blind test study of crania of known sex and race (white and black) from the Todd Collection and reported 82-87% accuracy in sex determination. Among the identifying cranial traits which he outlined, Krogman noted the following cranial base features characteristics of males: generally larger condyles, a relatively longer foramen magnum, larger foramina, a longer basilar portion of the occipital, and a longer body of the spenoid than are characteristic for females.

Numerous discriminant function analyses for sex determination of crania have also been developed as a way to utilize a combination of cranial measurements (Giles and Elliot, 1963; Kajanoja, 1966; Thieme and Schull, 1957; Thieme, 1957; Pons, 1955). The most widely used discriminant function, that of Giles and Elliott (1963), demonstrated 82-89% accuracy with Negro and Caucasian skulls from the Terry and Todd collections. Measurements used in their study included glabello-occipital length, opisthion-forehead length, maximum width, basion-bregma height, basion-nasion, maximum diameter bi-zygomatic, basion-prosthion, prosthion-nasion height, nasal breadth, palate-external breadth, and mastoid length--none of which are solely cranial base measurements and most of which require fairly complete crania.

Although the Giles and Elliott (1963) discriminant function has been used extensively, many questions have been raised regarding its usefulness in analyzing crania of races different from those employed to establish the discriminant function. Kajanoja (1966), for example, sexed a Finnish skeletal collection with only 65% accuracy when using the Giles and Elliott discriminant function. Keen (1950) suggested that in order to accurately sex skulls from a known group, something should be known about differential sexual cranial characteristics for the different races. Birkby (1966) questioned the accuracy of using the Giles and Elliot (1963) discriminant function for sexing American Indian crania, and he suggested that discriminant functions are only applicable for crania from the population on which the functions were established.

Birkby (1966) also found that female crania were more often misclassified than male crania. Weiss (1972) described a regular and systematic bias in the sexing of skulls and estimated approximately 12% of sex determinations are classified incorrectly in favor of males due to secondary sexual characteristics in bone--particularly for classifications based on "larger" and "smaller" characteristics.

The overall accuracy of sex determination has been shown to be dependent upon the completeness of the skeleton (Krogman, 1962; Giles, 1964; Bass, 1971). As numerous studies show, it is generally accepted that the cranium is only second-best to the innominate bone in sex determination (Reynolds, 1945, 1949; Washburn, 1948, 1947; Hanna and Washburn, 1953; Stewart, 1954; Krogman, 1962; Hoyme, 1957). Stewart (1948) indicated an accuracy of 90-95% in sex determination from the examination of an adult innominate alone, versus 80% accuracy from an adult skull alone. Phenice (1967) suggested a correct sex determination rate of 95% from a visual examination of the adult pubic bone. Meindl et al. (1985) examined the observational sexing of skulls versus the observational sexing of pelves and concluded that "the overall sex-ratio and specific age-class sex ratios of prehistoric cemetaries must be estimated from only those adult burials with fully preserved pelves."

A different problem develops in determining the sex of fragmentary skeletal remains, however, as most methods for sex determination have been designed from measurements and/or observations of complete skeletal material. Recently, in an effort to develop a method for sexing fragmentary crania, Holland (1986b) proposed a sex discriminant function using nine cranial base measurements. His sample consisted of 100 crania of known sex, race, and age from the Terry skeletal collection, including 50 males and 50 females between the ages of 20 and 50, divided equally by race as Negroes and Caucasians. Twenty crania were remeasured after a period of time to check measurement replicability. Holland reported an average measurement error of less than 3.1% and suggested that the foramen magnum measurements--Length of the Foramen Magnum (LFM) and Width of the Foramen Magnum (WFM)-- were the most accurate of the remeasurements.

Sex prediction rates for the sample crania in Holland's study ranged from 71-90%, and a test group of 20 crania was sexed with 70-85% accuracy. But, as Holland (1986b) indicated at the conclusion of his study, "while the technique presented here proved effective in determining the sex of dissection-room crania, it should be tested on larger, more geographically diverse populations before it can be used with confidence in forensic cases."

This study is an attempt to expand Holland's method for sexing fragmentary crania, and to test its usefulness in sex determination of a North American Indian skeletal sample.

Holland's technique is evaluated based upon the degree of difficulty in taking each of the cranial base measurements, the degree of accuracy and replicability of the measurements themselves as demonstrated by a test of measurement error, and the appropriateness of use of this method in future studies of crania from archaeological samples and/or forensic cases.

CHAPTER II

METHODS AND MATERIALS

SKELETAL SAMPLE

The North American Indian sample used in this study consists of Arikara skeletal material from three archaeological sites in South Dakota. Site names and numbers, approximate dates, and sample sizes from each site are given in Table I. Figure 1 shows the location of the sites, all three of which were excavated in the mid- and late 1960's and in 1970 under the direction of Dr. William M. Bass.

Skeletal material from the Larson site (39WW2), an earth lodge village, represents the largest skeletal collection from a single-component site in the Northern Plains. A total of 628 skeletons was recovered, and the collection is currently housed at The University of Tennessee, Knoxville. The Larson site is on the east bank of the Missouri River, approximately two miles southeast of the present city of Mobridge, South Dakota, and the occupation is dated between 1679 and 1733 (Jantz and Owsley, 1984; Owsley and Bass, 1979; Jantz, 1973). Data collected from 115 crania (57 males and 58 females) from the Larson site were used for this study.

The Mobridge site (39WW1), located on the east bank of the Missouri River is just west of Mobridge, South Dakota. The site dates to the first half of the 17th century and represents a

Table 1. Arikara Sites Used in this Study

		Sample Sizes (with innominates)		Test Samples (without innominates)	
Site	Date (Approximate)	Males	Females	Males	Females
Leavenworth (39CO9)	1802-1832	13	13	3	1
Larson (39WW2)	1679-1733	46	52	11	6
Mobridge (39WW1)	1600-1700	25	26	0	5

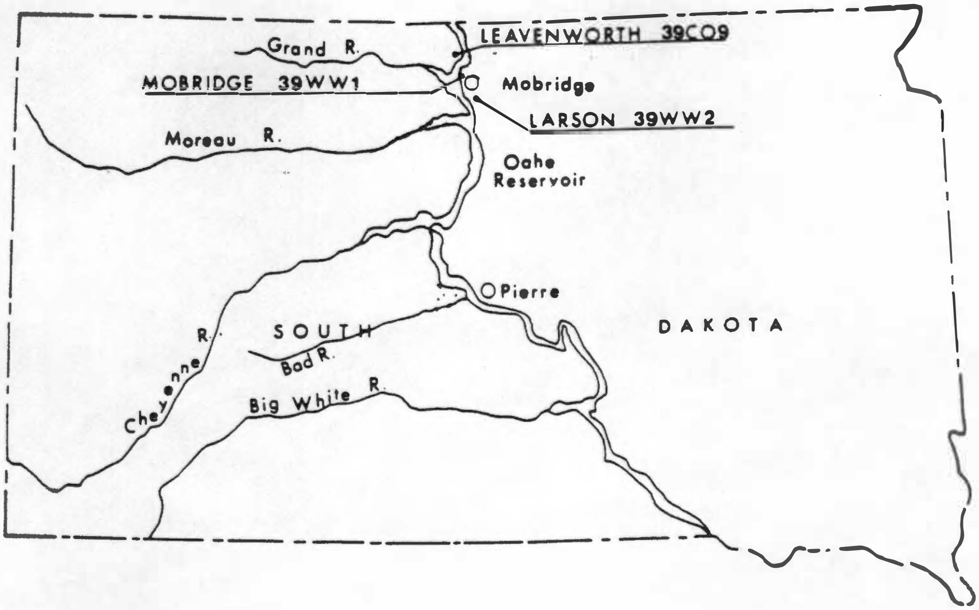


Figure 1. Map of South Dakota showing the location of Arikara archaeological sites from which skeletal sample was obtained (Jantz and Owsley, 1984).

protohistoric agricultural Arikara occupation (Merchant and Ubelaker, 1977). Measurements from a total of 56 crania (25 males and 31 females) from this site were used.

Leavenworth (39CO9), the third site, dates to the early 1800's and is located on the west bank of the Missouri River--10 air miles north of Mobridge, South Dakota. Burials at the site were located behind the village on high terraces (Bass et al., 1971). The sample used from Leavenworth totaled 30 (16 males and 14 females).

Only adult crania with fairly complete cranial bases were used in this study. These individuals were sexed based on a visual assessment of the crania and innominates, and the identifications were then compared to sex determinations from site reports and burial records. Crania from specimens with at least one innominate present were used in the statistical analyses, but those from burials with no innominates present were used only as part of a test sample. Although there is no way to determine positively the sex of individuals from an archaeological skeletal population, the presence of an innominate increases the accuracy of the overall sex determination process.

MEASUREMENTS

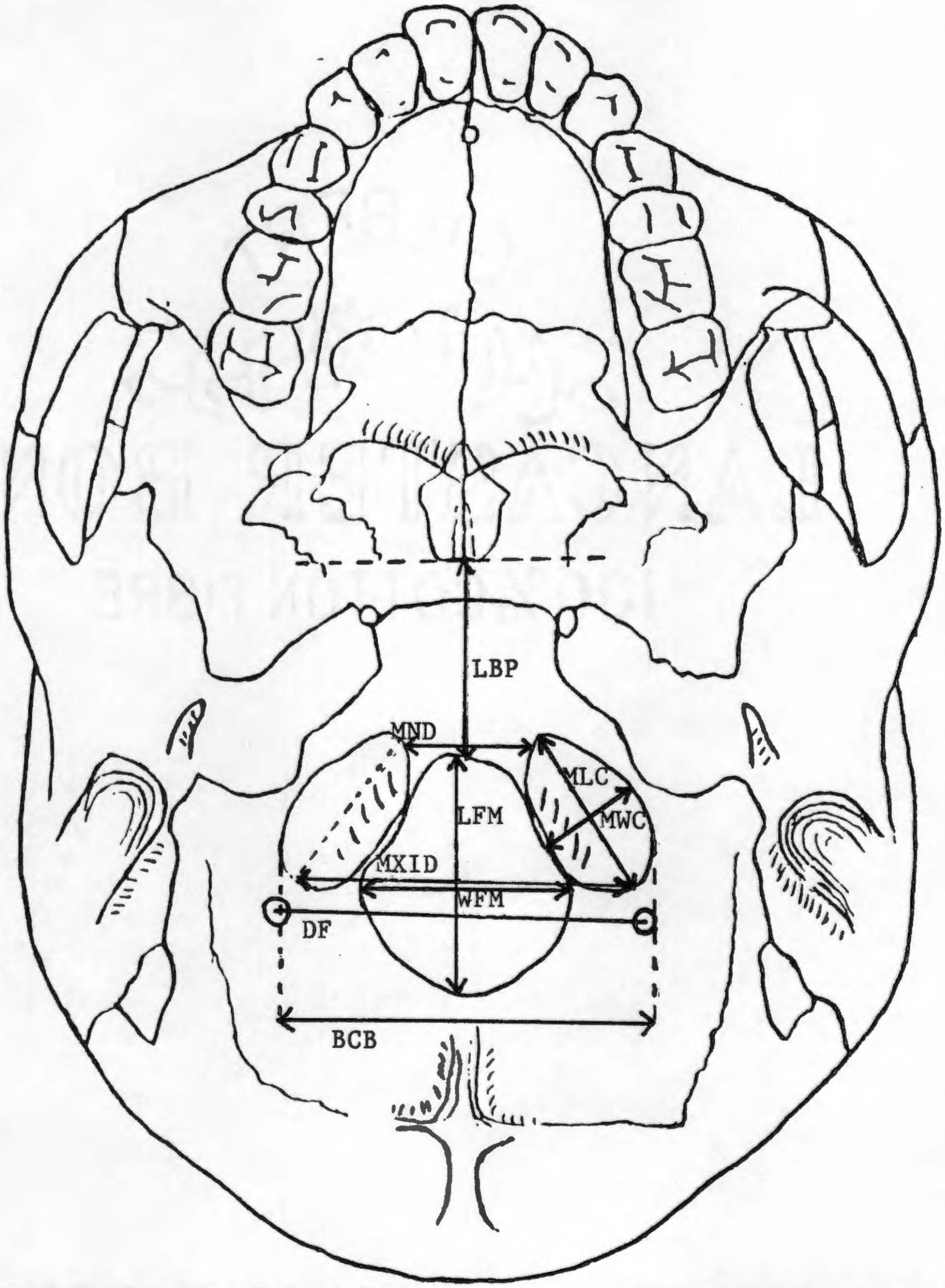
The following nine cranial base measurements were taken on each cranium with the aid of a sliding caliper. All measurements but the Length of the Basilar Process (LBP) were taken as described by Holland (1986a; 1986b) and Martin-Saller (1957), and an illustration of the measurements is shown in Figure 2.

1. Maximum Length of Condyle (MLC)- maximum length of left condyle along the long axis from the edges of the articular surface.
2. Maximum Width of Condyle (MWC) - Maximum width of left condyle from the articular edges along a line perpendicular to the long axis.
3. Minimum Distance between Condyles (MnD) - Minimum distance between the medial edges of the articular surfaces of condyles.
4. Bicondylar Breadth (BcB) - Maximum distance between the lateral edges of the articular surfaces of the condyles.
5. Maximum Interior Distance (MxID) - Maximum distance between the medial articular margins of the condyles (i.e., intercondylar breadth).
6. Length of Foramen Magnum (LFM) - Maximum internal length of the foramen magnum along the midsagittal plane.
7. Width of Foramen Magnum (WFM) - Maximum internal width of the foramen magnum perpendicular to the midsagittal plane.
8. Length of Basilar Process (LBP) - Maximum length of the basilar process from basion to the midpoint of the tuberculum sellae portion of the sphenoid bone.
9. Distance between Postcondyloid Foramina (DF) - Distance between centers of post-condyloid foramina.

Five of the nine measurements involve some aspect of the condyles. These condylar measurements were only taken on crania with complete and undamaged condyles, although damaged condyles are common among crania in the Arikara collection.

For some crania, both postcondyloid foramina were not present, and the Distance between Foramina was calculated based on a measurement between the one existing foramen and either an indentation (sometimes present) above the other condyle or a symmetric estimation of where the foramen would be located based on the foramen present.

The length of the basilar process (LBP), as described by Holland (1986b), was a measurement often impossible to take. Very few of the crania had a distinct basilar suture, therefore a variation of the measurement was used. Instead of measuring between basion and the midpoint of the basilar suture, a similar measurement was taken between basion and the edge of the sphenoid bone. Figure 2 illustrates this measurement.



MLC - Maximum Length of Condyle
MWC - Maximum Width of Condyle
MND - Minimum Distance between condyles
BCB - Bi-condylar Breadth
MXID - Maximum Distance between condyles

LFM - Length Foramen Magnum
WFM - Width Foramen Magnum
LBP - Length Basilar Process
DF - Distance between Foramina

Figure 2. Illustration of cranial measurements used in study.

CHAPTER III

STATISTICAL ANALYSIS/RESULTS

First, to test for measurement error, twenty crania from the Larson site were measured a second time. Tables II and III show correlations, means, and standard deviations for measurements and remeasurements, and with the exception of Distance between Foramina (DF) indicate an average of 17.5% of variation due to measurement error. Minimum Distance between condyles (MND), Bicondylar Breadth (BCB), and Maximum Length of the Condyle (MLC) are the most reliable remeasurements, followed closely by measurements of the foramen magnum.

Data for the Distance between Foramina (DF) measurement, on the other hand, indicate that as much as 70% of the variation between measurements may be due to measurement error. Although mean differences between the first and second measurements for the overall set of cranial measurements do not indicate a directional bias, the large standard deviation for DF suggests that that particular measurement is not reliable and can not be remeasured accurately. The DF measurement was excluded, therefore, from all other statistical analyses.

The Discriminant Function and Candisc procedures of the SAS package were used for analysis of the cranial measurement data (SAS Institute, 1982). As indicated previously, only crania with associated innominates were used in the calibration sample, while crania without innominates were employed as a test sample.

Table II. Pearson Correlation Coefficients / Probability > |R|
for 20 Cranial Base Measurements and Remeasurements

MLC - RMLC	0.91741 / 0.0001
MWC - RMWC	0.88977 / 0.0001
MND - RMND	0.98268 / 0.0001
BCB - RBCB	0.97631 / 0.0001
MXID - RMXID	0.84706 / 0.0001
LFM - RLFM	0.89307 / 0.0001
WFM - RWFM	0.89072 / 0.0001
LBP - RLBP	0.86271 / 0.0001
DF - RDF	0.54647 / 0.0127

Variables:

MLC - Maximum Length of Condyle
MWC - Maximum Width of Condyle
MND - Minimum Distance between condyles
BCB - Bi-condylar Breadth
MXID - Maximum Interior Distance between condyles
LFM - Length of Foramen Magnum
WFM - Width of Foramen Magnum
LBP - Length of Basilar Process

Table III. Means and Standard Deviations for 20 Cranial Base Measurements, their Remeasurements, and Difference between Measurements and Remeasurements

Variable	Mean	Standard Deviation
MLC	24.2275	1.9133
MWC	15.3385	1.6179
MND	20.3500	3.0039
BCB	51.9575	2.6622
MXID	46.0475	2.5102
LFM	35.4325	2.6586
WFM	29.7350	2.6370
LBP	23.3975	3.3476
DF	45.0000	4.5248
RMLC	24.2175	2.1400
RMWC	15.0900	1.5778
RMND	20.2800	2.8792
RBCB	52.0600	2.6404
RMXID	46.0275	2.4649
RLFM	35.2800	2.9142
RWFM	30.0250	2.9058
RLBP	23.5375	2.7790
RDF	43.7950	4.4975
DMLC	0.0100	0.8531
DMWC	0.2485	0.7513
DMND	0.0700	0.5613
DBCB	-0.1025	0.5775
DMXID	0.0200	1.3764
DLFM	0.1525	1.3123
DWFM	-0.2900	1.3217
DLBP	-0.1400	1.6964
DDF	1.2050	4.2965

The within-sex correlation matrix, shown in Table IV, suggests very little correlation between most of the variables. The highest correlation is that of Bi-condylar Breadth (BCB) and Maximum Interior Distance (MXID) at .7802. The next highest correlations are those of the Length of the Foramen Magnum (LFM) with Width of the Foramen Magnum (WFM) at .4602, and MXID with WFM at .5030.

The total canonical structure, as part of the canonical discriminant analysis, is given in Table V. It shows that measurements of Width of the Foramen Magnum (WFM) and Length of the Foramen Magnum (LFM) contribute the most, followed next by Minimum Distance between the condyles (MND), Maximum Interior Distance between the condyles (MXID), and Bi-condylar Breadth (BCB). Measurements of Maximum Width of the Condyle (MWC), Length of the Basilar Process (LBP), and Maximum Length of the Condyle (MLC) contribute much less to the total canonical structure.

Four discriminant functions were calculated and are shown in Table VI. The first utilized all eight cranial base measurements and sexed the sample of 163 crania (78 males and 85 females) with 76% accuracy. Males were sexed with 77% accuracy and females with an accuracy of 75%. The same function, however, when used with the test sample (14 males and 11 females) correctly sexed only 48% of the sample, with the "correctness" based on the previous visual sex determination of the crania in the test sample. Of the 13 crania presumably misclassified, 11 were males misclassified as females.

The second discriminant function involved the five measurements contributing most to the function: Minimum Distance

Table IV. Pooled Within-Sex Correlation Matrix for Arikara Skeletal Collection

Variable	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
MLC	1.0000	0.0322	-0.0467	0.4466	0.3305	0.2409	0.2225	0.2185
MWC	0.0322	1.0000	0.1258	0.3659	0.1763	-0.0103	0.0152	-0.0095
MND	-0.0467	0.1258	1.0000	0.3373	0.3119	0.3037	0.1844	0.0240
BCB	0.4466	0.3659	0.3373	1.0000	0.7802	0.2662	0.4448	0.1677
MXID	0.3305	0.1763	0.3119	0.7802	1.0000	0.2559	0.5030	0.0944
LFM	0.2409	-0.0103	0.3037	0.2662	0.2559	1.0000	0.4602	0.1082
WFM	0.2225	0.0152	0.1844	0.4448	0.5030	0.4602	1.0000	0.0870
LBP	0.2185	-0.0095	0.0240	0.1677	0.0944	0.1082	0.0870	1.0000

Table V. Total Canonical Structure for Arikara Skeletal Sample

Variable	CAN 1
MLC	0.2085
MWC	0.3316
MND	0.6502
BCB	0.5194
MXID	0.5731
LFM	0.7757
WFM	0.8333
LBP	0.3215

Table VI. Linear Discriminant Functions Developed for the Arikara Skeletal Collection

	Equation Number (Number of Measurements) 1(8)	2(5)	3(4)	4(2)
MLC	.001763		-.021676	
MWC	.198085		.210080	
MND	.138052	.148178		
BCB	-.112004	-.032006		
MXID	.055330	.034327		
LFM	.146806	.153669	.215651	.209378
WFM	.273389	.270622	.289499	.325477
LBP	.090951			
Constant	-18.142	-16.506	-19.002	-17.253
Sectioning Point	.0297	.0280	.0344	.0311
% Accuracy for sample	76% N=163	74.5% N=165	73% N=167	74.6% N=173
% Accuracy for test sample	48% N=25		56% N=25	

Variables:

MLC - Maximum Length of Condyle
MWC - Maximum Width of Condyle
MND - Minimum Distance between condyles
BCB - Bi-condylar Breadth
MXID - Maximum Interior Distance between condyles
LFM - Length of Foramen Magnum
WFM - Width of Foramen Magnum
LBP - Length of Basilar Process

between the condyles (MND), Bi-condylar Breadth (BCB), Maximum Interior Distance between the condyles (MXID), Length of Foramen Magnum (LFM) and Width of the Foramen Magnum (WFM). This function correctly classified the sample of 165 crania (79 males and 86 females) with a 74.5% accuracy. A total of 74.7% of males were sexed correctly, and 74.4% of females.

A third discriminant function was developed with four measurements Holland (1986b) had used for a similar sex discriminant: Maximum Length of the Condyle (MLC), Maximum Width of the Condyle (MWC), and the two foramen magnum measurements (LFM and WFM). This function was used to sex a sample of 167 (79 males and 88 females) with 73% accuracy, correctly classifying 71% of males and 75% of females. This discriminant was also applied to the test sample, but with a 57.5% accuracy rate. Of those misclassified, 82% were males incorrectly classified as females.

The two foramen magnum measurements (LFM and WFM) were used to develop the fourth discriminant function, which sexed the sample of 173 (82 males and 91 females) with a 74.6% accuracy. Males were sexed correctly with 72% accuracy, and females with 77% accuracy.

Although there is probably some variation between the three Arikara sites used in this study, it can be presumed that variation among sites is minimal as to sex dimorphism, and sample sizes from the individual sites are not large enough to warrant having separate by-site discriminant functions. Also, the value of the sex discriminants for use with skeletal material from other archaeological sites would be diminished.

Overall, the accuracy of sex prediction for the discriminant functions in this study is much lower than prediction rates reported by Holland (1986b). In using all nine measurements for a discriminant function, Holland was able to sex the calibration sample from the Terry collection with an accuracy of 90%, versus a 71% accuracy from a discriminant function using foramen magnum measurements only. The prediction rates in this study were 76% with an eight measurement discriminant function, and 71% for a discriminant function with LFM and WFM. Although LFM and WFM were more useful in sex determination with the Arikara sample than with the Terry collection, the inclusion of the additional six measurements did not greatly improve the accuracy of the sex determination process for the Arikara.

To test the applicability of Holland's discriminant functions developed from the Terry collection, his discriminant function based on four measurements, Maximum Length of the Condyle (MLC), Maximum Width of the Condyle (MWC), Length of the Foramen Magnum (LFM), and Width of the Foramen Magnum (WFM) was used to sex the Arikara sample (N=167). Only 52.5% of the crania were classified correctly, and of the misclassifications, 90% were females misclassified as males--an indication that Arikara females are more robust than females from the Terry Collection.

CHAPTER IV

DISCUSSION

Several factors may be affecting the results of this study, particularly because the sample consists of archaeological skeletal material. Males and females are thought to be fairly equally represented, and to minimize inaccurate sex classifications, only burials with complete crania and at least one innominate present are used in the statistical analyses. Nevertheless, the uncertainty involved in determining the sex of archaeological material, and thus the inability to carefully select the sample probably affects the outcome to some degree. The percent of individuals from the sample misclassified by the discriminant function may actually be slightly higher or lower depending on the accuracy of the preliminary sex classifications. The low percentage sex classifications of the test sample in particular, are probably affected not only by the uncertainty involved in sexing material from an archaeological site, but also by the lack of associated innominates to increase the accuracy of sex determination.

Age may also be a factor, because several anthropologists have found that age may affect cranial measurements (Israel, 1973; Zuckerman, 1955), and the age of individuals can not be confirmed for an archaeological sample. Israel (1973) states that the cranium is characterized by "continuing overall growth from early adulthood to later life. The cranium thickens and the skull diameter increases.

Endocranial dimensions enlarge as well. This suggests larger overall skull size and expansion of the cranial cavity...the entire system is involved in a process of symmetrical enlargement." Although Israel's findings deal primarily with changes in craniofacial size and not so much with measurements of the cranial base and although only adult crania were measured for this study, it's unclear how much effect skeletal age may have on this research. In light of Clark's (1986) vertebral neural canal data, however, it is possible that the effects of both skeletal aging and and changing health conditions on cranial base measurements could be tested with the Arikara sample.

Angel (1982) suggests that skull base height (porion to basion) shows an increase with improved nutrition and health conditions. In a study he conducted with the Terry Collection, he found the skull base height to be approximately six times more sensitive to health-related factors than general skull size change. Because crania for this study are from Arikara Indian sites of different time periods, differing stress levels may result in some intersite cranial base variation. It is possible too, that health conditions contribute to the fact that Holland's (1986b) sex discriminant functions, developed from studies on Negroes and Caucasians, do not work well when used to classify Arikara Indian crania.

This racial bias of Holland's research contributes to the ineffectiveness of his discriminant functions, supporting Birkby's (1966) argument that discriminants should be developed from the sample expected to be used. In testing the usefulness of predicting sex from these cranial base measurements, the racial bias must be eliminated for the discriminants to have much value in analyses of fragmentary crania- from forensic cases or archeological sites.

The lack of high correlations between measurements is good, indicating that the different measurements are not contributing the same information to the discriminant function. But, the inability to accurately remeasure all nine of the measurements Holland used suggests that inclusion of all measurements in future studies may adversely alter results. Holland reported an average measurement error of less than 3.1%, but the measurement error in this study averaged 17.5%, excluding the Distance between Foramina measurement which was not used. It is questionable that the Distance between Foramina measurement can be included when the remeasurements were so inaccurate. It is also unclear how Holland measured the Length of the Basilar Process, since the basilar suture is not always distinguishable on crania.

Utermohle et al. (1982), after conducting a study of intraobserver measurement error in craniometry cautioned investigators of problems with intraobserver repeatability. Perhaps, as they suggested, some of the error may be due to overly-sensitive statistical tests. The lack of repeatability of the DF measurement, in particular, was due in part to the absence and often irregular shapes of many of the post-condylar foramina for the Arikara sample.

The four discriminant functions developed from the Arikara skeletal collection could be useful in sex determination of archaeological skeletal material from other North American Indian sites. Even though the sex prediction percentage range is only 73% - 76%, no other more accurate methods for determining the sex of fragmentary crania have yet been developed. And, because there is very little difference in the accuracy of the four discriminant functions, even fragmentary crania with damaged condyles could conceivably be sexed with over 70% accuracy, just from measurements of length and width of the foramen magnum.

This study does not present a method more accurate than previously developed methods for sex determination of crania. Instead, as Holland (1986b) intended in his earlier study, it presents a method for determining the sex of fragmentary cranial remains. Additionally, it involves the development of a sex discriminant function much more appropriate than Holland's for use with archaeological material from North American Indian sites, and potentially for use with other archaeological skeletal material. This discriminant function has limited applications because of its low accuracy in sex determination. But, it demonstrates the need to further evaluate Holland's sex discriminants by testing them on larger, more diverse populations before they can be applied with accuracy to forensic cases.

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APPENDIX

Table VII. Class Means for Cranial Base Measurements

	Male	Female
Maximum Length of Condyle (MLC)	24.50680	24.06188
Maximum Width of Condyle (MWC)	15.24705	14.64365
Minimum Distance between Condyles (MND)	21.21090	19.07941
Bi-condylar Breadth (BCB)	53.17564	51.45647
Maximum Interior Distance between condyles (MXID)	47.04295	44.93471
Length of Foramen Magnum (LFM)	36.91051	34.55941
Width of Foramen Magnum (WFM)	31.26987	28.99647
Length of Basilar Process (LBP)	24.81218	23.95529

Table VIII. Measurement Data for Arikara Skeletal Sample

LEAVENWORTH SITE (39CO9)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
1	101	3B	M	22.45	12.20	19.60	51.55	47.25	36.00	30.30	22.85
2	101	7	M	23.35	12.35	19.75	52.75	49.50	34.95	28.90	25.20
3	101	12	F	24.00	13.80	17.10	51.45	43.30	33.30	26.60	25.80
4	101	18A	M	20.70	13.95	19.85	51.75	46.50	38.50	30.35	25.00
5	101	31A	F	21.70	14.00	21.15	49.95	42.50	36.50	29.55	25.90
6	101	30	M	22.95	15.65	20.50	51.50	47.40	36.40	31.25	25.00
7	101	35	F	20.80	14.45	19.30	48.35	41.00	33.70	28.10	22.05
8	101	48A	F	23.60	12.65	20.90	48.35	44.25	34.20	30.90	22.05
9	201	4	F	25.00	12.85	19.80	51.40	45.55	38.60	33.05	23.80
10	201	6	F	23.55	13.70	23.00	53.70	47.15	36.70	32.35	26.80
11	102	4	F	21.15	11.85	21.20	48.05	41.20	37.40	30.15	22.90
12	102	16	F	20.20	12.30	16.25	46.20	40.90	32.75	27.95	22.70
13	102	17	M	31.40	13.00	23.55	57.55	51.65	39.55	33.05	25.00
14	102	22	M	23.55	13.30	21.80	48.30	42.25	38.90	31.25	24.50
15	102	41A	F	23.60	13.25	20.05	48.55	40.85	34.15	27.70	24.85

Table VIII. (continued)

LEAVENWORTH SITE (39CO9)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
16	102	42	M	30.50	18.00	20.50	55.00	48.70	36.65	33.15	24.05
17	102	46	M	24.80	15.10	25.60	55.45	46.65	41.20	33.85	23.75
18	102	50	M	24.10	12.70	23.35	52.20	46.75	33.75	28.95	25.65
19	102	55	M	25.10	15.80	19.80	54.50	51.00	38.00	31.70	24.95
20	202	3	M	25.40	13.25	16.10	48.55	42.50	36.15	28.80	23.25
21	202	10B	F	23.95	15.35	20.30	47.55	40.95	34.85	28.35	23.30
22	202	13	M	23.90	14.15	23.15	54.25	46.80	41.25	31.85	25.65
23	202	17C	F	21.80	13.80	19.40	50.60	42.40	39.35	29.00	20.25
24	402	1	F	27.70	13.40	19.25	53.85	48.95	39.95	33.20	24.00
25	220	9C	F	24.45	14.00	18.15	53.90	45.75	37.70	32.60	24.60
26	101	68	M	25.25	.	21.10	56.10	50.15	38.45	31.45	23.30
MOBRIDGE SITE (39WW1)											
27	101	2A	F	22.00	15.10	20.50	52.25	45.05	30.10	25.00	21.80
28	101	4B	F	24.00	14.45	17.25	45.25	39.60	37.20	26.90	24.70
29	101	9E	F	26.90	15.50	15.55	52.00	42.20	34.65	29.80	24.60
30	101	12B	M	24.80	13.80	19.50	52.75	47.05	34.70	31.05	25.10

Table VIII. (continued)

MOBRIDGE SITE (39WW1)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
31	101	19B	F	19.40	16.80	17.75	49.65	39.90	35.75	29.35	22.10
32	101	19E	F	23.20	16.75	17.10	51.40	48.10	33.15	30.45	23.65
33	101	19F	M	24.60	16.95	20.20	52.00	43.15	37.90	31.80	24.10
34	101	20B	F	25.00	13.60	15.10	52.30	46.70	29.55	31.10	24.10
35	101	25C	M	24.00	15.10	19.15	52.20	48.65	31.50	31.60	24.50
36	101	22C	F	18.35	12.70	20.00	45.00	40.70	33.35	26.45	23.10
37	101	22E	F	26.75	15.65	16.95	53.10	49.60	36.00	32.40	26.00
38	101	25D	M	23.40	16.20	25.70	55.70	50.10	37.60	31.20	23.40
39	101	27C	F	24.55	15.90	22.45	54.25	44.95	31.75	29.00	27.10
40	101	27F	M	22.00	14.60	20.80	47.10	39.35	34.00	27.60	23.95
41	101	29A	M	25.05	13.20	18.90	52.60	43.80	37.70	31.80	26.10
42	101	22B	M	26.20	15.35	17.35	55.30	46.40	38.05	30.90	27.60
43	101	22D	M	23.45	17.10	21.85	53.85	45.50	36.10	31.60	24.25
44	101	29D	M	22.60	13.30	20.50	47.20	43.10	38.50	32.50	24.75
45	201	2B	F	22.45	13.35	15.65	49.25	40.25	30.20	27.50	20.60

Table VIII. (continued)

MOBRIDGE SITE (39WW1)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
46	201	8B	F	23.40	14.75	20.90	48.50	39.00	30.55	26.70	23.10
47	201	8C	M	24.80	18.20	23.45	53.60	44.20	33.50	31.45	24.05
48	201	11F	F	22.35	14.65	21.45	49.85	42.90	34.25	27.70	22.80
49	201	17	F	24.75	15.70	19.85	50.40	42.05	34.50	27.80	26.20
50	201	26D	F	22.70	13.50	17.85	50.10	43.40	33.00	28.65	21.90
51	201	26E	M	26.25	17.55	16.75	52.15	44.75	33.55	29.20	22.90
52	201	36D	F	25.15	13.75	18.15	52.50	43.85	33.65	28.70	24.90
53	302	5B	M	24.60	13.45	17.25	51.65	45.00	33.90	28.20	25.10
54	301	7D	M	29.90	15.35	19.45	56.45	54.00	44.70	33.60	23.35
55	302	9	M	29.00	15.70	25.00	56.70	50.65	38.35	32.70	24.55
56	302	26B	F	23.35	14.40	17.30	49.10	43.85	31.45	26.70	24.65
57	301	7B	M	25.90	15.15	23.70	53.75	44.40	37.30	29.50	24.25
58	302	12B	M	27.20	14.90	19.65	52.40	42.75	38.25	30.90	26.50
59	301	7E	M	23.50	13.65	17.45	49.80	45.60	34.20	29.85	25.05
60	302	21D	F	22.35	13.60	14.40	50.10	36.75	32.95	27.65	24.05

Table VIII. (continued)

MOBRIDGE SITE (39WW1)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
61	302	27C	M	21.55	14.10	26.05	52.65	44.35	37.35	32.15	24.30
62	302	22	F	26.25	16.25	17.35	52.95	44.80	36.35	31.05	24.25
63	302	24	M	24.05	15.40	24.15	54.05	45.60	37.80	30.80	28.05
64	302	25D	F	24.60	16.75	15.15	51.20	40.60	34.85	26.75	24.10
65	302	27B	F	23.60	15.20	20.90	55.75	51.90	36.25	29.00	23.70
66	302	27D	M	24.05	14.15	20.60	52.60	45.60	36.50	32.95	26.35
67	302	33B	M	24.00	14.40	20.90	53.80	44.85	37.00	31.70	23.50
68	302	32	M	25.50	15.50	23.15	54.95	48.40	37.35	31.10	24.65
69	302	33A	F	25.20	13.90	23.60	53.80	47.30	34.35	28.70	23.20
70	302	27E	F	23.15	15.75	19.40	50.30	40.45	35.30	26.90	24.05
71	302	38C	F	21.10	16.90	21.00	51.05	45.50	35.20	29.50	21.60
72	303	1A	F	22.80	15.60	20.40	50.90	41.55	34.85	27.20	24.95
73	303	2B	M	25.35	15.30	20.50	53.10	48.15	35.85	33.15	25.85
74	101	10E	F	26.00	.	15.25	53.10	42.15	36.40	28.35	24.10
75	301	12A	M	.	.	.	53.10	43.15	34.85	30.90	24.95

Table VIII. (continued)

MOBRIDGE SITE (39WW1)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
76	301	26A	F	19.50	13.90	.	55.30	49.55	34.90	29.45	23.85
77	303	2C	M	.	19.40	.	56.80	48.30	34.40	30.35	25.55
LARSON SITE (39WW2)											
78	201	38B	F	24.80	15.60	21.80	54.80	48.10	32.55	29.25	16.65
79	201	63B	M	20.85	11.70	18.50	51.10	46.60	36.85	34.40	21.75
80	201	64A	F	26.00	14.40	24.80	55.80	49.50	36.10	30.45	20.00
81	201	66	M	24.30	17.05	26.80	52.65	49.10	40.15	33.05	22.50
82	201	68A	M	20.85	14.65	23.40	50.85	47.05	40.15	31.10	21.10
83	201	69C	M	25.75	16.25	20.85	51.60	45.45	32.45	29.50	19.10
84	201	71E	M	24.10	15.30	22.25	51.75	47.00	38.10	29.75	19.25
85	201	75A	M	26.65	15.80	20.75	52.00	47.00	38.65	31.65	18.35
86	201	38C	F	26.00	14.30	16.25	50.40	46.55	35.45	29.60	24.95
87	201	50	F	22.75	14.25	20.10	51.15	45.35	34.75	28.35	24.05
88	201	54B	M	24.60	14.35	23.75	56.95	49.10	34.80	33.10	25.10
89	201	55F	F	24.80	15.35	24.20	53.80	48.15	31.90	29.70	27.75

Table VIII. (continued)

LARSON SITE (39WW2)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
90	201	84I	M	26.65	16.10	17.75	55.90	46.70	33.00	28.65	27.60
91	201	85	F	22.10	17.00	27.55	52.50	49.00	36.45	28.05	25.70
92	201	94	M	29.10	11.35	21.10	52.20	46.80	38.60	29.15	27.60
93	201	95	M	24.15	13.90	16.85	52.05	47.10	34.40	42.10	21.30
94	201	97G	M	22.20	18.55	17.90	55.00	48.90	36.80	33.40	26.15
95	201	101B	F	25.95	16.25	19.60	58.40	51.15	36.75	32.50	24.40
96	201	111C	F	20.95	16.35	20.10	49.65	44.50	32.95	26.45	23.75
97	201	113D	F	26.50	13.90	17.55	50.10	46.20	36.25	29.65	23.35
98	201	114B	F	23.90	14.55	20.60	46.00	43.75	35.15	30.85	26.85
99	201	117	F	23.20	14.05	19.30	49.85	42.85	34.90	29.75	21.00
100	201	120B	F	23.35	12.00	20.20	50.85	44.95	36.30	29.60	24.40
101	201	124B	M	27.05	14.10	21.20	53.60	49.85	37.50	30.10	26.50
102	201	124C	F	23.80	12.25	15.00	45.20	41.20	31.15	24.15	23.20
103	201	124F	F	29.55	12.95	19.65	52.00	46.95	36.80	31.45	27.10
104	201	124G	M	25.85	17.80	16.90	56.95	52.10	33.30	33.30	28.25
105	201	127B	M	23.45	17.05	22.05	57.45	47.55	38.95	31.80	23.90

Table VIII. (continued)

LARSON SITE (39WW2)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
106	201	129A	M	27.30	16.40	22.50	56.55	48.95	39.85	32.30	27.60
107	201	129B	F	27.65	15.60	17.05	49.30	40.60	33.20	23.05	26.10
108	201	130B	M	30.40	16.15	20.90	56.10	47.65	37.40	31.85	23.25
109	201	130C	F	27.15	16.45	19.55	55.55	46.55	38.60	31.55	27.35
110	201	8A	M	26.35	17.40	24.70	55.10	46.05	36.80	29.95	22.60
111	201	55I	M	22.45	18.42	17.80	54.55	48.50	34.35	30.75	27.15
112	201	4C	M	21,60	16.35	21.00	53.10	47.50	32.25	26.90	14.65
113	201	8D	M	24.50	15.30	23.05	53.80	44.75	35.75	28.20	28.85
114	101	10D	F	21.75	16.55	20.25	51.90	46.15	36.50	30.40	21.65
115	101	32B	F	25.10	16.50	17.30	54.00	47.85	35.20	30.85	23.35
116	201	3A	F	24.10	14.20	17.85	48.75	41.65	32.50	26.00	23.50
117	201	3E	M	23.80	15.90	24.75	54.90	51.30	35.90	30.10	24.15
118	201	6A	M	23.10	15.35	25.65	49.50	44.50	38.55	32.30	25.50
119	201	6B	F	25.55	14.00	19.65	50.50	43.20	36.85	28.20	24.55
120	201	7B	M	23.75	16.20	23.15	52.80	47.15	43.35	33.00	26.00

Table VIII. (continued)

LARSON SITE (39WW2)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
121	201	14D	F	25.80	15.05	15.80	53.70	45.80	32.50	27.60	24.00
122	201	19D	F	24.40	16.50	18.10	50.85	45.80	32.70	28.70	22.20
123	201	22B	M	21.00	13.85	18.30	47.05	42.85	33.45	28.50	22.50
124	201	26B	F	26.60	15.90	19.60	51.80	44.45	33.50	26.65	21.00
125	201	32B	M	26.10	15.40	18.80	49.35	43.50	36.15	28.60	28.20
126	201	32C	M	27.00	15.60	20.85	53.85	49.65	36.80	35.95	27.05
127	201	35C	F	24.75	12.20	17.10	46.75	44.20	32.60	27.20	19.30
128	201	132	F	24.65	13.35	20.90	50.90	46.55	33.40	28.45	24.50
129	201	135	F	24.70	14.85	19.10	54.65	47.90	35.25	30.00	26.75
130	201	137C	F	22.50	15.15	16.45	54.55	45.95	31.50	29.65	24.10
131	201	141B	F	24.15	15.75	17.90	52.00	46.90	36.25	28.05	24.10
132	201	142	F	25.55	17.50	21.80	55.05	47.30	35.90	29.35	25.25
133	201	145D	M	22.80	16.40	21.80	52.10	47.40	36.60	28.80	27.80
134	201	148D	F	23.60	12.05	24.90	53.20	49.65	32.35	31.15	26.70
135	201	148G	M	25.45	15.10	18.25	47.10	39.70	37.40	29.60	27.20

Table VIII. (continued)

LARSON SITE (39WW2)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
136	301	2B	F	23.30	14.05	18.90	51.10	45.80	35.55	29.90	25.65
137	301	2F	M	23.85	14.45	23.70	55.40	49.40	38.55	33.70	28.60
138	301	3H	M	25.40	13.95	20.10	53.60	49.85	36.45	30.00	28.50
139	301	1I	M	22.50	14.15	25.65	55.35	50.75	37.55	33.95	30.90
140	301	12C	M	24.25	14.20	23.40	59.15	53.90	39.30	33.40	25.60
141	301	16	F	27.40	14.20	18.15	54.00	46.15	37.60	29.95	24.20
142	301	19D	M	20.70	14.40	22.35	55.80	53.40	39.30	32.55	22.05
143	301	27D	M	24.60	15.90	21.15	56.15	49.85	40.75	33.60	25.35
144	301	29B	F	25.00	14.20	17.55	52.65	44.95	32.00	25.90	26.40
145	301	33C	F	22.75	15.05	18.95	50.70	46.75	33.40	29.95	23.40
146	301	36B	F	26.20	15.00	17.15	54.30	48.65	38.10	31.10	25.00
147	301	37	F	29.95	11.90	20.05	55.65	48.00	36.05	30.90	25.85
148	301	38A	M	26.05	16.25	22.35	55.65	47.40	37.55	30.90	26.70
149	301	42	M	26.10	16.40	23.55	56.15	49.20	39,40	31.30	25.65
150	301	41A	F	21.80	17.41	19.10	53.45	46.95	35.75	29.75	25.50

Table VIII. (continued)

LARSON SITE (39WW2)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
151	301	49A	F	25.40	16.35	15.15	53.10	47.30	37.00	32.05	24.45
152	301	50B	F	23.50	16.80	23.35	55.05	49.70	33.35	29.60	20.15
153	301	50G	M	22.50	13.00	15.65	47.90	43.55	35.72	28.25	24.90
154	301	54A	M	23.30	18.30	27.50	55.95	49.05	39.60	32.30	24.45
155	301	54E	F	26.05	14.35	17.30	52.00	46.00	34.30	29.80	24.25
156	301	54D	M	23.10	14.75	18.65	51.50	46.45	32.90	29.00	23.10
157	301	58F	F	20.30	14.80	19.70	50.35	44.45	32.90	29.30	22.60
158	301	60B	F	20.15	15.15	20.55	50.40	43.60	34.70	28.45	22.75
159	301	60C	M	23.45	15.45	25.30	51.65	44.90	33.15	30.95	28.30
160	301	62B	M	20.00	19.90	18.80	51.05	45.60	32.20	28.10	26.85
161	301	77B	F	22.70	13.05	17.90	49.15	42.95	35.85	28.45	22.50
162	102	1A	F	26.75	13.35	20.55	57.70	52.70	34.50	31.85	25.30
163	102	2	M	26.30	15.45	19.75	54.10	47.00	35.90	28.70	28.55
164	888	88	M	24.55	13.60	16.25	47.95	43.80	38.20	30.35	24.10
165	101	12B	F	22.45	15.25	16.60	52.60	45.50	33.00	26.15	23.05

Table VIII. (continued)

LARSON SITE (39WW2)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
166	201	9A	F	23.70	14.45	.	52.65	47.85	34.70	29.05	24.75
167	201	12I	F	22.50	13.00	.	49.70	43.80	35.55	27.00	23.10
168	201	134	F	23.15	13.75	12.70	47.75	43.00	30.20	27.15	24.05
169	201	13B	M	27.10	18.95	22.95	58.85	50.15	37.15	32.15	22.30
170	201	34B	F	25.61	13.90	16.50	52.95	45.60	32.80	28.65	24.80
171	201	52B	M	27.20	12.25	18.65	51.10	45.80	.	30.60	26.60
172	201	56E	M	25.45	16,75	.	51.85	46.70	36.55	28.00	27.10
173	201	86	M	26.20	15.15	.	54.00	.	34.50	.	21.90
174	301	25	F	.	.	.	.	43.35	37.50	29.25	25.90
175	301	47	F	.	.	.	.	46.60	34.75	30.55	24.50

Table IX. Measurement Data For Arikara Test Sample

LEAVENWORTH SITE (39CO9)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
1	102	11A	F	26.50	12.90	19.05	53.95	46.55	36.25	29.55	25.50
2	102	18D	M	26.15	13.45	19.95	54.35	50.50	38.40	33.35	22.50
3	202	12	M	24.00	15.50	22.30	53.55	43.40	33.60	29.70	24.95
4	120	2A	M	24.30	14.35	19.30	49.55	42.60	35.25	28.45	23.05
MOBRIDGE SITE (39WW1)											
5	201	1I	F	24.85	14,90	15.40	49.05	38.00	33.70	26.40	23.25
6	301	7A	F	22.80	14.45	19.70	48.95	40.20	33.50	28.60	22.20
7	302	44D	F	25.00	16.10	19.50	50.45	41.70	35.70	28.35	21.10
8	303	1D	F	26.00	15.60	21.15	57.30	46.45	35.75	31.40	26.60

Table IX. (continued)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
MOBRIDGE SITE (39WW1)											
9	302	44C	F	.	14.50	.	53.10	46.60	34.35	30.30	26.05
LARSON SITE (39WW2)											
10	101	33E	M	23.20	16.05	19.85	50.55	40.20	34.01	28.50	26.80
11	201	69B	M	26.65	14.60	17.55	49.10	44.10	31.70	29.30	13.25
12	201	47F	F	28.55	17.85	21.35	56.20	48.05	34.70	28.10	25.10
13	201	84E	M	27.60	17.60	16.80	59.15	51.75	35.75	30.85	25.50
14	201	84F	M	22.05	16.50	20.75	50.70	42.15	31.75	25.80	25.65
15	201	84H	F	23.40	13.90	19.85	49.20	43.45	32.85	26.40	27.10
16	201	130A	M	25.10	14.65	18.20	52.05	44.40	37.40	29.75	23.65

Table IX. (continued)

LARSON SITE (39WW2)

Obs	Feature	Burial	Sex	MLC	MWC	MND	BCB	MXID	LFM	WFM	LBP
17	201	148F	M	25.95	12.55	22.90	51.90	48.95	38.00	31.15	26.75
18	301	1M	M	27.60	13.10	17.40	55.15	48.90	35.05	32.10	25.30
19	301	3D	M	30.15	15.50	12.85	55.50	47.25	36.60	31.70	27.25
20	301	1G	F	21.10	15.05	19.85	48.55	39.10	34.45	26.10	22.00
21	301	3C	F	23.25	14.85	17.50	46.60	45.60	32.90	27.50	24.05
22	301	1D	M	23.35	15.80	20.80	54.05	47.65	39.50	32.55	26.60
23	102	3C	M	25.80	13.55	17.90	50.05	47.35	34.05	29.20	23.15
24	301	3G	F	27.20	15.95	19.75	53.00	47.25	35.70	30.20	22.60
25	301	3F	F	25.00	14.25	17.60	51.45	45.30	37.10	31.70	25.80
26	301	3E	M	27.80	14.85	19.10	51.00	43.30	37.20	29.25	23.75

VITA

Margaret Motelle Williams was born in Knoxville, Tennessee on November 2, 1960. She grew up in Newport, Tennessee then attended high school at Salem Academy in Winston-Salem, North Carolina. In September 1978, she entered The University of Tennessee, Knoxville, and in June 1982 received a Bachelor of Arts degree, having majored in the College Scholars honors program with an emphasis in Anthropology.

Following graduation, she worked for a year as Director of Student Activities at Salem Academy. In September 1983, having accepted a graduate assistantship in the International Student Affairs Office, she returned to The University of Tennessee to pursue a Master of Arts degree in Anthropology. Then, in February 1984 she accepted the full-time position of Panhellenic Advisor--a position she held until receiving her graduate degree in June 1987.

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