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BIOLOGICAL AFFINITIES OF ANCIENT EGYPTIANS AND NUBIANS: AN ANALYSIS OF CRANIAL NONMETRIC TRAITS

BY

TRACY L. PROWSE ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of MASTER OF ARTS.

DEPARTMENT OF ANTHROPOLOGY

Edmonton, Alberta
Fall, 1994

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled BIOLOGICAL AFFINITIES OF ANCIENT EGYPTIANS AND NUBIANS: AN ANALYSIS OF CRANIAL NONMETRIC TRAITS submitted by TRACY L. PROWSE in partial fulfillment of the requirements for the degree of MASTER OF ARTS.

Dr. Nancy C. Lovell

Dr. Owen B. Beattie

Richard C. Smith

Dr. Richard C. Smith

In memory of my mother,

Judith Anne Prowse

ABSTRACT

This study examines the biological affinities of eight Nile Valley skeletal samples from the early phases of Egyptian and Nubian cultural history (ca. 4400-1800 B.C.). Data on fifty-eight nonmetric traits of the cranium have been collected from a total of 372 crania. Prior to the calculation of biological distance, nonmetric trait frequencies from four skeletal samples are statistically tested for correlations with age, sex and side, using chi-squared and correlation statistics.

The analysis of biological variation in the Nile Valley samples is divided into three separate studies, each using the multivariate Mean Measure of Divergence (MMD) statistic to measure empirically the variation between skeletal samples. The first study examines the intrasite biological affinities among three Predynastic cemeteries at the site of Naqada. The second study investigates temporal variation of biological relationships between two samples from the A-Group and C-Group periods in Nubia. The final biological distance study is a regional investigation of intersite variation among eight skeletal samples from the sites of Abydos, Badari, Keneh and Naqada in Egypt, as well as the Scandinavian Joint Expedition (SJE) sites 179 and 277 in Nubia.

Results of age and sex correlation analysis indicate that although there are slight age and sex associations with nonmetric trait frequencies, the overall pattern of these associations is not consistent between the samples studied and, therefore, age and sex are not considered to affect the outcome of subsequent biological distance calculations significantly. Chi-squared analysis of right and left associations of bilateral traits demonstrates moderately high levels of interdependence between sides and correlations between sides are found to be generally positive. If the model for the genetic basis of nonmetric traits is accepted, however, then the unilateral and bilateral expression of nonmetric traits is primarily due to genetic, and not environmental factors. Therefore, scoring by sides will more accurately reflect the genetic character of nonmetric traits.

The biological distance analysis of the Naqada skeletal samples reveals that the elite cemetery, Cemetery T, is biologically distinct from the other two cemeteries, Cemetery B and the Great Cemetery. Examination of the archaeological and skeletal evidence suggests that the biological distinction of Cemetery T is due to genetic drift caused by the selective interbreeding of an elite segment of the local population. Cemetery T is therefore treated as a separate sample in the final biological distance analysis, while Cemetery B and the Great Cemetery are combined for further analysis.

Biological distance analysis of the Nubian A- and C-Group samples, SJE179 and SJE277, reveals that there is evidence of biological continuity between the A- and C-Group periods on the basis of cranial nonmetric traits. Archaeological evidence for differences between the two cultural periods can be attributed to local cultural evolution of biologically homogeneous populations. The two Nubian samples are therefore combined for the final study of biological distance.

Cluster analysis of the MMD's in the final biological distance study shows close biological affinities between the Naqada and Nubian skeletal samples. The general pattern of biological relationships among the sites is largely geographical, however, the site of Keneh tends to confound these relationships and is considered to be a biological outlier, however, lack of information about this site precludes a definitive interpretation. The Abydos sample is notably distinct from all other samples. This finding, in conjunction with archaeological evidence, suggests that the Abydos sample is a biologically distinct group that arrived in Upper Egypt with members of the ruling elite from Lower Egypt during the unification of Upper and Lower Egypt.

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CHAPTER 1

INTRODUCTION

The use of skeletal remains in the investigation of biological variation among past populations can broadly be divided into metric and nonmetric studies of the cranium, postcranium and dentition. Metrical analysis of human skeletal samples has traditionally been the predominant method of inquiry in physical anthropology, however, since the 1960's, skeletal nonmetric traits have been increasingly used in the analysis of human biological variation, although their existence has been recognized for centuries. The application of nonmetric traits to the analysis of biological relationships in humans was largely due to the discovery of their genetic nature in a series of studies on mice. Berry and Berry's (1967) initial study on cranial nonmetric variation in humans significantly influenced the direction of subsequent research.

A variety of expressions have been introduced to refer to minor skeletal variants in biological distance analysis. The term 'nonmetric' reflects the qualitative scoring of these traits as either present or absent, in contrast to the quantitative nature of metric characters. The term 'epigenetic' has been applied to minor skeletal variants and refers to the genetic control over the progressive differentiation of cells and tissues in different environments (Hauser and De Stefano, 1989). This term was first applied in studies of nonmetric traits in mice in order to emphasize that nongenetic factors could affect trait expression. Grüneberg (1952) coined the expression 'quasi-continuous variation' in order to express the underlying continuous distribution of the discrete, physical manifestation of nonmetric traits.

The implicit assumption in nonmetric trait analysis is that genetic factors are primarily responsible for the expression of individual traits. Thus, researchers are able to investigate patterns of nonmetric trait variation in skeletal samples and assume that the variation observed is related to the genetic, or biological, differences between populations (Berry and Berry, 1967). Nonmetric traits, however, are also influenced by environmental factors and, therefore, the final expression of a particular trait is the result of both genetic and environmental influences during development. The actual degree of control of both these components is unknown, but it is generally assumed that the genetic component is the determining factor.

Skeletal studies on the ancient Egyptians have traditionally relied on metric analysis of human variation to investigate biological relationships and have largely focused on the identification of the racial origins of Egyptian civilization (e.g., Batrawi, 1935, 1945, 1946; Crichton, 1966; Elliot-Smith 1915; Fawcett and Lee, 1902; Giuffrida-Ruggeri, 1915; Morant 1925, 1935; Pearson, 1896; Thomson and MacIver, 1905; Warren, 1897). These studies were based on racial typological analyses, which used racial 'types' to classify populations. Modern biological distance studies, however, employ the biological population model as a theoretical framework, which uses the local breeding population as the basic unit of analysis. The study of biological affinities among past populations therefore assumes that the skeletal sample is the local breeding population and attempts to explain the pattern of variation without any preestablished categories (Keita, 1993).

This study investigates the biological diversity in the Nile Valley on four different levels of analysis. First, it is an examination of the methodological considerations involved in the use of cranial nonmetric traits for biological distance analysis, including the effects of age and sex on trait manifestation as well as the controversy over the scoring of nonmetric traits. Second, it is an analysis of intrasite variation among three skeletal samples from Naqada, one of which has, on the basis of archaeological evidence, been identified as a socially distinct group. Nonmetric trait analysis will be used to determine if this social differentiation can be correlated with biological diversity. A third level of analysis examines temporal variation of nonmetric frequencies through a study of two skeletal samples from successive time periods in Nubia. The final aspect of this study is a regional analysis of biological variation in the Nile Valley.

The analysis of the differences in nonmetric trait frequencies between skeletal samples can lead to new interpretations of the relationships between past populations (Connor, 1990). Thus, it is the goal of biological distance analysis to describe and quantify not only the variation observed, but also to attempt to explain this variation within the framework of our genetic, environmental, demographic, geographical and cultural knowledge of the populations studied (Bocquet-Appel, 1984).

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CHAPTER 2

HISTORICAL AND THEORETICAL BACKGROUND TO BIOLOGICAL DISTANCE ANALYSIS

Historical and Theoretical Considerations

Nonmetric traits of the cranium and postcranium have been identified and studied for at least the past three centuries, consisting mainly of studies by European anatomists in which nonmetric traits were viewed as skeletal anomalies (e.g., Allen, 1896; Blumenbach, 1776; Chambellan, 1883; Gruber, 1852, 1870a, 1870b; Henle, 1855; Hyrtl, 1859; Kerckring, 1670; Krause, 1880; Oetteking, 1930; Quain, 1908; Sullivan, 1922; Testut, 1889; Virchow, 1875 - as reviewed by Hauser and De Stefano, 1989 and Molto, 1983). The purpose of these early studies was primarily the description and classification of observed skeletal variants (e.g., LeDouble, 1903, 1906). Consistent with the 19th century theory of recapitulation, many skeletal variants were considered to be evolutionary vestiges of features seen in lower mammals (Saunders, 1978). The theory of recapitulation postulated that an organism passed through morphological stages of lower evolutionary forms during its development, a concept that consequently generated extensive research in the area of comparative physiology (Mayr, 1982). As a result, minor skeletal variants began to be used for population comparisons in humans based on the premise that traits identified as ancestral were evidence of racial primitiveness in certain human groups (e.g., Morton, 1839; Scott, 1893 - reviewed by Saunders, 1989). Russell's (1900) study on North and South American skeletal samples was one of the earliest comparative, versus purely descriptive, studies employing nonmetric traits. Similarly, Wood-Jones (1930-31) later proposed that non-adaptive traits could be used in comparative studies of populations, however, most nonmetric studies continued to be mainly descriptive in nature. After the rejection of the theory of recapitulation, the number of nonmetric trait studies diminished as interest in physical anthropology turned to metric studies of variation (Saunders, 1978).

A significant shift in the nature of nonmetric trait analysis occurred when a model for the genetic control of trait inheritance in mice was proposed by Grüneberg (1952). This model had a major influence on human nonmetric trait studies, as it provided a theoretical justification for the study of morphologically analogous traits in humans, although direct evidence for the genetic nature of nonmetric traits came primarily from studies on nonhuman skeletal samples. Studies that have found evidence for the genetic control of nonmetric traits were mainly those performed on wild and laboratory populations of mice (*Mus musculus*) (e.g., Berry, 1963, 1964; Grewal, 1962; Grüneberg, 1951, 1952, 1955; Searle, 1954a, 1954b). In an early study on nonmetric trait inheritance in mice, Grüneberg (1951) demonstrated that the inherited variable in third molar agenesis was the size of the tooth rudiment during development, and not the actual presence or absence of that trait. Grüneberg (1952) subsequently developed the theory of quasi-continuous inheritance which proposed that discrete trait expression was determined by an unspecified, and still largely unknown, physiological threshold acting on the underlying continuous distribution of a trait (e.g., the size of the tooth rudiment). The final expression of a nonmetric trait was considered to be due to the additive effects of a number of equally dominant gene loci, and was influenced by general and specific environmental stressors superimposed on the underlying genetic framework. In general, the quasi-continuous model assumes that the underlying continuity of a particular trait is normally distributed and is affected by both genetic and environmental factors. This normal distribution represents the liability of a trait to be expressed, and if this liability exceeds the value of the imposed physiological threshold, the trait will be expressed. More than one degree of trait expression is explained through the existence of multiple thresholds (Hauser and De Stefano, 1989).

Following Grüneberg's early work on the genetics of nonmetric traits, research turned to the investigation of the possible environmental causes of trait variation in mice. The effects of sex, litter size, parity, maternal age, gestation length and diet on nonmetric trait variation were examined, and it was found that factors affecting the size of the offspring during development produced variation in trait expression, although intangible factors accounted for over eighty percent of the variation in three-quarters of the traits examined (Searle, 1954a, 1954b). The influence of diet on trait expression was subsequently confirmed by Deol and Truslove (1957). A later study found similar correlations between trait frequency and general size in mice, but also showed that when a number of traits were examined simultaneously, environmental factors had no influence on trait expression (Howe and Parsons, 1967). Additional studies of population variation in mice concluded that genetic factors played a predominant role in determining variation in trait expression between populations and that environmental factors had a comparatively minor role (Berry, 1963, 1964; Grewal, 1962).

In contrast to the considerable evidence for the inheritance of nonmetric traits in mice, the evidence for humans is largely indirect. Berry and Berry (1967) have argued that there are three lines of evidence that imply the genetic control of nonmetric traits in humans; (1) the frequency of any particular variant is constant in a given 'race' and is similar in related races; (2) the proven genetic determination of certain skeletal variants in mice, which are assumed to be morphologically analogous to variants in humans; and (3) results of familial studies in humans that have shown skeletal variants to be genetically inherited.

Further evidence for the genetic nature of nonmetric traits has been obtained from heritability studies in both nonhuman and human samples. The heritability of nonmetric traits is defined as the proportion of the total variance attributed to the additive effects of multiple genes (Pietrusewsky and Douglas, 1993). Analysis of heritability in animals includes studies of mice (Self and Leamy, 1978) and a series of extensive studies on Rhesus macaques (Cheverud and Buikstra, 1981a, 1981b, 1982). Heritability studies in humans, consisting of radiographic and physical examination of twins and family groups, have found a significant genetic component in the inheritance of certain nonmetric traits. These traits include atlas bridging, clinoid bridging (Saunders and Popovich, 1978; Saunders et al., 1976), metopism, wormian bones (Torgersen, 1951a, 1951b), torus palatinus and torus mandibularis (Johnson et al., 1965; Suzuki and Sakai, 1960). Sjøvold (1984), however, found that nonmetric traits had comparatively lower levels of heritability when compared to metric traits. Heritability estimates are also population specific and therefore can only be considered valid for the specific population studied.

In the absence of familial studies, the genetic basis of nonmetric traits has also been inferred from traits that appear before birth (e.g., wormian bones) (El-Najjaar and Dawson, 1977). Another method used to determine indirectly the genetic control of nonmetric trait variation is the analysis of trait frequencies in related groups (Pietrusewsky and Douglas, 1993). It is assumed that if two groups are closely related, the frequency of any given trait will be correspondingly similar. At the genetic level, there are four mechanisms that can affect gene frequency within a population; mutation, natural selection, genetic drift and gene flow. In human biological distance studies, observed variations in nonmetric trait frequencies are usually attributed either to gene flow (i.e., migration) or genetic drift. Gene flow is the transfer of alleles from one population to another as a result of the mating of individuals from each population. Genetic drift is a chance deviation of allele frequency in a population, primarily associated with the size of a breeding population. The genetic basis for the inheritance of nonmetric traits in humans has been accepted by most researchers with the exception of Rösing (1984), who has criticized the unconditional use of nonmetric traits when only a small number of traits have been proven to be of genetic origin. This premise of the underlying genetic control of nonmetric traits has formed the theoretical basis for the analysis of population variability in humans.

Human Biological Distance Studies

One of the pioneering studies in the analysis of human biological variation was Laughlin and Jorgensen's (1956) analysis of Greenlandic Eskimo variation using a multivariate statistical analysis on trait prevalence and was soon followed by Brothwell's (1958) study of metric and nonmetric traits in fourteen world-wide populations. Neither of these initial studies had a significant impact on the direction of study of nonmetric traits at that time, largely due to methodological problems (Kozintsev, 1993). Intensive use of nonmetric traits in populational studies of humans began with Berry and Berry's (1967) oft-cited study of thirty cranial variants in eight global geographic groups. This study attempted to develop a systematic scoring procedure for nonmetric traits and introduced the C.A.B. Smith Mean Measure of Divergence statistic for the calculation of biological distances. Berry and Berry contended that nonmetric traits were superior to cranial measurements for biological distance studies based on the apparent lack of correlations with age, sex and between individual traits, as well as the relative ease of scoring. The influence of environmental factors was also considered to be minimal, as demonstrated in previous studies of mice (Howe and Parsons, 1967). This led to the assertion that the use of a larger number of nonmetric traits would more accurately reflect true genetic relationships (Ossenberg, 1974). A major contribution of Berry and Berry's (1967) study to nonmetric trait analysis was that it encouraged a vast amount of research in biological distance studies during the next decade, which generally followed the same research model and statistical methods (e.g., Berry, 1974; Corruccini, 1972; Kellock and Parsons, 1970a, 1970b; Lane and Sublett, 1972; Rightmire, 1972). Numerous Ph.D. dissertations also examined the biological affinities of human populations using skeletal nonmetric traits, including; Birkby (1973), Cybulski (1972), Gaherty (1970), Jantz (1970), McWilliams (1974), Ossenberg (1969), Pietrusewsky (1969), Suchey (1975) and Wade (1970) (reviewed by Hemphill, 1992, and Saunders, 1989).

A shift in research focus has occurred within biological distance studies in the past forty years, as studies have turned away from interracial and interpopulational research (e.g., Berry and Berry, 1967, 1972; Berry et al., 1967; Kellock and Parsons, 1970a, 1970b) towards intraregional and intrasite studies (e.g., Buikstra, 1976; Cybulski, 1975; Lane and Sublett, 1972; Molto, 1983; Ossenberg, 1974; Rothhammer et al., 1984; Sciulli, 1990). This trend was identified based on an analysis of the proportion of articles published in the American Journal of Physical Anthropology between 1955 and 1985 (Buikstra et al., 1990). The study of interpopulational variation has continued throughout this period, however, most notably by Ossenberg (1976, 1986, 1992) and Dodo and Ishida (1987) on Eskimo, North American and Japanese skeletal material, as well as Pietrusewsky (1984) on Australian and other samples from the Pacific and Asia.

As the study of biological affinities of human groups continued in the 1970's and 1980's, previously held assumptions concerning effects of age, sex and side on nonmetric trait frequencies were tested and shown to be questionable, which led to an increase in the number of methodological studies on nonmetric traits. In addition to the increased emphasis on methodological studies, debate also arose over the relative ability of metric versus nonmetric traits to determine biological affinities. Berry and Berry (1967) originally contended that nonmetric traits were superior to metric traits for biodistance analysis, based on the relative lack of correlations and ease of scoring. Numerous subsequent studies compared biological distances derived from both nonmetric and metric variants in relation to other sources of cultural or linguistic information, but no consensus was reached on the relative merits of nonmetric versus metric traits (e.g., Carpenter, 1976; Gaherty, 1974; Ossenberg, 1977; Rightmire, 1972; Sjøvold, 1977; Thoma, 1981). The controversy over the superiority of metric versus nonmetric traits was resolved when it was demonstrated that both types of traits shared similar developmental patterns (Cheverud et al., 1979;

Corruccini, 1976). Corruccini's (1976) observations of the correlation between trait type and general skull size led to the conclusion that nonmetric traits were essentially an alternative expression of metric variables. Further, Cheverud et al. (1979) proposed that correlations between nonmetric and metric traits indicated that both trait types were determined by the same developmental processes, and therefore there was no biological basis for the superiority of one type over the other as both were expressions of the same underlying continuous variable.

One of the most controversial elements of Berry and Berry's (1967) influential study was their statistical treatment of nonmetric traits, in particular the assumed lack of age, sex, side and intertrait correlations. It then became common practice to pool samples without examining the data for any significant associations before biological distances were calculated (Saunders, 1978). Shortly after the publication of Berry and Berry's (1967) article, Anderson (1968) used seventy-five nonmetric traits of the cranium and postcranium to analyze geographic and temporal distances among fourteen Ontario Iroquois skeletal samples. His conclusions concerning the utility of nonmetric traits in distance studies were more reserved than those of Berry and Berry and recommended that sides and sexes be considered separately, as well as emphasizing the need for more precision in data collection. Molto (1983) has asserted that Anderson's influence was seen in numerous later methodologically-oriented studies (e.g., Cybulski, 1975; Lane and Sublett, 1972; Ossenberg, 1974).

One of the most negative critiques of nonmetric trait analysis was by Corruccini (1974), in a study of seventy-two nonmetric traits on crania from the Terry Collection in which he found significant age, sex and intertrait correlations. He concluded that nonmetric traits were the least desirable method available to study genetic relationships among skeletal samples. This study significantly damaged the credibility of the nonmetric trait approach to biological distance analysis, however, was itself also flawed methodologically (Molto, 1983). Corruccini's (1974) study generated extensive research on the methodological aspects of nonmetric trait analysis, in which correlations with age, sex, side, cranial deformation were examined, as well as investigation of intertrait relationships among skeletal variants.

Age Correlations

Several studies have examined the correlations between nonmetric trait frequencies and age, including a number of Ph.D. dissertations (reviewed by Saunders, 1978, including; Birkby, 1973; Buikstra, 1972; Finnegan, 1972; Korey, 1970; Ossenberg, 1969). The majority of published studies that have examined age correlations found no significant associations with trait frequencies (e.g., Berry, 1975; Molto, 1983; Perizonius, 1979; Saunders, 1978; Vecchi, 1968). Additionally, Buikstra (1976) found that age had little effect on trait frequency in adults, but when pre-adolescents were included in the sample significant age associations appeared. Ossenberg (1970) similarly concluded that the differences in age-associated trait frequencies would not significantly alter the results of distance analyses. She did note, however, that differences in age associations tended to follow a pattern correlated with hypostotic-hyperostotic trait manifestation. Hypostotic traits, arising from insufficient ossification, followed an age-regressive pattern up to a certain stable level, whereas hyperostotic traits, arising from excess ossification, generally followed an age-progressive pattern of development. In contrast, Corruccini's (1974) study on the Terry Collection demonstrated that there were twice as many correlations between age and trait prevalence than expected by chance alone for this sample, although he was later criticized on the basis of his use of certain traits considered to be of little value in the study of population affinities (e.g., nasal sill development and inion salience) and for combining more than one single breeding population in his analysis (Molto, 1983). The conflicting results in adult age correlation studies have been attributed to a variety of factors, including differences in sample sizes, nonmetric traits studied and statistical methods employed (Saunders, 1989). The best way to examine the relationship between age and trait expression is through longitudinal familial studies. A familial study of atlas bridging and clinoid bridging found that both traits appeared to stabilize in the mid-teens and did not undergo significant changes in frequency during adult life (Saunders and Popovich, 1978). Similarly, jugular foramen bridging was found to be an age stable trait based on a study of fetal skeletal material (Dodo, 1986). It is recommended that subadults be excluded from distance analyses and that skeletal samples be examined for possible age associations prior to distance analysis (Saunders, 1989).

Sex Correlations

In general, there have been no consistent results in the analysis of correlations of nonmetric trait frequencies with sex. In their initial study of cranial nonmetric traits in humans Berry and Berry (1967) did not find any significant sex-related correlations, however, two biologically distinct samples were combined in order to increase the size of the overall sample and males and females from different biological populations were combined prior to analysis, therefore invalidating their results. In a later study, some sex related differences were found, but it was argued that there was little consistency in their manifestation between different populations, and therefore nonmetric traits could still be considered as valid biological indicators if equal numbers of males and females were studied (Berry, 1975). Similarly, other studies have found no significant or consistent sex differences (e.g., Cosseddu et al., 1979; Cybulski, 1975; Dodo, 1974).

Studies that have found significant correlations between trait frequency and sex have suggested a variety of methods for dealing with intersex variation in biological distance studies. It has been suggested that sex differences in nonmetric traits are likely significant in all human populations, and therefore sexes should be considered separately in distance studies (Corruccini, 1974). The separation of sexes in skeletal analysis, however, may produce more statistical distortion than would occur if males and females were pooled for analysis (Ossenberg, 1976). It has also been recommended that sex-related traits should be excluded from biological distance analysis (Perizonius, 1979). Most recently, studies using cranial nonmetric traits have eliminated those characters that have shown either significant age, sex, or intertrait correlations (e.g., Connor, 1990; Konigsberg, 1990; Scuilli, 1990), although the removal of selected traits may exclude valuable genetic information. As is the case with age correlations, sex correlations should be examined prior to biological distance analysis.

Ossenberg (1970) found that variation in trait frequencies due to sex correlations could be explained through the differential manifestation of hypostotic versus hyperostotic traits. In general, hypostotic traits tended to be more common in females and hyperostotic traits tended to occur more often in males. This pattern is consistent with the model of quasi-continuous inheritance for nonmetric traits which predicts that trait frequencies may be affected by size differences as the result of sexual dimorphism (Grüneberg, 1952). Even with this observed pattern of variation in hypostotic and hyperostotic traits, it was concluded that effects due to sex would not greatly affect population comparisons (Ossenberg, 1970).

Side Correlations

A large number of the cranial nonmetric traits used in biological distance studies are bilaterally expressed, raising the issue of scoring procedures used in data collection of bilateral traits. Numerous studies have employed the side count method for scoring bilateral traits, based on the assumption that trait expression on one or both sides is largely determined by the additive genetic effects of a particular trait (e.g., Berry and Berry, 1967, Hemphill, 1992; Kozintsev, 1990; Ossenberg, 1976, 1981, 1986, 1992). It has also been suggested that side asymmetry may be due in part to a lower degree of ossification of the right side of the cranium due to increased innervation on that side (Ossenberg, 1970; Searle, 1954a). A test of the different methods of bilateral trait scoring found that the bilateral side count method, in which both sides of the cranium are scored, provided the most information in fragmentary skeletal samples (Green et al., 1979). Further, it was found that the bilateral occurrence of nonmetric traits rose with increased overall frequency of expression, consistent with the quasi-continuous model of inheritance which predicts that individuals expressing a trait bilaterally have a greater genetic liability to express that trait (Hauser and De Stefano, 1989; Ossenberg, 1981). Therefore, scoring by sides more accurately reflects the underlying genetic liability of a particular trait (Ossenberg, 1981).

The side count method assumes that each side of the cranium is independent for bilateral trait expression and therefore can be scored separately. Proponents of the individual count method, however, have argued that a number of bilateral traits demonstrate significant side interdependence and therefore should not be considered separately (Molto, 1983; Saunders, 1978). In addition, it has been argued that the pooling of right and left sides artificially increases the sample size and introduces redundant genetic information (Molto, 1983). It is further suggested that most bilateral traits eventually will be expressed bilaterally and therefore any asymmetry in trait expression is due to random developmental noise, and not genetic factors (Korey, 1980; Saunders, 1989). The commonly used alternative method of trait scoring involves the cranium as the unit of analysis, which scores a trait as present if it occurs on either the right or left side of the skull (e.g., Korey, 1980; Connor, 1990; Ishida and Dodo, 1993). Although there is likely little significant difference between the frequency of right and left sides in bilateral traits, this difference is greater than zero, and therefore the use of only one side of the cranium may result in an underestimation of trait frequency in fragmentary skeletal remains and a loss of genetic information (Finnegan and Rubison, 1984; Saunders, 1989).

Intertrait Correlations

The Mean Measure of Divergence statistic used in biological distance studies treats all nonmetric trait frequencies as statistically independent. In order to be able to use nonmetric traits for analysis, traits should not be significantly correlated with each other. According to the quasi-continuous model of nonmetric trait inheritance, differences in trait expression are assumed to be the result of independent genetic and nongenetic developmental processes (Berry and Berry, 1967). Thus, the factors that lead to the final expression of each individual trait are ideally not correlated. Nonmetric traits may be correlated, however, if they grow in the same developmental pattern or if they are influenced by the same genetic or environmental stimuli (Saunders, 1989). This is not inconsistent with the quasi-continuous model, which proposes that if a number of traits are under the control of one dominant gene, the expression of one trait may be correlated with the expression of a number of other traits under the same control. Therefore, low levels of correlations can be expected.

Low levels of correlations between nonmetric traits were found in studies on mice (Truslove, 1961) and low levels of intertrait correlations have also been found in human cranial and postcranial studies (e.g., Berry and Berry, 1967; Corruccini, 1974; Kellock and Parsons, 1970b; Saunders, 1978). In contrast, a study of seven nonmetric traits on the parietal bone found that there were higher associations between topographically closer sites on the cranium (Hertzog, 1968), although a subsequent reanalysis of the same data using principal components analysis found no significant associations between traits (Benfer, 1970). Molto (1983) found twenty correlations between traits, which was approximately five times the number expected due to random variation. Most of the correlations discovered were among accessory sutural bones. It has been suggested that correlations between traits tend to fall into three general categories of association (Saunders, 1978). Correlations can occur between traits if they develop as part of the same expression (e.g., accessory sutural bones), exhibit a common pattern of development (e.g., hyperostotic traits), or develop due to common regional, embryological or genetic origins (e.g., supraorbital variants) (Saunders, 1978). Nonmetric traits may possess low levels of intertrait correlations as the result of both genetic and environmental factors, however, the typically small size of skeletal samples will minimize the effects of intertrait correlations on biological distance estimates (Sjøvold, 1977).

Cranial Deformation

Prior to Ossenberg's (1970) study on the effect of artificial cranial deformation on nonmetric traits, relatively few researchers had investigated the effects of deformation on trait expression and none had empirically examined this relationship. Ossenberg found a higher number of wormian bones present in the posterior region of the vault in deformed skulls and fewer ossicles in the lateral vault area, and concluded that the increased prevalence of sutural bones was an adaptive response to physical stress. This is consistent with the quasi-continuous model which proposes that although trait expression is largely determined by genetic factors, nonmetric traits can be modified by environmental stress (Grüneberg, 1963). Buikstra (1976) however, criticized Ossenberg's statistical methodology and explanatory model, and in her own study found only one trait that exhibited a strong association with cranial deformation. A subsequent study concluded that the presence of wormian bones in the lambdoidal suture was not the direct result of cranial deformation, however, deformation did affect the prevalence of wormian bones on each side of the cranium if the trait was already present (El-Najjaar and Dawson, 1977). A recent study found that some nonmetric traits were affected by cranial deformation, but these effects did not significantly influence the distances calculated between samples (Konigsberg et al., 1993). Since it has been repeatedly demonstrated that nonmetric traits are not independent of environmental influences, crania that show pathological or intentional deformation should not be included in biological distance analysis (Hauser and De Stefano, 1989).

Interobserver and Intraobserver Error

The standard scoring procedure for most nonmetric traits is a dichotomous method of data collection (i.e., present or absent), but according to the quasi-continuous model of inheritance (as outlined by Grüneberg, 1952), these discrete phenotypic expressions have an underlying continuous distribution. Therefore, it should be possible to have more than two degrees of expression, which can be explained by the existence of multiple thresholds acting on this underlying continuity (Molto, 1983). Thus, one of the main problems in nonmetric trait scoring is the lack of consistency in the scoring of partial manifestations of certain traits. The majority of previous studies on intra- and interobserver error have examined the inconsistencies in craniometric measurements (e.g., Heathcote, 1980-81; Jamison and Zegura, 1974; Utermohle and Zegura, 1982). In contrast, there have been comparatively few studies that have directly investigated observer error in nonmetric trait studies. Three independent examinations of the same cranial material found that interobserver error was extremely high, even for relatively well defined traits and particularly for those traits that involved the attachment of tendons or ligaments (De Stefano et al., 1984). It was concluded that the main causes of scoring inconsistencies were the variable degree of expression of certain traits, insufficient trait descriptions, precision of observations, lack of methodological standardization and poor preservation of the skeletal samples (De Stefano et al., 1984). One of the few studies of observer error in nonmetric trait analysis examined the effect of intraobserver error on calculated distance measurements (Molto, 1979). Eight of the thirty-nine traits studied showed unacceptable levels of scoring precision (i.e., observer error >5%), which led to the conclusion that intraobserver error could potentially distort the results of biological distance analysis (Molto, 1979). A number of foraminal traits have been identified as too ambiguous in expression or morphological significance to permit the establishment of standard descriptive criteria for dichotomous scoring and it was recommended that these traits be eliminated from biodistance analyses (Ossenberg, 1974).

An additional problem faced in nonmetric trait analysis is the inability to perform meaningful comparisons between studies due to a lack of detailed trait descriptions and standardized scoring procedures. Hauser and De Stefano (1989) have made a significant contribution towards the resolution of these problems with the recent publication of their atlas of epigenetic variants of the cranium, which includes not only trait descriptions and scoring procedures, but also extensive information concerning the etiology and development of each trait. This book has provided a means for the standardization of nonmetric trait scoring, which may help to minimize both intra- and interobserver error, as well as facilitate the comparison of results between studies.

Previous Biological Distance Studies on Ancient Egyptians and Nubians

Egypt

Initial anthropological studies on the ancient Egyptians were undertaken in order to investigate the 'racial' origins of Egyptian civilization, largely based on morphological and osteometric analysis of human skeletal samples. Studies of this nature attempted to place skeletal samples within established racial categories or 'types'. The observed geographic and temporal variation in the physical characteristics of Egyptian skeletal samples was assumed to be the result of racial admixture of indigenous and foreign populations (e.g., Elliot-Smith, 1915; Fawcett and Lee, 1902; Giuffrida-Ruggeri, 1915; Thomson and MacIver, 1905). Research focused on the classification of human groups based on the relative amount of 'Negroid' and 'Caucasoid' racial elements present within each sample. For example, Thomson and MacIver (1905) concluded that there were two or more, often different, racial elements in each sample studied from the Predynastic to Roman periods in Egypt. A more parsimonious explanation of ancient Egyptian biological variation proposed that there were two distinct racial types present in Egypt during the Predynastic period, an 'Upper Nile type' with more Negroid characteristics and a 'Lower Nile type' with comparatively less Negroid characteristics (Morant, 1925). Variation in racial composition during later stages of Egyptian civilization was explained by the blending of these two racial types, initiated by the unification of Upper and Lower Egypt at the beginning of the Archaic period. Derry (1956) alternatively hypothesized that the transition between the Predynastic and Dynastic periods was due to an invasion or immigration of a foreign population from southwest Asia and that the Dynastic race was biologically distinct from the Predynastic inhabitants of Egypt. Barnard (1934-35) also found a significant difference between Predynastic and later Dynastic skeletal series.

Implicit in many of these studies was the assumption that populations with a relatively higher Negroid component were culturally less advanced. A craniometric analysis of Badarian skeletal material concluded that this sample was distinct from later Predynastic groups and possessed more Negroid characteristics (Stoessiger, 1927). Further, Morant (1935) hypothesized a gradual evolution of racial characteristics over time and attributed this evolution to the reduction of Negroid elements in later populations. Additional craniometric studies on Egyptian material supported the hypothesis of a Negroid influence on cranial characteristics in the earlier Predynastic populations (e.g., Batrawi, 1945, 1946; Billy, 1977; Crichton, 1966; Strouhal, 1968, 1971, 1981; Wiercinski, 1965, 1978). More recently, however, craniometric analysis of biological affinities among ancient Egyptians has shifted away from the traditional typological analysis of racial types to investigations of biological variability without reference to predetermined categories (e.g., Brace et al., 1993; Keita, 1990, 1992). The vast number of morphological and metric studies that have been performed on ancient Egyptian skeletal material is far too extensive to be adequately reviewed here, but has been comprehensively reviewed elsewhere (e.g., Keita, 1993; Strouhal, 1981; Wiercinski, 1978).

In contrast to the large number of craniometric studies on Egyptian material, there have been comparatively few nonmetric studies of Egyptian biological affinities. Egyptian crania from the Predynastic to Christian periods were analyzed by Berry and Berry (1967) in their first study of nonmetric traits in humans, which introduced the use of the Mean Measure of Divergence statistic in biological distance analysis. Two subsequent analyses also examined the biological relationships between Predynastic and later Dynastic skeletal samples based on cranial nonmetric traits (Berry et al., 1967; Berry and Berry, 1972). All of these studies concluded that the population of Egypt was characterized by biological continuity over a period of 5,000 years, however, in at least one of the studies (Berry et al., 1967), statistically significant differences were found among the Predynastic and early Dynastic skeletal samples. The data from the study by Berry et al. (1967) were also used in a comparative study of Roman period Nubian skeletal samples (Strouhal and Jungwirth, 1979). Additional nonmetric studies on Egyptian cranial material have included a comparative analysis of crania from Predynastic and Dynastic Gebelen and Asiut in which it was concluded that the Gebelen skeletal samples exhibited biological continuity from the Predynastic to Dynastic periods (Reggio et al., 1969). A subsequent reanalysis of the Gebelen and Asiut crania found that age and sex correlations influenced nonmetric trait frequencies, which had not been investigated in the previous study (Ardito, 1975).

Nubia

Initial anthropological studies on ancient Nubians resembled the research undertaken on Egyptian skeletal material in the use of anthropometric analyses of human skeletal samples in order to investigate Nubian racial origins. These studies similarly attempted to explain the succession of cultural periods in Nubia's history based on theories of migration, population replacement and racial admixture (e.g., Batrawi, 1945, 1946; Elliot-Smith and Derry, 1910a, 1910b; Morant, 1925). Thus, racial differences were similarly used to explain cultural development in Nubia, and cultural advancement was usually attributed to increased Caucasoid elements in populations, whereas cultural decline was associated with increased Negroid elements (Carlson, 1976). Adams (1968) identified the racial model for culture change as the 'theory of successive populations', which dominated anthropological research on Nubia up to the 1960's. Intensive archaeological research in Nubia was undertaken in the 1960's due to the construction of the Aswan High Dam, which threatened the existence of numerous monuments and innumerable undiscovered archaeological sites. The archaeological evidence uncovered from these salvage excavations contradicted earlier theories of successive cultural periods initiated by the arrival of foreign groups (Adams et al., 1978). Although many modern scholars accept a model of overall cultural and biological continuity in Nubia throughout most of its history (e.g., Adams, 1967, 1968, 1977; Carlson and Van Gerven, 1979), others still contend that there is evidence of biological discontinuity between successive cultural phases in Nubia (e.g., Bietak, 1986; Billy, 1977; Burnor and Harris, 1968; Crichton, 1966; Irish and Turner, 1990; Strouhal, 1971; Turner and Markowitz, 1990).

Although Nubian skeletal material has been extensively used in craniometric studies, there has been comparatively less analysis of cranial nonmetric variation. Nubian samples have been included in previous cranial nonmetric studies of Egyptian skeletal series for comparative purposes (e.g., Berry and Berry, 1972; Berry et al., 1967; Mukherjee et al., 1955), but have rarely been examined for intrapopulational variation among ancient Nubians. A nonmetric and metric study of the skeletal material recovered by the Scandinavian Joint Expedition to Sudanese Nubia, using A-Group through Christian period samples, found that samples further apart chronologically appeared to be more distantly related, however, A- and C-Group samples appeared to be relatively biologically homogeneous (Nielsen, 1970). A study of the biological affinities of Roman period Nubians found that they were biologically distinct from all other skeletal samples, including C-Group Nubians and ancient Egyptians (Strouhal and Jungwirth, 1979).

Dental nonmetric traits have also been used to examine biological variation within Nubian skeletal samples and have found evidence of general biological continuity of Nubian populations over time (e.g., Greene, 1966, 1972, 1982). Similarly, studies on craniofacial variation of Nubian skeletal samples that have focused largely on the Meroitic, X-Group and Christian periods have also found evidence of biological continuity in Nubia over time (e.g., Carlson, 1976; Van Gerven et al., 1973; Van Gerven et al., 1977).

Conclusions

The focus in the study of the biological affinities of ancient populations has shifted away from racial typological analysis towards an assessment of biological variation within an evolutionary framework, based on the evolutionary mechanisms of mutation, natural selection, genetic drift and gene flow. Early studies on the racial origins of Egyptian civilization relied almost exclusively on theories of major population migrations (i.e., gene flow) to explain biological variation. In addition, the implicit assumption of many of these studies was that cultural advancement in ancient Egypt occurred with the introduction of European or 'Caucasoid' racial characteristics into the local populations, reflecting a prevalent Eurocentric view of the inferiority of 'Negroid' races. In contrast, the goal of modern biological distance analysis is to explain the observed variation in trait frequencies within and between populations based on all the genetic and nongenetic information available, without any pre-established categories. The purpose of the present research is to examine the cranial nonmetric variation empirically at the intrasite, intersite and regional level of eight Egyptian and Nubian skeletal samples, in light of the available archaeological knowledge on the ancient populations of the Nile Valley.

Research on skeletal nonmetric traits in the past two decades has demonstrated that methodological considerations, such as age, sex, bilaterality and intertrait correlations may influence the variation observed in biological distance studies, however, there is no general agreement among researchers on the degree of influence of these factors. Therefore, these aspects of nonmetric analysis should be examined prior to biological distance analysis. In studies of biological variation it is often ignored or overlooked that the distances calculated are, in fact, only estimations of an unknown genetic relationship. Studies of this nature can only infer genetic associations based on observed phenotypic characteristics and empirically derived biological distances may not directly reflect genetic distances. If the quasi-continuous model of inheritance for nonmetric traits is accepted, however, then it can be assumed that the predominant factor controlling the expression of nonmetric traits is genetic, and explanations of population variation can be based on modern concepts of human biological evolution.

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CHAPTER 3

HISTORICAL BACKGROUND ON ANCIENT EGYPT AND NUBIA

Ecological Setting

The history of human occupation in Egypt has been consistently influenced by the country's geography and environment. Ancient Egypt's relative geographical isolation by boundaries to the north and east by the Mediterranean and Red seas, the Sahara desert to the west and the Cataracts to the south, may have protected it from foreign invasions for most of its history (Wenke, 1990) (Figure 3.1). Ancient Egyptian civilization developed and flourished along the banks of its most valuable resource, the Nile river. The Nile has three main tributaries; the White Nile rising in Lake Victoria, Kenya; the Blue Nile rising in Lake Tana, Ethiopia; and the Atbara River which joins the Nile in the Sudan (Hobson, 1987). Within Egypt the river travels north near modern-day Cairo where it splits into two major branches; the Damietta on the east and the Rosetta on the west. These rivers form the boundary of the region in Lower Egypt known as the Delta, approximately 250 by 160 kilometers of fertile agricultural land. The regular seasonal flooding of the Nile deposited rich alluvial silt along the floodplains of the river, creating a narrow band of extremely fertile land, often only three kilometers wide on each side of the river (Wenke, 1990). Situated beyond the narrow strip of land known as the Nile Valley is a much less hospitable desert environment, which makes up the majority of Egypt's territory. It is within the Nile Valley and the northern Delta region that the Predynastic origins of Egyptian civilization have been found.

Egypt's climate has not always been characterized by its present hot and arid environment, but instead consisted of moist pluvial periods separated by periods of relative aridity from the Pleistocene epoch onwards. The present climate has existed in Egypt since the end of the third millennium B.C. (Hayes, 1965). It has been proposed that severe arid spells in Egypt and surrounding regions around 7000-6000 B.P. were responsible for large-scale population movements into the more hospitable Nile Valley (Hassan, 1986). An alternative hypothesis, however, suggests that a moister climate was largely responsible for the rise of Egyptian civilization in the Nile Valley by facilitating the movement of peoples through the deserts and encouraging rapid cultural development (Trigger, 1983). Many of the features of Egyptian civilization have often been attributed to the unique nature of the Nile Valley environment, including its distinctive ideological uniformity and characteristic settlement patterns of small, dispersed nonurban populations (Wenke, 1991).

Paleolithic Origins

The earliest material evidence of human presence in Egypt and Nubia are stone tools dated to the beginning of the Paleolithic period (ca. 700,000 B.P.), discovered at Abu Simbel (Hoffman, 1979; Grimal, 1992). Paleolithic tool assemblages have been found along wadi and river terraces in Egypt and Nubia (Hayes, 1965). Paleolithic subsistence patterns are characterized by a nomadic lifestyle of hunting and gathering, with the congregation of groups around permanent water sources during drier periods (Hoffman, 1979). During the Middle Paleolithic period there is evidence of regional specialization among human groups, as indicated by the existence of distinctive Nilotic and Saharan tool industries (Hoffman, 1979). Lower and Middle Paleolithic artifact clusters have been discovered, usually as surface finds, at numerous sites including the Kharga Oasis and the Fayum in Egypt and at 'Arkin-8' near Wadi Halfa, which has also produced the earliest known habitation structures in Egypt and Nubia, consisting of large oval pits lined with flat sandstone slabs (Hoffman, 1979).

The Late Paleolithic period in both Egypt and Nubia was characterized by a large diversity of tool industries. It has been similarly hypothesized that the presence of a wide range of lithic assemblages during the Late Paleolithic, as in the Middle Paleolithic period, may indicate the co-existence of a number of distinct cultural, or perhaps biological, groups (Adams, 1977; Arkell and Ucko, 1965). Evidence of possible attempts at plant and animal domestication has been found at the Late Paleolithic site of Tushka in Lower Nubia, indicated by the presence of sickle blades, grinding stones and a high number of animal remains (Hoffman, 1979; Grimal, 1992). After 10,500 B.C., sickle blades and grinding stones were no longer present, and it appears that the populations existing at this time returned to hunting, gathering and fishing modes of subsistence. The first evidence of intentional human burials is found at the Late Paleolithic sites of Jebel Sahaba, Gezira Dabarosa, Tushka and Wadi Kubbaniya in Lower Nubia (Geus, 1991; Wendorf and Schild, 1986). The graves were located outside of settlement areas and consisted of contracted burials covered with stone slabs and were frequently associated with bovine crania (Hoffman, 1979).

Subsistence patterns in the Epipaleolithic period (ca. 6400 B.C.) continued to be characterized by a hunting and fishing lifestyle and the temporary occupation of seasonal campsites (Hoffman, 1979). It has been suggested that technological developments in tool industries during this period, and a concomitant expansion of the subsistence base, may have resulted in population expansion and cultural development in subsequent periods (Arkell and Ucko, 1965). Very little information is available on the transitional period between the end of the Paleolithic period and the beginning of the Neolithic and Predynastic periods in Egypt. The lack of archaeological evidence for this period has been attributed to the destruction of sites due to the shifting flood levels of the Nile (Hassan, 1988).

Neolithic and Predynastic Periods in Egypt

It has been suggested that the deterioration of the Saharan environment between 7000 and 6000 B.P. may have initiated migrations into the Nile Valley just prior to the Neolithic period. The beginning of the Neolithic period (ca. 5500 B.C.) (Figure 3.2) is associated with the introduction of domesticated plants and animals into Egypt likely from southwest Asia (Wenke, 1990; Hassan, 1988), although some scholars have hypothesized the independent development of food production within Africa (Trigger, 1983). Plant and animal domesticates included wheat, barley, flax, sheep, goats, dogs, cattle and pigs (Trigger, 1983). Pottery also made its first appearance during the Neolithic period. Although plant and animal species were increasingly exploited throughout the Neolithic and Predynastic periods, the indigenous subsistence practices of hunting, gathering and fishing continued throughout this time (Trigger, 1983). Early attempts at food production were closely tied to the seasonal variations in Nile levels. During periods of inundation, populations would move to higher desert terraces and await the recession of the flood waters, when cereal planting and cultivation would take place. This was followed by a period of drought during which time populations would return to a reliance on hunting and gathering resources and then the cycle would begin again with the flooding of the Nile (Hassan, 1984).

Evidence from sites in Upper and Lower Egypt indicate that these two regions developed relatively independently of each other. Archaeological evidence for cultural development in Lower Egypt is represented almost exclusively by early Neolithic settlement sites, while slightly later Predynastic cemeteries are the most common type of sites in Upper Egypt, with a few outstanding exceptions, such as the late Predynastic settlements at Hierakonpolis and Naqada. Distinctive differences exist between Lower and Upper Egyptian pottery styles. Lower Egyptian pottery is relatively plain and undecorated in nature, in contrast to the more refined and decorative style of the Upper Egyptian pottery forms. Lower Egyptian burials usually had no grave goods associated with the individual and were generally located within settlement areas, whereas Upper Egyptian burials were characterized by a relative abundance of personal items and grave goods and were typically located in cemeteries outside the settlements.

Lower Egypt

In contrast to the abundant archaeological evidence for the Upper Egyptian cultural sequence, there is comparatively little information available on Lower Egypt, largely due to the location of sites below the water table or below modern towns, hindering excavation efforts (Trigger, 1983). A small number of sites, however, have been discovered in the Delta and Fayum regions, including El-Omari, Gerza, Harageh, Heliopolis, Maadi, Merimda, Minshat Abu Omar and Wadi Digla.

The earliest Neolithic sites in Lower Egypt are found at Merimda and in the Fayum. The Fayum sites were discovered on the periphery of Lake Moeris in the Fayum depression by Caton-Thompson and Gardner in the 1920's. Radiocarbon dating has produced a date of 4700 B.C. for the largest Fayum site, Kom W, which is roughly contemporaneous with the date for Merimda (Hassan, 1988). Fayum populations lived in semi-sedentary communities with a subsistence pattern intermediate between nomadic hunter-gatherers and sedentary agriculturalists (Hassan, 1988). No evidence of permanent dwellings has been found in any of the Fayum sites, although there is abundant evidence of hearths, storage pits for holding emmer wheat and barley, as well as cultural debris, including fragments of plain handmade pottery, sickle blades and specialized lithics designed for hunting (Hayes, 1965). The pottery from the Fayum was generally coarse ware cups and pots, as well as some burnished and red slipped wares (Arkell and Ucko, 1965). No graves have been discovered in the Fayum area.

Excavations at Merimda have uncovered the earliest evidence of a fully sedentary agricultural community in Egypt. The site was extremely large, covering an area of 180,000 square meters and was continuously inhabited for a period of approximately six hundred years (Trigger, 1983). The earliest remains of permanent dwellings from the middle occupation layers of the site were semi-subterranean oval structures built from wooden posts, mud and wicker (Hoffman, 1979; Trigger, 1983). During a later phase at Merimda, dwellings were aligned adjacent to paths, perhaps indicating an organized village structure (Arkell and Ucko, 1965). Basket or clay granaries were also present in association with larger individual dwellings, suggesting an increased reliance on agricultural products (Trigger, 1983). Graves at Merimda were shallow oval pits with individuals buried in a contracted position and without any associated grave goods and were typically located within the settlement. Kemp (1968), however, has argued that the presence of burials within the settlement at Merimda was due to the practice of burying the dead in abandoned areas of the site, and therefore the burials were not directly associated with occupied areas.

The later site of El-Omari (ca. 4000 B.C.) produced possible evidence of incipient social stratification in Lower Egypt, as well as evidence of increased contacts with Upper Egypt. Grave goods in the form of pendants made of shells, eggshells, animal bones and stone, have been found in burials at this site (Hayes, 1965). In addition, a stone-lined burial containing an individual interred with a carved wooden staff has been identified as a local official or ruler (Hayes, 1965). The two cemeteries discovered at El-Omari are from the latest phase of occupation in this region (roughly contemporaneous with the late Gerzean period in Upper Egypt), and demonstrate an evolution of burial practices from interment within the settlement to the Upper Egyptian pattern of isolated cemeteries. Typical El-Omari graves consisted of contracted burials placed in shallow pits and covered by small stones, sometimes accompanied by pottery (Hoffman, 1979).

At the site of Maadi (ca. 3650 B.C.) located near El-Omari, large storage cellars and numerous storage jars were found on the outskirts of the settlement. This discovery, as well as the presence of foreign pottery styles, infers active participation in foreign trade (Hoffman, 1979; Trigger, 1983). Additional evidence of growing contacts with Upper Egypt has also been discovered at this site, in the form of Upper Egyptian Black-topped pottery and slate pigment palettes (Hoffman, 1979). Burials in the Maadi South cemetery demonstrate significant influences from Upper Egypt, including the presence of numerous grave goods found in association with the burials, as well as evidence of developing social differentiation among burials (Hoffman, 1979).

Upper Egypt

Much more is known about the cultural development of Upper Egypt, based largely on the vast number of cemeteries that have been excavated in this region. The Upper Egyptian Predynastic sequence is divided into three general chronological time periods, the Badarian, the Amratian and the Gerzean, based on pottery seriation dates developed by W.M.F. Petrie for the sites of Naqada and Ballas (Petrie, 1901).

The Badarian period is dated to ca. 4400-3800 B.C., based on recent radiocarbon estimates (Hassan, 1988), thus placing the beginning of Predynastic occupation of Upper Egypt to slightly later than the Fayum Neolithic cultures in Lower Egypt. Archaeological evidence from Badarian settlement sites at Hemamieh and Deir Tasa suggests a semi-sedentary lifestyle, but the presence of hearths, storage pits, and domesticated emmer wheat and barley, implies intensification of agricultural activity (Hassan, 1988; Trigger, 1983). Two characteristic types of pottery associated with the Badarian cultural tradition are the black-topped and rippled pottery styles. Badarian graves were located in cemeteries outside of settlement areas and consisted of contracted burials placed in oval or rectangular pits. The burials were covered with matting and contained a wide variety of grave goods and food offerings and generally showed no evidence of social differentiation (Trigger, 1983). A recent quantitative study of Badarian burials, however, has demonstrated that there were two economically distinct groupings of burials within the cemeteries, which may reflect possible social differentiation early in the Upper Egyptian Predynastic period (Anderson, 1992).

Amratian period material has been found at the sites of Hierakonpolis, Hemamieh, Keir Tasa, Naqada, Hu, Mahasna and Amrah. Radiocarbon estimates suggest a date between 3800-3600 B.C. for Amratian sites (Arkell and Ucko, 1965). Pottery of this period is characterized by white cross-lined painted forms, and almost all the distinctive ivory and clay human figurines from the Predynastic period are from Amratian cemeteries (Arkell and Ucko, 1965). Remains of late Amratian dwellings have been found at the site of Hemamieh, in the form of clay-lined hut circles with wattle and daub walls (Trigger, 1983). Amratian sites tended to be larger and more numerous than the preceding Badarian sites, but still consisted of small independent communities living in huts with associated storage and refuse areas, as well as enclosures for domesticated herds (Hassan, 1988). Amratian burials were essentially the same as Badarian burials, interred in a contracted position within circular pits, but with a slightly greater number and variety of associated grave goods (Adams, 1988).

Subsistence patterns during the Gerzean period (ca. 3500 to 3100 B.C.) were primarily based on agricultural and herding activities, as well as a continued reliance on fishing (Hassan, 1988). This period is also characterized by significant changes in the form of dwelling structures as well as in burial styles. Remains of rectangular housing structures have been uncovered at the sites of Badari and Hierakonpolis and a clay model of a rectangular house was found in a burial at El-Amrah (Hassan, 1988). Gerzean graves increased in size and evolved into a rectangular shape and were frequently lined with wood or mud bricks (Adams, 1988; Arkell and Ucko, 1965). There is also archaeological evidence for social stratification at this time, based on the appearance of a wide variety of burial styles and the variable number and quality of grave goods found within burials, as at the site of Naqada, where larger and more elaborate tombs were consistently clustered together in a separate cemetery (Cemetery T) (Adams, 1988). An elaborate tomb at Hierakonpolis, lined with brick and decorated with painted plaster, has been interpreted as indicative of an emerging royalty during the Gerzean period (Kemp, 1973).

Distinctive Gerzean pottery styles include standard red slipped and painted wares, often with depictions of boats, as well as wavy handled forms, which are either imports from Palestine or locally made copies (Trigger, 1983). Numerous zoomorphic vessels and figurines present in Gerzean tombs attest to extensive trade contacts to the north, both within and outside of Egypt (Arkell and Ucko, 1965). Evidence for the development of urbanization during the Late Gerzean period comes from excavations at two major settlement sites in Upper Egypt, which demonstrate the development of centralized towns in Predynastic Egypt; South Town at Naqada, with an estimated population of 800-900 inhabitants, and the immense town site of Hierakonpolis, perhaps with as many as 2500 inhabitants (Hassan, 1988). Both sites continued to be occupied well into the Dynastic period and were later affiliated with religious deities, implying that they may have been centers of religious and administrative control during the Predynastic period (Hassan, 1988). Excavations at Hierakonpolis uncovered the foundation of a possible administrative center as well as immense fortifications around the site, suggesting that Hierakonpolis was a capital of Upper Egypt by the end of the Predynastic period (Wenke, 1991). The predominant character of Predynastic Upper Egyptian life, however, was still small, nonurban settlements with agricultural subsistence bases.

Dynastic Egypt

The traditional interpretation of the transition between Predynastic and Dynastic Egypt is associated with the political unification of Egypt (ca. 3000 B.C.) through the military conquest of Lower Egypt by the South, however, controversy exists over the actual identity of the ruler responsible for the unification of Upper and Lower Egypt. Emery (1961) has proposed that Menes was the traditional founder of the First Dynasty, and he may have also been known as King Scorpion (Arkell, 1963). Another candidate for Menes, King Narmer, has also been credited with the unification process, based on an interpretation of the palette of Narmer found at Hierakonpolis (Edwards et al., 1970). It is most likely, however, that the process of unification occurred over a long period preceding the First Dynasty, and the depiction of military conquests by Scorpion, Menes or Narmer should be viewed as commemorative representations of an extended process (Grimal, 1992; Hassan, 1988). The cultural and political developments established in the Predynastic period were further developed during the subsequent Archaic period (ca. 3050-2686 B.C.).[1] Evidence from the royal and elite burials at Abydos and Saqqara suggests that an elaborate social hierarchy was well established by the First Dynasty, however, the burials of commoners remained largely unchanged from the preceding Predynastic period. This period is also recognized for the establishment of the religious, political and artistic standards that would become fully developed in the Old Kingdom, including the concept of divine kingship, an elaborate hierarchical political system and the development of an inscriptional recording system known as hieroglyphics.

The Old Kingdom (ca. 2695-2160 B.C.) was characterized by the development of a centralized administrative government at Memphis and the establishment of a theocratic rule over Egypt, although most of the population of Egypt still occupied small independent agricultural communities (Wenke, 1990). The concept of divine kingship was a justification for political control of Egypt. This control is most effectively demonstrated by the construction of monumental tomb structures at Saqqara and Giza (Kemp, 1983). The Third Dynasty step pyramids at Saqqara were the structural precursors of the pyramids at

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[1] The dates listed for the Dynastic periods in Egypt have been adapted from Kemp, 1991.

Giza. The three pyramids at Giza were built for kings Khufu (Cheops), Khephren (Chephren) and Menkaure (Menkaura) of the Fourth Dynasty. By the end of the Sixth Dynasty, control had shifted into the hands of provincial nomarchs, as indicated by the increased prosperity of provincial towns like Hierakonpolis, Abydos, Elephantine and Tell Edfu at this time (Kemp, 1983). Butzer (1984) has suggested that Nile flood levels may have directly influenced the political stability of Pharaonic Egypt, and a period of low Nile flood levels may have been partially responsible for the collapse of centralized control at the beginning of the First Intermediate Period (ca. 2160-1991 B.C.). During this time Egypt was under the control of provincial rulers, until the re-unification of Egypt by Nebhepetre Mentuhotep II near the end of the Eleventh Dynasty, marking the beginning of the Middle Kingdom.

There was relative political stability and prosperity in Egypt during the Middle Kingdom (ca. 1991-1785 B.C.) (Wenke, 1990). Foreign relations were reestablished with the Mediterranean and the Near East. The cult of Osiris predominated during this period, and the practice of intentional mummification was beginning to be extensively used, but would not be perfected until the New Kingdom (Hobson, 1987). Miniature models of daily life were included in Middle Kingdom tombs, which were used to ensure the comfort of the deceased in the afterlife (Moorey, 1983). The Second Intermediate Period (ca. 1785-1540 B.C.) began during the Thirteenth Dynasty and was characterized by a succession of short-lived rulers, as well as the establishment of an independent line of rulers in the northern Delta region. While Egypt was weakened by the dissolution of a centralized government, a group of Asiatics known as the Hyksos established a separate capital at Avaris, eventually capturing Memphis and ruling over Egypt during the Fifteenth and Sixteenth Dynasties (Moorey, 1983). The monarchy ruling southern Egypt from Thebes at this time, however, would eventually conquer the Hyksos at the beginning of the Eighteenth Dynasty, establishing the New Kingdom period (ca. 1540-1070 B.C.). The Eighteenth Dynasty ruler, Ahmose, is credited with the expulsion of the Hyksos from Egypt, and began a period of immense prosperity for all of Egypt. The dominant religious cult at the beginning of this period was that of Amon-Re, but the pharaoh Akhenaten changed the religious foundations in Egypt by rejecting the previous tradition of polytheistic worship in favor of a monotheistic religion, represented by the Aten (the sun disc) (Moorey, 1983; Wenke, 1990). Under Akhenaten's influence, the established traditions of Egyptian art changed dramatically and a new capital was established at el-Amarna. One of Akhenaten's successors was the young pharaoh Tutankhamun, who re-established the capital at Thebes, but is known for little else besides the richness of his tomb in the Valley of the Kings. This was followed by the Ramesside rulers of the Nineteenth and Twentieth Dynasties, who were responsible for the monumental structures at Abu Simbel, Medinet Habu and in the Valley of the Kings. During the Third Intermediate Period (ca. 1070-712 B.C.), extending from the Twenty-first to Twenty-fourth Dynasties, the rule of Egypt was divided between North and South. The Twenty-fifth Dynasty (ca. 712-656 B.C.) was a period of Nubian rule, followed by the reestablishment of local control during the Saïte period (ca. 664-525 B.C.) marking the beginning of the Late period. Egypt lost its political independence again in 525 B.C. through the conquest of Egypt by the Persian Empire. In 332 B.C. Alexander the Great took control of Egypt away from the Persians and began a period of Greek domination in Egypt until it was taken over by the Roman Empire. Egypt became a province of Rome in 30 B.C. and was under Roman rule until the dissolution of the empire in AD 395, after which it was controlled by Byzantium until the Arab conquest in AD 641.

Nubia

Nubia's cultural history has been intimately connected to Egypt since the origins of the A-Group culture in Lower Nubia at the beginning of the Dynastic period in Egypt (ca. 3100 B.C.) (Haynes, 1992). Access to Nubia's vast resources, particularly gold and other luxury items, was likely the major reason for Egypt's interest in this area (Mokhtar, 1990). The borders of ancient Nubia extended from the First Cataract near Aswan in southern Egypt to the point of union of the White and Blue Nile rivers, near Khartoum. As in Egypt, the Nile river played an essential role in the lifeways of the ancient Nubians, however, the agricultural potential of the Nile Valley in Nubia was never as great as in Egypt, and could only sustain a much smaller population (Trigger, 1983).

Evidence from post-Paleolithic sites in Nubia dated to the Mesolithic period (ca.8000-5000 B.C.)(Geus, 1991) suggests that there was an increased utilization of plant resources and more permanent settlements during this time. The majority of Mesolithic sites have been found in Upper Nubia, such as Khartoum, Saggai and Kadada (Håland, 1986), although there is some evidence of occupation in Lower Nubia at the sites of Nabta Playa and Bir Kiseiba (Midant-Reynes, 1992; Wenke, 1990). The earliest definitively agricultural community in Nubia was the Khartoum Neolithic, (ca. 3500 B.C.), roughly contemporaneous with the Gerzean period of Predynastic Upper Egypt (Trigger, 1983). There is no evidence of cemeteries in the Neolithic period, however, Adams (1977) reported that early Khartoum sites contained burials within settlement areas.

A-Group Period (ca. 3100-2800 B.C.)[2]

A-Group sites have been discovered in the region from the First Cataract in Lower Nubia to the Batn-al-Hadjar region further south (Mokhtar, 1990). There is evidence of extensive trade contacts between Egypt and Nubia during the late Predynastic and Archaic periods in Egypt, but trade between the two regions declined by the end of the First Dynasty, likely as a result of Egypt's military conquest of Nubia during the A-Group period in order to gain control over their resources (Trigger, 1983). The A-Group culture had a semi-nomadic mode of existence, based on herding, fishing, hunting and agricultural activities. Settlements were small villages that became increasingly sedentary by the end of the A-Group period (Nielsen, 1970; Trigger, 1983). Nubian A-Group burials were oval pits, often associated with a sunken chamber to one side. The individual was placed in a contracted position within the pit along with numerous grave goods and personal items, including characteristic red painted pottery with a basketwork motif and pointed base jars (Adams, 1977). Material evidence from the A-Group cemeteries reflects a relatively egalitarian society (Geus, 1991), however, evidence of social stratification during the terminal phase of the A-Group culture has been found at the sites of Sayala and Qustul (Trigger, 1983).

The next phase of Nubian history, marked by a noticeable decrease in the material wealth of burials, is dated to the period between the decline of the A-Group and the appearance of the C-Group. It was initially suggested that the disappearance of the A-Group culture was due to the invasion of a biologically distinct 'B-Group', who were identified based on the absence of grave goods within burials and on a racial analysis of the skeletal material (Adams, 1977). Alternatively, it has been proposed that Nubia was not abandoned during the cultural hiatus between the A- and C-Group periods, but rather that the decline was due to a dispersal of the population, and the relatively poorer graves are an indication of the economic impoverishment experienced by the Nubians as the result of Egypt's political domination and occupation of Lower Nubia (Adams, 1977; Kemp, 1983).

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[2] Nubian dates have been obtained from Haynes, 1992.

C-Group Period (ca. 2000-1500 B.C.)

The reappearance of an indigenous Nubian cultural tradition coincided with the collapse of the Egyptian monarchy at the end of the Old Kingdom. It was originally hypothesized that the appearance of the C-Group culture was the result of another invasion of a foreign group into Nubia, however, more recent archaeological evidence suggests that the C-Group was culturally continuous with the A-Group (Adams, 1977). The settlement pattern and subsistence economy of the C-Group closely resembles that of the A-Group, but with an increased reliance on agriculture and herding of cattle (Nielsen, 1970). C-Group graves are characterized by single chamber tombs, covered by a circle of stone masonry filled with rubble (Adams, 1977). Individuals were buried in a contracted position within a rectangular chamber with associated grave goods. Later developments include the presence of wood or mud brick lining in tombs, animal sacrifices and the adoption of Egyptian mortuary practices (Geus, 1991). The C-Group culture continued to exist in Nubia up to the beginning of the Eighteenth Dynasty in Egypt.

South of the Third Cataract, a culture contemporaneous with the Nubian C-Group was established at the site of Kerma. The Kerma culture is known for its apparent wealth and developed social hierarchy, which are indicated by clusters of elaborate burials, as well as animal and human sacrifices (Bonnet, 1991; Geus, 1991). Another contemporary culture was the Pan-Grave culture, so named for the characteristic shape of their burials. It has been suggested that these were nomadic peoples specialized in the use of the bow, who were hired as militia for Egyptian rulers (Haynes, 1992). Following the re-establishment of the Egyptian monarchy at the beginning of the Eighteenth Dynasty, Nubia was once again ruled by Egypt, until the Third Intermediate Period in Egypt, when a Kushite king from the Napatan period conquered Egypt (Haynes, 1992). After the subsequent expulsion of the Nubian rulers from Egypt, they returned to Upper Nubia and formed the kingdom of Meroë which lasted until the middle of the 3rd century AD, when it was replaced in the archaeological record by the X-Group, a cultural continuation of the Meroitic period, and subsequently by the Christian phase of Nubian history.

Figure 3.1 - Map of Egypt and Nubia

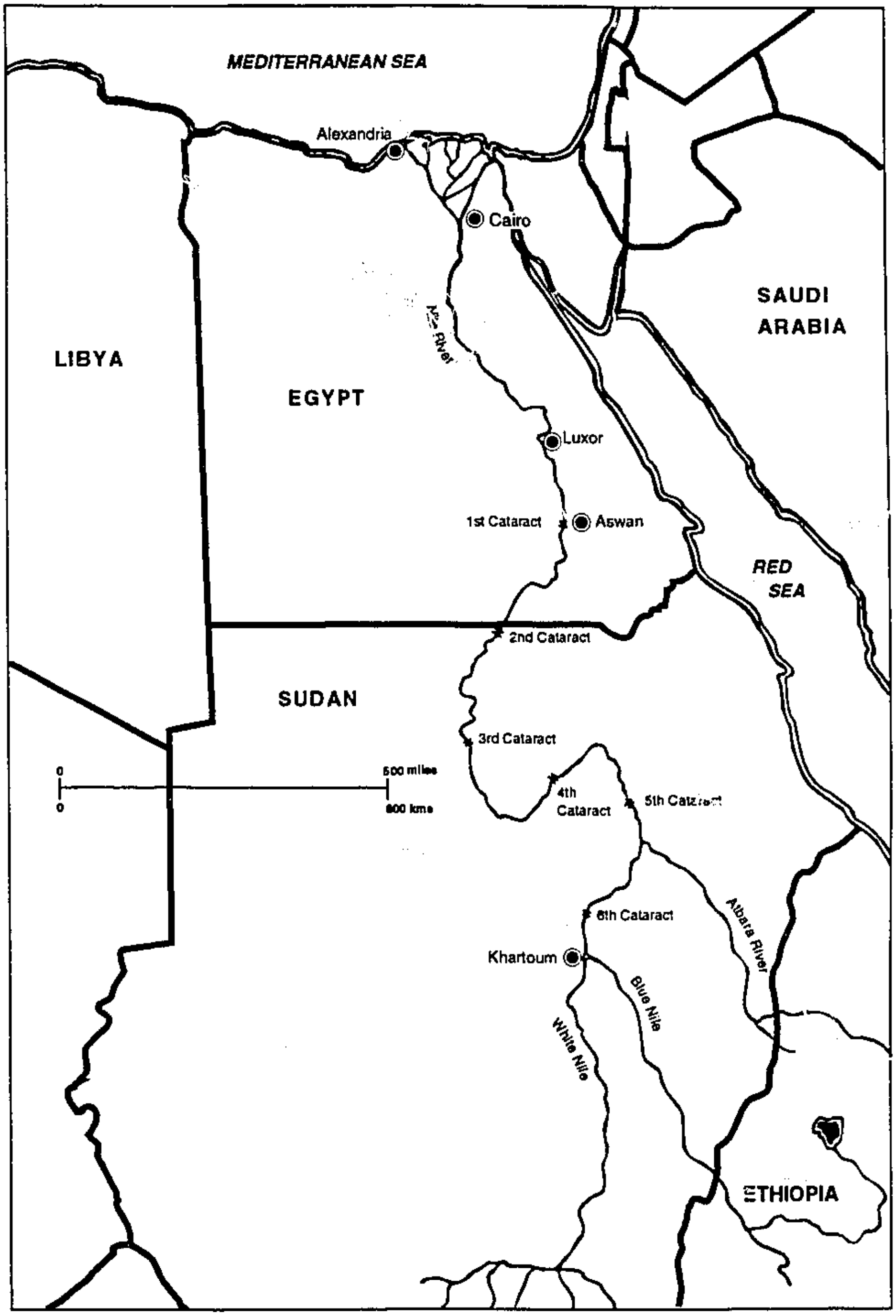
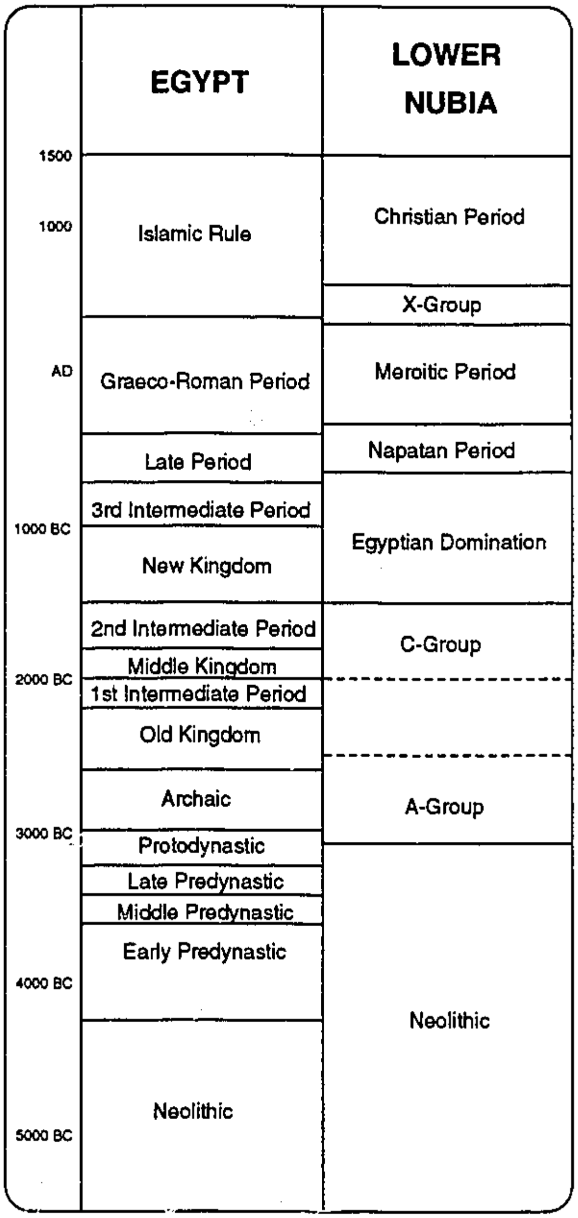


Figure 3.2 - Chronology of Egypt and Lower Nubia



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CHAPTER 4

MATERIALS AND METHODS

Introduction

Ossenberg (1976) has reported the existence of over two hundred cranial nonmetric traits. A list of 49 cranial nonmetric traits was developed in 1991 for use in this study and was then expanded to a total of 58 traits in 1992. The traits for which data have been collected were compiled from the following sources; Berry and Berry (1967), Brothwell (1981), Buikstra (1976), Hauser and De Stefano (1989), Ossenberg (1970), and Rose et al. (1991). Table 4.1 summarizes the cranial nonmetric traits selected for this study, and the sources used for trait description and scoring methodology. Detailed descriptions of each nonmetric trait are presented in Appendix 4.1. In each biological distance study traits were excluded from statistical analysis if they were absent in more than half of the samples studied. This minimized the possibility of chance occurrences of rare traits having a significant effect on the final calculation of biological distance. Traits were also excluded from analysis if they were one hundred percent present in all samples, as this provided no meaningful distinction in trait frequencies between populations. The nonmetric traits were grouped into six general categories (adapted from Hemphill, 1992; Ossenberg, 1970; Saunders, 1989) which have been included in this study as an analytic framework used to detect patterns of trait expression in the analysis of age and sex correlations. The traits have been divided into six categories; hyperostotic, hypostotic, accessory sutures or ossicles, facet variation, foraminal variation, and unclassified (see Table 4.2).

The Skeletal Samples

A total of 372 crania from six archaeological sites in Egypt and Nubia, were examined in this study. The eight skeletal samples are from the Nile Valley sites of Abydos, Badari, Keneh, Naqada in Egypt, and sites 179 and 277, excavated by the Scandinavian Joint Expedition in Nubia (Figure 4.1). All sites are dated to the Egyptian Predynastic and early Dynastic periods, with the exception of site 179 in Lower Nubia, which is contemporaneous with the beginning of the First Intermediate period in Egypt. The number of crania in each sample ranges from thirty-eight to sixty-eight. A description of the samples and their provenance is presented below.

Abydos

The Abydos skeletal sample consists of 48 crania, curated at the Department of Biological Anthropology, Cambridge University, England. Abydos is located on the west bank of the Nile in Upper Egypt. The earliest evidence of occupation at Abydos is in the Predynastic period (Peet, 1913; Petrie, 1902, 1903). At the beginning of the Dynastic period a town was established at Abydos, and rulers of the First and Second Dynasties constructed royal tombs outside the settlement area (Kemp, 1977). During the Middle Kingdom, Abydos became a cult center for the worship of Osiris, and many pharaohs of the Middle and New Kingdom periods constructed temples and monuments dedicated to the worship of Osiris and other deities.

The first concession to the site of Abydos was held by Emile Amelineau from 1895 to 1898, during which time he excavated the region of the area known as 'Umm-el-Qa'ab', in search of the royal tombs of the early Dynastic kings (Kemp, 1983). In 1899, the concession was obtained by Sir William Matthew Flinders Petrie, who excavated at Umm-el-Qa'ab until 1903. Petrie discovered ten royal tombs belonging to rulers of the First and

Second Dynasties, surrounded by hundreds of subsidiary burials which were hypothesized to be members of the royal entourage (Trigger, 1983). Results of these excavations were published by Petrie in the early 1900's (Petrie, 1900, 1901, 1902, 1903).

From 1910 to 1913, T.E. Peet excavated a large cemetery area located outside the settlement area at Abydos and discovered a series of linearly arranged burials near two large mud-brick enclosures, now known to be the funerary palaces of the Second Dynasty kings, Khasekhumui and Peribsen (Peet, 1913, 1914). Petrie returned to Abydos in 1921, and continued excavations around the funerary palace structures and subsequently identified the nearby burials as the 'Tombs of the Courtiers' of the First Dynasty rulers, Djer, Djet and Merneith (Petrie, 1925). Approximately 500 subsidiary burials were excavated by Petrie from this area, many with stone stelae (Petrie, 1925). The burials formed three rectangular groupings, as if enclosing architectural structures, similar to the subsidiary tombs excavated at Umm-el-Qa'ab. No remains of any architectural features were discovered inside the areas enclosed by the burials, with the exception of a length of wall running inside and parallel to the Merneith enclosure, and another small section of wall perpendicular to this (Kemp, 1966). Numerous intrusive burials from later Dynastic periods have been discovered within and around the area of the funerary palace enclosures, and may have disturbed the structures originally located there (Petrie, 1925). The subsidiary burials were mud-brick lined structures, often divided by brick or wooden cross walls and covered by brick superstructures (Petrie, 1925). Kemp (1966) hypothesized that these burials were originally associated with panelled brick enclosures that would have been styled after actual palace structures, and which were intended as funerary palaces for the deceased kings. Excavations presently continue at Abydos under the direction of D. O'Connor with the University of Pennsylvania (O'Connor, 1992).

Badari

The Badari skeletal sample consists of 58 crania, housed at the Department of Biological Anthropology, Cambridge University, England. Badari is located on the east bank of the Nile river in Upper Egypt. Badarian artifacts represent the earliest Predynastic culture in Upper Egypt, and are known from numerous cemeteries discovered in the region between el-Matmar and el-Etmanieh (Trigger, 1983). Between 1922 and 1925, G. Brunton and G. Caton-Thompson excavated along the eastern bank of the Nile River and uncovered burials and settlement traces dating to this period. The site of el-Badari consists of seven cemeteries, from which a total of two hundred and sixty-two burials were recovered (Anderson, 1992). Results of these excavations were reported by Brunton (1927, 1928), and Brunton and Caton-Thompson (1928). A recent re-analysis of the Badarian artifacts excavated in the 1920's has suggested that social stratification may be inferred from the material remains, thus challenging the traditional view that a relatively egalitarian social structure existed in the early Predynastic period (Anderson, 1992).

Keneh (Qena)

The Keneh skeletal sample consists of 40 crania, presently curated at the Peabody Museum, Harvard University, U.S.A.. The site of Keneh, also known as Nag el-Hai, is located on the east bank of the Nile in Upper Egypt, north of the modern city of Luxor. The area excavated was a Predynastic cemetery, approximately 400 meters by 400 meters in size, was dated to the Late Predynastic Period. Very little is known about Keneh, as the excavation reports have never been published. The information presented here was obtained from Reisner's field notes, which are stored at the Boston Museum of Fine Arts (N. Lovell, personal communication). Reisner held the concession for the site of Keneh and was project director of the excavations in 1913, however, L.C. West undertook the actual excavations. No information on the burials or their contents has been published.

Naqada

A total of 147 crania form the sample from the site of Naqada; 40 from Cemetery B, sixty-eight from the Great Cemetery, and 39 from Cemetery T. All crania are housed at the Department of Biological Anthropology, Cambridge University, England. Naqada is located on the west bank of the Nile river, south of Abydos. The burials at this site were found in three cemeteries located near two Predynastic settlement areas, and were excavated by Petrie in 1894 and 1895 (Bard, 1989). The publication by Petrie and Quibell (1896) on the sites of Naqada and Ballas reported only a small portion of the total burials excavated (Castillos, 1981). Most of Petrie's excavation reports were never published and almost all of his field notes were later destroyed, however, some records were miraculously salvaged and were later published by Baumgartel (1970).

The three cemeteries excavated by Petrie were identified as Cemetery B (named after the nearby mound of Kom Belal), Cemetery T (located near two tumuli), and the Great Cemetery (Bard, 1989). The Great Cemetery contained approximately 2000 burials, and was the cemetery that Petrie associated with the arrival of a foreign race into Egypt, based on the discovery of new artifact types previously unknown in Upper Egypt (Hoffman, 1979). Cemeteries B and T are located to the south of the Great Cemetery and contained a total of 144 and 69 graves, respectively (Bard, 1989). The comparatively greater number and higher quality of grave goods associated with the burials in Cemetery T led to the suggestion that this cemetery was reserved for an elite social class at Naqada (Petrie and Quibell, 1896). It has also been suggested that the larger tombs in this cemetery were royal tombs, and have been compared with the royal tombs at Abydos and Hierakonpolis (Kemp, 1973; Hoffman, 1979). Alternatively, it has been proposed that the artifacts from Cemetery T may indicate the existence of a special status group, but not necessarily a wealthy or royal one (Davis, 1983). Recent anthropological research has investigated the evidence for social inequality at Naqada (e.g., Bard, 1989, 1992; Johnson and Lovell, 1994).

Nubia - Sites 277 and 179

The Nubian skeletal material consists of 38 crania from site 277 (A-Group), and 41 crania from site 179 (C-Group), presently curated at the Laboratory of Biological Anthropology, University of Copenhagen, Denmark. In the 1960's, UNESCO headed a salvage campaign to recover archaeological monuments and sites threatened by the construction of the Aswan High Dam (Hobson, 1987). The Scandinavian Joint Expedition to Nubia was one of twenty-seven countries involved in this salvage excavation effort. Between 1963 and 1964, research was conducted along the east bank of the Nile river, beginning at the Egyptian border and extending sixty kilometers to the south (Nielsen, 1970).

The A-Group site, 277, is located at Halfa Kegheim, south of Wadi Halfa (Nordström, 1972). Sixty-six burials were excavated from this site by S.E. Pousette in 1963. Material recovered from the burials was dated to the Classic and Terminal A-Group periods, contemporaneous with the Archaic period in Egypt (Nordström, 1972).

Site 179 is a C-Group site, located north of Wadi Halfa on the east bank of the Nile. Little information is available on the excavation of the C-Group sites, however, it is known that C-Group burials comprised almost half of the total burials discovered by the Scandinavian Joint Expedition (Nielsen, 1970). The existence of C-Group sites is correlated with the beginning of the First Intermediate Period in Egypt.

Methods of Analysis

Data on the skeletal samples from Abydos and Badari were collected by T. Prowse in the summer of 1991. The samples from Nubia and Naqada were examined by M. Bartell, and that from Keneh by N. Lovell, in 1992. Prior to data collection, each cranium was examined in order to determine sex and age at death. Sex was determined based on standard gross morphological features of the cranium (according to Bass, 1987; Brothwell, 1981; Ubelaker, 1989; and White, 1991). The sex distribution of the skeletal samples is presented in Table 4.3. Age of adult specimens was determined by degree of ectocranial suture closure (after Meindl and Lovejoy, 1985). Incomplete or fragmentary crania were aged by degree of tooth wear (adapted from Lovejoy, 1985).[1] If both methods provided an age estimation, cranial suture age was used in subsequent analyses.[2] The skeletal samples were subdivided into five age categories; Teen (13-20 years), Young Adult (21-30 years), Middle Adult (31-40 years), Old Adult (41+ years), and Adult (Indeterminate) (after Jurmain, 1990; and Lovell, 1994). The final age category was included for crania that could be confidently identified as adults based on general size and development, but a more precise age could not be determined due to the fragmentary nature of the material. The age of juvenile specimens used in the age, sex and side correlation analyses was determined based on standard stages of tooth eruption (after Ubelaker, 1989). If a general age range was obtained based on any of the above-mentioned methods, the age used for analysis was the median value of that range. Table 4.4 summarizes the age distribution of the skeletal samples used in this study.

Scoring procedures for each trait followed the methods outlined in Appendix 4.1. Bilateral traits were scored separately for each side. The side count method of data collection was was used for bilateral trait scoring, as this method produces the most information, and provides a basis for the methodological analysis of trait bilaterality and side-to-side correlation (Hauser and De Stefano, 1989). Partial trait manifestations were scored as present (after Buikstra, 1972).

The effects of interobserver and intraobserver error were not examined in this analysis. It has been demonstrated that these factors may influence the results of biological distance analysis (e.g., Molto, 1979; De Stefano et al., 1984), however, the effects of both inter- and intraobserver error were minimized in this study through the use of a lab manual for data collection, which included descriptions, illustrations and standard scoring procedures for each nonmetric trait studied. In addition, all data collection occurred under the supervision of N. Lovell in order to ensure scoring consistency.

Age, Sex and Side Correlations

The raw data were entered onto a Microsoft Excel 3.0 spreadsheet, and were reduced to a binary form (e.g., present =1, absent = 0). All data entries were verified manually. Statistical analysis was performed using a Systat program (5.2.1.) for Macintosh. Chi-squared statistics were calculated to determine age and sex differences in nonmetric trait frequencies within individual skeletal samples (shown below). Yate's Correction for Continuity was used if the expected value was less than ten, and Fisher's Exact Test was used if the expected value was less than five (as recommended by Thomas, 1986). Two further statistical tests were performed to examine the correlation between

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[1] The tooth wear scoring method developed by Lovejoy (1985) was modified for the Egyptian samples by N. Lovell due to the comparatively lesser degree of anterior tooth wear observed in the Egyptian material (N. Lovell, personal communication).

[2] It is acknowledged that the ages obtained using ectocranial suture closure in skeletal samples are not precise, particularly due to the often large age ranges obtained. In addition, the tooth wear method of aging may not be directly applicable to ancient Egyptian skeletal samples due to the probable existence of environmental factors (e.g., differences in diet), that could differentially affect the degree of tooth wear observed. Due to the fragmentary and often incomplete nature of these skeletal samples, however, no other more reliable indicators were available. For the comparative purposes of this analysis it is the relative ages of the samples, not the absolute ages, that is of importance. I am confident that these methods adequately distinguish between the age categories outlined in the text.

right and left sides of bilateral nonmetric traits. A chi-squared test examined the independence of occurrence of bilateral traits (after Green et al., 1979).

Chi-squared statistic:

$$X^2 = \frac{n(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

n = total sides observed (a+b+c+d)

A second statistical test used a correlation coefficient to examine the degree of correlation between the two sides of a bilateral trait. A value of r=1 indicated a perfect correlation between right and left sides. Side to side correlation was calculated using the statistic recommended by Green et al. (1979:631):

$$r = \left[\frac{(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)} \right]^{1/2}$$

(On Systat 5.2.1., this correlation statistic was identified as the Phi Correlation Coefficient)

Due to time constraints, intertrait correlations were not investigated in this study. Independence of nonmetric traits in human skeletal samples has been demonstrated in a number of studies (e.g., Benfer, 1970; Berry and Berry, 1967; Kellock and Parsons, 1970). More recent research, however, has found low but significant levels of intertrait correlations (e.g., Buikstra, 1976; Corruccini, 1974), although Sjøvold (1977) concluded that intertrait correlations would not greatly affect distance studies due to the small size of most human skeletal samples. Therefore, it is recognized that intertrait correlations may exist between some of the nonmetric traits used in this study, but it is assumed that the effect of these correlations will only minimally affect the outcome of the biological distance analysis.

Biological Distance Analysis

Prior to the calculation of biological distance, nonmetric trait frequencies were arcsine transformed into angular values in order to stabilize the variance when dealing with small skeletal samples. This enables comparisons to be made between skeletal series with different variances due to different sample sizes (Green and Suchey, 1976; Molto, 1983). The Freeman and Tukey arcsine transformation for small sample sizes was used in this study (after Green and Suchey, 1976):

$$\emptyset = \frac{1}{2} \sin^{-1} [1-2(k/n+1)] + \frac{1}{2} \sin^{-1} [1-2(k+1/n+1)]$$

k = observed frequency of the trait (right plus left sides)
n = number of sides observable for the trait

Biological distance was calculated using the multivariate Mean Measure of Divergence (MMD) statistic, developed by C.A.B. Smith, and later refined by Green and Suchey (1976) and Finnegan and Cooprider (1978). It is presently the most widely used statistic for evaluating the biological variation among skeletal samples (Molto, 1983), and has been used in a number of recent studies (e.g., Buikstra, 1976; Greene, 1982; Pietrusewsky, 1984; Turner, 1987; Scuilli, 1990). The MMD, its variance and standard deviation were calculated according to Sjøvold (1973) and Green and Suchey (1976):

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

$$\mathrm{var\ MMD} = \frac{2}{r^2} \sum_{i=1}^{r} \left(\frac{1}{n_{1i} + 1/2} + \frac{1}{n_{2i} + 1/2} \right)^2$$

$$\mathrm{sd\ MMD} = \mathrm{var\ MMD}$$

$\o_{1i}$ = the transformed frequency of the *ith* trait in sample 1
$\o_{2i}$ = the transformed frequency of the *ith* trait in sample 2
n_{1i} = the number of sides observed for the *ith* trait in sample 1
n_{2i} = the number of sides observed for the *ith* trait in sample 2
r = the number of traits

The MMD value is significant at the 0.05 probability level if that value exceeds twice its standard deviation (Sjøvold, 1973). It has been suggested that standardized MMD scores are more appropriate when comparing samples of different sizes (Sofaer et al., 1986). A standardized MMD value is calculated by dividing the raw MMD value by its standard deviation. Cluster analysis was performed on the standardized MMD values in order to represent the relationships calculated graphically (after Dodo and Ishida, 1990; Hemphill et al., 1991).

Figure 4.1 - Map of Egypt and Nubia Showing the Location of the Sites Used in This Study

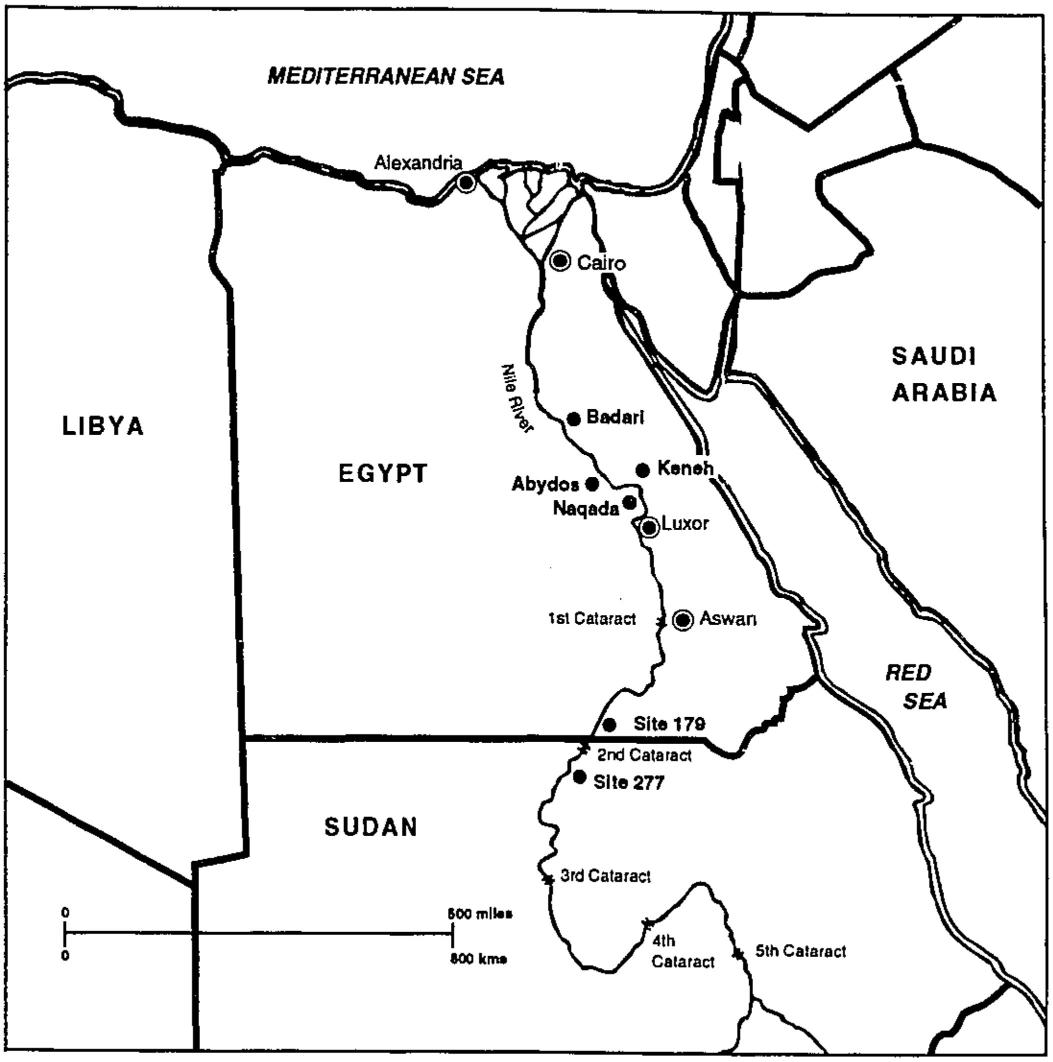

Table 4.1 - Nonmetric Traits for Which Data Were Collected

#	Trait Name	References
1	Highest Nuchal Line*	Berry and Berry, 1967
2	Ossicle at Lambda	Berry and Berry, 1967
3	Inca Bone	Hauser and De Stefano, 1989; Rose et al., 1991
4	Lambdoidal Suture Ossicle*	Berry and Berry, 1967; Rose et al., 1991
5	Biasterionic Suture*	Hauser and De Stefano, 1989
6	Ossicle at Asterion*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
7	Parietal Foramen*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
8	Obelionic Foramen	Olivier, 1969; Rose et al., 1991
9	Bregmatic Bone	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
10	Apical Bone	Rose et al., 1991
11	Coronal Suture Ossicle*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
12	Os Sagittal Suture	Hauser and De Stefano, 1989; Rose et al., 1991
13	Epipteric Bone*	Berry and Berry, 1967; Hauser and De Stefano, 1989
14	Fronto-temporal Articulation*	Berry and Berry, 1967; Brothwell, 1981; Hauser and De Stefano, 1989
15	Parietal Notch Bone*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
16	Parietal Notch Present*	Rose et al.,1991
17	Occipitomastoid Wormians*	Hauser and De Stefano, 1989
18	Auditory Torus*	Berry and Berry, 1967; Buikstra, 1980; Hauser and De Stefano, 1989; Rose et al., 1991
19	Sutural Foramen*	Berry and Berry, 1967; Hauser and De Stefano, 1989
20	Mastoid Foramen*	Berry and Berry, 1967; Hauser and De Stefano, 1989
21	Occipital Foramen*	Berry and Berry, 1967; Hauser and De Stefano, 1989
22	Tympanic Dehiscence*	Berry and Berry, 1967; Hauser and De Stefano, 1989;Rose et al., 1991

Table 4.1 - Continued

23	Posterior Condylar Canal Patent*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
24	Condylar Facet Double*	Berry and Berry, 1967; Hauser and De Stefano, 1989
25	Precondylar Tubercle*	Berry and Berry, 1967; Hauser and De Stefano, 1989
26	Paracondylar Process*	Ossenberg, 1970; Hauser and De Stefano, 1989
27	Anterior Condylar Canal Double*	Berry and Berry, 1967; Buikstra, 1980; Hauser and De Stefano, 1989; Rose et al., 1991
28	Foramen Ovale Incomplete*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
29	Foramen Spinosum Open*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
30	Pterygo-alar Spurs*	Hauser and De Stefano, 1989; Rose et al., 1991
31	Pterygo-spinous Spurs*	Hauser and De Stefano, 1989; Rose et al., 1991
32	Palatal Suture	Brothwell, 1981; Hauser and De Stefano, 1989
33	Accessory Lesser Palatine Foramen*	Berry and Berry, 1967; Hauser and De Stefano, 1989
34	Palatine Torus	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991; Turner et al., 1991
35	Maxillary Torus*	Brothwell, 1981; Hauser and De Stefano, 1989
36	Zygomaxillary Tubercle*	Hauser and De Stefano,1989
37	Marginal Tubercle*	Hauser and De Stefano, 1989
38	Zygomatico-facial Foramen*	Hauser and De Stefano, 1989; Rose et al., 1991
39	Zygomatic Arch Suture*	Brothwell, 1981
40	Os Japonicum*	Brothwell, 1981; Hauser and De Stefano, 1989; Rose et al., 1991
41	Supraorbital Foramen*	Berry and Berry, 1967; Buikstra, 1980; Hauser and De Stefano, 1989; Rose et al., 1991
42	Accessory Supraorbital Foramen*	Rose et al., 1991; Turner et al., 1991
43	Metopism*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991

Table 4.1 - Continued

44	Frontal Foramen*	Berry and Berry, 1967; Rose et al., 1991
45	Frontal Grooves*	Hauser and De Stefano, 1989
46	Anterior Ethmoid Foramen Exsutural*	Berry and Berry, 1967; Hauser and De Stefano, 1989
47	Posterior Ethmoid Foramen*	Berry and Berry, 1967
48	Nasal Bone	Brothwell, 1981
49	Accessory Infraorbital Foramen*	Berry and Berry, 1967; Hauser and De Stefano, 1989; Rose et al., 1991
50	Infraorbital Suture*	Buikstra, 1980; Hauser and De Stefano, 1989; Rose et al., 1991
51	Accessory Mental Foramen*	Hauser and De Stefano, 1989; Rose et al., 1991
52	Rocker Jaw	Turner et al., 1991
53	Mylohyoid Arch*	Buikstra, 1980; Hauser and De Stefano, 1989
54	Lingula Bridge*	Hauser and De Stefano, 1989
55	Mandibular Torus*	Brothwell, 1981; Hauser and De Stefano, 1989; Rose et al., 1991; Turner et al., 1991
56	Genial Tubercles	Hauser and De Stefano, 1989
57	Median Mental Spine	Hauser and De Stefano, 1989
58	Genial Pits	Hauser and De Stefano, 1989

* indicates bilateral traits

Table 4.2 - Classification of Nonmetric Traits†

Hyperostotic traits
Highest nuchal line
Auditory torus
Precondylar tubercle
Paracondylar process
Pterygo-alar spurs
Pterygo-spinous spurs
Palatine torus
Maxillary torus
Zygomaxillary tubercle
Marginal tubercle
Mylohyoid arch
Lingula Bridge
Genial tubercles
Median mental spine
Mandibular torus
Anterior condylar canal double

Accessory sutures/ossicles
Ossicle at lambda
Inca bone
Lambdoidal ossicle
Biasterionic suture
Ossicle at asterion
Bregmatic bone
Apical bone
Coronal suture ossicle
Os sagittal suture
Epipteric bone
Parietal notch bone
Parietal notch
Occipitomastoid wormians
Palatal suture
Nasal bone variation

Facet variation
Condylar facet double

Hypostotic traits
Tympanic dehiscence
Posterior condylar canal patent*
Foramen ovale incomplete
Foramen spinosum open
Zygomatic arch suture
Os japonicum
Metopism
Genial pits
Infraorbital suture

Foraminal traits
Parietal foramen
Obelionic foramen
Mastoid foramen
Accessory lesser palatine foramen
Zygomatic facial foramen
Supraorbital foramen complete
Accessory supraorbital foramen
Frontal foramen
Frontal grooves
Anterior ethmoid foramen exsutural
Posterior ethmoid foramen absent
Accessory infraorbital foramen
Accessory mental foramen

Unclassified Traits
Fronto-temporal articulation
Occipital foramen**
Sutural foramen**
Rocker jaw

* This trait could also be classified as a foraminal trait
** Hemphill (1992) notes that these traits are difficult to classify
† adapted from Hemphill (1992), Ossenberg (1970) and Saunders (1989)

Table 4.3 - Sex Distribution in Skeletal Samples from Abydos, Badari, Keneh, Naqada and Nubia

	SEX			
	Female	Male	Unknown	Total
	n	n	n	n
SITE				
Abydos	13	35	0	48
Badari	24	33	1	58
Keneh	17	9	14	40
Naqada - B	13	21	6	40
Naqada - G	27	41	0	68
Naqada - T	19	20	0	39
Nubia - 179	19	19	3	41
Nubia - 277	10	27	1	38
Total	142	204	26	372

n = number of crania

Table 4.4 - Age Distribution in Skeletal Samples of Skeletal Samples from Abydos, Badari, Keneh, Naqada and Nubia

	AGE				
	Teen (13-20 years) n	Young Adult (21-30 years) n	Middle Adult (31-40 years) n	Old Adult (>40 years) n	Adult (Indeterminate Age) n
SITE					
Abydos	0	0	19	9	20
Badari	1	1	20	17	19
Keneh	3	3	6	13	15
Naqada-B	5	5	11	16	3
Naqada-G	5	9	24	30	0
Naqada-T	2	1	16	15	5
N - 179	0	5	9	21	6
N - 277	3	11	9	7	8
Total	19	35	114	128	76

n = number of crania

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APPENDIX 4.1 - DESCRIPTIONS OF NONMETRIC TRAITS

Trait Descriptions

1. Highest Nuchal Line. A third line for the attachment of the epicranial eponeurosis is sometimes present above the inferior and superior nuchal lines on the occipital bone. It originates at the superior nuchal line on the external occipital protuberance and arches anteriorly and laterally. It is scored as present or absent (illustrated in Berry and Berry, 1967:364).

2. Ossicle at Lambda. A bone is sometimes present at the point of intersection of the sagittal and lambdoidal sutures (lambda). It is scored as present or absent (illustrated in Berry and Berry, 1967:365).

3. Inca Bone. An Inca bone is distinguished from an ossicle at lambda (Trait #2) if the suture that forms the inferior border of the ossicle completely divides the occipital bone in the region of the highest nuchal line. Bipartite, tripartite and multipartite inca bones can exist if one or more longitudinal or transverse sutures subdivide the bone. It is scored as present-single, present-bipartite, present-tripartite, present-partial, or absent (illustrated in Hauser and De Stefano, 1989:100-101).

4. Lambdoidal Suture Ossicle. One or more ossicles may be present in the lambdoidal suture. This trait is scored as present or absent. If present, the number of ossicles observed is recorded (illustrated in Berry and Berry, 1967:364).

5. Biasterionic Suture (Sutura Mendosa). A suture may occur on the lateral margins of the occipital squama, originating at the junction of the mastoid portion of the temporal bone, and the parietal and occipital bones. It is scored as present if its length exceeds 1cm (illustrated in Hauser and De Stefano, 1989:195).

6. Ossicle at Asterion. An ossicle may occur at asterion, which is the point of union of the lambdoidal, parietomastoid and occipitomastoid sutures. It is scored as present or absent. Ossicles situated in the occipitomastoid suture are scored separately (see Trait #18)(illustrated in Berry and Berry, 1967:365, and Hauser and De Stefano, 1989:195).

7. Parietal Foramen. One or more foramina may pierce the parietal bone lateral to the sagittal suture, anterior to lambda. This trait is scored as present or absent (illustrated in Berry and Berry, 1967:365, and Hauser and De Stefano, 1989:79).

8. Obelionic Foramen. A foramen is sometimes located at obelion, which is the point of intersection along the sagittal suture at a line drawn between the parietal foramina (when present). It is scored as present or absent (illustrated in Olivier, 1969:164).

9. Bregmatic Bone. An ossicle may occur at the junction of the sagittal and coronal sutures. It is scored as present or absent (illustrated in Berry and Berry, 1967:365, and Hauser and De Stefano, 1989:98).

10. Apical Bone. An ossicle is sometimes present at apex along the sagittal suture. Apex is defined as "the point where a perpendicular line drawn to the Frankfort Horizontal Plane through porion intersects the midsagittal contour" (Bass, 1987:66). It is scored as present or absent (no illustration).

11. Coronal Suture Ossicle. One or more ossicles may be present in the coronal suture. This trait is scored as present or absent. If present, the number of ossicles observed is recorded (illustrated in Berry and Berry, 1967:367, and Hauser and De Stefano, 1989:98).

12. Os Sagittal Suture. One or more ossicles may be present along the sagittal suture. This trait is scored as present or absent. If present, the number of ossicles is recorded (illustrated in Brothwell, 1981:94).

13. Epipteric Bone. An ossicle may be present between the antero-inferior angle of the parietal bone and the greater wing of the sphenoid, sometimes including the squamous portion of the temporal bone. It is scored as present or absent (illustrated in Berry and Berry, 1967:365, and Hauser and De Stefano, 1989:211-212).

14. Fronto-temporal Articulation. Normally the frontal bone and squamous portion of the temporal bone are separated at pterion by segments of the parietal and sphenoid bones. Occasionally there is an anterior projection of the temporal squama, which forms the fronto-temporal articulation. If present, this trait is categorized as an "H"(normal), "X", or "Y" pattern, according to Brothwell (1981) (illustrated in Berry and Berry, 1967:367, Brothwell, 1981:46, and Hauser and De Stefano, 1989:217).

15. Parietal Notch Bone. The postero-lateral portion of the parietal bone may angle inferiorly between the squamous and mastoid portions of the temporal bone, forming a notch. Occasionally there will be one or more ossicles in this location. This trait is scored as present or absent. If present, the number of ossicles observed is recorded (illustrated in Berry and Berry, 1967:365, and Brothwell, 1981:94).

16. Parietal Notch Present. The postero-lateral portion of the parietal bone may angle inferiorly between the squamous and mastoid portions of the temporal bone, forming a notch. It is scored as present or absent. This trait is also scored as present if a parietal notch bone (Trait #15) is observed (no illustration).

17. Occipitomastoid Wormians. One or more ossicles may occur in the occipitomastoid suture, and are distinguished from ossicles that occur at asterion (Trait #6). This trait is scored as present or absent. If present, the number of ossicles observed is recorded (illustrated in Brothwell, 1981:94, and Hauser and De Stefano, 1989:195).

18. Auditory Torus. A bony protuberance of variable size may occur on the floor of the external auditory meatus. It is scored as absent, less than one-third auditory aperture occluded, one-third to two-thirds auditory aperture occluded, or more than two-thirds auditory aperture occluded (illustrated in Berry and Berry, 1967:365, and Hauser and De Stefano, 1989:181).

19. Sutural Foramen. One or more foramina may be present in the occipitomastoid suture. This trait is scored as present or absent. If present, the number of foramina are recorded (illustrated in Berry and Berry, 1967:364, and Hauser and De Stefano, 1989:203).

20. Mastoid Foramen. One or more foramina may be present in the occipitomastoid suture. Less frequently, these foramina will be situated on the mastoid portion of the temporal bone. This trait is scored as present or absent. If present, the number of foramina are recorded (illustrated in Berry and Berry, 1967:364, and Hauser and De Stefano, 1989:203).

21. Occipital Foramen. One or more foramina may be present in the occipitomastoid suture. Sometimes these foramina will be located on the occipital bone near the occipitomastoid suture. This trait is scored as present or absent. If present, the number of foramina are recorded (illustrated in Berry and Berry, 1967:364, and Hauser and De Stefano, 1989:203).

22. Tympanic Dehiscence (Foramen of Huschke). Occasionally there is a dehiscence, or perforation, of the tympanic plate on the external auditory meatus. This trait is scored as absent, trace (translucent area visible on tympanic plate), perforation of variable size present on tympanic plate, partial absence of tympanic plate, or complete absence of tympanic plate (scoring by N. Lovell) (illustrated in Berry and Berry, 1967:366, and Hauser and De Stefano, 1989:145).

23. Posterior Condylar Canal Patent. A canal is usually present in the condylar fossa immediately posterior to the occipital condyle. This trait is scored as present only when the canal completely penetrates the bone (illustrated in Berry and Berry, 1967:366, and Hauser and De Stefano, 1989:105).

24. Condylar Facet Double. The articular surface of the occipital condyle, located antero-lateral to the foramen magnum, may be partially or completely divided. This trait is scored as present only if there is complete division of the articular surface (illustrated in Berry and Berry, 1967:364&366, and Hauser and De Stefano, 1989:114&119).

25. Precondylar Tubercle. One or two bony tubercles of variable size may be present on the anterior margin of the foramen magnum. Occasionally an articular facet may also be present on the tubercle. This trait is scored as present or absent (illustrated in Berry and Berry, 1967:366, and Hauser and De Stefano, 1989:113&119).

26. Paracondylar Process. A process may occur between the occipital condyle and the mastoid process in the region posterior to the jugular fossa. This trait is scored as present or absent (illustrated in Hauser and De Stefano, 1989:113&130).

27. Anterior Condylar Canal (Hypoglossal Canal) Double. The canal for the transmission of the hypoglossal nerve passes through the occipital bone anterior to the occipital condyle, and is sometimes divided in two for part, or all, of its length. This trait is scored as absent, partial division on medial surface of canal (near the foramen magnum), complete division on medial surface of canal, partial internal division of canal, or complete internal division of the canal (illustrated in Berry and Berry, 1967:364, and Hauser and De Stefano, 1989:123).

28. Foramen Ovale Incomplete. The foramen ovale is located on the sphenoid bone, posterior to the foramen rotundum. The postero-lateral wall of the foramen is sometimes partial or incomplete, so that it is continuous with the foramen spinosum. This trait is scored as complete or incomplete (illustrated in Berry and Berry, 1967:366, and Hauser and De Stefano, 1989:150).

29. Foramen Spinosum Open. The foramen spinosum is located immediately posterior to the foramen ovale, and the external border of this foramen is occasionally incomplete (open). This trait is scored as complete or incomplete (illustrated in Berry and Berry, 1967:366, and Hauser and De Stefano, 1989:150).

30. Pterygo-alar Spurs. A bony outgrowth on the posterior border of the lateral pterygoid plate may extend to form a complete bridge between the lateral lamina and inferior surface of the greater wing on the sphenoid. The trait is scored as present if bony spurs are observed (illustrated in Hauser and De Stefano, 1989:158-159).

31. Pterygo-spinous Spurs. A continuous bridge may be formed between the spina angularis and the hamulus of the medial pterygoid plate on the sphenoid. This trait is scored as present if bony spurs are observed (illustrated in Hauser and De Stefano, 1989:158-159).

32. Palatal Suture. The transverse palatine suture connects the palatine process of the maxilla with the horizontal portion of the palatine bone. This trait is scored as normal, patent premaxillary suture, posterior medio-palatine bones and anterior medio-palatine bones (illustrated in Brothwell, 1981:46, and Hauser and De Stefano, 1989:173).

33. Accessory Lesser Palatine Foramen. The greater palatine foramen is located in the posterior region of the palate, along the suture between the alveolar process of the maxilla and the horizontal portion of the palatine bone. Immediately posterior to the foramen there is often one or more accessory foramina. This trait is scored as present or absent. If present, the number of foramina observed is recorded (illustrated in Berry and Berry, 1967:366, and Hauser and De Stefano, 1989:165&169).

34. Palatine Torus. A bony protuberance is sometimes found along the median suture of the hard palate. The trait is scored as absent, trace (1-2mm elevation), medium (2-5mm elevation), marked (>5mm elevation), or very marked (10mm elevation & 10-20mm width) (illustrated in Brothwell, 1981:96, and Hauser and De Stefano, 1989:175).

35. Maxillary Torus. A bony projection of variable size is sometimes located on the maxilla along the lingual aspect of the molar region. It is scored as present or absent (illustrated in Brothwell, 1981:96, and Hauser and De Stefano, 1989:181).

36. Zygomaxillary Tubercle. In the region of inferior border of the zygomatico-maxillary suture an inferiorly projecting tubercle of variable size is sometimes present. This trait is scored as present or absent (illustrated in Hauser and De Stefano, 1989:75&77).

37. Marginal Tubercle. A bony projection of variable size may occur on the zygomatic bone, at the temporal border of the frontal process. This trait is scored as present or absent (illustrated in Hauser and De Stefano, 1989:228-229).

38. Zygomatico-facial Foramen. One or more foramina may be present on the lateral surface of the zygomatic bone, generally below the orbital border. This trait is scored as absent, single, or multiple (illustrated in Hauser and De Stefano, 1989:211&228).

39. Zygomatic Arch Suture. There is variability in the pattern of the sutures and the degree of division of the zygomatic bone. This trait is scored as present if one of the four patterns shown in Brothwell (1981) is observed, including Os Japonicum (Trait #38) (illustrated in Brothwell, 1981:46).

40. Os Japonicum. The complete sutural division of the zygomatic bone by one or two sutures is identified as Os japonicum. It is scored as present or absent (illustrated in Brothwell, 1981:46, and Hauser and De Stefano, 1989:211&224).

41. Supraorbital Foramen Complete. A foramen or notch is often present along the medial aspect of the superior orbital border. This trait is scored as absent, partial (one-half partially occluded by spicules) or complete (one-half completely occluded by spicules) (illustrated in Berry and Berry, 1967:367, and Hauser and De Stefano, 1989:52).

42. Accessory Supraorbital Foramina. Foramina are sometimes located lateral to supraorbital foramina and frontal foramina. They must have an aperture on both the orbital and exterior surfaces of the frontal bone in order to be scored as present (no illustration).

43. Metopism. Metopism is the partial or complete persistence into adulthood of the metopic suture, located on the midline of the frontal bone. It is scored in individuals older than 2 years of age as present or absent (illustrated in Berry and Berry, 1967:367, and Hauser and De Stefano, 1989:45).

44. Frontal Foramen (or Notch). A well-defined accessory notch or foramen may be present immediately lateral to the supraorbital foramen. It is scored as present or absent (illustrated in Berry and Berry, 1967:365&367).

45. Frontal Grooves. Single or paired grooves may occur on the lateral and external surface of the frontal bone, usually occurring between the frontal eminence and the temporal line. This trait is scored as present or absent. If present, the number of grooves is recorded (illustrated in Hauser and De Stefano, 1989:49).

46. Anterior Ethmoid Foramen Exsutural. Two foramina are normally found along the suture between the medial edge of the orbital plate of the frontal bone and the ethmoid bone. Occasionally the anterior foramen is located exsuturally on the orbital plate. This trait is scored as absent, present along suture, or present exsuturally (illustrated in Berry and Berry, 1967:366, and Hauser and De Stefano, 1989:61).

47. Posterior Ethmoid Foramen. The posterior ethmoid foramen is normally found immediately posterior to the anterior ethmoid foramen on the medial wall of the orbital cavity. This trait is scored as present or absent (illustrated in Berry and Berry, 1967:366)

48. Nasal Bone. Variations in the standard pattern of nasal bone sutures can sometimes occur. This trait is scored according to the sutural variations shown in Brothwell (1981). It is scored as absent if the pattern is 'normal' (illustrated in Brothwell, 1981:46).

49. Accessory Infraorbital Foramen. The infraorbital foramen is located below the infraorbital margin on the anterior surface of the maxilla. Sometimes additional foramina may occur in association with the primary infraorbital foramen. The location of accessory foramina is variable. This trait is scored as present or absent (illustrated in Berry and Berry, 1967:365&367, and Hauser and De Stefano, 1989:71).

50. Infraorbital Suture. The infraorbital suture is the continuation of the infraorbital canal on to the external surface of the maxilla. The suture may continue inferiorly to the infraorbital foramen, or end before reaching the foramen. This trait is scored as absent, partial (suture does not extend to the infraorbital foramen), or complete (suture extends completely to the infraorbital foramen) (illustrated in Hauser and De Stefano, 1989:61&68).

51. Accessory Mental Foramina. On the external surface of the mandible inferior to the premolar region, there is usually a foramen present. Occasionally there may be one or more additional foramina. This trait is scored as present or absent. If present, the number of foramina is recorded (illustrated in Hauser and De Stefano, 1989:231).

52. Rocker Jaw. Rocker jaw is due to a pronounced curvature of the inferior surface of the horizontal ramus of the mandible. It is scored as absent (mandible does not rock back and forth on a flat surface), almost rocker (mandible will rock for about one second), or rocker (mandible will rock for several seconds) (no illustration).

53. Mylohyoid Arch (Mylohyoid Bridge). On the medial surface of the mandibular ramus, the mylohyoid groove runs antero-inferiorly. Sometimes there is a partial or complete bony covering of the groove. This trait is scored as arch absent, partial arch, or complete arch (illustrated in Hauser and De Stefano, 1989:231&235).

54. Lingula Bridge. The lingula is a sharp projection located at the superior margin of the mandibular foramen. Occasionally there will be a spur or a complete bony bridge connecting the lingula to the ascending ramus of the mandible. This trait is scored as absent, partial (lingula spur or hook present), or complete (scoring by N. Lovell) (no illustration).

55. Mandibular Torus. A bony protuberance of variable size is sometimes present on the lingual surface of the mandible, generally in the region of the second premolar. It is scored as absent (no elevation), trace (elevation can be palpated but is not visible), medium (2-5mm elevation), or marked (>5mm elevation) (illustrated in Brothwell, 1981:96).

56. Genial Tubercles. One or more small bony projections are sometimes located on the lingual surface of the anterior portion of the mandible. This trait is scored as present or absent. If present, the number of tubercles is recorded (illustrated in Hauser and De Stefano, 1989:231&239).

57. Median Mental Spine. A single median spine may occur in the same location as the genial tubercles on the mandible. It is scored as present or absent (illustrated in Hauser and De Stefano, 1989:231&239).

58. Genial Pits. One or two pits may occur in the same location as the genial tubercles on the mandible. This trait is scored as present or absent. If present, the number of pits is recorded (illustrated in Hauser and De Stefano, 1989:239).

CHAPTER 5

A STUDY OF AGE, SEX, AND SIDE CORRELATIONS IN FOUR NILE VALLEY SKELETAL SAMPLES

Introduction

Since the introduction of nonmetric trait variation as a means of assessing population variation, cranial nonmetric traits have been widely used in biological distance studies of past human populations. Intensive use of nonmetric traits for the analysis of population affinities began with Berry and Berry's (1967) influential study. A number of assumptions were advanced in this study concerning the characteristics of nonmetric traits that were applied in subsequent research. The study asserted that nonmetric trait frequency was independent of age and sex correlations, even though studies on the genetics of nonmetric traits in mice showed that a number of factors could influence nonmetric trait expression, including sex, litter size, parity, maternal age, gestation length and diet (Searle, 1954a, 1954b). This purported lack of correlation with age and sex among humans was particularly encouraging for the analysis of human skeletal remains, which were often too fragmentary or incomplete to determine age and sex with any accuracy. Corruccini (1974) was one of the first researchers to examine nonmetric trait correlations empirically, and although numerous subsequent studies have examined the effects of age and sex dependency, no general consensus has ever been reached on the effect these factors have on nonmetric trait frequency, nor on the treatment of traits that do show significant correlations (e.g., Berry, 1975; Corruccini, 1974; Cosseddu et al., 1979; Ossenberg, 1970; Perizonius, 1979; Vecchi, 1968).

Ossenberg (1970) proposed that age and sex related variation of nonmetric trait expression followed a pattern consistent with the developmental nature of many of the variants studied. Hypostotic traits, due to insufficient ossification during development, were found to occur more frequently in females, and tended to follow an age-regressive pattern of development. Hyperostotic traits, resulting from excessive ossification, were found more commonly in males, and followed an age-progressive pattern of development. This classification of nonmetric traits provided an analytical framework within which patterns of age and sex correlations could be examined.

In addition to the controversy over the effects of age and sex dependence of nonmetric traits, further debate arose over the treatment of bilateral nonmetric traits. The main issue concerned the method of scoring of bilateral nonmetric traits, based on either the total number of sides or the total number of individuals (i.e., crania). Scoring by sides assumes that the asymmetrical occurrence of a bilateral trait is due to the additive genetic effects responsible for nonmetric trait expression, and therefore the higher the genetic liability for trait expression, the more likely that trait will be expressed bilaterally. Proponents of the side scoring method have argued that scoring both sides of bilateral nonmetric traits provides a more accurate estimate of the genetic composition of the sample (Ossenberg, 1981).

Korey (1980), however, has argued that scoring by individual crania assumes that the asymmetrical occurrence of a trait is due to developmental noise, and not genetic factors. Therefore, use of the side count method would introduce extraneous genetic information into the calculation of biological distance or would artificially inflate sample size. Numerous studies have examined the interdependence of right and left sides of bilateral traits, but, as in the case of age and sex correlations, no consensus has been reached the treatment of bilateral traits (e.g., Cosseddu et al., 1979; Korey, 1980; Ossenberg, 1981; Trinkaus, 1978).

This study examines four skeletal samples for age, sex and side correlations among fifty-eight cranial nonmetric traits. Four skeletal samples were used in this study in order to provide a comparative analysis among samples from the same geographic region. A number of previous studies have made generalized statements concerning the age, sex and side dependency of cranial nonmetric traits based solely on the analysis of only one skeletal sample, or a number of samples collapsed into one larger group (e.g., Corruccini, 1974; Cosseddu et al., 1979; Korey, 1980; Perizonius, 1979). The comparison of more than one skeletal sample from the same geographical region permits the investigation of the overall pattern of age, sex and side associations both within and between samples.

Materials and Methods

Skeletal samples from four Nile Valley sites in Egypt and Nubia were used in this study, consisting of a total of 215 crania. The Egyptian skeletal samples from Abydos, Badari, and the Great Cemetery at Naqada were examined at the Department of Biological Anthropology, Cambridge University, England. The Nubian material from the Scandinavian Joint Expedition (SJE) site 179 was examined at the Laboratory of Biological Anthropology, University of Copenhagen, Denmark. The age of adult specimens was determined by the degree of ectocranial suture closure and degree of tooth wear (after Meindl and Lovejoy, 1985; Lovejoy, 1985).[1] If there was a discrepancy between the two aging methods, suture closure estimates were used. Subadult specimens were aged according to standard stages of tooth eruption (Ubelaker, 1989). Sex was determined on the basis of standard gross morphological features of the cranium (according to Bass, 1987; Brothwell, 1972; Ubelaker, 1989; White, 1991). Age and sex distributions of the skeletal samples are presented in Table 5.1 and Table 5.2.

Data were collected on the Abydos and Badari cranial samples by T. Prowse in 1991. In 1992, M. Bartell and N. Lovell completed data collection on the Naqada and Nubia crania. Nonmetric traits used in this study were selected from the following sources; Berry and Berry (1967), Brothwell (1972), Buikstra (1976), Hauser and De Stefano (1989), Ossenberg (1970), and Rose et al. (1991). Both sides of the cranium were scored for bilateral traits and partial trait manifestations were scored as present. Intraobserver and interobserver error were minimized through the use of standard scoring procedures outlined in a data collection manual, specifically developed for this research by M. Bartell, N. Lovell and T. Prowse. Individual trait descriptions were supplemented by figures and illustrations to assist in identification, and all data were collected under the supervision of N. Lovell to ensure scoring consistency.

Age and sex correlations of nonmetric trait frequencies within individual skeletal samples were calculated using chi-squared statistics based on two-by-two contingency tables (shown below). Individuals of unknown age or sex were excluded from analysis. Due to the small size of the skeletal samples, it was necessary to collapse the original age categories into two groups for statistical analysis: Young Adult (< 40 years) and Old Adult (> 40 years). The original age categories of Subadult, Young Adult, Middle Adult and Old Adult resulted in frequencies that were too small for meaningful statistical analysis.

Contingency Tables for Age and Sex Analysis

	Male	Female
Trait Present	a	b
Trait Absent	c	d

	Young Adult	Old Adult
Trait Present	a	b
Trait Absent	c	d

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[1] The method for determining the degree of tooth wear developed by Lovejoy (1985) was modified by N. Lovell in 1991 for the Nile Valley cranial material due to the comparatively lesser degree of anterior tooth wear observed in the Nile Valley material (N. Lovell, personal communication).

In the chi-squared analysis, Yate's Correction for Continuity and Fisher's Exact Test for small sample sizes were frequently applied when the expected side count frequency fell below ten or five, respectively (after Thomas, 1986).

Chi-square statistic: $$X^2 = \frac{n(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

n = total sides observed (a+b+c+d)

The relationship between right and left sides of bilateral nonmetric traits was examined using two statistical tests; (1) the chi-squared statistic as outlined above, which tested the independence of occurrence between left and right sides of bilateral traits based on data in a two-by-two contingency table (after Green et al., 1979):

Contingency Table for Side Correlation Analysis

		Right Side	
		Present	Absent
Left Side	Present	a	b
	Absent	c	d

(2) the Phi Correlation coefficient (r), which expressed the degree of correlation between right and left sides (after Green et al., 1979):

Phi Correlation Coefficient: $$r = \left[\frac{(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)}\right]^{1/2}$$

Results and Discussion

The nonmetric traits and their side count frequencies are provided in Table 5.3.

Sex Analysis

Table 5.4 presents the results of the chi-squared analysis for sex within each of the skeletal samples. A summary of the traits demonstrating significant sex differences is provided in Table 5.5, including level of significance, nonmetric trait category according to developmental etiology, and the sex with the highest frequency for each trait.

The results presented in Table 5.5 indicate that significant sex differences ($p< 0.05$) exist within each of the skeletal samples. Only in the Naqada sample, however, does the number of traits with significant differences (12/58) exceed the number that would normally be expected to occur due to random variation (i.e., 5% of the total number of traits studied). In addition, none of the traits showing statistically significant variation due to sex within each sample are repeated in any of the other three samples. These results suggest that with the exception of the Naqada sample, nonmetric trait frequencies are not significantly affected by sex. Further, there is no consistency among those traits that show sex correlations from one sample to another. The results from the present study are consistent with numerous other studies that have found no significant or consistent sex association among nonmetric traits (e.g., Cosseddu et al., 1979; Cybulski, 1975; Dodo, 1974; Ossenberg, 1970, 1976). A comparable number of studies have found significant sex associations (e.g., Berry, 1975; Corruccini, 1974; Finnegan, 1978; Molto, 1983; Perizonius, 1979; Saunders, 1978), however, these differences may be explained by the greater degree of sexual dimorphism in those samples. It has been suggested, however, that conflicting results between studies on the effects of sex, age and side correlations may be due to differences in sample size, trait selection and statistical procedures employed (Saunders, 1978). Finnegan (1978) and Saunders (1978) examined postcranial nonmetric traits, and the comparatively larger number of sex associations may be explained by greater sexual dimorphism of bones in the postcranium for those particular samples (i.e., differences in size and robusticity of bones). Berry (1975) and Perizonius (1979) examined only one skeletal sample in each of their studies, and Molto (1983) collapsed a number of skeletal samples from the same geographical region for analysis. The significantly higher number of sex dependent nonmetric traits in the Naqada skeletal sample may be explained by a higher level of sexual dimorphism between males and females within this particular sample. Craniometric studies performed on the Naqada skeletal material by Fawcett and Lee (1902), however, did not find a greater degree sexual of dimorphism in the Naqada crania than in other Egyptian, European and Indian samples studied, although their assessment was based only on estimates of cranial capacity, and not metric or nonmetric features. Similarly, Warren (1897) studied the postcrania of the Naqada skeletal series, and did not find any significant differences between the sexes. Other studies that have included the Naqada crania have either used only male specimens (e.g., Morant, 1925; Pearson, 1896), or have not investigated variation between the sexes (Batrawi, 1946; Berry and Berry, 1967; Crichton, 1966; Mukherjee et al., 1955). The Naqada cranial sample is the largest in this study, and therefore sample size is likely not a factor in these results. Although it can not be confirmed at the present time, the most parsimonious explanation for the high number of sex correlations in the Naqada sample is due to higher levels of sexual dimorphism among the Naqada males and females than in the other samples.

Although no consistent patterns of sex associations between the skeletal samples were detected in this study, there is a general correlation between sex and hyperostotic/hypostotic trait manifestation, as proposed by Ossenberg (1970) (see Table 5.5). Hyperostotic traits tend to be more frequent in males in those traits that do show significant sex differences. The two hypostotic traits, posterior condylar canal and tympanic dehiscence, are both more common among females. The overall difference between males and females in the expression of hyperostotic and hypostotic traits has been correlated with general size factors associated with sexual dimorphism and the tendency of females to retain more juvenile characteristics (Ossenberg, 1970). Examination of the other trait categories reveals that males and females have an equal number of foraminal traits, which is consistent with Saunders (1989) conclusion that there is no sex related pattern evident for foraminal traits. Similarly, Hemphill (1992) found generally similar frequencies of foraminal traits among males and females in skeletal material from Harappa, Pakistan. In the present study, accessory ossicle traits tend to be more common in females than males in a three-to-one ratio. Hemphill (1992) also found a significantly higher number of females with accessory ossicles.

Age Analysis

The results of the age analysis for males and females within each skeletal sample are provided in Table 5.6, and traits that showed significant age differences ($p< 0.05$) are summarized in Table 5.7. In the SJE179 male series, no significant age associations were found among any of the nonmetric traits studied. The results presented in Table 5.7 indicate a low number of significant age-related traits within each skeletal sample, but less than the number that would be expected to occur due to random variation (i.e., < 5%). None of the traits showing significant age associations are repeated in any of the other samples. These results agree with previous studies which have demonstrated that nonmetric traits are generally independent of age when dealing with adult material (Berry, 1975; Buikstra, 1976; Perizonius, 1979). Similarly, familial studies in living human groups found that certain traits (i.e., atlas bridging, clinoid bridging and jugular foramen bridging) showed overall age stability (Dodo, 1986; Saunders and Popovich, 1978). Additional cranial and postcranial nonmetric traits shown to be age stable in postadolescence and over the entire age span are summarized by Saunders (1989). While other studies have found that age was a significant factor in nonmetric trait frequency (Corruccini, 1974; Molto, 1983; Saunders, 1978; Vecchi, 1968), methodological factors such as trait selection, method of statistical analysis (including different age categories), and samples studied may account for the discrepancies between studies (Saunders, 1978).

Again, although there were no overall patterns of significant age associations (as with sex associations) among the skeletal samples in this study, hypostotic/hyperostotic trait expression was examined in those traits that did show statistical significance. Hyperostotic traits are considered to be age-progressive, and therefore a higher number of hyperostotic traits should occur among older adults. In this study, hyperostotic traits showing significant age dependence are found in relatively equal proportions between young and old adults. Only one hypostotic trait (i.e., foramen spinosum open) was found to be significantly associated with age, and is consistent with a pattern of greater prevalence of hypostotic traits in young adults (Ossenberg, 1970). The age related nature of hyperostotic and hypostotic traits has been demonstrated in earlier studies of nonmetric trait variation (Ossenberg, 1970; Saunders, 1978, Molto, 1983). Only one case of significant association between accessory ossicles and age is present in this study, with parietal notch more commonly found among younger adults in the Naqada male sample. Molto (1983) also found a decrease in the frequency of accessory ossicles with increased age. Similarly, Hemphill (1992) found that older Harappan adults had almost no accessory ossicles. These results are consistent with the progressive obliteration of cranial sutures with advancing age, making accessory ossicles more difficult to detect. Three foraminal traits are significantly associated with older adults in this study, while other studies have not found a consistent pattern of age correlation with foraminal traits (Hemphill, 1992; Molto, 1983).

In general, it has been concluded that age dependency of nonmetric traits is minimal in adult skeletal samples, and the exclusion of subadults from biological distance analysis will reduce any age effects on nonmetric trait frequency (Berry, 1975; Buikstra, 1976; Perizonius, 1979).

Side Analysis

Table 5.8 presents the results of the chi-squared and correlation analyses for left and right sides of the cranium. A summary of these results, showing the number of nonmetric traits with significant side interdependencies and perfect side correlations within each sample, is presented in Table 5.9.

Results of the chi-squared analysis indicate that in all but the Abydos female subsample, there is a significant dependency between right and left sides of bilateral traits, at a level of 20% or higher. The correlation analysis demonstrates that there is a high positive correlation between right and left sides in all of the skeletal samples, but this correlation is not perfect, and is consistently less than 50% in all of the skeletal samples.

Previous studies on side interdependence and correlation have similarly found that right and left sides are highly interdependent and show a strong positive correlation between sides (e.g., Green et al., 1979; Molto, 1983; Perizonius, 1979; Saunders, 1978). These correlations were rarely found to be perfect (i.e., 100%), as is the case in this study, and tended to vary among different skeletal samples, therefore it can not be assumed that right and left sides are perfectly correlated (Hauser and De Stefano, 1989).

The disagreement over the side and cranial count methods centers on the opposing views of genetic versus environmental influence on unilateral and bilateral trait expression. Opponents of the side count method argue that unilateral expression is a transitional phase due to environmental and not genetic factors. Therefore, the scoring of bilateral traits based on the individual reduces the amount of spurious genetic information that would be introduced by using the side count method (Korey, 1980; Saunders, 1989; Trinkaus, 1978). The major argument for the use of the side count method, however, is that trait expression is largely under genetic control, and that unilateral and bilateral trait manifestations reflect divergent genetic liabilities, and therefore scoring by individual would underestimate the actual genetic composition of a population (Ossenberg, 1981).

Further, since there is generally an imperfect correlation between right and left sides of the cranium, as demonstrated in this study, per individual scoring would tend to underestimate the true prevalence of that trait, particularly when dealing with fragmentary skeletal samples. The side count method, while admittedly increasing sample size, would more accurately reflect true trait frequencies.

Conclusions

Results of this study can be summarized by the following four points:

1. There are low levels of significant sex correlations within each of the skeletal sample studied, however, only in the case of the Naqada sample does this exceed normal levels of variation expected due to random factors, and is best explained by a high level of sexual dimorphism in the Naqada sample.
2. There are also low levels of significant age correlations within each of the skeletal samples, with the exception of the SJE179 male sample (which did not have any significant age correlations), but all are within acceptable levels of variations due to chance.
3. The pattern of correlations between skeletal samples reveals that there is no consistency between samples with respect to those traits that show age and sex associations. The exclusion of traits showing age and sex dependency may result in the loss of valuable genetic information for biological distance analysis. Alternatively, the separate analysis of males and females may produce greater errors in the calculation of biological distance due to small samples sizes than would result due to the distortion based on sex dependent traits (Ossenberg, 1976). Based on these considerations, no traits will be eliminated from further biological distance analysis due to age and sex correlations. Therefore sexes and age groups will be pooled for further analysis in Chapters 6, 7 and 8. Subadults, however, will be eliminated from the final biological distance analysis, as recommended by Berry (1975), Buikstra (1976) and Perizonius (1979).
4. The bilateral expression of nonmetric traits is positively correlated between sides, but perfect correlations occurred in less than half of the cases observed within each sample. In addition, side interdependence is high but not absolute. If the model of quasi-continuous inheritance of nonmetric traits is accepted, then the unilateral and bilateral expression of traits is a reflection of the genetic potential of that particular trait. Therefore, the determination of trait frequency by sides versus the individual will produce a more accurate estimate of genetic relatedness among skeletal samples. While this method artificially inflates the sample size, the alternative choice of potentially excluding genetic information through the use of the individual count method is less desirable. Therefore, the calculation of biological distance analysis among skeletal samples in subsequent chapters (6, 7, and 8) will use the side count method, based on the total number of sides observable.

The inconsistency in previous studies of age, sex and side correlations analysis indicates the need for independent assessment of correlations with each new study of biological distance. The results therein should only be applied to the study in question, as it is apparent that nonmetric trait correlations are not consistent between samples, or even within the same geographical area, as has been demonstrated in this study. Therefore the results of this study should be considered only within the context of the subsequent analysis of biological variation within the Nile Valley (Chapters 6, 7, and 8).

Table 5.1 - Age Distribution of Four Nile Valley Skeletal Samples

	AGE					
	Subadult (13-20 years)	Young Adult (21-30 years)	Middle Adult (31-40 years)	Old Adult (>40 years)	Adult (Indeterminate Age)	Total
SAMPLE	n	n	n	n	n	n
Abydos	0	0	19	9	20	48
Badari	1	1	20	17	19	58
Naqada	5	9	24	30	0	68
SJE179	0	5	9	21	6	41
Total	6	15	72	77	45	215

n = number of crania

Table 5.2 - Sex Distribution of Four Nile Valley Skeletal Samples

	SEX			
	Female	Male	Unknown	Total
	n	n	n	n
SAMPLE				
Abydos	13	35	0	48
Badari	24	33	1	58
Naqada	27	41	0	68
SJE179	19	19	3	41
Total	83	128	4	215

n= number of crania

Table 5.3 - Cranial Nonmetric Trait Frequencies Used in Age, Sex and Side Correlation Analysis†

	Abydos			Badari			Naqada			SJE 179		
TRAIT	n	N	Freq.	n	N	Freq.	n	N	Freq.	n	N	Freq.
Highest Nuchal Line (HNUCH)	52	94	0.55	60	114	0.53	2	118	0.02	6	68	0.09
Ossicle at Lambda (OSSLAMDA)	4	46	0.09	4	53	0.08	6	57	0.11	1	32	0.03
Inca Bone (INCABONE)	0	47	0.00	0	54	0.00	0	57	0.00	1	34	0.03
Lambdoidal Suture Ossicle (LSUTOSS)	41	89	0.46	44	108	0.41	26	79	0.33	7	43	0.16
Biasterionic Suture (BSUTURE)	*	*	*	*	*	*	4	110	0.04	1	54	0.02
Ossicle at Asterion (ASTERIO)	10	92	0.11	21	102	0.21	10	114	0.09	3	38	0.08
Parietal Foramen (PFORAM)	39	94	0.42	51	111	0.46	68	116	0.59	39	60	0.65
Obelionic Foramen (OBFORAM)	7	47	0.15	8	56	0.14	3	55	0.06	3	30	0.10
Bregmatic Bone (BREGMA)	0	44	0.00	0	52	0.00	0	55	0.00	0	31	0.00
Apical Bone (APICAL)	0	46	0.00	0	54	0.00	1	39	0.03	0	27	0.00
Coronal Suture Ossicle (COSS)	4	85	0.05	5	95	0.05	4	83	0.05	0	52	0.00
Os Sagittal Suture (OSSUTURE)	3	36	0.08	2	47	0.04	4	38	0.11	0	29	0.00
Epipteric Bone (EPIPTER)	9	88	0.10	15	96	0.16	12	99	0.12	4	30	0.13
Fronto-temporal Articulation (FTART)	84	86	0.98	61	80	0.76	100	100	1.00	23	29	0.79
Parietal Notch Bone (PNBONE)	4	94	0.04	16	106	0.15	8	111	0.07	2	34	0.06
Parietal Notch Present (PNOTCH)	75	95	0.79	66	106	0.62	100	111	0.90	27	34	0.79
Occipitomastoid Wormians (OWORM)	*	*	*	*	*	*	4	102	0.04	1	28	0.04
Auditory Torus (ATORUS)	4	93	0.04	0	110	0.00	0	112	0.00	0	63	0.00
Sutural Foramen (SUTFOR)	40	88	0.46	24	98	0.25	62	101	0.61	13	29	0.45
Mastoid Foramen (MASTFOR)	18	88	0.21	50	98	0.51	77	101	0.76	19	29	0.66
Occipital Foramen (OCCFOR)	2	88	0.02	7	98	0.07	9	101	0.09	4	29	0.14
Tympanic Dehiscence (TYMPDEH)	2	94	0.02	8	108	0.07	12	109	0.11	12	61	0.20
Post. Condylar Canal Patent (PCANAL)	12	54	0.22	35	69	0.51	24	87	0.28	9	33	0.27
Condylar Facet Double (CFACET)	0	84	0.00	0	90	0.00	2	100	0.02	1	50	0.02
Precondylar Tubercle (PRECTUB)	4	85	0.05	7	93	0.08	24	104	0.23	6	51	0.12
Paracondylar Process (PARAC)	*	*	*	*	*	*	45	91	0.50	4	27	0.15
Ant. Condylar Canal Double (ANTCAN)	19	76	0.25	33	96	0.34	34	106	0.32	18	56	0.32
Foramen Ovale Incomplete (FOVALE)	0	78	0.00	2	91	0.02	7	101	0.07	1	44	0.02
Foramen Spinosum Open (FSPINOS)	30	72	0.42	23	85	0.27	39	100	0.39	8	43	0.19
Pterygo-alar Spurs (PASPURS)	20	63	0.32	15	25	0.60	3	28	0.11	3	11	0.27
Pterygo-spinous Spurs (PSSPURS)	7	55	0.13	2	11	0.18	0	13	0.00	0	6	0.00
Palatal Suture (PSUTURE)	37	38	0.97	36	36	1.00	37	37	1.00	11	11	1.00
Acc. Lesser Palatine Foramen (PALATIN)	9	58	0.16	22	66	0.33	64	89	0.72	20	45	0.44
Palatine Torus (PTORUS)	7	44	0.16	4	47	0.09	7	49	0.14	3	36	0.08
Maxillary Torus (MAXTOR)	1	89	0.01	0	96	0.00	0	102	0.00	0	68	0.00
Zygomaxillary Tubercle (ZYGOMAX)	*	*	*	*	*	*	84	97	0.87	42	60	0.70
Marginal Tubercle (MARGTUB)	*	*	*	*	*	*	90	98	0.92	44	61	0.72
Zygomatico-facial Foramen (ZFACIAL)	56	80	0.70	67	87	0.77	74	98	0.76	54	62	0.87
Zygomatic Arch Suture (ZARCH)	2	77	0.03	2	82	0.02	0	98	0.00	0	60	0.00
Os Japonicum (OJAPON)	0	76	0.00	0	79	0.00	0	98	0.00	0	60	0.00
Supraorbital Foramen (SUPFOR)	54	92	0.59	46	103	0.45	53	116	0.46	39	68	0.57
Acc. Supraorbital Foramen (ACCSUP)	10	93	0.11	7	102	0.07	8	116	0.07	14	67	0.21
Metopism (METOPISM)	1	47	0.02	4	55	0.07	2	58	0.03	1	35	0.03
Frontal Foramen or Notch (FRONFOR)	17	93	0.18	12	100	0.12	19	116	0.16	4	68	0.06
Frontal Grooves (FGROOVE)	*	*	*	*	*	*	33	114	0.29	19	56	0.34
Ant. Ethmoid Foramen Exsutural (ANTETI	67	67	1.00	65	65	1.00	61	62	0.98	22	22	1.00
Posterior Ethmoid Foramen (POSETH)	48	61	0.79	44	47	0.94	54	59	0.92	21	21	1.00
Nasal Bone (NASAL)	0	44	0.00	1	48	0.02	3	41	0.07	1	14	0.07
Accessory Infraorbital Foramen (ACCINF)	12	84	0.14	10	83	0.12	10	93	0.11	13	48	0.27
Infraorbital Suture (INFRAO)	73	82	0.89	59	79	0.75	60	94	0.64	23	48	0.48
Accessory Mental Foramen (ACCMENT)	7	79	0.09	5	91	0.06	5	90	0.06	3	73	0.04
Rocker Jaw (ROCKER)	6	26	0.23	6	38	0.16	11	37	0.30	6	24	0.25
Mylohyoid Arch (MYLOHY)	18	75	0.24	5	91	0.06	5	85	0.06	9	67	0.13
Lingula Bridge (LINGULA)	30	77	0.39	16	84	0.19	5	85	0.06	3	67	0.05
Mandibular Torus (MTORUS)	0	82	0.00	0	99	0.00	0	87	0.00	0	70	0.00
Genial Tubercles (GENIAL TU)	*	*	*	*	*	*	40	46	0.87	30	36	0.83
Median Mental Spine (MMSPINE)	*	*	*	*	*	*	32	46	0.70	28	36	0.78
Genial Pits (GENIAL PI)	*	*	*	*	*	*	31	46	0.67	29	36	0.81

* - trait unobservable
† - bilateral trait frequency equals right plus left sides
n - number of sides present
N - total number of sides observable

Table 5.4 - Chi-squared Values of Sex Differences in Skeletal Samples

	ABYDOS							BADARI						
	Female		Male					Female		Male				
TRAITS	n	N	n	N	Chi-square	p	Fisher Exact	n	N	n	N	Chi-square	p	Fisher Exact
HNUCH	11	26	41	68	2.46	0.12	.	19	46	41	66	4.72	**0.03** †	.
OSSLAMDA	2	13	2	33	.	.	0.57	1	21	3	31	.	.	0.64
INCABONE	0	21	0	32	.	.	.	0	21	0	32	.	.	.
LSUTOSS	15	24	26	65	3.57	0.06	.	16	44	26	62	0.33	0.56	.
BSUTURE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ASTERIO	1	25	9	67	.	.	0.28	10	40	11	60	**0.30	0.58	.
PFORAM	11	26	28	68	0.01	0.92	.	16	44	35	65	3.22	0.07	.
OBFORAM	2	13	5	34	.	.	1.00	4	22	4	33	.	.	0.70
BREGMA	0	22	0	29	.	.	.	0	22	0	29	.	.	.
APICAL	0	22	0	31	.	.	.	0	22	0	31	.	.	.
COSS	1	23	2	62	.	.	0.30	2	34	3	59	.	.	1.00
OSSUTURE	2	10	1	26	.	.	0.18	1	20	1	26	.	.	1.00
EPIPTER	3	23	6	65	.	.	0.69	6	39	9	55	**0.00	1.00	.
FTART	22	22	62	64	.	.	1.00	20	30	39	48	**1.41	0.24	.
PNBONE	2	25	2	69	.	.	0.29	6	44	10	60	**0.02	0.88	.
PNOTCH	18	26	57	69	**1.31	0.25	.	23	44	41	60	2.77	0.10	.
OWORM	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ATORUS	0	23	4	70	.	.	0.57	0	44	0	64	.	.	.
SUTFOR	12	25	28	63	0.09	0.76	.	6	39	18	57	**2.43	0.12	.
MASTFOR	1	25	17	63	.	.	**0.02** †	20	39	28	57	0.04	0.84	.
OCCFOR	1	25	1	63	.	.	0.49	6	39	1	57	.	.	**0.02** †
TYMPDEH	0	25	2	69	.	.	1.00	2	43	6	63	.	.	0.47
PCANAL	4	13	8	41	.	.	0.45	14	28	20	39	0.01	0.92	.
CFACET	0	20	0	64	.	.	.	0	31	0	57	.	.	.
PRECTUB	3	22	1	63	.	.	**0.05** †	1	34	6	57	.	.	0.25
PARAC	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ANTCAN	4	19	15	57	.	.	0.77	10	38	13	56	**0.01	0.92	.
FOVALE	0	16	0	62	.	.	.	0	39	2	50	.	.	0.50
FSPINOS	6	14	24	58	**0.00	1.00	.	8	36	13	47	**0.10	0.76	.
PASPURS	2	13	18	50	.	.	0.20	4	9	9	14	.	.	0.42
PSSPURS	0	17	7	38	.	.	0.09	1	1	1	10	.	.	0.18
PSUTURE	9	10	28	28	.	.	0.26	13	13	22	22	.	.	.
PALATIN	4	16	5	42	.	.	0.24	7	26	15	38	**0.59	0.44	.
PTORUS	1	11	6	33	.	.	0.66	2	18	2	28	.	.	0.64
MAXTOR	1	22	0	67	.	.	0.25	0	38	0	56	.	.	.
ZYGOMAX	*	*	*	*	.	.	.	*	*	*	*	.	.	.
MARGTUB	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ZFACIAL	13	19	43	61	**0.00	1.00	.	25	34	42	51	**0.50	0.48	.
ZARCH	0	17	2	60	.	.	1.00	0	33	2	47	.	.	0.51
OJAPON	0	17	0	59	.	.	.	0	31	0	46	.	.	.
SUPFOR	14	24	40	68	**0.00	1.00	.	20	41	26	60	0.29	0.59	.
ACCSUP	4	24	6	69	.	.	0.28	0	42	7	58	.	.	**0.02** †
METOPISM	0	13	1	34	.	.	1.00	0	21	4	33	.	.	1.00
FRONFOR	2	24	15	69	.	.	0.22	5	41	7	57	.	.	1.00
FGROOVE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ANTETH	13	13	54	54	.	.	.	27	27	36	36	.	.	.
POSETH	9	12	39	49	.	.	0.71	19	19	24	27	.	.	0.26
NASAL	0	12	0	32	.	.	.	0	19	1	28	.	.	1.00
ACCINF	3	21	9	63	.	.	1.00	4	33	6	48	.	.	1.00
INFRAO	17	19	56	63	.	.	1.00	23	31	34	46	**0.00	1.00	.
ACCMENT	0	21	7	58	.	.	0.18	4	34	1	55	.	.	0.07
ROCKER	2	7	4	19	.	.	1.00	4	15	2	22	.	.	0.20
MYLOHY	5	21	13	54	.	.	1.00	2	34	3	55	.	.	1.00
LINGULA	6	20	24	57	**0.47	0.49	.	4	31	11	51	**0.48	0.49	.
MTORUS	0	22	0	60	.	.	.	*	*	*	*	.	.	.
GENIALTU	*	*	*	*	.	.	.	*	*	*	*	.	.	.
MMSPINE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
GENIALPI	*	*	*	*	.	.	.	*	*	*	*	.	.	.

n - number of right plus left sides present
N - number of right plus left sides observable
* - trait unobservable
** - Yates Corrected value
† - significant at the 0.05 probability level

Table 5.4 - Continued

	SJE 179							NAOADA						
	Female		Male					Female		Male				
TRAITS	n	N	n	N	Chi-square	p	Fisher Exact	n	N	n	N	Chi-square	p	Fisher Exact
HNUCH	2	32	4	34	.	.	0.67	0	40	2	78	.	.	0.55
OSSLAMDA	1	14	0	17	.	.	0.45	1	20	5	37	.	.	0.41
INCABONE	0	15	1	18	.	.	1.00	0	20	0	37	.	.	.
LSUTOSS	2	18	5	23	.	.	0.44	9	28	17	51	0.00	1.00	.
BSUTURE	1	26	0	28	.	.	0.48	0	39	4	71	.	.	0.30
ASTERIO	2	17	1	21	.	.	0.58	4	39	6	75	.	.	0.73
PFORAM	15	30	2	26	4.48	**0.03 †**	.	19	39	49	77	2.38	0.12	.
OBFORAM	2	15	1	13	.	.	1.00	3	19	0	36	.	.	**0.04 †**
BREGMA	0	13	0	16	.	.	.	0	19	0	36	.	.	.
APICAL	0	13	0	13	.	.	.	0	15	1	24	.	.	1.00
COSS	0	25	0	23	.	.	.	0	28	4	55	.	.	0.30
OSSUTURE	0	14	0	14	.	.	.	0	14	4	24	.	.	0.28
EPIPTER	2	16	2	14	.	.	1.00	8	34	4	65	.	.	**0.02 †**
FTART	14	16	9	13	.	.	0.36	35	35	65	65	.	.	.
PNBONE	1	16	1	18	.	.	1.00	6	39	2	72	.	.	**0.02 †**
PNOTCH	14	16	13	18	.	.	0.41	32	39	68	72	.	.	**0.05 †**
OWORM	0	15	1	13	.	.	0.46	4	34	0	68	.	.	**0.01 †**
ATORUS	0	27	0	33	.	.	.	0	37	0	75	.	.	.
SUTFOR	4	13	9	16	0.99	0.32	.	15	35	47	66	7.76	**0.01 †**	.
MASTFOR	7	13	12	16	.	.	0.27	25	35	52	66	0.68	0.41	.
OCCFOR	3	13	1	16	.	.	0.30	3	35	6	66	.	.	1.00
TYMPDEH	5	26	7	32	0.00	1.00	.	7	35	5	74	.	.	**0.05 †**
PCANAL	3	13	6	20	.	.	1.00	12	27	12	60	4.41	**0.04 †**	.
CFACET	0	20	1	26	.	.	1.00	0	37	2	63	.	.	0.53
PRECTUB	2	22	2	25	.	.	1.00	6	36	18	68	0.78	0.38	.
PARAC	2	11	2	16	.	.	1.00	11	35	34	56	7.39	**0.01 †**	.
ANTCAN	7	22	11	30	0.01	0.95	.	9	37	25	69	1.57	0.21	.
FOVALE	0	22	1	21	.	.	0.49	2	36	5	65	.	.	1.00
FSPINOS	5	21	3	21	.	.	0.70	14	36	25	64	0.00	0.99	.
PASPURS	1	7	2	4	.	.	0.49	1	13	2	15	.	.	1.00
PSSPURS	0	4	0	2	.	.	.	0	9	0	4	.	.	.
PSUTURE	6	6	5	5	.	.	.	15	15	22	22	.	.	.
PALATIN	7	21	13	24	1.22	0.27	.	24	37	40	52	1.56	0.21	.
PTORUS	1	16	2	19	.	.	1.00	2	17	5	32	.	.	1.00
MAXTOR	0	29	0	37	.	.	.	0	38	0	64	.	.	.
ZYGOMAX	17	27	23	31	0.41	0.52	.	29	34	55	63	.	.	0.77
MARGTUB	21	28	22	32	0.06	0.81	.	33	36	57	62	.	.	1.00
ZFACIAL	26	29	26	31	.	.	0.71	27	36	47	62	0.00	1.00	.
ZARCH	0	27	0	31	.	.	.	0	36	0	62	.	.	.
OJAPON	0	27	0	31	.	.	.	0	36	0	62	.	.	.
SUPFOR	16	29	22	35	0.39	0.53	.	16	40	37	76	0.80	0.37	.
ACCSUP	4	29	10	34	1.40	0.24	.	4	40	4	76	.	.	0.44
METOPISM	0	16	1	17	.	.	1.00	1	20	1	38	.	.	1.00
FRONFOR	2	29	2	35	.	.	1.00	2	40	17	76	4.57	**0.03 †**	.
FGROOVE	10	26	9	28	0.04	0.84	.	11	38	22	76	0.00	1.00	.
ANTETH	12	12	10	10	.	.	.	26	26	35	36	.	.	1.00
POSETH	11	11	10	10	.	.	.	23	24	31	35	.	.	0.64
NASAL	0	6	1	8	.	.	1.00	2	14	1	27	.	.	0.27
ACCINF	6	20	7	26	0.00	1.00	.	7	36	3	57	.	.	**0.04 †**
INFRAO	10	20	13	26	0.00	1.00	.	23	36	37	58	0.00	0.99	.
ACCMENT	3	38	0	29	.	.	0.25	1	36	4	54	.	.	0.64
ROCKER	4	13	1	10	.	.	0.34	6	15	5	22	.	.	0.30
MYLOHY	4	35	4	26	.	.	0.71	4	34	1	51	.	.	0.15
LINGULA	3	35	0	26	.	.	0.25	2	34	3	51	.	.	1.00
MTORUS	0	36	0	28	.	.	.	0	35	0	52	.	.	.
GENIALTU	13	19	14	14	.	.	**0.03 †**	14	18	26	28	.	.	0.19
MMSPINE	14	19	11	14	.	.	1.00	10	18	22	28	1.76	0.18	.
GENIALPI	16	19	11	14	.	.	1.00	10	18	21	28	1.10	0.29	.

n - number of right plus left sides present
N - number of right plus left sides observable
* - trait unobservable
** - Yates Corrected value
† - significant at the 0.05 probability level

Table 5.5 - Summary of Statistically Significant Sex Differences
Based on Chi-squared Analysis

Sample	Trait	Level of Significance	Trait Category	Sex w/ Highest Frequency
Abydos	MASTFOR	0.02	Foraminal	Male
	PRECTUB	0.05	Hyperostotic	Female
Badari	ACCSUP	0.02	Foraminal	Male
	OCCFOR	0.02	Unclassified	Female
	HNUCH	0.03	Hyperostotic	Male
Naqada	PARAC	0.01	Hyperostotic	Male
	OBFORAM	0.04	Foraminal	Female
	PNBONE	0.02	Acc. Ossicle	Female
	EPIPTER	0.02	Acc. Ossicle	Female
	PNOTCH	0.05	Acc. Ossicle	Male
	OWORM	0.01	Acc. Ossicle	Female
	SUTFOR	0.01	Unclassified	Male
	PCANAL	0.04	Hypostotic	Female
	FRONFOR	0.03	Foraminal	Male
	ACCINF	0.04	Foraminal	Female
	TYMPDEH	0.05	Hypostotic	Female
SJE 179	PFORAM	0.03	Foraminal	Female
	GENIALTU	0.03	Hyperostotic	Male

Table 5.6 - Chi-squared Values of Age Differences in Skeletal Samples

ABYDOS

	MALE							FEMALE						
	Y Adult		O Adult					Y Adult		O Adult				
TRAITS	n	N	n	N	Chi-square	p	Fisher Exact	n	N	n	N	Chi-square	p	Fisher Exact
HNUCH	19	30	4	12	**2.02	0.16	.	4	8	3	6	.	.	1.00
OSSLAMDA	1	15	1	5	.	.	0.45	1	4	0	3	.	.	1.00
INCABONE	0	15	0	6	.	.	.	0	4	0	3	.	.	.
LSUTOSS	14	30	3	9	.	.	0.70	5	6	5	6	.	.	1.00
BSUTURE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ASTERIO	5	30	3	12	.	.	0.67	0	7	0	6	.	.	.
PFORAM	13	30	5	12	**0.01	0.95	.	3	8	3	6	.	.	1.00
OBFORAM	5	15	0	6	.	.	0.26	1	4	1	3	.	.	1.00
BREGMA	0	14	0	5	.	.	.	0	3	0	3	.	.	.
APICAL	0	15	0	6	.	.	.	0	3	0	3	.	.	.
COSS	2	30	0	6	.	.	1.00	1	6	1	5	.	.	1.00
OSSUTURE	1	12	0	1	.	.	1.00	1	3	0	1	.	.	1.00
EPIPTER	3	27	1	12	.	.	1.00	1	5	0	6	.	.	0.46
FTART	27	27	12	12	.	.	.	6	6	4	4	.	.	.
PNBONE	1	29	0	12	.	.	1.00	0	8	0	6	.	.	.
PNOTCH	26	29	11	12	.	.	1.00	5	8	4	6	.	.	1.00
OWORM	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ATORUS	0	30	4	12	.	.	**0.00 †**	0	7	0	4	.	.	.
SUTFOR	14	28	5	10	**0.00	1.00	.	4	7	0	6	.	.	0.07
MASTFOR	8	28	2	10	.	.	0.70	1	7	0	6	.	.	1.00
OCCFOR	1	28	0	10	.	.	1.00	0	7	0	6	.	.	.
TYMPDEH	0	29	0	12	.	.	.	0	7	0	6	.	.	.
PCANAL	4	22	0	7	.	.	0.55	0	4	0	3	.	.	.
CFACET	0	29	0	10	.	.	.	0	5	0	6	.	.	.
PRECTUB	0	30	1	9	.	.	0.23	3	6	0	6	.	.	0.18
PARAC	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ANTCAN	3	23	5	11	.	.	0.08	1	5	1	4	.	.	1.00
FOVALE	0	26	0	12	.	.	.	0	4	0	2	.	.	.
FSPINOS	10	26	3	11	.	.	0.71	2	4	0	2	.	.	0.47
PASPURS	6	25	4	6	.	.	0.07	1	4	0	1	.	.	1.00
PSSPURS	4	16	0	5	.	.	0.53	0	4	0	3	.	.	.
PSUTURE	12	12	5	5	.	.	.	3	3	1	2	.	.	0.40
PALATIN	2	16	2	10	.	.	0.63	1	6	0	2	.	.	1.00
PTORUS	5	14	0	5	.	.	0.26	0	3	0	2	.	.	.
MAXTOR	0	29	0	10	.	.	.	0	6	1	4	.	.	0.40
ZYGOMAX	*	*	*	*	.	.	.	*	*	*	*	.	.	.
MARGTUB	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ZFACIAL	15	26	8	9	.	.	0.12	2	4	2	3	.	.	1.00
ZARCH	0	26	0	9	.	.	.	0	3	0	2	.	.	.
OJAPON	0	26	0	9	.	.	.	0	3	0	2	.	.	.
SUFFOR	21	29	6	12	.	.	0.28	2	8	3	4	.	.	0.22
ACCSUP	1	29	4	12	.	.	**0.02 †**	0	8	1	4	.	.	0.33
METOPISM	1	15	0	6	.	.	1.00	0	4	0	3	.	.	.
FRONFOR	5	29	0	12	.	.	0.30	1	8	0	4	.	.	1.00
FGROOVE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ANTETH	22	22	10	10	.	.	.	4	4	*	*	.	.	.
POSETH	17	21	6	8	.	.	1.00	1	4	*	*	.	.	.
NASAL	0	13	0	5	.	.	.	0	3	0	3	.	.	.
ACCINF	6	28	1	9	.	.	0.66	0	5	0	4	.	.	.
INFRAO	21	27	9	9	.	.	0.30	4	5	3	4	.	.	1.00
ACCMENT	1	24	2	10	.	.	0.20	0	7	0	3	.	.	.
ROCKER	0	8	1	3	.	.	0.27	0	1	0	2	.	.	.
MYLOHYO	6	22	2	10	.	.	1.00	0	7	1	4	.	.	0.36
LINGULA	14	22	3	10	.	.	0.13	0	6	3	4	.	.	**0.03 †**
MTORUS	0	24	0	10	.	.	.	0	8	0	4	.	.	.
GENIALTU	*	*	*	*	.	.	.	*	*	*	*	.	.	.
MMSPINE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
GENIALPI	*	*	*	*	.	.	.	*	*	*	*	.	.	.

* - trait unobservable
** - Yates Corrected value
Y Adult - < 40 years
O Adult - > 40 years

n - number of sides present
N - total number of sides observable
† - significant at the 0.05 probability level

Table 5.6 - Continued

BADARI

	MALE							FEMALE						
	Y Adult		O Adult					Y Adult		O Adult				
TRAITS	n	N	n	N	Chi-square	p	Fisher Exact	n	N	n	N	Chi-square	p	Fisher Exact
HNUCH	10	18	11	20	**0.00	1.00	.	7	22	10	16	**2.40	0.12	.
OSSLAMDA	0	9	1	8	.	.	0.47	0	10	1	7	.	.	0.41
INCABONE	0	9	0	9	.	.	.	0	10	0	7	.	.	.
LSUTOSS	7	18	6	16	**0.00	1.00	.	10	21	2	15	**3.21	0.07	.
BSUTURE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ASTERIO	4	17	2	15	.	.	0.66	6	19	2	13	.	.	0.42
PFORAM	10	18	9	19	**0.03	0.87	.	5	21	8	15	**2.15	0.14	.
OBFORAM	1	9	2	10	.	.	1.00	1	10	2	8	.	.	0.56
BREGMA	0	9	0	7	.	.	.	0	10	0	8	.	.	.
APICAL	0	9	0	8	.	.	.	0	10	0	8	.	.	.
COSS	3	17	0	14	.	.	0.23	0	19	2	7	.	.	0.07
OSSUTURE	0	7	0	6	.	.	.	1	10	0	6	.	.	1.00
EPIPTER	2	16	0	12	.	.	0.49	3	17	1	14	.	.	0.61
FTART	9	14	4	6	.	.	1.00	11	15	5	7	.	.	1.00
PNBONE	4	17	4	15	.	.	1.00	4	20	1	16	.	.	0.36
PNOTCH	14	17	10	15	.	.	0.42	12	20	4	16	**3.11	0.08	.
OWORM	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ATORUS	0	18	0	18	.	.	.	0	19	0	15	.	.	.
SUTFOR	5	17	3	16	.	.	0.69	1	18	2	12	.	.	0.55
MASTFOR	7	17	11	16	**1.54	0.22	.	12	18	3	12	**3.47	0.06	.
OCCFOR	0	17	1	16	.	.	0.49	1	18	4	12	.	.	0.13
TYMPDEH	0	17	0	18	.	.	.	2	19	0	15	.	.	0.49
PCANAL	9	14	4	9	.	.	1.00	9	13	4	8	.	.	0.65
CFACET	0	18	0	12	.	.	.	0	12	0	11	.	.	.
PRECTUB	1	18	0	14	.	.	1.00	0	16	1	12	.	.	0.43
PARAC	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ANTCAN	6	17	2	13	.	.	0.41	4	16	6	14	.	.	0.44
FOVALE	0	14	0	12	.	.	.	0	16	0	15	.	.	.
FSPINOS	3	14	3	11	.	.	1.00	7	14	0	14	.	.	**0.01** †
PASPURS	3	4	0	1	.	.	0.40	2	5	2	2	.	.	0.43
PSSPURS	*	*	0	2	.	.	.	1	1	*	*	.	.	.
PSUTURE	7	7	4	4	.	.	.	7	7	3	3	.	.	.
PALATIN	4	14	3	7	.	.	0.64	6	15	0	5	.	.	0.26
PTORUS	0	9	0	6	.	.	.	1	8	1	6	.	.	1.00
MAXTOR	0	18	0	10	.	.	.	0	15	0	14	.	.	.
ZYGOMAX	*	*	*	*	.	.	.	*	*	*	*	.	.	.
MARGTUB	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ZFACIAL	12	14	7	10	.	.	0.62	11	14	8	13	.	.	0.42
ZARCH	0	12	0	9	.	.	.	0	15	0	12	.	.	.
OJAPON	0	12	0	8	.	.	.	0	13	0	12	.	.	.
SUPFOR	2	18	9	15	**6.74	**0.01**†	.	6	17	8	14	**0.73	0.39	.
ACCSUP	2	18	3	13	.	.	0.63	0	18	0	14	.	.	.
METOPISM	1	9	1	10	.	.	1.00	0	9	0	8	.	.	.
FRONFOR	2	16	1	14	.	.	1.00	2	18	2	15	.	.	1.00
FGROOVE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
ANTETH	12	12	4	4	.	.	.	11	11	8	8	.	.	.
POSETH	6	9	3	3	.	.	0.51	11	11	5	5	.	.	.
NASAL	1	8	0	6	.	.	1.00	0	9	0	6	.	.	.
ACCINF	0	14	1	8	.	.	0.36	4	15	0	11	.	.	0.11
INFRAO	12	14	5	8	.	.	0.60	13	14	6	11	.	.	0.06
ACCMENT	0	16	0	12	.	.	.	0	13	0	12	.	.	.
ROCKER	1	5	0	5	.	.	1.00	2	7	1	5	.	.	1.00
MYLOHYO	0	15	0	13	.	.	.	0	13	0	12	.	.	.
LINGULA	3	14	4	11	.	.	0.66	2	12	2	11	.	.	1.00
MTORUS	0	16	0	15	.	.	.	0	14	0	14	.	.	.
GENIALTU	*	*	*	*	.	.	.	*	*	*	*	.	.	.
MMSPINE	*	*	*	*	.	.	.	*	*	*	*	.	.	.
GENIALPI	*	*	*	*	.	.	.	*	*	*	*	.	.	.

* - trait unobservable
** - Yates Corrected value
Y Adult - < 40 years
O Adult - > 40 years

n - number of sides present
N - total number of sides observable
† - significant at the 0.05 probability level

Table 5.6 - Continued

NAQADA

	MALE							FEMALE						
	Y Adult		O Adult					Y Adult		O Adult				
TRAITS	n	N	n	N	Chi-square	p	Fisher Exact	n	N	n	N	Chi-square	p	Fisher Exact
HNUCH	0	42	2	36	.	.	0.21	0	24	0	16	.	.	.
OSSLAMDA	2	20	3	17	.	.	0.64	1	12	0	8	.	.	1.00
INCABONE	0	20	0	17	.	.	.	0	12	0	8	.	.	.
LSUTOSS	9	29	8	32	**0.01	0.92	.	5	14	4	14	.	.	1.00
BSUTURE	2	39	2	32	.	.	1.00	0	23	0	16	.	.	.
ASTERIO	2	40	4	35	.	.	0.41	2	23	2	16	.	.	1.00
PFORAM	26	42	23	35	0.12	0.73	.	9	24	10	15	**2.08	0.15	.
OBFORAM	0	19	0	17	.	.	.	3	11	0	8	.	.	0.23
BREGMA	0	20	0	16	.	.	.	0	11	0	8	.	.	.
APICAL	1	16	0	8	.	.	1.00	0	9	0	6	.	.	.
COSS	4	33	0	22	.	.	0.14	0	14	0	14	.	.	.
OSSUTURE	3	16	1	8	.	.	1.00	0	8	0	6	.	.	.
EPIPTER	2	37	2	28	.	.	1.00	2	18	6	16	.	.	0.11
FTART	37	37	28	28	.	.	.	19	19	16	16	.	.	.
PNBONE	1	39	1	33	.	.	1.00	4	23	2	16	.	.	1.00
PNOTCH	39	39	29	33	.	.	**0.04** †	20	23	12	16	.	.	0.42
OWORM	0	36	0	32	.	.	.	3	18	1	16	.	.	0.60
ATORUS	0	41	0	34	.	.	.	0	21	0	16	.	.	.
SUTFOR	24	36	23	30	0.80	0.37	.	6	19	9	16	**1.27	0.26	.
MASTFOR	29	36	23	30	**0.01	0.93	.	15	19	10	16	.	.	0.45
OCCFOR	0	36	6	30	.	.	**0.01** †	2	19	1	16	.	.	1.00
TYMPDEH	5	40	0	34	.	.	0.06	4	22	3	13	.	.	1.00
PCANAL	7	32	5	28	**0.00	0.95	.	6	16	6	11	.	.	0.45
CFACET	2	35	0	28	.	.	0.50	0	21	0	16	.	.	.
PRECTUB	11	38	7	30	**0.06	0.81	.	4	20	2	16	.	.	0.67
PARAC	18	29	16	27	0.05	0.83	.	5	19	6	16	**0.12	0.73	.
ANTCAN	16	39	9	30	0.89	0.35	.	5	21	4	16	.	.	1.00
FOVALE	11	34	4	31	.	.	0.18	1	20	1	16	.	.	1.00
FSPINOS	14	35	11	29	0.03	0.87	.	10	20	4	16	**1.40	0.24	.
PASPURS	2	10	0	5	.	.	0.52	1	8	0	5	.	.	1.00
PSSPURS	0	2	0	2	.	.	.	0	7	0	2	.	.	.
PSUTURE	12	12	10	10	.	.	.	9	9	6	6	.	.	.
PALATIN	26	30	14	22	**2.61	0.11	.	10	21	14	16	**4.71	**0.03** †	.
PTORUS	2	18	3	14	.	.	0.63	1	10	1	7	.	.	1.00
MAXTOR	0	36	0	28	.	.	.	0	22	0	16	.	.	.
ZYGOMAX	30	34	25	29	.	.	1.00	19	19	10	15	.	.	**0.01** †
MARGTUB	31	34	26	28	.	.	1.00	19	21	14	15	.	.	1.00
ZFACIAL	24	34	23	28	**0.58	0.45	.	16	21	11	15	.	.	1.00
ZARCH	0	34	0	28	.	.	.	0	21	0	15	.	.	.
OJAPON	0	34	0	28	.	.	.	0	21	0	15	.	.	.
SUPFOR	23	42	14	34	1.39	0.24	.	10	24	6	16	**0.00	1.00	.
ACCSUP	4	42	0	34	.	.	0.12	1	24	3	16	.	.	0.28
METOPISM	1	21	0	17	.	.	1.00	1	12	0	18	.	.	1.00
FRONFOR	8	42	9	34	**0.25	0.62	.	2	24	0	16	.	.	0.51
FGROOVE	12	42	10	34	**0.00	1.00	.	8	22	3	16	.	.	0.30
ANTETH	20	20	15	16	.	.	0.44	12	12	14	14	.	.	.
POSETH	17	20	14	15	.	.	0.62	9	10	14	14	.	.	0.42
NASAL	1	13	0	14	.	.	0.48	1	7	1	7	.	.	1.00
ACCINF	1	32	2	25	.	.	0.58	4	20	3	16	.	.	1.00
INFRAO	21	32	16	26	**0.00	0.96	.	15	20	8	16	**1.45	0.23	.
ACCMENT	2	28	2	26	.	.	1.00	1	21	0	15	.	.	1.00
ROCKER	3	9	2	13	.	.	0.61	5	10	1	5	.	.	0.58
MYLOHYO	1	26	0	25	.	.	1.00	2	21	2	13	.	.	1.00
LINGULA	0	26	3	25	.	.	0.11	2	21	0	13	.	.	0.51
MTORUS	0	26	0	26	.	.	.	0	22	0	13	.	.	.
GENIALTU	14	15	12	13	.	.	1.00	8	11	6	7	.	.	1.00
MMSPINE	12	15	10	13	.	.	1.00	6	11	4	7	.	.	1.00
GENIALPI	11	15	10	13	.	.	1.00	7	11	3	7	.	.	0.63

* - trait unobservable
** - Yates Corrected value
Y Adult - < 40 years
O Adult - > 40 years

n - number of sides present
N - total number of sides observable
† - significant at the 0.05 probability level

Table 5.6 - Continued

NUBIA SJE 179

	MALE							FEMALE						
	Y Adult		O Adult					Y Adult		O Adult				
TRAITS	n	N	n	N	Chi-square	p	Fisher Exact	n	N	n	N	Chi-square	p	Fisher Exact
HNUCH	2	8	2	16	.	.	0.58	0	16	2	16	.	.	0.48
OSSLAMDA	0	4	0	9	.	.	.	0	6	1	8	.	.	1.00
INCABONE	0	4	1	9	.	.	1.00	0	7	0	8	.	.	.
LSUTOSS	3	6	2	15	.	.	0.12	2	6	0	12	.	.	0.10
BSUTURE	0	8	0	14	.	.	0.00	1	12	0	14	.	.	0.46
ASTERIO	0	5	1	14	.	.	1.00	1	7	1	10	.	.	1.00
PFORAM	5	8	14	16	.	.	0.29	9	14	6	16	.	.	0.27
OBFORAM	0	4	1	8	.	.	1.00	0	7	2	8	.	.	0.47
BREGMA	0	4	0	9	.	.	.	0	7	0	6	.	.	.
APICAL	0	4	0	8	.	.	.	0	6	0	7	.	.	.
COSS	0	6	0	17	.	.	.	0	13	0	12	.	.	.
OSSUTURE	0	4	0	9	.	.	.	0	7	0	7	.	.	.
EPIPTER	2	4	0	10	.	.	0.07	2	6	0	10	.	.	0.13
FTART	3	3	6	10	.	.	0.50	6	6	8	10	.	.	0.50
PNBONE	1	7	0	11	.	.	0.39	1	7	0	9	.	.	0.44
PNOTCH	5	7	8	11	.	.	1.00	7	7	7	9	.	.	0.48
OWORM	1	3	0	10	.	.	0.23	0	7	0	8	.	.	.
ATORUS	0	8	0	17	.	.	.	0	14	0	13	.	.	.
SUTFOR	2	4	7	10	.	.	0.58	3	7	1	6	.	.	0.56
MASTFOR	4	4	8	10	.	.	1.00	2	7	5	6	.	.	0.10
OCCFOR	0	4	1	10	.	.	1.00	0	7	3	6	.	.	0.07
TYMPDEH	2	8	2	16	.	.	0.58	2	14	3	12	.	.	0.64
PCANAL	4	6	2	11	.	.	0.11	2	7	1	6	.	.	1.00
CFACET	1	7	0	13	.	.	0.35	0	12	0	8	.	.	.
PRECTUB	0	6	2	16	.	.	1.00	0	14	2	8	.	.	0.12
PARAC	0	5	2	9	.	.	0.51	2	7	0	4	.	.	0.49
ANTCAN	4	8	5	15	.	.	0.66	3	13	4	9	.	.	0.38
FOVALE	0	6	1	12	.	.	1.00	0	11	0	11	.	.	.
FSPINOS	0	6	3	12	.	.	0.52	4	11	1	10	.	.	0.31
PASPURS	*	*	2	4	.	.	.	1	6	0	1	.	.	1.00
PSSPURS	*	*	0	2	.	.	.	0	4	*	*	.	.	.
PSUTURE	*	*	5	5	.	.	.	3	3	3	3	.	.	.
PALATIN	1	4	8	14	.	.	0.58	4	11	3	10	.	.	1.00
PTORUS	1	4	1	10	.	.	0.57	1	8	0	8	.	.	1.00
MAXTOR	0	8	0	20	.	.	.	0	14	0	15	.	.	.
ZYGOMAX	6	8	12	17	.	.	1.00	11	14	6	13	.	.	0.12
MARGTUB	6	8	16	18	.	.	0.56	14	15	7	13	.	.	0.03 †
ZFACIAL	8	8	14	17	.	.	0.53	14	15	12	14	.	.	0.60
ZARCH	0	8	0	17	.	.	.	0	14	0	13	.	.	.
OJAPON	0	8	0	17	.	.	.	0	14	0	13	.	.	.
SUPFOR	6	7	10	18	.	.	0.36	5	13	11	16	.	.	0.14
ACCSUP	1	7	5	18	.	.	0.64	2	13	2	16	.	.	1.00
METOPISM	0	4	1	9	.	.	1.00	0	18	0	8	.	.	.
FRONFOR	0	7	2	18	.	.	1.00	0	13	2	16	.	.	0.49
FGROOVE	0	8	6	17	.	.	0.13	7	14	3	12	.	.	0.25
ANTETH	2	2	8	8	.	.	.	6	6	6	6	.	.	.
POSETH	2	2	8	8	.	.	.	6	6	5	5	.	.	.
NASAL	1	2	0	5	.	.	0.29	0	2	0	4	.	.	.
ACCINF	1	6	6	16	.	.	0.62	1	10	5	10	.	.	0.14
INFRAO	4	6	6	16	.	.	0.35	7	10	3	10	.	.	0.18
ACCMENT	0	6	0	14	.	.	.	1	20	2	18	.	.	0.60
ROCKER	0	3	1	6	.	.	1.00	1	7	3	6	.	.	0.27
MYLOHYO	0	6	3	12	.	.	0.52	2	18	2	17	.	.	1.00
LINGULA	0	6	0	12	.	.	.	2	18	1	17	.	.	1.00
MTORUS	0	6	0	13	.	.	.	0	18	0	18	.	.	.
GENIALTU	3	3	7	7	.	.	.	6	10	7	9	.	.	0.63
MMSPINE	2	3	5	7	.	.	1.00	8	10	6	9	.	.	0.63
GENIALPI	2	3	7	7	.	.	0.30	9	10	7	9	.	.	0.58

* - trait unobservable
† - significant at the 0.05 probability level
Y Adult - < 40 yrs
O Adult - > 40 yrs

n - number of sides present
N - total number of sides observable

Table 5.7 - Summary of Statistically Significant Age Differences Based on Chi-squared Analysis

Sample&Sex	Trait	Level of Significance	Trait Category	Age Range w/ Highest Frequency
Abydos Males	ATORUS	0.00	Hyperostotic	Old Adult
	ACCSUP	0.02	Foraminal	Old Adult
Abydos Females	LINGULA	0.03	Hyperostotic	Young Adult
Badari Males	SUPFOR	0.01	Foraminal	Old Adult
Badari Females	FSPINOS	0.01	Hypostotic	Young Adult
Naqada Males	PNOTCH	0.04	Acc. Ossicle	Young Adult
	OCCFOR	0.01	Foraminal	Old Adult
Naqada Females	PALATIN	0.03	Hyperostotic	Old Adult
	ZYGOMAX	0.01	Hyperostotic	Young Adult
SJE179 Males	-	-	-	-
SJE179 Females	MARGTUB	0.03	Hyperostotic	Young Adult

Table 5.8 - Chi-squared and Phi Correlation Values of Bilateral Nonmetric Trait Analysis

ABYDOS

	MALES								FEMALES					
	Left		Right				Fisher	Side	Left		Right		Fisher	Side
	n	N	n	N	Chi-sqare	p	Exact	Correlation	n	N	n	N	Exact	Correlation
TRAITS														
HNUCH	21	34	20	34	****26.27**	**0.00†**	.	0.94	7	13	4	13	0.07	0.62
LSUTOSS	14	33	12	32	.	.	0.47	0.15	8	12	7	12	0.48	0.48
BSUTURE	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ASTERIO	4	34	5	33	.	.	**0.01 †**	0.62	1	13	0	12	.	.
PFORAM	11	34	17	34	**2.14	0.14	.	0.31	6	13	5	13	0.10	0.54
COSS	1	31	1	31	.	.	**0.03 †**	1	2	12	0	11	.	.
EPIPTER	3	31	3	34	.	.	0.19	0.36	2	12	1	11	1.00	-0.15
FTART	29	30	33	34	.	.	**0.03 †**	1	11	11	11	11	.	.
PNBONE	1	35	1	34	.	.	1.00	-0.03	1	13	1	12	1.00	-0.09
PNOTCH	29	35	28	34	.	.	**0.00 †**	0.6	10	13	8	13	1.00	-0.06
OWORM	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ATORUS	2	35	2	35	.	.	**0.00 †**	1	0	12	0	11	.	.
SUTFOR	16	33	12	30	.	.	0.47	0.15	6	13	6	12	0.08	0.67
MASTFOR	7	33	10	30	.	.	**0.03 †**	0.44	0	13	1	12	.	.
OCCFOR	0	33	1	30	.	.	.	.	0	13	1	12	.	.
TYMPDEH	1	35	1	34	.	.	**0.03 †**	1	0	13	0	12	.	.
PCANAL	5	23	3	18	.	.	0.12	0.47	1	5	3	8	0.25	1.00
CFACET	0	33	0	31	.	.	.	.	0	10	0	10	.	.
PRECTUB	1	32	0	31	.	.	.	.	1	11	2	11	0.18	0.67
PARAC	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ANTCAN	9	29	6	28	.	.	0.63	0.16	2	9	2	10	0.25	0.66
FOVALE	0	31	0	31	.	.	.	.	0	8	0	8	.	.
FSPINOS	11	28	13	30	.	.	**0.00 †**	0.84	2	7	4	7	0.43	0.55
PASPURS	9	24	9	26	.	.	1.00	0.1	1	8	1	5	.	.
PSSPURS	4	20	3	18	.	.	0.35	0.3	0	9	0	8	.	.
PALATIN	1	21	4	21	.	.	1.00	-0.12	2	8	2	8	0.46	0.33
MAXTOR	0	33	0	34	.	.	.	.	0	11	1	11	.	.
ZYGOMAX	*	*	*	*	.	.	.	.	*	*	*	*	.	.
MARGTUB	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ZFACIAL	22	30	21	31	.	.	0.08	0.36	6	9	7	10	0.23	0.50
ZARCH	1	30	1	30	.	.	**0.04 †**	1	0	9	0	8	.	.
OJAPON	0	29	0	30	.	.	.	.	0	9	0	8	.	.
SUPFOR	20	33	20	35	****8.25**	**0.00†**	.	0.56	6	12	8	12	0.55	0.35
ACCSUP	4	34	2	35	.	.	0.23	0.3	2	12	2	12	0.32	0.40
FRONFOR	7	34	8	35	.	.	**0.00 †**	0.75	0	12	2	12	.	.
FGROOVE	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ANTETH	26	26	28	28	.	.	.	.	7	7	6	6	.	.
POSETH	19	24	20	25	.	.	**0.05 †**	0.49	5	7	4	5	0.40	0.61
ACCINF	4	31	5	32	.	.	**0.00 †**	0.85	2	10	1	11	0.20	0.67
INFRAO	29	32	27	31	.	.	**0.04 †**	0.52	8	9	9	10	1.00	-0.13
ACCMENT	4	29	3	29	.	.	0.37	0.19	0	12	0	9	.	.
MYLOHYO	7	27	6	27	.	.	1.00	-0.05	2	11	3	10	1.00	0.22
LINGULA	13	28	11	29	.	.	**0.00 †**	0.6	4	11	2	9	0.17	0.60
MTORUS	0	30	0	30	.	.	.	.	0	11	0	11	.	.

* - trait unobservable
** - Yates Corrected value
† - significant at the 0.05 level
n - number of sides present
N - total number of sides observable

Table 5.8 - Continued

BADARI

	MALES								FEMALES					
	Left		Right				Fisher	Side	Left		Right		Fisher	Side
TRAITS	n	N	n	N	Chi-square	p	Exact	Correlation	n	N	n	N	Exact	Correlation
HNUCH	20	33	21	33	.	.	**0.00** †	0.81	11	23	8	23	**0.00** †	0.76
LSUTOSS	10	32	16	30	.	.	**0.00** †	0.61	9	23	7	21	**0.00** †	0.69
BSUTURE	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ASTERIO	6	29	5	31	.	.	0.27	0.22	7	21	3	19	0.11	0.49
PFORAM	19	33	16	32	**1.14	0.29	.	0.25	7	23	9	21	0.12	0.42
COSS	2	29	1	30	.	.	0.07	0.69	0	18	2	16	.	.
EPIPTER	3	26	6	29	.	.	**0.05** †	0.52	2	19	4	20	**0.01** †	1.00
FTART	20	24	19	24	.	.	**0.00** †	1.00	9	13	11	17	**0.00** †	1.00
PNBONE	5	28	5	32	.	.	1.00	0.08	4	23	2	21	0.35	0.26
PNOTCH	19	28	22	32	.	.	0.21	0.29	11	23	12	21	**0.03** †	0.52
OWORM	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ATORUS	0	32	0	32	.	.	.	.	0	22	0	22	.	.
SUTFOR	9	30	9	27	.	.	0.67	0.13	4	20	2	19	1.00	-0.18
MASTFOR	13	30	15	27	.	.	1.00	0.67	11	20	9	19	**0.04** †	0.63
OCCFOR	1	30	0	27	.	.	.	.	3	20	3	19	0.49	0.18
TYMPDEH	3	31	3	32	.	.	**0.00** †	1.00	1	21	1	22	**0.05** †	1.00
PCANAL	11	20	9	19	.	.	0.06	0.52	7	14	7	14	0.08	0.63
CFACET	0	28	0	29	.	.	.	.	0	14	0	17	.	.
PRECTUB	4	28	2	29	.	.	**0.02** †	0.68	0	16	1	18	.	.
PARAC	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ANTCAN	8	28	5	28	.	.	1.00	-0.10	6	18	4	20	**0.01** †	0.76
FOVALE	2	26	0	24	.	.	.	.	0	19	0	22	.	.
FSPINOS	8	25	5	22	.	.	0.29	0.30	4	18	4	18	**0.01** †	0.83
PASPURS	5	8	4	6	.	.	1.00	0.58	1	4	3	5	.	.
PSSPURS	0	4	1	6	.	.	.	.	*	*	*	*	.	.
PALATIN	7	19	8	19	.	.	0.60	0.15	4	13	3	13	0.24	0.41
MAXTOR	0	28	0	28	.	.	.	.	0	18	0	20	.	.
ZYGOMAX	*	*	*	*	.	.	.	.	*	*	*	*	.	.
MARGTUB	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ZFACIAL	20	25	22	26	.	.	1.00	-0.20	14	17	11	17	0.14	0.48
ZARCH	1	22	1	25	.	.	**0.05** †	1.00	0	17	0	16	.	.
OJAPON	0	21	0	25	.	.	.	.	0	16	0	15	.	.
SUPFOR	13	30	13	30	**0.51	0.48	.	0.21	10	22	10	19	1.00	0.11
ACCSUP	3	29	4	29	.	.	**0.05** †	0.52	0	23	0	19	.	.
FRONFOR	3	29	4	28	.	.	**0.00** †	0.80	2	22	3	19	**0.02** †	0.79
FGROOVE	*	*	*	*	.	.	.	.	*	*	*	*	.	.
ANTETH	19	19	17	17	.	.	.	.	14	14	13	13	.	.
POSETH	13	14	11	13	.	.	0.20	0.67	11	11	8	8	.	.
ACCINF	4	22	2	26	.	.	**0.03** †	0.67	1	17	3	16	0.23	0.53
INFRAO	17	23	17	23	.	.	**0.00** †	0.88	8	12	15	19	0.38	0.38
ACCMENT	0	28	1	27	.	.	.	.	2	17	2	17	0.10	1.00
MYLOHYO	2	27	1	28	.	.	0.08	0.69	1	18	1	16	0.07	1.00
LINGULA	5	25	6	26	.	.	**0.00** †	0.87	2	15	2	16	0.30	0.41
MTORUS	0	30	0	29	.	.	.	.	0	19	0	19	.	.

* - trait unobservable
** - Yates Corrected value
† - significant at the 0.05 level
n - number of sides present
N - total number of sides observable

Table 5.8 - Continued

NAQADA

	MALES								FEMALES					
	Left		Right				Fisher	Side	Left		Right		Fisher	Side
	n	N	n	N	Chi-square	p	Exact	Correlation	n	N	n	N	Exact	Correlation
TRAITS														
HNUCH	1	39	1	39	.	.	**0.03 †**	1.00	0	20	0	20	.	.
LSUTOSS	10	26	7	25	.	.	**0.00 †**	0.64	4	14	5	14	0.10	0.52
BSUTURE	2	35	2	36	.	.	**0.00 †**	1.00	0	9	0	20	.	.
ASTERIO	2	37	4	38	.	.	**0.01 †**	0.69	2	19	2	20	0.21	0.44
PFORAM	25	39	24	38	**5.43	**0.02†**	**0.01 †**	0.44	8	19	11	20	**0.02 †**	0.60
COSS	2	27	2	28	.	.	**0.00 †**	1.00	0	14	0	14	.	.
EPIPTER	2	31	2	34	.	.	**0.00 †**	1.00	3	16	5	18	0.21	0.37
FTART	31	31	34	34	.	.	.	.	17	17	18	18	.	.
PNBONE	0	35	2	37	.	.	.	.	3	19	3	20	**0.00 †**	1.00
PNOTCH	33	35	35	37	.	.	**0.00 †**	1.00	16	19	16	20	**0.00 †**	0.84
OWORM	0	33	0	35	.	.	.	.	3	16	1	18	0.19	0.54
ATORUS	0	37	0	38	.	.	.	.	0	18	0	19	.	.
SUTFOR	21	32	26	34	.	.	**0.01 †**	0.49	7	17	8	18	0.64	0.17
MASTFOR	26	32	26	34	.	.	0.15	0.28	13	17	12	18	**0.05 †**	0.56
OCCFOR	3	32	3	34	.	.	**0.00 †**	1.00	0	17	3	18	.	.
TYMPDEH	3	37	2	37	.	.	**0.00 †**	1.00	5	18	2	17	**0.04 †**	0.66
PCANAL	5	29	7	31	.	.	**0.00 †**	0.67	5	13	7	14	0.10	0.54
CFACET	1	31	1	32	.	.	**0.03 †**	1.00	0	19	0	18	.	.
PRECTUB	10	34	8	34	.	.	**0.00 †**	0.86	3	18	3	18	**0.00 †**	1.00
PARAC	16	26	18	30	.	.	**0.00 †**	0.92	6	18	5	17	**0.00 †**	1.00
ANTCAN	10	34	15	35	.	.	0.25	0.25	5	19	4	18	**0.04 †**	0.56
FOVALE	3	31	2	34	.	.	**0.01 †**	0.80	1	18	1	18	1.00	-0.07
FSPINOS	14	30	11	34	.	.	0.06	0.38	8	18	6	18	0.12	0.52
PASPURS	1	8	1	7	.	.	0.20	1.00	0	5	1	8	.	.
PSSPURS	0	2	0	2	.	.	.	.	0	4	0	5	.	.
PALATIN	21	26	19	26	.	.	**0.05 †**	0.49	12	18	12	19	**0.00 †**	0.89
MAXTOR	0	31	0	33	.	.	.	.	0	19	0	19	.	.
ZYGOMAX	27	31	28	32	.	.	**0.00 †**	1.00	14	16	15	18	0.01†	1.00
MARGTUB	28	31	29	31	.	.	**0.00 †**	1.00	16	17	17	19	0.06	1.00
ZFACIAL	22	31	25	31	.	.	**0.03 †**	0.45	12	17	15	19	**0.05 †**	0.56
ZARCH	0	31	0	31	.	.	.	.	0	17	0	19	.	.
OJAPON	0	31	0	31	.	.	.	.	0	17	0	19	.	.
SUPFOR	17	38	20	38	**18.33	**0.00†**	.	0.75	6	20	10	20	**0.01 †**	0.66
ACCSUP	3	38	1	38	.	.	1.00	-0.05	2	20	2	20	0.20	0.44
FRONFOR	8	38	9	38	.	.	**0.00 †**	0.93	1	20	1	20	**0.05 †**	1.00
FGROOVE	10	38	12	38	.	.	**0.01 †**	0.49	6	19	5	19	**0.02 †**	0.62
ANTETH	17	17	18	19	.	.	.	.	12	12	14	14	.	.
POSETH	15	16	16	19	.	.	0.13	0.68	11	12	12	12	.	.
ACCINF	2	29	1	28	.	.	0.08	0.69	4	17	3	19	**0.01 †**	0.84
INFRAO	21	29	16	29	.	.	**0.00 †**	0.72	12	18	11	18	**0.01 †**	0.74
ACCMENT	2	26	2	28	.	.	1.00	-0.09	1	19	0	17	.	.
MYLOHYO	5	22	0	24	.	.	.	.	2	16	2	18	**0.01 †**	1.00
LINGULA	1	27	2	24	.	.	0.09	0.69	1	16	1	18	0.07	1.00
MTORUS	1	27	0	25	.	.	.	.	0	17	0	18	.	.

* - trait unobservable

** - Yates Corrected value

† - significant at the 0.05 level

n - number of sides present

N - total number of sides observable

Table 5.8 - Continued

SJE 179

	MALES						FEMALES					
	Left		Right		Fisher Exact	Side Correlation	Left		Right		Fisher Exact	Side Correlation
	n	N	n	N			n	N	n	N		
TRAITS												
HNUCH	2	17	2	17	**0.01** †	1.00	1	16	1	16	0.06	1.00
LSUTOSS	2	12	3	11	0.49	0.24	1	10	1	8	1.00	-0.14
BSUTURE	0	15	0	13	.	.	0	13	1	13	.	.
ASTERIO	0	11	1	10	.	.	1	9	1	8	1.00	-0.14
PFORAM	10	13	11	13	**0.04** †	0.78	8	15	7	15	**0.04** †	0.61
COSS	0	12	0	11	.	.	0	13	0	12	.	.
EPIPTER	1	9	1	5	0.20	1.00	1	8	1	8	0.13	1.00
FTART	6	8	3	5	0.10	1.00	7	8	7	8	0.13	1.00
PNBONE	0	10	1	8	.	.	1	9	0	7	.	.
PNOTCH	7	10	6	8	**0.05** †	1.00	8	9	6	7	0.14	1.00
OWORM	1	8	0	5	.	.	0	8	0	7	.	.
ATORUS	0	17	0	16	.	.	0	14	0	13	.	.
SUTFOR	5	9	4	7	0.14	0.75	2	7	2	6	1.00	-0.31
MASTFOR	7	9	5	7	0.29	0.65	3	7	4	6	1.00	0.00
OCCFOR	0	9	1	7	.	.	2	7	1	6	0.33	0.63
TYMPDEH	4	16	3	16	**0.00** †	1.00	3	14	2	12	**0.02** †	1.00
PCANAL	4	10	2	10	0.17	0.60	2	8	1	5	1.00	0.58
CFACET	1	13	0	13	.	.	0	11	0	9	.	.
PRECTUB	1	13	1	12	0.08	1.00	1	11	1	11	0.09	1.00
PARAC	1	9	1	7	0.14	1.00	1	5	1	6	0.26	1.00
ANTCAN	7	16	4	14	0.58	0.19	5	11	2	11	1.00	0.00
FOVALE	1	10	0	11	.	.	0	12	0	10	.	.
FSPINOS	3	10	0	11	.	.	2	12	3	9	0.25	0.66
PASPURS	1	2	1	2	.	.	0	5	1	2	.	.
PSSPURS	*	*	*	*	.	.	0	2	0	2	.	.
PALATIN	6	11	7	13	1.00	0.07	4	11	3	10	0.53	0.32
MAXTOR	0	18	0	19	.	.	0	14	0	15	.	.
ZYGOMAX	12	15	11	16	**0.00** †	1.00	8	13	9	14	**0.00** †	1.00
MARGTUB	11	16	11	16	**0.00** †	1.00	10	14	11	14	0.20	0.43
ZFACIAL	11	15	15	16	0.31	0.43	13	15	13	14	0.14	0.68
ZARCH	0	15	0	16	.	.	0	13	0	14	.	.
OJAPON	0	15	0	16	.	.	0	13	0	14	.	.
SUPFOR	11	17	11	18	**0.00** †	1.00	8	15	8	14	**0.03** †	0.68
ACCSUP	6	17	4	17	0.55	0.23	3	15	1	14	0.23	0.53
FRONFOR	1	17	1	18	0.06	1.00	1	15	1	14	0.08	1.00
FGROOVE	4	15	5	13	0.13	0.54	6	13	4	13	0.27	0.38
ANTETH	5	5	5	5	.	.	6	6	6	6	.	.
POSETH	5	5	5	5	.	.	5	5	6	6	.	.
ACCINF	4	14	3	12	0.15	0.54	4	12	2	8	**0.05** †	1.00
INFRAO	9	14	4	12	0.55	0.31	6	12	4	8	0.14	0.75
ACCMENT	0	14	0	15	.	.	1	19	2	19	0.11	0.69
MYLOHYO	2	12	2	14	0.18	0.67	2	17	2	18	**0.01** †	1.00
LINGULA	0	12	0	14	.	.	1	17	2	18	0.06	1.00
MTORUS	0	13	0	15	.	.	0	18	0	18	.	.

* - trait unobservable
** - Yates Corrected value
† - significant at the 0.05 level
n - number of sides present
N - total number of sides observable

Table 5.9 - Results of Chi-squared and Phi Correlation Analysis

Sample&Sex	Number of Traits Showing Significant Side Dependence*	%	Number of Perfect Side Correlations (r =1)*	%
Abydos Males	16/31	51.6	5/30	16.7
Abydos Females	0/20	00.0	1/20	5.0
Badari Males	12/28	42.9	3/28	10.7
Badari Females	10/24	41.7	5/24	20.8
Naqada Males	24/33	72.7	11/33	33.3
Naqada Females	17/28	60.7	8/28	28.6
SJE 179 Males	7/24	29.2	11/24	45.8
SJE 179 Females	6/29	20.7	12/29	41.4

* - Number of traits out of the total number of traits observable ($p < 0.05$)

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CHAPTER 6

THE BIOLOGICAL AFFINITIES OF THREE NAQADA CEMETERY SAMPLES ON THE BASIS OF CRANIAL NONMETRIC TRAIT ANALYSIS

Introduction

Traditionally, studies on the biological relationships of the ancient Egyptians have focused on the racial origins of Egyptian civilization. These studies were mainly concerned with assessing the amount of 'Negroid' influence on measurable physical characteristics of Egyptian skeletal samples (e.g., Batrawi, 1935, 1945, 1946; Crichton, 1966; Elliot-Smith 1915; Fawcett and Lee, 1902; Giuffrida-Ruggeri, 1915; Morant 1925, 1935; Pearson, 1896; Thomson and MacIver, 1905; Warren, 1897). Recent anthropological research, however, has shifted away from racial typological studies of human variation to investigations of biological affinities based on evolutionary principles (i.e., genetic drift, gene flow and natural selection). Recent studies have used both metrical and nonmetrical analysis of human skeletal samples to investigate the biological relationships of ancient populations in the Nile Valley (e.g., Berry and Berry, 1972; Berry et al., 1967; Brace et al., 1993; Greene, 1972, 1982; Keita, 1990, 1992; Reggio et al., 1969). The Naqada skeletal material has been used in a number of studies on the biological affinities of the ancient Egyptians (e.g., Berry and Berry, 1972; Berry et al., 1967; Brace et al., 1993; Crichton, 1966; Keita, 1990, 1992; Wiercinski, 1965, 1978), however, intrasite analysis of biological variation at Naqada has only recently been undertaken (e.g., Johnson and Lovell, 1994).

Radiocarbon estimates date the Predynastic period to approximately 4400-3050 BC (Hassan, 1988)[1]. It was during this time, prior to the political unification of Upper and Lower Egypt (ca. 3050 BC), that significant cultural changes occurred in the Nile Valley. The Predynastic period is characterized by a number of significant innovations including the development of sedentary agricultural communities, the establishment of foreign trade relations, and increased political and social complexity. Recent studies have examined the evolution of social complexity in Predynastic Egypt, largely based on evidence from sites in Upper Egypt including Naqada (Anderson, 1992; Bard, 1989, 1992; Hassan, 1988). Evidence for a well established social hierarchy early in the Dynastic period can be seen in the wide range of burial styles during Archaic period, from the elaborate royal tombs of First and Second Dynasty kings at Abydos, to the simple pit graves of commoners at Abu Roash, Naga-ed-Der and Saqqara (Bard, 1989). It is suggested that this high degree of social stratification had its origins during the Predynastic period (Trigger, 1983).

The Predynastic site of Naqada is located on the west bank of the Nile in Upper Egypt (Figure 6.1). Excavations by Petrie in 1894 and 1895 uncovered two settlement sites, and three cemeteries which contained well over two thousand burials (Petrie and Quibell, 1896). Petrie later developed a method of sequence dating for the Predynastic period based on the evolution of pottery forms from Naqada, Ballas and Diospolis Parva (Petrie, 1900, 1901). The three cemeteries excavated by Petrie at Naqada were identified as Cemetery B (named after the nearby mound of Kom Belal), Cemetery T (named for its location near two tumuli), and the Great Cemetery. The Great Cemetery was originally identified by Petrie as the location of the burials of the 'Great New Race' that had entered Egypt at the end of the Old Kingdom period (Petrie and Quibell, 1896), although this theory was subsequently disproved (De Morgan, 1897). The individuals in Cemetery T were identified as an elite segment of the population, based on the comparatively fewer number of burials, their larger size, and the greater number and higher quality of grave goods within each burial (Petrie and Quibell, 1896). Petrie first suggested that the

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[1] This date does not include Neolithic sites from Lower Egypt.

comparatively richer Cemetery T burials could be explained by the existence of a wealthy segment of the population at Naqada (Petrie and Quibell, 1896). More recent comparisons of the burial goods found within each cemetery have also led to suggestions that Cemetery T represents a distinct social class or ruling elite (Bard, 1989, 1992; Davis, 1983). Structural and stylistic comparisons of the 'Decorated Tomb' at Hierakonpolis with some of the larger tombs in Cemetery T, as well as an intrasite comparison of tombs at Naqada, have led to the hypothesis that this was the burial place of Predynastic chiefs or kings (Case and Payne, 1962; Castillos, 1981; Kemp, 1973). Archaeological evidence suggests that Naqada was a religious and political center during the Predynastic period and was in control of local resources and trade relations (Hassan, 1988; Trigger, 1983). This would have required the development of an administrative or managerial elite to control access to these resources (Bard, 1989; Hassan, 1988). Further evidence for social stratification at Naqada was uncovered at the settlement site of South Town with the discovery of large 'palatial' houses dated to the late Predynastic period (Hassan, 1988).

It is apparent from the archaeological evidence that Cemetery T represents a distinct segment of the population at Naqada. The question arises whether this social differentiation is simply the result of cultural differences (e.g., material wealth), or is perhaps due to biological differences as well. Evidence for the biological discontinuity of Cemetery T from the Great Cemetery and Cemetery B has been found in a recent analysis of dental nonmetric trait variation, and it was proposed that the individuals in Cemetery T represent a biologically distinct, elite segment of the population, due to preferential inbreeding within a high status group (Johnson and Lovell, 1994). The present study uses cranial nonmetric traits to assess the biological affinities among the cemeteries at Naqada within the context of social differentiation during the Predynastic period, and particularly in light of the recent findings by Johnson and Lovell (1994).

Materials and Methods

The three skeletal samples used in this study consist of 35 crania from Cemetery B, 63 crania from the Great Cemetery, and 37 crania from Cemetery T. Standard gross morphological features of the cranium were used to determine sex (according to Bass, 1987; Brothwell, 1972; Ubelaker, 1989; White, 1991). The degree of ectocranial suture closure was used to determine age at death (after Meindl and Lovejoy, 1985). Incomplete or fragmentary crania were aged based on the degree of tooth wear (after Lovejoy, 1985).[2] Age and sex distribution of the Naqada skeletal samples is presented in Table 6.1. Age and sex correlations with nonmetric trait frequencies were tested in a previous study (Chapter 5). In general, no significant correlations were found, therefore all age and sex categories are pooled in this analysis. While intertrait correlations were not directly tested in this study, previous research has found levels of correlations between traits to be approximately equal to the number of correlations expected to occur due to random variation caused by independent factors (Berry and Berry, 1967; Corruccini, 1974; Saunders, 1978, 1989; Sjøvold, 1973, 1977). Sjøvold (1977) demonstrated that intertrait correlations were a function of sample size, and concluded that the small size of most skeletal samples would minimize any effects due to intertrait correlations.

Data on fifty-eight cranial nonmetric traits were collected in 1992 at the Department of Biological Anthropology, Cambridge University, England. The traits were selected from the following sources; Berry and Berry (1967), Brothwell (1972), Buikstra (1976), Hauser and De Stefano, (1989), Ossenberg (1970), and Rose et al. (1991). Bilateral traits were scored using the side count method, and partial trait manifestations were scored as

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[2] Lovejoy's (1985) tooth wear scoring method was modified for the Egyptian cranial samples due to the comparatively lesser degree of anterior tooth wear observed in the Egyptian skeletal material (N. Lovell, personal communication).

present. All data were collected by one observer (M. Bartell). Intraobserver error was minimized through the use of standardized scoring procedures aided by a data collection manual, composed of trait descriptions and illustrations. Molto (1979) tested the effects of intraobserver error on nonmetric trait frequencies, and concluded that most errors in data collection were random and could be reduced to acceptable levels if standardized methods were used. Ten nonmetric traits were eliminated from the final statistical analysis based on the exclusion of those traits that were absent in at least two of the skeletal samples, as well as those traits with 100% frequency in all samples, thus reducing the final data set to forty-eight traits.

Nonmetric trait frequencies were arcsine transformed using the Freeman and Tukey transformation for small sample sizes, as recommended by Green and Suchey (1976):

$$\phi = \frac{1}{2}\sin^{-1}[1 - 2(k/n+1)] + \frac{1}{2}\sin^{-1}[1 - 2(k+1/n+1)]$$

k = total number of sides present
n = total number of sides observable

Biological distances between the three skeletal samples were calculated using the multivariate Mean Measure of Divergence statistic (MMD). Each MMD value, its variance, and standard deviation were calculated according to Green and Suchey (1976) and Sjøvold (1973):

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

$$\mathrm{var\ MMD} = \frac{2}{r^2}\sum_{i=1}^{r} \left[\frac{1}{n_{1i}+1/2} + \frac{1}{n_{2i}+1/2}\right]^2$$

$$\mathrm{sd\ MMD} = \mathrm{var\ MMD}$$

ϕ_{1i} = the transformed frequency of the *ith* trait in sample 1
ϕ_{2i} = the transformed frequency of the *ith* trait in sample 2
n_{1i} = the number of sides observed for the *ith* trait in sample 1
n_{2i} = the number of sides observed for the *ith* trait in sample 2
r = the number of traits

An MMD value was considered significant at the 0.05 probability level if that value exceeded twice its standard deviation. It is recommended, however, that standardized MMD values be used when comparing samples of different sizes (Hemphill et al., 1991; Sofaer et al., 1986), such as is the case in this study. Standardized MMD values were calculated by dividing each raw MMD score by its standard deviation. Standardized MMD values greater than 2.0 are considered statistically significant (p=0.05) (Sjøvold, 1973).

Results

Nonmetric trait frequencies of the pooled age and sex samples are presented in Table 6.2. Table 6.3 presents the raw MMD distance, as well as the variation, standard deviation, and standardized MMD scores for each pairwise comparison. The values of the standardized MMD's in Table 6.3 indicate that Cemetery B and the Great Cemetery are not statistically differentiated from each other (MMD = 1.363). There are significant differences, however, between both of these samples and Cemetery T. The largest MMD value (2.847) is between Cemetery T and Cemetery B. The difference between Cemetery T and the Great Cemetery is also statistically significant (MMD = 2.033).

Discussion

The results of this analysis indicate that Cemetery T is biologically distinct from the other two cemeteries at Naqada, on the basis of cranial nonmetric traits. Additionally, these results show that Cemetery B and the Great Cemetery are a biologically homogeneous group. These findings support a recent study of the Naqada cemeteries by Johnson and Lovell (1994), in which it was found that Cemetery T was biologically differentiated from Cemetery B, and nearly so from the Great Cemetery based, on the analysis of eleven nonmetric traits of the dentition. The results of the present cranial nonmetric trait analysis clearly differentiate Cemetery T from the other two cemeteries. Johnson and Lovell (1994) concluded that dental microevolution could not account for the differences between the cemeteries, and further argued that the similarity in the styles of grave goods among all the cemeteries excluded the possibility of Cemetery T representing an immigrant population. It was therefore concluded that Cemetery T was biologically distinct due to inbreeding within an elite segment of the local population. Although Johnson and Lovell (1994) noted that the small number of dental traits available for their analysis may have affected the reliability of their results, the present study corroborates their findings using a much larger sample of forty-eight cranial nonmetric traits. Even though the standardized MMD values in this study are statistically significant, the magnitude of those distances is not as large as would be expected if Cemetery T represented a foreign immigrant population. Therefore, a hypothesis of selective inbreeding (i.e., genetic drift) within a local elite segment of the population is the most parsimonious explanation for the biological distinction of Cemetery T, based on the available biological and archaeological evidence.

Conclusions

Cranial nonmetric trait analysis of the biological affinities among three cemeteries at Naqada demonstrate convincingly that the elite cemetery, Cemetery T, is biologically distinct from the other two, nonelite, cemeteries, Cemetery B and the Great Cemetery. These results confirm similar findings based on dental nonmetric trait analysis of the same skeletal material (Johnson and Lovell, 1994). Thus, the archaeological evidence for the social differentiation of Cemetery T, based on the greater material wealth of these burials, can be explained by the existence of an elite, distinct segment of the population. Although significant, the relatively small magnitude of the MMD values between Cemetery T and the other two cemeteries suggests that Cemetery T was not an immigrant population, but rather an elite segment of the population at Naqada who were biologically differentiated through selective inbreeding within a social group.

Figure 6.1 - Map of Egypt and Nubia Showing the Location of the Predynastic site of Naqada.

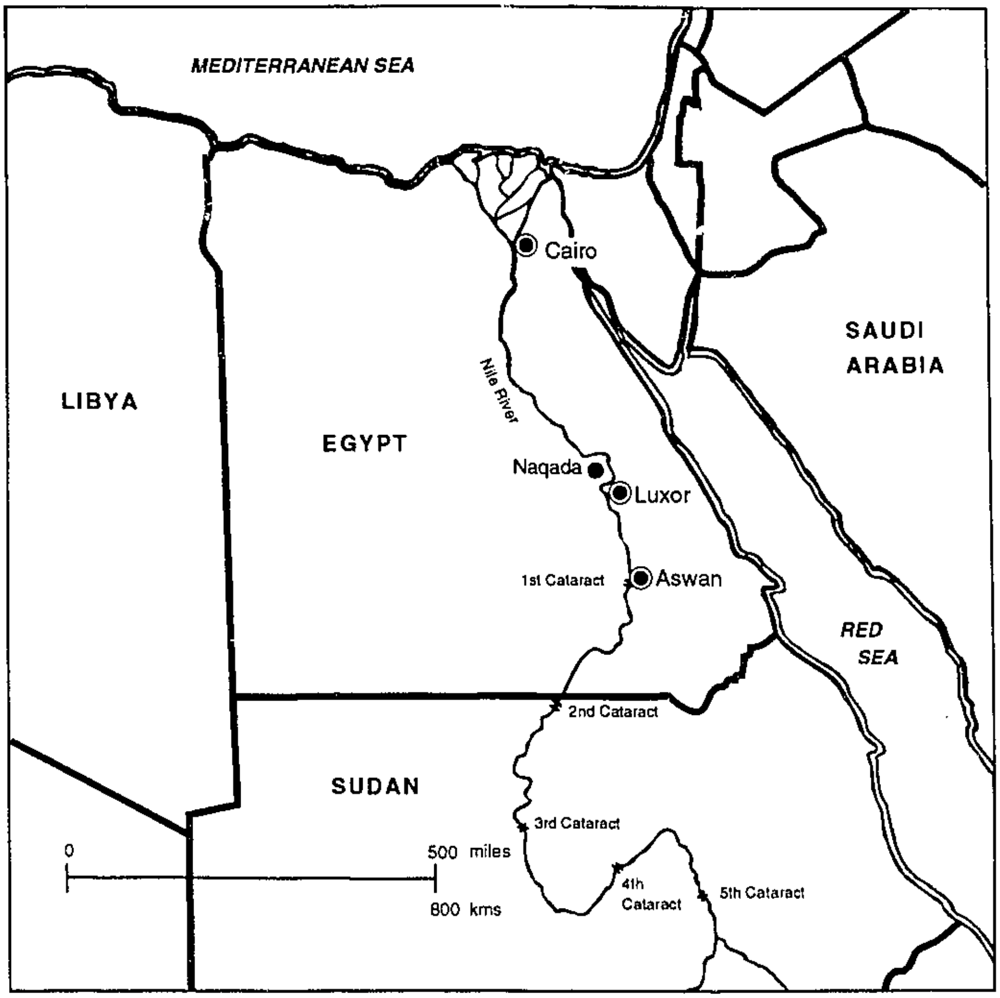

Table 6.1 - Age and Sex Distribution of the Naqada Skeletal Samples

		AGE				
		Young Adult (21-30 years)	Middle Adult (31-40 years)	Old Adult (> 40 years)	Adult (Indeterminate Age)	Total
		n	n	n	n	n
SITE						
Cemetery B	- female	2	1	4	1	8
	- male	2	9	9	1	21
	- unknown	0	2	4	0	6
Cemetery T	- female	1	10	4	2	17
	- male	0	5	12	3	20
	- unknown	0	0	0	0	0
Great Cemetery	- female	4	7	11	0	22
	- male	5	16	20	0	41
	- unknown	0	0	0	0	0
Total		14	50	64	7	135

n= number of crania

Table 6.2 - Frequencies of Nonmetric Cranial Traits in the Naqada Skeletal Samples

	Cemetery B		Cemetery T		Great Cemetery	
TRAITS	n	N	n	N	n	N
Highest Nuchal Line (HNUCH)	6	50	4	58	2	108
Ossicle at Lambda (OSSLAMDA)	4	22	4	29	5	52
Inca Bone (INCABONE)	1	24	2	29	0	52
Lambdoidal Suture Ossicle (LSUTOSS)	10	34	13	49	24	73
Biasterionic Suture (BSUTURE)	3	38	7	48	4	101
Ossicle at Asterion (ASTERIO)	8	39	3	53	10	105
Parietal Foramen (PFORAM)	32	50	42	60	63	106
Obelionic Foramen (OBFORAM)	0	26	3	30	2	50
Coronal Suture Ossicle (COSS)	1	30	2	43	4	78
Os Sagittal Suture (OSSUTURE)	2	15	1	15	4	34
Epipteric Bone (EPIPTER)	2	27	6	40	12	92
Parietal Notch Bone (PNBONE)	3	41	4	53	8	102
Parietal Notch Present (PNOTCH)	22	42	39	53	92	102
Occipitomastoid Wormians (OWORM)	5	36	2	45	3	95
Sutural Foramen (SUTFOR)	23	42	24	46	59	94
Mastoid Foramen (MASTFOR)	33	42	31	46	71	94
Occipital Foramen (OCCFOR)	6	42	4	46	9	94
Tympanic Dehiscence (TYMPDEH)	4	53	13	46	10	101
Post. Condylar Canal Patent (PCANAL)	13	34	12	34	20	79
Condylar Facet Double (CFACET)	0	40	1	35	2	90
Precondylar Tubercle (PRECTUB)	15	44	19	38	22	94
Paracondylar Process (PARAC)	15	26	10	32	44	82
Ant. Condylar Canal Double (ANTCAN)	14	45	11	43	30	96
Foramen Ovale Incomplete (FOVALE)	2	31	3	45	6	92
Foramen Spinosum Open (FSPINOS)	10	31	13	45	33	91
Pterygo-alar Spurs (PASPURS)	0	5	1	7	3	25
Palatal Suture (PSUTURE)	11	11	11	11	33	33
Acc. Lesser Palatine Foramen (PALATIN	17	33	17	23	58	79
Palatine Torus (PTORUS)	1	18	6	14	6	44
Zygomaxillary Tubercle (ZYGOMAX)	27	30	26	32	76	89
Marginal Tubercle (MARGTUB)	25	32	36	36	82	88
Zygomatico-facial Foramen (ZFACIAL)	25	29	30	34	66	88
Supraorbital Foramen (SUPFOR)	25	44	29	57	48	106
Acc. Supraorbital Foramen (ACCSUP)	4	44	4	56	7	106
Metopism (METOPISM)	0	23	1	29	2	53
Frontal Foramen or Notch (FRONFOR)	4	44	13	57	19	106
Frontal Grooves (FGROOVE)	6	45	18	54	29	106
Posterior Ethmoid Foramen (POSETH)	6	8	24	25	49	54
Nasal Bone (NASAL)	0	17	4	18	3	39
Accessory Infraorbital Foramen (ACCINF	4	28	3	29	8	84
Infraorbital Suture (INFRAO)	12	24	19	29	53	86
Accessory Mental Foramen (ACCMENT)	3	29	1	24	4	84
Rocker Jaw (ROCKER)	2	10	5	11	11	35
Mylohyoid Arch (MYLOHY)	2	22	4	24	5	79
Lingula Bridge (LINGULA)	0	25	2	24	5	79
Genial Tubercles (GENIAL TU)	12	15	10	13	38	43
Median Mental Spine (MMSPINE)	8	15	5	13	30	43
Genial Pits (GENIAL PI)	9	15	11	12	29	43

† - bilateral trait frequencies are based on right plus left sides
n - number of sides present
N - total number of sides observable

Table 6.3 - Mean Measure of Divergence Values Calculated Between Cemeteries B, T, and Great

	Cemeteries B & Great	Cemeteries B & T	Cemeteries T & Great
Mean Measure of Divergence (MMD)	0.0184	0.0541	0.0250
Variation of MMD	0.0002	0.0004	0.0002
Standard deviation of MMD	0.0135	0.0190	0.0123
Standardized MMD†	1.3630	**2.8474***	**2.0325**

†standardized MMD = MMD/standard deviation
*numbers in bold are statistically significant

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CHAPTER 7

THE BIOLOGICAL AFFINITIES OF TWO NUBIAN A- AND C-GROUP SAMPLES BASED ON AN ANALYSIS OF CRANIAL NONMETRIC TRAITS

Introduction

Investigation into the racial origins of Egyptian and Nubian civilization was first undertaken in the early 1900's (e.g., Batrawi, 1935, 1945, 1946; Fawcett and Lee, 1902; Firth, 1927; Junker, 1921; Morant, 1925, 1935; Stoessiger, 1927; Thomson and MacIver, 1905). In accordance with scholarly tradition at that time, differences between populations were explained from a racial typological perspective, which assumed that populations could be classified into racial 'types', and any variations observed were due to racial admixture (Keita, 1`993). Early studies of Nubian cultural history used models of multiple migrations and population replacement to explain observed discontinuities in the archaeological record, which were subsequently corroborated by studies providing evidence of racial distinctions between different cultural periods (e.g., Batrawi, 1935, 1945; Junker, 1921).

Beginning in the 1960's, however, reexamination of both skeletal and archaeological evidence found that ancient Nubia was characterized by both cultural and biological continuity throughout most of its history (e.g., Adams, 1967, 1968, 1977; Carlson and Van Gerven, 1979; Greene, 1966, 1967, 1982; Nielsen, 1970). In contrast to these widely accepted models of local evolution of Nubian populations, a number of other skeletal-based studies still argued that there was evidence of biological discontinuity between successive cultural phases in Nubia, which was assumed to be the result of major 'racial' movements (e.g., Bietak, 1986; Billy, 1977; Burnor and Harris, 1968; Crichton, 1966; Irish and Turner, 1990; Strouhal, 1971; Strouhal and Jungwirth, 1979; Turner and Markowitz, 1990). This study uses cranial nonmetric traits to investigate the hypothesis of biological continuity between two successive cultural groups in Nubia, known as the A-Group and C-Group cultures.

The first Nubian archaeological survey, conducted in the early 1900's, took place under the direction of G.A. Reisner, who found evidence of a series of occupations in Nubia which were differentiated by distinctive artifact assemblages and burial customs. This led to Reisner's classification of Nubian cultural development into a series of cultural phases known as the A, B, C, and X Groups, each supposedly initiated by the arrival of distinct, biologically unrelated groups (Adams, 1977). Analysis of the skeletal remains recovered by the first Nubian archaeological survey confirmed Reisner's theory of culture change through the migration of foreign groups into Nubia, as skeletal evidence of racial distinctions were reportedly discovered (e.g., Elliot-Smith 1908, 1909a, 1909b; Elliot-Smith and Derry, 1910a, 1910b). Reisner's model, as summarized by Adams (1967), proposed that the A-Group represented a migration into Nubia of Predynastic Egyptians, who were then succeeded by the B-Group, an invasive 'Negroid' group responsible for the apparent decline in material wealth of Nubian culture at this time. The C-Group represented a third foreign migration into Lower Nubia, of people who were unrelated to either preceding group.

In contrast, modern scholars consider the A-Group to be an indigenous population that developed in Lower Nubia from Neolithic predecessors, and which was roughly contemporaneous with Egyptian late Predynastic and early Dynastic groups (ca. 3100 - 2800 B.C.) (Haynes, 1992). Archaeological evidence from A-Group sites suggests that these populations occupied seasonal campsites consisting of grass and reed huts, sometimes lined with stones (Adams, 1977). Subsistence patterns consisted of herding of domesticated sheep, goats, and cattle, as well as a reliance on fishing, hunting and gathering (Adams, 1967, 1977; Mokhtar, 1990; Nielsen, 1970). Agricultural activity involved mixed farming of wheat, barley and legumes (Trigger, 1983). There is also evidence of extensive trade contacts with Predynastic Egypt, in the form of wavy-handled and black burnished pottery, copper artifacts, and luxury items of Egyptian origin (Adams, 1977; Nielsen, 1970). The reciprocity of this trade with Egypt is indicated by the presence of Nubian pottery types in late Predynastic graves in Upper Egypt (Smith, 1991).

Evidence from A-Group burials suggests an increased concern with the afterlife, the accumulation of wealth, and close commercial ties with Predynastic Egypt (Adams, 1977). Individuals were buried in a contracted position within oval pits and surrounded by grave goods (Adams, 1977). The relative uniformity in burial styles reflects a relatively egalitarian society (Geus, 1991). Contents included personal items, tools, jewelry, and A-Group pottery with a distinctive red painted style, decorated with a basket motif on the external surface (Adams, 1977; Geus, 1991; Mokhtar, 1990).

Archaeological evidence for the existence of the A-Group in Nubia continues up to the middle of the First Dynasty in Egypt, and it has been suggested that the cultural hiatus between the A- and C-Group periods was due to Egyptian political and military domination of Nubia at that time (Nielsen, 1970; Trigger, 1983). The proposed existence of a distinct B-Group culture is no longer widely accepted, and this period is now thought to represent the socioeconomic decline of the A-Group culture as a result of Egypt's aggression (Adams, 1977; Smith, 1966). It has also been suggested that there was a considerable decrease in population density in Lower Nubia at that time, as large segments of the population abandoned their A-Group sites and migrated south due to political pressures (Nielsen, 1970). Evidence for the reoccupation of Lower Nubia by the C-Group culture appeared near the end of the Old Kingdom period (ca. 2300 B.C.), coinciding with a period of political instability in Egypt just prior to the First Intermediate Period. The collapse of the government in Egypt may have been largely responsible for the reappearance of a distinct Nubian cultural tradition in the archaeological record (Adams, 1977).

C-Group subsistence strategies were similar to earlier A-Group practices, but with a greater emphasis on agricultural activities. Hunting, fishing and herding were still practiced, although to a more limited extent (Adams, 1977; Nielsen, 1970). Some scholars suggest that the widespread artistic representations of cattle during the C-Group period reflected a reliance on cattle herding (e.g., Nielsen, 1970; Mokhtar, 1990), while others have argued that cattle were largely used as indicators of wealth (e.g., Adams, 1970; 1977). Settlement sites tended to be larger than previous A-Group sites, and consisted of larger and more permanent dwellings, including storage facilities for agricultural surpluses (Adams, 1977). Cultural continuity between A- and C-Groups is indicated by the reoccupation of A-Group settlement sites by later C-Group peoples (Adams, 1970, 1977).

Differences between A- and C-Group burial customs are attributed to an evolution of funerary styles in the C-Group period related to external influences on mortuary practices, likely coming from Egypt (Geus, 1991). C-Group burials were often larger, consisting of mud-brick burial chambers covered by circular superstructures of stone masonry, and containing a wider variety of grave goods as well as distinctive clay figurines of women and cattle (Adams, 1977; Geus, 1991). Sacrificial animals were often included in later C-Group burials, including sheep, goats, gazelles, dogs and, less frequently, cattle (Adams, 1977). The variability of grave goods within C-Group burials may reflect increasing social stratification during this cultural period (Adams, 1977). The cultural continuity between the A- and C-Groups has been from the apparent reuse of A-Group habitation and cemetery sites by later C-Group populations, as well as the similarities in subsistence patterns and burial practices (Adams, 1970; Nielsen, 1970).

Recent skeletal research on the biological affinities of the ancient Nubians has focused largely on craniofacial and dental nonmetric variation of later Meroitic, X-Group and Christian samples (ca. 0 - 1500 A.D.), and has found evidence for the biological continuity of these groups over time, concluding that any cultural variation observed in the archaeological record was due to *in situ* evolution (e.g., Calcagno, 1986; Carlson, 1976; Carlson and Van Gerven, 1979; Greene 1966, 1967, 1972, 1982; Van Gerven, 1982; Van Gerven et al., 1973, 1977). A study of earlier Mesolithic skeletal remains from the Wadi Halfa region, employing both dental and cranial nonmetric traits as well as craniometric data, also found evidence of biological continuity (Greene and Armelagos, 1972). In contrast, two recent studies of dental nonmetric variation have found evidence of biological discontinuity between the Pleistocene and later Meroitic, X-Group, and Christian periods, and have argued that the variation observed can be explained by the mass migration of a foreign population into Nubia (Irish and Turner, 1990; Turner and Markowitz, 1990). Keita (1993), however, has countered that relatively rapid evolution can occur through the mechanisms of punctuated microevolution and genetic drift of indigenous populations. Thus, the issue of biological continuity versus discontinuity in Nubia's cultural history remains unresolved.

In contrast to the large number of skeletal studies on the later phases of Nubian cultural history, comparatively less has been done on the biological affinities of populations during Nubia's earlier stages, particularly the A- and C-Group periods. Craniometric studies of the A- and C-Groups have found evidence of biological continuity between the two cultural periods (Batrawi, 1946; Mukherjee et al., 1955). Only one previous nonmetric study has specifically examined the A- and C-Groups, and found slight evidence of discontinuity between the two periods but concluded that these results could not definitively suggest biological diversity (Nielsen, 1970). Unfortunately, Nielsen (1970) grouped his material according to cultural periods, therefore combining skeletal series from different geographical locations. Even though his A-Group and C-Group samples consisted of skeletal remains from a variety of archaeological sites, he did not test for significant differences between sites within each cultural group, and therefore it is not known if the combined samples were actually biologically homogeneous. In addition, the small number of traits and divergent sample sizes may have influenced the results of his analysis. Nielsen (1970) used the chi-squared statistic for comparisons between cultural periods, but as this it is not a multivariate statistic, it does not express the overall pattern of variability between the samples. Hence, this study is a multivariate analysis of forty-five nonmetric traits using the Mean Measure of Divergence statistic, in order to test the biological variation between two skeletal samples from the A- and C-Group periods.

Materials and Methods

The skeletal samples used in this study were recovered by The Scandinavian Joint Expedition to Nubia in 1963 and 1964, during the survey and excavation of a 60 km stretch of land south of the modern border between Egypt and Sudan (Nielsen, 1970). The A-Group sample was excavated from site 277, located at Halfa Kegheim, south of Wadi Halfa (Nordström, 1972) (Figure 7.1). Material recovered from the burials date this site to the Classic and Terminal A-Group periods, contemporaneous with the Archaic period in Egypt (Nordström, 1972). The C-Group site, 179, is situated north of Wadi Halfa and is roughly dated to the First Intermediate Period or early Middle Kingdom in Egypt (Nielsen, 1970).

The A-Group sample consisted of 38 crania, and the C-Group sample consisted of 41 crania. The sex of each cranium was determined using standard morphological features (according to Bass, 1987; Brothwell, 1972; Ubelaker, 1989; White, 1991). Degree of ectocranial suture closure was used to estimate age (after Meindl and Lovejoy, 1985). Many of the crania used in this study were extremely fragmentary (M. Bartell, personal communication), and therefore age was also assessed using degree of tooth wear (after Lovejoy, 1985).[1] Age and sex distributions of the skeletal samples are presented in Table 7.1.

Previous analysis of age and sex correlations of nonmetric trait frequencies (Chapter 5) found no overall significant patterns of association, and therefore age and sex categories were pooled in the present study. Three subadult crania (< 20 years) from the A-Group were excluded from statistical analysis in order to eliminate the age effect of subadult specimens (after Berry, 1975; Buikstra, 1976; and Perizonius, 1979), thus reducing that sample to thirty-five crania. Although intertrait correlations are considered by some researchers to affect significantly the outcome of biological distance analysis, they were not considered a factor in this study, as previous research has found that correlations between traits in small skeletal samples are rarely statistically significant (Berry and Berry, 1967; Corruccini, 1974; Saunders, 1978, 1989; Sjøvold, 1973, 1977).

Fifty-eight cranial nonmetric traits were originally scored for each sample. Traits selected for use in this study were chosen from six sources; Berry and Berry (1967); Brothwell (1972); Buikstra (1976), Hauser and De Stefano (1989), Ossenberg (1970), and Rose et al. (1991). Data on the Nubian skeletal samples were collected by M. Bartell at the Laboratory of Biological Anthropology, University of Copenhagen, Denmark in 1992. Bilateral traits were scored using the side count method. Partial trait manifestations were scored as present. Molto's (1979) test of intraobserver error in cranial nonmetric analysis found that although most errors in data collection were random, they could significantly affect biological distance analysis, but a standardized methodology could reduce intraobserver error to acceptable levels. In this study, data were collected using standardized scoring procedures outlined in a data collection manual, composed of trait descriptions and illustrations, thus reducing the effects of intraobserver error.

The final list of traits used in the calculation of biological distance was first reduced to forty-five traits, based on the exclusion of those traits that were completely absent in both skeletal samples, as well as those traits that had 100% frequency in both samples. A further seven traits were excluded from analysis due to extremely low frequencies (i.e., 0 and 1) in both samples. These seven traits were consistently absent in the smaller A-Group sample. It was decided that these frequencies were an artifact of the extremely low number of observable cases in the C-Group sample, and would artificially overestimate the degree of divergence between the A- and C-Group samples.

The Freeman and Tukey arcsine transformation for small samples sizes was used to stabilize the variance of the nonmetric trait frequencies (as recommended by Green and Suchey, 1976):

$$\phi = \frac{1}{2}\sin^{-1}[1 - 2(k/n+1)] + \frac{1}{2}\sin^{-1}[1 - 2(k+1/n+1)]$$

k = total number of sides present
n = total number of sides observable

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[1] The scoring method outlined by Lovejoy (1985) was modified by N. Lovell for this study, due to the observation that the Nubian samples exhibited a comparatively lesser degree of anterior tooth wear than did those in the Lovejoy study (N. Lovell, personal communication).

The multivariate Mean Measure of Divergence statistic (MMD) was used to calculate biological distance. The MMD value, its variance, and standard deviation were calculated according to Green and Suchey (1976) and Sjøvold (1973):

$$\text{MMD} = \frac{\sum_{i=1}^{r} \left([\text{ø}_{1i} - \text{ø}_{2i}]^2 - \left[\frac{1}{n_{1i}+1/2} + \frac{1}{n_{2i}+1/2} \right] \right)}{r}$$

$$\text{VarMMD} = \frac{2}{r^2} \sum_{i=1}^{r} \left[\frac{1}{n_{1i}+1/2} + \frac{1}{n_{2i}+1/2} \right]^2$$

$$\text{Sd MMD} = \text{variance of MMD}$$

ø_{1i} = the transformed frequency of the *ith* trait in sample 1
ø_{2i} = the transformed frequency of the *ith* trait in sample 2
n_{1i} = the number of sides observed for the *ith* trait in sample 1
n_{2i} = the number of sides observed for the *ith* trait in sample 2
r = the number of traits

In this study, a standardized MMD value is used to measure the biological affinity of the samples, as it is recommended that standardized scores be employed when comparing samples of different sizes (Hemphill et al., 1991; Sofaer et al., 1986). Standardized MMD values are calculated by dividing each raw MMD score by its standard deviation. A standardized MMD value greater than 2.0 is considered statistically significant at the 0.05 probability level (Sjøvold, 1973).

Results

Cranial nonmetric trait frequencies for both skeletal samples, sexes and ages pooled, are presented in Table 7.2. Results of the statistical analysis are presented in Table 7.3. As is clearly evident in Table 7.3, the standardized MMD value (-0.92) is well below significance. A negative Mean Measure of Divergence value can occur when the two samples studied have identical trait frequencies, or when the sample sizes are small, as is the case in this study (Ishida and Dodo, 1993). Results of this analysis indicate that there is no statistically significant difference between the A- and C-Group skeletal samples from sites 277 and 179 on the basis of nonmetric trait frequencies.

To ensure that the exclusion of the seven nonmetric traits with low frequencies (discussed above) did not significantly alter the outcome of the biological distance analysis, the Mean Measure of Divergence was recalculated including these traits. The calculated standardized MMD value (-1.5074) was still not statistically significant, and therefore the results of Table 7.3 can be accepted with confidence.

Discussion

The results presented in Table 7.3 suggest that there was biological continuity between the Nubian A- and C-Groups. These results corroborate previous studies that have found close biological affinities between A- and C-Group samples. Batrawi (1946) concluded that the populations of Lower Nubia were biologically homogeneous from the A-Group through Christian periods, on the basis of craniometric data, a finding which was subsequently confirmed by further craniometric analysis of Nubian skeletal material involving A- and C-Group samples (Mukherjee et al., 1955). Similarly, Nielsen's (1970) metric and nonmetric study of A-Group through post-Christian period skeletal samples found significant homogeneity of the A- and C-Groups.

Comparable studies on later Nubian cultural periods have also found evidence of biological continuity over time. Although morphological variability between groups was discovered, it was shown that this could be explained through *in situ* biological evolution due to environmental pressures. A series of studies on nonmetric dental variation in the Meroitic, X-Group, and Christian skeletal samples from the Wadi Halfa region concluded that the samples were biologically continuous over time (Greene, 1966, 1967, 1982). Similarly, studies on craniofacial variation in the Meroitic, X-Group and Christian skeletal samples repeatedly demonstrated the local evolution of craniofacial form correlated with changing masticatory functions. This evolution therefore was interpreted as being largely independent of major racial migrations (Carlson, 1976; Carlson and Van Gerven, 1979; Van Gerven, 1982; Van Gerven et al., 1977). Examination of the results of this study in light of the archaeological evidence suggests that the general cultural similarities observed between the A- and C-Group periods can be attributed to their close biological affinities, and the gradual variation in the material culture of the ancient Nubians was likely due to a combination of *in situ* cultural evolution and diffusion of ideas and material culture from Egypt. The archaeological evidence indicates that there were slight differences in the material culture, subsistence strategies, and mortuary practices between the A- and C-Groups, however, these differences appear to have developed out of existing A-Group traditions (Adams, 1967, 1970, 1977). This does not agree with a model of invasion or migration of a foreign groups into Nubia at the beginning of the C-Group period.

These results do not necessarily contradict the findings of Turner and colleagues, who found evidence of biological discontinuity between the Pleistocene and later Meroitic, X-Group and Christian periods (e.g., Irish and Turner, 1990; Turner and Markowitz, 1990). The results presented here suggest that there was continuity between the A- and C-Group periods, however, a change in the genetic makeup of ancient Nubian populations could have occurred either before the A-Group period or after the C-Group period.

Conclusions

Thirty-five cranial nonmetric traits were employed in a diachronic investigation of the biological affinities between the A- and C-Group cultural periods in ancient Nubia. The multivariate Mean Measure of Divergence statistic was used to test for biological continuity between sites 277 (A-Group) and 179 (C-Group), excavated by the Scandinavian Joint Expedition to Nubia. Statistical analysis revealed no significant difference between the A- and C-Group samples. This observed biological continuity supports the archaeological interpretation of the C-Group period representing a continuum of cultural evolution from the A-Group period (Adams, 1977). Any differences between the A- and C-Group periods is therefore likely the result of local cultural evolution, rather than due to the migration of a new population into Lower Nubia.

Figure 7.1 - Map of Egypt and Nubia Showing the Location of Sites 179 and 277

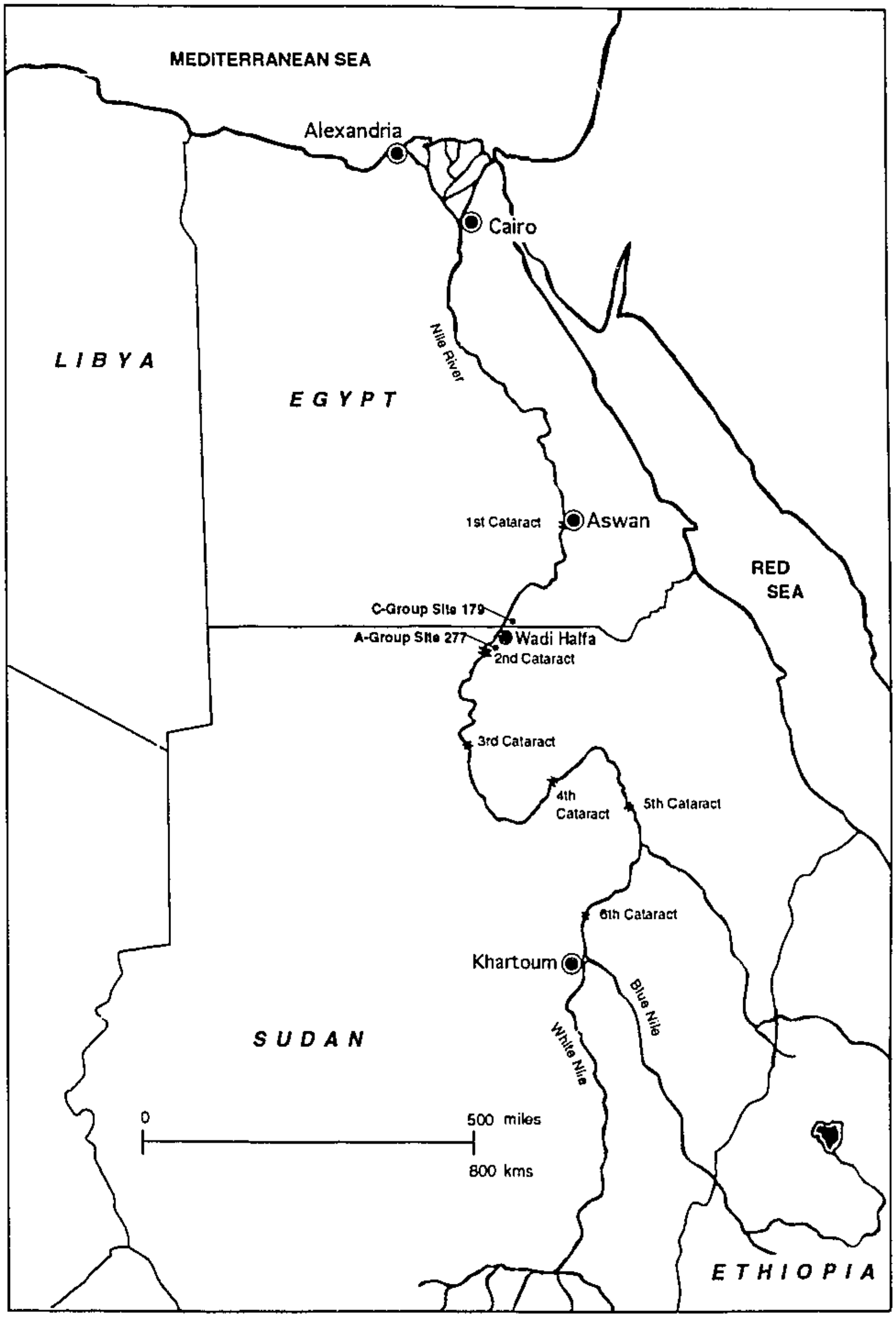

Table 7.1 - Age and Sex Distribution of Nubian Skeletal Samples from Sites 277 and 179

		AGE				
		Young Adult (21-30 years)	Middle Adult (31-40 years)	Old Adult (> 40 years)	Adult (Indeterminate Age)	Total
SITE &SEX		n	n	n	n	n
Site 277	- female	3	3	1	3	10
	- male	7	6	6	5	24
	- unknown	1	0	0	0	1
Site179	- female	3	7	9	0	19
	- male	2	2	10	5	19
	-unknown	0	0	2	1	3
Total		16	18	28	14	76

n = number of crania

Table 7. 2 - Cranial Nonmetric Trait Frequencies of Skeletal Samples from Sites 179 and 277 †

	Site 277		Site 179	
TRAITS	n	N	n	N
Highest Nuchal Line (HNUCH)	4	42	6	68
Ossicle at Lambda (OSSLAMDA)	1	11	1	32
Lambdoidal Suture Ossicle (LSUTOSS)	1	5	7	43
Ossicle at Asterion (ASTERIO)	2	7	3	38
Parietal Foramen (PFORAM)	18	25	39	60
Obelionic Foramen (OBFORAM)	1	12	3	30
Epipteric Bone (EPIPTER)	2	4	4	30
Fronto-temporal Articulation (FTART)	5	5	23	29
Parietal Notch Bone (PNBONE)	0	6	2	34
Parietal Notch Present (PNOTCH)	6	6	27	34
Sutural Foramen (SUTFOR)	3	4	13	29
Mastoid Foramen (MASTFOR)	4	4	19	29
Occipital Foramen (OCCFOR)	0	4	4	29
Tympanic Dehiscence (TYMPDEH)	5	29	12	61
Post. Condylar Canal Patent (PCANAL)	3	6	9	33
Precondylar Tubercle (PRECTUB)	0	18	6	51
Paracondylar Process (PARAC)	1	3	4	27
Ant. Condylar Canal Double (ANTCAN)	1	20	18	56
Foramen Spinosum Open (FSPINOS)	0	4	8	43
Pterygo-alar Spurs (PASPURS)	0	2	3	11
Acc. Lesser Palatine Foramen (PALATIN)	9	19	20	45
Palatine Torus (PTORUS)	1	17	3	36
Zygomaxillary Tubercle (ZYGOMAX)	20	28	42	60
Marginal Tubercle (MARGTUB)	25	32	44	61
Zygomatico-facial Foramen (ZFACIAL)	34	34	54	62
Supraorbital Foramen (SUPFOR)	28	53	39	68
Acc. Supraorbital Foramen (ACCSUP)	9	54	14	67
Frontal Foramen or Notch (FRONFOR)	5	47	4	68
Frontal Grooves (FGROOVE)	5	10	19	56
Accessory Infraorbital Foramen (ACCINF)	3	13	13	48
Infraorbital Suture (INFRAO)	5	14	23	48
Accessory Mental Foramen (ACCMENT)	5	55	3	73
Rocker Jaw (ROCKER)	3	10	6	24
Mylohyoid Arch (MYLOHY)	12	53	9	67
Lingula Bridge (LINGULA)	3	53	3	67
Genial Tubercles (GENIAL TU)	17	27	30	36
Median Mental Spine (MMSPINE)	19	27	28	36
Genial Pits (GENIAL PI)	24	27	29	36

† - bilateral trait frequencies are based on right plus left sides
n - number of sides present
N - total number of sides observable

Table 7.3 - Results of the Biological Distance Analysis Between the Nubian A-Group and C-Group Samples

Mean Measure of Divergence MMD = - 0.0344

Variation of MMD = 0.0014

Standard Deviation of MMD = 0.0373

Standardized MMD* = - 0.9204†

*Standardized MMD = MMD/ Standard Deviation
† - not statistically significant

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CHAPTER 8

A STUDY OF BIOLOGICAL VARIATION IN THE NILE VALLEY ON THE BASIS OF CRANIAL NONMETRIC TRAITS

Introduction

The establishment of Egyptian Dynastic civilization is commonly associated with the political unification of Upper and Lower Egypt at the beginning of the First Dynasty (ca. 3050 B.C.). Events in the preceding Neolithic and Predynastic periods (ca. 5500 - 3050 B.C.) that led up to the development of the Egyptian state are, however, of equal importance to many scholars. The major developments of the Predynastic period will only be briefly mentioned here, as they have been comprehensively studied in a number of recent reviews (e.g., Hassan, 1988; Trigger, 1983; Wenke, 1989, 1991).

Archaeological evidence for the Predynastic period has been obtained largely from cemetery sites concentrated in Upper Egypt, as well as a smaller number of poorly preserved settlement sites in Lower Egypt (Trigger, 1983). The Predynastic period is characterized by a number of important innovations, including the introduction of intentional agricultural practices into the Nile Valley, likely introduced from southwest Asia (Wenke, 1989). In addition, recent studies have found evidence of emerging social complexity in the cemeteries of the Predynastic period (e.g., Anderson, 1992; Bard, 1989). Incipient urbanization, craft specialization and long distance trade also originated in the Predynastic period, and were well established characteristics of Egyptian civilization by the Old Kingdom period (Trigger, 1983). The Nile river provided an ideal mechanism for the transport of material goods as well as people, and the history of human occupation in the Nile Valley has centered around this vital resource. Controversy exists, however, over the origins of the ancient Egyptians and Nubians, a topic which has received considerable attention from scholars interested in the inception and evolution of Egyptian civilization.

Traditionally, studies on the biological affinities of the ancient Egyptians have attempted to determine the racial composition of successive populations in the Nile Valley. This form of racial typological analysis was founded on the assumption that populations could be classified into preestablished types based on the proportion of racial characteristics within each group. Studies of this nature often used craniometric data to categorize populations as either 'Negroid', 'Caucasiod', or a type of racial hybrid resulting from the admixture of indigenous and foreign groups (e.g., Batrawi, 1945, 1946; Fawcett and Lee, 1902; Giuffrida-Ruggeri, 1915; Morant, 1925, 1935; Thomson and MacIver, 1905). Observed variation between populations was usually attributed to the migration of foreigners into Egypt. Derry's (1956) hypothesis of an invasive 'Dynastic race', responsible for the establishment of Egyptian Dynastic civilization, is one such example.

In contrast, most recent anthropological studies have abandoned the racial typological approach and have adopted the biological population model as a theoretical framework for analysis, although typologically based studies continue to appear in the literature (e.g., Billy, 1977; Crichton, 1966; Strouhal, 1968, 1971, 1981; Wiercinski, 1965, 1978). It is now known that variation *within* closely related human groups is usually the norm, and therefore the classification of populations into rigid racial types is no longer considered valid (Keita, 1993). The biological population model uses the local breeding population (i.e., the skeletal sample) as the basic unit of study. This modern approach to the analysis of biological affinities, using metric and nonmetric characters of the cranium and dentition, investigates the observed variation without reference to any pre-established racial categories or biological relationships (e.g., Berry and Berry, 1972; Berry et al., 1967; Greene, 1966, 1982; Greene and Armelagos, 1972; Keita, 1990, 1992; Reggio et al., 1969; Van Gerven, 1982). Keita (1993) has thoroughly reviewed the vast amount of physical anthropological research that has been conducted on the biological affinities of the ancient Egyptians.

This paper presents the results of a cranial nonmetric study of eight Egyptian and Nubian skeletal samples, ranging in date from the Predynastic period to the beginning of the First Intermediate period in Egypt. A chronology of Egyptian and Lower Nubian cultural phases is presented in Figure 8.1.[1] Cranial nonmetric studies on the ancient Egyptians and Nubians are relatively rare in comparison to the large number of metric and morphological studies present in the literature. Those studies that have examined the biological affinities of the ancient Egyptians found evidence of general biological continuity throughout the Predynastic, Old Kingdom and Middle Kingdom periods (Berry and Berry 1972; Berry et al., 1967), although these studies were later found to be methodologically flawed (Green and Suchey, 1976). Recent craniometric studies have focused mainly on the relationships of the ancient Egyptians with other African and non-African skeletal samples (e.g., Brace et al., 1993; Keita, 1990, 1992). These studies have examined the biological relationships of the ancient Egyptians with other world-wide populations, however, studies of intraregional variation along the Nile Valley are still lacking. This study is designed to provide a regional perspective on the biological affinities of Predynastic and early Dynastic Egyptians, as well as a comparison with skeletal samples from the earliest cultural periods in Lower Nubia, the A- and C-Groups.

Materials and Methods

A total of 353 crania from eight skeletal samples were examined in this study. The skeletal samples are from six archaeological sites along the Nile Valley in Egypt and Nubia; Abydos, Badari, Keneh, Naqada, and the Scandinavian Joint Expedition (SJE) sites 179 and 277 (Table 8.1) (Figure 8.2). The majority of these sites date to the Predynastic and early Dynastic periods. Abydos is located on the west bank of the Nile river, north of Luxor. The skeletal remains from this site were excavated by W.M.F. Petrie from the area of the 'Tombs of the Courtiers' in 1921. These were considered to be subsidiary burials associated with the funerary palaces of three First Dynasty rulers, Djer, Djet, and Merneith, and the individuals interred within the burials were identified as members of the royal entourage of those rulers (Petrie, 1925; Trigger, 1983). Badari, the type site for the earliest known Predynastic culture in Upper Egypt, is located to the north of Abydos and consists of seven cemeteries excavated by G. Brunton and G. Caton-Thompson between 1922 and 1925 (Brunton, 1927, 1928; Brunton and Caton-Thompson, 1928). Relatively little is known about the site of Keneh, as reports of the excavations by G.A. Reisner and L.C. West in 1913 were never published (N. Lovell, personal communication). The Naqada skeletal material was excavated by W.M.F. Petrie in 1894 and 1895 from three cemetery locations, designated Cemetery B (named after the nearby mound of Kom Belal), Cemetery T (named for its location near two tumuli), and the Great Cemetery (Petrie and Quibell, 1896). Crania from all three cemeteries have been included in this study. The Nubian skeletal samples were recovered from two archaeological sites in the Wadi Halfa region, excavated between 1963 and 1964 during salvage excavations by the Scandinavian Joint Expedition to Nubia (Nielsen, 1970). Site 277 is an A-Group site, contemporaneous with the Archaic period in Egypt (Nordström, 1972). Site 179 is a C-Group site, roughly dated to the end of the Old Kingdom and beginning of the First Intermediate Period in Egypt (Nielsen, 1970).

A previous study of the biological affinities among the three cemeteries at Naqada found that Cemetery T was biologically differentiated from the other two cemeteries

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[1] As there is still considerable debate over the dating of the Egyptian and Nubian cultural sequences, only the most recent and widely accepted dates have been used in this study (adapted from Hassan, 1988; Haynes, 1992; Kemp, 1991; Wenke, 1991).

(Chapter 6). Therefore, the Great Cemetery and Cemetery B are pooled in the present study, and Cemetery T is considered a separate sample. Another biological distance study found that the samples from the Nubian A-Group and C-Group sites were biologically homogeneous (Chapter 7), and are therefore pooled for this study.

Standard gross morphological features were used to determine the sex of each cranium prior to data collection (according to Bass, 1987; Brothwell, 1972; Ubelaker, 1989; White, 1991). Age at death was estimated using degree of ectocranial suture closure (after Meindl and Lovejoy, 1985). Incomplete or fragmentary crania were aged based on the degree of tooth wear (according to Lovejoy, 1985).[2] Age and sex distributions of the skeletal samples are presented in Tables 8.2 and 8.3. Age and sex correlations with nonmetric trait frequencies were tested in a previous study (Chapter 5). In general, no significant correlations were found, and therefore all age and sex categories are pooled in this analysis. Data on nineteen subadult crania (<20 years) were excluded from the final biological distance analysis in order to eliminate the age effect of subadult specimens (as recommended by Berry, 1975; Buikstra, 1976; and Perizonius, 1979). Intertrait correlations were not directly tested in this study , however,previous research has demonstrated that correlations between traits generally approximated the number expected due to random variation (Berry and Berry, 1967; Corruccini, 1974; Saunders, 1978, 1989; Sjøvold, 1973, 1977). Sjøvold (1977) demonstrated that intertrait correlations were a function of sample size, and concluded that the small size of most skeletal samples would minimize any effects due to intertrait correlations.

The fifty-eight cranial nonmetric traits initially chosen for this study were selected from Berry and Berry (1967), Brothwell (1972), Buikstra (1976), Hauser and De Stefano (1989), Ossenberg (1970), and Rose et al. (1991). Traits were excluded from statistical analysis if they were absent in more than half of the samples studied, or if they were universally present, thus reducing the final data set to fifty-one traits (see Table 8.4). The side count method was used to score bilateral traits, and partial trait manifestations were scored as present. Data were collected on the Abydos and Badari skeletal samples by T. Prowse in 1991. The Nubia and Naqada samples were examined by M. Bartell, and that from Keneh by N. Lovell, in 1992. Intraobserver error was minimized through the use of standardized scoring procedures outlined in a data collection manual, which were based on trait descriptions and illustrations from the sources listed above. Molto (1979) performed a test of intraobserver error in cranial nonmetric trait data collection, and found that most errors committed in data collection were random, although standardization of methods could reduce intraobserver error to acceptable levels. Interobserver error was reduced through the use of standardized scoring procedures, and all data were collected under the supervision of N. Lovell to ensure consistency in scoring.

Nonmetric trait frequencies were arcsine transformed using the Freeman and Tukey arcsine transformation for small sample sizes, as recommended by Green and Suchey (1976):

$$\text{ø} = \frac{1}{2}\sin^{-1}[1 - 2(k/n+1)] + \frac{1}{2}\sin^{-1}[1 - 2(k+1/n+1)]$$

k = total number of sides present
n = total number of sides observable

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[2] Lovejoy's (1985) tooth wear scoring method was modified for the Egyptian cranial samples by N. Lovell due to the comparatively lesser degree of anterior tooth wear observed in the Egyptian material (N. Lovell, personal communication).

Biological distances were calculated using the multivariate Mean Measure of Divergence statistic (MMD). The MMD value, its variance, and standard deviation were calculated according to Green and Suchey (1976) and Sjøvold (1973):

$$\text{MMD} = \frac{\sum_{i=1}^{r} \left\{ [\phi_{1i} - \phi_{2i}]^2 - \left[\frac{1}{n_{1i}+1/2} + \frac{1}{n_{2i}+1/2} \right] \right\}}{r}$$

$$\text{var MMD} = \frac{2}{r^2} \sum_{i=1}^{r} \left\{ \frac{1}{n_{1i}+1/2} + \frac{1}{n_{2i}+1/2} \right\}^2$$

$$\text{sd MMD} = \text{var MMD}$$

ϕ_{1i} = the transformed frequency of the *ith* trait in sample 1
ϕ_{2i} = the transformed frequency of the *ith* trait in sample 2
n_{1i} = the number of sides observed for the *ith* trait in sample 1
n_{2i} = the number of sides observed for the *ith* trait in sample 2
r = the number of traits

Standardized MMD values are recommended for the comparison of biological distances between samples of varying sizes (Hemphill et al., 1991; Sofaer et al., 1986). Standardized MMD values were therefore calculated by dividing the absolute MMD score by its standard deviation. A standardized MMD value greater than 2.0 is considered statistically significant (p=0.05) (Sjøvold, 1973).

Results

Cranial nonmetric trait frequencies of pooled age and sex samples are presented in Table 8.4. The standardized Mean Measure of Divergence and standard deviation for each pairwise comparison are presented in Table 8.5. All standardized MMD values are greater than 2.0, and therefore are all statistically significant. The smallest MMD value (2.57) is between the pooled Cemetery G & B sample and Cemetery T sample. The largest calculated distance (27.39) is between the Abydos sample and the Cemetery G & B sample. The distances between Abydos and all other skeletal series are, however, consistently quite large.

Cluster analysis was performed on the standardized MMD matrix from Table 8.5, and the cluster dendrogram is presented in Figure 8.3. The dendrogram shows that the skeletal samples are separated into a series of four hierarchical clusters. The Naqada cemeteries have the smallest distance between them (Cluster 1), and collectively are most closely related to the Nubian sample (Cluster 2). Badari and Keneh are grouped together (Cluster 3), and are then closest to the lumped Naqada/Nubia cluster (Cluster 4). Most notable in this figure is the isolation of the Abydos sample from the preceding clusters, indicating a relatively greater biological distance from the other samples studied. The general pattern can not be explained solely by geographical or temporal variation, as samples that are biologically close are either separated by large geographical distances (i.e., Naqada and Nubia), or are not from the same time period (i.e., Keneh and Badari).

Discussion

The results of this study suggest that there was a significant degree of biological heterogeneity among Nile Valley populations during the early periods of Upper Egyptian and Lower Nubian cultural history. It has been hypothesized that periods of severe aridity in the Sahara and Levant, just prior to the Neolithic period, forced populations to move into the Nile Valley and come into contact with indigenous Nilotic groups (Hassan, 1988) Therefore, the major cause of variability observed in Predynastic Egyptian populations may be attributed to the presence and interaction of numerous biologically distinct groups within the Nile Valley (Keita, 1992).

Berry et al. (1967) concluded that there was considerable homogeneity in Egypt for well over five thousand years (from the Predynastic period onwards), based on a cranial nonmetric study of skeletal samples from Badari, Naqada, and Abydos, as well as eleven other samples from later periods in Egypt and Nubia. Closer examination of their results, however, also shows significant statistical differences between the Badari and Naqada series, between Abydos and another early Dynastic site (Tarkhan), as well as between a late Naqada sample and all other Egyptian and Nubian samples studied. In a subsequent comparison of Egyptian skeletal material with seven other African, Palestinian, European and Indian samples, Berry and Berry (1972) found evidence of biological continuity among two samples from Middle Kingdom and Late period Giza, as well as a third sample from Predynastic Naqada. It should be noted, however, that both these studies used an angular transformation in their analyses, which was later shown to be inappropriate for small samples (Green and Suchey, 1976), and therefore the results of their analysis are suspect. In addition, age and sex correlations were not investigated in these earlier studies, and may have had an undetermined effect on the results. In the present study, biological distances were calculated based on the Freeman and Tukey arcsine transformation of nonmetric trait frequencies, which is considered to be more appropriate when dealing with small sample sizes (after Green and Suchey, 1976). Correlations with age and sex were tested prior to biological distance analysis in this study, and it was concluded they would have minimal effect on the trait frequencies (Chapter 5).

The Keneh-Badari cluster is difficult to interpret, due to the lack of information on the site of Keneh. In Reisner's unpublished field notes the Keneh material was dated to the late Predynastic period, making it more recent than the early Predynastic sample from Badari. Therefore, affinity based on temporal contemporaneity does not adequately explain their statistical proximity. The possibility exists that Keneh has been improperly dated , however, confirmation of this hypothesis would require a thorough reanalysis of Reisner's field notes. The Keneh sample may be a biological outlier, as it is statistically closest to the Nubian sample (see Table 8.5), but in the cluster analysis is grouped with Badari, due to the closer affinity of Nubia with Naqada (Figure 8.3). Removal of the Keneh sample from cluster analysis places Badari in a cluster with the combined Naqada-Nubia material, and is now nearest the Naqada samples (Figure 8.4). This modified cluster pattern conforms with a general pattern of a geographical cline between the sites, from north to south.

The Nubia-Naqada cluster corroborates the findings of close biological ties between Upper Egypt and Lower Nubia, based on craniometric analysis. Batrawi (1946) concluded that there were two closely related types in Egypt from the Neolithic period onwards, a 'northern type' in Middle Egypt and a 'southern type' in Upper Egypt. He further suggested that this latter type spread into Lower Nubia during the Predynastic period and developed into the Nubian A-Group culture. Similarly, a study by Mukherjee et al. (1955) found that samples from Naqada and Badari were biologically closer to Nubian material, including A- and C-Group samples, than they were to later Dynastic Egyptian samples. Additional craniometric studies have also found that there were northern and southern clusters of skeletal samples in the Nile Valley, and Upper Egyptian samples tended to be closer to more southerly African samples (e.g., Keita, 1990; Hillson, 1978 - cited in Keita, 1993). Keita (1990) found that samples from the northern Maghreb region in Africa resembled northern Egyptian samples from Sedment and Giza, while the southern Egyptian samples, including Badari and Naqada, more closely resembled a sample from Kerma, an Upper Nubian site chronologically contemporaneous with the C-Group culture in Lower Nubia. In addition, archaeological evidence exists for trade relations between Upper Egypt and Lower Nubia during the Predynastic period, indicated by the presence of late Predynastic Egyptian pottery and other artifacts in Lower Nubian graves, as well as Nubian pottery in Upper Egyptian graves (Smith, 1991; Trigger, 1983). The results from the present study suggest that these cultural associations may reflect close biological affinities.

The conspicuous segregation of Abydos from the other site clusters in Figure 8.3 is of particular interest. This relative isolation suggests that the individuals buried at Abydos were biologically distinct from earlier, Predynastic populations in Upper Egypt. These results are not inconsistent with a recent craniometric analysis that found both northern and southern Egyptian affinities in craniometric patterns of the Abydos crania (Keita, 1992). The northern affinities of the Abydos material is supported by archaeological and historical evidence which suggests that the Abydos elites were Lower Egyptians involved in political intermarriages with Upper Egyptians after the unification of Egypt, and who were likely accompanied by their courtiers (Keita, 1992). Thus, the present study supports the hypothesis that the courtiers of Abydos were biologically distinct from the other Upper Egyptian samples of Badari, Naqada and Keneh, which can be explained most parsimoniously by the presence of Lower Egyptian royalty, and their courtiers, at Abydos.

Conclusions

Biological distance analysis using cranial nonmetric traits supports a model of biological diversity in the Nile Valley during the Predynastic and early Dynastic periods. Cluster analysis reveals close biological affinities between Upper Egypt and Lower Nubia, which supports recent craniometric and archaeological evidence. The second cluster between Badari and Keneh does not fit into a geographical pattern of biological affinity among the samples studied. It is proposed that Keneh is an outlying sample, but more information about the site is required before a definitive conclusion can be reached. Exclusion of the Keneh sample from cluster analysis reveals a geographical cline of biological distances from north to south. The relative biological isolation of Abydos skeletal sample from the other sites in this study can be explained by the arrival of Lower Egyptian elites and their royal retainers into Upper Egypt at the time of the political unification of Upper and Lower Egypt. Further research should examine cranial nonmetric traits in Lower Egyptian material in order to confirm or refute this hypothesis.

Figure 8.1 - Map of Egypt and Nubia Showing the Location of the Sites Used in this Study

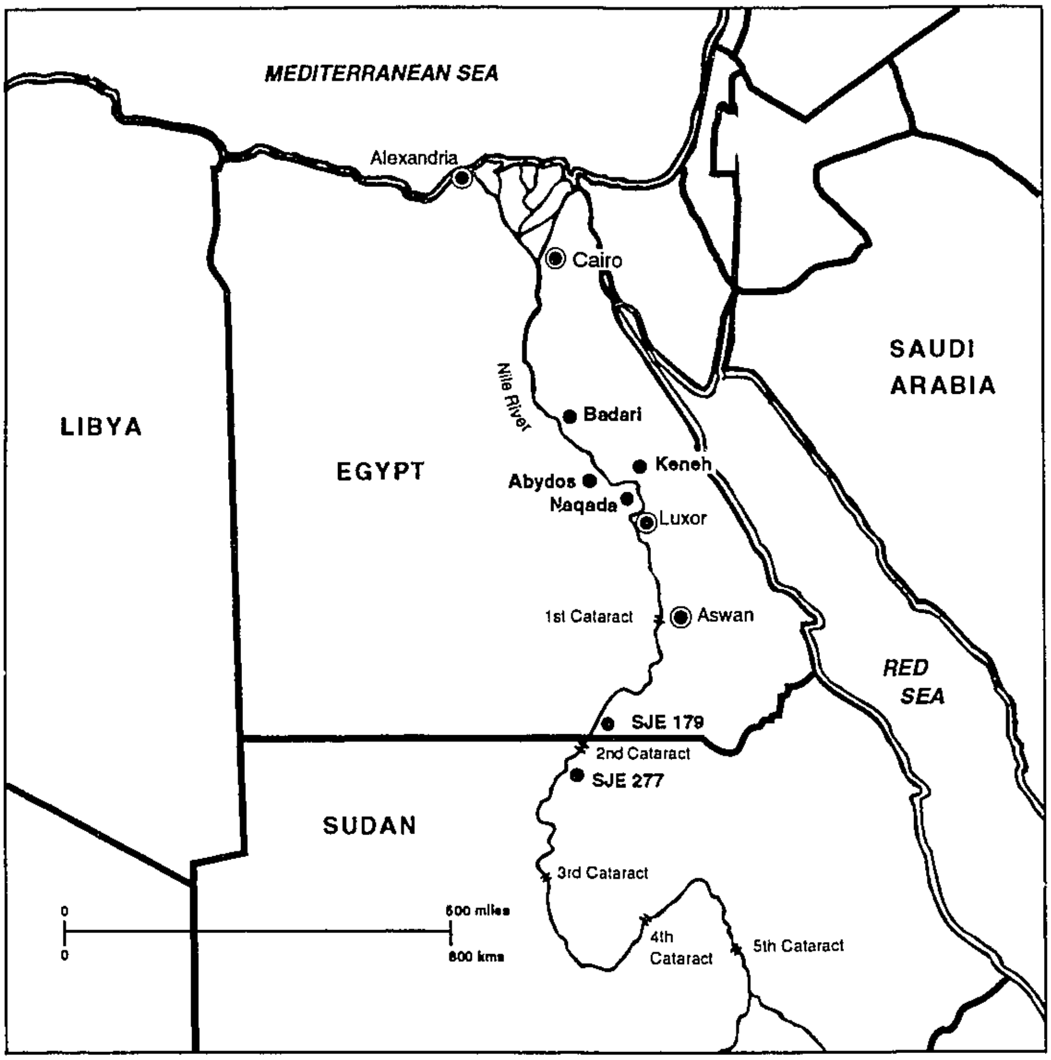


Figure 8.2 - Chronology of Egypt and Lower Nubia

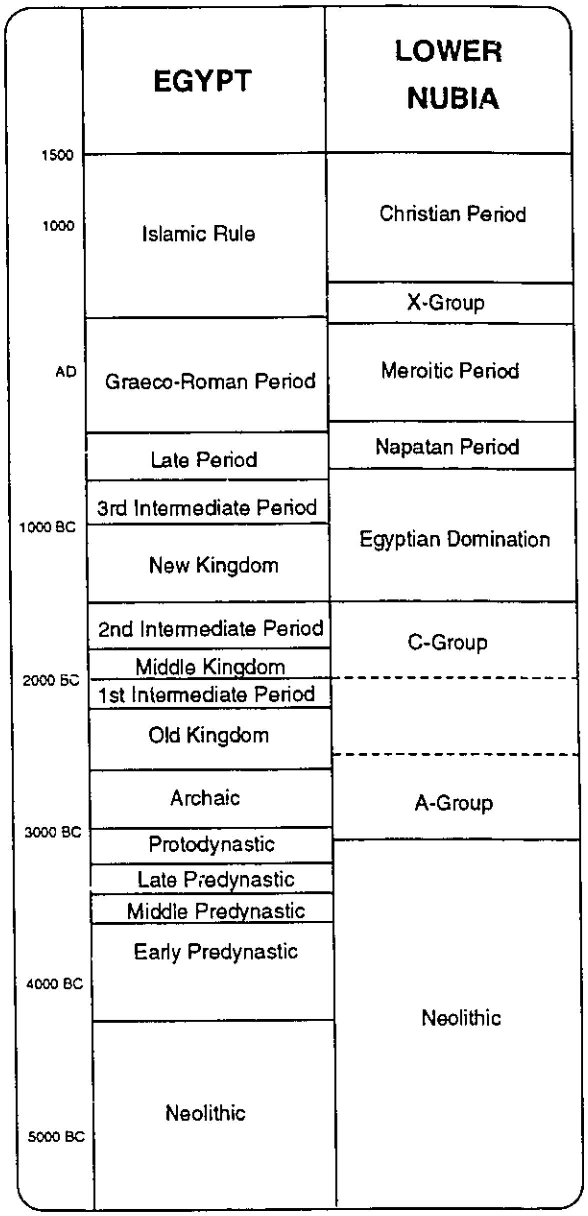


Table 8.1 - Sites Used in the Biological Distance Analysis and Where They are Stored

Site	Cultural Period	Location of Collection
Abydos	First Dynasty	Dept. of Biological Anthropology, Cambridge University, England
Badari	Predynastic	Dept. of Biological Anthropology, Cambridge University, England
Kench	Predynastic	Peabody Museum, Harvard University, U.S.
Naqada:	Predynastic	Dept. of Biological Anthropology, Cambridge University, England
Great Cemetery		
Cemetery B		
Cemetery T		
Nubia:		Biological Anthropology Laboratory, University of Copenhagen, Denmark
Site 277	A-Group	
Site 179	C-Group	

Table 8.2 - Sex Distribution of Skeletal Samples Used in the Study of Biological Affinities in the Nile Valley

	Female n	Male n	Unknown n	Total n
SITE				
Abydos	13	35	0	48
Badari	24	33	0	57
Keneh	17	9	11	37
Naqada - B	13	21	1	35
Naqada - G	22	41	0	63
Naqada - T	17	20	0	37
Nubia - 179	19	19	3	41
Nubia - 277	10	24	1	35
Total	142	204	26	353

n= number of crania

Table 8.3 - Age Distribution of Skeletal Samples Used in the Study of Biological Affinities in the Nile Valley

			AGE		
	Young Adult (21-30 years) n	Middle Adult (31-40years) n	Old Adult (>40 years) n	Adult (Indeterminate Age) n	Total n
SITE					
Abydos	0	19	9	20	48
Badari	1	20	17	19	57
Keneh	3	6	13	15	37
Naqada-B	5	11	16	3	35
Naqada-G	9	24	30	0	63
Naqada-T	1	16	15	5	37
Nubia - 179	5	9	21	6	41
Nubia - 277	11	9	7	8	35
Total	35	114	128	76	353

n = number of crania per age category

Table 8.4 - Cranial Nonmetric Trait Frequencies of Samples Used in this Study†

	Abydos		Badari		Keneh	
	n	N	n	N	n	N
TRAITS						
Highest Nuchal Line (HNUCH)	52	94	60	112	2	64
Ossicle at Lambda (OSSLAMDA)	4	46	4	52	3	40
Inca Bone (INCABONE)	0	47	0	53	0	40
Lambdoidal Suture Ossicle (LSUTOSS)	41	89	42	106	17	58
Biasterionic Suture (BSUTURE)	*	*	*	*	3	64
Ossicle at Asterion (ASTERIO)	10	92	21	100	3	62
Parietal Foramen (PFORAM)	39	94	51	109	33	59
Obelionic Foramen (OBFORAM)	7	47	8	55	1	40
Coronal Suture Ossicle (COSS)	4	85	5	93	2	60
Os Sagittal Suture (OSSUTURE)	3	36	2	46	0	39
Epipteric Bone (EPIPTER)	9	88	15	94	4	47
Fronto-temporal Articulation (FTART)	84	86	59	78	44	50
Parietal Notch Bone (PNBONE)	4	94	16	104	2	64
Parietal Notch Present (PNOTCH)	75	95	64	104	19	64
Occipitomastoid Wormians (OWORM)	*	*	*	*	0	64
Auditory Torus (ATORUS)	4	93	0	108	0	66
Sutural Foramen (SUTFOR)	40	88	24	96	27	58
Mastoid Foramen (MASTFOR)	18	88	46	96	31	59
Occipital Foramen (OCCFOR)	2	88	7	96	3	60
Tympanic Dehiscence (TYMPDEH)	2	94	8	106	19	63
Post. Condylar Canal Patent (PCANAL)	12	54	34	67	24	47
Condylar Facet Double (CFACET)	0	84	0	88	3	61
Precondylar Tubercle (PRECTUB)	4	85	7	9	7	62
Paracondylar Process (PARAC)	*	*	*	*	13	52
Ant. Condylar Canal Double (ANTCAN)	19	76	23	94	7	48
Foramen Ovale Incomplete (FOVALE)	0	78	2	89	0	53
Foramen Spinosum Open (FSPINOS)	30	72	21	83	7	52
Pterygo-alar Spurs (PASPURS)	20	63	13	23	1	1
Pterygo-spinous Spurs (PSSPURS)	7	55	2	11	4	4
Palatal Suture (PSUTURE)	37	38	35	35	3	21
Acc. Lesser Palatine Foramen (PALATIN)	9	58	22	64	28	38
Palatine Torus (PTORUS)	7	44	4	46	0	21
Zygomaxillary Tubercle (ZYGOMAX)	*	*	*	*	15	49
Marginal Tubercle (MARGTUB)	*	*	*	*	21	50
Zygomatico-facial Foramen (ZFACIAL)	56	80	67	85	44	50
Supraorbital Foramen (SUPFOR)	54	92	46	101	45	66
Acc. Supraorbital Foramen (ACCSUP)	10	93	7	100	9	65
Metopism (METOPISM)	1	47	4	54	0	42
Frontal Foramen or Notch (FRONFOR)	17	93	12	98	9	65
Frontal Grooves (FGROOVE)	*	*	*	*	8	63
Posterior Ethmoid Foramen (POSETH)	48	61	43	46	.	.
Nasal Bone (NASAL)	0	44	1	47	1	25
Accessory Infraorbital Foramen (ACCINF)	12	84	10	81	12	50
Infraorbital Suture (INFRAO)	73	82	57	77	19	50
Accessory Mental Foramen (ACCMENT)	7	79	5	89	0	24
Rocker Jaw (ROCKER)	6	26	6	37	9	15
Mylohyoid Arch (MYLOHY)	18	75	5	89	10	24
Lingula Bridge (LINGULA)	30	77	15	82	0	24
Genial Tubercles (GENIAL TU)	*	*	*	*	16	20
Median Mental Spine (MMSPINE)	*	*	*	*	10	20
Genial Pits (GENIAL PI)	*	*	*	*	19	20

* - trait unobservable
† - bilateral trait frequency equals right plus left sides
n - number of sides present
N - total number of sides observable

Table 8.4 - Continued

	Naqada B & Great		Naqada T		Nubia	
	n	N	n	N	n	N
TRAITS						
Highest Nuchal Line (HNUCH)	8	158	4	58	10	110
Ossicle at Lambda (OSSLAMDA)	9	74	4	29	2	43
Inca Bone (INCABONE)	1	76	2	29	1	52
Lambdoidal Suture Ossicle (LSUTOSS)	34	107	13	49	8	48
Biasterionic Suture (BSUTURE)	7	139	7	48	1	65
Ossicle at Asterion (ASTERIO)	18	144	3	53	5	45
Parietal Foramen (PFORAM)	95	156	42	60	57	85
Obelionic Foramen (OBFORAM)	2	76	3	30	4	42
Coronal Suture Ossicle (COSS)	5	108	2	43	0	58
Os Sagittal Suture (OSSUTURE)	6	49	1	15	0	32
Epipteric Bone (EPIPTER)	14	119	6	40	4	34
Fronto-temporal Articulation (FTART)	122	122	39	39	28	34
Parietal Notch Bone (PNBONE)	11	146	4	53	2	40
Parietal Notch Present (PNOTCH)	114	144	39	53	33	40
Occipitomastoid Wormians (OWORM)	8	131	2	45	1	32
Auditory Torus (ATORUS)	0	157	1	52	0	96
Sutural Foramen (SUTFOR)	82	136	24	46	16	33
Mastoid Foramen (MASTFOR)	104	136	31	46	23	33
Occipital Foramen (OCCFOR)	15	136	4	46	4	33
Tympanic Dehiscence (TYMPDEH)	14	154	13	46	17	90
Post. Condylar Canal Patent (PCANAL)	33	113	12	34	12	39
Condylar Facet Double (CFACET)	2	130	1	35	1	68
Precondylar Tubercle (PRECTUB)	37	138	19	38	6	69
Paracondylar Process (PARAC)	59	108	10	32	5	30
Ant. Condylar Canal Double (ANTCAN)	44	141	11	43	19	76
Foramen Ovale Incomplete (FOVALE)	8	123	3	45	1	48
Foramen Spinosum Open (FSPINOS)	43	122	13	45	8	47
Pterygo-alar Spurs (PASPURS)	3	30	1	7	3	13
Pterygo-spinous Spurs (PSSPURS)	0	12	0	6	*	*
Palatal Suture (PSUTURE)	44	44	11	11	12	12
Acc. Lesser Palatine Foramen (PALATIN)	75	122	17	23	29	64
Palatine Torus (PTORUS)	7	62	6	14	4	53
Zygomaxillary Tubercle (ZYGOMAX)	103	119	26	32	62	88
Marginal Tubercle (MARGTUB)	107	120	36	36	69	93
Zygomatico-facial Foramen (ZFACIAL)	91	117	30	34	88	96
Supraorbital Foramen (SUPFOR)	73	150	29	57	67	121
Acc. Supraorbital Foramen (ACCSUP)	11	150	4	56	23	121
Metopism (METOPISM)	2	76	1	29	1	46
Frontal Foramen or Notch (FRONFOR)	23	150	13	57	9	115
Frontal Grooves (FGROOVE)	35	151	18	54	24	66
Posterior Ethmoid Foramen (POSETH)	55	62	24	25	23	23
Nasal Bone (NASAL)	3	56	4	18	1	22
Accessory Infraorbital Foramen (ACCINF)	12	112	3	29	16	61
Infraorbital Suture (INFRAO)	65	110	19	29	28	62
Accessory Mental Foramen (ACCMENT)	7	113	1	24	8	128
Rocker Jaw (ROCKER)	13	45	5	11	9	34
Mylohyoid Arch (MYLOHY)	7	101	4	24	21	120
Lingula Bridge (LINGULA)	5	104	2	24	6	120
Genial Tubercles (GENIAL TU)	50	58	10	13	47	63
Median Mental Spine (MMSPINE)	38	58	5	13	47	63
Genial Pits (GENIAL PI)	38	58	11	12	53	63

* - trait unobservable

† - bilateral trait frequency equals right plus left sides

n - number of sides present

N - total number of sides observable

Table 8.5 - Matrix of Standardized Mean Measures of Divergence (MMD)† and Their Standard Deviations, Based on Cranial Nonmetric Trait Frequencies*

Skeletal Samples	Abydos	Badari	Keneh	Naqada G&B	Naqada T	Nubia
Abydos	.	0.009	0.001	0.00	0.00	0.00
Badari	**14.59**	.	0.001	0.00	0.00	0.00
Keneh	**16.44**	**13.19**	.	0.001	0.001	0.001
Naqada G&B	**27.39**	**17.69**	**17.70**	.	0.00	0.00
Naqada T	**13.52**	**8.22**	**12.83**	**2.57****	.	0.00
Nubia	**17.82**	**12.85**	**7.61**	**8.49**	**5.17**	.

*Standardized MMD's are in bold on the lower left side of the table; standard deviations are on the upper right side
† All standardized MMD values are statistically significant
**The MMD value for the Naqada G & B vs. Naqada T was calculated using the same number of traits, as in Chapter 6 (i.e., 48 traits)

Figure 8.3 - Euclidean Distance Dendrogram of MMD Values, Based on Cranial Nonmetric Trait Frequencies of Six Nile Valley Skeletal Samples

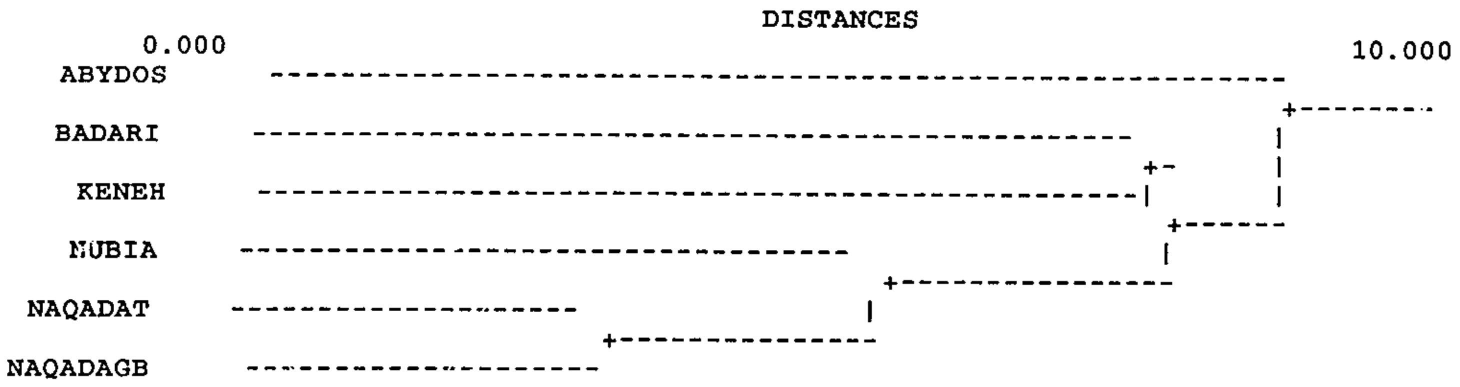
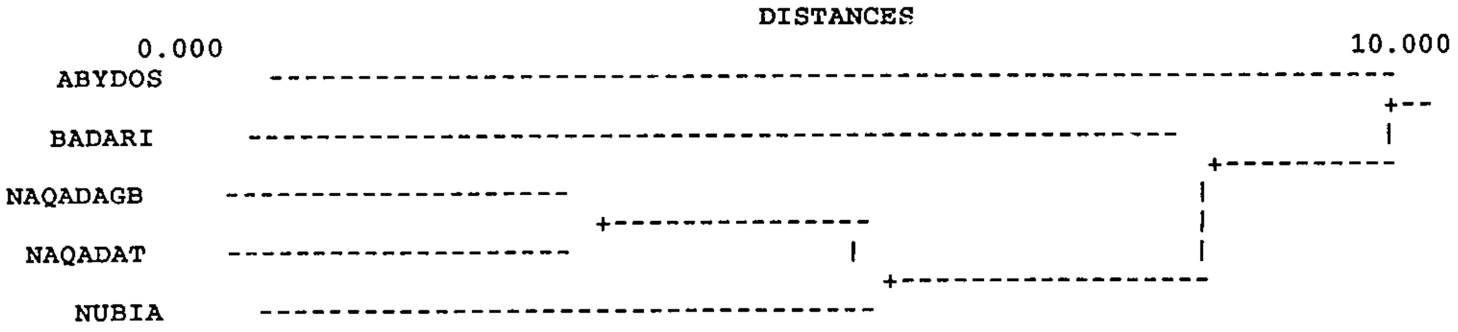


Figure 8.4 - Euclidean Distance Dendrogram of the MMD Values Without the Keneh Sample Included in the Analysis



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CHAPTER 9

CONCLUSIONS

A battery of fifty-eight cranial nonmetric traits were used to investigate the biological affinities of eight skeletal samples from six Nile Valley sites in Egypt and Nubia, using the multivariate Mean Measure of Divergence statistic. The sites of Abydos, Badari, Keneh, and Naqada date to the Predynastic and early Dynastic periods in Egypt. The sites 277 and 179, from the Scandinavian Joint Expedition to Nubia, date to the A-Group and C-Group cultural periods in Nubia respectively. Nonmetric trait frequencies were used to examine biological relationships among these populations at the intrasite and intersite levels, as well as over time.

Prior to biological distance analysis, a methodological study of age, sex and side correlations was performed to determine if these factors have a significant influence on the expression of nonmetric traits. Analysis of age and sex associations with cranial nonmetric trait frequencies revealed that correlations were present in low levels in each of the four samples studied, however, none of the traits that showed age and sex associations within each sample were repeated in any of the other samples. These inconsistent and random correlations suggest that age and sex will not significantly affect the outcome of further biological distance analysis. The Great Cemetery sample from Naqada, however, did have a higher than expected number of significant sex correlations, which may be due to a higher level of sexual dimorphism in that population. Analysis of side associations of bilateral traits found high levels of interdependency and generally positive correlations between right and left sides of the cranium, however, this relationship was not a perfect one. If the genetic model for the inheritance of nonmetric traits is accepted, then it can be assumed that unilateral and bilateral expression of nonmetric traits is largely the result of genetic factors. Therefore scoring both sides of the cranium will provide a more accurate estimation of true trait frequencies, particularly when dealing with fragmentary skeletal material.

An intrasite study of the biological affinities at Naqada found that the elite Cemetery, Cemetery T, was biologically distinct from the other two cemeteries found at that site. Larger tombs, fewer burials and a higher quality and quantity of grave goods provided archaeological evidence for the social differentiation of the individuals buried in Cemetery T. The results of this analysis, in light of the archaeological evidence, suggest that social stratification at Naqada may have been related to biological factors (i.e., an elite segment of the population). The relatively small magnitude of the distances calculated supports the hypothesis that the individuals in Cemetery T were not an immigrant group.

Temporal variation of the biological affinities between the Nubian A- and C-Group samples was also examined using cranial nonmetric trait frequencies. Recent interpretations of the archaeological evidence for cultural diversity between the Nubian A- and C-Groups have concluded that the differences can be explained in terms of a continuum of cultural evolution, and not necessarily through population migration or replacement. Similarly, biological distances based on nonmetric trait frequencies found evidence of the biological continuity of the Nubian A- and C-Groups over time.

A third biological distance study involved a regional analysis of biological affinities among six sites from the Nile Valley. Statistical analysis revealed that all the sites were statistically differentiated from each other. These results suggest the ancient populations of the Nile Valley were characterized by a considerable degree of biological heterogeneity during the Predynastic and early Dynastic periods. It has been proposed that increased desertification prior to the Neolithic period forced populations living in outlying areas to move into the Nile Valley, which may account for some of the biological variation found in this study. Cluster analysis of the standardized MMD values revealed a number of interesting relationships. The Nubian sample was closely related to the Naqada material, supporting archaeological evidence for close cultural contacts between Upper Egypt and Lower Nubia at the end of the Predynastic period. The biological differentiation of Abydos from the other skeletal samples may be explained through migration of elites, and their courtiers, from Lower Egypt during the unification of Upper and Lower Egypt.

The utility of nonmetric analysis in the investigation of biological relationships among past populations has been aptly demonstrated in this study. Cranial nonmetric trait analysis, in conjunction with other forms of skeletal and archaeological evidence, can provide useful models of biological variation among past populations.