SELECTED NON-METRIC MORPHOLOGY OF AN ARCHAIC PLAINS CEMETERY: THE GRAY SITE

by

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ABSTRACT

The Gray site represents a large sample of skeletons from Saskatchewan. With radiocarbon dates between 2915 and 5100 years B.P., these remains are assigned to the Plains Archaic and were found in association with Oxbow projectile points.

A number of non-metric variables structurally and functionally related to the vascular and nervous systems are described for a sample of 71 individuals. Sample frequencies for these traits are appended. Tests for association with age and sex are performed for all traits in order to screen out such biases.

The primary purpose of examining the morphological variability is to determine whether two or more distinct groups may have used the cemetery. The method used is a cluster analysis of the sample over 26 variables. The results indicate a single homogeneous group spanning more than 2000 years. Evidence also points to some females having been brought in from outside the population.

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This thesis is dedicated to my parents, Frank and Jean.

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CHAPTER I

INTRODUCTION

Little is known of the skeletal biology of the people inhabiting the Plains in the Archaic. The largest collection of human remains comes from the Gray site, a cemetery in southwest Saskatchewan. Extensive description and analysis of the skeletal material and the site has followed the series of excavations directed by J. Millar ('72, '78). The lack of large comparative collections has hindered the formulation of models to express morphological relationships and variation.

Part of the Oxbow Complex of the Plains Archaic, the Gray site is a piece of this puzzle stretching from Alberta to Manitoba and as far south as Wyoming and South Dakota. The major concentration appears to be southern Alberta and Saskatchewan. Identified mainly by tool types, both Oxbow and Mckean, another Complex within the Plains Archaic, overlap in time and space. Little in the way of skeletal remains relates the people to the tools and other evidence of material culture. The area covered by the tool complex and the span of two millenia (Millar '78) and possibly more (Callaghan '80) at the Gray site argues for high levels of population interaction, be it high mobility, actual migration or trade.

Much of this thesis is descriptive and exploratory. The paucity of comparative material, as well as the unsettled state of non-metric description precludes a more synthetic approach. Hypotheses of variation and population movement must await more information. The use of cluster analysis for structuring populations for inspection of evolutionary relationships usually proceeds from the sample frequencies of non-metric traits (Ossenberg '76, Zegura '75), or from raw metric data, amenable to regression techniques to 'fill in the blanks'. No cluster analysis has been performed, to my knowledge, using non-metric traits and the individual as the basic unit of analysis.

My major interest then, is the multivariate structuring of the sample, and the validity of the results. The only specific question to be entertained will be whether there are two or more morphologically distinct groups as suggested by Vyvyan ('77), and if they can be meaningfully coordinated with the hypothesis of temporally distinct groups (Millar '78). Visual inspection of the skeletons and associated artefacts gives no clue to these groupings. Indeed, the cultural material is highly variable and overall patterns are difficult to discern.

Research involving non-metric traits has followed a pattern much like that of metric or pathologic analysis of skeletons. Anthropological investigations early in the century started a systematic use of morphology to compare populations. Although much was anecdotal in nature, research quickly focused on the inherent population variation of non-metric variables (Oetteking '30) and the possibilities of phylogenetic studies as well (Wood-Jones '31).

The works of Grüneberg ('63) and Berry and Berry ('67) began an upsurge of interest in non-metric analysis. Even though a standard set of variables to be used has not been settled upon, non-metrics have increasingly been included in osteological research. Methodological problems are also given much attention. Studies of replicability (Molto '78), dependence upon age and sex (Akabori '33, Corruccini '74, Ossenberg '69) and intertrait correlation (Molto '79, Corruccini '74) have increased our knowledge of how these traits are affected. Many specific results are conflicting, but general concordance is found in many instances. Statistical treatment of these variables has evolved alongside a deeper understanding of biasing factors.

It is by no means clear to what degree environmental plasticity obscures the genetic control of non-metric variables. While a general genetic model entailing a threshold effect (Grüneberg '63) has probably been overstated, it makes sense to assume a large degree of non-genetic influence. Cheverud *et al.* ('79) have shown that growth and development play a much larger role in determining the final adult morphology than was suggested by earlier workers. The study of deformed crania has also shown that some traits are greatly affected by deviation from normal development.

In this light, qualitative variables can be no worse than quantitative characters and under such an assumption should provide for a more sound interpretation of variation when taken in concert with metric results (not to mention demography and pathology).

The first section details the traits used and their structural relations. Attention is then focused on the various possible associations with sex, age, side and between traits. After suitable manipulation, a cluster analysis is performed for a variety of samples. The results are interpreted in light of the metric analysis (Vyvyan '77), the chronology, and population variability in the Archaic.

CHAPTER II

MATERIALS

The Gray site is found in southwestern Saskatchewan, eight km. northwest of the city of Swift Current. Lying beside a now extinct lake, the site is made up of graves with from one to fourteen individuals in each grave. Apart from a tendency to bury infants by themselves, there is no obvious patterning by age, sex and/or number. Many different burial positions were used, no one major type being in the majority. The larger multiple interments resemble small ossuaries, although these may be the result of a number of different burials scattering the earlier remains. This is supported by a recent fluorine analysis (Callaghan '80).

Other cultural inclusions are red ochre, possible rock linings and bone, shell and stone artefacts. These latter suggest use of the cemetery in the Oxbow Phase of the Plains Archaic (Millar '72, '78). Nine radiocarbon dates span 2185 years, from 2915$\pm$85 (sample s-1449) to 5100$\pm$390 (sample s-647) years B.P. (Millar '78). At the time of excavation these dates greatly extended the duration of the Oxbow Phase.

There is no apparent spatial ordering of the cemetery by time. Nor does artefactual material suggest more than a single, homogeneous culture.

The preliminary demographic analysis of the Gray site (So and Wade '75) shows a steeply falling survivorship curve, with females at a higher risk from 15 to 25 years. This is followed by a reversal with males at higher risk from 25 years onward. The mean age at death is 15 years.

Disregarding the surface finds, the sample numbers 305, of which 113 are less than five years of age. Fully 57% of the sample is aged at less than 15. Subadults are not preserved, on the whole, nearly as well as adults. As a result, the sample used in the cluster analysis has only 13% (9/71) aged less than 12, while 42% (30/71) were adult female and 38% (27/71) adult male. The remainder are unsexed adults.

After the initial statistical analysis, four skeletons from other sites were added to judge their effect on the Gray site sample. Two skulls from the Skownan site on Waterhen Lake in the Interlake region of Manitoba were collected by Sid Kroker and subsequently reported upon (Kroker '77, Lambert '77). The site is approximately 620 km. east north-east of the Gray site. The few artefacts found near the bones proved to be non-diagnostic and cultural affiliation was not proposed.

The other two skeletons were found across the river from each other in the Whiteshell Provincial Park, southeast Manitoba. This site is roughly 900 km. due east of the Gray site. The Bjorklund skeleton is an older adult female, while the Whitemouth Falls skeleton is a somewhat younger female. Both have been tentatively assigned to the Archaic and a full report on both these individuals is in preparation (Meiklejohn and Pardoe n.d.).

The basis for selection of the sample was completeness. Of the 26 variables used in the analysis, an individual was included only when more than 20 observations were possible. Anything less than 75% completeness would only reduce the resolving power of the clustering techniques.

The traits examined were eliminated if there were very few observations made on the sample of 71 individuals. Of the original 47 variables, only 26 had sufficient observations to be included. The rest have been examined for correspondences between age, sex and side only.

The variants have been selected according to a single criterion: that they are morphologically related responses to variation in the circulatory and nervous systems, or as variation structurally related to the interaction between vessels and the surrounding bony structures. Interpretation of functional variation is beyond the scope of this research.

There are two reasons for using this one criterion as the basis for the collection and description of data.

1) It produces a more conceptually sound framework for the interpretation of non-metric traits in skeletal biology. Such _a priori_ methods provide a more coherent outline for study than the usual 'shotgun' approach incorporating hyperostotic and hypostotic traits as well as variation in centres of ossification and foramina (as defined by Ossenberg '69 and Sjøvold '77).

2) By a fortunate coincidence, these traits are often those

with the clearest variation in expression. leading to increased precision in scoring. Most other traits are of the gradationally scored variety and are not generally amenable to comparison between the works of different researchers. To illustrate this point, the vertebral bridges may be observed as unquestionably present. On the other hand, the supraorbital torus may be graded on relative size within the population as well as on shape. This relative size may vary from sample to sample while the scores used to record it often stay the same. Quantification is therefore only internally consistent.

Much of the research done on non-metrics involves the dichotomization of variables. Ossenberg ('69,'76), Saunders ('78), Finnegan ('78), and Perizonius ('79), to name a few, have studied various features such as population differentiation, trait associations and laterality using population frequencies. The most elegant way of manipulating the data is to use present/absent classifications. Unfortunately, many distinct and real categories are lumped together. Some use the frequency of absence and include all other variability in the 'present' category, and vice versa. While it makes no difference in computation (Perizonius '79), the amount of information inherent in that variation is considerably reduced.

Using more categories, when appropriate, has been possible (see method) and provides no insurmountable problem to comparison with other studies. Care was taken to use variables that could ultimately be dichotomized to accord with other categorizations. For instance, the mylohyoid arch has four categories increasing from no marking to a fully ossified bridge. Fully present or fully absent frequencies may be easily derived.

The following discussion describes each variable examined in terms of the vessels, both vascular and nervous which are, in part, the ultimate source of morphological variability.

It would be superfluous to attempt to describe the position and appearance of each trait on the bony skeleton, and I have not tried. Accurate descriptions along with diagrams and photographs may be found in Ossenberg ('69,'74, '76), Saunders ('78) and Finnegan ('78).

Table 1: Categorization of variables

TRAIT		CODE: 0	1	2	3	4
R FRGR L FRGR	* FRONTAL GROOVES	absent	present			
R SUOR L SUOR	* SUPRAORBITAL MORPHOLOGY	absent	1 foramen	2 foramina	1 notch	2 notches (5=both)
R ETFO L ETFO	EXTRA ETHMOIDAL FORAMEN	absent	1	2	3	4+
R ETPO L ETPO	ANT. ETHMOIDAL FOR. POSITION		suture	frontal	ethmoid	
R OPFO L OPFO	OPTIC FORAMEN		single	spur	divided	
R INOR L INOR	* INFRAORBITAL FORAMEN		1	2		
R ZYFO L ZYFO	* ZYGOMATICO-FACIAL FOR.	absent	1	2	3	4+
R ZYOR L ZYOR	*ZYGOMATICO-ORBITAL FOR.	absent	1	2	3	4+
R ZYTE L ZYTE	*ZYGOMATICO-TEMPORAL FOR.	absent	1	2	3	4+
R PAFO L PAFO	*PARIETAL FORAMEN	absent	1	2	3	
R MAFO L MAFO	* MASTOID FORAMEN	absent	1	2	3	4+

* Traits used in the final cluster analyses.

Table 1: Categorization of variables

TRAIT		CODE: 0	1	2	3	4
R MAPO L MAPO	* MASTOID FOR. POSITION	absent	occipital	mastoid-occipital	mastoid	parietal
R METE L METE	* MEDIAL TEMPORAL ARTERY	absent	groove on temporal	groove on parietal		
R POCC L POCC	* POSTERIOR CONDYLOID CANAL	absent	present			
R ANCC L ANCC	* ANTERIOR CONDYLAR CANAL		single	spur	divided	
R INCC L INCC	* INTERMEDIATE CONDYLAR CANAL	absent	incomplete	canal		
R STMA L STMA	* STYLOMASTOID FORAMEN		1	2		
R OVSP L OVSP	* OVALE-SPINOSUM	single	spur	divided		
R FOOV L FOOV	* FORAMEN OVALE		single	spur		open to petrous fissure
R FOSP L FOSP	* FORAMEN SPINOSUM		open to petrous fiss.	present		
R VEFO L VEFO	* VESALIAN FORAMEN	absent	present			
R PTBA L PTBA	* PTERYGOBASAL FORAMEN	absent	spur	foramen		

* Traits used in the final cluster analyses.

Table 1: Categorization of variables (cont.)

TRAIT		CODE: 0	1	2	3	4
R PTSP L PTSP	* PTERYGOSPINOUS FORAMEN	absent	spur	foramen		
R SPBA L SPBA	* SPINOBASAL FORAMEN	absent	spur	foramen		
R PTPL L PTPL	PTERYGOID PLATE FORAMEN	absent	present			
R PTPA L PTPA	PTERYGO-PALATINE CANAL	absent	groove (on sphenoid)	canal		
R PLFO L PLFO	* ACCESSORY PALATINE FOR.	absent	1	2	3	4
R CLCL L CLCL	CLINO-CLINOID BRIDGING	absent	spur	bridge		
R CACL L CACL	CAROTICO-CLINOID BRIDGING	absent	spur	bridge		
R MEBR L MEBR	* BRIDGING OF A. MENINGEA MEDIA	absent	incomplete	present		
SAGS	* SAGITTAL SINUS DIRECTION		right	left	common	indistinct
R MYAR L MYAR	* MYLOHYOID ARCH	absent	groove	notch	foramen	
R MNFO L MNFO	ACCESSORY MANDIBULAR FOR.	absent	1	2		

* Traits used in the final cluster analyses.

Table 1: Categorization of variables (cont.)

TRAIT		CODE: 0	1	2	3	4
R MEFO L MEFO	* ACCESSORY MENTAL FOR.	absent	1	2		
R SUSC L SUSC	SUPRASCAPULAR NOTCH	absent	notch	foramen		
R CISU L CISU	A. CIRCUMFLEX SULCUS	absent	present			
R SUAR L SUAR	GROOVE FOR SUBCLAVIAN A.	absent	present			
R SUVE L SUVE	GROOVE FOR SUBCLAVIAN V.	absent	present			
R CCDI L CCDI	FOR. TRANSVERS- ARIUM DIVIDED (C3)	single	spur	divided		
R CDDI L CDDI	C4	single	spur	divided		
R CEDI L CEDI	C5	single	spur	divided		
R CFDI L CFDI	C6	single	spur	divided		
R CGDI L CGDI	C7	single	spur	divided		
R FOTR L FOTR	FOR. TRANSVER- SARIUM POSITION	through C7 not T1	through T1 not T2	through C6 not C7		

* Traits used in the final cluster analyses.

Table 1: Categorization of variables (concl.)

TRAIT		CODE: 0	1	2	3	4
R POBR L POBR	POSTERIOR BRIDGE OVER VERTEBRAL A.	absent	spur	bridge		
R LABR L LABR	LATERAL BRIDGE OVER VERTEBRAL A.	absent	spur	bridge		
R RANO L RANO	RETROARTICULAR NOTCH	absent	spur	foramen		

FRONTAL GROOVES [FRGR]

Frontal grooves result from the impression of the supraorbital vessels upon the outer table of the frontal bone. The supraorbital artery, vein and nerve are a common bundle from the upper margin of the orbit outward. They diverge rapidly and make an absolute correlation with the grooves impossible. Dixon ('04) suggested the grooves were formed by differential growth of the nerve and the frontal bone. The position of the grooves is variable; from the temporal line to as far medially as the inner margin of the orbit. Frontal grooves are rarely bridged and occasionally arise directly from the diploe. In the latter case, the variation was scored present for two reasons. First, other studies using this trait do not make the distinction. Second, it is not impossible for the diploic vessel to actually be a branch of the supraorbital.

SUPRAORBITAL FORAMEN [SUOR]

Although this variable is fairly obviously related to passage of the nerve, artery and vein of the same name, variation of the supratrochlear groove can be confused with the supraorbital. The nasofrontal vein can also cause problems in discerning the probable vessel involved. Care was taken to discount the supratrochlear groove when distinct and close to the inner angle.

the inferior ophthalmic vein and the pterygoid plexus. It may be divided by a bar of bone. This effectively separates the vessels at one point. More rarely there are two canals originating from the infraorbital groove in the middle of the orbital floor and exiting some distance apart on the maxilla. No distinction was made for these two possible variations encountered in the Gray site sample.

There are two other canals derived from the infraorbital canal. However, it is not likely that they are related to the extra canal. They transmit some of the dental vascular and nervous vessels and are probably not subject to large variation.

ZYGOMATICOFACIAL FORAMEN [ZYFO]

ZYGOMATICOORBITAL FORAMEN [ZYOR]

ZYGOMATICOTEMPORAL FORAMEN [ZYTE]

The zygomatic nerve and artery branch from the infraorbital and lacrimal vessels respectively. They enter the zygomaticoorbital foramen with the exception of an occasional twig communicating with the lacrimal nerve through an accessory foramen. After entering the zygomatic bone the vessels branch into the zygomaticofacial and zygomaticotemporal, which exit through their named foramina.

PARIETAL FORAMEN [PAFO]

Also referred to as an obelionic foramen, it is found on the parietal close to the sagittal suture and slightly anterior to lambda. The parietal emissary vein exits here, and occasionally a meningeal twig of the occipital artery. When present, the latter is accompanied by a branch of the greater occipital nerve.

MASTOID FORAMEN [MAFO]

This variable is found near the mastoid-occipital suture. One or more of the foramina will rarely be found on the parietal. The emissary veins passing through the foramina connect the sigmoid sinus and the posterior auricular or occipital veins (Gray '74).

MASTOID FORAMEN POSITION [MAPO]

The position of the above foramen can be considered to vary along a line perpendicular to the mastoid-occipital suture. The largest (or only) foramen is judged to lie on the suture or one of the bones.

MEDIAL TEMPORAL ARTERY [METE]

I have recorded this variable somewhat differently than did Ossenberg ('69). Of the arteries supplying that portion of the scalp and muscle, Ossenberg recorded the frequency of an anomalous artery arising internally from the middle meningeal. The most common arteries found there are the parietal ramus and the medial branch of the superficial temporal. The variable examined is the grooving pattern of any of these arteries, although I will show that our methods and definitions are basically the same.

The absent category has no grooves. The [1] category is the presence of a groove on the temporal formed by the parietal ramus or the medial branch, but excluding the posterior branch, of the superficial temporal artery. There may be a continuation of the groove onto the parietal, but it is disregarded.

The last category [2], grooving of the parietal, is only relevant if there is no groove on the temporal squama. The frequencies for the last category are somewhat higher than other Plains groups examined by Ossenberg ('69) and could be methodologically biased. I would accept a groove with no obvious style shield as well as a rather common case where the groove is clearly associated with a middle meningeal artery, but has entered the diploe and exited the skull from 2-4cm. superior to the parietal-temporal juncture.

<u>POSTERIOR CONDYLOID CANAL [POCC]</u>

Another emissary vein, the posterior condyloid connects the sigmoid sinus with the suboccipital and vertebral plexuses (Ossenberg '69). An observation was deleted if the condyles had undergone extensive arthritic lipping <u>and</u> if the area of exit internally was unobservable.

<u>ANTERIOR CONDYLAR CANAL [ANCC]</u>

It is also named for the hypoglossal [cranial XII] nerve which is the major traversing vessel. The ascending pharyngeal artery also sends a meningeal branch through the foramen (Gray '74). Bridging of the canal occurs between the two major bundles of the twelfth cranial nerve, which commonly join only after passing through the canal.

INTERMEDIATE CONDYLAR CANAL [INCC]

The vein lying in the groove lateral to the occipital condyles connects the emissaria of the anterior and posterior canals. As with many variables, INCC can be trichotomized to complete, incomplete and absent; the former being a bridge anywhere along the length of the groove.

STYLOMASTOID FORAMEN [STMA]

Postero-lateral and adjacent to the styloid process is the stylomastoid foramen. It is constant and often double. The structures transmitted are the stylomastoid artery and vein and the facial nerve. This artery supplies much of the tympanic area. The associated vein drains into the posterior auricular vein, as does the mastoid emissary vein.

OVALE-SPINOSUM [OVSP]

FORAMEN OVALE [FOOV]

FORAMEN SPINOSUM [FOSP]

VESALIAN FORAMEN [VEFO]

These four variables are best considered together as they deal with the same structures. Wood-Jones ('31) attached phylogenetic import to the vessels and their associated foramina in the area of foramen lacerum medium, or the spheno-petrous fissure. The three foramina of interest; ovale, spinosum and vesalian, represent specializations of the primitive condition of a single large fissure. Foramen ovale transmits the mandibular portion of the trigeminal [cranial V] nerve, the petrosal nerve and a small meningeal artery (Gray '74), as well as an emissary vein connecting the cavernous sinus and the pterygoid plexus.

In humans, it is the emissary vein that varies to produce a vesalian foramen by separation from the rest of the foramen ovale bundle. Foramen spinosum carries the middle meningeal artery and vein and the mandibular nerve, meningeal branch (Woodburne '76).

OVSP is scored as single, indicating non-separation of the foramina, or as divided. Partial division of these two foramina is also taken into account. FOOV may sometimes be anteriorly spurred, possibly indicating incomplete separation of the vesalian foramen. It may also be open to the petrous fissure. FOSP is also observed for continuity with foramen lacerum, or the petrous fissure. The vesalian foramen can be found some distance from the anterior end of ovale and is scored as present or absent. There is some overlap between FOOV and VEFO in this respect. The anterior spurring of foramen ovale may be the incipient separation of the emissary vein. This is not anatomically correlated however, and could be explained by subdivision of the bundle within foramen ovale.