

DISCONTINUOUS MORPHOLOGICAL TRAITS OF THE SKULL AS
POPULATION MARKERS IN THE PREHISTORIC SOUTHWEST

by

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direction by Walter Hudson Birkby
entitled Discontinuous Morphological Traits of the Skull
as Population Markers in the Prehistoric Southwest.
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ABSTRACT

The analyses of prehistoric Southwestern human skeletal material have been hampered in the past by the fragmentary or incomplete condition of the remains, and by the rather high frequency of occurrence (over 75%) of artificial cranial deformation which is found among many archaeological populations.

The present study was initiated to determine if discrete or discontinuous cranial traits, and the new statistics developed to handle such data, would be useful for population analyses and comparisons on deformed or fragmentary and incomplete cranial remains. To this end, 501 human crania from four Late Mogollon archaeological sites (Grasshopper, Point of Pines, Turkey Creek, and Kinishba Ruins) were classified for 54 discrete or non-metric characters.

From the presence or absence of the traits, statistical comparisons were made between deformed and non-deformed crania and between skulls of males and females. These comparisons indicate that the factors of sex and deformation do not influence the frequency of appearance of the traits. Significant trait differences were observed, however, between the crania of individuals of pre-reproductive and reproductive age.

Mean measures of divergence or "biological distances" generated between the four site populations indicate that discrete traits are capable of distinguishing between prehistoric groups

as well as or better than previously used osteometric techniques. Additionally, two "cemeteries" or burial areas were delineated for the largest of the pueblos (Grasshopper Ruin), and data from an intra-site comparison suggest that at least two distinct habitation areas may have been occupied by different social units of the population. Trait comparisons between the interments in the cemeteries further indicate the existence of a male exogamous mating pattern and a probable matrilineal residence rule for the inhabitants of the site.

CHAPTER I

INTRODUCTION

For the most part, the study of prehistoric skeletal material--at least until rather recently--has been limited to metric and morphological descriptive comparisons of the osseous debris recovered from archaeological sites. In many instances these studies, so often relegated to the appendices of archaeological site reports, have dealt only with individual skeletal descriptions of each interment without recourse to interpopulational comparisons. Such is quite likely to be the case with the handling of material from small sites where the total exhumed skeletons may not exceed 10 in number--and sometimes considerably less. Where attempts have been made to compare such small samples with a major skeletal series, they have met with only a modicum of success, in part because of the broad ranges of the metrics in any set of measurements or indices. Thus, even with the most restrictive interpretations, a small skeletal sample could conceivably fall within the metric ranges of several unrelated but numerically large populations.

In other instances, and particularly in the Southwestern United States where recovered remains have been quantitatively greater, interpopulational metric and morphological comparisons have been attempted between major skeletal series (see especially Hooton 1930; Bennett 1967; Wade 1970). But these comparisons, too,

have had their analytical drawbacks for various and obvious reasons:

(1) the vast majority of crania from the Southwest are artificially deformed so that many cranial measurements can not be compared between populations; (2) more often than not, the number of metric observations which need to be taken for comparative purposes is severely limited because of poor preservation in the soils or faulty recovery of the material or both; and (3) skeletal populations, unlike living populations, are difficult to classify genetically because of the absence of prehistoric genealogies and an almost total lack of knowledge on the heritability of metric variables.

Fortunately, newer approaches to the study of human skeletal variability and micro-evolutionary change have appeared. These do not rely on metrical or "continuous variable" data, but utilize discrete traits or "discontinuous variables" as the basis for analysis. The history of the reporting of these traits is nicely summarized by Brothwell (1965: 9-10) and by Berry and Berry (1967: 361-2) and need not be repeated here. Suffice it to say that discrete traits, with early suggestions that they might be of possible anthropological interest (Chambellan 1883), have been in the literature for nearly 90 years. And, by the turn of the century, Russell (1900) first demonstrated that the percentage frequencies of discrete traits in New World Indian crania varied with regional populations. In all of the studies pre-dating the mid-20th Century, interpopulation analyses when they were made at all, employed little more than these same sorts of direct percentage frequencies of occurrence for

comparative purposes. In historical perspective, I suppose that very little more could have been done.

Only within the last 20 years, following modifications of the D^2 distance statistic by Penrose (1954) and C. A. B. Smith (reported by Berry and Berry 1967), has it become possible to make interpopulational comparisons for multiple, rather than single, discontinuous traits. The study of these variants or traits has several advantages:

1. While the inheritance of most discontinuous cranial variants in man is unknown or poorly understood, it has been suggested that they are "...morphologically analogous to those which occur in rodents, and what is known about their inheritance agrees with them being inherited in the same way as in the mouse" (Berry 1968: 111). The inheritance of discrete traits has been reviewed by others (Brothwell 1959 and 1965; Berry 1968; Kellock and Parsons 1970a; Ossenberg 1970).
2. Discontinuous traits appear to describe group similarities and differences, from the point of population genetics, as well as or better than the standard osteometric techniques (Laughlin and Jorgensen 1956; Brothwell 1959; Berry 1968; Jantz 1970; Pietrusewsky 1971a; and Lane and Sublett 1972).
3. Unlike osteometric variables, discrete traits are not differently expressed in the sexes (Berry 1968; Ossenberg 1970) and these data therefore can be pooled to increase sample sizes.

4. Also, in contrast to osteometrics, there appears to be little or no correlation between non-metric variables, that is, the traits are independent of each other (Berry and Berry 1967). Benfer (1970) has recently substantiated this advantage with a multivariate analysis of association for certain of the cranial traits.

5. Discrete traits are suggested to be promising avenues of approach for temporal as well as spatial analyses of skeletal populations (Brothwell 1965; Jantz 1970).

Armed with all of these apparent advantages, and this newer methodology for the analysis of variant data, I decided to initiate a study of the prehistoric Southwestern skeletal material recovered in Arizona from a series of spatially close and culturally similar sites. To this end, material from four Western Puebloan sites was selected as being representative of four local populations (the micro-races of Garn 1961). The sites (together with their designated site numbers) are: the Grasshopper Ruin (Ariz. P:14:1); Kinishba (Ariz. V:4:1); the Turkey Creek Ruin (Ariz. W:10:78); and the Point of Pines Ruin (Ariz. W:10:50). Descriptions of the sites are provided in Chapter II.

For this present study, I have tried to use as many cranial variants as have appeared either in previously published literature (Berry 1968; Pietrusewsky 1971a and b; Lane and Sublett 1972) or in unpublished dissertations (Butler 1971; Finnegan 1972; Jantz 1970). However, a few of the traits listed by others have seemed either somewhat superfluous (for example, a mylohyoid arch and a tunnel used

by Lane and Sublett 1972) or outside the range of variation noted in Southwestern American Indian groups (for example, a "rocker jaw" which is more apt to be a Polynesian feature and was listed by Pietrusewsky 1971a). These have been deleted from this study.

Other traits which I have encountered either in looking at crania or checking various anatomy texts, and which I deemed might have relevancy, have been added to this list. All are discussed in detail in Chapter III.

The purpose of this study is partly to test the newly developed non-metric distance statistic on Southwestern skeletal populations which, to the best of my knowledge, have never been analysed in this manner. Further, I would like to verify or reject with these Southwestern groups, certain conclusions drawn by other investigators of cranial variants, some of whom have been using a previously reported but probably erroneous distance statistic.

Therefore, certain hypotheses to be tested in this study, and which are framed in the form of questions, include:

1. Do the selected Southwestern skeletal populations lack sexually distinct cranial variants which would, as with other reported groups, allow the pooling of male and female non-metric data?

2. Does artificial cranial deformation in these selected groups significantly alter the non-metric trait frequencies as Ossenberg (1970) has reported for an eastern United States skeletal population?

3. Are there significant trait frequency differences between the pre-reproductive and the reproductive age groups in the selected Southwestern populations?

4. Can non-metric variants be employed to demonstrate that burial "plots" or cemeteries within a single site possibly were used by different breeding units of the population?

5. Can exogamous or endogamous mating patterns be determined for these prehistoric Southwestern sites by using the non-metric cranial traits of their skeletal populations?

CHAPTER II

SKELETAL MATERIAL

The crania used in this analysis are from four archaeological sites in east-central Arizona (Fig. 1) and all are maintained in the comparative Human Osteological Collection of the Arizona State Museum, University of Arizona. The total analytical sample of 501 crania consists of 177 males, 256 females, and 68 unsexable non-adults. Their site distribution is shown in Table 1.

The only criterion for the selection of crania from each of the four sites was the age of the individual at death, and not the completeness of the skull. No crania were used where the age estimation was under the arbitrarily set limit of 4 to 6 years. No crania over this age limit were rejected. This lower age-range limit was established for several reasons: (a) the dental age, based on the maturation and eruptive stages of the first permanent molar, could best be visualized during this time; (b) closure of the occipito-condylar synchondroses, which most frequently begins before the fourth year of life (Terry and Trotter 1953: 144), can best be determined; (c) osseous maturation of the skull in general is advanced enough so that it was felt that most cranial traits, if they were going to be present, would have appeared by the fourth year.

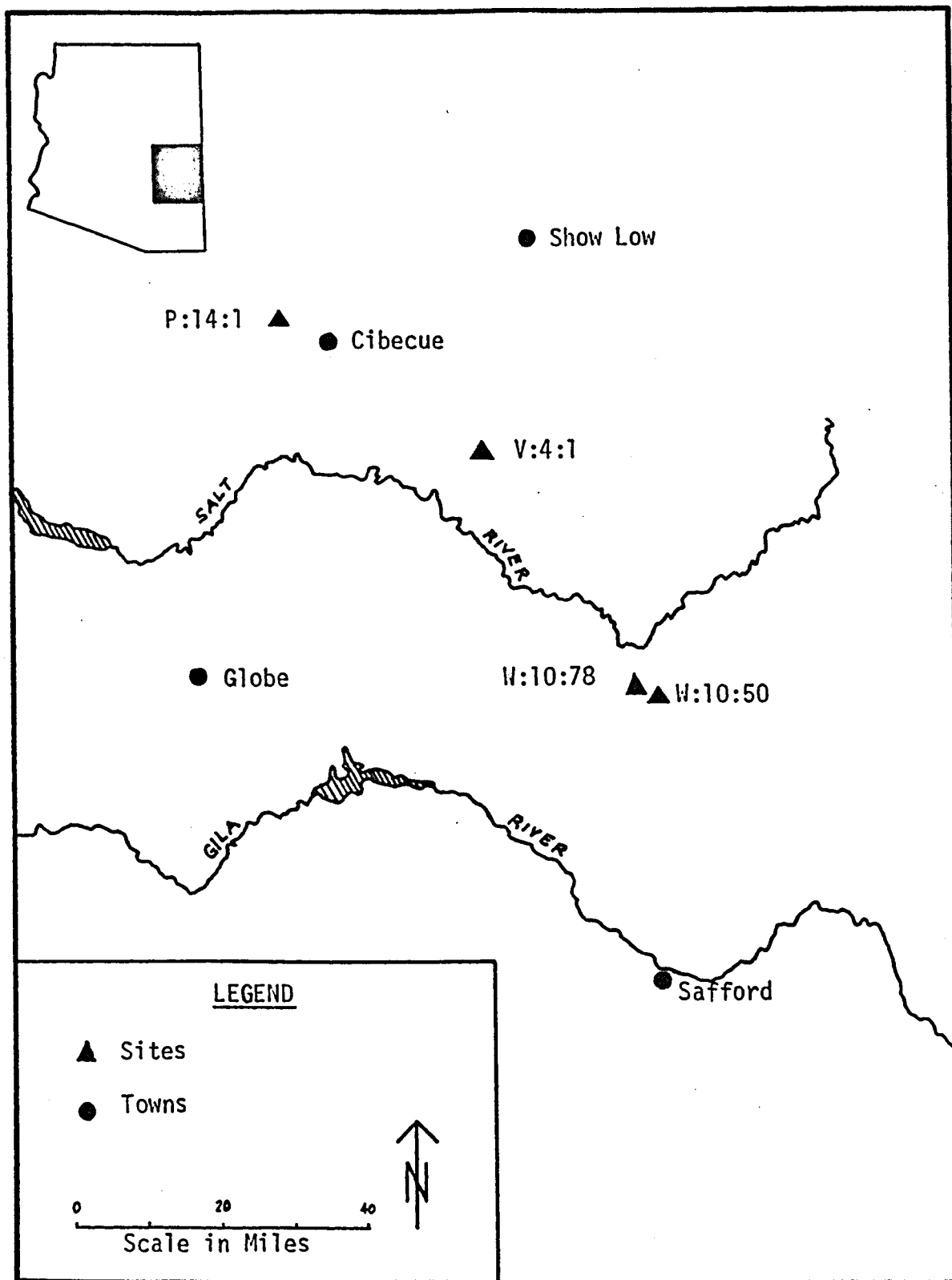


Fig. 1. Map of East-central Arizona and the locations of the four Mogollon archaeological sites.

TABLE 1

Distribution of crania by sex and archaeological site.

Site	Males	Females	Non-Adult	Total
Grasshopper (Ariz. P:14:1)	58	108	43	209
Kinishba (Ariz. V:4:1)	23	28	15	66
Point of Pines (Ariz. W:10:50)	41	55	5	101
Turkey Creek (Ariz. W:10:78)	55	65	5	125
Total	177	256	68	501

Age Estimates

The estimated skeletal age for the non-adults was determined from the order of appearance and fusion of the long bone epiphyses (Krogman 1962: 45-47) and the stages of eruption of the permanent dentition (Krogman 1960: 24; Johanson 1971: 24). The classification of non-adult obtained, at least in this study, until a skeletal age of about 15 to 17 years or until there were indications of sexual dimorphism in the cranial and post-cranial system, which ever came first.

Age estimations for adult material were determined by employing the standard techniques which have proven to be the most useful in cases of human identification, that is, age changes in the pubic symphysis (McKern and Stewart 1957) and late epiphyseal maturation or cranial suture closure (Krogman 1962). Not infrequently, however, it was necessary to assign broad age ranges based on the degree of dental attrition in cases where the material otherwise could be classified only as "adult."

Both non-adult and adult age determinations on material from two of the sites (Turkey Creek and Point of Pines Ruins) previously studied by Bennett (1967) were in close agreement with the ages assigned by me in this study. Only 24 (10.6%) of the 226 age estimations I made on burials from these sites would be considered as being outside the age ranges established by Bennett and listed on his raw data collection sheets at the Arizona State Museum. For purposes of this study, I have used my age estimates of the skeletal material where the ages were not in agreement.

Sex Determination

The determination of sex of the skeleton, which automatically categorizes the material as adult, was also defined by the usual methods employed in cases of human identification (Krogman 1962; McKern and Stewart 1957). Non-adult skeletal material can not be so classified because of the lack of osseous sexual dimorphism prior to the age of about 15 years.

While multivariate discriminant analyses have been used on other skeletal series (Giles and Elliot 1962) to aid in the determination of sex, such methods were not employed in the present study inasmuch as it would have required extensive craniometric observations on two (Kinishba and Grasshopper) of the four populations. Multivariate discriminant analysis run on metrics of populations other than those for which the functions were established can sex the crania erroneously in as many as 50% of the cases (Birkby 1966: 25). Moreover, the metric sexing of skeletal material can not be employed where crania have been deformed (Giles 1966: 85).

Sex estimates were occasionally made on grossly incomplete adult skeletons from the four sites whenever cranial traits were available for observation. In such instances, the remains were designated as either "questionably male" or "questionably female" based at times on measurements, such as size of the humeral or femoral heads, or on macroscopic inspection of the fragments for indications of robusticity or other sexually dimorphic differences, such as sharpness of the supraorbital borders or roundness of the nasal root.

Visual sex determinations had been made previously on the skeletal series from Turkey Creek and Point of Pines by Bennett (1967). My independent sex determination on the skeletons from these same sites indicated a quite close agreement between Bennett's sex estimates (on his raw data sheets) and mine. In the 216 skeletons from these two sites used in this study, there was disagreement in only 5 or 2.3% of the cases. Wherever there was disagreement as to the sex of an individual, my own determinations were used.

Artificial Deformation

Only two types of artificial cranial deformation, occipital and lambdoidal, occur at any of the four sites. The most prevalent is occipital deformation which ranges from a low of 72.4% (Table 2) at Point of Pines Ruin to a high of 83.5% at the Grasshopper Ruin. Lambdoidal deformation in the combined sexes ranks closer to the non-deformed crania in frequency of occurrence.

If Ossenberg's (1970) contention that cranial deformation does indeed affect the frequency of the discrete traits is correct, one can see from Table 2 that from 72 to 83% of the cranial material from these Southwestern sites would have to be rejected from this type of study.

The determination of whether a skull was deformed is based solely on the morphology of the posterior vault. Occipital deformation, ostensibly from cradle-boarding, was so classified where there was any degree of posterior vertical flattening. Usually, but not always, occipital deformation is centered somewhere on the mid-line of the occipital and involves the external occipital protuberance.

TABLE 2

Frequencies of artificial cranial deformation by site and sex.

Site (N) and Deformation	Male		Female		Both Sexes	
	n	%	n	%	n	%
Turkey Creek Ruin (N=102)						
None	4	3.9	8	7.8	12	11.7
Occipital	37	36.3	39	38.2	76	74.5
Lambdoidal	5	4.9	9	8.8	14	13.7
Point of Pines Ruin (N=80)						
None	6	7.5	11	13.7	17	21.2
Occipital	27	33.7	31	38.7	56	72.4
Lambdoidal	0	--	5	6.3	5	6.3
Kinishba Ruin (N=38)						
None	3	7.9	2	5.3	5	13.2
Occipital	14	36.8	17	44.7	31	81.5
Lambdoidal	1	2.6	1	2.6	2	5.2
Grasshopper Ruin (N=152)						
None	1	.6	8	5.3	9	5.9
Occipital	49	32.2	78	51.3	127	83.5
Lambdoidal	3	1.9	13	8.5	16	10.5

Occasionally, such deformation may be shifted laterally creating an asymmetrical form of occipital flattening. Asymmetrical occipital deformation, for purposes of this study, was classified the same as the "symmetrical" deformation.

Lambdoidal deformation is reasonably distinct from other posterior vault flattening. As its name implies, the anthropometric point "Lambda" is almost centrally involved in the deformation. The deformation plane is not at a 90° angle to the Frankfort Plane as is the classical occipital deformation. Rather, it more nearly approaches a 45° angle to the Frankfort Plane in its typical form. Whether this results from a peculiar type of cradle-board design or cradle-board padding (or both) is still somewhat debatable, although the suggestions cited by Bennett (1973: 10) are as good as any others advanced to date. Like Bennett (1973: 10), I found a slight decrease in the incidence of lambdoidal deformation through time at the Point of Pines-Turkey Creek complex.

The Sites

The archaeological sites were chosen because of their temporal provenience, their generally similar geographic location within east-central Arizona, and their proximity to each other, their similar cultural affinity, that is, Western Pueblo (Reed 1948; Thompson and Longacre 1966), and the availability of reasonably large skeletal collections from each site (Table 1). Whether the sites were settled by the same people, archaeologically speaking, is questionable. While the sites have certain ceramic and architectural similarities, they

nevertheless exhibit differing ceramic-type frequencies and other dissimilarities as well.

All of the sites, however, are located in very similar geographic environments at approximately the 6000 foot elevation. They are located on prairie plateaus and surrounded by higher elevations. The characteristic forest cover at this elevation is now, as it was during the period of prehistoric occupancy, predominately Ponderosa pine, Douglas-fir, juniper, pinyon and oak (Dean and Robinson, MS). The floors of the plateaus are covered by tall grasses and various forms of shrubs. A brief archaeological resume of each site follows.

The Grasshopper Ruin (Ariz. P:14:1). The site is located on the Fort Apache Indian Reservation about 10 miles west of Cibecue, Arizona. Excavations have been conducted at the site by the University of Arizona Archaeological Field School every summer since 1963. Dates for this 500 plus room complex can only be considered as tentative while it is still undergoing excavation. Tree-ring dates for the site thus far have a maximum clustering between A.D. 1280 and 1340 (Dean and Robinson, MS) with abandonment of the site shortly after A.D. 1400 (Longacre, MS).

To date, more than 500 primary flexed, semi-flexed and flexed interments have been removed from within the rooms and from areas surrounding the pueblo. From these interments, 209 crania were selected for analysis on the basis of the age of the individual at death (that is, greater than 5 years old). The seemingly small selected sample size results almost totally from the quite large number (60.2%) of "pre-reproductive age" deaths at this site (Birkby,

MS). The greater part of this early loss occurs at the critical ages of life prior to approximately 5 years of age.

The Point of Pines Ruin (Ariz. W:10:50). This approximately 800 room pueblo is located on the San Carlos Indian Reservation approximately 65 miles east of Globe, Arizona (Fig. 1). Excavations at the ruin were conducted every summer from 1947 to 1958 by the University of Arizona Archaeological Field School. The generally accepted dates for the site are A.D. 1250 to 1450.

A total of approximately 274 primary extended, semi-flexed and flexed interments were encountered at the site, although only 170 of these can be accounted for in the laboratory at this time. The reasons for this disparity between the number found and the number on hand has been discussed by Bennett (1973: 3). Of the 170 skeletons available for study, 101 crania could be utilized in this present analysis. As in the case of the other site material under consideration, selection was based solely on the age of the individual at death.

The sparse number of non-adult crania available for study (Table 1) is a reflection not only of the field selection which took place at the site during excavation, but also the high pre-reproductive age mortality (54.7%) which occurred at Point of Pines also (Birkby, MS). Here, as at the Grasshopper Ruin, the greater part of this loss was probably among the infants and children younger than 5 to 6 years of age. I suspect that the majority of these infant and childhood deaths were, even as in the United States prior to the use of antibiotics and chemotherapy, the direct result of upper respiratory infections which blocked the alveoli of their small lungs.

The inhumations at the site were recovered from within the rooms of the pueblo and from major broadside excavations in areas surrounding the habitation site. The many cremations recovered from the site have already been reported by Merbs (1967).

The Turkey Creek Ruin (Ariz. W:10:78). This pueblo, with more than 300 rooms, is located approximately 3 miles north of the Point of Pines Ruin and near the southern bank of Turkey Creek, a tributary of Willow Creek. The site was excavated by the University of Arizona Archaeological Field School during the summers of 1958-59. Temporally, the site is somewhat earlier than the larger Point of Pines Ruin and is generally considered to date from A.D. 1000 to 1250.

The number of recovered skeletons, according to the Field Burial Data Sheets, represented the remains of approximately 250 individuals. The number of skeletons and parts of skeletons in the laboratory, however, represents 260 individuals. The discrepancy here can be accounted for, at least partially, by multiple individuals from the same burial pit. Other problems exist with this skeletal count comparable to those at Point of Pines (Bennett 1973: 3). These problems notwithstanding, a sample of 125 crania was selected for this present study.

Some of the interments were excavated from the floors of the rooms within the building complex, but the majority were taken from eight large trashmounds which were circumferentially located around the pueblo. The burials were usually primary inhumations in the extended, flexed or semi-flexed positions.

The Kinishba Ruin (Ariz. V:4:1). The site of Kinishba is on the Fort Apache Indian Reservation approximately 30 miles south of Show Low, Arizona (Fig. 1). These ruins, like those at Grasshopper, consist of various building complexes with the largest two estimated at over 200 rooms each (Baldwin 1938: 13). Excavation of the ruins which began in 1931 and continued each summer through 1938, were conducted by the "Department of Archaeology of the University of Arizona and the Arizona State Museum" (Baldwin 1938: 12).

Slightly different beginning dates for the site have been suggested by Baldwin (1938) and Cummings (1940), but the bulk of the tree-ring dates now cluster around A.D. 1250 to 1325 (Breternitz 1966).

The interments, with the exception of three cremations, were all primary burials predominately in the extended position. Of the estimated 272 skeletons which were discovered, only 66 numbered remains (plus miscellaneous uncatalogued cranial and postcranial debris) could be found in the collections at the Arizona State Museum. All were utilized for purposes of this study. I strongly suspect that much of the skeletal material which was "discovered" at the site was not brought in from the field. Unfortunately, there are no existing catalog cards or burial records for this site. This poses a serious problem when trying to place any of the remains in their proper provenience within the site, and for this reason these skeletal materials have been deleted from certain parts of the analysis.

Many of the 501 crania from these four described sites were not intact, although the majority were in what could best be described as

a "reconstructable state." These non-restored crania result from several reasons, not the least of which is the lack of paid and trained personnel available who can keep up with the cleaning, preservation, labeling, and reconstruction of the ever-increasing amounts of skeletal material exhumed each year.

For example, as I write this, there have been an additional 115 or more inhumations unearthed at the Grasshopper site since the non-metric data were collected for this present study.

The growing back-log of skeletal material in need of analysis, even if only of a preliminary nature, could be one more reason (added to those in Chapter I) for the employment of the non-metric distance measure. These types of data, their comparison and analyses with other regional populations perhaps can give more rapid information to the archaeologist about the skeletal relationship of his site to another than can the longer, more conventional osteometric analysis which requires measurable crania.

This is not to say that the more conventional osteometric analyses are to be abandoned in favor of the one under consideration in this paper. On the contrary, both types of approaches are needed and necessary if one is to extract as much biological data as possible from the skeletal debris. However, since the non-metric trait data may be more rapidly collected, one should consider this as a logical initial approach.

CHAPTER III

ANALYTICAL METHODS

In the previous chapter, the spatial and temporal proveniences were established for the four prehistoric Southwestern sites from which the skeletal material was drawn. It will be necessary in this present chapter to establish (1) the osteological variants which will be used in estimating the measures of divergence ("distance") between the pairs of skeletal populations, and (2) the archaeological data which may be pertinent in defining the breeding units within each site population. The statistical method by which these ends are to be accomplished is considered in detail in Chapter IV.

Cranial Variant Data

A total of 54 different variants or discontinuous traits were observed on the cranium and mandible whenever possible. Forty-eight of the 54 variants occur bilaterally and six occur in the mid-line of the cranium. Therefore, it is possible for an intact skull to have a maximum of 102 separate recorded observations when the two sides are taken into account. This number decreases, of course, as the cranium becomes less and less complete. In reality, however, there were few crania on which at least 30% (16/54) of the traits could not be observed and scored.

All of the traits were chosen for their ability to be scored on the data sheets (Figs. 2 and 3) as either "absent," "present" or

CRANIAL VARIANTS

Site:	2	3	4	5	6	7	8	9	10	11	12	Burial:	13	14	15	16	17	18	19	
Sex:	20											Age:	21	22	23	24	25	26	27	
Deformation:	28											Date:								
											Observer:									

CARD 1-----

R	L	TORI	R	L	
29	30	Auditory	55	56	Post. ethmoid.
	31	Palatine	57	58	Ant. ethm. x-sut.
32	33	Mandibular	59	60	Access. infraorb.
	34	<u>OSSICLES</u>			
		Bregmatic	61	62	Zygo-facial
35	36	Coronal	63	64	Access. zygo-facial
	37	Lambda	65	66	Supraorb. foram.
38	39	Lambdoidal	67	68	Supraorb. notch
	40	<u>Os Inca</u>	69	70	Supratroch. spur
41	42	Riolan's	71	72	Frontal notch
43	44	Asterionic	73	74	Frontal
45	46	Parietal Notch	75	76	Parietal
47	48	Temp.-Squam.	77	78	Mastoid
49	50	Epipteric	79	80	Mast. x-sut.
51	52	<u>Os japonicum</u>	CARD 2-----		
		<u>FORAMINA</u>	20	21	Zygo-root
53	54	Lacrimale	22	23	Post. Cond. canal

Fig. 2. Recording form (page 1) developed and used in collection of data for cranial variants.

CRANIAL VARIANTS

Site: _____ Burial: _____

CARD 2 (Cont'd)-----

R	L		R	L	
<u>24</u>	<u>25</u>	Hypogloss. canal double	<u>57</u>	<u>58</u>	Petrosquam. suture
<u>26</u>	<u>27</u>	Dehiscence (Huschke)	<u>59</u>	<u>60</u>	Spine of Henle
<u>28</u>	<u>29</u>	Pterygospin. (Civinini)	<u>61</u>	<u>62</u>	Double condyl. facet
<u>30</u>	<u>31</u>	Pterygo-alar (Hyrtl)	<u>63</u>	<u>64</u>	Pre-cond. tubercle
<u>32</u>	<u>33</u>	F. Spinosum open	<u>65</u>		Pharyngeal fossa
<u>34</u>	<u>35</u>	Canalic. innomin.	<u>66</u>	<u>67</u>	Paramast. process
<u>36</u>	<u>37</u>	F. ovale incompl.	<u>68</u>	<u>69</u>	Mylo-hyoid bridge
<u>38</u>	<u>39</u>	Posterior malar	<u>70</u>	<u>71</u>	
<u>40</u>	<u>41</u>	Acc. less. palatine	<u>72</u>	<u>73</u>	
<u>42</u>	<u>43</u>	Carotico-clinoid	<u>74</u>	<u>75</u>	
<u>44</u>	<u>45</u>	Clinoid-clinoid bridge	<u>76</u>	<u>77</u>	
<u>46</u>	<u>47</u>	Double mental	<u>78</u>		
<u>48</u>	<u>49</u>	Acc. mandibular	<u>79</u>		
		<u>OTHER</u>			
	<u>50</u>	Metopic suture	<u>80</u>		
<u>51</u>	<u>52</u>	Front-Temp. Artic.			
<u>53</u>	<u>54</u>	Ext. front. sulcus			
<u>55</u>	<u>56</u>	Sut. into infraorb. F.			

Fig. 3. Recording form (page 2) developed and used in collection of data for cranial variants.

not observable (i.e., "0," "1," and "Blank" respectively). This type of scoring avoids such subjective and sometimes ambiguous judgements as "small," "medium," and "large," and lends itself readily to previously existing computer programs designed to handle just this type of binomial coding. Also, this same type of "have or have not" coding is necessary for determining the mean measures of divergence on non-metrical data where a "distance" formula is employed.

Statistically, it would be ideal to employ only those crania which are completely intact or which otherwise lend themselves to all 102 observations. However, the ideal can seldom be realized with archaeologically recovered skeletal material.

Data from fragmentary cranial material, and crania which were incomplete, were taken in the same manner as if the vault had been complete and intact. The traits were scored as "non-observable" where observations could not be made because of the actual absence of bone or where the traits were obscured either through advanced skeletal age (for example, obliteration or closure of certain sutures) or through a pathology. Here, as with whole crania, the observable medial and bilateral traits were scored in the same manner on the data collection sheets using the same binomial codings of "1," "0," and "Blank" respectively for traits "present," "absent," or "non-observable."

Inasmuch as it was not known in advance what frequencies of occurrence could be expected for any one trait in a prehistoric Southwestern Indian population, no deliberate attempt was made to select the variants on the basis of a preconceived concept of trait

availability. Rather, as many previously described traits (and some heretofore undescribed) as possible were established in an attempt to define non-metrically and non-morphologically any given skull.

The traits or variants for which data were collected from the four archaeological sites in Arizona are listed in Table 3. Figures 4 to 8 illustrate the location of each trait or variant as it appears on either the cranium or the mandible. The numbers itemizing the trait in the following descriptive paragraphs correspond to those in the Figures.

1. Auditory torus (Fig. 6B):

Also known as an ear exostosis, it includes all distinct bony protuberances or benign osteomata within the external auditory canal. These excrescences may range in size from a small "pearl" to ". . . the more or less irregular bony masses that in some cases fill almost the whole lumen of the meatus. . ." (Hrdlicka 1935: 1).

2. Palatine torus (Fig. 5B):

A median fusiform (spindle-shaped) ridge extending from the incisive foramen as far back as half or even the whole of the bony palate.

3. Mandibular torus (Fig. 8B):

Ordinarily, a smoothly rounded exostosis located on the lingual surface at the border between the body of the mandible and the alveolar process. It is most often situated between the canines and the premolars, and rarely forms in the molar region. More than one

TABLE 3

Itemized list of the 54 cranial traits used in the present study and the illustrations in which they appear. Traits numbered 2, 4, 6, 8, 44, and 52 are medially appearing features. All others occur bilaterally.

Trait Number	Character Trait	Illustrated in Figure
1	Auditory torus	6B
2	Palatine torus	5B
3	Mandibular torus	8B
4	Bregmatic ossicle	5A
5	Coronal ossicle	5A
6	Ossicle at Lambda	4B
7	Lambdoidal ossicle	4B
8	<u>Os Inca</u>	4B
9	Riolan's ossicle	4B
10	Asterionic ossicle	4A
11	Parietal notch bone	4A
12	Temporo-squamosal bones	4A
13	Epipteric bones	4A
14	<u>Os japonicum</u>	6B
15	Lacrimal foramen	6A
16	Posterior Ethmoid foramen	6A
17	Anterior ethmoid foramen extra-sutural	6A
18	Accessory infraorbital foramen	6A
19	Zygo-facial foramen	6A
20	Accessory zygo-facial foramen	6A

Table 3, Continued

Trait Number	Character Trait	Illustrated in Figure
21	Supraorbital foramen	6A
22	Supraorbital notch	6A
23	Supratrochlear spur	6A
24	Frontal notch	6A
25	Frontal foramen	6A
26	Parietal foramen	4B
27	Mastoid foramen	4B
28	Mastoid foramen extra-sutural	4B
29	Zygo-root foramen	6B
30	Posterior condylar canal	5B
31	Hypoglossal canal double	7A
32	Dehiscence (Foramen of Huschke)	5B
33	Pterygo-spinous foramen of Civinini	6B
34	Pterygo-alar foramen of Hyrtl	6B
35	Foramen spinosum open	5B
36	<u>Canaliculus innominatus</u>	5B
37	Foramen Ovale incomplete	5B
38	Posterior malar foramen	7B
39	Accessory lesser palatine foramen	5B
40	Carotico-clinoid foramen	8A
41	Clino-clinoid bridge	8A
42	Mental foramen double	4A
43	Accessory mandibular foramen	8B

Table 3, Continued

Trait Number	Character Trait	Illustrated in Figure
44	Metopic suture	5A
45	Fronto-temporal articulation	6B
46	External frontal sulcus	5A
47	Sutures into the infraorbital foramen	6A
48	Petrosquamous suture	6B
49	Spine of Henle	6B
50	Double condylar facet	5B
51	Pre-condylar tubercle	5B
52	Pharyngeal fossa	5B
53	Para-mastoid process	5B, 4B
54	Mylo-hyoid bridge	8B

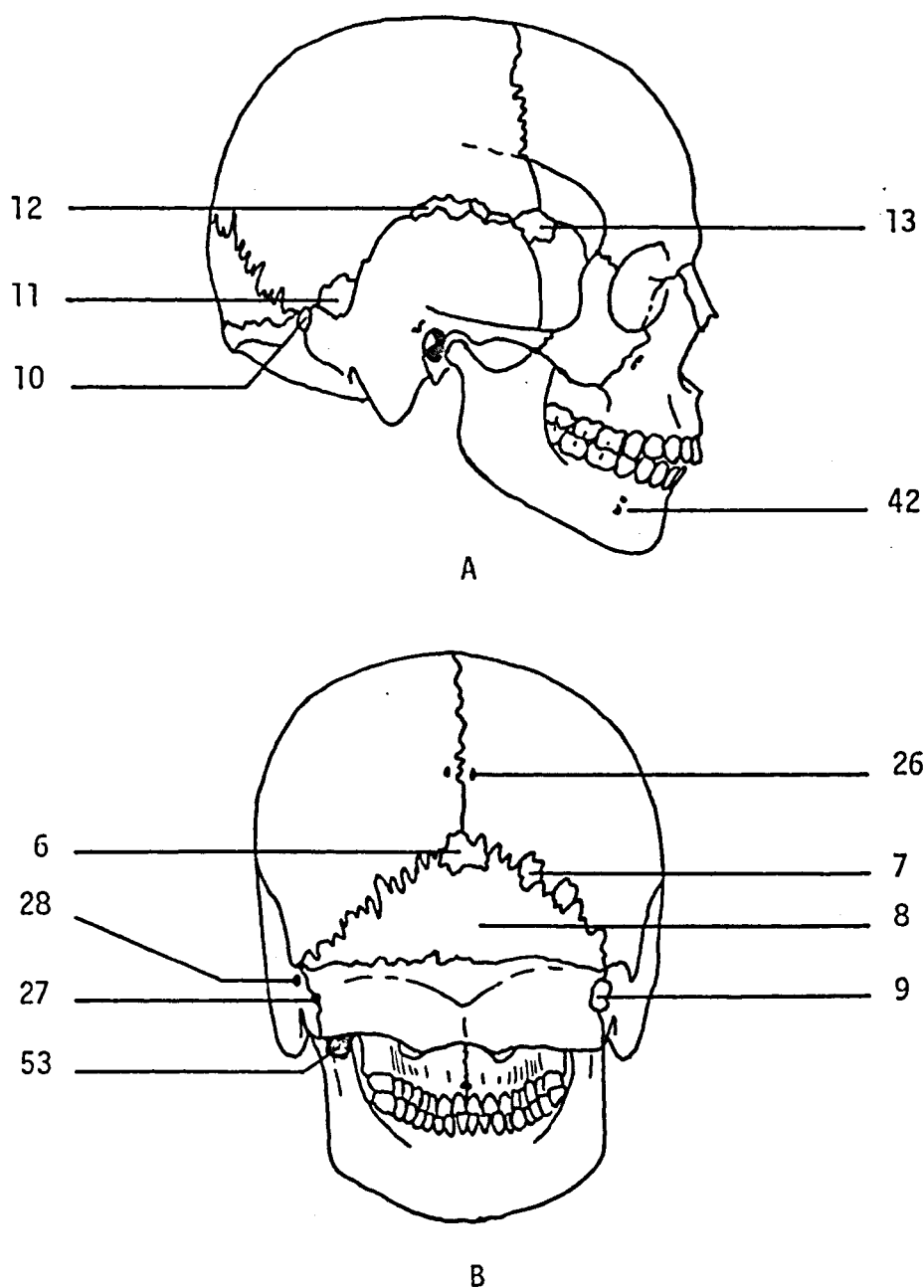


Fig. 4. Skull in norma lateralis (A) and norma occipitalis (B) with discrete traits indicated. Numbers refer to traits listed in Table 3.

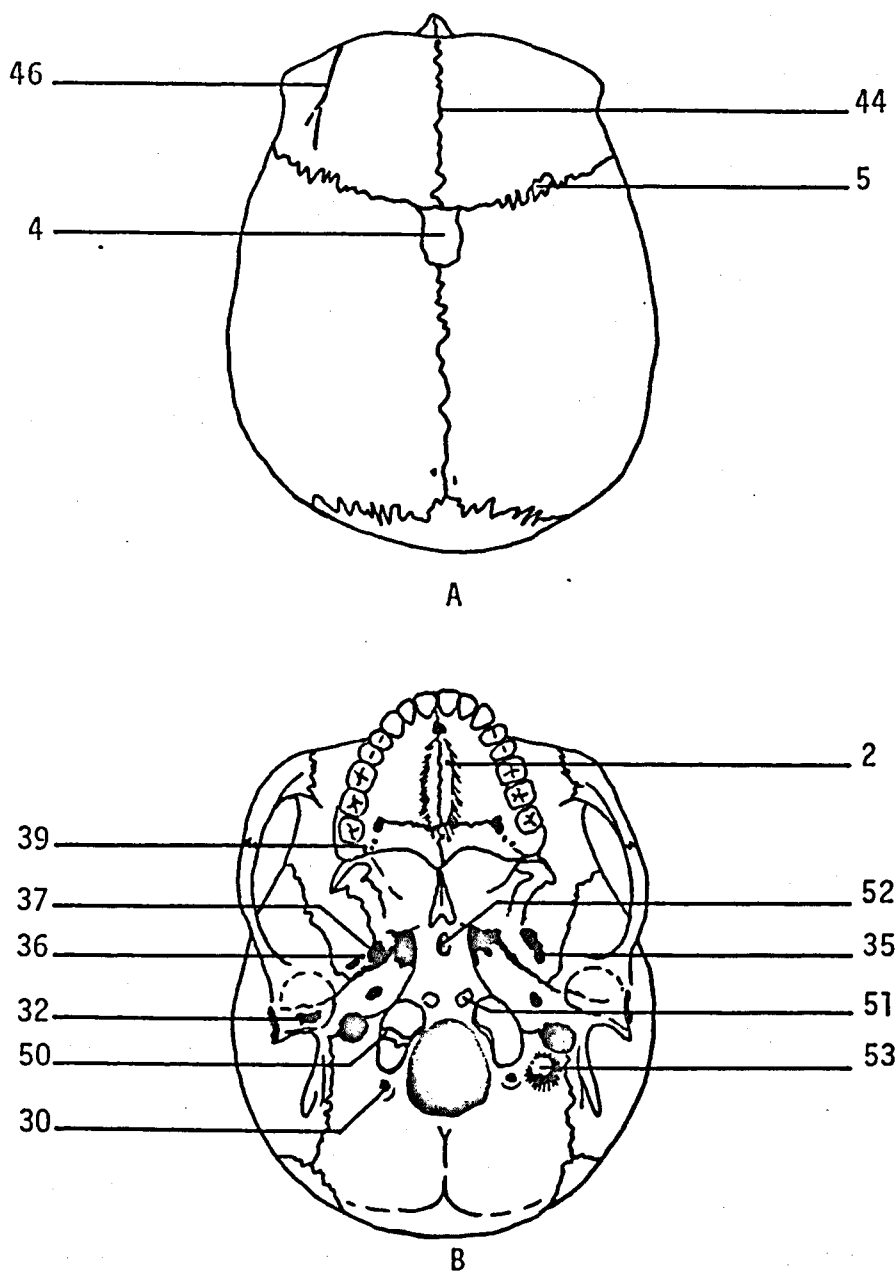
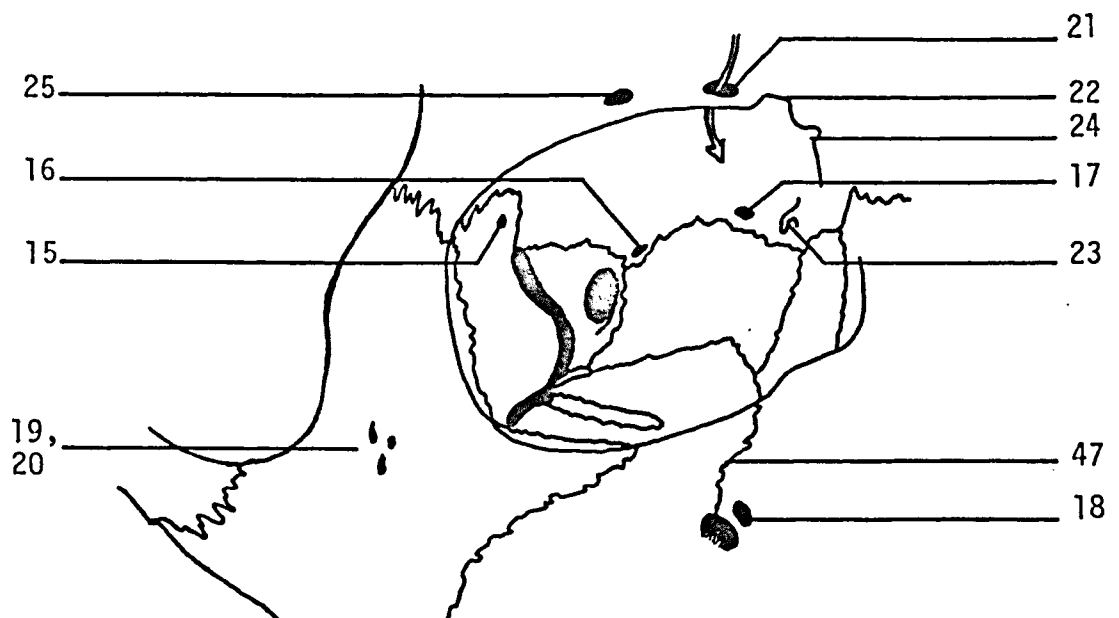
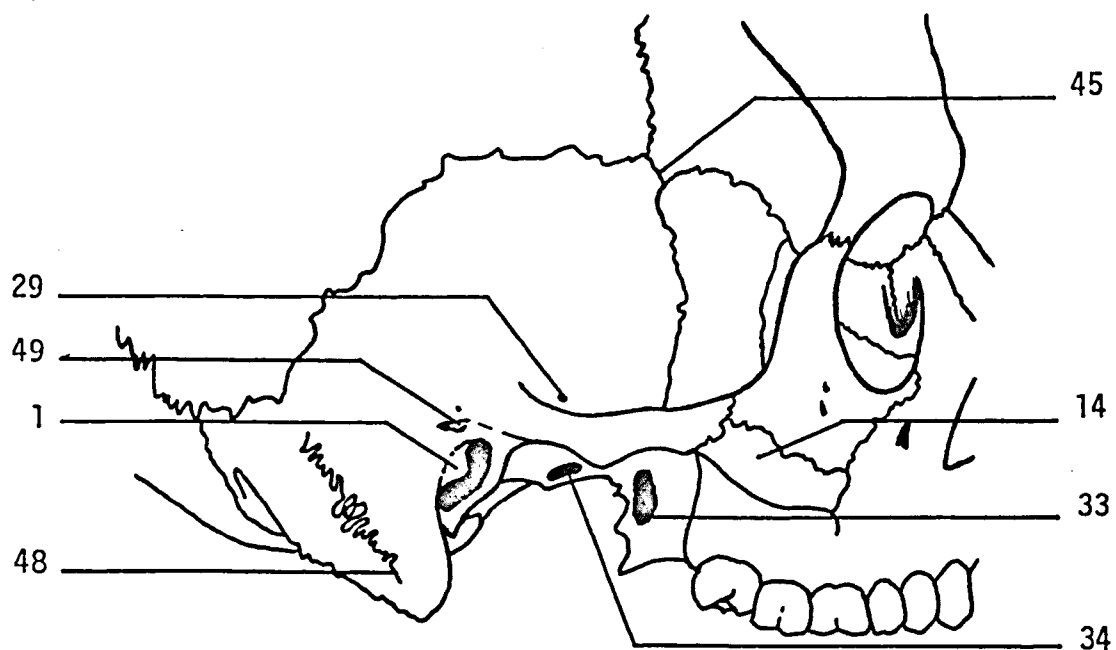


Fig. 5. Skull in norma verticalis (A) and norma basilaris (B) with discrete traits indicated. Numbers refer to traits listed in Table 3.



A



B

Fig. 6. Oblique view of right eye orbit (A) and lateral aspect of cranium (B) with discrete traits indicated. Numbers refer to traits listed in Table 3.

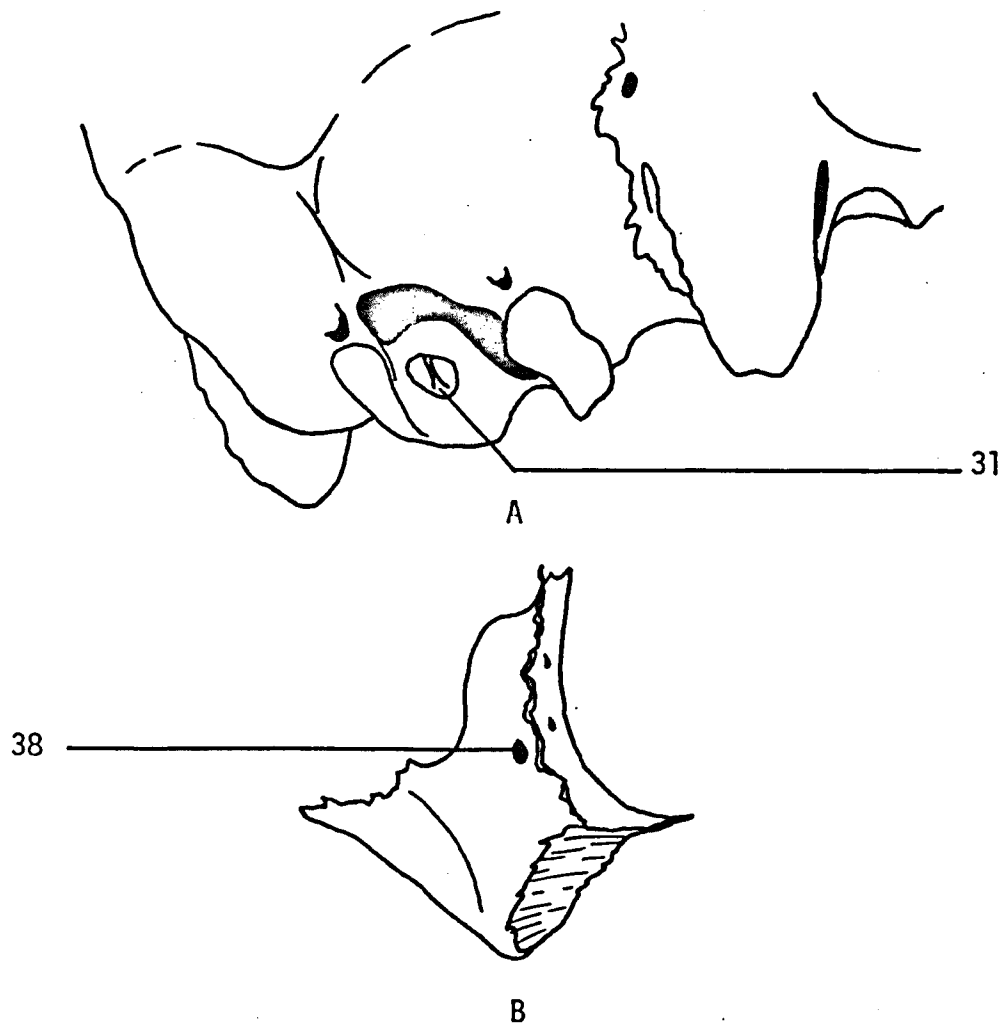


Fig. 7. Inferior left oblique view of occipital condylar area of cranium (A) and posterior aspect of left malar (B) with discrete traits indicated. Numbers refer to traits listed in Table 3.

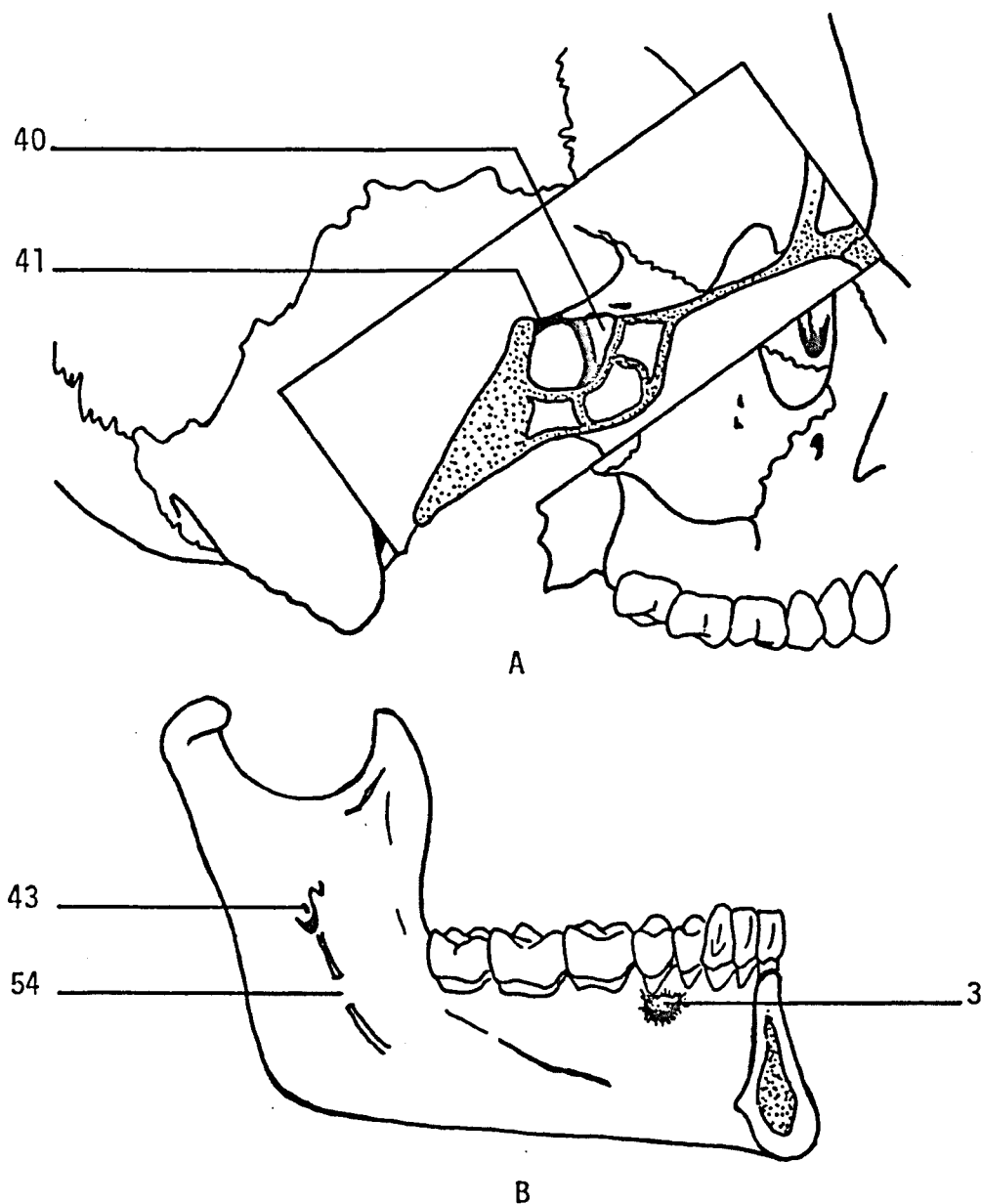


Fig. 8. Lateral view of cranium with cut-away showing sagittal section of sphenoid (A) and a lingual view of left mandibular half (B) with discrete traits indicated. Numbers refer to traits listed in Table 3.

torus may be present on any given side and it may appear unilaterally or bilaterally.

4. Bregmatic ossicle (Fig. 5A):

An inclusion bone which occurs at the junction of the sagittal and coronal sutures in the position of the anterior or bregmatic fontanelle.

5. Coronal ossicle (Fig. 5A):

An inclusion or Wormian bone which occurs anywhere along the coronal suture but outside of the area of the bregmatic ossicle (4) and usually medial to the fronto-parietal crest.

6. Ossicle at lambda (Fig. 4B):

A Wormian bone located at the junction of the sagittal and lambdoidal sutures in the area of what was once the occipital fontanelle. This ossicle can be distinguished from the large interparietal bone or Os Inca (8) in that the inferior border of the latter terminates in the mastoid or asterionic fontanelle region of the posterior vault.

7. Lambdoidal ossicle (Fig. 4B):

A Wormian or inclusion bone within the lambdoid suture but outside of the areas of the lambda ossicle (6) and the asterionic ossicle (10). Lambdoidal ossicles may appear singly or in multiples and may involve either or both branches of the lambdoid suture.

8. Os Inca (Fig. 4B):

Also referred to as an interparietal bone, the Os Inca extends inferiorly from the anthropometric point Lambda to the bi-asterionic

line. Its incorporation of the squamous of the occipital suggests that it may originate as a separate center of ossification in the membranous portion of that otherwise cartilagenous bone. (See 6, above.)

9. Riolan's ossicle (Fig. 4B):

A single but sometimes multiple inclusion or Wormian bone found in the suture between the occipital bone and the temporal bone below the area of the asterionic fontanelle. In order to qualify as a Riolan's ossicle in this present study, an inclusion bone must not be in contact at its superior extension with the lambdoid suture. Also referred to as an "Ossicle in the mastoid suture" (Jantz 1970: 25).

10. Asterionic ossicle (Fig. 4A):

An inclusion bone found at the junction of the lambdoid, mastoid, and parieto-mastoid sutures. This may be differentiated from lambdoidal Wormians (7) in that it is in contact with the petrosal portion of the mastoid while the latter have contact only with the parietal and occipital bones. This ossicle may form from a separate center of ossification within the asterionic or mastoid fontanelle.

11. Parietal Notch Bone (Fig. 4A).

An ossicle which occurs in the parietal notch (incisura parietalis) area of the mastoid bone. When the ossicle appears it does not alter the morphology of the mastoid bone, but rather the parietal in the region anterior to the mastoid angle.

12. Temporo-Squamous ossicles (Fig. 4A).

Thin, scale-like inclusions found between the squamous portion of the temporal bone and the parietal. It may appear anywhere along the

squamosal suture between the parietal notch area and the pterion region but must not be in contact with the greater wing of the sphenoid. One or more may appear in the sutural area.

13. Epipteric Bone (Fig. 4A):

Also known as the pterion ossicle (Berry and Berry 1967), it may be found inserted between the greater wing of the sphenoid and the sphenoidal border of the parietal. When large it may articulate with the squamous of the temporal bone. Since it may be a separate center of ossification formed within the sphenoid fontanelle, it is considered a distinct feature from the temporo-squamous ossicle (12) for purposes of the present investigation.

14. Os japonicum (Fig. 6B):

A bipartite malar or zygomatic bone so named because of its high frequency in the crania of the Japanese (Terry and Trotter 1953). On the few which I have observed, the dividing suture courses anteriorly-posteriorly from the maxillary border through the temporal process.

15. Lacrimal foramen (Fig. 6A):

The foramen, for the anastomosis between the middle meningeal and lacrimal arteries, is found in the orbital plate of the sphenoid or the frontal bone just beyond the supero-lateral end of the superior orbital fissure.

16. Posterior ethmoid foramen (Fig. 6A):

The foramen is usually situated above the fronto-ethmoidal suture near the confluence of that suture with the spheno-ethmoidal suture. When present it transmits the posterior ethmoid artery and nerve.

17. Anterior ethmoid foramen (extra-sutural) (Fig. 6A):

Ordinarily piercing the middle portion of the fronto-ethmoidal suture, this foramen will occasionally lie above the suture and perforate only the frontal bone. It transmits the anterior ethmoid artery and nerve.

18. Accessory infra-orbital foramen (Fig. 6A):

One or more foramina may be present in addition to the primary foramen which lies within the suborbital fossa. Both the primary and accessory foramina pass the terminal branches of the infra-orbital nerve and vessels.

19. Zygo-facial foramen (Fig. 6A):

One or more small foramen which perforate the malar bone near the junction of the infra-orbital and lateral margins of the eye orbit. Also known as the zygomaticofacial foramen, it passes the zygomaticofacial nerves and vessels. Occasionally, the foramen is absent.

20. Accessory zygo-facial foramina (Fig. 6A):

Where more than a single zygo-facial foramen (19) is present on the malar bone.

21. Supra-orbital foramen (Fig. 6A):

A foramen immediately above the medial half of the supra-orbital border. Its openings are on the frontal surface and on the roof of the orbital socket. It transmits the supra-orbital nerve and artery. The foramen at times may be incomplete (open) and therefore classified as a supra-orbital notch (22).

22. Supra-orbital notch (Fig. 6A):

See (21) above.

23. Supra-trochlear spur (Fig. 6A):

A thin bony spine or spur emanating from the medial wall of the orbital roof just behind the supero-medial angle of the orbital margin. This spur may represent partial ossification of the cartilaginous trochlea (pulley) for the Superior Oblique tendon. This should not be confused with the normally appearing trochlear spine located superiorly and anteriorly from the spur.

24. Frontal notch (Fig. 6A):

This occasionally appearing notch is located at the supero-medial angle of the orbital border and is medial to the supra-orbital foramen (21) or notch (22). It transmits the frontal artery and nerve.

25. Frontal foramen (Fig. 6A):

A well-defined foramen which when present is located lateral to the supra-orbital foramen (21). To qualify for this category, the posterior orifice must not open into the orbital cavity (as does 21), but directly into the diploic space. I do not know the etiology of this foramen, but I would suggest that it perhaps houses a lateral branch of the supra-orbital artery.

26. Parietal foramen (Fig. 4B):

Sometimes single but often paired foramina lying on either side of the sagittal suture approximately 2 cm above lambda. The foramen passes a small emissary vein and sometimes a small branch of the occipital artery.

27. Mastoid foramen (Fig. 4B):

When present, the foramen may lie either within the temporo-occipital suture or on either side of it. When the latter is the case, the foramen is categorized as being extra-sutural (See 28). The foramen transmits the mastoid emissary vein (to the transverse sinus) and the mastoid branch of the occipital artery.

28. Mastoid foramen extra-sutural (Fig. 4B):

See (27) above.

29. "Zygo-root" foramen (Fig. 6B):

This is a term coined for purposes of this study. It refers to a foramen which occasionally appears on the superior medial surface of the junction of the temporal squamous and the zygomatic process. It is usually positioned superiorly between vertical lines drawn through the anterior and middle roots of zygomatic process. The etiology of this foramen is questionable, although it possibly transmits a minor branch of the middle temporal artery.

30. Posterior condylar canal (Fig. 5B):

This frequently appearing foramen (also known as the condyloid canal) is located in the floor of the condyloid fossa immediately posterior to one of the occipital condyles. It transmits a vein from the transverse sinus.

31. Hypoglossal canal double (Fig. 7A):

The constant hypoglossal canal perforates the lateral portion of the occipital at the base of the occipital condyle. It is directed from the interior of the cranium, superior to the foramen magnum, in

a forward and lateral direction. Its function is to transmit the hypoglossal nerve and a small branch of the posterior meningeal artery. Occasionally the foramen is divided by a bridge of bone creating, in essence, a double canal.

32. Foramen of Huschke (Fig. 5B):

The foramen is also known as a dehiscence of the tympanic plate, and is ordinarily patent until puberty. However, it may remain open in some individuals throughout adult life. The foramen is non-functional in terms of nerve or vascular transmission, but nonetheless differs in its frequency of appearance in skeletal populations.

33. Foramen of Civinini (Fig. 6B):

"The pterygo-spinous foramen of Civinini is formed by the ossification of a pterygospinous ligament [which] stretches from the angular spine of the sphenoid to the spine of Civinini situated at about the middle of the posterior border of the lateral pterygoid lamina of the same bone" (Chouké 1946: 203-204). The foramen most often lies either below or on the medial side of the foramen ovale.

34. Foramen of Hyrtl (Fig. 6B):

This foramen is also known as the pterygo-alar foramen or the porus crotaphitico-buccinatorius as first described by Hyrtl in 1862 (Chouké 1946). It is formed by a bar of bone connecting the inferior lateral surface of the greater wing of the sphenoid to the root of the lateral pterygoid plate. This bony bar usually lies lateral to the foramen ovale and transmits a number of branches of the third division of the trigeminal nerve.

35. Foramen spinosum open (incomplete) (Fig. 5B):

This constant foramen is located on the inferior surface of the greater wing of the sphenoid posterior and lateral to the foramen ovale. It transmits the middle meningeal vessels and a branch of the mandibular nerve. Occasionally, the posterior medial wall of the foramen is incompletely formed.

36. Canaliculus innominatus (Fig. 5B):

This infrequently occurring tiny canal or foramen perforates the sphenopetrosal lamina behind and medial to the foramen ovale (37). The canal passes from the skull the small superficial petrosal nerve which is ordinarily transmitted by the foramen ovale.

37. Foramen ovale incomplete (Fig. 5B):

This large consistently appearing orifice is located near the posterior margin of the greater wing of the sphenoid at the root of the lateral pterygoid plate. Its function is the transmission of the mandibular branch of the trigeminal nerve, a small meningeal artery, and an emissary vein. Occasionally, the posterior medial wall of the foramen is incompletely formed or missing.

38. "Posterior malar" foramen (Fig. 7B):

This nomenclature is coined for purposes of the present study since no previously existing anatomical term could be found for this feature. The inconsistently appearing foramen, when present, occurs only on the temporal (posterior) surface of the malar usually at the junction of the large ascending frontal process and the main body of the bone. The orifice is most often as large as that of the foramen

ovale, and generally courses in a medial direction although it has been observed to enter the bone only anteriorly. The feature should not be mistaken for the more consistent, smaller, and superior positioned zygomaticotemporal foramen. Unlike this latter foramen, the "posterior malar" does not open onto the orbital process of the zygomatic bone. I suspect that this feature may house an inconsistent branch of the anterior deep temporal artery.

39. Accessory lesser palatine foramen (Fig. 5B):

These small multiple foramina appear near the posterior and medial border of the greater palatine foramen. Occasionally, there is only one enlarged lesser palatine foramen in which case this category is scored as absent. The lesser palatine foramen or foramina transmit the lesser palatine nerves.

40. Caroticoclinoid foramen (Fig. 8A):

A foramen formed by the ossified caroticoclinoid ligament that bridges the anterior and middle clinoid processes of the sphenoid. When present, it transmits the internal carotid artery. See (41) below.

41. "Clino-clinoid" bridge (Fig. 8A):

A coined term for a bony bridging of the sella turcica (hypophyseal fossa) which incorporates the anterior and posterior clinoid processes. It has been interpreted as being a vestige of the primitive cranial wall (Terry and Trotter 1953). This bridge, as well as the caroticoclinoid foramen (40), can best be visualized on intact crania by passing a small light source through the foramen magnum, observing the sella area through the superior orbital fissure,

while probing through the latter opening with a curved dental tool.

42. Double (or multiple) mental foramen (Fig. 4A):

Occasionally, the mental foramen on the mandible may have one or more accessory foramina associated with it (Montagu 1954 has a discussion of primate, ethnic, and positional variations). The constant primary foramen is generally located in the apical region of the premolar teeth on the external surface about midway between the inferior border of the mandible and the alveolar crest. Both the primary and accessory foramina, when present, transmit the mental nerve and vessels.

43. Accessory mandibular foramen (Fig. 8B):

A small inconstant foramen, usually situated posteriorly to the mandibular foramen, which courses in the same direction as the latter. Inasmuch as the primary foramen transmits the mandibular nerve and the inferior alveolar artery, it can be assumed that the accessory houses a branch of one of these structures.

44. Metopic suture (Fig. 5A):

A medio-frontal suture which divides the frontal squama at birth but ordinarily fuses and obliterates within the first two years of life. However, in a few individuals it may persist throughout adult life, remaining as patent as the sagittal or coronal sutures. Retention of the suture is known as metopism, which, according to Torgersen (1951), is a dominant trait with varying penetrance.

45. Fronto-temporal articulation (Fig. 6B):

The frontal bone is usually separated from the temporal squamous by the greater wing of the sphenoid and the sphenoidal angle of the parietal. However, it occasionally happens that this separation is not maintained (due perhaps to a shortening of the greater wing) and the frontal bone is afforded direct contact with the squamous.

46. "External frontal" sulcus (Fig. 5A):

A coined term for the vascular depressions which sometimes occur on the external surface of the frontal bone usually between the frontal eminence and the fronto-temporal crest. These grooves or sulci course longitudinally toward the coronal suture and may be as short as ca. 2 cm or as long as 6-8 cm. I suspect that their etiology might be depressions for the supra-orbital artery.

47. Suture into the infra-orbital foramen (Fig. 6A):

This suture, most easily observed on the skulls of young children, is sometimes retained into adult life. It probably is a remnant of the closure of the infra-orbital canal. In its fullest expression, it courses from the infra-orbital fissure into the infra-orbital foramen (See 18) and crosses the infra-orbital border near the zygo-maxillary suture. Quite often in the adult, only the anterior aspect of this suture remains patent.

48. Petrosquamous suture (Fig. 6B):

This remnant suture, when it appears, can be found on the mastoid process of the temporal bone between the supra-mastoid crest and the tip of the mastoid process itself. It represents the pre-birth union

of the membranous derived temporal squamous and the cartilaginous derived petrous portion. The appearance of the suture varies, being in some cases a series of depressions, but occasionally a well-marked fissure. It is the latter that is scored as present for purposes of this study.

49. Spine of Henle (Fig. 6B):

A small tubercle of bone which projects from the posterosuperior margin of the external auditory meatus and is also known as the suprameatal spine. I have not been able to determine the exact etiology of this spine, although I have heard for some years that it is more frequent in males than in females; hence, the inclusion of this feature in the present study.

50. Double condylar facet (Fig. 5B):

Two discrete articular surfaces may occasionally appear on one or both occipital condyles. These surfaces, in order to qualify for inclusion in this category, must be separated by non-articular bone. This non-articular bone is not to be confused with the condylar synchondrosis which normally unites the basilar and lateral parts of the occipital after age 5 or 6 years.

51. Pre-condylar tubercle (Fig. 5B):

These eminences of bone lie on either side of the mid-line of the occipital (when they occur bilaterally) anterior and medial to the ventral border of the condyles. Only those tubercles which are discrete and separate from the occipital condyle (the Type I of Broman, 1957) are considered in this present study. The etiology of

these eminences is questionable (Marshall 1955; Broman 1957), but I would suggest that they may represent ossification of the lateral bundles of the anterior atlanto-occipital membrane, or insertions for the rectus capitis anterior muscle.

52. Pharyngeal fossa (Fig. 5B):

The fossa is a somewhat oval depression lying in the mid-line of the basiocciput about mid-way between the basilar synchondrosis and the anterior edge of the foramen magnum. While there are several explanations for its etiology (Sullivan 1920), Terry and Trotter (1953) suggest it may be a vestige of the canal of the notochord.

53. Paramastoid process (Fig. 5B):

Also known as the paraoccipital or paracondyloid process, this unilaterally or bilaterally occurring protuberance is located on the inferior surface of the occipital in the area between the foramen magnum and the mastoid process. Occasionally, the paramastoid process may present an articular surface at its inferior end for contact with the transverse process of the first cervical vertebra. Gregg and Steele (1969) consider the process to be a congenital anomaly.

54. Mylohyoid bridge (Fig. 8B):

There is an occasional bony bridging of the mylohyoid groove of the mandible which houses the mylohyoid nerve and artery. The groove, located on the internal aspect of the ascending ramus, commences just below the lingula and courses obliquely downward and forward.

Archaeological Burial Data

In addition to the 54 non-metric cranial traits described above, and the age, sex and cranial deformation determinations made on each skeleton (see Chap. II), one item of site and burial data was also collected using site maps and the original Field Burial Record Forms. (Unfortunately, the latter type of record does not exist for site Ariz. V:4:1 (Kinishba), so that this site had to be eliminated from certain aspects of the study).

The purpose of collecting such non-osseous information was to determine if, with-in any single site, there was a clustering or greater frequency of occurrence of the non-metric traits when a feature such as burial location was taken into account. A regular cluster analysis such as the BCTRY or CLUSTAN programs can not be used for non-metric data coded with "have" or "have not" scores simply because there is no variance in the data as far as the computer is concerned. Thus, it becomes necessary for the investigator to describe a possible parameter (very often a priori assumptions) which might have some social or biological (or both) significance with respect to what the prehistoric population was doing.

Therefore, the intra-site burial location was chosen for each site (but omitting Ariz. V:4:1 for the reason mentioned above), realizing that this "shot in the dark" division may have little to do with the socio-biological behavioral patterns of the populations under consideration.

If there were discrete with-in site breeding units, it is hypothetically possible that these units may have been utilizing

different burial areas or "cemeteries" for the disposal of the dead. It seemed worthwhile therefore to assign a "cemetary" status to the various prehistoric construction features at Ariz. P:14:1, the excavated trash heaps at Ariz. W:10:78, and the large excavated broadsides at Ariz. W:10:50.

At the Grasshopper Ruin (Ariz. P:14:1), there are two major construction features, the East and West Units, which are separated from each other by a stream channel. As an initial point of departure, all burials within and in the vicinity of the East Unit and east of the channel were classified as one group (coded "0"), while those associated with the West Unit or found on the west side of the channel were classified as a second group (coded "1").

At the Turkey Creek Ruin (Ariz. W:10:78) there were eight trash mounds situated circumferentially around the pueblo. Each of these trash heaps, some measuring in excess of 30 meters in diameter, contained inhumations. Each trash heap was classified as a separate "cemetery" for purposes of this study; Trashmounds 3 and 4 were lumped because of the dearth of usable material recovered from them. Interments from within the ruin itself were given a separate group classification (coded "0"). Trashmounds 1 and 2 were coded "1" and "2" respectively; the combined Trashmounds 3 and 4 were coded "3"; Trashmounds 5 through 8 were coded "4" through "7" respectively.

Theoretically, it is possible that each mound or perhaps group of mounds had been used by differing social or biological subgroups of the site population. It is also possible that these places of

final interment were merely fortuitous soft-soil repositories and really represent nothing more than a prehistoric concept of "why do it the hard way."

The "cemeteries" chosen for the Point of Pines Ruin (Ariz. W:10:50) are archaeological broadsides located peripherally to the east and west walls of the pueblo. Broadsides 2 and 3 were coded together as "1" due to the paucity of usable crania from the latter and the close proximity of the two. Broadside 1 was coded as "0," Broadside 4 as "2," and Broadside 5 as "3."

The possibility that these broadsides are as representative of discrete burial plots for this population's sub-groups is as good (or as bad) as that for the chosen "cemeteries" of the other two sites.

The 54 cranial variants and the single archaeological variable listed herein does not constitute the total possible array of observations which could be made for a skeletal series. As mentioned earlier in this chapter, this was one selected observation which was chosen for purposes of evaluating the use of the distance statistic on prehistoric Southwestern populations. The incorporation of the cranial data with the archaeological phenomenon of burial location hopefully may elicit socio-biological patterns not previously possible with the standard osteometric analysis.

CHAPTER IV

ANALYSIS OF CRANIAL NON-METRIC DATA

One method for the analysis of populational differences in the occurrence of non-metric or discontinuous data is a version of the mean measure of divergence (that is, "distance") statistic devised by C. A. B. Smith. This measure was first applied to a mouse population by Grewal (1962), but no method was indicated for determining the variance of his distance measure. Berry and Berry (1967) and Berry (1968) later used this same distance formula on human crania from a series of world-wide skeletal populations and generated a formula for the variance.

Since 1968, other publications (Kellock and Parsons 1970a and 1970b; Pietrusewsky 1970, 1971a and 1971b; Lane and Sublett 1972) and manuscripts (Jantz 1970; Finnegan 1972) have appeared covering local or regional skeletal populations wherein Smith's "distance" and Berry and Berry's (1967) variance formula for that "distance" have been employed. The above studies generally have shown that the variation exhibited in these groups conforms to what is suspected archaeologically about most of the populations. That these previous analyses may have relied on erroneous measures of divergence and variance will be considered in Chapter IV.

The calculation of the mean measure of divergence requires that the percentage frequency (p) of each trait be transformed into an

angular value (θ), measured in radians, which corresponds to the trait frequency such that

$$\theta = \sin^{-1} (1-2p).$$

The difference between two populations (1 and 2) with respect to any trait is $(\theta_1 - \theta_2)^2$, where θ_1 and θ_2 are angular transformations of the percentage occurrence of the trait in populations 1 and 2 respectively. The mean measure of divergence (MD) between the two populations for the whole array of traits is calculated from the formula

$$MD = \frac{\sum \left[(\theta_1 - \theta_2)^2 - (1/n_1 + 1/n_2) \right]}{N}$$

where N is the number of traits classified and n is the number of individuals in each population. The term $1/n_1 + 1/n_2$ is the variance of the differences due to random sampling fluctuations. The estimate of the variance (V) of the MD for any pair of populations classified for N traits is computed as

$$V = 4 \frac{\sum \frac{(1/n_1 + 1/n_2)}{N} \left[(\theta_1 - \theta_2)^2 - (1/n_1 + 1/n_2) \right]}{N^2}$$

The mean measure of divergence (MD) will be significant at the .05 level of probability when it is twice as large or larger than its standard deviation (the square root of the variance V).

Both formulae differ somewhat from those which have been used in previous analyses. Those presented here were developed by T. S. Constandse-Westermann (1972). How these particular formulae were developed and why need not be gone into in this study. She has answered these queries at length in her 1972 publication.

The basic assumption of the MD measures is that all of the traits under consideration have an equal genetic expression in the phenotype, that they are uncorrelated or independent of each other and, for these reasons, can be summed. While there are some indications that this may not be an entirely accurate assumption, the correlations found to date among such traits have been quite small. Truslove (1961) found that nearly all of the traits she examined in mouse populations were uncorrelated. Berry and Berry (1967) found only 10 pairs out of 378 which were significantly correlated. Hertzog (1968) found 10 out of 21 2X2 comparisons significant in his samples which suggested that some are highly correlated. However, Benfer (1970) re-evaluated Hertzog's data and found that the appearances of these traits were in fact independent of each other.

No attempt was made to determine whether the 54 variants were correlated in this preliminary study of Southwestern prehistoric populations. The assumption being made here is that the traits, on the basis of the above studies from other investigators, are uncorrelated or only very weakly correlated and therefore will not alter appreciably the results of the distance measures.

A chi-square was used to check for significant differences in trait frequencies between the sexes, the sides (for bilateral traits),

and deformed/non-deformed crania. The X^2 and frequency tabulations were generated on the CDC 6400 Computer at the University of Arizona Computer Center using canned CHIGEN and SPSS (Statistical Package for the Social Sciences) programs. The mean measure of divergence and the variance formulations were successfully programmed for the computer by David Taylor, Department of Anthropology, University of Arizona.

As I mentioned above, I now have some doubts as to the validity of the formulae which have been used on human skeletal populations beginning with the publication of the Berry and Berry (1967) and Berry (1968) divergence statistics. Constandse-Westermann (1972), whose measures I have used, has suggested changes in the formulae for several reasons. First, Grewal's (1962) "corrected" mean measure of divergence will not allow for different samples with different sizes, that is, $1/n_1$ must be equal to or very nearly equal to $1/n_2$.

Second, when the variance formula given by Berry and Berry (1967) is applied to their published data, the values for the variances and standard deviations do not correspond with those reported in the text. "It appears that, to obtain the corresponding values we should divide by $r^2 [N^2$ in my formula of Chap. IV] instead of r " (Constandse-Westermann 1972: 120).

It seems to me that on reading the skeletal population "distances" generated to date (both published and unpublished), the various authors have either relied on the published Berry and Berry (1967) measure and variance (e.g., Jantz 1970; Lane and Sublett 1972; Pietrusewsky 1970, 1971a, 1971b; Kellock and Parsons 1970b) as being

correct or have tried to somehow overcome the problem of variation in populations sizes. For example, Finnegan (1972) resorts to the means of the number of individuals in each population when computing divergences and variances. Kellock and Parsons (1970a) have compounded the confusion by publishing (but hopefully not using) an erroneous formula for the standard deviations of the mean measure of divergence.

All of the above notwithstanding, one of the principle advantages of using discrete or non-metric traits in the study of archaeologically recovered skeletal material is that the bones do not have to be intact or in a nearly complete and measurable condition as they do for continuous data analyses.

Another advantage is that the sample size can be substantially increased by pooling the observations from each of the sexes and the sides if so desired. The feasibility of doing so, however, depends on whether there are significant sex and side differences within the skeletal populations. Thus far, there has been reasonable evidence which suggests that there are no significant trait frequency differences between right and left sides or even between the males and females. Berry and Berry (1967) found few sex differences in their study of world-wide cranial series and concluded that the pooling of the data for the sexes was a valid procedure. Jantz (1970), Finnegan (1972), and Lane and Sublett (1972) found 9 out of 25, 12 out of 42, and "a large number" of traits respectively which differed significantly between the sexes.

Testing for Significant Differences

Corrected Chi-square statistics were performed on the four prehistoric Southwestern populations to determine if there were any significant frequency differences between the sides which would preclude the pooling of my data. That is to say, would one be justified in treating each side as an individual trait occurrence, thus almost doubling the sample sizes for the four populations when computing the "distance" between the groups? In 192 male side comparisons (Table 4), only three showed significant differences: one at the .05 level and two at the .01 level. Of the 192 female side comparisons in Table 5, no significant differences were observed. These three instances in the 384 pairwise comparisons are not more than would be expected to have occurred by chance alone ($\chi^2_c df=1 = 1.344$). Therefore, one would be justified (in this present study) in pooling the sides and treating each as individual units when determining the mean measure of divergence (MD) between populations.

However, this approach was not used in the present study since, as will be shown later in this chapter, it adds nothing to the distance measures that can not be determined when the individuals are treated as the unit of study. Phrased another way, the enhancement of the sample sizes does not advantageously or adversely alter the measures of divergence generated between any two populations. Also, it makes more sense intuitively to treat the individuals, rather than the sides, as members of breeding units.

TABLE 4

Side differences in incidences of cranial traits, males. The numerators indicate the trait occurrence and the denominators are the total observations possible for the trait.

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c
1	0/55	0/57	.0000	0/22	0/22	.0000	4/32	6/33	.0846	1/48	0/45	.0010
3	16/52	13/53	.2468	4/16	4/14	.0373	15/32	9/30	1.2153	21/41	16/44	1.3491
5	0/50	0/51	.0000	0/17	0/19	.0000	0/26	1/22	.0071	0/28	0/24	.0000
7	16/48	19/45	.4490	4/15	8/19	.3294	10/22	14/26	.0839	8/24	6/26	.2418
9	11/40	15/42	.3154	2/13	3/16	.0653	8/21	5/22	.5847	7/31	5/22	.1027
10	9/50	6/50	.3137	4/18	3/17	.0071	3/24	3/23	.1454	7/35	6/30	.0967
11	3/49	5/50	.1149	2/18	0/19	.5877	1/26	1/28	.4458	1/38	1/39	.4871
12	4/37	1/35	.7450	1/14	1/17	.3509	1/24	0/17	.0308	0/27	0/22	.0000
13	2/32	1/29	.0076	2/12	0/13	.6349	0/13	0/12	.0000	0/12	1/16	.0216
14	0/51	0/52	.0000	0/14	0/15	.0000	0/24	0/25	.0000	0/33	0/31	.0000
15	26/31	30/33	.2234	7/12	5/10	.0015	14/15	14/19	1.0801	8/9	12/13	.2303
16	26/28	29/31	.1706	10/10	7/7	.0000	12/12	13/13	.0000	5/5	13/13	.0000
17	8/9	11/12	.2878	4/4	3/4	.5000F	7/7	5/5	.0000	1/1	1/1	.0000
18	3/40	3/39	.1540	3/15	1/14	.2158	3/25	0/24	1.3352	2/29	2/31	.2014
19	50/53	49/52	.1572	11/13	15/15	.7069	24/26	24/27	.0020	33/36	31/33	.0102
20	30/52	28/50	.0007	9/13	9/15	.0128	21/25	12/27	7.1362*	23/32	22/33	.0346
21	31/55	25/53	.5827	7/21	7/20	.0471	12/28	18/33	.4264	20/41	16/40	.3266

Table 4, Continued

Trait	Az. P:14:1			R	Az. V:4:1			R	Az. W:10:50			R	Az. W:10:78		
	R	L	X_c^2		R	L	X_c^2		R	L	X_c^2		R	L	X_c^2
22	30/53	37/50	2.7022		15/22	15/22	.1048		18/27	15/30	1.0078		27/39	27/36	.0891
23	15/34	16/33	.0129		0/17	0/12	.0000		5/15	6/17	.0657		7/16	7/14	.0006
24	19/43	24/46	.2930		10/20	7/17	.0423		14/24	18/25	.4963		9/28	13/27	.8760
25	20/54	19/54	.0000		7/22	7/20	.0119		13/28	11/30	.2377		21/40	16/38	.4790
26	33/52	18/52	7.5412*		10/17	13/18	.2289		16/30	16/29	.0143		29/37	19/37	4.8029+
27	52/56	52/53	.7376		19/20	19/21	.0019		27/27	28/29	.0013		36/38	38/40	.2124
28	44/54	42/51	.0189		14/20	13/21	.0471		20/26	21/27	.0645		25/34	28/36	.0183
29	21/56	21/56	.0381		8/22	8/22	.0982		11/31	9/28	.0000		20/49	25/43	2.1008
30	41/44	41/46	.0928		8/9	10/10	.4737		19/20	22/22	.0023		21/24	13/21	2.7078
31	5/48	11/51	1.5212		1/8	2/10	.5882		4/19	1/23	1.4048		4/25	5/23	.0193
32	13/54	15/55	.0265		7/21	7/21	.1071		6/32	7/31	.0041		6/45	6/44	.0721
33	0/17	0/18	.0000		3/8	1/6	.4056		2/9	0/7	.3000		1/10	0/9	.5263
34	1/39	2/44	.0113		0/13	0/12	.0000		2/18	0/21	.7058		1/24	2/21	.0143
35	1/41	3/43	.2150		0/15	1/13	.0053		0/18	2/22	.3402		0/30	2/26	.6807
36	6/40	5/41	.0019		2/15	1/13	.0172		3/18	0/21	1.8077		4/29	0/30	2.5247
37	0/37	0/45	.0000		0/13	0/13	.0000		0/17	0/21	.0000		0/22	0/28	.0000
38	29/52	29/48	.0716		8/14	8/15	.0280		14/25	10/23	.3339		16/32	13/32	.2522
39	27/40	30/38	.7813		9/11	10/13	.0442		15/22	14/19	.0018		18/27	20/26	.2742

Table 4, Continued

Trait	Az. P:14:1			R	Az. V:4:1			R	Az. W:10:50			R	Az. W:10:78		
	R	L	χ^2_c		R	L	χ^2_c		R	L	χ^2_c		R	L	χ^2_c
40	4/28	3/30	.0095		2/7	3/8	.5734 ^F		1/9	0/11	.4500		2/8	2/8	.7154
41	3/31	0/30	1.3345		0/6	2/8	.3077		1/8	0/10	.4444		1/7	0/6	.5385
42	2/55	4/56	.1577		3/18	1/17	.2216		1/34	4/35	.8013		5/46	2/47	.6654
43	31/53	29/53	.0384		9/17	10/17	.0000		17/32	10/30	1.7278		20/44	17/41	.0231
45	0/39	1/39	.0000		0/15	0/17	.0000		0/17	0/17	.0000		0/23	0/19	.0000
46	13/53	12/54	.0028		2/21	5/21	.6857		13/31	9/30	.4954		8/36	10/41	.0021
47	11/43	11/43	.0611		8/15	6/14	.0370		11/24	10/25	.0153		1/25	5/32	.9687
48	9/56	10/57	.0018		1/19	2/22	.0174		3/32	2/29	.0132		3/41	5/43	.0906
49	43/56	41/58	.2769		13/21	12/22	.0323		26/34	28/33	.3113		34/49	31/43	.0030
50	0/40	0/45	.0000		0/7	0/8	.0000		0/16	0/20	.0000		0/20	0/20	.0000
51	1/43	0/44	.0001		0/7	1/8	.5333		4/17	1/18	1.0723		0/18	2/14	.8466
53	2/18	4/22	.0317		0/6	1/9	.6000		3/8	3/12	.4551		1/12	2/10	.0289
54	10/53	10/52	.0405		3/17	4/17	.0000		4/33	7/34	.3666		8/44	11/44	.2685

F Fisher's Exact Test where combined sample size was 20 or less.

+ χ^2_c significant at the .05 level.

* χ^2_c significant at the .01 level.

TABLE 5

Side differences in incidences of cranial traits, females. The numerators indicate the trait occurrence and the denominators are the total observations possible for the trait.

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c
1	0/103	0/100	.000	0/25	0/26	.000	1/50	0/46	.001	0/56	0/55	.000
3	17/91	17/91	.036	6/22	3/21	.450	14/42	9/41	.833	14/38	13/41	.059
5	2/76	0/74	.480	0/19	0/20	.000	0/34	0/35	.000	0/27	0/24	.000
7	40/84	39/84	.000	9/20	7/17	.009	19/36	17/35	.013	15/33	10/31	.680
9	19/73	16/68	.021	3/21	1/18	.134	8/33	11/34	.216	11/37	8/32	.028
10	15/86	19/92	.125	4/20	5/20	.000	10/38	7/36	.181	5/39	7/39	.098
11	6/98	8/95	.114	1/23	2/24	.001	2/40	1/36	.008	0/48	0/45	.000
12	3/82	4/85	.002	1/19	1/23	.347	1/28	0/32	.004	2/31	1/30	.000
13	5/60	6/53	.046	0/15	1/16	.001	3/22	1/27	.545	2/21	0/15	.242
14	1/86	0/81	.000	0/19	0/18	.000	0/38	0/36	.000	0/32	0/37	.000
15	56/66	53/67	.404	6/10	8/10	.314F	25/31	23/28	.035	19/23	14/20	.377
16	57/57	55/55	.000	11/12	8/9	.287	18/18	16/16	.000	19/19	14/14	.000
17	25/28	27/27	1.334	5/7	4/5	.636F	10/10	7/7	.000	6/6	3/3	.000
18	6/69	7/68	.000	1/18	2/19	.002	2/34	5/35	.573	3/25	4/34	.144
19	81/92	81/87	.808	19/21	15/18	.034	37/39	37/39	.263	32/36	40/40	2.727
20	48/90	46/82	.044	13/21	10/18	.005	27/37	19/36	2.385	17/34	17/37	.010
21	45/94	47/94	.021	18/25	18/28	.093	21/46	23/44	.174	18/47	24/47	1.076

Table 5, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c
22	64/90	64/91	.002	8/25	11/28	.070	29/46	24/45	.527	35/47	27/44	1.244
23	29/68	27/61	.000	4/15	3/17	.035	5/23	5/29	.003	5/26	7/26	.108
24	22/81	27/78	.715	10/21	11/23	.083	21/34	22/38	.008	10/39	13/37	.423
25	32/90	34/94	.004	7/23	6/28	.169	15/46	11/43	.245	19/42	12/47	2.976
26	61/99	51/99	1.665	12/20	10/20	.101	31/47	29/44	.046	37/51	34/46	.006
27	85/99	85/95	.298	20/24	21/25	.104	41/45	34/41	.659	44/49	39/50	1.745
28	60/89	53/89	.872	13/22	18/22	1.746	26/38	22/31	.001	31/43	28/34	.616
29	57/104	55/98	.002	15/25	11/25	.721	15/42	21/48	.314	23/51	31/54	1.136
30	75/79	74/79	.000	13/14	12/14	.000	29/31	21/23	.045	29/33	29/35	.058
31	10/87	18/87	2.085	1/14	2/14	.000	4/31	8/25	1.970	7/35	13/40	.920
32	22/101	23/100	.001	10/27	8/26	.036	8/48	9/43	.063	14/55	21/55	1.508
33	0/36	1/31	.005	0/7	1/7	.500F	0/14	1/13	.001	1/12	0/14	.006
34	2/67	3/70	.002	0/16	0/15	.000	2/29	2/24	.105	1/30	2/32	.003
35	3/77	2/75	.000	0/17	0/18	.000	0/31	0/25	.000	3/35	3/36	.152
36	6/82	14/81	2.891	2/17	1/19	.010	3/30	3/27	.087	2/35	4/36	.152
37	0/87	0/84	.000	0/14	0/17	.000	0/29	0/29	.000	0/33	0/34	.000
38	39/89	42/84	.437	12/20	6/18	1.738	12/39	12/36	.000	10/35	19/37	2.990
39	46/62	42/71	2.705	15/17	14/16	.219	14/21	14/26	.349	13/23	15/27	.047
40	8/48	8/55	.000	0/7	1/10	.588	2/20	3/17	.038	3/13	5/15	.032

Table 5, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c	R	L	χ^2_c
41	7/55	7/58	.032	1/5	0/8	.384F	3/14	3/18	.013	1/8	2/9	.547F
42	4/99	5/98	.000	0/23	0/22	.000	3/44	3/43	.155	3/53	2/51	.001
43	45/84	51/91	.031	13/19	10/18	.218	18/37	11/40	2.816	20/46	15/45	.606
45	1/73	0/65	.003	0/17	0/21	.000	0/28	0/32	.000	0/29	0/21	.000
46	33/101	30/96	.003	6/24	8/26	.019	12/46	15/46	.209	12/46	7/44	.854
47	33/68	28/69	.584	11/18	8/20	.950	23/33	20/36	.925	11/27	16/34	.054
48	9/97	9/99	.040	2/27	2/27	.270	2/43	5/40	.793	2/54	4/54	.176
49	36/102	30/100	.425	7/26	8/28	.028	25/47	22/47	.170	15/55	19/58	.185
50	0/76	0/78	.000	0/11	0/11	.000	0/26	0/21	.000	0/34	1/37	.001
51	6/77	8/74	.128	1/14	1/11	.318	2/23	2/22	.227	1/26	2/26	.000
53	1/45	2/42	.003	2/11	1/11	.000	3/23	2/17	.131	2/25	2/22	.152
54	8/89	9/93	.009	4/19	3/18	.006	3/37	6/43	.221	9/51	9/50	.045

F Fisher's Exact Test where combined sample size was 20 or less.

Significant sex differences in the trait occurrences were determined for the same reasons as given in the side comparisons, and again the corrected χ^2 statistic was used for the computation of the significance levels. Of the 192 right side pairings between the sexes (Table 6), 7 produced significant differences: one at the .05 level and two each at the .02, .01, and .001 levels. There were 11 significant differences between the sexes in the 192 left side comparisons (Table 7): four at the .05 level, two at the .02 and .001 levels, and three at the .01 level. These 18 differences in the 384 pairwise comparisons of the sexes could have occurred by chance alone (χ^2_c df=1 = .525) and one is therefore justified in pooling the sexes when computing the "distances" (MD) between the four prehistoric Southwestern populations.

Some investigators (for example, Jantz 1970: 69) believe that those traits which exhibit significant sexual dimorphism should be deleted from the analysis when deriving intergroup distances from the pooled sex samples. I share the opinion expressed by Finnegan, that ". . .by omitting character variants which show significant sexual dimorphism, we are at the same time omitting some of the most important character variants for differentiating between populations" (1972: 63).

One final word regarding the right and left side sex-differences tables (Tables 6 and 7). The reader will note that the frequencies of occurrence do not always correspond to those presented in Tables 4 and 5. This has happened because Tables 6 and 7 were produced from data generated by a different computer program which requested slightly

TABLE 6

Right side sex differences in incidences of cranial traits. The numerators indicate the trait occurrence and the denominators are the total observations possible for the trait.

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c
1	0/55	0/103	.000	0/21	0/25	.000	4/32	1/50	2.147	1/49	0/58	.007
3	16/53	17/91	1.902	4/15	6/22	.113	15/32	14/42	.887	21/41	14/39	1.335
5	0/50	2/76	.183	0/17	0/19	.000	0/26	0/35	.000	0/29	0/28	.000
7	17/49	40/84	1.616	3/14	9/20	1.104	10/22	19/36	.073	8/24	15/35	.216
9	12/41	19/73	.024	2/13	3/21	.168	8/21	8/33	.610	7/31	12/39	.245
10	10/51	15/86	.008	3/17	4/20	.057	3/24	10/38	.963	7/35	6/41	.098
11	3/49	6/98	.133	2/18	1/23	.049	1/26	2/40	.148	1/38	0/50	.019
12	4/38	3/82	1.155	1/14	1/19	.265	1/24	1/28	.375	0/27	2/33	.334
13	2/32	5/60	.003	2/13	0/15	.817	0/13	3/22	.589	0/12	3/23	.452
14	0/51	1/85	.070	0/13	0/19	.000	0/24	0/38	.000	0/34	0/33	.000
15	26/31	56/66	.031	7/12	6/10	.127	14/15	25/31	.470	8/9	20/24	.022
16	25/27	57/57	1.725	9/9	11/12	.022	12/12	18/18	.000	5/5	20/20	.000
17	9/10	25/28	.288	3/3	5/8	.030	7/7	10/10	.000	1/1	7/7	.000
18	3/41	6/69	.011	3/14	1/18	.653	3/25	2/34	.130	2/30	3/26	.028
19	50/53	81/92	.892	10/12	19/21	.003	24/26	37/39	.011	34/37	33/37	.000
20	30/52	48/90	.108	8/12	13/21	.011	21/25	27/37	.503	24/33	18/35	2/423
21	31/55	45/94	.690	6/20	18/25	6.278#	12/28	21/46	.000	21/42	20/49	.444

Table 6, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c
22	30/53	64/90	2.506	15/21	8/25	5.606#	18/27	29/46	.003	27/40	35/49	.029
23	15/34	29/68	.005	0/16	4/15	2.813	5/15	5/23	.173	7/16	5/27	2.049
24	19/43	22/81	2.950	9/19	10/21	.091	14/24	21/34	.000	10/29	12/41	.041
25	20/54	32/90	.000	7/21	7/23	.014	13/28	15/46	.887	21/41	20/44	.099
26	34/53	61/99	.017	9/16	12/20	.013	16/30	31/47	.754	30/38	38/53	.292
27	52/56	85/99	1.093	19/20	20/24	.543	27/27	41/45	1.129	37/39	45/51	.522
28	44/54	60/89	2.681	14/20	13/22	.172	20/26	26/38	.212	26/35	32/45	.004
29	22/56	57/104	2.915	7/21	15/25	2.272	11/31	15/42	.051	20/50	24/53	.117
30	41/44	75/79	.000	7/8	13/14	.123	19/20	29/31	.156	21/24	30/34	.105
31	5/48	10/87	.009	1/8	1/14	.123	4/19	4/31	.134	4/25	7/36	.000
32	13/54	22/101	.015	6/20	10/27	.037	6/32	8/48	.004	6/46	14/57	1.485
33	0/17	0/36	.000	3/8	0/7	1.356	2/9	0/14	1.183	1/10	1/12	.371
34	1/39	2/67	.232	0/13	0/16	.000	2/18	2/29	.001	1/24	1/32	.270
35	1/41	3/77	.014	0/15	0/17	.000	0/18	0/31	.000	0/30	4/37	1.792
36	6/40	6/82	1.028	2/15	2/17	.161	3/18	3/30	.051	4/29	2/37	.555
37	0/37	0/87	.000	0/13	0/14	.000	0/17	0/29	.000	0/22	0/35	.000
38	29/52	39/89	1.429	7/13	12/20	.000	14/25	12/39	3.043	16/33	10/36	2.324
39	27/40	46/62	.257	9/11	15/17	.006	15/22	14/21	.048	18/27	13/24	.391

Table 6, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	M	F	X_c^2	M	F	X_c^2	M	F	X_c^2	M	F	X_c^2
40	5/29	8/48	.062	2/7	0/7	.583	1/9	2/20	.323	2/8	3/14	.113
41	3/32	7/55	.015	0/6	0/5	.009	1/8	3/14	.003	1/7	1/9	.327
42	2/56	4/99	.083	3/17	0/23	2.213	1/34	3/44	.063	5/46	3/54	.368
43	31/53	45/84	.150	8/16	13/19	.580	17/32	18/37	.017	20/48	21/47	.019
45	0/39	1/73	.102	0/15	0/17	.000	0/17	0/28	.000	0/23	0/31	.000
46	13/53	33/101	.746	2/21	6/24	.929	13/31	12/46	1.460	9/37	13/48	.001
47	12/43	33/68	3.831	7/14	11/18	.073	11/24	23/33	2.371	2/26	12/28	6.946*
48	10/56	9/97	1.678	0/18	2/27	.196	3/32	2/43	.118	3/42	2/56	.110
49	43/56	36/102	23.263 ^e	13/20	7/26	5.210 ⁺	26/34	25/47	3.641	35/50	17/57	15.639 ^e
50	0/40	0/76	.000	0/7	0/11	.000	0/16	0/26	.000	0/20	0/35	.000
51	1/44	6/7	.716	0/7	1/14	.131	4/17	2/23	.724	0/18	1/27	.043
53	2/18	1/45	.709	0/6	2/11	.105	3/8	3/23	.977	1/12	2/26	.335
54	10/54	8/89	1.975	3/16	4/19	.065	4/33	3/37	.025	8/44	9/52	.024

+ X_c^2 significant at the .05 level.

X_c^2 significant at the .02 level.

* X_c^2 significant at the .01 level.

^e X_c^2 significant at the .001 level.

TABLE 7

Left side sex differences in incidences of cranial traits. The numerators indicate the trait occurrence and the denominators are the total observations possible for the trait.

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c
1	0/57	0/100	.000	0/21	0/26	.000	6/33	0/16	6.646*	0/46	0/56	.007
3	13/54	17/91	.317	4/13	3/21	.517	9/30	9/41	.244	16/44	13/42	.091
5	0/50	0/74	.000	0/18	0/20	.000	1/22	0/35	.056	0/25	0/26	.000
7	20/46	35/84	.019	7/18	7/17	.043	14/26	17/35	.022	6/26	10/33	.106
9	16/42	16/68	2.011	3/15	1/18	.533	5/22	11/34	.226	5/23	8/32	.002
10	6/51	19/92	1.233	3/16	5/20	.002	3/23	7/36	.080	6/31	7/40	.012
11	5/51	8/95	.001	0/18	2/24	.273	1/28	1/36	.295	1/40	0/46	.005
12	1/35	4/85	.002	1/16	1/23	.224	0/17	0/32	.000	0/23	1/31	.023
13	1/29	6/53	.650	0/13	1/16	.011	0/12	1/27	.178	1/17	1/16	.470
14	0/53	0/81	.000	0/15	0/18	.000	0/25	0/36	.000	0/32	0/37	.000
15	30/33	53/67	1.427	5/10	8/10	.879	14/19	23/28	.110	12/13	15/21	1.054
16	28/30	55/55	1.414	7/7	8/9	.017	13/13	16/16	.000	13/13	14/14	.000
17	10/11	27/27	.221	3/4	4/5	.394	5/5	7/7	.000	1/1	3/3	.000
18	3/40	7/68	.020	1/14	2/19	.078	0/24	5/35	2.131	2/32	4/35	.098
19	50/53	81/87	.004	15/15	15/18	1.103	24/27	37/39	.185	32/34	40/40	.699
20	29/51	46/82	.009	9/15	10/18	.009	12/27	19/36	.160	23/34	17/37	2.567
21	25/53	47/94	.025	6/19	18/28	3.625	18/33	23/44	.001	17/41	24/48	.350

Table 7, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c
22	37/50	64/91	.071	15/21	11/28	3.771	15/30	24/45	.002	27/37	28/45	.632
23	16/32	27/61	.095	0/12	3/17	.842	6/17	5/29	1.056	7/14	7/26	1.237
24	25/46	27/78	3.852+	7/16	11/23	.006	18/25	22/38	.757	14/28	13/37	.903
25	20/54	34/94	.005	7/19	6/28	.684	11/30	11/43	.572	16/39	12/48	1.851
26	19/53	51/99	2.809	13/18	10/20	1.138	16/29	29/44	.459	19/38	35/48	3.837
27	52/53	85/95	2.542	18/20	21/25	.022	28/29	34/41	1.914	39/41	40/51	3.933+
28	43/51	53/89	8.112*	12/20	18/22	1.491	21/27	22/31	.084	29/37	29/35	.033
29	20/56	55/98	5.152+	8/21	11/25	.011	9/28	21/48	.571	26/44	31/55	.055
30	42/47	74/79	.275	10/10	12/14	.249	22/22	21/23	.478	14/22	30/36	1.917
31	11/52	18/87	.023	2/10	2/14	.034	1/23	8/25	4.334+	5/24	13/41	.433
32	15/55	23/100	.157	7/21	8/26	.016	7/31	9/43	.013	6/45	21/56	6.257#
33	0/18	1/31	.077	1/6	1/7	.426	0/7	1/13	.104	0/9	0/14	.000
34	2/43	3/70	.144	0/12	0/15	.000	0/21	2/24	.395	2/21	2/33	.004
35	3/43	2/75	.414	1/13	0/18	.028	2/22	0/25	.667	2/26	3/37	.171
36	5/40	14/81	.172	1/13	1/19	.216	0/21	3/27	.954	0/30	4/37	1.792
37	0/45	0/84	.000	0/13	0/17	.000	0/21	0/29	.000	0/28	0/35	.000
38	30/49	42/84	1.151	8/15	6/18	.646	10/23	12/36	.260	13/33	19/37	.581
39	30/38	42/71	3.487	10/13	14/16	.065	14/19	14/26	1.091	20/26	15/28	2.281
40	4/31	8/55	.013	3/8	1/10	.679	0/11	3/17	.721	2/8	5/16	.025

Table 7, Continued

Trait	Az. P:14:1			M	Az. V:4:1			M	Az. W:10:50			M	Az. W:10:78		
	M	F	χ^2_c		M	F	χ^2_c		M	F	χ^2_c		M	F	χ^2_c
41	1/31	7/58	1.001		2/8	0/8	.571		0/10	3/18	.531		0/6	2/10	.152
42	4/57	5/98	.018		1/16	0/22	.026		4/35	3/43	.082		2/47	2/52	.166
43	30/54	51/91	.013		9/16	10/18	.093		10/30	11/40	.069		17/41	15/46	.400
45	1/39	0/65	.067		0/16	0/21	.000		0/17	0/32	.000		0/20	0/22	.000
46	12/54	30/96	.985		4/20	8/26	.236		9/30	15/46	.000		10/42	8/46	.231
47	12/44	28/69	1.539		6/14	8/20	.035		10/25	20/36	.874		6/33	17/35	5.716#
48	10/57	9/99	1.691		1/21	2/27	.051		2/29	5/40	.127		5/44	4/55	.124
49	41/58	30/100	22.946@		12/21	8/28	2.959		28/33	22/47	10.402*		32/44	20/59	13.688@
50	0/46	0/78	.000		0/8	0/11	.000		0/20	0/21	.000		0/21	1/38	.092
51	0/45	8/74	3.634		1/8	1/11	.268		1/18	2/22	.033		2/14	2/27	.022
53	4/23	2/42	1.523		1/9	1/11	.359		3/12	2/17	.185		2/11	2/23	.055
54	10/53	9/93	1.773		4/16	3/18	.031		7/34	6/43	.217		11/44	9/51	.390

+ χ^2_c significant at the .05 level.

χ^2_c significant at the .02 level.

* χ^2_c significant at the .01 level.

@ χ^2_c significant at the .001 level.

different data sorts from that of Tables 4 and 5. Therefore, the frequencies may vary by one or two occurrences only for some traits between the latter and the former two tables.

There are no significant mid-line or medial cranial trait differences between the sexes (Table 8) either. Thus, these six traits may also be pooled with the others when computing the mean measure of divergence between the four sites.

Before proceeding with the actual distance statistics for these Southwestern populations, two further questions must be answered since they may have a direct bearing on whether certain crania should be excluded from the study. First, does artificial cranial deformation in the Southwest significantly alter the trait frequencies between those which are deformed and those which are non-deformed? Second, are the trait frequencies age-related, that is, do any appear in significantly greater frequencies among non-adults (less than 15 years of age) than among the adults?

With regard to the first question, Ossenberg (1970) has found in bifronto-occipitally deformed Hopewellian crania from Illinois that some traits are significantly increased over the non-deformed crania while others are significantly decreased. She found this to be particularly the case for the "posterior wormians" (ossicle at Lambda, lambdoidal ossicles, Riolan's ossicle, and asterionic ossicles) and the "lateral wormians" (parietal notch bone, epipteric bone, and coronal ossicles) respectively. Her data indicate that there is an increased frequency of wormians in the deformed crania where growth

TABLE 8

Mid-line cranial trait sex differences. The numerators indicate the trait occurrence and the denominators are the total observations possible for the trait.

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c	M	F	χ^2_c
2	2/42	2/77	.009	0/16	1/18	.004	2/25	2/35	.031	4/30	5/33	.024
4	0/46	0/75	.000	0/17	0/21	.000	0/29	0/44	.000	0/31	0/43	.000
6	6/45	26/86	3.701	3/17	6/21	.163	7/24	11/36	.030	7/30	10/35	.038
8	2/57	0/104	1.388	0/19	0/25	.000	0/34	0/47	.000	1/45	0/59	.019
44	0/57	1/103	.091	0/21	0/26	.000	1/34	0/51	.042	0/47	1/60	.015
52	13/50	29/81	.951	2/9	3/12	.137	7/23	6/26	.067	11/19	13/24	.490

to the posterior vault has been inhibited, and a decreased frequency of wormians in the lateral portions where the cranium was free to expand. She concludes that, based on her findings, ". . .deformed crania should be excluded from population studies using frequencies of minor morphological variants to estimate genetic divergence between groups" (Ossenberg 1970: 370).

One can see what such exclusion would do to studies of Southwestern populations where, as in the groups presently under consideration, cranial deformation accounts for very nearly 80 percent of the total sexable adult crania (Table 2). Therefore, tests of significance (Table 9) were calculated for all 54 traits on the adult crania from each of the four Southwestern groups to see if the variants do indeed differ significantly by deformation as they apparently did among the Illinois Hopewell.

The data presented in Table 9 indicate that only 3 out of 216 pairwise comparisons differ significantly: two at the .05 level and one at .01 level. This small number of differences, based on what I have observed from the other tables, could easily have occurred by chance alone. When considering only those traits which Ossenberg listed as "posterior" and "lateral wormians," I find no significant differences between the deformed and the non-deformed adult crania from any of the four prehistoric Southwestern sites. Tests of significance with one degree of freedom yielded corrected Chi-square values of .012, 2.127, .180 and .713 for the Grasshopper, Kinishba, Point of Pines and Turkey Creek populations respectively.

TABLE 9

Trait incidences in deformed (Df) and non-deformed (nDf) adult crania for the four prehistoric Southwestern populations. The numerators indicate the trait occurrence and the denominators are the total observations possible for the trait.

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	Df	nDf	χ^2_c	Df	nDf	χ^2_c	Df	nDf	χ^2_c	Df	nDf	χ^2_c
1	0/140	0/9	.000	0/32	0/6	.000	6/62	2/16	.017	0/84	0/12	.000
2	4/105	0/7	.276	1/20	0/4	.835	4/42	0/10	.126	6/47	2/9	.050
3	39/128	1/7	.238	10/23	1/5	.220	10/49	7/14	.198	32/66	5/7	.573
4	0/106	0/6	.000	0/24	0/6	.000	0/52	0/15	.000	0/58	0/8	.000
5	2/113	0/9	.924	0/26	0/5	.000	1/51	0/15	.430	0/47	0/8	.000
6	30/119	0/7	1.135	4/27	4/6	4.641+	13/44	5/15	.002	12/53	3/8	.220
7	64/125	4/7	.007	12/27	4/6	.285	28/49	11/16	.280	24/59	6/9	1.215
8	1/142	0/9	3.483	0/31	0/6	.000	0/62	0/17	.000	1/84	0/12	1.299
9	44/117	1/8	1.104	7/29	1/6	.019	22/50	7/15	.013	23/65	2/10	.361
10	35/134	3/8	.087	8/29	2/5	.001	16/56	1/15	2.030	20/73	2/11	.078
11	16/137	1/9	.235	1/32	3/6	7.336*	4/56	1/16	.188	2/80	0/12	.258
12	8/125	0/7	.015	2/30	1/6	.000	2/46	0/16	.001	3/62	0/11	.006
13	9/93	1/5	.000	0/23	0/4	.000	3/32	0/13	.234	1/37	1/4	.555
14	0/132	1/8	3.667	0/23	0/5	.000	0/54	0/14	.000	0/63	0/11	.000
15	88/101	7/8	.269	14/19	2/2	.002	37/42	11/13	.022	32/38	7/7	.275
16	84/86	6/6	1.145	15/16	4/4	.800F	29/29	6/6	.000	28/28	5/5	.000
17	37/39	5/5	.387	8/10	2/2	.682F	15/15	3/3	.000	4/4	3/3	.000

Table 9, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	Df	nDf	χ^2_c	Df	nDf	χ^2_c	Df	nDf	χ^2_c	Df	nDf	χ^2_c
18	12/111	1/8	.193	3/22	1/5	.113	6/47	2/11	.000	7/61	2/10	.057
19	130/136	8/8	.092	21/23	6/6	.024	54/55	16/16	.438	66/67	11/11	1.078
20	88/132	7/8	.698	15/23	6/6	1.404	37/51	12/16	.017	46/62	7/11	.127
21	86/135	5/9	.018	22/23	4/6	.143	37/61	9/16	.001	44/76	6/11	.013
22	104/130	6/8	.012	20/33	4/6	.031	41/60	11/15	.004	57/72	8/11	.008
23	51/101	3/7	.000	2/22	0/5	.060	11/39	4/8	.621	15/48	3/6	.211
24	52/120	6/8	1.892	17/29	4/6	.008	42/54	7/10	.016	25/64	5/9	.336
25	66/137	4/8	.069	11/33	2/6	.222	28/61	6/16	.102	42/76	5/11	.082
26	113/136	5/9	2.601	25/30	4/6	.142	47/61	14/17	.018	64/74	6/10	2.747
27	133/139	9/9	.056	29/32	6/6	.002	57/60	14/15	.148	74/79	12/12	.047
28	116/136	4/8	4.473+	23/31	6/6	.746	45/53	12/13	.060	62/73	8/11	.335
29	91/140	6/9	.067	19/32	1/6	2.182	33/61	7/16	.208	52/83	9/11	.838
30	122/124	8/8	1.279	19/19	4/4	.000	40/41	11/11	.509	49/56	10/12	.007
31	35/133	3/8	.080	4/19	0/2	.051	10/42	4/11	.208	21/58	4/12	.020
32	39/140	3/9	.001	9/31	4/6	1.691	16/61	3/15	.028	24/85	4/12	.001
33	0/61	1/5	2.610	3/12	2/2	.110	2/21	1/8	.200	2/22	0/6	.016
34	4/111	1/7	.155	0/23	0/4	.000	3/42	3/13	1.213	5/53	1/9	.205
35	7/119	0/7	.036	1/27	0/4	1.265	2/44	0/14	.001	6/66	1/9	.172
36	25/122	1/7	.007	5/27	1/4	.138	4/42	4/14	1.750	8/69	2/9	.135
37	0/127	0/9	.000	0/25	0/3	.000	0/40	0/14	.000	0/63	0/9	.000
38	82/133	4/8	.080	15/23	4/5	.013	29/52	8/16	.014	31/62	5/11	.002

Table 9, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	Df	nDf	χ^2_c	Df	nDf	χ^2_c	Df	nDf	χ^2_c	Df	nDf	χ^2_c
39	86/112	4/6	.006	17/20	4/4	.000	32/41	7/9	.182	37/53	6/8	.013
40	17/91	1/6	.176	2/12	1/2	.396	4/25	0/7	.235	7/22	2/6	.179
41	12/96	1/7	.204	1/11	1/2	.295	3/23	1/8	.328	1/14	2/5	.155
42	10/134	1/9	.062	2/23	1/6	.033	6/52	2/15	.069	6/80	1/11	.174
43	90/131	8/9	.814	16/23	5/5	.730	30/51	6/15	.984	42/74	5/12	.437
44	1/139	0/9	3.400	0/32	0/6	.000	0/62	0/16	.000	0/82	0/10	.000
45	2/104	0/7	1.205	0/25	0/6	.000	0/37	0/13	.000	0/48	0/7	.000
46	57/136	1/9	2.177	11/33	2/6	.222	21/58	9/17	.916	19/75	4/11	.166
47	48/112	2/8	.383	14/21	3/5	.058	28/48	5/11	.193	21/60	2/8	.027
48	25/140	1/9	.004	3/32	2/6	.874	6/58	2/16	.044	10/80	0/12	.640
49	75/141	5/9	.043	18/32	3/6	.027	40/62	12/16	.246	50/84	6/12	.098
50	0/120	0/7	.000	0/13	0/3	.000	0/37	0/10	.000	1/55	0/9	1.086
51	8/114	1/6	.006	1/14	1/3	.331	5/33	2/11	.057	4/39	0/7	.025
52	39/115	0/6	1.651	4/15	0/3	.446	10/36	2/9	.007	17/35	4/8	.102
53	8/73	0/4	.020	3/19	1/3	.005	8/30	1/11	.607	6/41	1/7	.308
54	20/130	2/9	.005	7/23	0/5	.730	12/51	3/15	.004	23/80	2/12	.280

F Fisher's Exact Test where combined sample size was 20 or less.

+ χ^2_c significant at the .05 level.

* χ^2_c significant at the .01 level.

The deformation exhibited by these prehistoric Southwest American Indian crania does not alter the frequency of the variants as does the bifronto-occipital type of deformation found among the Hopewellians. Thus, one can ignore the deformed/non-deformed dichotomy when computing mean measures of divergence for the populations used in the present study.

I can only surmise why the Hopewell crania differed in trait frequency between the deformed and the non-deformed. Although Ossenberg (1970) felt that the archaeological evidence (such as, burial provenience and grave furniture) supported her contention that the deformed and non-deformed were drawn from the same population, they may indeed have been from different breeding units. This might also explain why she found almost twice as many deformed males as females in the one group, but an almost even sex distribution among the non-deformed group. Similarities in grave furnishings need not imply genetic relationships. After all, it is not the ceramics which do the breeding!

One final word of caution about Table 9 must be given. The frequencies will not necessarily match the number of deformed and non-deformed males and females listed in Table 2. This occurs because some adults which could not be sexed, but for which there is deformation data, have been included in the former table and necessarily excluded from the latter.

One must now face the second question posed regarding the possibility for significant trait frequency differences between adult

and non-adult crania, and the necessity for excluding the non-adults from populational distance measures. To date, few investigators have considered non-adults in a population analysis; most have limited their studies to adult crania only and possibly with good reason. Buikstra (MS) has been one of the first to investigate the age dependent nature of non-metric traits using a Middle Woodland skeletal series from Illinois. She stipulated in her manuscript that a large number of cranial traits in her study showed strong correlations with age, but when all individuals under the age of 12 were dropped from the sample, the significant age correlations disappear for nearly all of the variants. It was the opinion of Buikstra (MS) that ". . .age-dependence is indeed a factor limiting the usage of certain non-metric traits for biological distance comparison" (p. 10).

Her findings make it mandatory in the present study to evaluate the possible differences between adult and non-adult crania. If the non-adults differ significantly from the adults, they should not be included in the divergence measures for the populations. If there are no differences, there is every reason to include them in the sample not only to increase the size of the sample but also to have groups which are more nearly representative of true populations.

Fifty-four pairwise comparisons between the adults and the non-adults using χ^2 tests of significance were produced for all of the traits. Rather than present tabular data for all 54 of the traits, only those which exhibited significant differences between the two broad age categories have been included in Table 10. This table was established for the combined sites rather than with each of the sites

TABLE 10

Selected adult and non-adult cranial traits from the combined sites which have significant differences in their frequency of occurrence.

Trait	Adult	Non-adult	χ^2_c
3 Mandibular torus	130/348	1/55	25.744@
7 Lambdoidal ossicles	159/309	41/61	4.478+
8 <u>Os Inca</u>	2/387	3/64	5.324+
23 Supratrochlear spur	96/256	5/52	14.010@
32 Dehiscence of Huschke	120/410	41/68	23.765@
35 For. spinosum open	18/319	8/36	10.772@
39 Acc. lesser palatine for.	216/282	27/44	3.885+
43 Acc. mandibular for.	224/369	47/57	9.174*
47 Sutures into infraorb. for.	139/310	44/55	21.716@
49 Spine of Henle	234/414	22/68	12.747@
54 Mylo-hyoid bridge	81/373	0/59	14.376@

+ χ^2_c significant at the .05 level.

* χ^2_c significant at the .01 level.

@ χ^2_c significant at the .001 level.

considered separately. While the latter method would have been the ideal, the small number of non-adults available (Table 1) for sites W:10:50 and W:10:78 precluded this approach, and all sites were therefore lumped together.

A total of 11 significant differences (3 at the .05, one at the .01 and 7 at the .001 levels) were obtained, some of which can not be readily explained in terms of age-regressive or age-progressive development. For example, lambdoidal ossicles (Trait 7) and the Os Inca (Trait 8) appear as age-regressive cranial variants, yet the conditions were not scored as absent in the adults (crania greater than 15 years of age) if there was evidence for sutural obliteration. The accessory lesser palatine foramen (Trait 39) is unusual in that it appears as an age-progressive variant at a significant level. Foramina tend either to decrease significantly in their frequency of occurrence with increased age (as in Trait 43) or to remain relatively stable with no significant differences observed between the age groups 5 to 15 years and 15 to 50 plus years.

The significance found in the remainder of the age-progressive traits (3, 23, 49, and 54) can be explained on the basis that they only achieve expression sometime after puberty (Johnson, Gorlin and Anderson 1965; Ossenberg 1970). The significance found in the other age-regressive traits (32, 35, 43, and 47) can be explained by their normally high occurrence in the fetal or infantile stages of skeletal development with a normally decreasing retention into adulthood (Ossenberg 1970; Buikstra MS).

Inasmuch as 20% (11/54) of the traits have a significant age-dependency, I have decided to exclude from the present divergence analyses all crania under 15 years of age since they could bias the distance measures either between or within the populations. (In any future evaluation of non-adult material, it would be better to examine the fetal through adolescent ages rather than just from the middle childhood years onward as has been attempted here. This is particularly true if questions are to be answered with regard to differential survivorship as reflected by variant frequency differences between pre-reproductive and reproductive age skeletal material).

Mean Measures of Divergence

As mentioned earlier in this chapter, the mean measures of divergence (MD) between pairs of populations has been handled in several different ways by other researchers. Jantz (1970) and Finnegan (1972), for example, utilized the sides as the units of measure for the bilateral traits rather than the presence or absence of a trait for the crania per se. Buikstra (MS) on the other hand views the individual as the most reasonable "epigenetic" unit, since the splitting of bilateral variants artificially increases the sample size and could misrepresent trait frequencies.

I share Buikstra's opinion, and in order to test this impression regarding the better of the two methods which have been employed, the adult variant data were injected into the distance formula in each of two ways. First, the trait frequencies (p) and sample sizes (n) of

each trait were handled as if each side was an independent unit (that is, two "individuals" for each cranium). Second, the trait frequencies and sample sizes for each trait were scored as positive or present in a given skull if the trait appeared either unilaterally or bilaterally. Where one side could not be scored because of missing or damaged bone, the remaining side determined how the variant would be scored for that skull. Thus, the first scoring procedure could conceivably yield variant sample sizes which are twice as large as those determined by the second method in cases where the crania are complete or intact.

Rather than present tabular data for the technique which will not be used in the populational analysis, I have chosen to give only those data pertinent to my selected method for scoring the variants. Table 11 contains the requisite information used in the distance formula, as set forth in the beginning of this chapter, from which the mean measures of divergence and the standard deviations of Table 12 are derived. The divergences between each population pair in this table and in Table 13 are all significant at the .05 level of probability as defined by Constandse-Westermann (1972), that is, the distances are all greater than twice their standard deviations.

Table 13 was computed from slightly different trait frequencies of occurrence and much larger trait sample sizes since the sides were being considered separately as described above. This latter table is presented only to demonstrate that measures obtained by either of the two methods under investigation differ very little from each other. (Actually, Table 13 shows consistently decreased distances between pairs

TABLE 11

Percentage frequency (p), sample size (n), and angular transformation (θ) for each cranial trait in the four Southwestern populations where the sexes are pooled and the crania are considered as the units of measure.

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	p	n	θ	p	n	θ	p	n	θ	p	n	θ
1	.000	161	1.5708	.000	49	1.5708	.090	89	.9614	.009	112	1.3808
2	.034	118	1.1999	.029	34	1.2285	.067	60	1.0471	.145	62	.7895
3	.295	146	.4224	.333	36	.3405	.436	78	.1283	.471	87	.0580
4	.000	120	1.5708	.000	37	1.5708	.000	73	1.5708	.000	71	1.5708
5	.015	132	1.3252	.000	38	1.5708	.014	70	1.3336	.000	57	1.5708
6	.246	130	.5329	.243	37	.5398	.300	60	.4115	.254	63	.5144
7	.511	137	.0220	.514	37	.0280	.600	65	.2014	.435	69	.1304
8	.006	160	1.4157	.000	43	1.5708	.000	81	1.5708	.010	101	1.3705
9	.353	133	.2984	.211	38	.6163	.433	67	.1344	.333	78	.3405
10	.270	152	.4780	.282	39	.4511	.233	73	.5633	.261	88	.4984
11	.109	156	.8979	.087	46	.9720	.063	80	1.0634	.020	102	1.2870
12	.065	139	1.0552	.068	44	1.0432	.030	66	1.2226	.039	77	1.1732
13	.104	106	.9141	.091	33	.9579	.061	49	1.0717	.067	45	1.0471
14	.007	150	1.4033	.000	37	1.5708	.000	77	1.5708	.000	83	1.5708
15	.881	118	.8664	.792	24	.6236	.879	58	.8602	.857	49	.7952
16	.980	100	1.2870	.955	22	1.1433	1.000	36	1.5708	1.000	35	1.5708
17	.957	46	1.1530	.750	12	.5236	1.000	19	1.5708	1.000	7	1.5708

Table 11, Continued

Trait	Az. P:14:1			p	Az. V:4:1			p	Az. W:10:50			p	Az. W:10:78		
	p	n	θ		n	θ	n		θ	n	θ				
18	.116	129	.8757	.143	35	.7952	.130	69	.8331	.115	78	.8788			
19	.961	155	1.1732	.947	38	1.1062	.976	82	1.2597	.989	89	1.3606			
20	.689	151	.3876	.737	38	.4938	.740	77	.5006	.720	82	.4556			
21	.630	154	.2630	.660	47	.3257	.588	85	.1769	.571	98	.1425			
22	.830	147	.6510	.667	48	.3405	.720	82	.4556	.793	92	.6261			
23	.509	114	.0180	.091	33	.9579	.300	50	.4115	.351	57	.3026			
24	.463	136	.0741	.535	43	.0701	.754	69	.5329	.402	82	.1973			
25	.487	154	.0260	.396	48	.2095	.446	83	.1082	.546	97	.0921			
26	.810	153	.6687	.811	37	.6713	.790	81	.6187	.848	92	.7698			
27	.956	159	1.1481	.915	47	.9791	.953	85	1.1337	.952	105	1.1290			
28	.838	154	.7423	.778	45	.5896	.842	76	.7532	.833	96	.7288			
29	.658	161	.3215	.560	50	.1203	.529	87	.0580	.636	110	.2755			
30	.986	138	1.3336	1.000	26	1.5708	.983	58	1.3093	.853	75	.7838			
31	.255	149	.5121	.240	25	.5468	.250	60	.5236	.368	76	.2672			
32	.280	161	.4556	.408	49	.1850	.259	85	.5029	.274	113	.4690			
33	.014	70	1.3336	.294	17	.4246	.097	31	.9374	.065	31	1.0552			
34	.047	128	1.1337	.000	32	1.5708	.103	58	.9174	.087	69	.9720			
35	.058	137	1.0843	.028	36	1.2345	.032	62	1.2111	.083	84	.9863			
36	.201	139	.6410	.167	36	.7288	.153	59	.7670	.116	86	.8757			

Table 11, Continued

Trait	Az. P:14:1			Az. V:4:1			Az. W:10:50			Az. W:10:78		
	p	n	θ	p	n	θ	p	n	θ	p	n	θ
37	.000	146	1.5708	.000	33	1.5708	.000	58	1.5708	.000	78	1.5708
38	.603	151	.2075	.676	37	.3597	.519	77	.0380	.524	84	.0480
39	.762	126	.5515	.909	33	.9579	.764	55	.5562	.706	68	.4246
40	.176	102	.7050	.278	18	.4601	.121	33	.8602	.300	30	.4115
41	.119	109	.8664	.187	16	.6764	.125	32	.8481	.143	21	.7952
42	.077	155	1.0084	.103	39	.9174	.122	82	.8572	.104	106	.9141
43	.682	151	.3726	.722	36	.4601	.551	78	.1022	.500	102	.0000
44	.006	159	1.4157	.000	46	1.5708	.012	85	1.3513	.010	104	1.3705
45	.017	119	1.3093	.000	39	1.5708	.000	56	1.5708	.000	58	1.5708
46	.385	156	.2321	.298	47	.4159	.405	84	.1912	.274	95	.4690
47	.419	129	.1627	.618	34	.2382	.557	70	.1142	.320	75	.3683
48	.169	160	.7235	.082	49	.9899	.106	85	.9075	.113	106	.8851
49	.531	162	.0620	.469	49	.0620	.685	89	.3790	.571	112	.1425
50	.000	134	1.5708	.000	20	1.5708	.000	52	1.5708	.014	69	1.3336
51	.078	128	1.0047	.095	21	.9441	.146	48	.7867	.080	50	.9973
52	.323	130	.3618	.200	20	.6435	.265	49	.4893	.500	48	.0000
53	.107	84	.9043	.167	24	.7288	.220	41	.5944	.132	53	.8271
54	.174	149	.7102	.250	36	.5236	.203	79	.6360	.278	108	.4601

TABLE 12

Mean measures of divergence* (with their standard deviation) between pairs of Southwestern skeletal populations where the traits were scored for individual crania.

	Az. V:4:1	Az. W:10:50	Az. W:10:78
Az. P:14:1	.04674 (.00189)	.02606 (.00100)	.02676 (.00093)
Az. V:4:1	----- -----	.05766 (.00246)	.07139 (.00301)
Az. W:10:50	----- -----	----- -----	.02233 (.00101)

*Distances are significant at the .05 level of probability if they are equal to or greater than twice their standard deviations.

TABLE 13

Mean measures of divergence* (with their standard deviation) between pairs of Southwestern skeletal populations where the traits were scored using the sides as separate entities.

	Az. V:4:1	Az. W:10:50	Az. W:10:78
Az. P:14:1	.03704 (.00122)	.02152 (.00103)	.02425 (.00096)
Az. V:4:1	----- -----	.04250 (.00182)	.05598 (.00219)
Az. W:10:50	----- -----	----- -----	.02113 (.00090)

*Distances are significant at the .05 level of probability if they are equal to or greater than twice their standard deviations.

of populations). One therefore must question the need to enlarge the sample sizes by treating the sides as separate entities in any populational study as other researchers have done in the recent past.

In order to better visualize the non-enhanced data of Table 12, a schematic representation (Fig. 9) of these distances is presented. The distances have been drawn to scale in a two-dimensional plane to emphasize their relationships.

The least divergence (.02233 units) occurs between the Turkey Creek (Ariz. W:10:78) and Point of Pines (Ariz. W:10:50) populations, and this distance demonstrates that there are significant differences between the two groups. Unfortunately, the measure does not indicate in what specific manner the populations deviate, but it does indicate a clear separation of the sites which the osteometric technique employed by Bennett (1973) failed to accomplish. One can suggest therefore that perhaps these types of non-metric data analyses are better discriminators of local or regional skeletal populations than are the usual statistical techniques employed in an osteometric analysis. Whether this statement would be true for the more sophisticated distance analyses of continuous (metric) data has not been tested to the best of my knowledge on any Southwestern skeletal series.

The "distance" generated between the archaeologically related Turkey Creek and Point of Pines groups may represent nothing more than microevolutionary changes in trait frequencies of these populations. Without comparative data from known Anasazi (preferably Kayenta Anasazi) skeletal material, the question of a major Kayenta migration

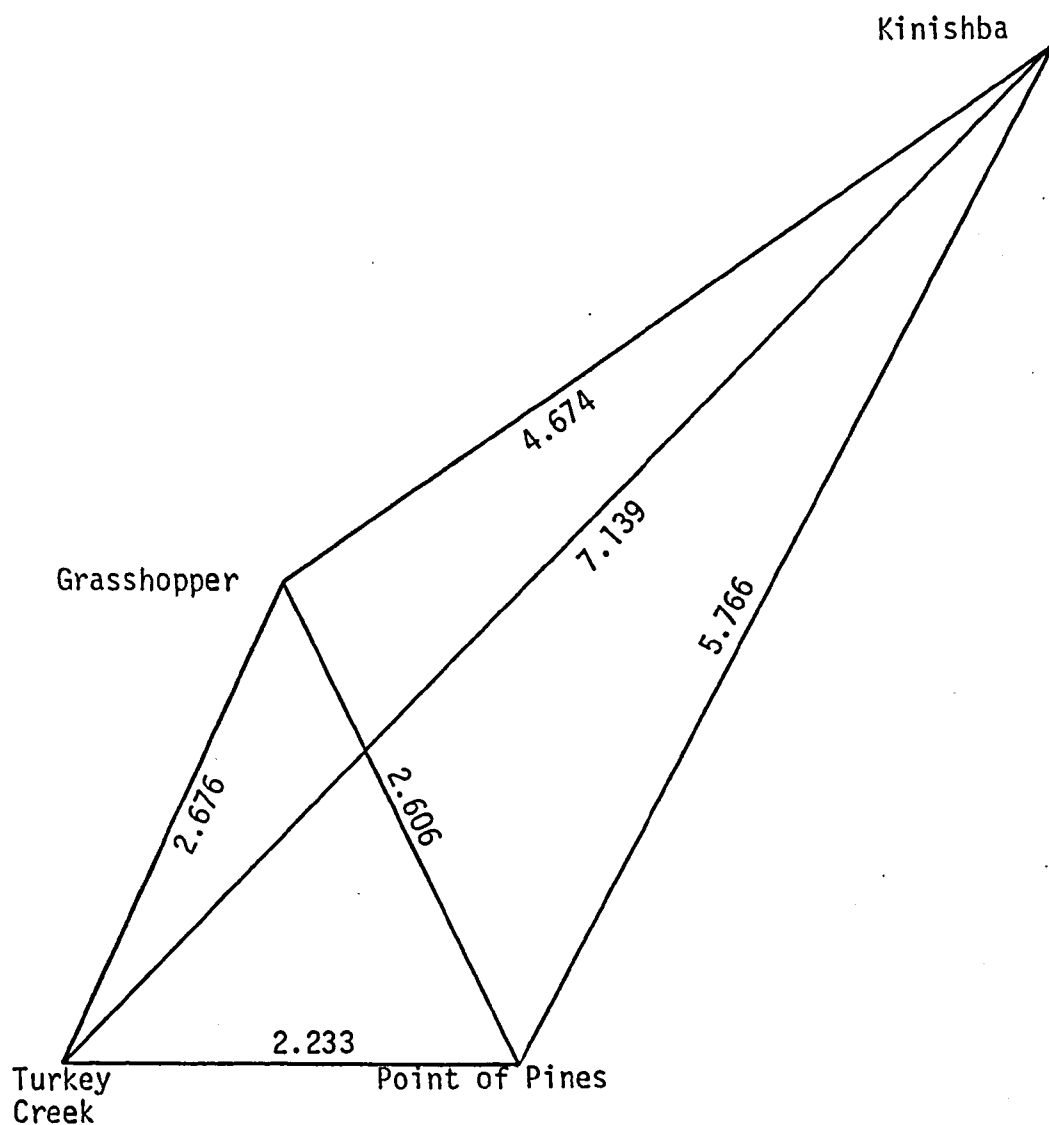


Fig. 9. Schematic representation of the mean measures of divergence (X 100) for the four Southwestern archaeological populations.

into the Point of Pines area around A.D. 1285 (Haury 1958) can not be adequately resolved at this time. It would be premature to hypothesize genetic influences from such a migrant group to account for the significant differences observed between the earlier and later Point of Pines inhabitants.

The inhabitants of the Grasshopper site, although differing significantly from the two most southerly groups, were nevertheless more similar to the Point of Pines area inhabitants regardless of their temporal provenience than they were to the residents of the Kinishba Ruin. This would seem to occur despite the fact that the pueblo of Kinishba was nearly 40 air miles closer to, and on the same side of the Salt River as, the possibly coeval Grasshopper site.

There are several possible explanations which could account for the "distance" relationships observed for these four local populations. These explanations are based solely on the divergence data (Fig. 9) and are given in their increasing order of likelihood:

1. Both the Grasshopper and Turkey Creek sites, although supposedly temporally separated, were initially inhabited by the same or genetically similar peoples who diverged to about the same extent through time. Thus, the Grasshopper population differs little more from the Turkey Creek group than it does from the inhabitants of Point of Pines, that is, a difference of only .00070 units. The Kinishba people in such a context may be related to each of the other groups, but only as "distant cousins."

2. Both the coeval Point of Pines and Grasshopper sites were founded by the Turkey Creek inhabitants who were migrating or otherwise dispersing from the pueblo. For this reason, the differences in the divergences observed between the Grasshopper and Turkey Creek materials and between the Point of Pines and Turkey Creek samples are quite small (.00443 units). Again, the lesser related "second cousins" from the coeval Kinishba Ruin are the most divergent of any of the four groups.

3. Genetic exchanges between the groups at the Grasshopper and Point of Pines Ruins were more frequent or of greater magnitude than were those between the Grasshopper and the Kinishba inhabitants, even though the latter were geographically more accessible to the former. Since the people at the Point of Pines site were archaeologically the same as those from Turkey Creek, but separated by time, the Grasshopper-Turkey Creek and the Grasshopper-Point of Pines "distances" appear to be nearly identical. The somehow less genetically related Kinishba group can be seen to differ the most from the temporally distant Turkey Creek people and their coeval but geographically less accessible Point of Pines neighbors; they differ the least, as one might expect, from the geographically closer and genetically more accessible Grasshopper inhabitants.

I can not explain why the Kinishba population stands as the least genetically related of the four compared groups. However, the divergences observed from that group are not much greater than Berry (1968) was able to demonstrate for regional variations in some populations of wild mice. Whether similar "distances" between groups of mice convey

the same meaning when applied to man has not as yet been ascertained. Nevertheless, for purposes of this study, I shall interpret such degrees of divergence as indicating that the Kinishba inhabitants were more than merely isolated intermittently by the geographical distances between them and their neighbors. I would suggest that there may have been social or cultural barriers as well which were responsible for the divergences noted, especially when one considers the proximity of the Kinishba Ruin to the Grasshopper site.

Thus far in this study on the utility on no-metric trait analyses for Southwestern cranial series, it has been demonstrated that: (1) the technique is capable of discriminating between local or regional populations better than the older osteometric methods; (2) Southwestern Indian crania lack sexually distinct traits which therefore allows the sexes to be pooled for populational analysis (Hypothesis 1 of Chapter I); (3) artificial cranial deformation does not significantly alter the trait frequencies on the material under consideration (Hypothesis 2); and (4) there are differences in trait frequencies between pre-reproductive and post-reproductive age groups (Hypothesis 3) which may preclude the use of sub-adults in populational analyses.

Hypothesis 4 and 5 of Chapter I, which deal with certain archaeological site data and the non-metric cranial traits, will be considered in the following chapter.

CHAPTER V

ANALYSIS OF ARCHAEOLOGICAL BURIAL DATA

Inasmuch as inter-site populational differences were demonstrable when using the non-metric distance statistic, attention can now be focused on the study of intra-site group relationships by employing the same type of analytical approach. That such an approach is feasible for such closely related peoples within a single archaeological site was suggested by the work of Lane and Sublett (1972) on Seneca Indian rural-neighborhood cemeteries wherein historic residence patterns were reflected by an analysis of selected non-metric cranial traits.

However, there were no clearly defined "cemeteries" per se at the three Southwestern archaeological sites selected for this part of the study. Therefore, as discussed in Chapter III, a cemetery status was arbitrarily assigned to 1) areas of prehistoric pueblo construction at the Grasshopper site, 2) excavated trash heaps at the Turkey Creek site, and 3) large archaeological broadsides at the Point of Pines site from which, in each instance, human skeletal material had been exhumed.

Unfortunately, the partitioning of the inhumations into these smaller categories reduces each "cemetery" sample size to the point where the generated "distances" are no longer believable.

For example, it would appear from Tables 14 and 15 that each Trash-mound and each Broadside at the Turkey Creek and Point of Pines site respectively had been utilized as places of interment by different populations or populational sub-groups since all paired comparisons differed significantly in the "distances" based on cranial non-metric traits. While it is possible that each of the nine selected "cemeteries" were meaningfully different in cranial traits, it is not very probable. I suggest, therefore, that the MD statistic may have a threshold (possibly around an $N=30$) below which erroneous distances are produced due to the small sample sizes and hence the rather inflated percentage frequencies upon which the angular transformations (θ_1 and θ_2) are determined.

Therefore, with the above consideration in mind, and rather than attempt a partition of the Turkey Creek and Point of Pines sites into only two "cemeteries" each (although it would greatly increase the sample size for each such division), I have decided with some reluctance to delete these two site populations from this aspect of the study of intra-site differences. Perhaps a future re-evaluation of possible intra-site "cemeteries" or a refinement of the MD statistic (if not the utilization of an entirely different statistic) will yield the desired information from these two rejected groups. For the present, however, such re-evaluations are beyond the imposed time limits of the dissertation.

Fortunately, the populationally larger Grasshopper site remains whereby one can test whether cranial traits may be employed

TABLE 14

Mean measures of divergence* (with their standard deviations)
between selected "cemeteries" (Trashmounds) at the Turkey
Creek site, Az. W:10:78.

	Trashmound 2	Trashmound 5	Trashmound 6	Trashmound 7
Trashmound 1 (N=30)	.09437 (.00798)	.06807 (.00555)	.05370 (.00294)	.07887 (.00561)
Trashmound 2 (N=14)	-----	.15407 (.00804)	.08393 (.00604)	.07202 (.00568)
Trashmound 5 (N=12)	-----	-----	.10691 (.00548)	.10984 (.00537)
Trashmound 6 (N=24)	-----	-----	-----	.10353 (.00498)
Trashmound 7 (N=20)	-----	-----	-----	-----

*Distances are significant at the .05 level of probability if they are equal to or greater than twice their standard deviations.

TABLE 15

Mean measures of divergence* (with their standard deviations)
between selected "cemeteries" (Broadside) at the Point of
Pines site, Az. W:10:50.

	Broadside 2, 3	Broadside 4	Broadside 5
Broadside 1 (N 11)	.11469 (.00593)	.17025 (.00837)	.15617 (.00735)
Broadside 2, 3 (N=41)	-----	.05650 (.00292)	.06089 (.00315)
Broadside 4 (N=20)	-----	-----	.08031 (.00442)
Broadside 5 (N=15)	-----	-----	-----

*Distances are significant at the .05 level of probability if
they are equal to or greater than twice their standard deviations.

to distinguish between different breeding units within a single archaeological site if such units should have existed. To this end, interments from within and around the East Unit and from within and around the West Unit of the site were considered to represent two separate "cemeteries."

The two major construction units at the site were chosen primarily because of their physical separation and the suggestion that the East Unit was perhaps the earlier of the two building complexes. Only later, during the writing of this study, Longacre pointed out to me that McKusick (MS) had found a greater frequency of black-feathered bird remains in the East Unit than in the West and a greater frequency of macaws and hawk-like birds in the West Unit as opposed to the East Unit. She does not make this distinction clear in her manuscript, although she does state that if a moiety system such as found at Zuni could have existed at the Grasshopper site, "it would account for some of the peculiarities [sic] of the macaw sample as well as the unusual number of raven-like birds" (MS: 12).

Mean Measures of Divergence

The mean measure of divergence (MD) generated on the cranial data from these two "cemetery" areas, or possibly the "moiety" areas of the site as suggested above, produced a "distance" of .01369 units. This figure indicates that the burial populations from these two building complexes were for whatever reason significantly different

from each other since the divergence was greater than twice its standard deviation (.00106). Unlike the adverse conditions encountered with the other site breeding units which had to be deleted from the study, the partitioning of the 163 adult Grasshopper Pueblo interments resulted in a sample of 75 crania from the East Unit and 88 crania from the West Unit of the site. One therefore can feel somewhat more confident about the resultant biological "distance" inasmuch as both samples fall well above the postulated critical threshold for this statistic.

It would appear, on the basis of the MD statistic, that there were at least two different intra-site breeding units at the Grasshopper Pueblo, each of which had preferred burial areas within and around the habitation complexes. It is doubtful that these intra-site groups varied significantly due to any temporal differences between the construction units since the site itself was probably occupied for a period of less than 200 years.

There are several different reasons which may be offered in attempting to explain the observed differences between the inhabitants of the two major construction units at the site: (1) the site was initially populated by several different founding groups; (2) a somewhat later and possibly migratory group joined the already established site and constructed their own habitation units; (3) the two construction units were peopled by members of different "moities" as McKusick (MS) had suggested. Since the divergence generated between the East Unit and West Unit populations is so small, it is

doubtful that any very disparate groups could have been involved in either the first or second explanation. The measure would best fit the last or third proposal which does not call for large or major influxes from outside groups.

In order to test the three proposed explanations, however, determinations must be made for possible differences or similarities between the sexes in the breeding groups of the two construction units. That is, the divergence between the sexes of the two habitation units should show, when using the MD statistic, whether the males were more similar to the males than to the females or vice versa, or whether differences occurred in all possible sex comparisons.

If the first two explanations for the observed intra-site divergence were true, then one would expect to find that both the males and the females differed markedly from their counterparts at the opposite construction unit, and that between these units the males differed from the females in a similar manner. If the third explanation could account for the observed divergence, then one would expect to find little or no difference in only one of the same-sex comparisons between the East Unit inhabitants and those from the West Unit. At the same time, the other same-sex comparison should appear markedly different as would the comparison between the opposing sexes of the two units.

The cranial trait frequencies and their angular transformations which were used in computing the measures of divergence (MD) between the sexes of the two habitation units are presented in Table 16. The

TABLE 16

Percentage frequency (p), sample size (n), and angular transformation (θ) for each cranial trait and each of the sexes in the East and West construction units at the Grasshopper Ruin, Az. P:14:1.

Trait	East Unit Males			West Unit Males			East Unit Females			West Unit Females		
	p	n	θ	p	n	θ	p	n	θ	p	n	θ
1	.000	26	1.5708	.000	30	1.5708	.000	48	1.5708	.000	57	1.5708
2	.000	16	1.5708	.080	25	.9973	.057	35	1.0886	.000	42	1.5708
3	.292	24	.4290	.379	29	.2444	.268	41	.4825	.269	52	.4802
4	.000	20	1.5708	.000	25	1.5708	.000	32	1.5708	.000	43	1.5708
5	.000	23	1.5708	.000	28	1.5708	.000	37	1.5708	.045	44	1.1433
6	.105	19	.9108	.160	25	.7478	.293	41	.4268	.311	45	.3876
7	.417	24	.1668	.400	25	.2014	.634	41	.2713	.511	47	.0220
8	.037	27	1.1837	.000	29	1.5708	.000	48	1.5708	.000	56	1.5708
9	.375	24	.2527	.458	24	.0841	.417	36	.1668	.245	49	.5352
10	.280	25	.4556	.185	27	.6815	.205	44	.6311	.357	56	.2900
11	.080	25	.9973	.154	26	.7643	.085	47	.9791	.121	58	.8602
12	.150	20	.7754	.040	25	1.1681	.045	44	1.1433	.060	50	1.0759
13	.000	16	1.5708	.100	20	.9273	.107	28	.9043	.143	42	.7952
14	.000	26	1.5708	.000	30	1.5708	.000	43	1.5708	.020	51	1.2870
15	1.000	18	1.5708	.895	19	.9108	.806	36	.6586	.889	45	.8915
16	.923	13	1.0084	.955	22	1.1433	1.000	26	1.5708	1.000	39	1.5708
17	.800	5	.6435	1.000	7	1.5708	.929	14	1.0314	1.000	20	1.5708

Table 16, Continued

Trait	East Unit Males			West Unit Males			East Unit Females			West Unit Females		
	p	n	θ	p	n	θ	p	n	θ	p	n	θ
18	.045	22	1.1433	.160	25	.7478	.135	37	.8183	.111	45	.8915
19	.962	26	1.1784	1.000	30	1.5708	.978	45	1.2730	.926	54	1.0198
20	.650	26	.3131	.700	30	.4115	.659	44	.3236	.725	51	.4668
21	.556	27	.1122	.679	28	.3661	.636	44	.2755	.636	55	.2755
22	.923	26	1.0084	.643	28	.2900	.756	41	.5375	.865	52	.8183
23	.526	19	.0520	.524	21	.0480	.457	35	.0861	.538	39	.0761
24	.542	24	.0841	.615	26	.2321	.462	39	.0761	.340	47	.3257
25	.519	27	.0380	.414	29	.1729	.533	45	.0660	.472	53	.0560
26	.720	25	.4556	.741	27	.5029	.870	46	.8331	.836	55	.7369
27	.962	26	1.1784	1.000	30	1.5708	.933	45	1.0471	.948	58	1.1107
28	.840	25	.7478	1.000	30	1.5708	.857	42	.7952	.737	57	.4938
29	.440	25	.1203	.667	30	.3405	.688	48	.3855	.724	58	.4645
30	1.000	22	1.5708	.966	29	1.1999	.974	39	1.2469	1.000	48	1.5708
31	.280	25	.4556	.207	29	.6261	.205	44	.6311	.314	51	.3812
32	.370	27	.2630	.207	29	.6261	.333	48	.3405	.228	57	.5752
33	.000	12	1.5708	.000	11	1.5708	.043	23	1.1530	.000	24	1.5708
34	.100	20	.9273	.037	27	1.1837	.029	35	1.2285	.043	46	1.1530
35	.000	20	1.5708	.143	28	.7952	.100	40	.9273	.000	49	1.5708
36	.050	20	1.1198	.286	28	.4423	.268	41	.4825	.160	50	.7478

Table 16, Continued

Trait	East Unit Males			West Unit Males			East Unit Females			West Unit Females		
	p	n	θ	p	n	θ	p	n	θ	p	n	θ
37	.000	22	1.5708	.000	27	1.5708	.000	44	1.5708	.000	53	1.5708
38	.808	26	.6636	.552	29	.1042	.568	44	.1364	.558	52	.1163
39	.850	20	.7754	.714	28	.4423	.765	34	.5586	.750	44	.5236
40	.190	21	.6687	.118	17	.8695	.138	29	.8096	.229	35	.5728
41	.158	19	.7532	.000	18	1.5708	.129	31	.8360	.146	41	.7867
42	.077	26	1.0084	.100	30	.9273	.089	45	.9649	.056	54	1.0930
43	.630	27	.2630	.724	29	.4645	.659	44	.3236	.706	51	.4246
44	.000	26	1.5708	.000	30	1.5708	.000	47	1.5708	.018	56	1.3017
45	.000	17	1.5708	.042	24	1.1580	.000	33	1.5708	.022	45	1.2730
46	.192	26	.6636	.393	28	.2157	.467	45	.0660	.404	57	.1932
47	.130	23	.8331	.440	25	.1203	.553	38	.1062	.442	43	.1163
48	.259	27	.5029	.233	30	.5633	.104	48	.9141	.145	55	.7895
49	.852	27	.7810	.800	30	.6435	.362	47	.2796	.379	58	.2444
50	.000	21	1.5708	.000	27	1.5708	.000	40	1.5708	.000	46	1.5708
51	.045	22	1.1433	.000	24	1.5708	.079	38	1.0010	.136	44	.8154
52	.333	24	.3405	.200	25	.6435	.351	37	.3026	.364	44	.2755
53	.267	15	.4848	.133	15	.8242	.038	26	1.1784	.071	28	1.0314
54	.240	25	.5468	.241	29	.5468	.136	44	.8154	.137	51	.8125

MD and the standard deviation for each distance generated between the units for each sex are presented in Table 17.

The data presented in the latter table show that: (1) all of the sub-groups differ significantly both within and between the construction units of the site; (2) the divergence between the East and West Unit males (.09918) is greater than that for the females of the two units; (3) the generated distance between the females of the East and West construction units (.02734) is less than any of the other distances either within or between units; (4) the male-female divergences within the East and West units (.08254 and .08365 respectively) have the second highest values and are nearly equal numerically; (5) male-female distances between the East and West units (.06998 and .04014 respectively) are less than that found between the males alone, but are greater than that seen between only the females of the two units.

These findings would exclude the possibility that either one or both construction units were initially inhabited by different founding or migratory groups. However, the data would support the earlier suggestion that the two construction units were habitation sites for different "moieties" or other social units inasmuch as the females are much more homogeneous than are the males. Further, one can infer from these data that these social units were practicing male exogamy and that the residence pattern was probably matrilocal. Such residence patterns and mating rules are certainly observed among the speculative descendents of the Late Mogollon, that is, the Western

TABLE 17

Mean measures of divergence* by sex (with standard deviations)
between the East and West construction units at the Grasshopper
Ruin, Az. P:14:1.

	West Unit Males	East Unit Females	West Unit Females
East Unit Males	.09918 (.00391)	.08254 (.00299)	.06998 (.00313)
West Unit Males	-----	.04014 (.00202)	.08365 (.00260)
East Unit Females	-----	-----	.02734 (.00147)
West Unit Females	-----	-----	-----

*Distances are significant at the .05 level of probability if
they are equal to or greater than twice their standard
deviations.

Puebloans such as the Hopi (Dozier 1965). The inference posed here for comparable systems at the Grasshopper Pueblo is based on the greater heterogeneity in the males as revealed by the male-male divergence between the two construction units.

I would speculate one step further--fully realizing how hypothetically tenuous such speculation might be--and suggest, based on the data from Table 17, that a rule of exogamy extended to the males of the pueblo as a whole. Male exogamy for the social units and for the village would be not unlike the classic case for the Iroquois clans. And, while specific data are lacking for a similar cross-village mating system operating among the historic Western Pueblos, the Hopi nevertheless have a requisite clan grouping wherein these units also occur simultaneously in the villages on the three mesas (Eggan 1950). I would suggest that a similar distribution of "clans" or some biologically based social units could have existed prehistorically among the Mogollon. This suggestion stems from the greater degree of heterogeneity seen in the male-female divergences than was observed in the female-female comparison. For example, the two male-female within-unit distances differ but little from the highest value obtained for the males alone (.09918). Simultaneously, the two male-female between-unit divergences are greater than that for the females alone (.02734). It would appear, therefore, that the males of one unit are not much more "related" to the females from the opposite unit (although allegedly from the same social unit as the males) than they are to the females with whom

they mated and who should be of a different social unit. If truly reflective of mating patterns, these findings would support a contention that male exogamy may have been practiced to a major extent for the Grasshopper site as a whole.

Still in a speculative vein, I would hypothesize further that the same male exogamous social units which existed at the Grasshopper site may have existed also at various coeval peripheral sites as well. Inasmuch as it would be necessary for each male to mate outside his own with-in site social unit and outside his village as well, the only females available as mates would come from the opposite prescribed social unit at another village. Thus, with a structured mating system such as this, male exogamy coupled with a matrilocal residence rule would have created strong social solidarity between the Grasshopper site and the various surrounding villages in the region.

All of the foregoing assumes, of course, that the male exogamous social units were indeed a prehistoric reality and that the distances generated for the males in Table 17 are not greater than they would have been had their sample sizes been more adequate. For example, the East Unit male sample falls below the suggested critical threshold of 30 crania, while the West Unit males are at that threshold. If the number of male crania were increased to something numerically comparable to those of the females, it is possible that any of the comparisons involving the former would have produced smaller divergences. However, I doubt that such altered

distances would have approached those produced between the females alone for the two construction units.

Admittedly, these speculations and suggestions are based on rather scanty data or are, in the case of comparable social units existing between various coeval sites, fabricated on a complete lack of skeletal populations from ruins within the immediate area of the Grasshopper site. Hopefully, as the multidisciplinary approach to archaeology continues at the Grasshopper Ruin (and perhaps at peripheral sites as well) and if greater quantities of human skeletal remains are recovered from other major pueblos, the assumptions expressed here may be more adequately supported or rejected through subsequent osseous and auxiliary studies.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The foregoing analysis is an attempt to show the feasibility of using cranial non-metric variants or traits (1) to define or delineate prehistoric populations and their sub-groups, and (2) to reconstruct some aspects of the social organization of these sub-groups using a mean measure of divergence statistic. To this end, human skeletal remains from four Mogollon ruins (Turkey Creek, Point of Pines, Grasshopper and Kinishba) were selected for testing with a newly developed "distance" formula. The selected sites fall into roughly contemporaneous time periods (about A.D. 1250 to 1450) with the exception of the Turkey Creek Ruin which preceded the others at A.D. 1000 to 1250.

The results of these analyses can be summarized as follows:

1. The mean measure of divergence statistic can differentiate between prehistoric Southwestern populations as well as or better than the more familiar osteometric techniques.
2. Sexually distinct cranial variants, for the most part, are lacking in these Southwest populations.
3. Artificial cranial deformation, which so often plagues craniometric analyses, does not alter the appearance of non-metric cranial variants in the populations under investigation. For this reason, cranial non-metrics should be valuable in Southwestern

comparative populational analyses where groups practiced deformation of the skull.

4. There are significant differences in trait frequencies between pre-reproductive and reproductive age groups in the populations selected. This fact has precluded the use of the younger material in this particular study, but it suggests another area for future research with regard to genetic wastage.

5. Cranial non-metric traits are useful in demonstrating possible prehistoric "cemeteries" or "burial plots" within an archaeological site if the sample sizes for the "cemeteries" are greater than 30 crania. Populational sub-groups represented by less than 30 crania are apt to give false positive results.

6. Data derived from an intra-site "cemetery" comparison at the Grasshopper Ruin suggest that two differing social units existed at the site, each inhabiting one of the two major construction units there. This finding corroborates or is corroborated by an analysis of avian faunal remains recovered from the two construction units.

7. A male exogamous mating pattern is indicated for the proposed Grasshopper pueblo social units. Similarly, for the same population, a matrilocal residence rule is suggested as a corollary to the mating pattern.

8. Mean measures of divergence generated between burial areas at the Grasshopper Ruin suggest that not only did the social units practice male exogamy, but the site population as a whole was male exogamous as well.

The hypothesized social unit and village male exogamy and the solidarity between sites that such a system could create, might explain the lack of fortified sites in the Late Mogollon period and the dearth of skeletal remains which exhibit evidence of any violently induced traumata. The period A.D. 1250 to 1450 or a little later was apparently a time of peaceful coexistence between coeval and spatially close sites in spite of what must have been ever widening circles of hunting and gathering as the immediate areas around the populationally large sites became more and more depleted of animal and fuel resources.

Since each site may have been composed of males from the various pueblos, and since the males were probably the political and the religious leaders as well as the hunters for each village, close personal ties between the males and across the various sites could have stayed potentially explosive inter-site discord or created a strong alliance against possible intermittent migrating territorial intruders. It is also possible that this same cohesiveness would prove advantageous where large numbers of workers were needed periodically for such things as the expansion of habitation units as suggested by the so-called "building spurts" detected archaeologically at the Grasshopper Ruins.

While the above summary attests to the usefulness or potential usefulness of non-metric variants in a distance analysis of South-western prehistoric populations, there are several considerations which should be mentioned with respect to future research. Foremost

is the fact that little is known about the mode of inheritance for the majority of the 54 cranial traits. It would be useful, therefore, to determine statistically which variants contribute most to the distance measures and which do not. If such a method is possible for the discrete traits as it now is for metric data, it may well be that by selecting only the most distinguishing characters for regional populations, different conclusions would be drawn from the same skeletal material of the present study.

Second, there are several other distance programs now in existence which might produce other or better results than the statistic selected in this study. In a similar vein, there are other archaeological burial data which should be investigated for initially dividing the site populations into sub-groups for comparison. Such data might include burial orientation, head direction of the interment, its degree of flexure, the amount or kinds of grave furniture in association.

Third, non-adult skeletal material is very often not considered when dealing with discontinuous data. This has certainly been the case in the present study. However, we may be missing potentially valuable information with regard to selection at very early ages for certain non-metric traits. Whether these traits are pleiotropic with some other phenotypic condition is a moot point for the present.

Finally, consideration should be given to the post-cranial discrete traits in future studies of Southwestern skeletal material.

These, coupled with the cranial variants and osteometric data may hopefully allow an investigator to pose some cogent speculations on the biological relationships of regional and perhaps even more widely dispersed skeletal series.

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