CRANIAL DISCRETE TRAIT ANALYSIS OF FOUR MISSISSIPPIAN SITES:

AN INVESTIGATION OF GENETIC RELATIONSHIPS BETWEEN PREHISTORIC POPULATIONS IN ALABAMA

by

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ABSTRACT

The goal of this study was to use discrete trait analysis to elucidate genetic relationships among the following Mississippian sites in Alabama: 1Lu25 (Perry site), 1Lu92 (Koger's Island), 1Ms80 (Harris site), and Msm (Moundville). Previous research (Bass, 1956; Coleman, 1965; Griffin, 1939; Snow, 1941; Webb and DeJarnette, 1942, 1948; Webb and Wilder, 1951) indicated that Moundville was genetically similar to the two sites in the Pickwick Basin (1Lu25, 1Lu92) and 1Ms80. Additionally, the Archaic component of 1Lu25 was found to be physically different from the previously mentioned Mississippian sites. Lastly, there was speculation that women buried at Moundville with nonindigenous pottery were foreign (Welch, 1991, 1993).

Based on this background information, three hypotheses were formulated as to the genetic relationships that would be revealed during the course of this study. First, it was thought that the Archaic sample would prove to be dissimilar from all Mississippian sites. Secondly, it was thought Moundville would prove to be related to 1Lu92, Mississippian 1Lu25, and 1Ms80. Lastly, it was thought that females at Moundville interred with nonlocal pottery would be different from other females at Moundville.

Results supported only some of the hypotheses presented. For instance, Moundville was found to be genetically similar to both sites in the Pickwick Basin, while the Harris site was found to be divergent from all other Mississippian sites. Conversely, the Archaic sample was found to be similar to each of the Mississippian sites. Finally, Moundville females buried with nonlocal pots were revealed to be similar to other Moundville females.

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INTRODUCTION

Discrete trait analysis is a handy tool for examining biological relationships of prehistoric populations. This study uses discrete trait analysis and the Standardized Mean Measure of Divergence to investigate the relationships of five prehistoric populations at four different sites in Alabama: Moundville (Msm), the Perry site (1Lu25), the Harris site (1Ms80) and Koger's Island (1Lu92) (see Figure 1). Moundville is a large Mississippian cultural center located on the Black Warrior river. The Perry site contains both Archaic and Mississippian burials and is located in Lauderdale county on Seven Mile Island. Koger's Island is a small land mass in the Tennessee River, and the Harris site is near Columbus, Alabama.

Previous research (Bass, 1956; Coleman, 1965; Griffin, 1939; Guderjan, 1979; Snow, 1941; Webb and DeJarnette, 1942, 1948; Webb and Wilder, 1951) indicates possible biological and cultural links between Moundville and each of the remaining Mississippian sites. Furthermore, most burials at Moundville containing nonindigenous pottery are the graves of females (Welch, 1991:172, 1993:36). This raises the question of possible links between these women and some other site. Based on this evidence, it is postulated that three different groups of relationships will become evident during the course of analysis. First, the Archaic burials of 1Lu25 will be genetically different from the rest of the Mississippian sites. Second, Moundville will be genetically similar to 1Lu25, 1Lu92, and 1Ms80, but 1Ms80 will differ from 1Lu25 and 1Lu92. Lastly, females buried at Moundville with nonlocal pots are hypothesized to have a different complex of epigenetic traits than other Moundville females.

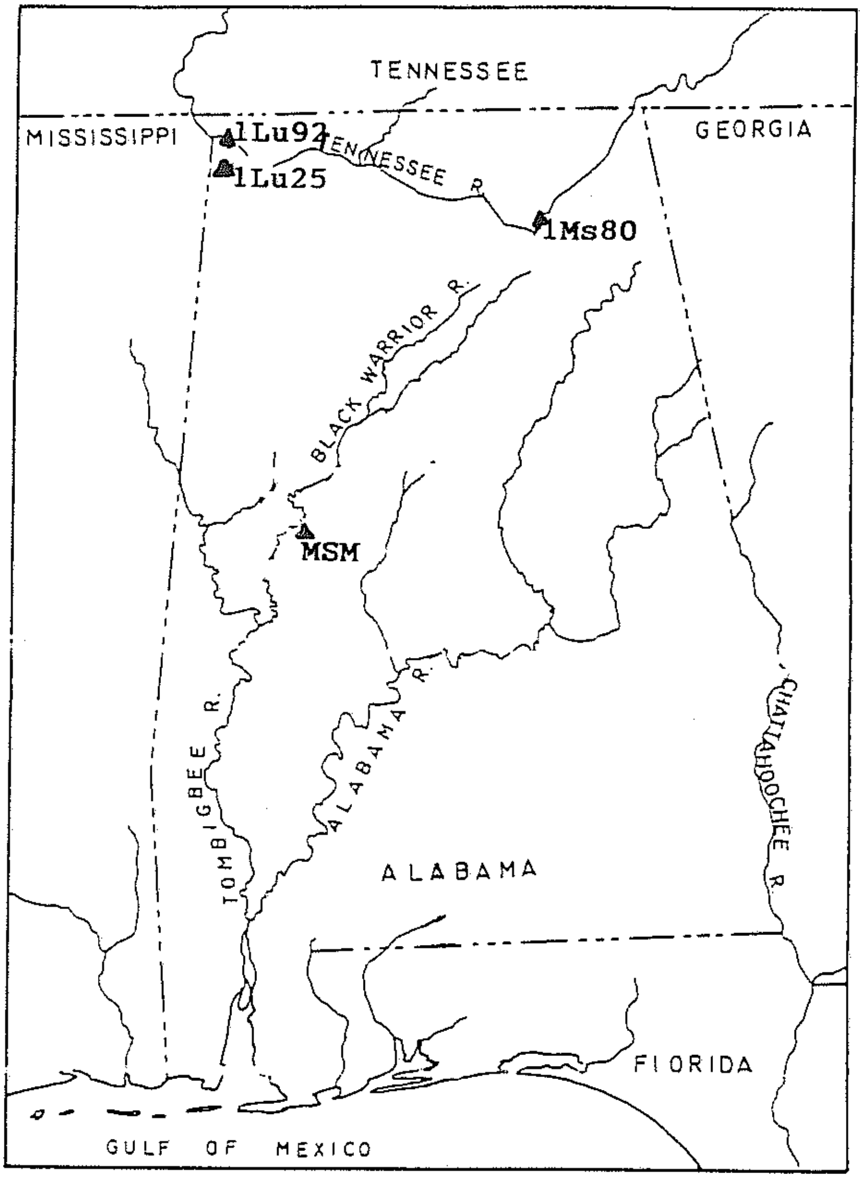


Figure 1: Location of study sites. Msm = Moundville, 1Lu25 = Perry site, 1Lu92 = Koger's Island, 1Ms80 = Harris site. (Adapted from Welch, 1991:24)

Craniometry and Epigenetic Traits

Biological distance, or determining the degree of genetic relatedness between groups, is a vital area of research in anthropology. Not only do biodistance studies provide archaeological information concerning the movements and relatedness of populations, but such studies also have much to contribute to other areas of anthropology. In addition to providing pertinent information on archaeological problems, genetic information is also useful for paleopathological and paleodemographic studies (Buikstra et al., 1990). Two methods for determining genetic relatedness are craniometry and epigenetic trait analysis (Buikstra, 1976; Droessler, 1981; Howells, 1966; Key, 1983; Ossenberg, 1976; Sjøvold, 1973).

Craniometry has had a much longer history than discrete trait analysis in the field of anthropology. In the 1820's when Samuel K. Morton collected and measured skulls of Native Americans, craniometry began to make its mark on physical anthropology. In fact, cranial measurements became so important to physical anthropology that in 1906 an international meeting was held in Monaco to standardize those measurements for the scientific community (Armelagos et al., 1982; Stewart, 1982). Following standardization, prodigious names in anthropology like Boaz (1928), Hooten (1930), and Hrdlicka (1924), all avidly supported the practice of measuring crania.

The purpose of measuring skulls has typically been that of creating taxonomies for racial classification. Prior to evolutionary and genetic theories, thought in physical anthropology was dominated by the notion of static, measurable, discrete types of human beings characterized by unique traits. The skull was measured most frequently since it was thought to be the best indicator of racial affinity (Armelagos et al., 1982). After the development of the theories of evolution and genetic inheritance, scholars were capable of postulating relationships between races with similar morphological and anthropometric features. In other words, human beings were no longer part of a fixed discrete category. Instead, similar features between groups indicated genetic admixture between two or more populations.

Inquiry into the history of craniometry provides a framework to understanding the previous research conducted on Moundville and the two sites in the Pickwick Basin, Koger's Island and the Perry site. Throughout the examination of the genetic relatedness between these sites, explanations revolved around taxonomies and genetic admixture. For instance, Snow (1941) distinguished two physical types from his measurements of 15 restored Moundville adult skulls. These types were the brachycephalic or round-headed type, and the dolichocephalic or long-headed type. He identified the brachycranic type as being closely allied with the Koger's Island type found in the Pickwick Basin, and the dolichocephalic group to be more similar to the Archaic shell mound series represented by the Archaic component of 1Lu25. Snow speculated that the dolichocephalic group at Moundville migrated from the Pickwick Basin. There is no direct evidence that the dolichocephalic and brachycranic groups intermixed, but Snow comments that it is highly unlikely the two coexisted in the same location without some degree of mixing (Snow, 1941:14-15).

An additional study also bases its conclusions on measurements of a sample of Moundville crania (Bass, 1956). These results suggest that the population at Moundville is racially Native American, and demonstrates similarities to the Walcolid type characterized by Newman (1952). Furthermore, Bass suggests the Moundville Indians are practically identical to their contemporaries living in the Pickwick Basin. Finally, Coleman (1965:111), using cranial and dental measurements on 56 Moundville crania, reveals that the Moundville series is closely related to skeletons from the Pickwick Basin, but also suggests that Moundville exhibits distinctly Mongolian features similar to skulls from the Southwest and Eskimo populations.

Advanced techniques and sophisticated statistical measures of distance provide additional viewpoints on the issue of genetic relatedness between Moundville and the Pickwick Basin. A prime example is the study conducted by Guderjan (1979) which uses multivariate cluster analysis to examine the topic. His results show that Archaic groups show more internal homogeneity than do Moundville phase sites. Furthermore, although Moundville (Msm) and the Pickwick sites are more similar than Moundville is to the Archaic sites, the Perry site (1Lu25) stood quite distinct from the Moundville/Koger's Island (1Lu92) comparison (Guderjan, 1979:31).

Analysis of divergence between populations is not limited to studies of craniometry, however. Another research option is epigenetic trait analysis which concentrates on the "developmental and environmental processes that affect cranial growth, and consequently, cranial form" (Armelagos et al., 1982:318). Defined as minor skeletal anomalies, epigenetic traits are simply the phenotypic expression of the genes that control development (Berry and Berry, 1967). Thus, the study of epigenetic traits is a study into the ontogeny of the skull and its interactions with developmental and environmental influences.

A major characteristic of epigenetic traits is heritability. Although most, if not all, epigenetic traits are polygenic (the result of more than one gene), there are two sources of evidence to support the heritability of discrete traits. Unfortunately, both sources of evidence are indirect. Direct evidence must come from a skeletal population for which biological relationships are explicitly recorded for several generations, and such an archaeological finding is rare. One solution to this dilemma is to study epigenetic traits in living populations where genetic relationships are known. Thus, the available evidence of discrete trait inheritance in humans is from familial studies (Berry and Berry, 1967; Sjøvold, 1976-77).

One such familial study concerns the palatine torus and the mandibular torus (Suzuki and Sakai, 1960). The palatine torus is a bony ridge that develops along the midline of the hard palate. The mandibular torus is a similar ridge located along the lingual side of the mandible generally ranging from the premolars back to the molars (see Appendix A). Suzuki and Sakai examined 150 families in three different Japanese villages for these traits since both can be detected in living subjects. The results indicate that both palatine torus and mandibular torus occur with a higher rate in children whose parents also exhibit these traits. In addition, Suzuki and Sakai discovered a close correlation in degree of development of the tori between parents and children (Suzuki and Sakai, 1960:267).

Similarly, Saunders and Popovich (1978) conducted a study on 147 families in Ontario looking for atlas bridging and clinoid bridging. Atlas bridging occurs in the first cervical vertebrae and is a bony division of the vertebral artery grooves (Hauser and DeStefano, 1989:110) (see Appendix B Fig. 16). Clinoid bridging is a similar division but of the clinoid processes of the sphenoid bone (Hauser and DeStefano, 1989:162). Both atlas bridging and clinoid bridging are internal traits and can only be detected in living populations by x-ray. The results indicate a higher correlation of both traits between immediate relatives as opposed to the rest of the population (Saunders and Popovich, 1978).

Indirect evidence of discrete trait heritability is much easier to come by than direct evidence, since not all discrete traits can be easily detected in living populations. One source of indirect evidence results from the simple, widely noted fact that discrete traits occur at different frequencies in different populations (Berry and Berry, 1967; Brothwell, 1959; Hauser and DeStefano, 1989). Thus, epigenetic distributions seem to pattern themselves after distributions of traits known to follow Mendelian inheritance like blood groups (Szathmary and Ossenberg, 1978). A secondary line of evidence results from controlled experiments on mice which seem to demonstrate a clear inheritance of discrete traits (Grüneberg, 1952; Berry, 1968; Berry and Berry, 1967).

From these lines of evidence, a theoretical model for the inheritance of nonmetric traits has been developed. The model rests on the concept of liability, first developed by Falconer (1965,1967) to explain the heritability of polygenic diseases. Falconer defines liability as "all the causes, both genetic and environmental, that make an individual more or less likely to develop the disease..." (Falconer, 1967:1). Falconer further states that "the liability of an individual cannot be measured, but the mean liability of the population or group can be evaluated from the incidence of the disease in that population or group" (Falconer, 1967:1). Thus, the liability of a population forms a normally distributed curve, upon which is a threshold point, or the point on the scale above which individuals are affected and below which individuals are not affected (Falconer, 1965:52). This threshold point allows scholars to compare populations with different mean liabilities. As seen in Figure 2, each population possesses a different mean liability, and comparisons are made with reference to a fixed threshold point.

Hauser and DeStefano (1989) have used this theory of the heritability of disease and applied it to another measurable factor of populations resulting from the effect of combinations of genes and the influence of the surrounding environment: epigenetic traits. Thus, for each trait there is a normally distributed continuum of incidence on which there is a threshold point. The percentage of the population above the threshold exhibit the trait phenotypically, while the percentage below the threshold do not. Falconer (1965,1967) compared different threshold points of disease incidence between populations; likewise, scholars can conduct similar comparisons based on epigenetic traits.

The question then becomes one of how the environment affects the liability distribution and the threshold point. The environment will cause different populations to possess different mean liabilities, which also serves to increase or decrease the percentage of individuals above the threshold point. Thus, as illustrated in Figure 3, an individual in population C is less likely to manifest a trait phenotypically than an individual in population B or A. In this example, the environment shifts the mean liability to the left. The threshold point of a trait remains constant, so the effects of shifting the trait liability

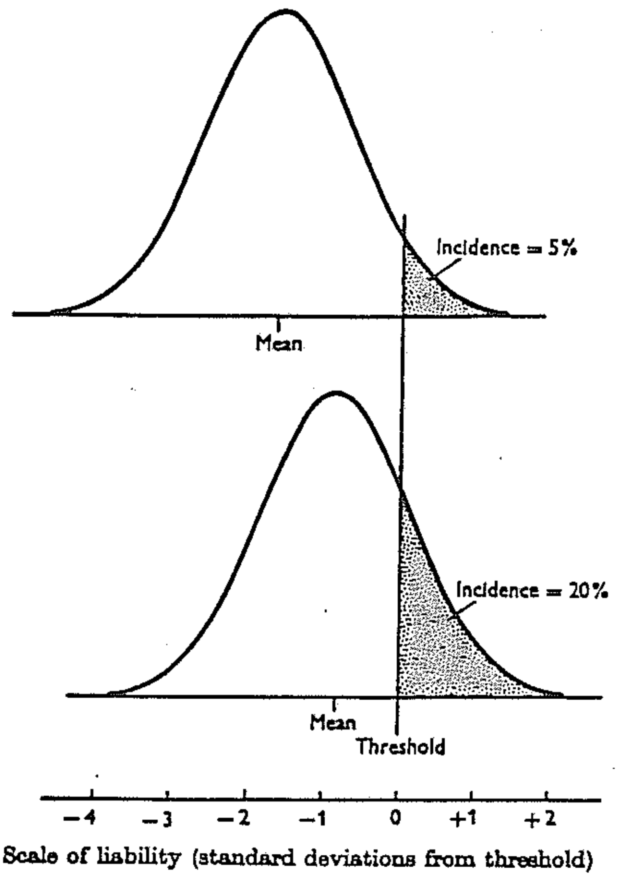


Figure 2: Representations of the liability curves of two populations. Both curves are normally distributed with equal variances. The two populations, compared with respect to a fixed threshold, have different mean liabilities. The result is varying incidences of individuals above the threshold point, represented by the shaded area of the curve. (Adapted from Falconer, 1965:53)

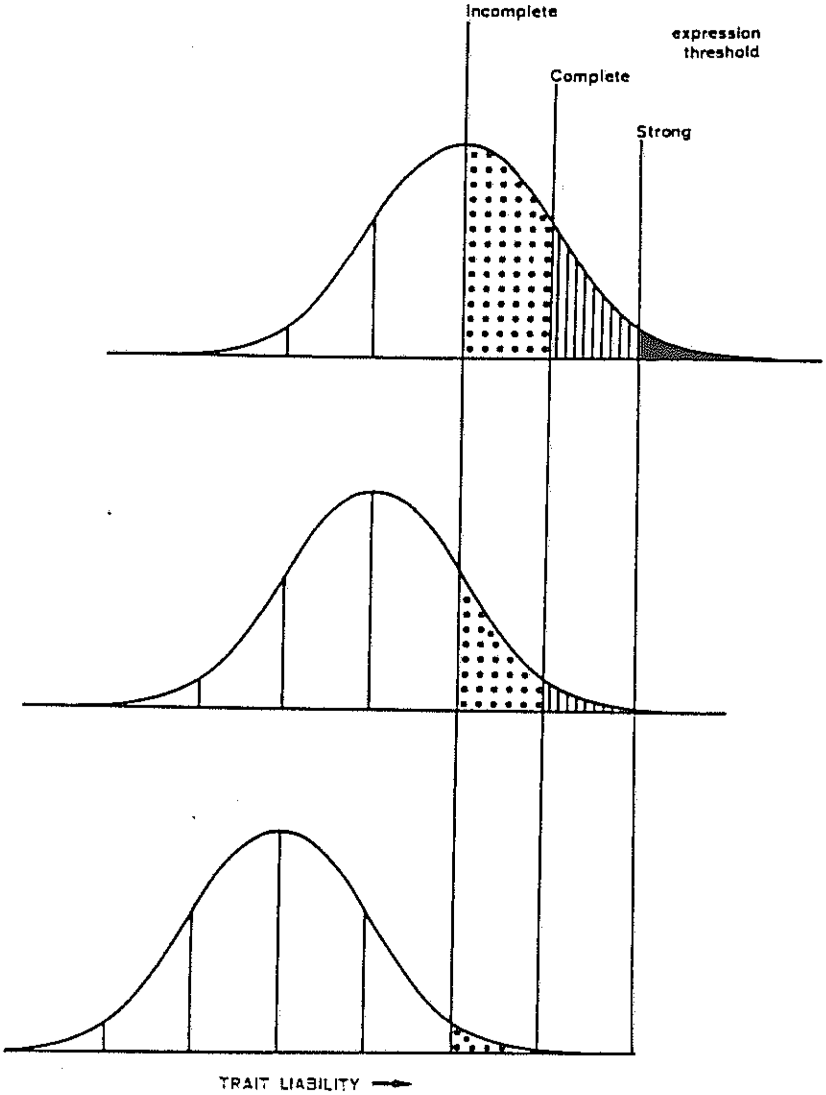


Figure 3: Illustration showing how the environment can shift mean liabilities thereby altering the number of individuals above the threshold. (Adapted from Hauser and DeStefano, 1989:7)

curve to left is a decreasing number of individuals that have phenotypic expression of that trait. If the order of the diagram was reversed so population C was first, it would appear that the environment shifts the mean liability to the right, thereby increasing the number of individuals above the threshold point. Regardless of direction of the shift, however, a greater influence of environment equates to a greater shift in mean liability. In addition, dramatic environmental changes within a single population also have an effect. Environmental upheavals serve to shift the mean liability in a specific population over time. This makes it possible to chart the effects of environment on epigenetic trait expression through time (Hauser and DeStefano, 1989:7-8).

In addition to simply changing the mean liability of a trait, the environment may also enhance or impede the expression of a trait. There are many examples of the environment influencing the expression of a trait in individuals already possessing the inherited potential for development of the trait. For example, Corruccini and Beecher (1984) associate a diet consisting of soft, processed foods with malocclusion of the teeth in baboons. In humans, the mandibular torus has been found to correlate with an increase in consumption of meat, fish and dairy products in Icelandic peoples (Axelsson and Hedegard, 1981). Lastly, auditory exostoses are known to increase in size with cold water swimming (Ascenzi and Balistreri, 1975).

In summary, environmental influences tend to affect the degree of expression of a trait or change the mean liability of a population, yet the genetic threshold point of a trait remains unchanged. Thus, populations having different diets, climates or cultural practices such as cranial deformation (Konigsberg et al., 1993) are still valid subjects for comparison. In fact, the more traits that are examined, the greater the percentage of the population gene pool involved (Berry, 1975; Berry and Berry, 1972); therefore, significant correlations between underlying genotypes, are more likely to become evident if the study is based on a summation of many traits in a population.

An additional feature of epigenetic trait analysis that makes this technique useful is that it can be used to examine patterns of affinity across gender. Patterning in the spatial placement of skeletons which exhibit discrete traits, should yield well-formed tests of culturally instructed behavior patterns. Lane and Sublett (1972) have tested this principle with respect to discrete trait analysis. Using ethnohistorical data on the Seneca Indians ranging from the 1850's to the 1930's, Lane and Sublett hypothesize that the method of using discrete traits to determine residence patterns is viable. Thus, if Seneca social organization kept related males together then the following patterns should be evident:

1. Males within a site will have a homogenous distribution of traits.
2. Males between sites will differ in discrete trait distribution.
3. Females will exhibit more variance within a site than between sites.

Assuming the society kept related females together, then the opposite of the above pattern would be true (Lane and Sublett, 1972:189).

This test of the application of discrete analysis to cultural questions was a success. Lane and Sublett (1972:191) found that females exhibited more divergence within a cemetery than females compared between cemeteries. Furthermore, males and females were greatly divergent from each other within cemeteries, yet males exhibited more variance between sites. The revealed pattern suggested that Seneca social organization kept related males together, a pattern supported by the available ethohistorical data (Lane and Sublett, 1972:198).

Despite the obvious benefits of discrete trait analysis, the technique has met with some criticism from researchers reluctant to assign to discrete trait analysis the precision and reliability traditionally afforded to craniometry. For example, Corruccini (1974) conducted a study on the Terry collection in Washington, DC using both discrete traits and cranial measurements to assess the strength of the epigenetic technique. The findings, later corroborated by Carpenter (1976), suggest that discrete trait analysis is not as reliable as previously thought. On the contrary, Corruccini's (1974) conclusions suggest that discrete trait analysis is most powerful when combined with craniometry. Both methods yield significant results based on genetic affiliation, yet measure different sets of polygenic complexes. Thus, if used together, cranial measurements and discrete trait analysis will provide more genetic information than a single method alone (Corruccini, 1976). Specifically, craniometry is a more reliable method of determining basic affinity, while discrete trait analysis is more useful in the illustration of the processes of affinity like migration and residence patterns (Corruccini, 1974:440).

In contrast, later studies (Cheverud et al., 1979, 1982) suggest both that nonmetric traits are highly inheritable, and that metric and nonmetric traits are highly correlated. The conclusion reached is that discrete and metric traits share genes that control the processes of development; therefore, these two types of traits are two expressions of the same underlying genotype. As a result, there will not be much difference in the results based on the two methods.

An attempt is made in this study to resolve the contrasting viewpoints by utilizing both methods. As no epigenetic research has been done on this area of the Southeast, it is necessary to rely on the previous research on the relatedness of prehistoric populations in Moundville and the Pickwick Basin as a guide. The results of these previous studies are based on craniometry (Bass, 1956; Coleman, 1965; Guderjan, 1979) and other postcranial measurements (Newman and Snow, 1942). Thus, this study incorporates results based on traditional methods and adds epigenetic analysis based on the method developed by Hauser and DeStefano (1989). This method combines qualitative variables such as presence/absence, position, and number of traits present, with quantitative measurements taken of diameters of foramen, lengths of suture extension, and depths of fossas. Essentially, discrete trait analysis is combined with a system of measurement. The combination of the two types of variables serves to standardize the gradient system of scoring nonmetric variables, thus, reducing observer error and improving reliability.

Hauser and DeStefano's (1989) insistence on precision and standardization is a fairly recent concern in epigenetic analysis. Early studies recognized discrete traits as merely anomalies and variants, and were noted, if seen, as curiosities (Corruccini, 1972). Papers were written on these singular anomalies. Examples include the perforation of a parietal in an ancient Egyptian (Derry, 1914), a description of the irregularities of the supra-inial portion of an occipital bone (Hepburn, 1908), and a lengthy discussion of divided parietal bones (Hrdlicka, 1903). It was not until Laughlin and Jorgensen (1956) examined the anomalies with respect to a specific population that the usefulness of discrete traits in physical anthropology began to be tested. Soon after the Laughlin and

Jorgensen study, Brothwell (1959) outlined a plan for using discrete traits to characterize populations. However, it was not until Grüneberg (1952) conducted experiments on discrete traits in mice that epigenetic traits became established as a viable method of determining biological distance. Berry and Berry (1967) extended Grüneberg's research to human populations, providing a standardized trait list for the cranium, based on the presence/absence scoring dichotomy. Since then, studies on epigenetic traits have been numerous and wide ranging (Berry, 1974; Buikstra, 1976; Dahlberg, 1951; Ortner and Corruccini, 1976; Sjøvold, 1973). Hauser and DeStefano (1989) represent the attempt to advance beyond just the noting of presence and absence of some traits to a more comprehensive and descriptive list of cranial traits that includes standardized gradients of expression. Their modifications allow researchers to analyze and compare the presence and expression of traits across populations. Unfortunately, although cited in the literature, these gradients and standardized scoring methods have had limited testing by researchers.

In summary, the Hauser and DeStefano (1989) technique of epigenetic analysis is used to investigate and fine tune previously existing hypotheses concerning the genetic relationships between Moundville and the sites in the Pickwick Basin. The results of previous studies have been based on cranial measurements (Bass, 1956; Coleman, 1965; Guderjan, 1979) and postcranial measurements (Newman and Snow, 1942). This study builds on the previous hypotheses by applying the new method of epigenetic analysis to the data.

Redistribution in chiefdoms and archaeology

Archaeological evidence, such as similarities in pottery styles and other artifacts, supports the notion of contact linking Moundville, 1Lu25, 1Lu92, and 1Ms80. Moundville Black Ware is found at all four sites, for instance, although other artifacts are more site specific. For example, a triangular red stone pendant recovered from the Perry site is speculated to be of Moundville production (Webb and DeJarnette, 1942, plate 58.2; Steponaitis, 1983, figure 10g; Welch, 1991:185). Furthermore, copper pendants discovered at Koger's Island (Webb and DeJarnette, 1942), and strap-handle cooking pots in the Wheeler Basin (Griffin, 1939) link both 1Lu92 and 1Ms80 to Moundville. According to Welch (1991:190), these findings are not unusual since Moundville, being a trade center, tended to export goods to the north and west (see Figure 4). In order to understand the possible cultural implications of trade between Moundville, 1Lu25, 1Lu92, and 1Ms80, it is necessary to examine the dynamics of social structure and the patterned flow of commodities in a Mississippian chiefdom.

Extensive research exists on the internal social structure of the Mississippian chiefdom. It is generally understood that chiefdoms are characterized by complex organization, increased productivity, and dense population. Leadership was institutionalized in the form of a chief who ruled from a paramount center. From this center the chief controlled all the surrounding districts, as well as the outlying farmsteads (Peebles and Kus, 1977; Welch, 1991, 1993).

A prime example of a complex chiefdom is the Natchez (Brown, 1989; Steponaitis, 1978). The Natchez were ruled by two great chiefs: the supreme chief called the Great

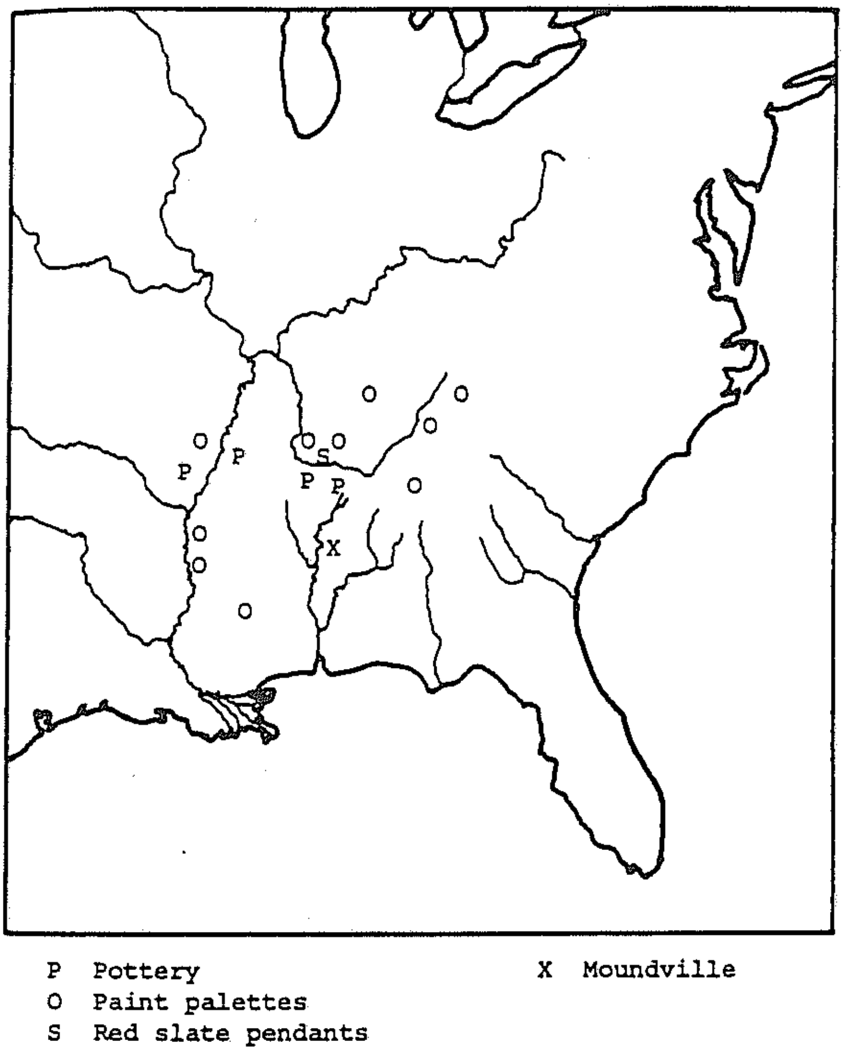


Figure 4: Location and identification of probable exports from Moundville. (Adapted from: Welch, 1991:189)

Sun, and the War Chief called the Tattooed Serpent. Absolute authority was accorded to these rulers including the power of life and death (Brown, 1989). A tight hand was extended over the entire territory through the delegation of responsibility to lower ranking chiefs. These second tier rulers controlled regional districts with the exception of the residence of the Great Sun and the Tattooed Serpent where the two supreme chiefs administered directly (Steponaitis, 1978).

Each district of the Natchez Chiefdom consisted of a ceremonial center and a scattering of villages. The center served as the residence of reigning officials and may have held only a handful of people. The majority of the populace was scattered throughout the countryside in household settlements (Brown, 1989). Commodities flowed from the households to the local district center, and from there to the central district of the Great Sun and Tattooed Serpent. Flow of commodities was facilitated each month by a festival of tribute. According to Swanton (1911), these feasts were grand affairs with much eating, dancing, religious ritual and games.

It is pertinent to note that in the above illustration of the Natchez, commodities flowed upward, yet no mention is made of a reciprocal flow of goods back to the populace. This pattern does not conform to the principle of redistribution, a central identifying concept of chiefdoms. Redistribution involves reciprocity between chief and subjects (Sahlins, 1972:188), yet such reciprocity is not evident in the Natchez social organization.

Contradictions such as this led Peebles and Kus (1977) to examine the organization and process of redistribution more closely. Using precontact Hawaii as an ethnohistorical example, Peebles and Kus (1977) demonstrate that most of the outlying household settlements, called ahupua'a, are self-sufficient in producing subsistence goods. Reciprocal exchange of subsistence goods occurs within an ahupua'a among kinsmen. Districts also participated in reciprocal exchange. Districts in different locations had access to different raw materials and produced different subsistence items. As a result, trade between districts for subsistence goods and raw materials is tantamount to survival.

The question then becomes determining the function of the chief. If goods are redistributed through reciprocity, then according to the traditional definition of a chiefdom, the chief would play no useful role in society. This, however is not the case. Peebles and Kus (1977:425) note that in pre-contact Hawaii the chief controlled the redistribution of luxury goods. Since the chief performed this necessary service, he and his entourage are supported by the people.

In sum, subsistence goods flow upward to the chief and officials of the realm while luxury goods typically flow from the chief to the populace. As a corollary, it should be noted that luxury goods typically have a differential distribution with those in higher classes receiving more exotic and valuable goods than those in the lower classes. Peebles and Kus (1977:425) note that in precontact Hawaii the nobles had access to capes made of feathers, while commoners received gourds to create bowls, or coconut and pandanus fibers to make rope.

Given the above example, the next question is how the flow of commodities in a complex chiefdom appears in the archaeological record. Assuming a person's role and status in life is reflected in the items buried with the individual at death, we can expect to discover certain patterns in the distribution of burial goods. Generally, within a site, individuals of higher status are buried with a higher quality of grave goods than individuals of lower status. Additionally, among the sites that compose a chiefdom, the ceremonial center will contain the individuals with the most exotic grave goods, while the outlying sites will have burials containing lesser exotic goods.

This is precisely the pattern found at Moundville, an extensive Mississippian site located on the Black Warrior River. Within Moundville, the hierarchy of individuals is evident from the differential distribution of exotic grave goods (Steponaitis, 1991). An entire spectrum of wealth is indicated with the elite graves containing copper axes, pearl beads, copper covered shell beads, bear tooth pendants, and the skeletons of infants, while the lower classes were buried with ceramic vessels, projectile points, effigy vessels, or nothing at all (Peebles and Kus, 1977:429).

Additionally, archaeological evidence sheds light on the social structure and flow of commodities within the Moundville chiefdom. While the internal dynamics of a Moundville phase site replicates the distribution of exotic goods in mortuary rituals at Moundville, the highest ranking officials at Moundville phase sites lack the most valuable of all goods - the copper ax. This indicates that officials at these Moundville phase sites are lower in rank than the chief who resided at Moundville (Peebles and Kus, 1977:441).

Lastly, archaeological evidence can be used to examine interregional trade, or trade between chiefdoms. A large gap exists in the literature concerning relations between polities. There is evidence at Moundville that such trade existed in the forms of marine shells from the Florida Gulf coasts, ceremonial objects from Tennessee, copper from the

Appalachians and Great Lakes (Goad, 1978) and pottery from the North and West (Peebles and Kus, 1977:443; Steponaitis, 1983,1991:208). There is no doubt trade existed, yet there is little information concerning the dynamics of such trade.

Welch (1991:175) has tried to fill the gap in the literature by tracing nonlocal luxury items through Moundville's system of redistribution. The archaeological evidence at Moundville and surrounding sites seems to indicate that distribution of nonlocal goods depends on the value and function of the object. For example, nonlocal ceramics are only found at Moundville, yet Mill Creek chert hoes are widely distributed. Nonetheless, analysis of craft production sites indicates manufacture with nonlocal materials only at Moundville (Steponaitis, 1991; Welch, 1993). Thus, while there are some nonlocal objects that begin and end their use life at Moundville, others begin life at Moundville and end their life at outlying mound sites (Welch, 1993:37). The evidence implies that interregional trade essentially equates to trade between paramount centers. In other words, as depicted in Figure 5, Moundville is the center from which nonlocal prestige goods enter and leave the Moundville chiefdom. Some nonlocal prestige goods that enter Moundville flow to the single mound centers while others remain at Moundville. Similarly, local prestige goods are exported from Moundville to other regions and are shipped to local single mound centers. In contrast, subsistence items flow up the scale from the outlying homestead sites to local single mound centers, and finally end up at Moundville.

The question of interregional trade is further elucidated by a concentrated examination of the provenience of nonlocal pottery at Moundville. Most of the nonlocal

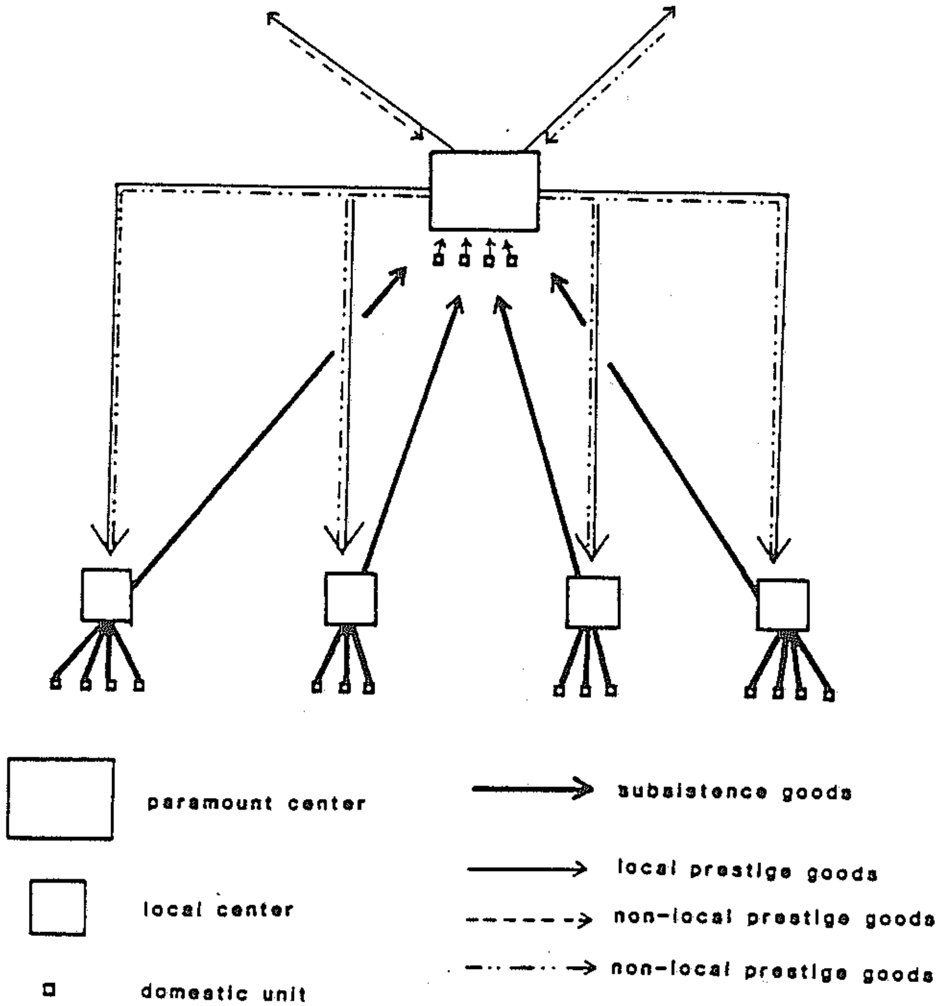


Figure 5: Illustration of the flow of subsistence and prestige goods in the Moundville economy. Subsistence goods tend to flow upwards to the paramount center. Prestige goods are imported and exported from the paramount center and flow downwards towards the domestic units. (Adapted from Welch, 1991:180)

pots are buried with females (Welch, 1993:37). This raises the interesting question of whether or not those females are nonlocal individuals who brought their pottery with them (Welch, 1991:172). If so, then interregional trade at Moundville may also be connected to residence patterns and political alliances. This issue is examined using epigenetic analysis coupled with the hypotheses postulated by Lane and Sublett (1972). In other words, if the females buried with nonlocal pots are, in fact, immigrants to Moundville, then they should exhibit a different complex of discrete traits from other females at Moundville, and be more similar to the females of some other site.

In summary, interregional trade between Moundville and other chiefdoms seems to be limited to trade between the paramount centers. In addition to trading objects and raw materials, there is the possibility that women were also traded as marriageable partners. The evidence for this hypothesis lies with the fact that all nonlocal pots at Moundville are buried with women (Welch, 1991:172). Epigenetic trait analysis is used in this study to genetically test the implication of the archaeological evidence.

METHODS

Site Description

The sites selected for this study based on the biological and archaeological evidence available are 1Lu25 (Perry site), 1Lu92 (Koger's Island), Msm (Moundville), and 1Ms80 (Harris site). Moundville is a major Mississippian cultural center located on the Black Warrior River in Moundville, Alabama. This site is the second largest prehistoric mound site, with only Cahokia being larger. The Perry site, 200 miles north of Moundville, is a shell mound in Lauderdale county on the north shore of Seven Mile Island. This site is unique in that there are two components. Originally, the Perry site was late Archaic with a radiocarbon date of 2815 +/- 250BC (Guderjan, 1979:6). Later, there was an extensive Mississippian occupation during the Moundville phase. These intrusive Mississippian burials seem to be very similar in type to another site in the Pickwick Basin, the Koger's Island site (Webb and DeJarnette, 1942:82). Koger's Island is a Moundville phase village and cemetery located on Koger's Island in the Tennessee River (Webb and DeJarnette,1942:212). The last site, the Harris site, is a small village site located on the West Bank of the Tennessee River near Columbus, Alabama (Webb, 1951) (refer to Figure 1).

Sampling of Skeletons

Sampling of skulls is for this study is based on the sample of a previous study (Bridges, 1989). The selection criteria for the previous study is based on whether or not a definite cultural designation, Archaic or Mississippian, could be assigned to the burial (n=160). The Moundville sample is subjected to a different selection process, however. It was necessary to know which individuals were buried with nonlocal pots, thus a list of nonlocal pots with gravelot numbers was used (Steponaitis, 1983) (n=19). The remaining Moundville sample came from Bridges's (1989) original sample (n=8) or selection based on whether or not most of the skull was present (n=25). A conplete list of burial numbers used in the study is given in Appendix C.

Table 1 depicts basic demographics of the sample by site. From the 204 individuals scored, 34 are categorized as Archaic. Of those 34 skeletons, there is an equal number of males and females. Overall, the distribution of males and females is fairly even. Moundville is the exception, however, with 17 more females than males. The mean age of the entire sample is 34.7 years, and the mean age at each site tends to fall around this central tendency ranging from 31 years to 36.5 years.

Measurements

Skeletal material was examined at the Alabama Museum of Natural History Laboratory of Human Osteology at the University of Alabama. Skulls were examined for epigenetic traits as defined by Hauser and DeStefano (1989) (see Appendix A and B). The actual scoring consists of several determinations: presence or absence, number, position, size and gradation level. Presence is scored with a 1, absence with a 0, and unscorable traits are denoted with a 9. Number refers to quantity of the trait, and position is scored with respect to side, except in the cases of mental foramen, mandibular tori, and maxillary tori, where position is scored according to the proximity of the nearest premolar. Measurements of size vary according to trait categories. Foramen and notches are measured using standardized steel drill blanks produced by the MSC Industrial Supply

		Sex		Mean Age
		Males	Females	
Site	1Ms80	10	10	36.5
	Msm	15	32	31.3
	1Lu92	30	29	35.6
	Archaic 1Lu25	17	17	35.8
	Mississippian 1Lu25	17	22	33.8

Table 1: Basic sample demographics of males and females at study sites.

Company, ranging in size from 1mm to 6mm in .5mm increments. If more than one foramen is present, both are noted with the larger being measured, as suggested by Hauser and DeStefano (1989). The remaining traits are measured with a metric ruler in millimeters. For example, tubercles and spines are measured according to the length of protrusion from the skull. Ossicles are sized according to the length of the diameter of the bone, and lastly, depth is the determining factor of depression measurements.

In addition, grades and degrees of expression are scored using the standards set by Hauser and DeStefano (1989) in various diagrams and verbal descriptions (see Appendix A and B). It is important to note that form and degree of expression are two terms describing the same phenomenon. Simply stated, a single trait may have several different manifestations of phenotypic expression. For example, the hypoglossal canal, a bilateral trait piercing the base of the two occipital condyles (Hauser and DeStefano, 1989:120), may either be undivided or divided by an osseous bridge. However, between those two extremes, many differing expressions exist. The canal may be divided by the slightest trace of a bony bridge, or only halfway divided. This spectrum of expression is the very thing Hauser and DeStefano (1989:1-2) attempt to clarify and standardize. All data are recorded on standardized scoring sheets. (see Appendix D).

Selection of Traits

Due to the many contrasting scholarly opinions surrounding epigenetic traits, care is essential when selecting variants to include in the analysis. This section outlines and describes possible confounding factors associated with discrete traits and the consequent elimination of specific variants found to pose problems in the study.

Sex

Although Berry and Berry (1967), Brothwell (1959), and Berry (1974) argue that discrete traits are not associated with sex, others state that certain traits like parietal foramen (Coseddu et al., 1979), and frontal grooves (Corruccini, 1974) show distinct signs of sexual dimorphism. One method of compensating for a possible correlation is by eliminating commonly cited sexually dimorphic traits (Buikstra, 1976). However, this approach is problematic as there does not seem to be a standard list of sexually dimorphic traits. Hauser and DeStefano (1989:9) present the best solution to the dilemma. They suggest analyzing the data first by differentiating between the sexes. To that end, chi-square tests ($\alpha = .05$) of independence are calculated for sex and presence/absence of a trait (see Table 2). The following traits demonstrate significant chi-square values for sex, and are, therefore, eliminated from the study: Highest nuchal line, craniopharyngeal canal, foramen of Vesalius, frontal grooves, auditory torus, palatine torus, pharyngeal tubercle, mastoid foramen, supratrochlear lateral foramen, mandibular torus, pharyngeal foveola, and tympanic aperture.

Representation and Reliability

It is also important to consider consistency of measurement and frequency of occurrence when selecting traits for epigenetic analysis. Too few occurrences of a trait or unreliable measurements would both seriously hamper and bias conclusions. For this reason, traits that could not be scored consistently, mainly due to lack of access to an x-ray machine, are eliminated from the study. These traits are clinoid bridging, and shape of maxillary sinuses, nasal cavities, and orbital openings. In addition, the following traits are

Chi Square Values for Trait Versus Sex

Trait	χ^2	p-value
Accessory Mandibular Foramen	.479	.48
Anterior Ethmoidal Foramen	.008	.92
*Auditory Torus	40.8	<.001
Biasterionic Suture	.729	.39
Bifid Mandibular Condyles	1.02	.31
Canal of Robinson Orifice	1.12	.28
Condylar Foramen	2.50	.11
*Craniopharyngeal Canal	4.35	.03
Double Occipital Condylar Facet	.414	.52
Epipteric Bone	1.33	.24
*Foramen of Vesalius	3.84	.05
Frontal Grooves	6.90	.009
Fronto-temporal Articulation	1.02	.31
*Highest Nuchal Line	4.22	.04
Inca Bone	2.32	.12
Inferior Parietal Foramen	3.0	.055
Inferior Squamous Foramen	.004	.95
Infraorbital Foramen	.905	.34
Infraorbital Suture	2.67	.10
Intermediate Condylar Canal	.945	.33
Jugular Foramen Bridging	1.05	.30
Lesser Palatine Foramen	.345	.55
*Mandibular Torus	5.97	.01
Marginal Foramen	.167	.68
Marginal Tubercle	1.28	.25
*Mastoid Foramen	4.02	.04
Maxillary Torus	.122	.72
Median Basilar Canal	.001	.97
Metopic Suture	.908	.34
Molar Foramen	.803	.37
Mylohyoid Bridging	2.90	.08
Nasal Foramen	.302	.58
Occipital Foramen	1.93	.16
Occipitomastoid and Asterion Ossicles	1.09	.29
*Palatine Bridging	3.89	.04
*Palatine Torus	11.5	<.001
Paracondylar Process	.503	.47
Parietal Foramen	.090	.76
Parietal Notch Bone	.773	.37
Parietal Process of the Temporal Squama	2.91	.08
*Pharyngeal Foveola	11.1	<.001
Pharyngeal Tubercle	7.71	.005
Postglenoid Foramen	.025	.87

Table 2: Chi square values for the comparison between trait and sex. Traits with significant values are marked with an asterix.

Trait	χ^2	p-value
Precondylar Tubercle	<.001	.99
Pterygo-alar Bridge	1.09	.29
Pteryo-spinous Bridge	.698	.40
Retromastoid Process	.061	.80
Retromolar Foramen	2.95	.08
Squamomastoid Suture	.147	.70
Squamous Ossicles	1.03	.31
Superior Squamous Foramen	.586	.44
Suprameatal Spine and Depression	2.80	.09
Supranasal Suture	2.93	.08
Supraorbital Lateral Foramen	.359	.54
Supraorbital Medial Foramen	1.42	.23
Supraorbital Medial Notch	1.49	.22
***Supratrochlear Lateral Foramen**	9.41	.002
Supratrochlear Medial Foramen	<.001	.99
Supratrochlear Notch	.644	.42
Transverse Palatine Suture	1.47	.22
Trochlear Spine	2.76	.096
***Tympanic Aperture**	3.90	.04
Zygomatico-facial Foramen	.119	.73
Zygomaxillary Tubercle	2.42	.11

Table 2: Continued.

excluded because they only appear in the sample once or not at all: atlas bridging (none present), bifid condyles (one present), canal of robinson (one present), metopic fissure (none present), metopic suture (one present), os japonicum (none present), supraorbital lateral notch (none present), squamous ossicles (one present), symmetrical thinness of parietal bones (none present), and partitioned temporal squama (none present).

In addition, following Buikstra's (1976) example, all traits that are not represented at all four sites are eliminated from the study. This method bolsters the comparability of the traits when converted to standardized MMD's. The traits eliminated in this manner are listed here with the site or sites that do not exhibit the trait: epipteric bone (1Ms80), inca bone (1Ms80), palatine bridging (1Ms80), postglenoid foramen (1Ms80), parietal notch bone (1Ms80), parietal process of the temporal squama (1Ms80), precondylar tubercle (MSM, 1Ms80), retromastoid process (1Ms80), and superior squamous foramen (1Ms80, 1Lu92). Three additional traits, supraorbital lateral foramen, anterior ethmoidal foramen, and marginal foramen are not present in the subsample of Moundville females buried with nonlocal pottery, so they were eliminated from that single comparison.

Age

Epigenetic traits are, by definition, subject to the genes controlling development, which would make it reasonable to assume that age is greatly correlated with discrete traits. However, the evidence for age dependence is neither consistent nor convincing. For example, Korey (1970) found many traits to be age dependent, such as tympanic aperture, hypoglossal canal, infraorbital foramen and epipteric bones. Yet, Berry (1975) only discovered age dependence of the tympanic aperture, which was later denied by

Dodo (1974), Corruccini (1974), and Cesnys (1985). Hauser and DeStefano (1989:9) conclude that the evidence for age dependency of traits is insufficient in all cases save for subadults. For this reason, individuals (n=36) estimated to be less than 18 years of age are excluded from the study.

Symmetry and Asymmetry in Bilateral traits

Many previous studies have stated that there is a significant level of independence between the presence of bilateral traits and side on which the trait occurs (Korey, 1970, Buikstra, 1976). In fact, it is generally assumed that bilaterality of discrete traits is governed by the principle of morphogenetic homeostasis. Simply stated, morphogenetic homeostasis means that symmetry is favored over asymmetry in the phenotypic expression of bilateral traits (Parsons and Howe, 1967; Green et al., 1979). For instance, the phenotypic expression of mental foramen, openings on the external surface of the mandible generally below the premolars (Hauser and DeStefano, 1989:230), is more likely to occur on both the right side and the left side of the mandible (symmetry) as opposed to only one side (asymmetry).

In view of this morphogenetic homeostasis, presence of a trait will be counted by individuals as opposed to sides. In other words, a trait will be scored as present once if it appears on one or both sides of the skull. This technique has been successfully used by both Korey (1970), and Buikstra (1976). Admittedly, this technique underestimates trait frequency (Green et al., 1979; Buikstra, 1976), but it provides more information in a collection of fragmentary skeletons than simply scoring the trait only if it appears on one arbitrarily chosen side.

Intertrait correlation

Traits that are close in proximity on the skull, such as metopism and supraorbital and supratrochlear foramen (Ossenberg, 1969), demonstrate dependence in other studies (Hertzog, 1968; Bergman and Hauser, 1985). Accordingly, chi square tests of significance (α=.05) are conducted on remaining pairwise combinations of traits (Buikstra, 1976:51). A significant chi square test is interpreted as an undesirable correlation of phenotypic expression between two traits requiring the elimination of one of the pair. Table 3 is an extensive listing of the pairwise chi square tests and results. Variants found to exhibit a correlation with one or more traits, indicated by a significant chi square value, are eliminated from the study. Excluded traits are as follows: accessory mandibular foramen, fronto-temporal articulation, double occipital condylar facet, condylar foramen, biasterionic suture, inferior parietal foramen, intermediate condylar canal, inferior squamous foramen, squamomastoid suture, marginal tubercle, molar foramen, maxillary torus, jugular foramen bridging, infraorbital suture, nasal foramen, paracondylar process, occipital condylar foramen, pterygo-spinous bridge, pterygo-alar bridge, supranasal suture, median basilar canal, and supraorbital medial notch.

It should be noted here that any sequential statistical test with a set α level leads to an increased amount of error. The probability of error (α) is multiplied each time the test is performed, thus some of these significant correlations may be spurious. An association is thought to be spurious if two statistically correlated traits are not in close proximity to each other on the skull. For instance, the median basilar canal is on the occipital bone yet is significant when compared to the supraorbital medial foramen, a trait located on the

Trait	Bis		Cf		Docf		Fta		Icc		Ins	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Amf	.187	.67	1.44	.23	.343	.56	.827	.36	1.53	.22	.354	.55
Bis	--	--	3.52	.06	.156	.69	N/A	N/A	N/A	N/A	.129	.72
Cf	--	--	--	--	**4.09**	**.04**	N/A	N/A	N/A	N/A	.579	.45
Docf	--	--	--	--	--	--	N/A	N/A	.083	.77	1.20	.27
Fta	--	--	--	--	--	--	--	--	N/A	N/A	.719	.39
Icc	--	--	--	--	--	--	--	--	--	--	N/A	N/A

Trait	Ipf		Isqf		Jfb		Lpf		Maxt		Mbc	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Amf	.022	.88	1.14	.29	.050	.82	1.43	.23	<.001	.99	.271	.60
Bis	.393	.53	.072	.79	.189	.66	.210	.65	2.33	.13	.694	.40
Cf	.690	.41	**5.47**	**.02**	.225	.63	.138	.71	.135	.71	2.44	.12
Docf	1.21	.27	**6.38**	**.01**	.923	.34	**7.61**	**.006**	.559	.45	.079	.78
Fta	.118	.73	**10.3**	**.001**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Icc	N/A	N/A	.105	.75	N/A	N/A	N/A	N/A	.039	.84	.576	.45
Ins	***5.49**	**.02**	1.12	.29	<.001	1.0	1.61	.21	**4.06**	**.04**	***8.93**	**.003**
Ipf	--	--	.362	.55	.462	.50	.459	.50	.460	.50	2.34	.13
Isqf	--	--	--	--	.117	.73	.420	.52	.697	.40	.067	.80
Jfb	--	--	--	--	--	--	.225	.63	N/A	N/A	.381	.54
Lpf	--	--	--	--	--	--	--	--	.048	.83	1.63	.20
Maxt	--	--	--	--	--	--	--	--	--	--	3.59	.06

Table 3: Pairwise Chi square test for intertrait correlation. Significant values are in boldface type. Suspicious associations are marked with an asterix.

Trait	Mf		Molf		Mt		Mylo		Nf		Ocf	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Amf	.520	.47	.736	.39	.126	.72	.004	.95	.709	.40	.309	.58
Bis	.802	.37	.810	.37	.084	.77	1.12	.29	.954	.33	2.42	.12
Cf	.589	.44	2.95	.09	1.07	.30	1.48	.22	***6.78**	**.009**	.064	.80
Docf	.598	.44	1.13	.29	.961	.33	3.55	.06	.538	.46	.170	.68
Fta	N/A	N/A	1.71	.19	N/A	N/A	.339	.56	N/A	N/A	N/A	N/A
Icc	.150	.70	.479	.49	.143	.71	.87	.59	N/A	N/A	N/A	N/A
Ins	.095	.76	.040	.84	**3.72**	**.05**	2.74	.10	2.07	.15	.249	.62
Ipf	.022	.88	1.33	.25	2.74	.10	.940	.33	.562	.45	***5.19**	**.02**
Isqf	.804	.37	**8.64**	**.003**	.922	.34	3.19	.07	.802	.37	.138	.71
Jfb	.492	.48	.577	.45	1.76	.19	.009	.92	.762	.38	.024	.88
Lpf	.323	.57	1.10	.29	.253	.62	.752	.39	.248	.62	2.83	.09
Maxt	**4.57**	**.03**	<.001	.99	.859	.35	.518	.47	.366	.55	.820	.37
Mf	--	--	.028	.87	.072	.79	.902	.34	1.14	.29	.237	.63
Molf	--	--	--	--	2.48	.12	1.86	.17	1.16	.28	.852	.36
Mt	--	--	--	--	--	--	.920	.34	.552	.46	.286	.59
Mylo	--	--	--	--	--	--	--	--	.283	.59	.013	.91
Nf	--	--	--	--	--	--	--	--	--	--	.172	.68

Trait	Omao		Para		Pf		Ptal		Pts		Rmf	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Amf	.417	.52	.343	.56	.657	.42	**4.32**	**.04**	**5.48**	**.02**	1.64	.20
Bis	1.35	.24	1.68	.20	**4.45**	**.03**	.002	.97	<.001	1.0	.961	.33
Cf	.253	.61	.234	.63	1.14	.29	2.00	.16	2.39	.12	1.84	.18
Docf	.609	.44	3.11	.08	.044	.83	.126	.72	.392	.53	1.29	.26
Fta	***4.48**	**.03**	N/A	N/A	N/A	N/A	.815	.37	N/A	N/A	.160	.69
Icc	N/A	N/A	N/A	N/A	.373	.54	1.05	.30	1.29	.26	.311	.58
Ins	.009	.93	.761	.38	.310	.58	.814	.37	.488	.48	.414	.52
Ipf	1.98	.16	<.001	1.0	.512	.47	.005	.94	1.70	.19	<.001	1.0
Isqf	.030	.862	.137	.71	2.42	.12	.858	.35	1.11	.29	.029	.86
Jfb	.852	.36	1.71	.19	**9.32**	**.002**	<.001	1.0	.772	.38	.007	.94
Lpf	.303	.58	.231	.63	1.23	.27	.011	.91	1.14	.29	.586	.44
Maxt	.261	.61	1.90	.17	.051	.82	.001	.97	.006	.94	<.001	.98
Mbc	N/A	N/A	.133	.71	.113	.74	.095	.76	.067	.80	.005	.94
Mf	1.48	.22	.545	.46	.260	.61	.605	.44	.032	.86	1.29	.26
Molf	.518	.47	.685	.41	.002	.97	.009	.92	<.001	.98	**4.47**	**.03**
Mt	.310	.58	***4.47**	**.03**	1.43	.23	.008	.93	.079	.78	3.63	.06
Nf	.918	.34	<.001	1.0	.301	.58	.016	.90	.079	.78	.002	.96
Ocf	.113	.74	.218	.64	.028	.87	.013	.91	.007	.93	***6.25**	**.01**
Omao	--	--	.408	.52	1.36	.24	.420	.52	**6.50**	**.01**	.019	.89
Para	--	--	--	--	**4.69**	**.03**	**4.98**	**.03**	.003	.95	.237	.63
Pf	--	--	--	--	--	--	.633	.43	.086	.77	.578	.45
Ptal	--	--	--	--	--	--	--	--	.014	.91	.116	.73
Pts	--	--	--	--	--	--	--	--	--	--	.544	.46

Table 3: Continued.

Trait	Sms		Sn		Solf		Somf		Somn		Sq	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Amf	.868	.35	.561	.45	1.23	.27	.286	.59	1.06	.30	**7.76**	**.005**
Bis	.637	.42	.838	.36	1.55	.21	1.62	.20	.577	.45	2.17	.14
Cf	.206	.65	2.85	.09	.101	.75	2.73	.10	.166	.68	.854	.36
Docf	.772	.38	.297	.59	.022	.88	1.15	.28	.011	.92	1.92	.17
Fta	.031	.86	.127	.72	.273	.60	.619	.43	**4.57**	**.03**	.899	.34
Icc	.048	.83	***4.05**	**.04**	.183	.67	1.59	.21	.375	.54	1.16	.28
Ins	.099	.75	.273	.60	**3.98**	**.04**	.573	.45	.062	.80	.589	.44
Ipf	1.23	.27	1.02	.31	1.71	.19	.486	.49	.086	.77	.273	.60
Isqf	1.17	.28	<.001	.98	1.16	.28	.125	.72	.834	.36	.264	.61
Jfb	.229	.63	.667	.41	.099	.75	.480	.49	.274	.60	.248	.62
Lpf	.111	.74	.513	.47	.428	.51	.800	.37	.289	.59	.104	.75
Maxt	.383	.54	1.37	.24	.038	.85	**3.99**	**.04**	1.77	.18	.051	.82
Mbc	.309	.58	2.01	.16	.004	.95	**5.71**	**.02**	.398	.53	3.63	.06
Mf	1.28	.26	.276	.60	.269	.60	.007	.94	.206	.65	1.06	.30
Molf	.642	.42	**9.81**	**.002**	<.001	.99	.178	.67	1.84	.18	1.57	.21
Mt	.524	.47	.458	.50	.137	.71	.040	.84	1.67	.20	.792	.37
Nf	.434	.51	.659	.42	.199	.66	.152	.70	.705	.40	**4.71**	**.03**
Ocf	1.89	.17	.883	.35	1.48	.22	.397	.53	1.02	.31	.057	.81
Omao	.427	.51	.227	.63	.443	.51	1.50	.22	.005	.94	.005	.94
Para	.495	.48	.002	.97	.003	.95	2.62	.11	.148	.70	.260	.61
Pf	.057	.81	.918	.34	2.02	.16	1.48	.22	.064	.80	3.75	.052
Ptal	2.04	.15	1.12	.29	1.25	.26	***6.95**	**.008**	.037	.85	.736	.39
Pts	**3.83**	**.05**	.775	.38	3.58	.06	.414	.52	.470	.49	<.001	1.0
Rmf	2.17	.14	<.001	.99	.116	.73	.173	.68	.559	.45	2.96	.09
Sms	--	--	1.29	.26	.382	.54	.378	.54	1.36	.24	3.30	.07
Sn	--	--	--	--	.430	.51	**6.57**	**.01**	.212	.65	1.49	.22
Solf	--	--	--	--	--	--	1.71	.19	**5.84**	**.02**	.007	.93
Somf	--	--	--	--	--	--	--	--	**16.9**	**<.001**	***5.40**	**.02**
Somn	--	--	--	--	--	--	--	--	--	--	2.73	.10

Table 3: Continued.

Trait	Stmf		Stn		Ts		Zff		Zmt	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Amf	**10.1**	**.001**	3.17	.07	.871	.35	.082	.77	2.03	.15
Bis	1.17	.28	.302	.58	.414	.52	<.001	.99	.032	.86
Cf	2.52	.11	1.45	.23	N/A	N/A	.452	.50	.307	.58
Docf	2.35	.12	.012	.91	.291	.59	***15.9**	**<.001**	3.19	.07
Fta	.580	.45	.299	.58	.048	.83	**7.36**	**.007**	N/A	N/A
Icc	.488	.48	.257	.61	N/A	N/A	.127	.72	N/A	N/A
Ins	.399	.53	.092	.76	.140	.71	.236	.63	.079	.78
Ipf	.135	.71	.183	.67	.307	.58	.275	.60	.197	.66
Isqf	1.12	.29	2.14	.14	.210	.65	2.69	.10	2.79	.09
Jfb	.326	.57	.567	.45	**6.63**	**.01**	1.05	.30	.186	.67
Lpf	.011	.92	.204	.65	.146	.70	.249	.62	.849	.36
Maxt	.373	.54	.003	.96	.217	.64	.943	.33	.146	.70
Mbc	.897	.34	1.83	.18	.010	.92	.826	.36	.540	.46
Mf	.081	.78	.004	.95	.742	.39	.118	.73	.983	.32
Molf	.010	.92	1.38	.24	<.001	1.0	.011	.92	.374	.54
Mt	.235	.63	.121	.73	1.27	.26	.905	.34	.108	.74
Nf	***4.06**	**.04**	.705	.40	1.11	.29	.825	.36	.295	.59
Ocf	.036	.85	2.23	.14	3.28	.07	1.84	.17	.958	.33
Omao	.034	.85	.266	.61	.197	.66	.706	.40	.703	.40
Para	.124	.72	2.33	.13	.270	.60	.041	.84	1.95	.16
Pf	.398	.53	.101	.75	1.52	.22	3.47	.06	2.76	.10
Ptal	.957	.33	.813	.37	<.001	1.0	1.12	.29	.073	.79
Pts	.040	.84	.442	.51	.672	.41	2.73	.10	.006	.94
Rmf	1.23	.27	.047	.83	.783	.38	.556	.46	.003	.95
Sms	1.87	.17	.368	.54	.215	.64	1.08	.30	<.001	.99
Sn	.642	.42	.733	.39	.097	.76	.819	.37	.075	.78
Solf	1.65	.20	.768	.38	.026	.87	.087	.77	.270	.60
Somf	2.68	.10	.204	.65	.066	.80	.042	.84	.380	.54
Somn	.897	.34	.470	.49	1.37	.24	.023	.88	.002	.96
Sq	**5.36**	**.02**	.044	.83	.824	.36	<.001	.99	.032	.86
Stmf	--	--	2.46	.12	.168	.68	.011	.92	1.33	.25
Stn	--	--	--	--	.121	.73	.002	.97	.115	.73
Ts	--	--	--	--	--	--	.032	.86	2.03	.15
Zff	--	--	--	--	--	--	--	--	.063	.80

Table 3: Continued.

Trait Abbreviation	Trait Name
Amf	Accessory Mandibular Foramen
Bis	Biasterionic Suture
Cf	Condylar Foramen
Docf	Double Occipital Condylar Facet
Fta	Fronto-Temporal Articulation
Icc	Intermediate Condylar Canal
Ins	Infraorbital Suture
Ipf	Inferior Parietal Foramen
Isqf	Inferior Squamous Foramen
Jfb	Jugular Foramen Bridging
Lpf	Lesser Palatine Foramen
Maxt	Maxillary Torus
Mbc	Median Basilar Canal
Mf	Marginal Foramen
Molf	Molar Foramen
Mt	Marginal Tubercle
Nf	Nasal Foramen
Ocf	Occipital Foramen
Omao	Occipitomastoid and Asterion Ossicles
Para	Paracondylar Process
Pf	Parietal Foramen
Ptal	Pterygo-alar Bridge
Pts	Pteryo-spinous Bridge
Rmf	Retromolar Foramen
Sms	Suprameatal Spine and Depression
Sn	Supranasal Suture
Solf	Supraorbital Lateral Foramen
Somf	Supraorbital Medial Foramen
Somn	Supraorbital Medial Notch
Sq	Squamomastoid Suture
Stmf	Supratrochlear Medial Foramen
Stn	Supratrochlear Notch
Ts	Trochlear Spine
Zff	Zygomatico-facial Foramen
Zmt	Zygomaxillary Tubercle

Table 3: Legend

frontal bone. However, it is better to err on the side of caution, so those variants with questionable associations were eliminated from the study nonetheless.

Final trait list

The final list of variants unaffected by confounding variables is listed below. The frequencies per site of each of these twelve traits are summed and converted into standardized Mean Measure of Divergence scores. The results indicate which population groups are genetically similar and which groups are not.

1. Zygomaxillary tubercle
2. Supraorbital medial foramen
3. Supratrochlear medial foramen
4. Supratrochlear notch
5. Zygomatic-facial foramen
6. Suprameatal spine and depression
7. Retromolar foramen
8. Supraorbital lateral foramen
9. Anterior ethmoidal foramen
10. Lesser palatine foramen
11. Marginal foramen
12. Parietal foramen

Traits for Gradation of Expression analysis

In addition to the traits listed above, there is also a group of traits that cannot be analyzed by the SMMD test. Simply stated, these variants cannot be analyzed based on the presence/absence dichotomy because they are always present on skulls scorable for that trait. Thus, these traits must be analyzed based on the frequencies of different forms and degrees of expression. This study uses the gradations designed by Hauser and DeStefano (1989) to accomplish this task (see Appendix A). The traits involved are:

1. Lambdoid suture
2. Posterior ethmoidal foramen
3. Oval foramen

4. Mental foramen
5. Infraorbital foramen
6. Hypoglossal canal
7. Genial tubercles
8. Foramen spinosum
9. Coronal suture
10. Sagittal suture
11. Transverse palatine suture

Statistical analysis

Chi square

Chi square tests of independence at $\alpha = .05$ are used to test the validity of the measured epigenetic traits. A significant chi square test is considered to indicate a confounding variable or an undesirable correlation, with the consequent elimination of that trait from the study (Buikstra, 1976:53).

Frequencies

Frequencies are computed for all variables on basic presence/absence data and the differing degrees of expression created by Hauser and DeStefano (1989). Basic frequencies are calculated according to the formula p/n where p is the incidence of the trait or form of the trait, and n is the number of skulls scorable for that trait.

Mean Measure of Divergence

The Mean Measure of Divergence sums the angular transformation of the incidence of epigenetic traits per trait per population. Devised by C.A.B. Smith, the Mean Measure of Divergence was first used by Grewal (1962), and later used and outlined by Sjøvold (1973). Green and Suchey (1976) modified the formula by incorporating the Freeman-Tukey transformation for small sample sizes, and this modification has been used by researchers (Johnson and Lovell 1994). The modified formula is:

$$MMD = \frac{\sum(\varnothing_1-\varnothing_2)^2-[(1/n_1+½)+(1/n_2+½)]}{N}$$

where

$\varnothing = ½\sin^{-1}(1-2[p/n_1+1]) + ½\sin^{-1}(1-2[p+1/n_2+1])$ measured in radians
p = incidence of the trait
n = the number of scorable skulls for a trait
N = total number of summed traits

The variance for the Mean Measure of Divergence statistic is the following:

$$VAR_{MMD} = 2/N^2\sum[((1/n_1+½) + (1/n_2+½))^2]$$

and the standard deviation is calculated as

$$SD_{MMD} = \sqrt{VAR_{MMD}}$$

To facilitate comparisons, distance scores are standardized by dividing the raw MMD score by its standard deviation. Standardization allows distance scores from samples of differing sizes to be compared (Sofaer et al., 1986). According to Sjøvold (1973), any SMMD score greater than 2.0 is statistically significant at the α=.05 level.

RESULTS

The first part of the analysis consists of discussing frequency tables of the analysis of form for the list of traits that are always present in skulls scorable for that trait. A prime example of this category of traits is the three major sutures of the cranium: the coronal, the sagittal, and the lambdoid. The coronal suture joins the frontal to the parietals, the sagittal suture joins the two parietals, and the lambdoid suture is the junction of the parietals to the occipital (Hauser and DeStefano, 1989:84). Each suture is scored on the basis of three criteria: size of suture extension, suture configuration, and the shape of secondary protrusions. The suture extension can be described as the maximum length of the major fingerlike projections along the cranium. Suture configuration, on the other hand, is the overall shape and appearance of the suture. Secondary protrusions are the small projections off the main suture extension (see Appendix B, Fig. 13).

With those definitions, discussion of the varying forms of sutures is possible. Coronal suture extensions tend to be very small or nonexistent in the Archaic component of 1Lu25 implying that Archaic coronal sutures are almost plain wobbly lines (see Table 4). Likewise, Moundville and 1Ms80 skulls have coronal sutures with trace extensions, while small to medium extensions are most common at Mississippian 1Lu25 and 1Lu92. Sagittal suture extensions tend to be large spanning across all five groups with Moundville exhibiting a relatively high frequency of medium extensions, and 1Ms80 maintaining a relatively high frequency of small extensions (see Table 5). Lastly, lambdoid suture extensions are more similar to those of the sagittal suture because the highest frequencies for all five groups are categorized as large (see Table 6).

Frequency Table for Coronal Suture Extensions										
	Moundville		**Miss 1Lu25**		**Archaic 1Lu25**		**1Lu92**		**1Ms80**	
	p/n	**%**	**p/n**	**%**	**p/n**	**%**	**p/n**	**%**	**p/n**	**%**
Absent (1)	3/21	14	2/16	12.5	5/14	36	5/27	19	--	--
Trace (2)	9/21	43	3/16	18.75	5/14	36	2/27	7	3/5	60
Small (3)	7/21	33	5/16	31.25	2/14	14	9/27	33	2/5	40
Medium (4)	2/21	9.5	5/16	31	2/14	14	9/27	33	--	--
Large (5)	--	--	1/16	6	--	--	2/27	7	--	--
Excessive (6)	--	--	--	--	--	--	--	--	--	--
Total Scorable	21/52	40	16/39	41	14/34	41	27/59	46	5/20	25
Unscorable (9)	31/52	60	23/39	59	20/34	59	32/59	54	15/20	75

Table 4: Frequencies of the varying forms of Coronal suture extensions

Frequency Table for Saggital Suture Extensions										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Absent (1)	--	--	--	--	--	--	--	--	--	--
Trace (2)	--	--	--	--	--	--	1/24	4	--	--
Small (3)	2/18	11	--	--	--	--	2/24	8	2/6	33
Medium (4)	6/18	33	2/10	20	4/15	27	6/24	25	--	--
Large (5)	9/18	50	6/10	60	11/15	73	13/24	54	4/6	67
Excessive (6)	1/18	6	2/10	20	--	--	2/24	8	--	--
Total Scorable	18/52	35	10/39	26	15/34	44	24/59	41	6/20	30
Unscorable (9)	34/52	65	29/39	74	19/34	56	35/59	59	14/20	70

Table 5: Frequencies of varying forms of Sagittal suture extensions

Frequency Table for Lambdoid Suture Extensions										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Absent (1)	--	--	--	--	--	--	--	--	--	--
Trace (2)	--	--	--	--	1/10	10	--	--	--	--
Small (3)	1/13	8	--	--	--	--	1/29	3	1/4	25
Medium (4)	2/13	15	--	--	4/10	40	8/29	28	1/4	25
Large (5)	8/13	62	13/15	87	5/10	50	13/29	45	2/4	5
Excessive (6)	2/13	15	2/15	13	--	--	7/29	24	--	--
Total Scorable	13/52	25	15/39	38	10/34	29	29/59	49	4/20	20
Unscorable (9)	39/52	75	24/39	62	24/34	71	30/59	51	16/20	80

Table 6: Frequencies of the varying forms of Lambdoid suture extensions

Just as each suture reveals its own type of extension, similarly each suture exhibits a unique primary configuration. For instance, the coronal suture is most commonly simple in its configuration at Archaic 1Lu25, Moundville and 1Ms80 (see Table 7). Although Mississippian 1Lu25 and 1Lu92 demonstrate coronal sutures with simple configurations, both sites have an approximately equal proportion of individuals exhibiting a widely looped configuration. The majority of sagittal suture configurations, on the other hand, are widely looped for all five groups (see Table 8). Lambdoid suture configuration is predominately narrow looped (see Table 9) with the exception of Moundville where the most common configuration is widely looped.

Secondary protrusions also differ according to the suture examined. Coronal sutures generally do not have secondary protrusions (see Table 10) while the majority of sagittal secondary protrusions are weakly expressed for all sites except Moundville (see Table 11). Interestingly, sagittal sutures at Moundville resemble coronal sutures in that most do not exhibit secondary protrusions. Finally, the lambdoid suture exhibits weakly expressed secondary protrusions although Mississippian 1Lu25 reveals equal frequencies in both weakly expressed and well expressed categories (see Table 12).

In addition to the three primary sutures of the skull, there are many other traits that must be analyzed according to degree of expression. One of those traits is the transverse palatine suture, the suture that joins the palatine bones to the palatine process of the symmetric transverse, although some variations may occur (see Table 13) (see Appendix B, Fig. 29). Four of the five groups analyzed have the straight symmetric form of this

Frequency Table for Coronal Suture Configuration										
	Moundville		**Miss 1Lu25**		**Archaic 1Lu25**		**1Lu92**		**1Ms80**	
	p/n	**%**	**p/n**	**%**	**p/n**	**%**	**p/n**	**%**	**p/n**	**%**
Simple (1)	14/21	67	5/16	31	9/14	64	8/27	29.6	5/5	100
Widely Dentate (2^d)	4/21	19	2/16	12.5	2/14	14	2/27	29	--	--
Widely Looped (2^l)	3/21	14	6/16	37.5	3/14	21	8/27	29.6	--	--
Narrow Dentate (3^d)	--	--	2/16	12.5	--	--	1/27	4	--	--
Narrow Looped (3^l)	--	--	1/16	6.25	--	--	8/27	29.6	--	--
Total Scorable	21/52	40	16/39	41	14/34	41	27/59	46	5/20	25
Unscorable (9)	31/52	60	23/39	59	20/34	59	32/59	54	15/20	75

Table 7: Frequencies of varying Coronal suture configurations

Frequency Table for Saggital Suture Configuration										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Simple (1)	--	--	--	--	--	--	1/23	4	--	--
Widely Dentate (2^{d})	4/18	22	3/10	30	--	--	1/23	4	1/6	17
Widely Looped (2^{l})	13/18	72	7/10	70	13/15	87	16/23	69.6	5/6	83
Narrow Dentate (3^{d})	1/18	6	--	--	1/15	7	1/23	4	--	--
Narrow Looped (3^{l})	--	--	--	--	1/15	7	4/23	17	--	--
Total Unscorable	18/52	35	10/39	26	15/34	44	23/59	39	6/20	30
Unscorable (9)	34/52	65	29/39	74	19/34	56	36/59	61	14/20	70

Table 8: Frequencies of varying forms of Sagittal suture configurations

Frequency Table for Lambdoid Suture Configuration										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Simple (1)	--	--	--	--	--	--	--	--	--	--
Widely Dentate (2^d)	--	--	--	--	--	--	1/29	3	1/4	25
Widely Looped (2^l)	8/13	62	5/15	33	3/10	30	8/29	28	1/4	25
Narrow Dentate (3^d)	--	--	1/15	7	--	--	1/29	3	--	--
Narrow Looped (3^l)	5/13	38	9/15	60	7/10	70	19/29	66	2/4	50
Total Scorable	13/52	25	15/39	38	10/34	29	29/59	49	4/20	20
Unscorable (9)	39/52	75	24/39	62	24/34	71	30/59	51	16/20	80

Table 9: Frequencies of differing forms of Lambdoid suture configurations

Frequency Table for Coronal Suture Protrusions										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Absent (1)	11/21	52	11/16	69	10/14	71	14/27	52	5/5	100
Weakly Expressed (2)	8/21	38	5/16	31	4/14	29	8/27	29.6	--	--
Well Expressed (3)	2/21	9.5	--	--	--	--	2/27	7	--	--
Strongly Expressed (4)	--	--	--	--	--	--	3/27	11	--	--
Total Scorable	21/52	40	16/39	41	14/34	41	27/59	46	5/20	25
Unscorable (9)	31/52	60	23/39	59	20/34	59	32/59	54	15/20	75

Table 10: Frequencies of the varying forms of Coronal suture secondary protrusions

Frequency Table for Saggital Suture Protrusions										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Absent (1)	9/18	50	1/10	10	1/15	7	4/24	17	2/6	33
Weakly Expressed (2)	6/18	33	9/10	90	14/15	93	17/24	71	4/6	67
Well Expressed (3)	3/18	17	--	--	--	--	2/24	8	--	--
Strongly Expressed (4)	--	--	--	--	--	--	1/24	4	--	--
Total Scorable	18/52	35	10/39	26	15/34	44	24/59	41	6/20	30
Unscorable (9)	34/52	65	29/39	74	19/34	56	35/59	59	14/20	70

Table 11: Frequencies of the differing forms of Sagittal suture secondary protrusions

Frequency Table for Lambdoid Suture Protrusions

	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Absent (1)	1/13	8	--	--	--	--	1/29	3	--	75
Weakly Expressed (2)	8/13	62	7/15	47	9/10	90	14/29	48	3/4	25
Well Expressed (3)	4/13	31	7/15	47	1/10	10	9/29	31	1/4	--
Strongly Expressed (4)	--	--	1/15	6	--	--	5/29	17	--	--
Total Scorable	13/52	25	15/39	38	10/34	29	29/59	49	4/20	20
Unscorable (9)	39/52	75	24/39	62	24/34	71	30/59	51	16/20	80

Table 12: Frequencies of differing forms of Lambdoid suture secondary protrusions

Frequency Table for the Transverse Palatine Suture Configuration										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Symmetric, Straight (a)	5/8	50	2/4	50	6/8	75	9/11	82	--	--
Straight, Extensions (b)	2/8	25	--	--	--	--	1/11	9	--	--
Irregular Junction (c)	1/8	12.5	1/4	25	--	--	--	--	2/3	67
Symmetric, Convexity (d)	--	--	--	--	--	--	--	--	--	--
Convex (e)	--	--	1/4	25	--	--	--	--	--	--
Irregular, Convexity (f)	1/8	12.5	--	--	--	--	--	--	--	--
Anterior Convexity (g)	--	--	--	--	--	--	--	--	--	--
Symmetric, Anterior, Convex (h)	--	--	--	--	2/8	25	--	--	1/3	33
Rectangular (i)	--	--	--	--	--	--	1/11	9	--	--
Total Scorable	8/52	15	4/39	10	8/34	24	11/59	19	3/20	15
Unscorable (9)	44/52	85	35/39	90	26/34	76	48/59	81	17/20	85

Table 13: Distribution of differing forms of the Transverse Palatine suture

suture as the highest frequency. The only exception is 1Ms80 which has an unusually high frequency of an asymmetrical irregular junction of the two halves of the transverse suture. Similarly, the mylohyoid bridge, an osseous covering of the mylohyoid groove on the inside of the mandibular ramus (Hauser and DeStefano, 1989:234), has one predominant form, that of a complete bridge (see Table 14) (see Appendix B, Fig. 37). The frequency tables indicate an overwhelming number of mylohyoid bridges are complete when the scoring is based on a dichotomy of complete versus incomplete. The only exception to this is the Archaic sample of 1Lu25 which has a much lower frequency of complete bridges.

Two traits have one predominant position as opposed to form. These traits were scored according to position with respect to a specific cranial landmark. For example, the mental foramen, apertures on the external surface of the mandible (Hauser and DeStefano, 1989:230), are scored with respect to the nearest premolar (see Table 15). Frequencies indicate that mental foramen have a much greater tendency to be located just under the second premolar as opposed to the first. Likewise, posterior ethmoidal foramen, apertures in the back of the ethmoid near the orbital plate of the frontal bone (Hauser and DeStefano 1989:58), are either lying on the ethmoidal-frontal suture or above it. The frequency tables indicate that posterior ethmoid foramen are predominately located on the suture (see Table 16).

Genial tubercles, median mental spine, and genial pit are all manifestations of muscle attachments at the midline, lingual side of the mandible (Hauser and DeStefano, 1989:236). Such muscle attachments cause many individual variations in appearance (see

Frequency Table for the Completeness of the Mylohyoid Bridge

	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Complete (c)	6/6	100	4/4	100	6/9	67	9/10	90	4/4	100
Incomplete (i)	--	--	--	--	3/9	33	1/10	10	--	--
Total Scorable	6/52	12	4/39	10	9/34	26	10/59	17	4/20	20
Unscorable (9)	46/52	88	35/39	90	25/34	74	49/59	83	16/20	80

Table 14: Percentages of complete and incomplete Mylohyoid bridges

Frequency Table for the Placement of the Mental Foramen										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
First Premolar (1)	5/39	13	2/37	5	--	--	5/51	9.8	1/16	6.25
Second Premolar (2)	34/39	87	35/37	95	33/33	100	46/51	90	15/16	94
Total Scorable	39/52	75	37/39	95	33/34	97	51/59	86	16/20	80
Unscorable (9)	13/52	25	2/39	5	1/34	3	8/59	14	4/20	20

Table 15: Variants of the position of Mental foramen

Frequency Table for the Placement of the Posterior Ethmoidal Foramen

	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Above suture (a)	--	--	--	--	--	--	1/12	8	--	--
Below suture (b)	--	--	--	--	--	--	--	--	--	--
Suture (s)	12/12	100	8/8	100	5/5	100	11/12	92	2/2	100
Total Scorable	12/52	23	8/39	21	5/34	15	12/59	20	2/20	10
Unscorable (9)	40/52	77	31/39	79	29/34	85	47/59	80	18/20	90

Table 16: Distribution of differing positions of the Posterior Ethmoidal foramen

Appendix B, Fig. 38). For instance, a pit could be paired with a spine, there could be three tubercles, or simply a single pit. The most common variation appears to be two superior tubercles (see Table 17). Four of the groups have relatively high frequencies of the two superior tubercles and one inferior tubercle variation, while Moundville is approximately divided between two superior tubercles and one inferior tubercle and two superior and two inferior tubercles.

Foramen are either classified as undivided or divided, with several different degrees of division. A prime example is the oval foramen which is an elliptical foramen in the pterygoid process of the greater wing of the sphenoid bone (Hauser and DeStefano, 1989:149) (see Appendix B, Fig. 24). The most common form of the oval foramen is undivided, that is to say, a complete foramen (see Table 18). The five groups studied have very small percentages of divided oval foramen. Of the divided foramen, a partially incomplete oval foramen is the most frequent, and it occurs at the Mississippian sites. Similarly, the foramen spinosum, the smaller circular foramen of the greater wing of the sphenoid, is most commonly complete (undivided) (see Table 19), yet the small percentages of divided foramen spinosum are much higher than the frequencies of divided oval foramen. The most common form of divided foramen spinosum is an extreme degree of incompleteness. Another example is the hypoglossal canal, defined previously, which is also most frequently undivided with a relatively small percentage of divided canals (see Table 20) (see Appendix B, Fig. 17). Of those divided canals, Archaic 1Lu25, Msm, Mississippian 1Lu25, 1Lu92, and 1Ms80 all exhibit relatively high frequencies of complete divisions. Msm and 1Ms80, on the other hand, exhibit high frequencies of trace divisions.

	Moundville		Mississippian 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Absent (a)	--	--	--	--	--	--	--	--	--	--
Single Pit (b)	--	--	--	--	--	--	1/49	2	--	--
Superior pit, inferior tubercle (c)	--	--	2/35	6	--	--	1/49	2	--	--
Two superior tubercles, one inferior tubercle (d)	4/33	12	10/35	29	8/28	29	14/49	29	7/18	39
Median spine (e)	--	--	2/35	6	1/28	4	6/49	12	1/18	6
Superior and inferior pit (f)	--	--	--	--	--	--	--	--	--	--
Two superior tubercles (g)	24/33	73	16/35	46	19/28	68	25/49	51	9/18	50
Two superior and two inferior tubercles (h)	5/33	15	5/35	14	--	--	2/49	4	1/18	6
Total Scorable	33/52	63	35/39	90	28/34	82	49/59	83	18/20	90
Unscorable (9)	19/52	37	4/39	10	6/34	18	10/59	17	2/20	10

Table 17: Frequencies of differing forms of Genial tubercles, spine, and pit

Frequency Table for the Division of the Oval Foramen										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Complete (a)	23/27	85	20/24	83	17/19	89	34/38	89	14/15	93
Trace (b)	--	--	--	--	--	--	--	--	--	--
Partial (c)	--	--	--	--	--	--	--	--	--	--
Partial , trace (d)	--	--	--	--	1/19	5	--	--	--	--
Confluent (e)	1/27	4	--	--	--	--	--	--	--	--
Partial oval (f)	--	--	4/24	17	--	--	--	--	--	--
No medial wall oval (g)	1/27	4	--	--	1/19	5	1/38	3	--	--
No medial wall, fissure (h)	--	--	--	--	--	--	--	--	1/15	7
No medial wall, both (i)	--	--	--	--	--	--	2/38	5	--	--
Incomplete (j)	2/27	7	--	--	--	--	1/38	3	--	--
Total Scorable	27/52	52	24/39	62	19/34	56	38/59	64	15/20	75
Unscorable (9)	25/52	48	15/39	38	15/34	44	21/59	36	5/20	25

Table 18: Percentages of variations in the expression of the Oval foramen

Frequency Table for the Division of the Foramen Spinousm

	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Complete (a)	15/24	62.5	18/28	64	14/21	67	27/35	77	10/14	71
Trace (b)	--	--	--	--	--	--	--	--	--	--
Partial (c)	--	--	--	--	--	--	2/35	5.7	--	--
Partial , trace (d)	--	--	--	--	1/21	5	--	--	--	--
Confluent (e)	1/24	4	1/28	4	--	--	--	--	--	--
Partial oval (f)	--	--	--	--	--	--	--	--	--	--
No medial wall oval (g)	--	--	--	--	--	--	1/35	2.9	1/14	7
No medial wall, fissure (h)	--	--	--	--	--	--	--	--	--	--
No medial wall, both (i)	--	--	--	--	--	--	1/35	2.9	--	--
Incomplete (j)	8/24	33	9/28	32	6/21	29	4/35	11	3/14	21
Total Scorable	24/52	46	28/39	72	21/34	62	35/59	59	14/20	70
Unscorable (9)	28/52	54	11/39	28	13/34	38	24/59	41	6/20	30

Table 19: Percentages of varying forms of the foramen Spinosum

Frequency Table for the Division of the Hypoglossal Canal										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Undivided (1)	12/18	67	22/30	73	20/28	71	30/41	73	8/16	50
Trace (2)	2/18	11	1/30	3	2/28	7	3/41	7	6/16	37.5
Incomplete (3)	--	--	2/30	7	1/28	4	3/41	7	--	--
Partial up (4a)	--	--	--	--	1/28	4	1/41	2	--	--
Partial down (4b)	1/18	6	2/30	7	1/28	4	--	--	--	--
Complete (5)	3/18	17	3/30	10	4/28	14	4/41	9.8	2/16	12.5
Total Scorable	18/52	35	30/39	77	28/34	82	41/59	69	16/20	80
Unscorable (9)	34/52	65	9/39	23	6/34	18	18/59	31	4/20	20

Table 20: Percentages of varying degrees of division of the Hypoglossal canal

Lastly, the infraorbital foramen is most often undivided, or only divided by a trace of a bridge. Located on the external surface of the maxilla below the infraorbital margin (Hauser and DeStefano, 1989:70), only a relatively small percentage of infraorbital foramen exhibit any form of division greater than a trace (see Table 21) (see Appendix B, Fig. 10). Extreme division, evidenced by multiple foramina instead of one foramen, is greatest at Moundville, although some multiple foramina are found at the other sites as well.

Discussing the frequency of traits used in the calculation of SMMD scores is the second part of this analysis. These frequencies provide a genetic profile of the populations in this study as well as insight into how these populations vary. All of these traits were scored according to the presence/absence dichotomy (see Table 22). A few of these traits were also scored based on degrees of expression. A perfect example is the anterior ethmoidal foramen which is located towards the front of the ethmoidal-frontal suture (Hauser and DeStefano, 1989:58). Nearly always present, the anterior ethmoidal foramen is very similar to the posterior ethmoidal foramen discussed earlier. Not only is this trait nearly always present, but it is also most often located on the ethmoidal-frontal suture as opposed to above it (see Table 23). Similarly, zygomatic-facial foramen are scored on both presence/absence and form. These foramen are located on the facial surface of the zygomatic bone (Hauser and DeStefano, 1989:224) and exhibit varying high frequencies of presence in the different populations studied . The form of the zygomatic-facial foramen translates into the position of the foramen on the zygomatic bone (see Appendix B, Fig. 35). For example, most foramen are located on the frontal process of the

Frequency Table for Infraorbital Foramen Divisions										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Absent, Trace (a)	11/21	52	22/27	81	17/19	89	18/26	69	13/17	76
Weak, Strong (b)	1/21	5	--	--	--	--	2/26	8	1/17	6
Multiple, Excess (c)	9/21	43	5/27	19	2/19	11	5/26	19	3/17	18
Multiple, Excess (d)	--	--	--	--	--	--	1/26	4	--	--
Total Scorable	21/52	40	27/39	69	19/34	56	26/59	44	17/20	85
Unscorable (9)	31/52	60	12/39	31	15/34	44	33/59	56	3/20	15

Table 21: Percentages of variations in the division of the Infraorbital foramen

Trait	Moundville			Mississippian 1Lu25			Archaic 1Lu25			1Lu92			1Ms80		
	p/n	%	9	p/n	%	9	p/n	%	9	p/n	%	9	p/n	%	9
Anterior Ethmoidal Foramen	12/12	100	40	6/6	100	33	3/3	100	31	9/10	90	49	1/2	50	18
Zygomatico-facial Foramen	21/28	75	24	31/34	91	5	27/30	90	4	39/43	91	16	17/18	94	2
Zygomaxillary Tubercle	16/21	76	31	21/38	75	1	14/24	58	10	23/32	72	27	14/17	82	3
Lesser Palatine Foramen	14/16	87.5	36	17/17	100	22	20/20	100	14	20/21	95	38	15/15	100	5
Suprameatal Spine and Depression	41/43	95	9	38/38	100	1	32/34	94	0	47/53	88.7	6	19/20	95	0
Supratrochlear Medial Foramen	12/37	32	15	14/37	37.8	2	11/33	33	1	11/44	25	15	5/18	28	2
Supratrochlear Notch	8/37	21.6	15	3/37	8	2	9/31	29	3	3/44	6.8	15	8/18	44	2
Supraorbital Lateral Foramen	4/37	10.8	15	3/37	8	2	3/32	9	2	13/44	29.5	15	2/18	11	2
Supraorbital Medial Foramen	21/37	56.8	15	26/37	70	2	21/33	63.6	1	37/46	80	13	4/16	25	4
Retromolar Foramen	4/31	12.9	21	4/37	10.8	2	7/33	21	1	7/49	14.3	10	8/18	44	2
Marginal Foramen	2/35	5.7	17	4/35	11	4	1/31	3	3	10/52	19	7	4/18	22	2
Parietal Foramen	25/34	73.5	18	20/27	74	12	25/33	75.8	1	26/42	61.9	17	10/16	62.5	4

Table 22: Percentages of incidence for traits used in the calculation of SMMD

Frequency Table for the Placement of the Anterior Ethmoidal Foramen										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Above suture (a)	--	--	--	--	--	--	1/9	11	--	--
Below suture (b)	--	--	--	--	--	--	--	--	--	--
Suture (s)	12/12	100	6/6	100	3/3	100	8/9	89	1/1	100
Total Scorable	12/52	23	6/39	15	3/34	8	9/59	15	1/20	5
Unscorable (9)	40/52	77	33/39	85	31/34	91	50/59	85	19/20	95

Table 23: Distribution of differing positions of the Anterior Ethmoidal foramen

zygomatic bone in line with the inferior supraorbital margin, yet some were located higher up on the frontal process (see Table 24).

Another trait scored on both criteria is the zygomaxillary tubercle, a small bony protrusion at the zygomaxillary suture (see Appendix B, Fig. 12). Although presence of this trait is relatively high for the Mississippian sites, the frequency of presence in the Archaic component of 1Lu25 is much lower. In addition, form, scored by position of the tubercle in relation to zygomaxillary suture, receives a well spread distribution of frequencies (see Table 25). The most common location of a zygomaxillary tubercle is directly on the suture line, yet all the Mississippian sites reveal frequencies greater than 10% for tubercles located completely on the zygomatic bone. Furthermore, 1Ms80 reveals a relatively high frequency of tubercles on the maxilla bone.

Presence/absence and form are scored for the lesser palatine foramen as well. Generally present most of the time, these bilaterally expressed foramen are positioned along the inferior portion of the palatine bones (Hauser and DeStefano, 1989:163) (see Appendix B, Fig. 27). The lesser palatine foramen primarily exhibits one form, that of one foramen situated behind the major palatine foramen and the marginal crest (Hauser and DeStefano, 1989:164). Two other forms of the lesser palatine foramen also exhibit relatively high frequencies (see Table 26). Specifically, Moundville and 1Lu92 both demonstrate a great percentage of foramen located between the two bisecting ridges of the marginal crest. 1Ms80 reveals a percentage of foramen with no marginal crest, and foramen situated between two marginal crests.

Frequency Table for the Position of the Zygomatico-facial Foramen										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Corpus	--	--	1/31	3	1/27	4	--	--	2/17	12
Frontal Process	3/21	14	5/31	16	2/27	7	2/39	5	1/17	6
Medium Frontal Process	17/21	81	25/31	81	23/27	85	36/39	92	14/17	82
High Frontal Process	1/21	5	--	--	1/27	4	1/39	3	--	--
Total Scorable	21/52	40	31/39	79	27/34	79	39/59	66	17/20	85
Unscorable (9)	31/52	60	8/39	21	7/34	21	20/59	34	3/20	15

Table 24: Distribution of differing positions of Zygomatico-facial foramen

Frequency Table for the Position of the Zygomatic Tubercle										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Bilateral Absence	5/21	24	7/28	25	10/24	42	4/26	15	3/17	18
Bilateral Trace	5/21	24	6/28	21	2/24	8	4/26	15	2/17	12
Bilateral Medium	9/21	43	14/28	50	11/24	46	16/26	62	7/17	41
Bilateral Strong	2/21	10	1/28	4	1/24	4	2/26	8	5/17	29
Total Scorable	21/52	40	28/39	72	24/34	71	26/59	44	17/20	85
Unscorable (9)	31/52	60	11/39	28	10/34	29	33/59	56	3/20	15

Table 25: Percentages of varying positions of the Zygomaxillary tubercle

	Moundville		Mississippian 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
No Marginal Crest (a)	--	--	1/17	6	1/20	5	--	--	--	--
No Marginal Crest and Posterior-lateral Foramen (b)	--	--	--	--	1/20	5	--	--	4/15	27
Foramen on Marginal Crest (c)	--	--	--	--	--	--	--	--	--	--
Close to Marginal Crest (d)	--	--	--	--	1/20	5	1/20	5	--	--
Close to Posterior Crest (e)	10/13	77	14/17	82	15/20	75	12/20	60	8/15	53
Between Two Branches of Crest (f)	3/13	23	2/17	12	1/20	5	5/20	25	--	--
Between Two Crests (g)	--	--	--	--	1/20	5	1/20	5	3/15	20
In Sutural Area (h)	--	--	--	--	--	--	--	--	--	--
In Major Palatine Foramen (I)	--	--	--	--	--	--	1/20	5	--	--
On Pyramidal Process (j)	--	--	--	--	--	--	--	--	--	--
Total Scorable	13/52	25	17/39	44	20/34	59	20/59	34	15/20	75
Unscorable (9)	39/52	75	22/39	56	14/34	41	39/59	66	5/20	25

Table 26: Frequencies of differing degrees of expression of the Lesser Palatine Foramen

Variability of form is best demonstrated by the suprameatal spine and depression. This particular trait is located directly behind and slightly above the external acoustic meatus (Hauser and DeStefano, 1989:188), and is usually present in some form. Thesuprameatal spine and depression as an epigenetic trait can manifest itself in several different shapes. For example, Mississippian 1Lu25 and 1Lu92 both have a crest as the most common form (see Table 27). Although Moundville has a percentage of individuals exhibiting a crest, the distribution of forms is more evenly distributed between a pit form, a triangle-shaped ridge, or some combination of the pit and crest. The Harris site and Mississippian 1Lu25 share a relatively high frequency of triangle-shaped ridges, although 1Lu92 has a frequency well below the others. Interestingly enough, the combined expression of a pit and crest is not nearly as frequent in the Mississippian groups as it is in the Archaic sample where the combined form is most common. There is also a combined pit and triangle form, but it is not common at any site.

In addition to form, an attempt was made to chart the degree of expression for the suprameatal spine and depression according to the suggestions of Hauser and DeStefano (1989:190) (see Appendix B Fig. 30). This scoring technique proved to be redundant and uninformative because all possibilities are not outlined. For instance, there is only one category for a crest form and it is categorized as a large crest, yet there are differentiations between small triangles with small and large depressions, as well as large triangles with small and large depressions (see Table 28). No category for the pit/crest combination exists. Thus, the frequencies recorded in this particular table are suspect. The remaining traits are all ones that had no degree of expression to score; therefore, they were only

Frequency Table for the Shape of the Suprameatal Spine and Depression										
	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	%	p/n	%	p/n	%	p/n	%	p/n	%
Crest	11/41	27	19/38	50	12/32	37.5	34/47	72	6/19	32
Pit	10/41	24	2/38	5	--	--	2/47	4	2/19	11
Pit and Crest	6/41	15	3/38	8	16/32	50	2/47	4	1/19	5
Pit and Triangle	4/41	10	1/38	3	2/32	6	1/47	2	1/19	5
Triangle	10/41	24	13/38	34	2/32	6	8/47	17	9/19	47
Total Scorable	41/52	79	38/39	97	32/34	94	47/59	80	19/20	95
Unscorable (9)	11/52	21	1/39	3	2/34	6	12/59	20	1/20	5

Table 27: Percentages of variations on the shape of the Suprameatal spine and depression

	Moundville		Miss 1Lu25		Archaic 1Lu25		1Lu92		1Ms80	
	p/n	**%**	**p/n**	**%**	**p/n**	**%**	**p/n**	**%**	**p/n**	**%**
Large Crest (a)	11/41	27	19/38	50	12/32	38	35/47	74	6/19	32
Deep pit (b)	10/41	24	2/38	5	--	--	2/47	4	2/19	11
Small Triangle (c)	14/41	34	13/38	34	3/32	9	6/47	13	9/19	47
Small Triangle and Small Pit (d)	6/41	15	3/38	8	11/32	34	4/47	9	1/19	5
Large Triangle and Small Pit (e)	--	--	1/38	3	1/32	3	--	--	--	--
Large Triangle and Deep Pit (f)	--	--	--	--	5/32	16	--	--	1/19	5
Total Scorable	41/52	79	38/39	97	32/34	94	47/59	80	19/20	95
Unscorable (9)	11/52	21	1/39	3	2/34	6	12/59	20	1/20	5

Table 28: Frequencies of division and size of the Suprameatal spine and depression

scored on the basis of presence/absence (refer to Table 22). Four of these traits, the supratrochlear medial foramen, the supratrochlear notch, the supraorbital lateral foramen, and the supraorbital medial foramen all appear along the supraorbital margin of the frontal bone (Hauser and DeStefano, 1989:51) (see Appendix B, Fig. 9). The supraorbital medial foramen appears most frequently with percentages of presence as high as 80% and as low as 25% . Manifesting less frequently, yet approximately consistent across all sites, is the supratrochlear medial foramen. The remaining two traits, the supraorbital lateral foramen and the supratrochlear notch, appear less frequently along the supraorbital margin, yet exhibit great variation in the distribution across sites. For example, the supraorbital lateral foramen is much more frequent at 1Lu92 than any other site. The supratrochlear notch appears most often at 1Ms80, but manifests itself more at Archaic 1Lu25 and Msm than at either Mississippian 1Lu25 or 1Lu92. Varying distributions across sites also characterizes the retromolar foramen. Defined as an aperture along the inside of the mandibular ramus in the retromolar fossa (Hauser and DeStefano, 1989:241), the retromolar foramen is most frequent at 1Ms80 and considerably less so at the remaining sites. In addition, 1Ms80, as well as 1Lu92, exhibit the greatest percentages of marginal foramen, a very small aperture located along the outer margin of the tympanic plate (Hauser and DeStefano, 1989:1430). The frequencies of incidence of marginal foramen at the remaining sites are small to negligible indicating that the marginal foramen is a relatively infrequent trait. Lastly, the presence of parietal foramen, perforations on the posterior parietals near the sagittal suture (Hauser and DeStefano, 1989:78) is a fairly common occurrence across all sites.

In summary, the frequency tables make it apparent that different sites have different distributions of epigenetic traits and degrees of expression of those traits. The purpose of the Mean Measure of Divergence test, then, is to determine if those frequency differences when summed over multiple measurements are large enough to be statistically significant. In other words, if the standardized Mean Measure of Divergence is not significant, the two compared populations are said to be phenotypically similar and probably related. Conversely, a significant Mean Measure of Divergence indicates two populations are not phenotypically similar, and therefore are not related.

First, the Archaic component of 1Lu25 was compared with Mississippian 1Lu25 (see Table 29). Based on the previous craniometric evidence, it was thought that Archaic 1Lu25 would be different from its Mississippian counterpart. This is not borne out in this analysis. An SMMD score of .588 is considerably less than 2.0; therefore, Archaic 1Lu25 is genetically similar to Mississippian 1Lu25. To further test the implication that the Archaic population is not significantly different from Mississippian populations on a genetic level, Archaic 1Lu25 was then compared with Moundville, 1Lu92, and 1Ms80. The Moundville comparison yielded an SMMD score of .540, also not significant, indicating that the Archaic 1Lu25 population and the Moundville population are not genetically different even though separated by approximately 200 miles (Guderjan, 1979:6). Likewise, the 1Lu92 comparison yielded an SMMD score of .583 and 1Ms80 yielded a score of .991. Neither score is significant indicating discrete trait similarities between the Archaic component of 1Lu25 and populations in close proximity (1Lu92) and to the east (1Ms80).

Results of Comparisons with Archaic 1Lu25				
	Miss 1Lu25	**1Lu92**	**1Ms80**	**Msm**
SD	.059	.051	.088	.051
MMD	.032	.029	.087	.027
SMMD	.559	.583	.991	.540

Table 29: Standardized Mean Measure of Divergence Scores for comparisons with Archaic 1Lu25.

The second group of standardized Mean Measure of Divergence tests were designed to gauge the basic relatedness among the Mississippian sites in the study (see Table 30). Craniometric evidence coupled with ceramic comparisons indicate that Moundville has strong ties to the Pickwick Basin (Bass, 1956; Coleman, 1965; Guderjan 1979; Newman and Snow, 1942; Snow, 1941). Weaker evidence based solely on ceramic comparisons (Griffin, 1939) indicates a potential tie between the Harris site and Moundville. Evidence does not exist to indicate any kind of tie between the Harris site (1Ms80) and the Pickwick Basin (Mississippian 1Lu25, 1Lu92). Thus, it was thought Moundville would prove to be similar to Mississippian 1Lu25, 1Lu92, and 1Ms80, while the two sites in the Pickwick Basin (Mississippian 1Lu25, 1Lu92) would not show genetic similarities to 1Ms80. The results confirmed only part of the hypothesis. Moundville proved to be genetically similar to both Mississippian 1Lu25 (SMMD = .167) and 1Lu92 (SMMD = 1.58). Mississippian 1Lu25 received an insignificant SMMD score of .416 when compared with 1Lu92, demonstrating that the two sites in the Pickwick Basin are also similar to each other. 1Ms80 revealed itself to be completely different from Moundville as well as the Mississippian sites in the Pickwick Basin. As predicted, 1Ms80 received a significant SMMD score of 2.74 when compared with 1Lu92, and a score of 2.67 when compared with Mississippian 1Lu25 indicating divergence between 1Ms80 and both sites in the Pickwick Basin. However, when compared with Moundville, an SMMD score of 2.72 was calculated, indicating 1Ms80 is also different from Moundville, in direct contrast to the expected result.

Basic Mean Measure of Divergence Estimates for Mississippian Sites				
		Msm	**1Lu92**	**1Ms80**
Miss 1Lu25	**SD**	.080	.037	.074
	MMD	.006	.015	.197
	SMMD	.167	.416	2.67
Msm	**SD**	--	.031	.067
	MMD	--	.049	.181
	SMMD	--	1.58	2.72
1Lu92	**SD**	.031	--	.066
	MMD	.049	--	1.82
	SMMD	1.58	--	2.74

Table 30: Standardized Mean Measure of Divergence scores for pairwise comparisons of the Mississippian sites.

Lastly, Moundville females buried with nonlocal pots were tested against other Moundville females (see Table 31). If those females buried with nonlocal pots were, in fact, nonlocal females, then that group should possess a different complex of epigenetic traits from native Moundville females resulting in a significant SMMD score. The calculated SMMD score for this comparison is .119, indicating insignificant differences. This shows that the females at Moundville buried with nonlocal pots are not genetically different from Moundville females. To double check this analysis, females with nonlocal pots at Moundville were compared with females from the other Mississippian sites. When compared with females at 1Lu92 the SMMD score is .003, with females at 1Ms80 the SMMD score is .103, and with females at Mississippian 1Lu25 the SMMD score is .101. All scores are insignificant indicating that females at Moundville buried with nonlocal pots are genetically similar to females at Moundville, 1Lu92, Mississippian 1Lu25, and 1Ms80.

In conclusion, results of the standardized Mean Measure of Divergence tests illustrate three main points. First, the Archaic component of 1Lu25 does not differ genetically from the Mississippian component of 1Lu25 or any of the other Mississippian sites in the study. Second, the only site that diverges from the other Mississippian sites is 1Ms80. Third, Moundville females buried with nonlocal pots do not differ genetically from other Moundville females.

Results of Comparisons with Moundville Females Buried with Nonlocal Pots				
	Miss Female 1Lu25	**Female 1Lu92**	**Females 1Ms80**	**Female Msm**
SD	.838	.814	1.04	1.03
MMD	.085	.003	.107	.123
SMMD	.101	.003	.103	.119

Table 31: Standardized Mean Measure of Divergence scores for comparisons with Moundville females buried with nonlocal pots.

DISCUSSION

Limitations of the study

Several limitations have been uncovered through this study. First, as stated earlier, the method of analysis chosen for this study tends to underestimate frequencies for epigenetic traits. The result is an underestimation of genetic differences between groups. Consequently, future research should be structured to count presence/absence of a trait per side as opposed to individuals to counteract this effect (Green et al., 1979).

In addition, there is some question in this researcher's mind concerning the gravelot numbers on the list of nonlocal pottery at Moundville (Steponaitis, 1983). The skeletal numbering system for Moundville burials has been seemingly ad hoc and arbitrary in the past (Powell, 1988), a fact which became evident late in the course of research. Thus, a check should be made between gravelot numbers and burial numbers to see if they are accurate. If not, then the sample should be redone and the comparison between Moundville females buried with nonlocal pots and other Moundville females is an analysis that should be attempted again. If combined with prevalence estimates based on sides, then an improved estimation of divergence should result.

A further limitation is one recognized earlier involving the chi square tests used in trait elimination. Due to the multiplication of α values in sequential chi square tests, an error is built into the final trait list. Although significant values were eliminated regardless of the error, some traits may have been falsely rejected. A lower α value may help to compensate for this problem in future studies by increasing the number of traits used in the analysis, thereby improving the SMMD estimate.

Lastly, an expanded sample will always increase the statistical power of epigenetic studies. As Berry and Berry (1972) state, more traits used in the analysis equate to a greater percentage of the gene pool being involved. Similarly, the more individuals scored, the greater percentage of the population involved. As an entire skeletal population is still only a sample of the population that lived there, scoring skeletons from entire sites, while a daunting task, will be sure to yield better estimates.

Discussion of Results

Any comments on the results must begin with a discussion of frequency and gradients of expression. Although frequencies of presence of a trait vary across sites, gradients of expression generally have one dominant form which pervades across all five groups including 1Ms80, the one population that showed significant divergence. For example, the hypoglossal canal is most likely to be undivided for all five groups, the sagittal suture configuration is predominately widely looped, and posterior ethmoidal foramen are usually located on the ethmoid-frontal suture. The fact that most variants exhibit one predominate degree of expression across sites implies that form of a variant is not necessarily related to genetic divergence. If 1Ms80 is genetically distinct, as indicated by SMMD scores, then one would expect to discover variation of expression as well as differing frequencies. This is obviously not the case. On the contrary, since a particular variant has one predominant form even at 1Ms80, this would seem to indicate that a study of form is beneficial to the understanding of a particular variant, but not in elucidating information about genetic relationships between populations.

This raises the question of the usefulness or place in epigenetic studies of the differentiation of degrees of expression. Hauser and DeStefano (1989:2), pioneers of this method, state that using such standards may do one of two things. First, identifying differing degrees of expression will "lead to clarification not only of ... terminology but also of ... function [and] development." Secondly, gradients of expression "may also contribute to a better perception of these manifestations of complex genetic and environmental interaction" (Hauser and DeStefano, 1989:2). Thus, scoring according to a clear set of standardized variations is important in any epigenetic study since it clarifies the trait definition and has the potential of furthering scholars' understanding of the complex genetic-environmental interaction of epigenetic traits.

Although the Hauser and DeStefano (1989) standardizations are not faultless, they are a step in the right direction. If analysis of form is to become an important aspect of epigenetic research, however, many of the Hauser and DeStefano (1989) standardizations must be clarified and corrected. For example, the chart for measuring suture extensions does not depict mutually exclusive categories (see Appendix B, Fig. 13). Measurement brackets begin and end with the same numbers like small = 1-3mm and medium = 3-6mm. Not having mutually exclusive measuring brackets adds a source of confusion for the researcher as well as an opportunity for error in inconsistent categorization. A further illustration involves the faulty suprameatal spine and depression diagram mentioned earlier. In short, all potential variations like the pit/crest combination are not accounted for in the diagram again adding confusion and a potential source of inconsistent labeling.

In sum, standardizations of differing forms of epigenetic variants are valuable and should be improved upon for future use.

The second section of this discussion deals with the SMMD scores and possible implications of the results. The first group of divergence tests involve the Archaic component of 1Lu25. As noted by Buikstra (1976:54) "distinct morphological types associated with culturally or temporally distinct populations have been emphasized [in physical anthropology]". Nowhere is this more evident than in discussing comparisons with Archaic 1Lu25. All previous studies examining these Archaic skeletal remains have found them morphologically or anthropometrically different from the surrounding Mississippian populations. Snow (1941), Newman and Snow (1942), and Webb and DeJarnette (1942) all label the Archaic component of 1Lu25 as dolichocranic and Mississippian populations as brachycranic and state that the two groups are different both culturally and physically. In addition, Coleman (1965) uses cranial measurements and comparisons of means to reveal that the shell mound group, or Archaic 1Lu25, is not like the physical type at Koger's Island or Moundville. Lastly, Guderjan (1979) reaches the same conclusion through multivariate cluster analysis.

Due to the fact so much evidence points to the Archaic group being different from the Mississippian groups, it was thought that the complex of epigenetic traits would also be different between the two cultural groups. This, however, was not the case. The SMMD scores were consistently insignificant in all comparisons with Archaic 1Lu25. Thus, the Archaic sample does not differ from any of the Mississippian sites. Unquestionably, the Archaic sample precedes the Mississippian samples in time, and differs from the Mississippian population in physical appearance and cultural complex. The implication of these findings must therefore reveal an important characteristic of epigenetic traits; they are continuous through time.

The second group of tests involve all the Mississippian sites and strive to reveal the basic degree of relatedness between them. According to the results, all these sites have similar epigenetic complexes (insignificant SMMD scores) with the exception of 1Ms80. In other words, 1Ms80 is the only site that is dissimilar to the others. Similar finding were found by Turner (1980) when calculating estimates of divergence (the √MMD) for the Copena series with several other Mississippian sites in Alabama. In regards to this particular site, Turner states that 1Ms80 "is markedly dissimilar to all other skeletal series except the only other series (1Lu92) from the same culture period and river basin (Turner 1980:23)". This study deviates from Turner's conclusion only on the point of 1Lu92. This particular test yielded a 2.7 SMMD for the 1Ms80-1Lu92 comparison, which is the highest significant value in the study. The reason for this discrepancy could be related to one of two factors. First, Turner is basing his conclusion on a relative comparison to other estimates of divergence, while this study uses standardized estimates. Secondly, Turner calculates his statistic based on nine traits of the temporal bone, while this study uses twelve traits distributed over the entire skull. Only one trait is common to both studies, that of the suprameatal spine. It can be concluded, then, that rescoring Turner's sample based on the twelve traits used for this study, and calculating the SMMD should yield similar results.

The remainder of the findings, that Moundville, Mississippian Perry site, and Koger's Island are all genetically similar, are securely supported by the previous research conducted by differing methods. For example, Snow (1941), Newman and Snow (1942), and Webb and DeJarnette (1942) all use comparisons of morphology to assert that Koger's Island, Mississippian Perry site, and Moundville are all similar to each other. In addition, Bass (1956) and Coleman (1965) conclude the same using cranial metrics. Guderjan (1979) follows suit with his conclusions based on multivariate analysis.

Thus, based on previous evidence and the results of this study, it can be concluded that Moundville, Koger's Island, and the Mississippian component of the Perry site share a complex of discrete traits. One possible explanation for the relatedness between these sites is that all the skeletons at Moundville might not be the remains of those who lived there. According to Steponaitis (1993) analysis of midden deposits at Moundville points to a discrepancy between the size of the middens and the number of burials attributed to a specific phase. Specifically, middens decrease in number through time while burial numbers increase. Steponaitis (1993:7) explains this discrepancy by stating that people from other communities may have brought their dead to Moundville, the ritual center, for burial. If this is the case and individuals from 1Lu25 and 1Lu92 are interred at Moundville, then the SMMD scores would definitely indicate genetic similarity for the simple reason that the same population group is being compared against itself. There is one logical flaw to this explanation, though. Moundville and the Pickwick Basin are separated by 200 miles. It is highly doubtful anyone would traverse that distance with a decomposing body. If the bodies had been defleshed first, such a possibility might exist, but no evidence indicates such a practice. Thus, it is probably safe to say that if individuals used Moundville as a burial ground, those individuals were from local, relatively close locations.

Generally, homogeneity is dependent upon common ancestors, small population size, or the degree of isolation of a population leading to inbreeding (Newman and Snow, 1942:422). In a regional example such as this one, however, homogeneity is most likely not related to isolation. Isolation would tend to make sites internally homogenous, but would hardly explain how Moundville and sites in the Pickwick Basin could be similar while separated by approximately 200 miles. A more probable explanation is that of common ancestry. As demonstrated earlier, epigenetic traits have a great degree of continuity through time; thus, if the Mississippian populations derived from a common Archaic group, then genetic similarity among these sites might be explained. However, some degree of genetic admixture must have existed or else isolation would have led to internal homogeneity and separated that group genetically. Support for this conclusion is found in 1Ms80. 1Ms80 was found to be genetically similar to Archaic 1Lu25, but divergent from the rest of the Mississippian sites. In addition, the evidence linking Moundville to 1Ms80 was only based on pottery and not very strong. Thus, it seems reasonable to conclude that 1Ms80 originated from the same Archaic parent stock the other Mississippian sites did, but for some reason had very limited contact with Moundville, 1Lu92, and Mississippian 1Lu25. Isolation, or admixture from sites with no Moundville connection, would have led to the development of an epigenetic complex different from its Mississippian counterparts. In summary, then, the patterns of genetic similarity and difference found in this study can be explained by a combination of common ancestry, genetic admixture, and possible isolation in the case of 1Ms80.

The final Mean Measure of Divergence comparison is between females at Moundville buried with nonlocal pottery and other Moundville females. As stated earlier, an abundance of examples can be found at Koger's Island and the Perry site of luxury goods that could be categorized as Moundvillian in nature, yet few examples exist at Moundville of nonlocal luxury goods. The nonlocal pottery that does exist was found buried mostly with females (Welch, 1991:172, 1993:37). It stood to reason that if the women buried with nonlocal pots were, in fact, nonlocal women, then they would exhibit a different epigenetic trait complex than other women at Moundville. This proved not to be the case. The results yielded an insignificant SMMD indicating that females buried with nonlocal pottery at Moundville do not differ from other females at Moundville. This does not necessarily mean that females with nonlocal pots are not nonlocal. It has already been demonstrated, after all, that Moundville is genetically similar to 1Lu92 and Mississippian 1Lu25. Thus, if females were exchanged between these groups, it would be impossible to determine from epigenetic analysis.

There are several possibilities to explain the provenience of nonlocal pottery at Moundville. One possibility is that all nonlocal pots were made locally by women from other communities (Welch, 1993:36). The arrival of these women at Moundville could be the result of exogamous marriage practices, or a form of trade which considered women as luxury items. A further possibility is that these women were captives of war (Ortner, Corruccini, and Voli, 1976). It could also be true that nonlocal women did not come to Moundville at all, but their style of pottery making was passed to local potters, who then began to make what appear to be nonlocal pots. If the pottery was made by local potters, perhaps access to them was not restricted to those individuals of high status. This possibility could explain why "there is no tendency for nonlocal pottery to be in high-status graves" (Welch, 1993:37), and why men and women both are found buried with these pots (Welch, 1993:37). In summary, epigenetic analysis must be coupled with some other research angle to discern the relationship between nonlocal pottery at Moundville and the individuals with whom they were interred.

CONCLUSION

This study has used discrete trait analysis to test certain hypotheses concerning biological relationships between five skeletal populations at four different sites in Alabama. The original hypotheses postulated that three groups of relationships would become evident through this analysis. First, it was thought the Archaic population at 1Lu25 would prove to be dissimilar from all Mississippian sites tested. Second, Moundville was thought to be similar to all Mississippian sites. 1Lu92 and Mississippian 1Lu25 were thought to be similar to one another, but dissimilar from 1Ms80. Lastly, it was thought that Moundville females buried with nonlocal pottery would be dissimilar to other Moundville females.

The results indicate that the Archaic component of 1Lu25 is genetically similar to all the Mississippian sites, contrary to expectations based on previous research. Additionally, Moundville, 1Lu92, and 1Lu25 are genetically similar to each other, but all three sites diverge from 1Ms80. These results can be attributed to descent from common ancestors, probably the Archaic population inhabiting the area. If this is the case, then future studies should investigate the degree of epigenetic homogeneity in Archaic populations across sites.

The divergence of 1Ms80 is attributed to isolation from Moundville and the Pickwick Basin through time or to the admixture of the population at 1Ms80 with sites not genetically similar to Moundville and the Pickwick Basin. The possibility of genetic admixture at 1Ms80 with sites having no contact with Moundville and the Pickwick Basin is also a question worthy of investigation. It could be that the Harris site allied itself with a ceremonial center other than Moundville. Research on this question could serve to demarcate Moundville's eastern sphere of influence.

Finally, the results show that there is no genetic difference between Moundville females and those females at Moundville interred with nonlocal pottery. No other definite conclusion can be made although speculation leads to several possibilities. One option postulates a handful of immigrant potters making all nonlocal pots at Moundville (Welch, 1993:36). Another possibility is that the style of pot making was passed to local potters at Moundville who then began to make pottery that appears to be nonlocal. Regardless, it is apparent that a method other than epigenetic analysis must be employed to elucidate the relationship between individual skeletons and the nonlocal pottery included with grave goods.

REFERENCES CITED

Ardito G (1977) The epigenetic variants of the skulls in some ancient and recent Italian populations. J. Hum. Evol. *6*:689-695.

Armelagos GJ, Carlson DS, Van Gervin DP (1982) The theoretical foundations and development of skeletal biology. In Stewart F (ed.): A History of American Physical Anthropology 1930-1980. New York: Academic.

Ascenzi A and Balistreri P (1975) Aural exostoses in a Roman skull excavated at the "baths of the swimmer" in the ancient town of Ostia. J. Hum. Evol. *4*:579-584.

Axelsson G and Hedegaard B (1981) Torus mandibularis among Icelanders. Am. J. Phys. Anthropol. *67*:105-112.

Bass WM (1956) Indian crania from Moundville, Alabama. M.S. thesis, Department of Anthropology, University of Alabama.

Bergman P and Hauser G (1985) Multi-dimensional complexes of skull traits. Anthrop. Anz. *43*:165-171.

Berry AC (1974) The use of non-metrical variations of the cranium in the study of Scandinavian population movements. Am. J. Phys. Anthropol. *40*:345-358.

Berry AC (1975) Factors affecting the incidence of non-metrical skeletal variants. J. Anat. *120*:519-535.

Berry AC (1976) The anthropological value of minor variants of the dental crown. Am. J. Phys. Anthropol. *45*:257-267.

Berry AC and Berry RJ (1967) Epigenetic variation in the human cranium. J. Anat. *101*:361-379.

Berry AC and Berry RJ (1972) Origins and relationships of the ancient Egyptians. Based on a study of non-metrical variations in the skull. J. Hum. Evol. *1*:199-208.

Berry RJ (1968) Non-metrical variation in mice and men. In Brothwell DR (ed.): The Skeletal Biology of Earlier Human Populations. Oxford: Pergamon.

Berry RJ (1979) Genes and skeletons, ancient and modern. J. Hum. Evol. *8*:669-677.

Boas F (1899) The cephalic index. Am. Anth. 1:448-461.

Boas F (1911) Changes in the bodily form of descendants of immigrants. Senate Document 208, 61st Congress, 2nd session.

Boas F (1928) Materials for the Study of Inheritance in Man. Columbia University Contributions to Anthropology. Vol VI. New York: Columbia UP.

Bridges PS (1989) Spondylolysis and its relationship to degenerative joint disease in the prehistoric Southeastern United States. Am. J. Phys. Anthropol. *79*:321-330.

Brothwell DR (1959) The use of non-metrical characters of the skull in differentiating populations. Deutsche Gesellschaft Fur Anthropologie *6*:103-109.

Brown IW (1985) Natchez Indian Archaeology: Culture Change and Stability in the Lower Mississippi Valley. Mississippi Department of Archives and History Archaeological Report 15. Jackson, Mississippi.

Brown IW (1989) Natchez Indians and the remains of a proud past. In Polk N (ed.): Natchez Before 1830. Jackson: University Press of Mississippi. pp. 8-28

Buikstra JE (1976) Hopewell in the Lower Illinois Valley: A regional approach to the study of human biological variability and prehistoric behavior. Northwestern University Archaeological Program, Scientific Papers 2.

Buikstra JE (1977) Biocultural dimensions of archeological study: A regional perspective. In Blakely RL (ed.): Biocultural Adaptation in Prehistoric America. Athens: U of GA press.

Buikstra JE, Frankenberg SR, and Konigsberg LW (1990) Skeletal biological distance studies in American Physical Anthropology: Recent trends. Am. J. Phys. Anthropol. *82*:1-7.

Carpenter JC (1976) A comparative study of metric and non-metric traits in a series of modern crania. Am. J. Phys. Anthropol. *45*:337-344.

Cesnys G (1985) Variability of discrete cranial traits in the skulls of Lithuanian children. Anat. Anz. Jena *159*:43-54.

Cheverud JM and Buikstra JE (1982) Quantitative genetics of skeletal non-metric traits in the rhesus macaques on Cayo Santiago. III. Relative heritability of skeletal non-metric and metric traits. Am. J. Phys. Anthropol. *59*:151-155.

Cheverud JM, Buikstra JE and Twichell E (1979) Relationships between non-metric skeletal traits and cranial size and shape. Am. J. Phys. Anthropol. *50*:191-198.

Coleman WH (1965) Anthropometric and morphological studies on cranii of the Moundville Indian. M.S. thesis, Department of Biology, University of Alabama.

Corruccini RJ (1972) The biological relationships of some prehistoric and historic pueblo populations. Am. J. Phys. Anthropol. *37*:373-388.

Corruccini RJ (1974) An examination of the meaning of cranial discrete traits for human skeletal biological studies. Am. J. Phys. Anthropol. *40*:425-446.

Corruccini RJ (1991) Anthropological aspects of orofacial and occlusal variations and anomalies In Kelley MA and Larson CS (eds.): Advances in Dental Anthropology. New York: Wiley-Liss.

Corruccini RJ and Beecher RM (1984) Occlusofacial morphological integration lowered in baboons raised on soft diet. J. Craniof. Genet. Develop. Bio. *4*:135-142.

Cosseddu GG, Floris G and Vona G (1979) Sex and side differences in the minor non-metrical cranial variants. J. Hum. Evol. *8*:685-692.

Dahlberg AA (1986) The dentition of the American Indian. In Wenner-Gren Foundation for Anthropological Research: Papers on the Physical Anthropology of the American Indian. New York: Viking.

Derry E (1914) Parietal perforation accompanied with flattening of the skull in an ancient Egyptian. J. Anat. *48*:417-429.

Dodo Y (1974) Non-metrical traits in the Hokkaido Ainu and the Northern Japanese of recent times. J. Anthropo. Soc. Nip. *83*:31-51.

Droessler J (1981) Craniometry and Biological Distance: Biocultural Continuity and Change at the Late Woodland - Mississippian Interface. Research Series 1. Evanston: Center for American Archaeology.

Falconer DS (1965) The inheritance of liability to certain disease, estimated from the incidence among relatives. Ann. Hum. Genet. *29*:51-76.

Falconer DS (1967) The inheritance of liability to disease with variable age of onset, with particular reference to diabetes mellitus. Ann. Hum. Genet. *31*:1-20.

Goad SI (1978) Exchange Networks in the Prehistoric Southeastern United States. Ph.D. Diss. Department of Anthropology, University of Georgia, Athens. Ann Arbor: University Microfilm.

Green RF and Suchey JM (1976) The use of inverse sine transformations in the analysis on non-metric cranial data. Am. J. Phys. Anthropol. *45*:61-68.

Green RF, Suchey JM and Gokhale DV (1979) The statistical treatment of correlated bilateral traits in the analysis of cranial material. Am. J. Phys. Anthropol. *50*:629-634.

Grewal MS (1962) The rate of genetic divergence of sublines in the C57BL strain of mice. Genet. Res. *3*:226-237.

Griffin JB (1939) Report on the ceramics of Wheeler Basin. In Webb WS: An Archaeological Survey of Wheeler Basin on the Tennessee River in Northern Alabama. Bur. Am. Ethnol. *122*:127-65.

Grüneberg H (1952) Genetical studies on the skeleton of the mouse. IV. Quasi-continuous variations. J. Genet. *51*:95-114.

Guderjan TH (1979) Biological affinity among prehistoric populations in the Pickwick Basin and related sites. M.S. thesis. Department of Anthropology, Southern Methodist University.

Hauser G and DeStefano GF (1989) Epigenetic Variants of the Human Skull. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung.

Hepburn D (1908) Anomalies in the supra-inial portion of the occipital bone, resulting from irregularities of its ossification, with consequent variations of the interparietal bone. J. Anat. *42*:88-92.

Hertzog KP (1968) Associations between discontinuous cranial traits. Am. J. Phys. Anthropol. *29*:397-404.

Hooten EA (1930) The Indians of Pecos Pueblo: A Study of Their Skeletal Remains. New Haven, Connecticut: Yale UP.

Howells WW (1966) Craniometry and multi-variate analysis: The Jomon population of Japan. Papers of the Peabody Museum *57*:1-43.

Howells, WW (1971) Applications of Multivariate Analysis in Cranio-facial Growth. In Moyers RE and Krogman WM: Cranio-facial Growth in Man. Oxford: Pergamon.

Howells, WW (1973) Cranial Variation in Man: A Study of Multivariate Analysis of Patterns of Differences Among Recent Human Populations. Papers of the Peabody Museum of Archaeology and Ethnology 67. Cambridge, Massachusetts: Peabody Muserm Publications.

Hrdlicka A (1903) Divisions of the parietal bone in man and other mammals. Bull. Am. Mus. Nat. Hist. *19*:231-298.

Hrdlicka A (1924) Catalogue of Human Crania in the United States National Museum Collections. Proc. U.S. Nat. Mus. 63 Art. *12*:1-51.

Jantz RL (1973) Micorevolutionary change in Arikara crania: A multivariate analysis. Am. J. Phys. Anthropol. *38*:15-26.

Johnson AL and Lovell NC (1994) Biological differentiation at predynastic Naqada, Egypt: An analysis of dental morphological traits. Am. J. Phys. Anthropol. *93*:427-433.

Key PJ (1983) Craniometric Relationships Among Plains Indians. Report of Investigations 34. Knoxville: University of Tennessee.

Kongisberg LW, Kohn LAP and Cheverud JM (1993) Cranial deformation and non-metric trait variation. Am. J. Phys. Anthropol. *90*:35-48.

Korey K (1970) Characteristics of the distributions of non-metric variants of the skull. M.A. Diss. University of Chicago, Illinois.

Lane RA and Sublett AJ (1972) Osteology of social organization: Residence patterns. Am. Antiq. *37*:186-201.

Laughlin WS and Jorgensen JB (1956) Isolate variation in Greenlandic Eskimo. Acta Genet. Stat. Med. *6*:3-12.

Newman GK (1952) Archaeology and Race of the American Indians. In Griffin JB (ed): Archaeology of Eastern United States. Chicago: University of Chicago Press.

Newman MT and Snow CE (1942) Preliminary report on the skeletal material from Pickwick Basin, Alabama. In Webb WS and DeJarnette DL: An archaeological survey of Pickwick Basin in the adjacent portions of the states of Alabama, Mississippi and Tennessee. Bur. Am. Ethnol. Bull. 129.

Ortner DJ, Corruccini RS, and Voli RM (1976) The skeletal biology of the Virginia Indians. Am. J. Phys. Anthropol. *45*:717-722.

Ossenberg NS (1969) Discontinuous morphological variation in the human cranium. Ph.D. Diss. University of Toronto.

Ossenberg NS (1976) Within and between race distances in population studies based on discrete traits of the human skull. Am. J. Phys. Anthropol. *45*:701-716.

Parsons PA and Howe WL (1967) Morphogenetic homeostasis in mice. Aust. J. Bio. Sci. *20*:777-784.

Peebles CS and Kus SM (1977) Some archaeological correlates of ranked societies. Am. Antiq. 42:421-448.

Powell ML (1988) Status and Health in Prehistory. Washington, D.C.: Smithsonian Institution Press.

Sahlins MD (1972) Stone Age Economics. Chicago: Aldine.

Saunders SR and Popovich F (1978) A family study of two skeletal variants: Atlas bridging and clinoid bridging. Amer. J. Roent. 49:193-203.

Sjøvold T (1973) The occurrence of minor non-metrical variants in the skeleton and their quantitative treatment for population comparisons. Homo *24*:204-233.

Sjøvold T (1976-77) A method for familial studies based on minor skeletal variants. Ossa *3-4*: 97-107.

Snow CE (1941) Anthropological Studies at Moundville. Museum Paper 15. Alabama Museum of Natural History. Geological Survey of Alabama University, Alabama.

Sofaer JA, Smith P, and Kaye E (1986) Affinities between contemporary and skeletal Jewish and non-Jewish groups based on tooth morphology. Am. J. Phys. Anthropol. *70*:265-275.

Steponaitis VP (1978) Location theory and complex chiefdoms: A Mississippian example. In Smith BD (ed.): Mississippian Settlement Patterns. New York: Academic Press.

Steponaitis VP (1983) Ceramics, Chronology, and Community Patterns: An Archaeological Study at Moundville. New York: Academic Press.

Steponaits VP (1991) Contrasting patterns of Mississippian development. In Earle T (ed.): Chiefdoms: Power, Economy, and Ideology. New York: Cambridge University Press.

Steponaitis VP (1993) Population Trends at Moundville. Paper presented at 58th Annual Meeting of the Society for American Archaeology.

Stewart F (ed.) (1982) A History of American Physical Anthropology 1930-1980. New York: Academic Press.

Suzuki M, Sakai T (1960) A familial study of torus palatinus and torus mandibularis. Am. J. Phys. Anthropol. *18*: 263-272.

Swanton JR (1911) Indian tribes of the lower Mississippi Valley and adjacent coast of the Gulf of Mexico. Bur. Am. Ethnol. Bull. 43.

Szathmary EJE and Ossenberg NS (1978) Are the biological differences between North American Indians and Eskimos truly profound? Curr. Anthropol. *19*:673-701.

Turner KR (1980) Affinities of the Copena skeletal series from site 1Sc42. Misc. Paper 5. Tennessee Anthropological Association.

Webb WS and DeJarnette DL (1942) An Archaeological Survey of the Pickwick Basin in the Adjacent Portions of the States of Alabama, Mississippi, and Tennessee. Bur. Am. Ethnol. Bull. 129.

Webb WS and DeJarnette DL (1948) The Perry Site, 1Lu25. Alabama Museum of Natural History, Museum Paper 25. University of Alabama.

Webb WS and Wilder CG (1951) An Archaeological Survey of Guntersville Basin on the Tennessee River in Northern Alabama. Lexington: U of Kentucky Press.

Welch PD (1991) Moundville's Economy. Tuscaloosa: University of Alabama Press.

Welch PD (1993) What Were People Doing at Outlying Sites Within the Moundville Chiefdom? Paper presented at 58th Annual Meeting of the Society for American Archaeology.

APPENDIX A

DESCRIPTION, LOCATION, AND EXPRESSION OF EPIGENETIC VARIANTS

APPENDIX A

Each trait was scored according to presence/absence, number, position, and size. Degrees of expression were scored according to the standardized gradients suggested by Hauser and DeStefano (1989). The following list of trait descriptions, locations, and other diagrams of degree of expression all come directly from that source. Any direct modifications the researcher made to suit this specific research project are noted with an asterix.

1. Metopic suture - The persistence of the medio-frontal suture past the normal time of obliteration. Scoring: a = Incomplete persistence b = Complete persistence.

2. Supranasal suture - A short, complex, zig-zag suture located medially in the glabellar region. Scoring: a = Supranasal triangle b = Zig-zag suture.

3. Metopic fissure - Above nasion, the result of an incompletely fused metopic fontanelle. Scoring: a = Metopic ossicle b = Metopic W-shaped suture.

4. Frontal grooves - Grooves on the frontal bone extending between the frontal tuber and the temporal line. Scoring: a = trace (up to 10mm) b = well expressed (over 10mm).

5.* Supraorbital osseous structures - The following structures are all located along the supraorbital margin of the orbit and were scored separately: Supratrochlear notch, Supraorbital medial notch, Supraorbital lateral notch, Supratrochlear foramen, Medial supraorbital foramen, and Supraorbital lateral foramen. Scoring: No differentiation of expression.

6.* Ethmoidal foramen - Foramen at the line of junction between the ethmoid and the orbital plate of the frontal bone. This category is divided into an anterior and a posterior ethmoidal foramen and is scored separately, but according to the same criteria. Scoring: a = sutural b = exsutural.

7. Trochlear spine - A spine slightly above the fronto-lacrimal suture behind and below the medial end of the supraorbital margin. Scoring: a = trace (barely visible but palpable b = moderate (well visible and protruding up to 2mm) c = strong (protrudes more than 2mm).

8.* Nasal foramina - Small apertures on the outside of the nasal bones, often near the midline. Scoring: a = small (less than 1mm) b = medium (1mm) c = large (greater than 1mm) d = excessive (greater than 2mm).

9. Infraorbital suture - A suture originating at the infraorbital canal that appears either on the orbital surface or the facial surface. Scoring: a = running medial to the zygomaxillary suture b = touching it at the infraorbital margin c = blending with the zygomaxillary suture for some distance.

10. Infraorbital foramen - An aperture located on the external anterior surface of the maxilla below the infraorbital margin. Scoring: a = absence or trace expression of division b = weak expression of division or strong expression of division c = extreme division with multiple foramen or three infraorbital foramen d = two infraorbital foramen or four infraorbital foramina.

11.* Zygomaxillary tubercle - A protruding bony tubercle occurring on the inferior margin of the zygomatic process of the maxillary bone, or of the zygomatico-maxillary suture, or of the zygomatic bone. Scoring: a = bilateral absence of a zygomaxillary tubercle b = zygomaxillary tubercle in the zygomatic position c = zygomaxillary tubercle in sutural position d = zygomaxillary tubercle in maxillar position.

12.* Parietal foramen - Apertures in the parietal bone near the sagittal suture in the obelion area. Scoring: No degree of expression.

13. Symmetrical thinness of parietal bones - Thinness above the temporal ridge and usually equidistant from the coronal and lambdoid sutures. Scoring: a = weak (slight bilateral flattening of the parietal bones with no obvious deficiency of the outer table) b = medium (bilateral flattening of the parietal bones with central deficiency of the outer table but no wall formation c = strong (saucer-shape) d = extreme (saucer-shape with appearance of central pseudobossing of the internal table.

14. Sutures of the Cranial Vault - There are three major sutures of the cranium: the coronal, the sagittal, and the lambdoidal. The coronal suture forms the junction between the posterior edge of the frontal bone and the anterior edges of the parietal bones. The sagittal suture runs medial and joins the two parietal bones. The lambdoidal suture connects the posterior ends of the parietals with the squamous portion of the occipital bone. All three sutures are scored according to the same criteria: Maximal suture shape extension, basic configuration, and secondary protrusions. Scoring: Maximal suture shape extension: 1 = absent, 2 = trace (up to 1mm), 3 = small (1-3mm), 4 = medium (3-6mm), 5 = large (6-10mm), 6 = excessive (10mm and more).
Basic configuration: 1 = simple, 2^d = widely dentate, 2^l = widely looped, 3^d = narrow dentate, 3^l = narrow looped.

Secondary protrusions: 1 = absent, 2 = weak expression, 3 = medium expression, 4 = strong expression.

15. Inca bone - An Inca bone occurs when the squamous portion of the occipital bone is divided by a transverse suture. The part above the suture is called the Inca bone. Scoring: h = complete, undivided inca bone i = complete symmetric bipartite inca bone j = complete tripartite inca bone k = complete multipartite inca bones l = complete multipartite inca bones m = complete asymmetric bipartite inca bone n = incomplete asymmetric inca bone variants o = incomplete asymmetric inca bone variants p = incomplete symmetric bipartite inca bone q-s = incomplete asymmetric inca bone variants t-w = incomplete median inca bone variants x = pars incoidea squamae occipitalis.

16. Highest nuchal line - A well marked prominence midway between the external apex of the occipital squama and the foramen magnum. Scoring: a. trace = only palpable, barely visible b. medium = clearly visible, c. strong = markedly protruding, d. extreme = the formation of a torus across the occipital squama.

17. Retromastoid process - An osseous process at the point where the inferior nuchal line appears to merge with the superior nuchal line near the lateral margin of the occipital bone. Scoring: a. trace = protruding from the occipital surface up to 0.5mm, b. weak = 0.5-1.0mm, c. strong = protruding for more than 1mm.

18. Atlas bridging - Osseous bridging of the vertebral artery grooves of the first cervical vertebra called ponticuli atlantis posterior et lateralis. Scoring: a = no trace of a ponticulus atlantis lateralis, b = trace expression of a ponticulus atlantis lateralis, c = incomplete expression of a ponticulus lateralis, d = complete expression of a ponticulus lateralis, e = no trace of a ponticulus atlantis posterior, f = trace expression of a ponticulus atlantis posterior, g = incomplete ponticulus atlantis posterior, h = complete ponticulus atlantis posterior.

19.* Occiptial foramen - Apertures in the occipital squama at or slightly above inion. Scoring: No scoring for degree of expression.

20.* Condylar canal - Located behind the occipital condyle in the condylar fossa. Scoring: No scoring of degree of expression.

21. Condylar facet double - The occipital condyles are on both sides of the anterior portion of the foramen magnum. Scoring: c = complete, i = incomplete.

22. Hypoglossal canal - Bilaterally expressed, the hypoglossal canals pass medio-laterally through the base of the occipital condyles. Scoring: 1 = undivided, 2 = trace division, 3 = incomplete division, 4^a = partial division, up, 4^b = partial division, down, 5 = complete division.

23. Intermediate condylar canal - A groove running from the hypoglossal canal in a postero-lateral direction along the base of the condylar process. Scoring: a = absent, b = incomplete bridging originating from the margin of the jugular foramen, c = incomplete bridging originating from a paracondylar process, d = complete bridging between the lateral base of the condyle and the margin of the jugular foramen, e = complete bridging between the lateral base of the condyle and a paracondylar process.

24. Paracondylar process - A prominence located lateral of the occipital condyle, medial of the mastoid process, and posterior of the jugular fossa. Scoring: a = bilaterally weak expression of a medially positioned paracondylar process, b = of a medially positioned, and medium expression of a laterally positioned paracondylar process.

25. Jugular foramen bridging - This is located between the lateral part of the occipital bone postero-medially and the petrous part of the temporal bone antero-laterally. Scoring: a-c = external jugular foramen bridging incomplete (two spines), d-f = external jugular foramen bridging complete, g-l = incomplete internal jugular foramen bridging, m-o = complete internal jugular foramen bridging.

26. Precondylar tubercle - Osseous thickening on the inferior surface of the basilar part of the occipital bone, generally beside the anterior margin of the foramen magnum. Scoring: a = absence, b = bilaterally weak expression of precondylar tubercles, c = bilaterally strong expression of precondylar tubercles, d = presence of a median positioned precondylar tubercle.

27. Pharyngeal tubercle - Anterior to the foramen magnum on the basilar part of the occipital bone. Scoring: a = weakly expressed pharngeal tubercle (protrudes up to 2mm), b = medium expression (between 2mm and 4mm), c = strong expression (larger than 4mm).

28. Pharyngeal foveola - A median pit located on the hindmost part of the osseous roof of the pharynx, near the junction of the basiocciptial and sphenoid bones. Scoring: a = shallow (between 1-2mm), b = medium (between 2 - 4mm), c = deep (greater than 4mm).

29. Median basilar canal - A median opening on the interior surface of the basilar part of the occipital bone, above the anterior margin of the foramen magnum. Scoring: a = the inner orifice, b = the outer orifice of a single basilar canal, c = two inner orifices of a single median basilar canal, d = two upper and one lower positioned inner orifices of a bifurcating median basilar canal, e = transverse canal passing superficially through the bone inside and cranially of the foramen occipitale magnum, f = median basilar canal with multiple bifurcations but only three internally present orifices.

30.* Craniopharyngeal canal - A canal opening interiorly in the floor of the pituitary fossa and externally on the base of the skull forming the roof of the pharynx. Scoring: a = small (less than 1.0mm), b = large (at least 1.0mm).

31. Tympanic aperture - A foramen in the floor of the external acoustic meatus, the tympanic plate. Scoring: a = trace (pinpoint foramina or a thin translucent lamellar area), b = medium (well marked foramen), c = strong (the major part of the floor of the auditory meatus is missing), d = excessive (the whole tympanic floor is missing).

32.* Marginal foramen - A foramen towards the serrated lateral margin of the tympanic plate. Scoring: No degree of expression scored.

33.* Inferior squamous foramen - An aperture situated in the temporal squama near the posterior root of the zygomatic arch. Scoring: No degree of expression scored.

34.* Postglenoid foramen - An aperture situated directly behind the fovea of the mandibular joint in the line of fusion of the squamous and the tympanic part of the temporal bone. Scoring: No degree of expression scored.

35. Retropterygoid apertures in the Greater Wing - There are three aperture in the greater wing of the sphenoid bone, the spinous foramen, oval foramen, and the foramen of Vesalius. All three foramen are in the region behind the pterygoid the same scoring scheme. Scoring: Spinous and Oval foramen: a = complete expression of both foramina, b = trace of incompleteness, c = partial incompleteness of the spinous foramen, d = partial incompleteness of the spinous foramen and trace of incompleteness of the wall separating the two foramina, e = confluent oval and spinous foramina, f = partial incompleteness of the oval foramen only, g = complete absence of the medial wall of the oval foramen, h = complete absence of the medial wall of the oval foramen and a fissure in the wall separating the two foramina, i = absence of the medial wall of both the spinous (partial) and the oval foramina, j = extreme degree of incompleteness of the two foramina, also the wall between the two foramina is only partially expressed. Foramen of Vesalius: a = trace of separation of the venous part, b = incomplete separation of the venous part, c = complete separation (circular), d = complete separation (slit).

36. Basal Sphenoid bridges - There are two of these bridges: the pterygo-spinous bridge, and the pterygo-alar bridge. The pterygo-spinous bridge involves the fusing of the spina angularis with the lamina lateralis, while the pterygo-alar bridge occurs lateral to the oval foramen when the lateral lamina and the inferior surface of the greater wing are connected. Scoring: a = trace of the ptergo-alar bridge, b = incomplete ptergo-alar, c = complete expression of a ptergo-alar bridge, d = trace pterygospinous bridge, e = incomplete pterygospinous bridge, f = complete expression of a pterygospinous bridge.

37. Lesser palatine foramina - Apertures in the inferior area of the hard palate situated behind the major palatine foramen. Scoring: a = no marginal crest and one minor palatine foramen postero-medially of the major palatine foramen, b = no marginal crest and one minor palatine foramen postero-laterally of the major palatine foramen, c = one minor palatine foramen situated on the marginal crest, d = one minor palatine foramen situated close to the anterior slope of the crest, e = one minor palatine foramen situated close to the posterior slope of the crest, g = two parallel crests, one minor palatine foramen situated between them, h = one minor palatine foramen in the sutural area between alveolar and pyramidal process, i = one minor palatine foramen in the funnel of the major palatine foramen, j = one minor palatine foramen on the medial side of the pyramidal process.

38. Palatine bridging - Grooves extend from the major palatine foramen towards the transverse palatine suture. Often spines protrude from the margins of these grooves. Palatine bridges are the osseous connections between the spines protruding from these palatine grooves. Scoring: a = complete bridging, b = absence of bridging.

39. Transverse palatine suture - The palatine suture connects the palatine processes of the maxillae to the horizontal portions of the palatine bones. Scoring: a = straight transverse, symmetric, b = straight transverse with two posteriorly protruding small symmetric extensions at some distance from the midline, c = irregular junction of the two halves of a straight transverse suture, d = straight symmetric suture with a posteriorly and excessively protruding narrow midline convexity, e = total broad posteriorly protruding convex suture, f = irregular suture with a narrow anteriorly protruding midline convexity, h = totally and anteriorly convex symmetric suture, i = large, median rectangular anteriorly protruding extension of the otherwise symmetrical transverse suture.

40. Palatine torus - A paramedian bony protuberance situated along the median suture of the hard palate. Scoring: a = trace (slight elevation either partial or complete), b = medium (well developed elevation), c = strong (torus covers most of palate or elevation strongly developed), d = excessive (torus covers most of palate and elevation strongly developed).

41. Maxillary torus - Irregular bony nodules or mound-like thickening of the lingual margin of the alveolar process in the molar area of the maxilla. Scoring: a = small, b = large (well developed).

42.* Mandibular torus - Bony protuberance on the lingual side of the mandible below its free alveolar margin, generally centered around the 2nd premolar. Scoring: Degree of expression: a = weak (rugged patches separated by grooves), b = medium (oval thickenings with small protrusions and nodules), c = strong (large thickenings).

43. Auditory torus - Bony growths located within the external auditory meatus. Scoring: a = weak (small nodule), b = strong (one or more well developed protrusions), c = excessive (almost total occlusion of the meatus).

44. Suprameatal spine and depression - A crest, spine, or depression below the posterior root of the zygomatic process and above and behind the external auditory meatus. Scoring: a = large suprameatal spine (crest-type) and no depression, b = absence of a suprameatal spine and presence of a deep suprameatal depression, c = small suprameatal spine (triangular type) and no depression, d = small suprameatal spine (triangular) and small depression, e = large suprameatal spine (triangular) and small depression, f = large suprameatal spine (triangular) and deep depression.

45. Middle meningeal artery emisssaries - There are three of these artery emissaries. The parietal process of the temporal squama is a slim process of bone extending from the margin of the temporal squama and extending up into the parietal bone, covering a branch of the meningeal artery. If the artery has a different exit, it can result in an inferior parietal foramen, a foramen on the parietal above the temporal squama, or a superior squamous foramen, which is an aperture along the temporal squama. Scoring: No degree of expression scored.

46. Divided parietal bone - The parietal bone may be completely or incompletely divided by one or more accessory sutures. Scoring: a = trace (suture extends up to 1cm), b = partial division (suture extends more than 1cm, but does not completely bisect bone), c = complete division.

47. Partitioned temporal squama - A complete or incomplete suture bisects the temporal squama either horizontally or vertically. Scoring: c = complete, i = incomplete.

48.* Biasterionic suture - A simple suture along both lateral margins of the superior occipital squama. This suture never completely bisects the occipital squama. Scoring: e = originating below the asterion, f = originating in the asterion, g = originating above asterion.

49. Ossicles at asterion and occipitomastoid wormians - Extrasutural bones located at the external point of junction of the parieto-mastoid, occipito-mastoid and the lambdoid sutures. Scoring: a = protruding into the occipito-mastoid suture, b = protruding into the parietal, c = protruding into the occipital, d = protruding into the temporal, e = centrally located.

50. Mastoid foramen - Apertures situated behind the dorsal margin of the external acoustic porus. Scoring: t = located on temporal bone, s = located in the occipito-mastoid suture, o = located in the occipital bone.

51. Squamomastoid suture - This suture forms the junction between the anterior and posterior parts of the mastoid process. Scoring: a = absence, b-d = trace (between 1/5 and 1/3 the length of the mastoid process, e = complete suture in a newborn, f-h = partial persistence (between more than half and three quarters of the length of the mastoid process).

52. Parietal notch bone - An ossicle that articulates postero-inferiorly with the mastoid part of the temporal bone. Scoring: a = protruding towards the mastoid process, b = into the parietal bone, c = towards the posterior margin of the temporal squama, d = towards the occipital.

53. Epipteric bone - An accessory bone located in the area of the postero-inferior angle of the frontal, the antero-inferior angle of the parietal, the postero-superior angle of the greater wing of the sphenoid and the antero-superior margin of the squamous part of the temporal bone. Scoring: a = single large bone, b = a single large bone extending into the parietal bone along the superior margin of the temporal squama, c = a large bipartite epipteric bone of similar shape as the preceding one, d = a small epipteric bone bordering only the parietal and the sphenoid bone, in the middle of the sphenoparietal suture, e = large rectangular bone along the anterior squamous margin extending inferiorly from the sphenoparietal suture into the temporal squama, f = large rectangular ossicle along the posterior margin of the frontal bone extending into the sphenoid bone from the sphenoparietal suture, g = similar to e but extending into the temporal squama symmetrically above and below the sphenoparietal suture, i = squamous ossicles along the superior margin of the temporal squama extending into the parietal bone.

54. Fronto-temporal articulation - Pattern of contact between the sphenoid and the parietal bone in the pterion. Scoring: a = stenocrotaphia, b = more extended sutural connection, c = frontal process of the temporal bone, d = temporal process of the frontal bone (K-shape), e-f = false epipteric bones, g = true epipteric bone, h-j = variations of the H-shape with no fronto-temporal articulation, k-m = variations of trace expression.

55.* Squamous ossicles - Extrasutural bones between the temporal squama and the parietal bone. Scoring: No degree of expression scored.

56. Os Japonicum - Sutural division of the zygomatic bone. Scoring: a = single transverse (superior) , d = single oblique suture (medial), e = transverse (inferior) and oblique (medial) suture, f = transverse (superior) and transverse (inferior) suture.

57. Zygomatic-facial foramen - Apertures on the facial surface of the zygomatic bone. Scoring: a = positioned on the corpus, b = on the frontal process, c = on the frontal process tangential to the deepest points of the inferior margin and the

superior border of the zygomatic process, d = a very high position on the frontal process near the fronto-zygomatic suture.

58.* Marginal tubercle - A tubercle located on the temporal border of the frontal process of the zygomatic bone. Scoring: a = absence, b = weak (up to 2mm), c = medium (between 2 and 4mm), d = strong (greater than 4mm).

59.* Mental foramen - An aperture located on the external surface of the mandible in the area below the premolars. Scoring: 1 = below first premolar, 2 = below second premolar.

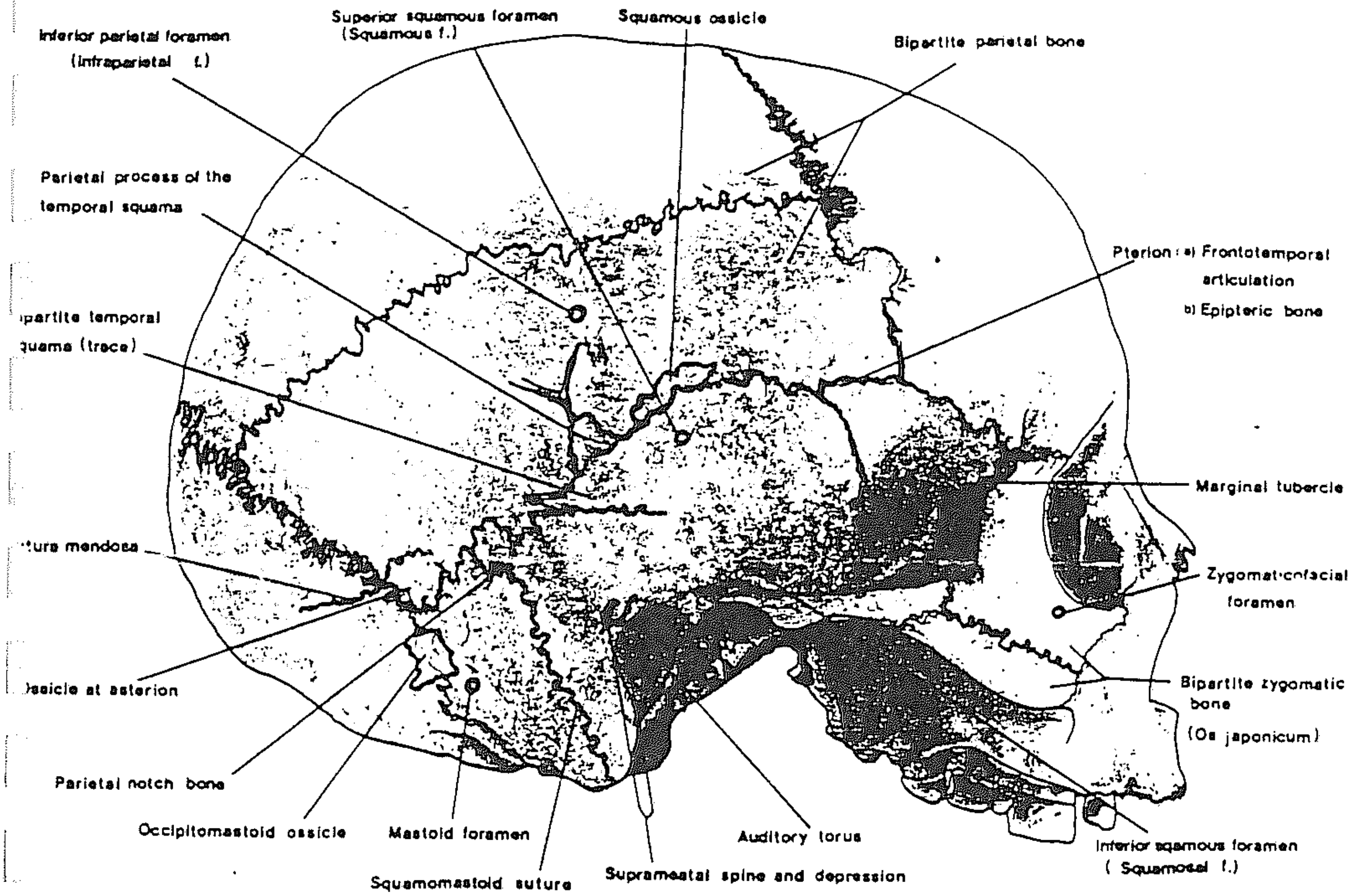
60.* Mylohyoid bridge - An osseous bridge covering the groove that runs from the mandibular foramen situated on the inside of the mandibular ramus leading downward and anteriorly. Scoring: i = incomplete, c = complete.

61. Genial tubercles, median mental spine and genial pit - Tubercles on the lingual surface of the mandible in or around the midline. Scoring: a = absence, b = single pit, c = superior pit and inferior tubercle, d = two superior tubercles and one inferior tubercle, e = common median spine, f = superior and inferior pit, g = two superior tubercles only, h = two superior and two inferior tubercles.

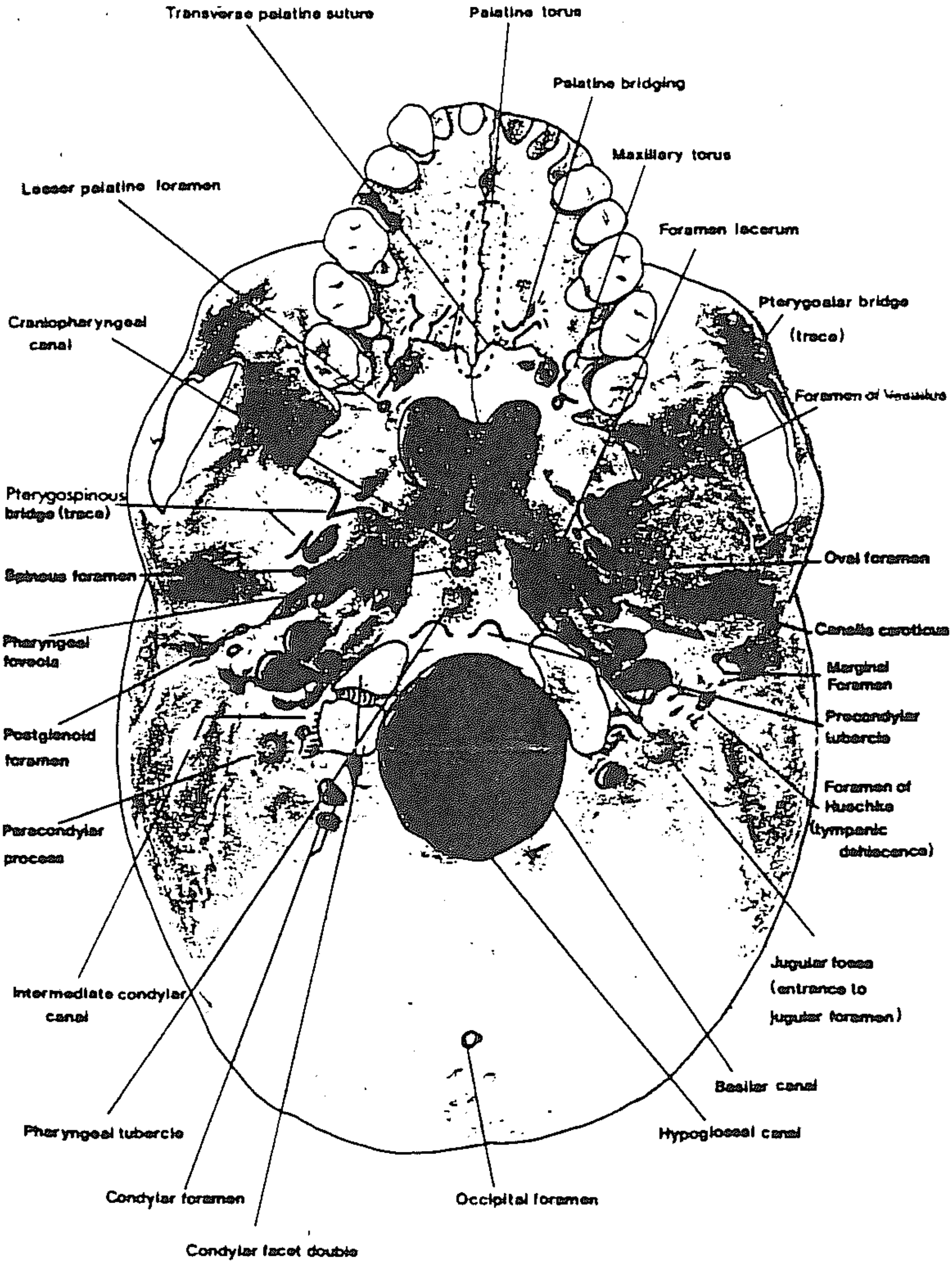
62. Accessory apertures in the mandibular ramus - There are three of these accessory apertures. The accessory mandibular foramen is situated behind and slightly below the mandibular foramen. The molar foramen is situated antero-superior of the mandibular foramen, and the retromolar foramen is situated in the retromolar fossa about 1/3 to midway between the molar occlusal plane and the tip of the coronoid process. Scoring: No degree of expression scored.

APPENDIX B

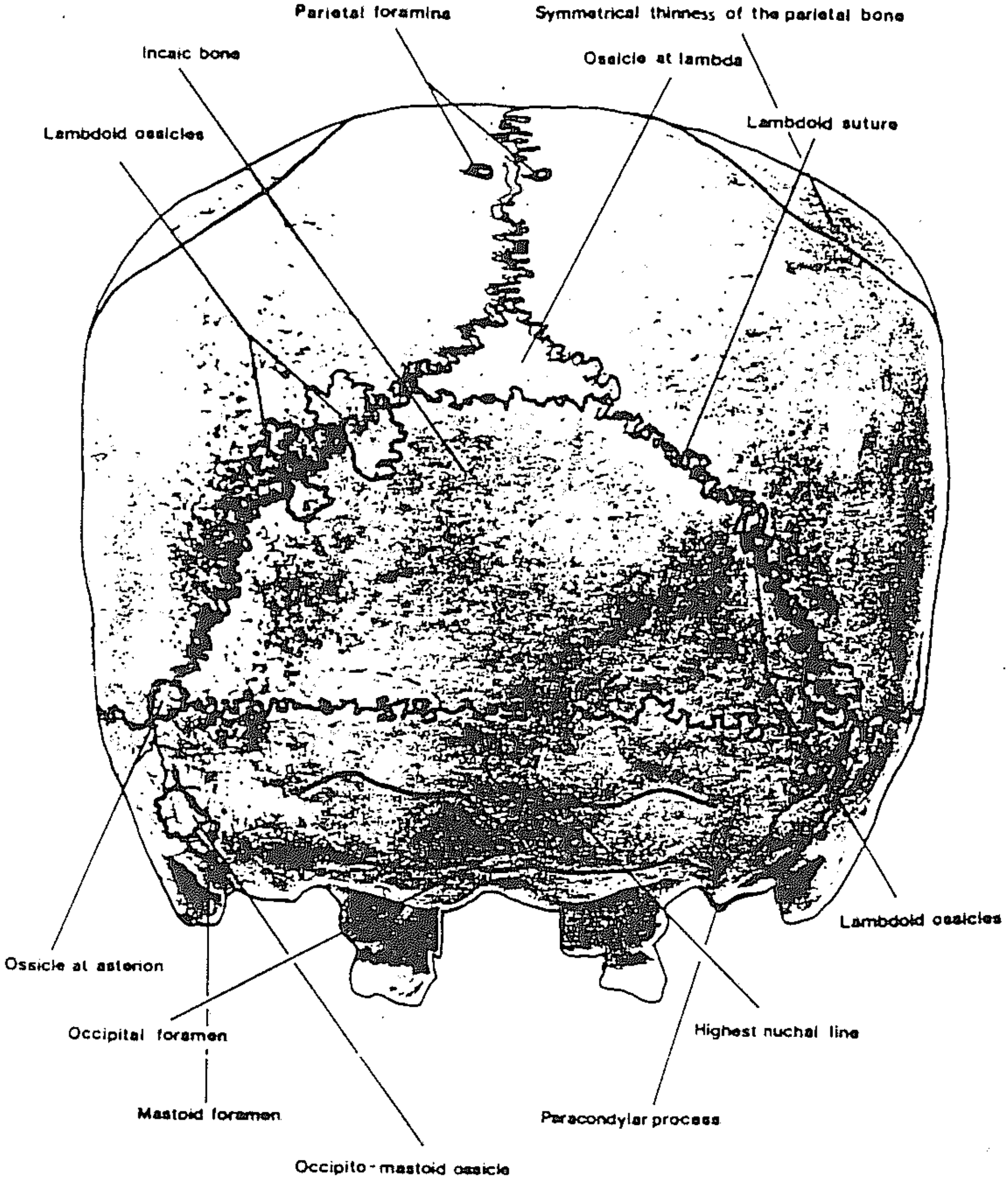
VISUAL REPRESENTATIONS OF EPIGENETIC VARIANTS



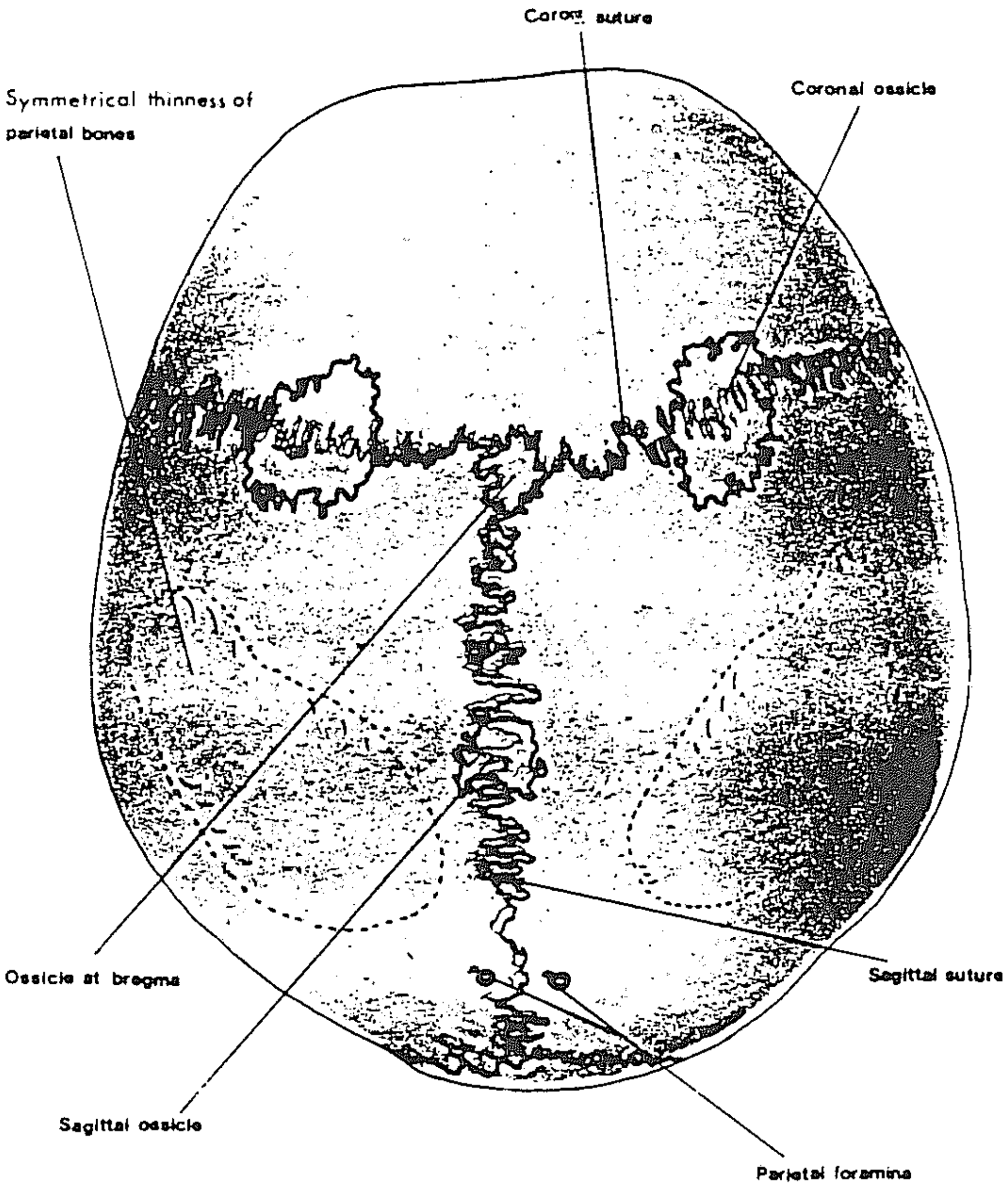
Appendix A: Fig. 1. Location of epigenetic traits, lateral view. (Adapted from: Hauser and DeStefano, 1989:29)



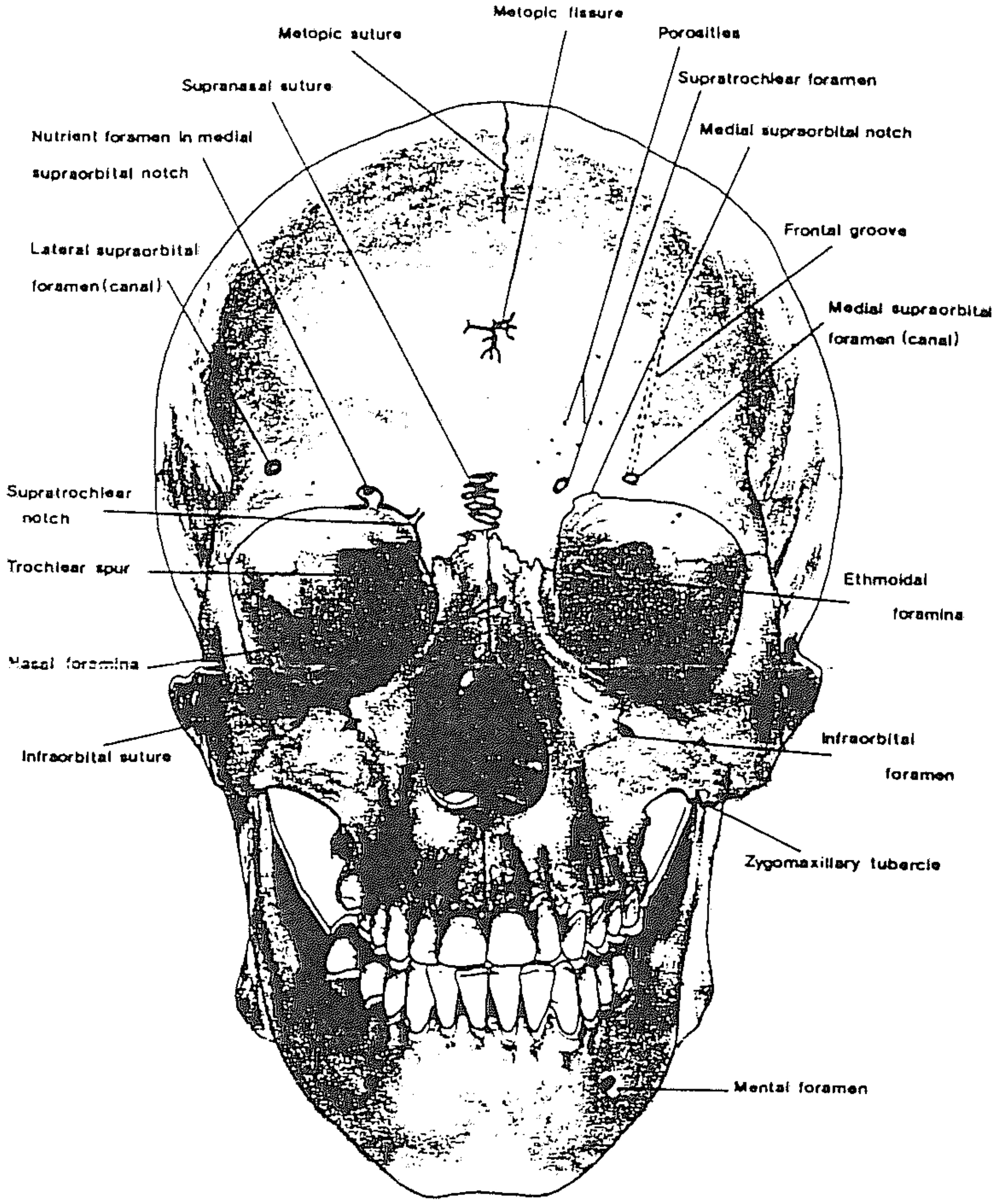
Appendix A: Fig. 2. Location of epigenetic traits, basal view. (Adapted from: Hauser and DeStefano, 1989:27)



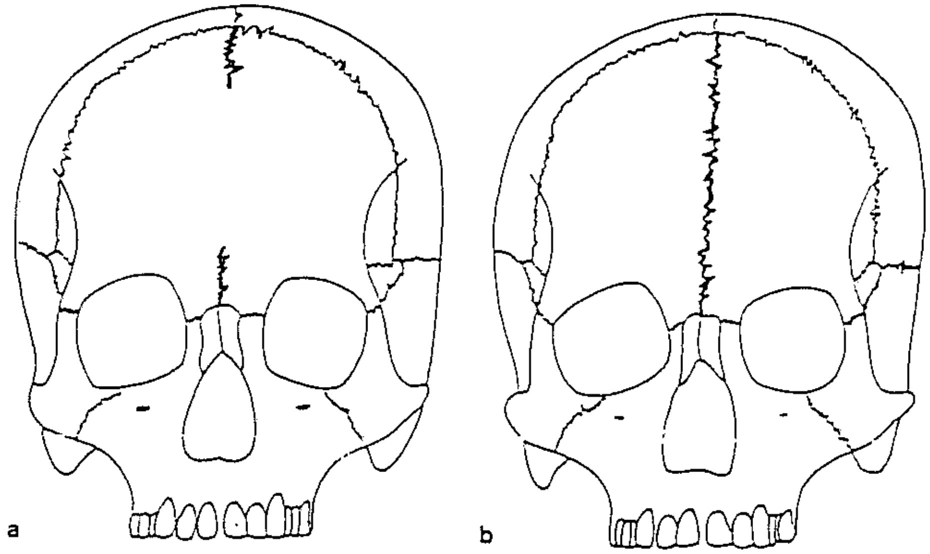
Appendix A: Fig. 3. Location of epigenetic traits, occipital view. (Adapted from: Hauser and DeStefano, 1989:26)



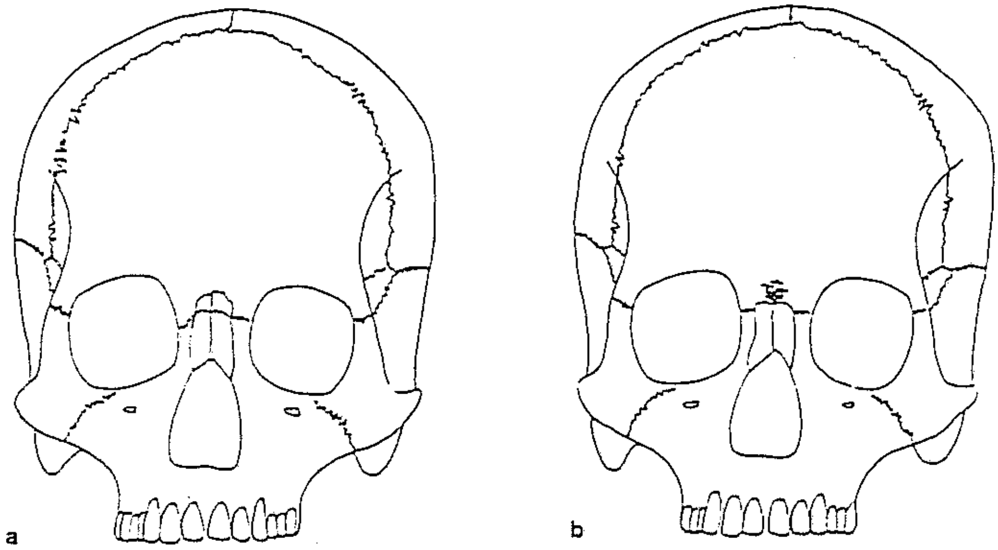
Appendix A: Fig. 4. Location of epigenetic traits, superior view. (Adapted from: Hauser and DeStefano, 1989:24)



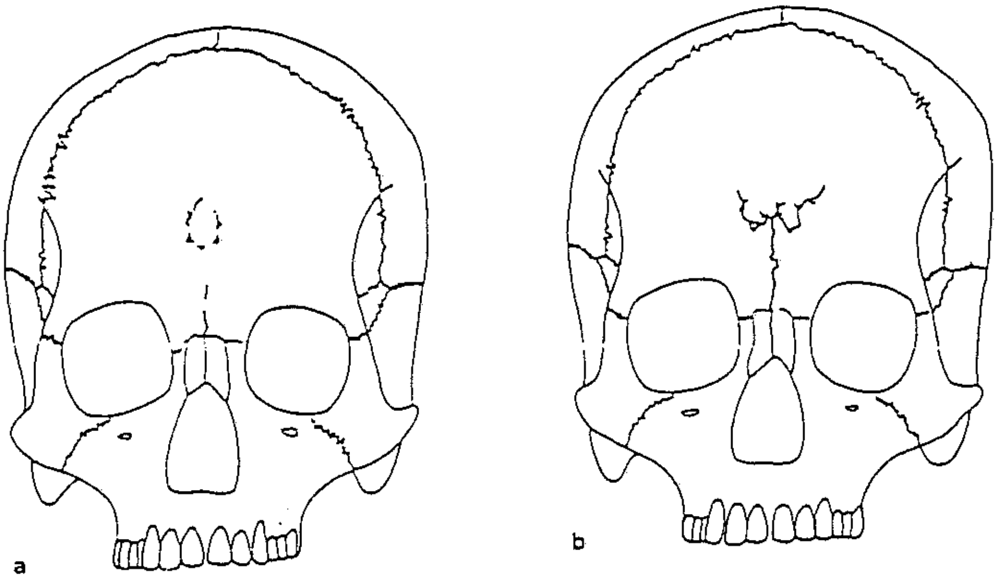
Appendix A: Fig. 5. Location of epigenetic traits, frontal view. (Adapted from: Hauser and DeStefano, 1989:22)



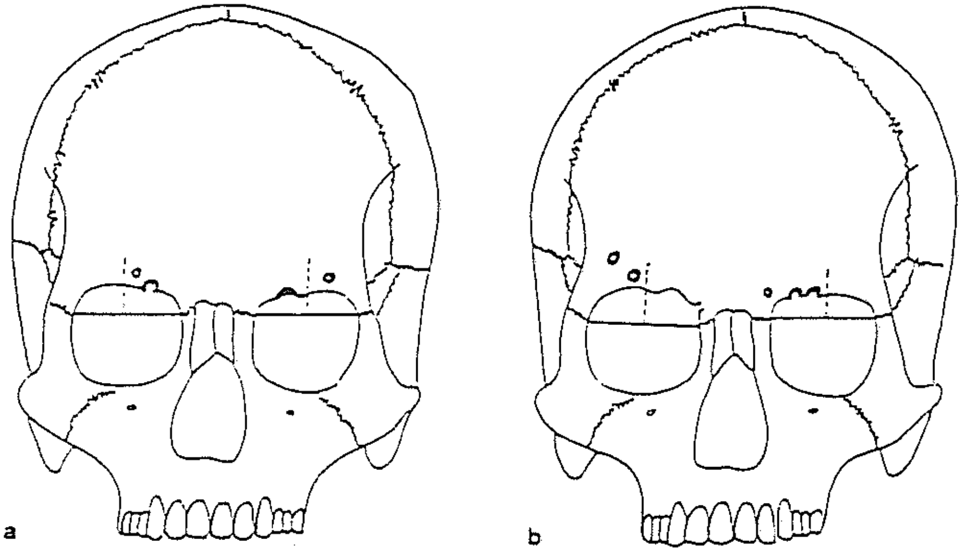
Appendix A: Fig. 6. Expressions of the metopic suture: a = incomplete, b = complete. (Adapted from: Hauser and DeStefano, 1989:41)



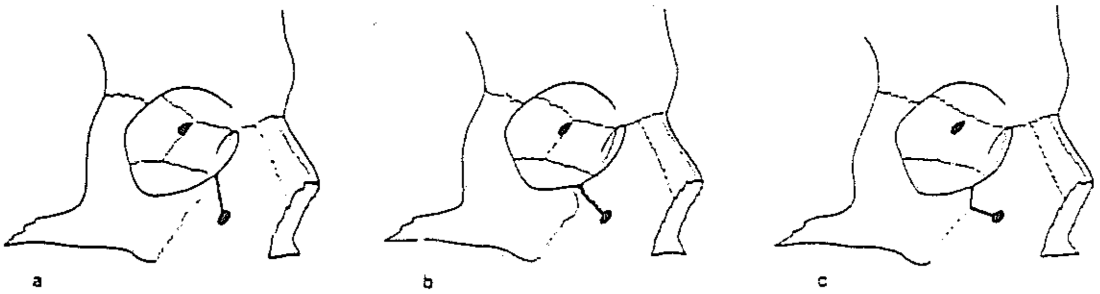
Appendix A: Fig. 7. Variations of the supranasal suture: a = supranasal triangle, b = zig-zag shape suture. (Adapted from: Hauser and DeStefano, 1989:46).



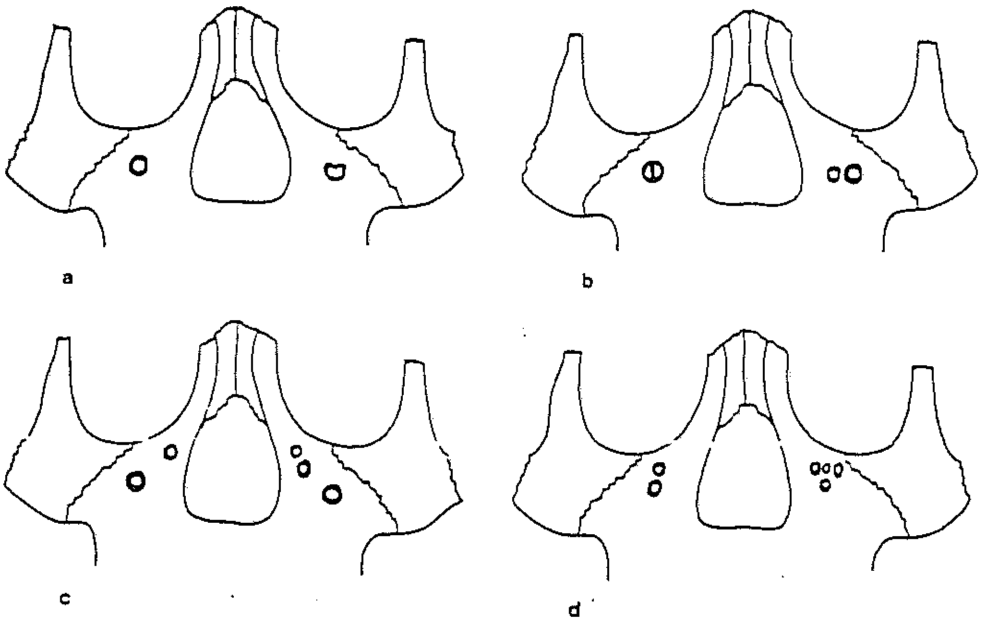
Appendix A: Fig. 8. Expressions of the metopic fissure: a = metopic ossicle, b = W-shaped suture. (Adapted from: Hauser and DeStefano, 1989:47).



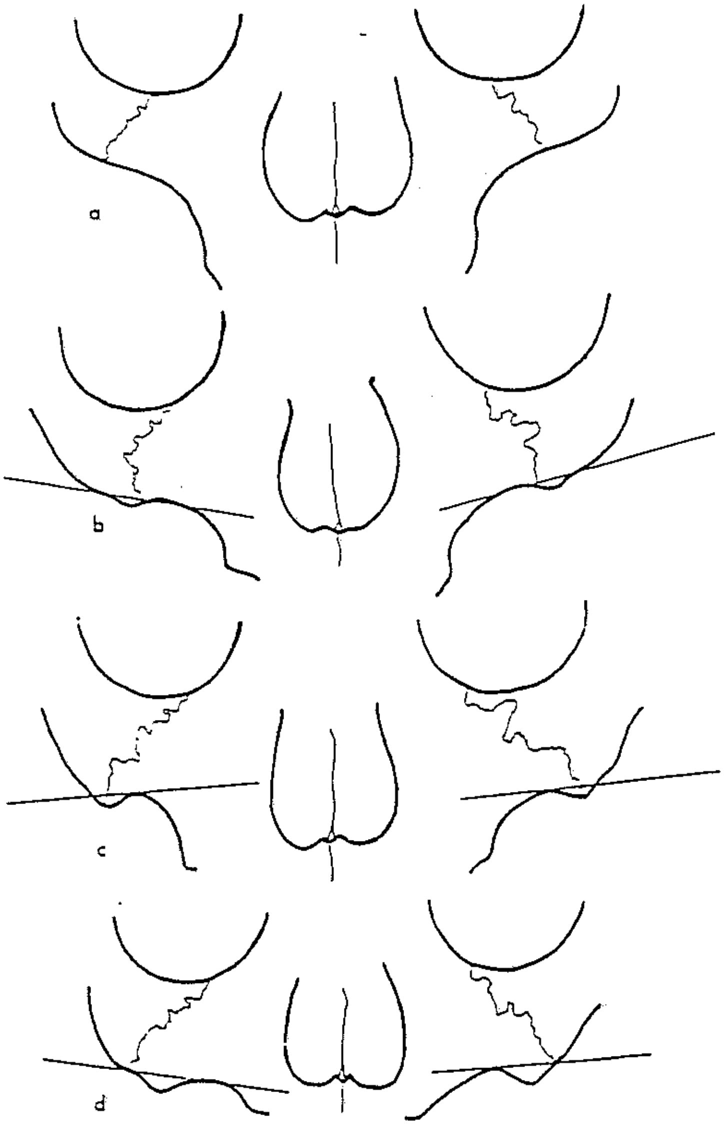
Appendix A: Fig. 9. Expression and location of supraorbital osseous structures: a = medial notch and a medial canal on the right side, large medial notch and a lateral canal on the left, b = supratrochlear notch, a medial notch, and two lateral canals on the right, supratrochlear canal and two medial notches on the left. (Adapted from: Hauser and DeStefano, 1989:54).



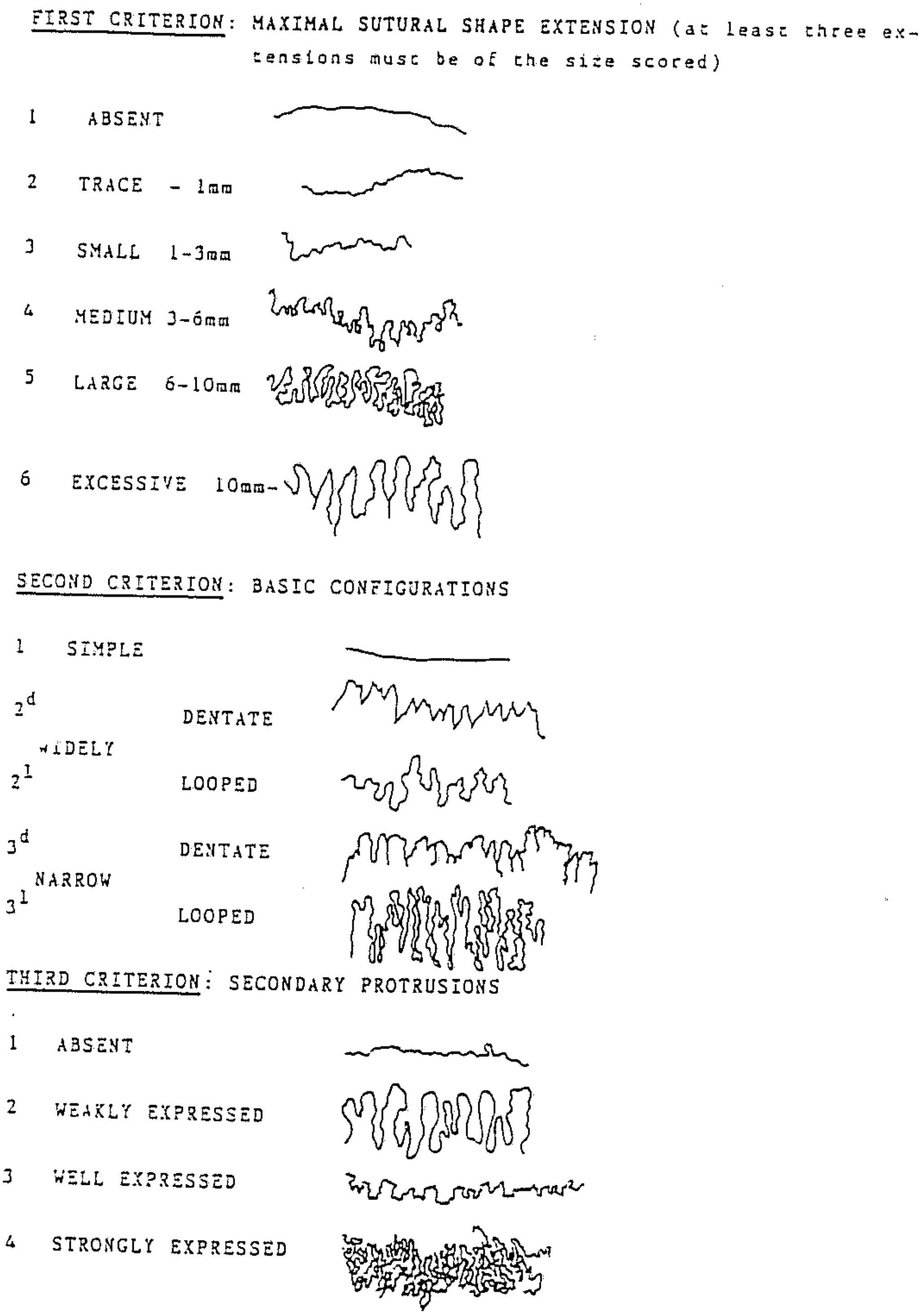
Appendix A: Fig. 10. Expression of the infraorbital suture on the face: a = runs medial to the zygomaxillary suture, b = intersects with the zygomaxillary suture at the infraorbital margin, c = partially blends with the zygomaxillary suture. (Adapted from: Hauser and DeStefano, 1989:68).



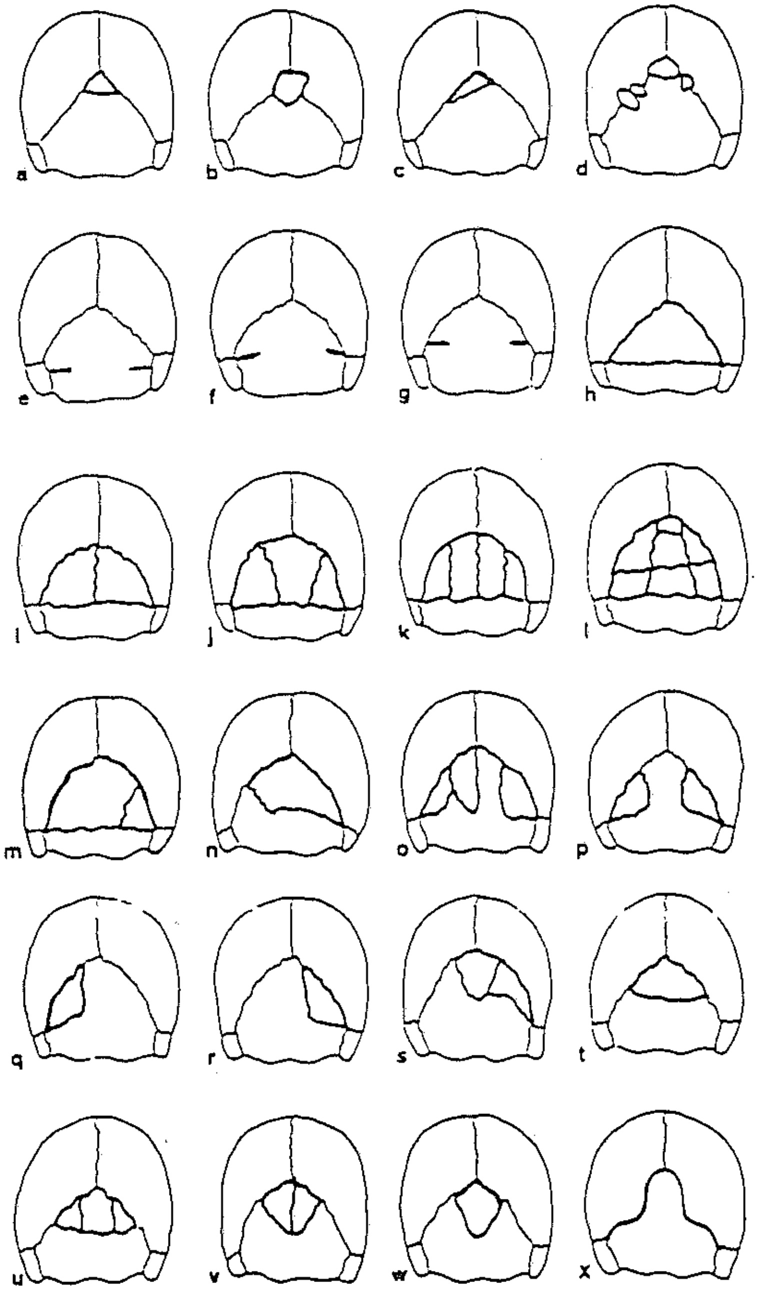
Appendix A: Fig. 11. Variations of infraorbital foramen division: a = absence of division on the right, trace division on the left, b = weak division on the right, strong division yielding two external openings for one internal canal on the left, c = extreme division yielding one external opening for each internal canal on the right, three foramen on the left, d = two foramen on the right, four foramen on the left. (Adapted from: Hauser and DeStefano, 1989:73).



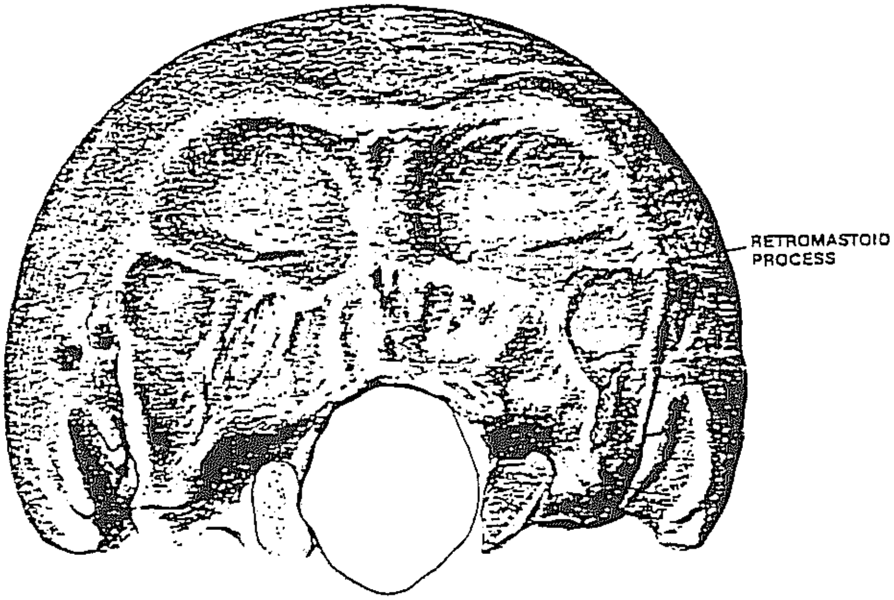
Appendix A: Fig. 12. Variations of the position of the zygomaxillary tubercle: a = absence, b = tubercle in the zygomatic position, c = tubercle on the sutural line, d = tubercle in the maxillar position. (Adapted from: Hauser and DeStefano, 1989:77).



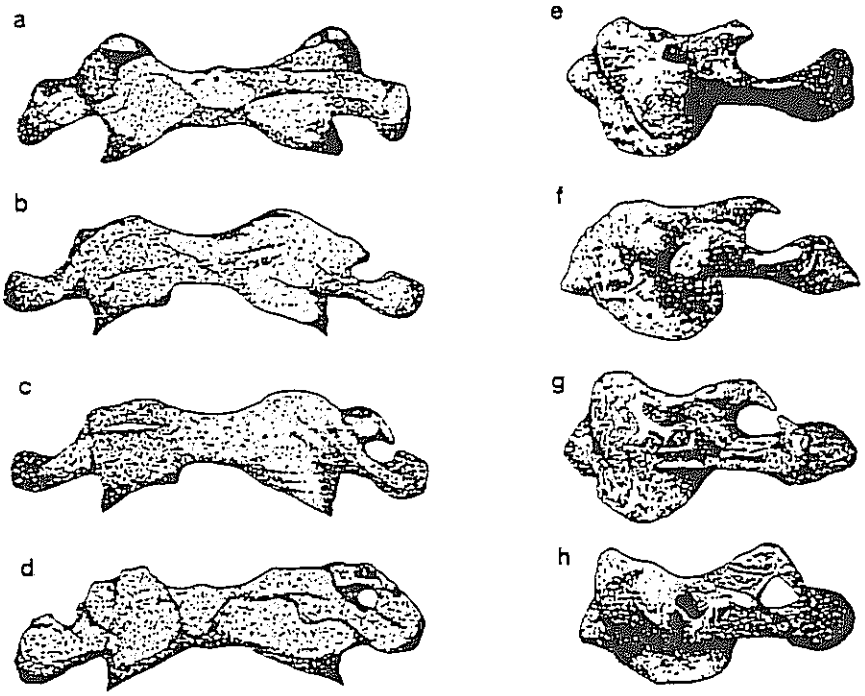
Appendix A: Fig. 13. Scoring criteria for the major sutures of the cranium. (Adapted from: Hauser and DeStefano, 1989:90).



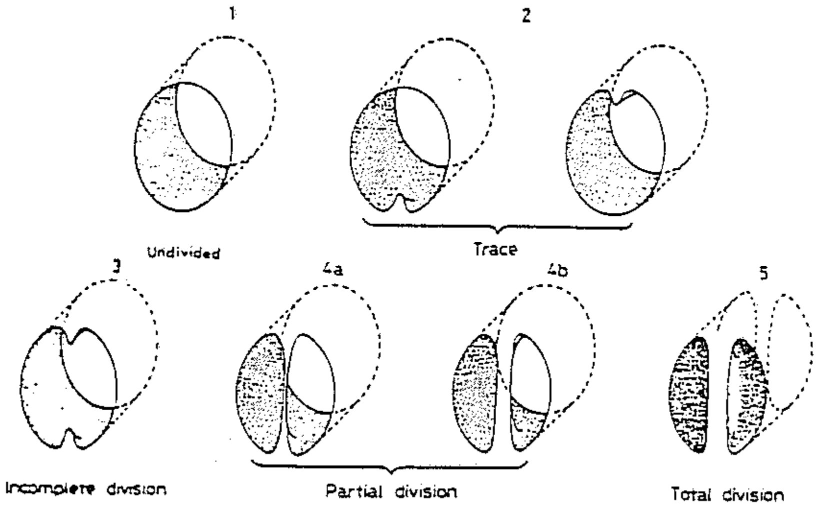
Appendix A: Fig. 14. Expression of ossicles at lambda, the biasterionic suture, and the inca bone: 1. a-d = expression of ossicles at lambda. a = protrudes into occiptial, b = protrudes into parietal and occipital, c = protrudes into the left occipital squama, d = multiple bones protruding into parietal and occiptial.
2. e-g = expressions of the biasterionic suture. e = bilateral, below asterion, f = bilateral, at asterion, g = bilateral, above asterion.
3. h-x = variants of the inca bone. h = complete, undivided, i = complete, symmetric, bipartite, j = complete tripartite, k, l = complete multipartite, m = complete asymmetric bipartite, n, o = incomplete asymmetric, p = incomplete symmetric bipartite, q, r, s = incomplete asymmetric, t, u, v, w = incomplete median, x = pars incoidea. (Adapted from: Hauser and DeStefano, 1989:101).



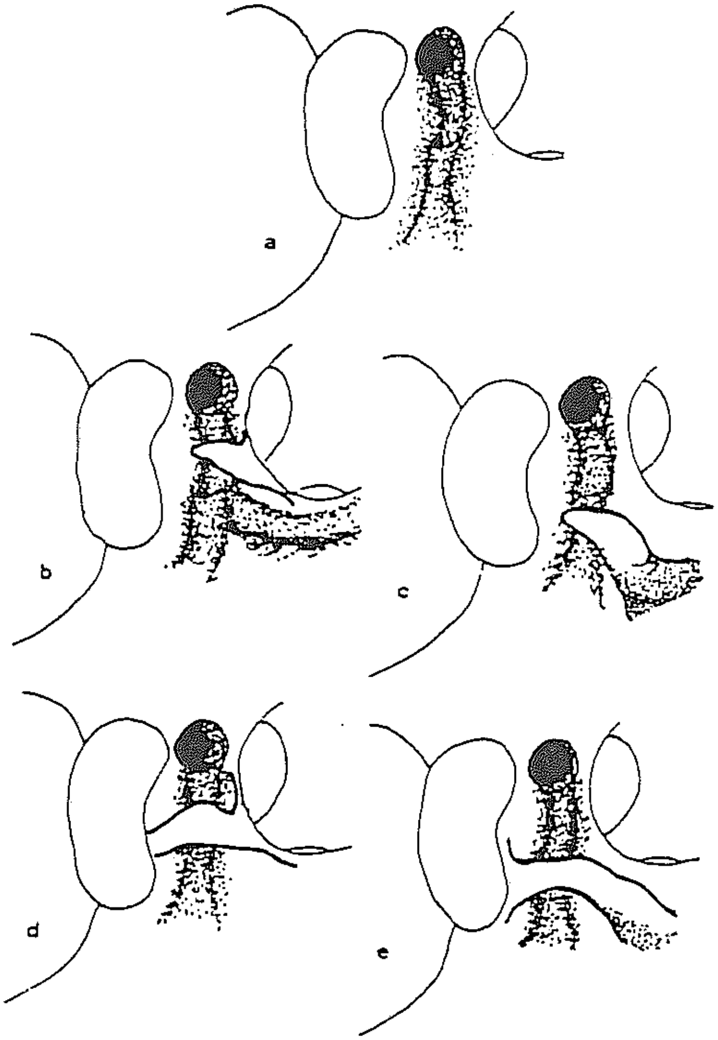
Appendix A: Fig. 15. Location of the retromastoid process (Adapted from: Hauser and DeStefano, 1989:108).



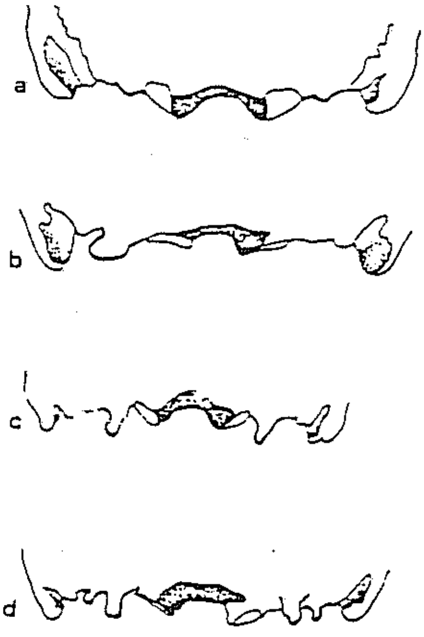
Appendix A: Fig. 16. Expressions of atlas bridging: (a-d = anterior view, ponticulus atlantis lateralis) a = absence, b = trace, c = incomplete, d = complete. (e-h = lateral view, ponticulus atlantis posterior) e = absence, f = trace, g = incomplete, h = complete. (Adapted from: Hauser and DeStefano, 1989:111).



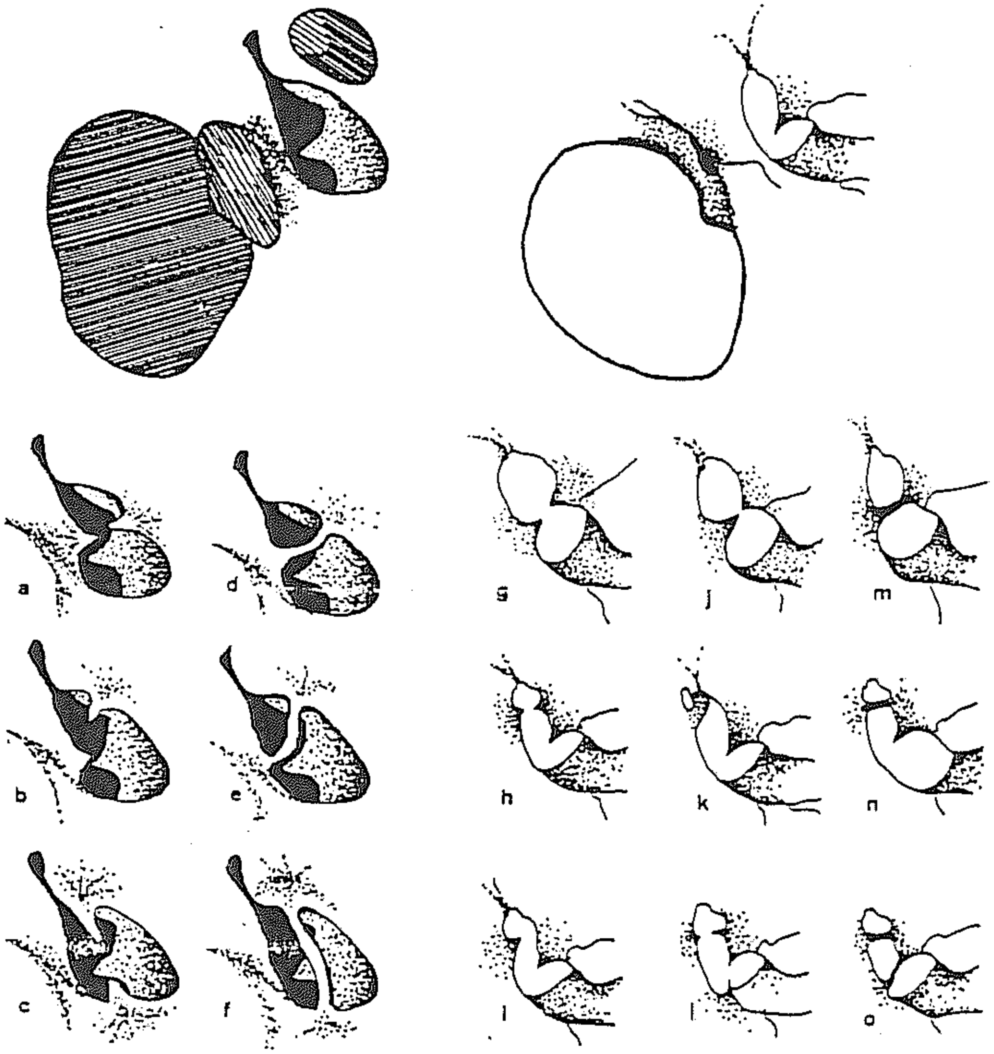
Appendix A: Fig. 17. Expressions of the hypoglossal canal: 1 = undivided, 2 = trace, 3 = incomplete division, 4a, 4b = partial division, 5 = complete division. (Adapted from: Hauser and DeStefano, 1989:125).



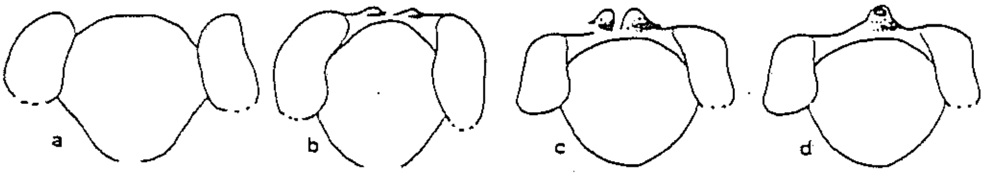
Appendix A: Fig. 18. Expressions of bridging of the intermediate condylar canal: a = absence, b = incomplete bridging from the jugular foramen margin, c = incomplete bridging from the paracondylar process, d = complete bridging between the jugular foramen and the condyle, e = complete bridging between the condyle and the paracondylar process. (Adapted from: Hauser and DeStefano, 1989:127).



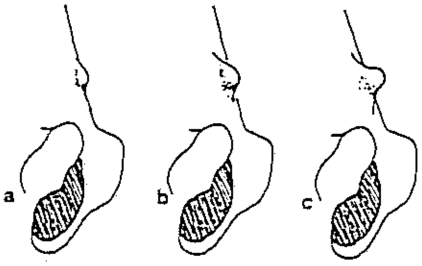
Appendix A: Fig. 19. Degrees of expression of the paracondylar process: a = bilaterally weak, b = strong expression on the left side, absence on the right, c= bilaterally strong, d = strong expression of medial tubercle, medium expression of lateral tubercle. (Adapted from: Hauser and DeStefano, 1989:130).



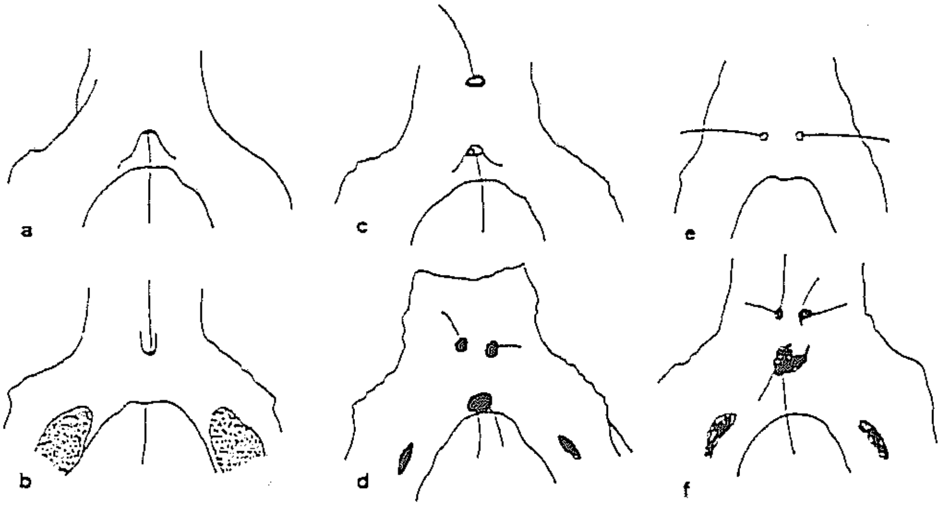
Appendix A: Fig. 20. Variations of jugular foramen bridging: Above left: absence of external bridging. a-c = incomplete external bridging, d-f = complete external bridging. Above right: absence of internal bridging. g-l = incomplete internal bridging, m-o = complete internal bridging. (Adapted from: Hauser and DeStefano, 1989:131).



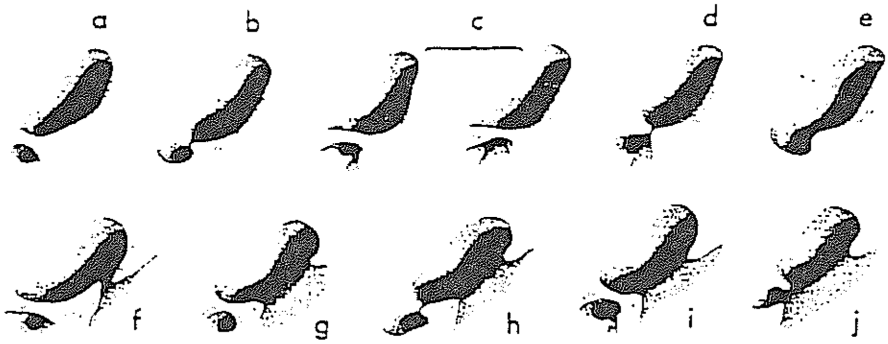
Appendix A: Fig. 21. Expressions of precondylar tubercles: a= absence, b = bilateral weak, c = bilateral strong, d = single median condyle with articular facet. (Adapted from: Hauser and DeStefano, 1989:136).



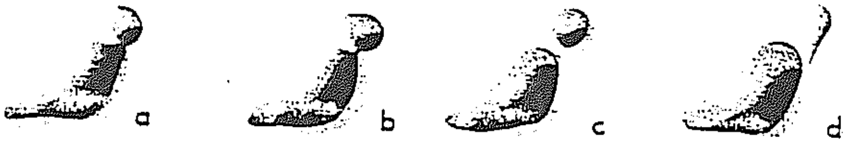
Appendix A: Fig. 22. Expressions of pharyngeal tubercles: a = weak, b = medium, c = strong. (Adapted from: Hauser and DeStefano, 1989:137).



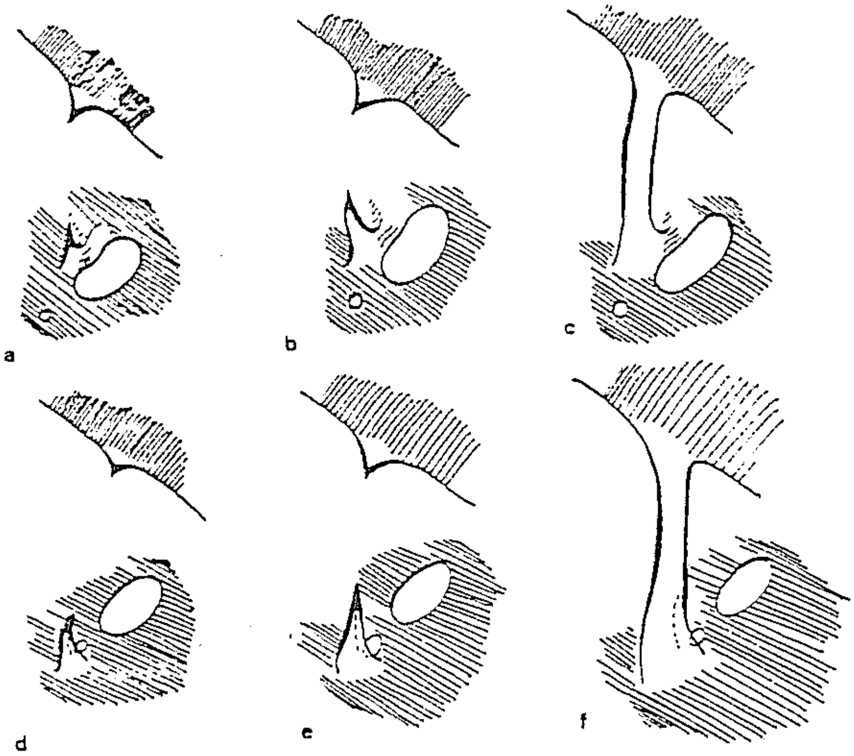
Appendix A: Fig. 23. Variations of the median basilar canal: a = inner opening, b = outer opening of a single canal, c = one canal with two inner openings, d = bifurcating canal with two upper and one lower opening, e = single transverse canal with two inner openings, f = canal with many branches but only three inner openings. (Adapted from: Hauser and DeStefano, 1989:141).



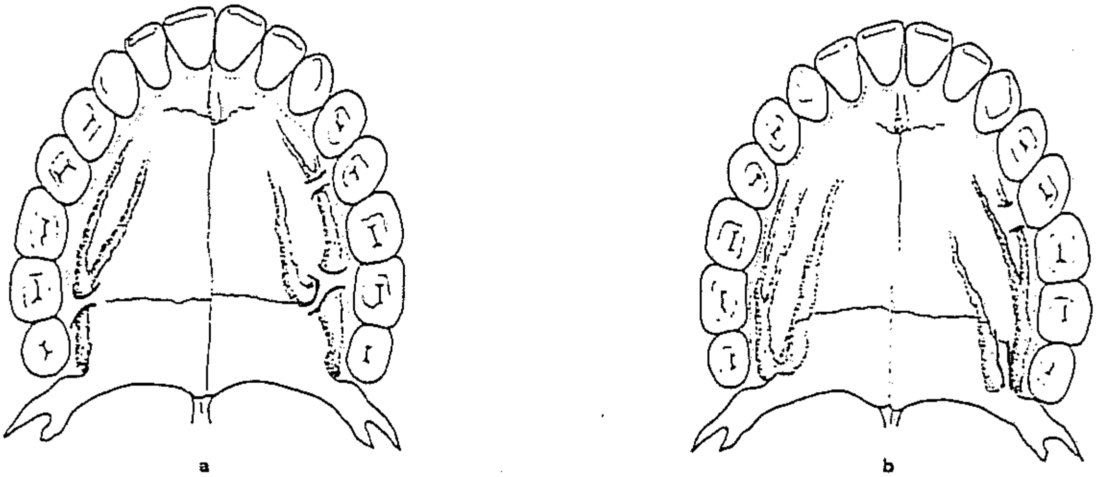
Appendix A: Fig. 24. Degrees of expression of the oval foramen, and the spinous foramen: a = both foramen complete, b = trace of incompleteness, c = partially incomplete spinous foramen, d = partially incomplete spinous foramen and slightly incomplete division of the two foramen, e = no division between the two foramen, f = partially incomplete oval foramen, g = absence of medial wall of the oval foramen, h = absence of medial wall of oval foramen and fissure in division between the two foramen, i = absence of medial wall of both foramen, j = extreme degree of incompleteness of both foramen. (Adapted from: Hauser and DeStefano, 1989:152)



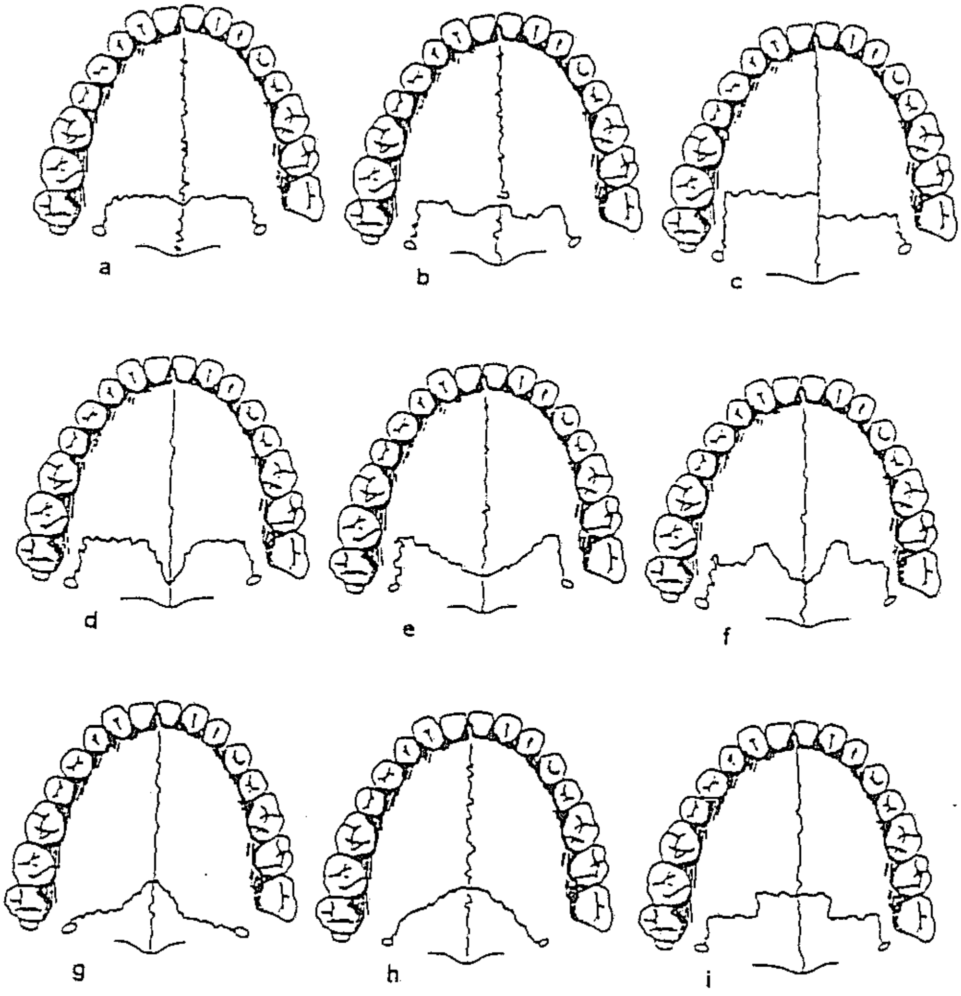
Appendix A: Fig.25. Expression of the foramen vesalius: a = trace, b = incomplete, c = complete foramen (oval), d = complete foramen (slit). (Adapted from: Hauser and DeStefano, 1989:152).



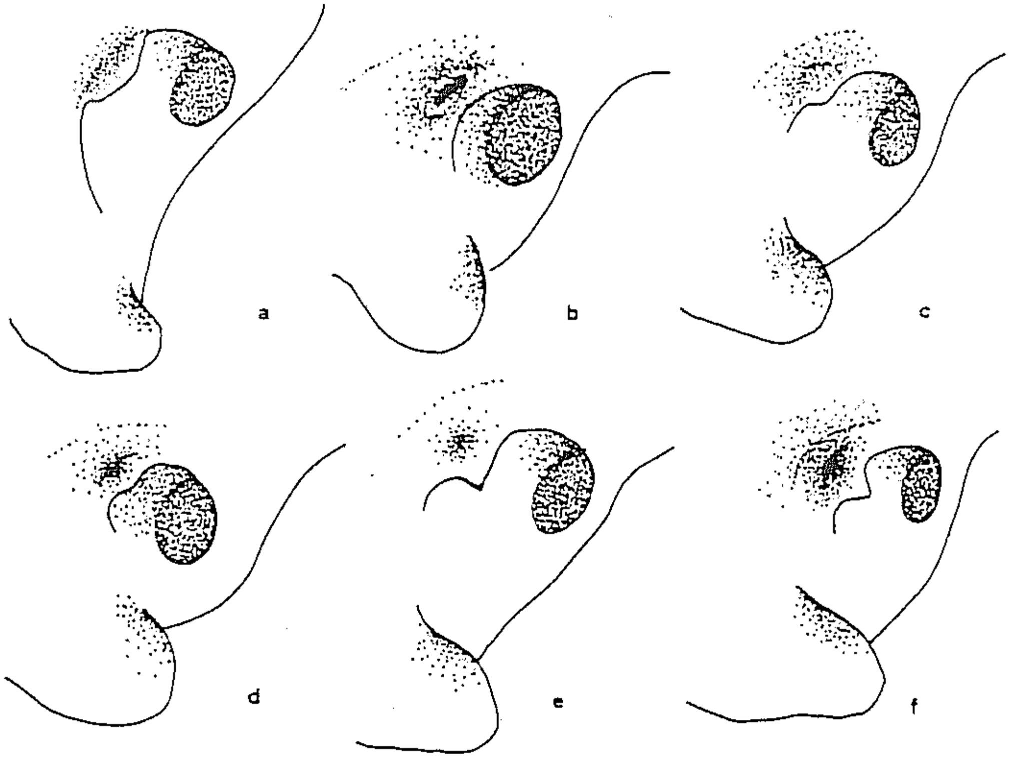
Appendix A: Fig. 26. Variants of the basal sphenoid bridges: (a-c = pterygoalar bridge) a = trace, b = incomplete, c = complete. (d-f = pterygospinous bridge) d = trace. e = incomplete, f = complete. (Adapted from: Hauser and DeStefano, 1989:158).



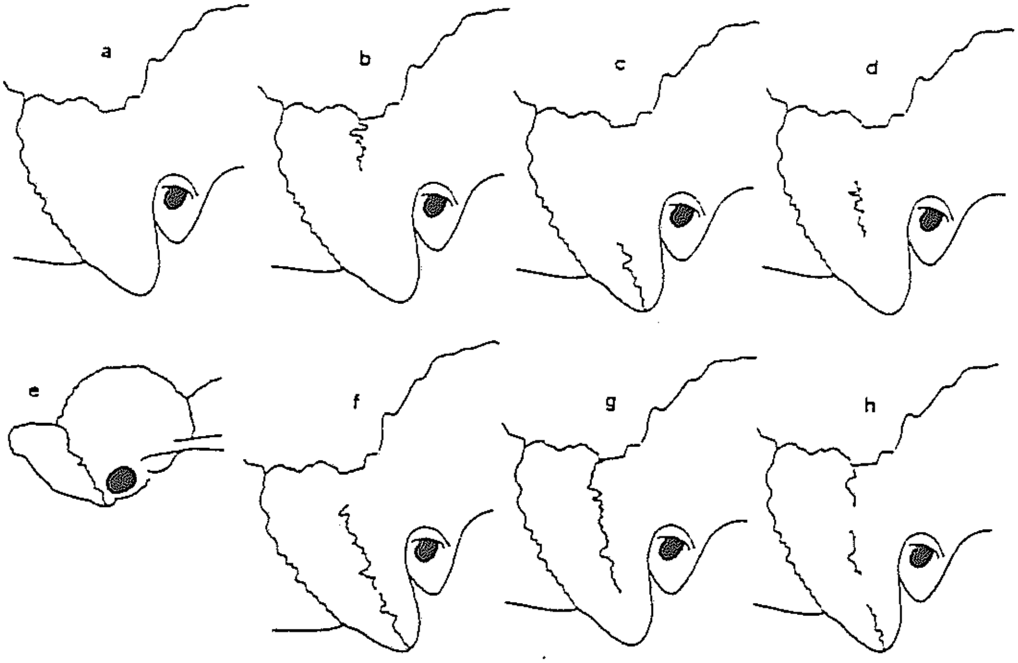
Appendix A: Fig. 28. Expressions of palatine bridging: a = complete bridge on right and multiple bridges on left, b = absence on the right and alveolar bridge on left. (Adapted from: Hauser and DeStefano, 1989:168).



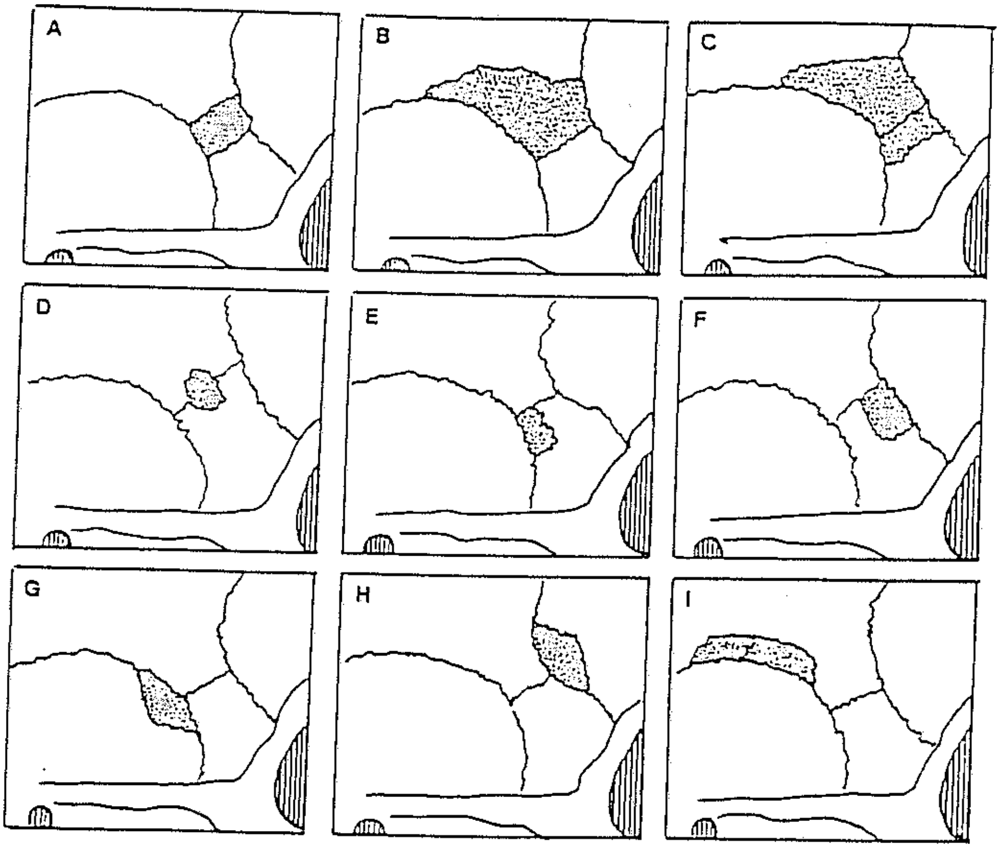
Appendix A: Fig. 29. Differing alignments of the transverse palatine suture: a = symmetric straight transverse, b = straight transverse with protruding extensions, c = irregular junction, d = symmetric straight transverse with a posterior convexity at the midline, e = posteriorly convex suture, f = irregular suture with posterior midline convexity, g = transverse symmetric suture with anterior midline convexity, h = anteriorly convex suture, i = rectangular symmetrical transverse suture. (Adapted from: Hauser and DeStefano, 1989:173).



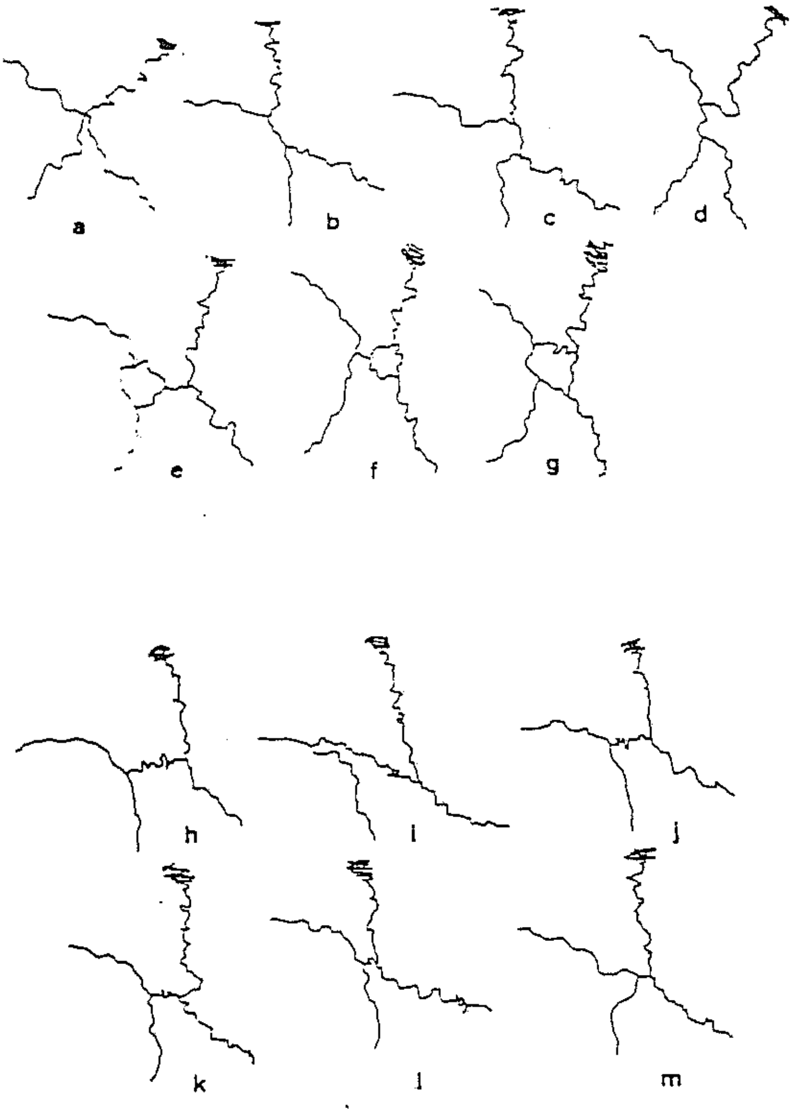
Appendix A: Fig. 30. Variants of expression of the suprameatal spine and depression: a = large crest, b = deep depression, c = small triangle crest, d = small triangle crest and small depression, e = large triangle crest and small depression, f = large triangle crest and deep depression. (Adapted from: Hauser and DeStefano, 1989:190).



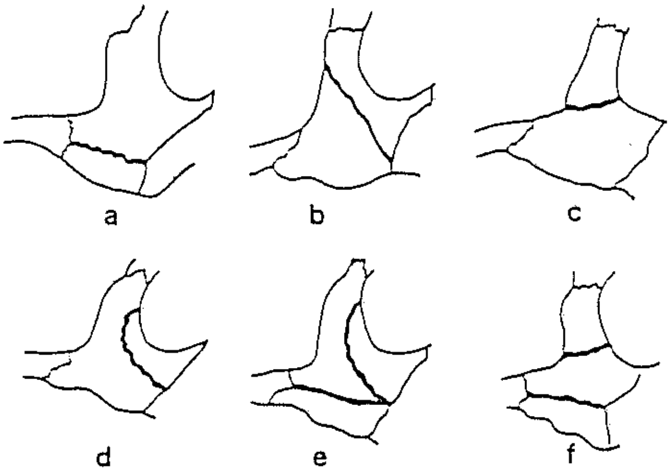
Appendix A: Fig. 31. Degrees of expression of the squamomastoid suture: a = absence, b = trace on top of mastoid process, c = trace on bottom of mastoid, d = trace in middle of mastoid, e = complete, f = paritial on bottom of mastoid, g = partial on top of mastoid, f = parital intermittent along mastoid. (Adapted from: Hauser and DeStefano, 1989:207).



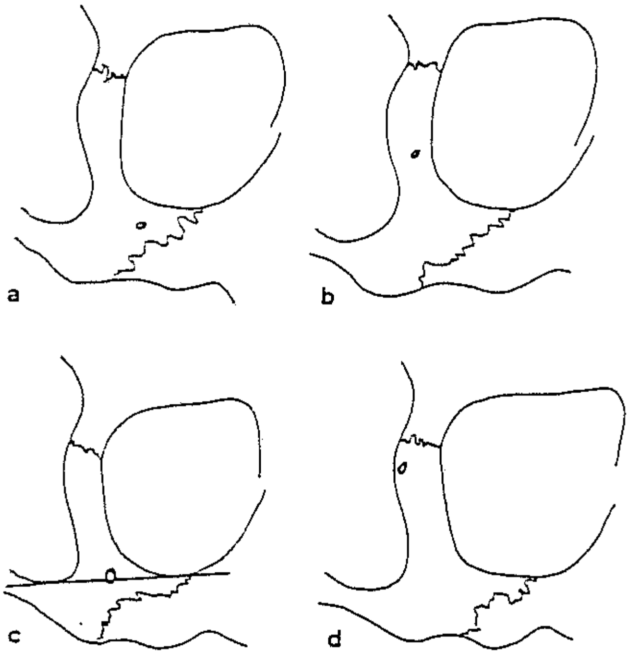
Appendix A: Fig. 32. Representations of the range of expression for the epiteric bone: (A-D are true epiteric bones, E-I are false epiteric bones) A = single bone, B = single bone protruding into the parietal, C = bipartite bone protruding into the parietal, D = small bone in the sphenoparietal suture, E = large bone along squamous margin of temporal, F = large bone along margin of frontal, G = small bone protruding into temporal squama, H = small bone protruding into frontal, I = squamous ossicles. (Adapted from: Hauser and DeStefano, 1989:212).



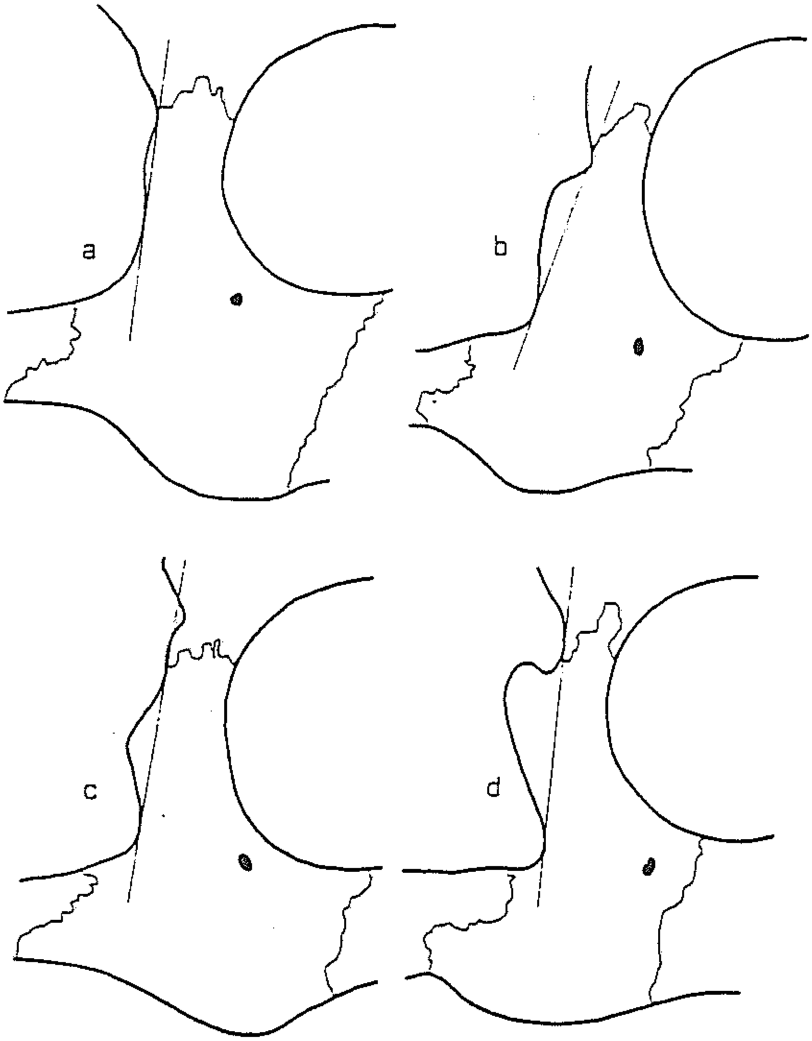
Appendix A: Fig. 33. Variants of fronto-temporal articulation: a = X-shape, connection at one point (stenocrotaphia), b = extended connection, c = connection at the frontal process of the temporal bone, d = connection at the temporal process of the frontal bone, e,f = false epiteric bone, g = true epiteric bone, h-j = H shape with no fronto-temporal articulation, k-m = no true articulation, but scored as trace connection. (Adapted from: Hauser and DeStefano, 1989:217).



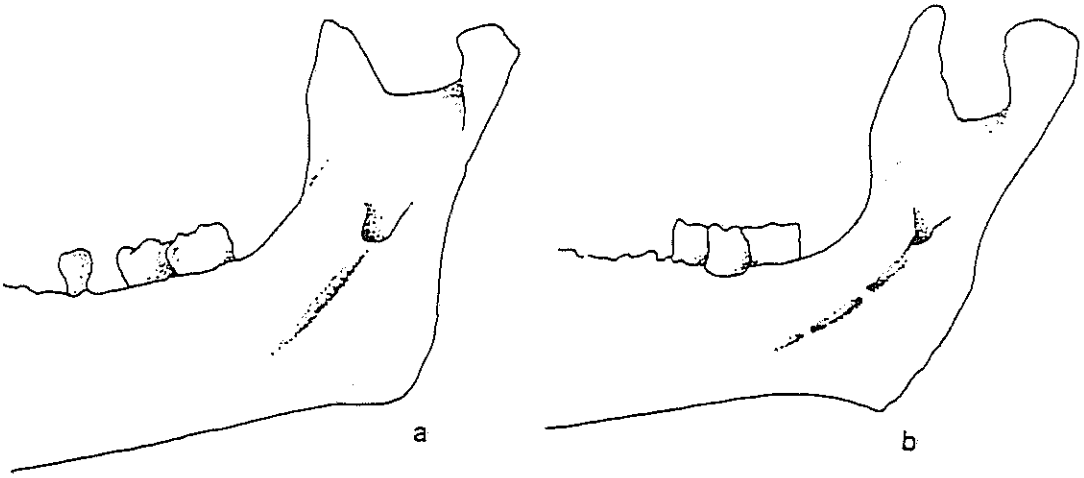
Appendix A: Fig. 34. Expressions of os japonicum: a = bipartite, inferior transverse suture, b = bipartite, oblique lateral suture, c = bipartite, superior transverse suture, d= bipartite, oblique medial suture, e = multipartite, inferior transverse and medial oblique sutures, f = multipartite, superior transverse and inferior transverse sutures. (Adapted from: Hauser and DeStefano, 1989:224).



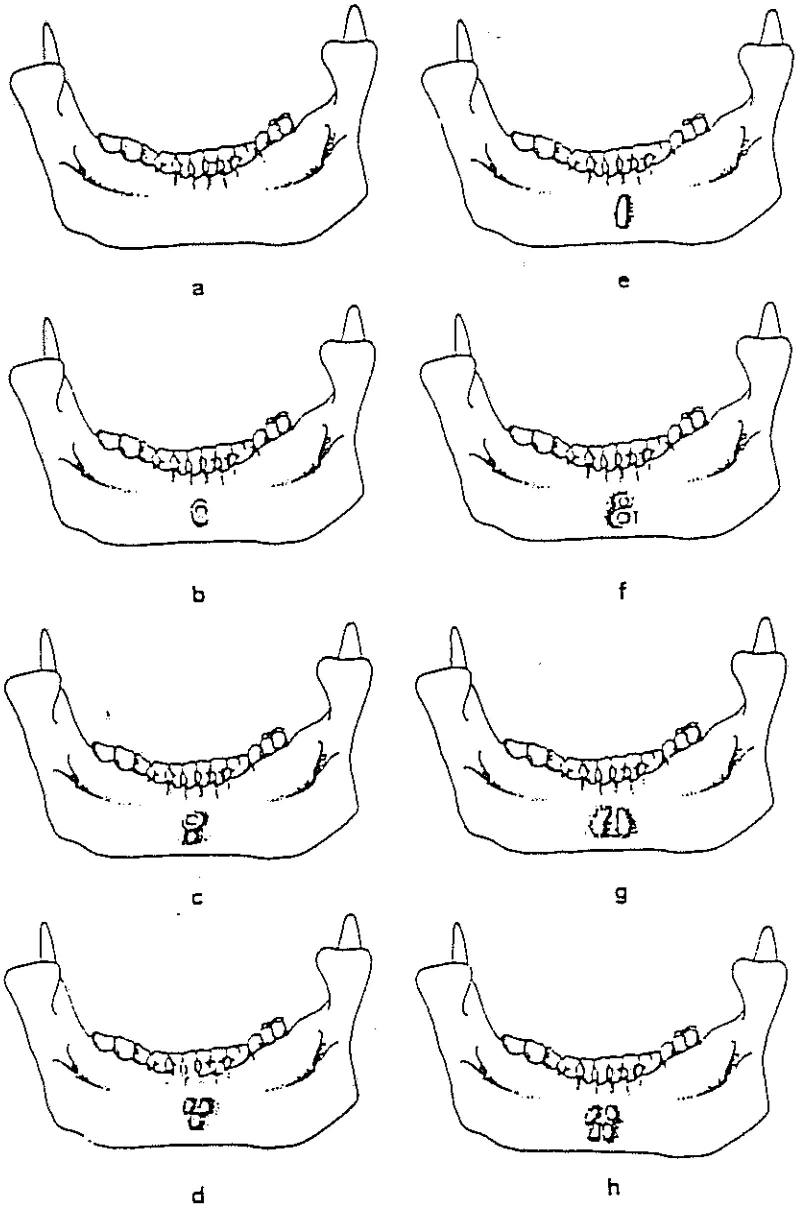
Appendix A: Fig. 35. Differing locations of the zygomatico-facial foramen: a = on the corpus, b = on the frontal process, c = on the frontal process tangential to the inferior orbital margin, d = high on frontal process near fronto-zygomatic suture. (Adapted from: Hauser and DeStefano, 1989:225).



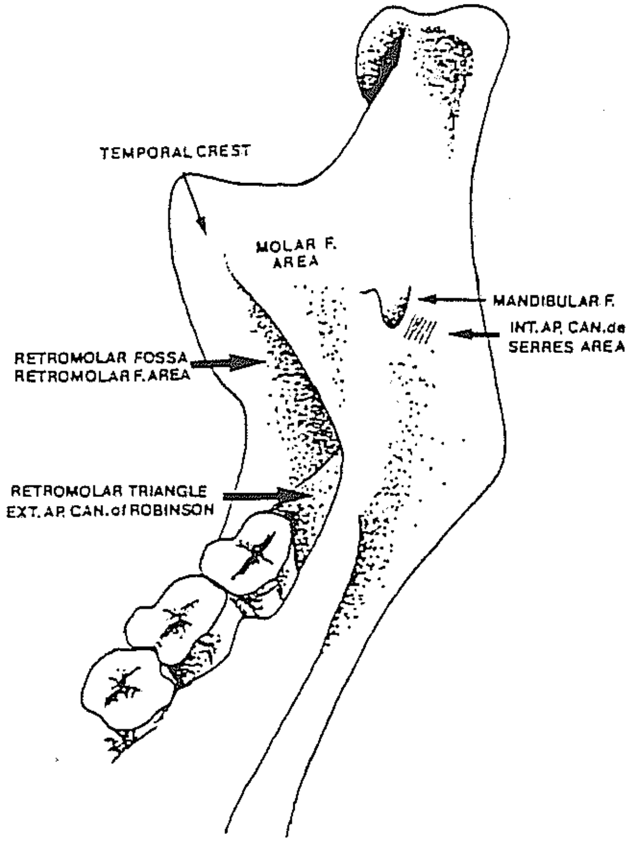
Appendix A: Fig. 36. Differing expressions of the marginal tubercle: a = absence, b = weak, c = medium, d = strong. (Adapted from: Hauser and DeStefano, 1989:228).



Appendix A: Fig. 37. Expressions of mylohyoid bridging: a = absence, b = at least one complete bridge. (Adapted from: Hauser and DeStefano, 1989:235).



Appendix A: Fig. 38. Variants of genial tubercles, median mental spine, and genial pit: a = absence, b = single pit, c = superior pit and inferior tubercle, d = two superior and one inferior tubercles, e = median spine, f = one superior and one inferior pit, g = two superior tubercles, h = two superior and two inferior tubercles. (Adapted from: Hauser and DeStefano, 1989:239).



Appendix A: Fig. 39. General locations of the molar foramen, retromolar foramen and the external orifice of the canal of Robinson (Adapted from: Hauser and DeStefano, 1989:240).

APPENDIX C

LISTING OF BURIAL NUMBERS ACCORDING TO SITE

Moundville Burial No.	Pot type
5a	local
64	local
102	local
104	local
107	local
924	local
944	local
966	nonlocal
1016	local
1033	nonlocal
1050	nonlocal
1153	nonlocal
1226	local
1232	nonlocal
1233	local
1264	nonlocal
1273	local
1293	nonlocal
1304	nonlocal
1318	local
1320	nonlocal
1322	local
1332	local
1349	local
1394	local
1397a	local
1423	local
1452	nonlocal
1519	nonlocal
1536	nonlocal
1539	nonlocal
1586	local
1597	local
1603	local
1605	nonlocal
1618	local
1620	nonlocal
1629	local
1634	local
1749	nonlocal
1784	nonlocal
1931	nonlocal
1934	nonlocal
1934a	local
1950	local
1955	nonlocal
1979	nonlocal
2042	nonlocal
2047	nonlocal
2079	nonlocal
2136	nonlocal
2161	nonlocal

1Lu25 Burial No.	**Class**
14	Archaic
22	Archaic
23	Archaic
38	Archaic
57	Archaic
58	Archaic
59	Archaic
76	Archaic
84	Archaic
87	Archaic
96	Archaic
107	Archaic
112	Archaic
113	Archaic
133	Archaic
141	Arhaic
145	Mississippian
152	Mississippian
158	Mississippian
161	Mississippian
163	Mississippian
169	Mississippian
178	Mississippian
180	Mississippian
188	Mississippian
226	Mississippian
227	Mississippian
234	Mississippian
244	Mississippian
247	Mississippian
270	Mississippian
279	Mississippian
283	Mississippian
287	Archaic
310	Archaic
311	Archaic
312	Archaic
314	Archaic
315	Archaic
326	Mississippian
327	Mississippian
328	Mississippian
342	Mississippian
343	Mississippian
358	Archaic
360	Archaic
365	Mississippian
374	Mississippian
392	Mississippian
401	Mississippian
413	Mississippian
436	Archaic
470	Archaic
492	Archaic
505	Mississippian
535	Mississippian
538	Mississippian
580	Archaic
607	Mississippian
608	Mississippian
615	Mississippian
642	Archaic
686	Archaic
689	Archaic
693	Archaic
717	Mississippian
740	Mississippian
762	Mississippian
776	Archaic
779	Mississippian
780	Mississippian
990	Mississippian
1018	Mississippian

1Lu92
Burial No.
4
5a was 5
11
14a was 14
15
16
20
21
24
25
26
30
31
32
33
34
35
36
37
38
39
40b was 40
41
42
43
45
46
47
51
52
53
54
57
60
61
64
65
66
67
70
72
73
74

1Lu92
Burial No.
75
79
81
83
84a
85
87
89
90
91
92
93
94
95
100
101

1Ms80
Burial No.
3
4
6
9
10
11
15
23
25
29
36
37
38
40
41
44
46
49
51
55

APPENDIX D

SCORING FORMS

NON-METRIC CRANIAL TRAITS						
SUTURES						
Burial No. ________	**Site** _______		**Observer** _______			
Age ________	**Sex** _______		**Date** ___________			
Traits	**Present (0,1)**	**Extension**	**Configuration**	**Position**	**Ossicles (0,1)**	
1. Metopic suture						
2. Supranasal suture						
3. Metopic fissure						
4. Infraorbital suture						
5. Coronal suture						
6. Saggital suture						
7. Lambdoid suture						
8. Transverse palatine suture						
9. Biasterionic suture						
10. Partitioned temporal squama						
11. Squamomastoid suture						
12. Os Japonicum						
13. Fronto-temporal articulation						

NON-METRIC CRANIAL TRAITS

FORAMEN, GROOVES, CANALS

Burial No. ________ **Site** ______ **Observer** ____

Age ________ **Sex** _______ **Date** _______

Traits	**Present (0,1)**	**Number**	**Position**	**Size**	**Division**	**Shape & Expression**
1. Frontal grooves						
2. Anterior ethmoidal foramen						
3. Posterior ethmoidal foramen						
4. Supratrochlear notch						
5. Supraorbital medial notch						
6. Suprorbital lateral notch						
7. Supratrochlear foramen						
8. Supraorbital medial foramen						
9. Supraorbital lateral foramen						
10. Nasal foramina						
11. Infraorbital foramen						
12. Parietal foramen						
13. Occipital foramen						
14. Condylar foramen						
15. Hypoglossal canal						
16. Intermediate condylar canal						
17. Jugular foramen bridging						
18. Median basilar canal						
19 Craniopharyngeal canal						

Traits	Present (0,1)	Number	Position	Size	Division	Shape & Expression
20. Tympanic aperture						
21. Marginal foramen						
22. Postglenoid foramen						
23. Inferior squamous foramen						
24. Foramen spinousm						
25. Oval foramen						
26. Foramen of Vesalius						
27. Lesser palatine foramen						
28. Inferior parietal foramen						
29. Superior squamous foramen						
30. Mastoid foramen						
31. Zygomatico-facial foramen						
32. Mental foramen						
33. Accessory mandibular foramen						
34. Molar foramen						
35. Retromolar foramen						
36. Canal of Robinson orifice						

NON-METRIC CRANIAL TRAITS

FOVEAS, SPINES, TUBERCLES, OSSICLES, PROCESSES, CONDYLES, AND BRIDGES

Burial No. ________ Site ________ Observer ____

Age ________ Sex ________ Date ________

Traits	Present (0,1)	Position	Size	Shape	Expression	
1. Trochlear spine						
2. Zygomaxillary tubercle						
3. Symmetrical thinness of parietal bones						
4. Inca bone						
5. Highest nuchal line						
6. Retromastoid process						
7. Atlas bridging						
8. Double occipital condylar facet						
9. Paracondylar process						
10. Precondylar tubercle						
11. Pharyngeal foveola						
12. Pteryo-spinous bridge						
13. Pterygo-alar bridge						
14. Palatine bridging						
15. Palatine torus						
16. Maxillary torus						
17. Mandibular torus						
18. Auditory torus						
19. Suprameatal spine and depression						

Traits	Present (0,1)	Position	Size	Shape	Expression	
20. Occipitomastoid & asterion ossicles						
21. Parietal notch bone						
22. Epipteric bone						
23. Squamous ossicles						
24. Marginal tubercle						
25. Mylohyoid bridge						
26. Genial tubercles, spine, and pit						
27. Bifid mandibular condyles						
28. Pharyngeal tubercle						
29. Parietal process of temporal squama						