AN OSTEOLOGICAL ANALYSIS OF THE NEOLITHIC SKELETAL POPULATION FROM GANJ DAREH TEPE, IRAN

A Thesis

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Master of Arts

by

Peter John B. Lambert

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ABSTRACT

Few skeletal series of any size have been reported from the Middle Eastern Neolithic. The population from Ganj Dareh Tepe, an Early Neolithic occupation, is comprised of 49 individuals and forms the study group for this thesis. A variety of descriptive and analytical techniques describe the attributes of these individuals and the population in comparison to other archaeological populations.

Postcranial and odontometric data are used to examine both relative sexual dimorphism and intra-sex populational differences. The surviving crania from Ganj Dareh show one of the earliest known annular deformation variants and are not used for comparative purposes.

Sexual dimorphism in the Neolithic population from Ganj Dareh Tepe is found to be absolutely and relatively minor in comparison to that observed for two Bronze Age populations. Further, Ganj Dareh adult development differs from that observed in Bronze Age adults with males and females from the former having relatively greater long bone lengths and widths, except in the femur. This implies that overall body proportions may have altered between Neolithic and Bronze Age periods as both unrelated Bronze Age populations show similar tendencies. Odontometrics indicate no relationships between Ganj Dareh and any other population examined. These last comparisons do, however, supply information concerning four of the comparative samples. These are

Erq el Ahmar, Jericho Pre-Pottery Neolithic B and Jericho Bronze Age and the Natufian samples. Odontometrics compared for these populations show that Erq el Ahmar is not biologically similar to the Natufians although it has been so considered in the past. In addition, comparisons suggest that the Natufians may be ancestral to the Jericho Bronze population but not to the earlier group from PPNB.

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I would like to thank the many people who were of assistance to me in producing this thesis.

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Credit for making the Ganj Dareh Tepe series available for study goes to Dr. P.E.L. Smith of l'Université de Montréal, Dr. Meiklejohn and Dr. Wade. Study space was supplied by Dr. Meiklejohn and the University of Winnipeg.

These acknowledgements would be incomplete without mentioning some of my fellow graduate students. These include Linda Fraser, Sid Kroker and, particularly, Colin Pardoe. Without their advice and opinions I would probably still be writing. Mr. Pardoe was always able to find time for discussion, especially on statistical matters and the pathologies evidenced by the skeletons.

Despite the considerable input made by those mentioned above, and some regrettably not, the errors to be found are mine alone. I trust these will prove to be few in number and importance.

This thesis is dedicated to my parents, Edith and John.

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CHAPTER 1

INTRODUCTION

This study is an examination of 49 individual skeletons from Ganj Dareh Tepe, an Early Neolithic occupation in Iran. A variety of data were collected in order to achieve two goals of value to osteology and Near Eastern prehistory. The first of these goals concerns use of a range of osteological techniques for collection of data from human skeletal remains. These data characterize this previously unreported series and are presented in appendices for subsequent osteological research. Further, these data comprise the basic information required for the comparisons appearing in ensuing chapters. The second objective concerns the comparison of Ganj Dareh Tepe remains, both between distinguishable subsamples of the study group, and between Ganj Dareh Tepe and a range of unassociated archaeological sites. Comparative sites with skeletal remains represent a wide range of geographical locations and chronology, coming from The Levant, Greece, Iraq and Iran and dating between Mesolithic and Bronze Age times.

The occupation mound designated as Ganj Dareh Tepe (P.E.L. Smith,'68) is situated in the province of Kermānshah. The tepe lies in the Gamas-Āb River valley, one of many such valleys found in the eastern flanks of the Zagros Mountains of western Iran.

The site (fig. 1) was discovered and excavated by Dr. P.E.L. Smith and crews from the Université de Montréal in 1967. This initial excavation was followed by three full field seasons in 1969, 1971 and 1974. The preliminary findings and interpretations appeared as a series of interim reports (P.E.L. Smith,'67; '68; '70; '72a, b; '74; '75; and '78). These form the basis for the brief description appearing below.

The roughly circular mound covers an area of approximately 1300 m^2 and has a maximum depth of about eight meters. The base of the mound lies about one meter below the present surface of the surrounding topsoil. Excavations through ca. twenty percent of the mound's volume exposed five major horizontal, culturally distinctive levels. These were designated, from upper to lower, Levels A through E. Carbon samples were recovered from four of these levels and subjected to radiocarbon dating techniques (Kigoshi ,'67; Lawn,'70). The resulting dates, in years B.C., are summarized by Singh ('74):

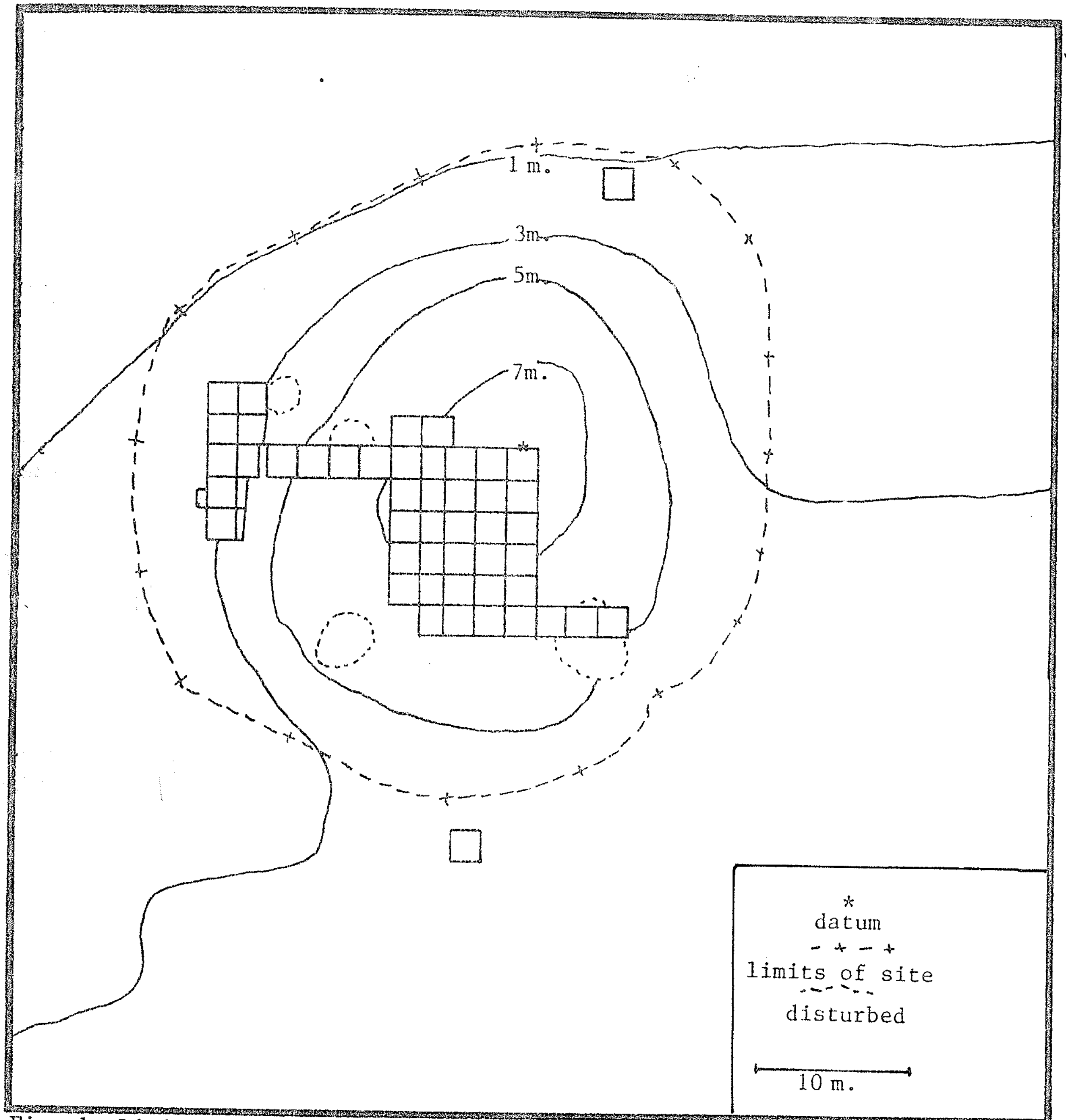


Fig. 1 Limits of excavation at Ganj Dareh Tepe, Kermanshah Province, Iran. (after P.E.L.Smith,n.d.)

Level A	6960 ± 170	(Gak 994)
Level B	6938 ± 98	(P 1486)
Level C	7289 ± 196	(P 1485)
Level D	7018 ± 100	(P 1484)
Level D (base)	8500 ± 150	(Gak 807)

The oldest remains were recovered from Level E. Relative to succeeding deposits, recovery was small but the assemblage was similar to the Upper Palaeolithic occupation from the nearby site of Tepe Asiab (P.E.L. Smith, '78,p.539). Features included a number of "round or oval depressions cut into virgin soil" that may have been for the placement of tents or reed huts (Burney,'77) or, for use as firepits (P.E.L. Smith,'74). There was no evidence to suggest that the site had been occupied on any more than a seasonal basis.

Deposits from Level D indicate greater permanence together with increasing dependence upon locally available resources. Remains from this level include chineh architecture, similar to that found at Jarmo (Burney,'77), clay bins and a variety of ceramics. Survival of the pottery from Level D is attributed to the intense burning of this occupation (P.E.L. Smith,'67; '68). This early occurrence of ceramics has led to the suggestion that Ganj Dareh Tepe represents an early and independent center of manufacture (P.E.L. Smith,'78), possibly the earliest known from the entire Near Eastern archaeological record (Burney,'77,p.32).

Additional evidence for incipient agriculture consists of high frequencies of blades and bladelets showing edge polish or "sickle-sheen" and ground-stone mortars and pestles (P. E. L., Smith,'67;'68; et al.; Burney,'77). Animal husbandry is suggested by the presence of domesticated goat (Capra sp.) identified by D. Perkins and B. Hesse (P.E.L. Smith,'72b; '74). Frequencies varied slightly in upper levels suggesting that a relatively stable cultural tradition persisted through the occupation.

Burial recording forms identify 42 features. All but four of these were discrete, with the remaining four features containing two individuals. However, because of in situ mixing, it is likely that features containing more than a single individual, with one exception, were discrete. This exception concerns three individuals (G. D. 15, 16 and 17) recovered from a claybrick sarcophagus.

In addition to the 46 individuals recovered from the mound, three were associated with a peripheral feature. While these are not documented by forms, they are assumed to belong to the Ganj Dareh Tepe series and designed as G. D. 43, 44 and 45.

Of the original 46 individuals, seven are presently without level associations, while six additional individuals have been given tentative association with the upper levels (A, B, C) using information from the burial recording forms. The remainder are securely associated to either Level B (three individuals), Level D (27 individuals) or Level E (three individuals). No skeletons were recovered from Level C.

When present, grave goods were found with young individuals rather than adults (P. E. L. Smith,'78). Frequently, fragments of sheep or goat crania and, sometimes, complete skulls were used. Less frequently, human or animal figurines were included. Traces of reed matting have been recovered with two burials, while a single young individual from Level D was wearing an exotic olivia-shell and stone-bead necklace (P. E. L. Smith,'70). Burial forms suggest that there was no prescription for orientation of the body or the head, nor for body flexion or extension.

Descriptions of individual skeleton from Ganj Dareh are provided in Chapter III. Each includes a general statement on the condition of the skeleton and an enumeration of bones used in assessing age and sex according to a variety of techniques. These are discussed in Chapter II. The importance of determining age and sex is that, together, they constitute the criteria for distinguishing between subsamples within a biological population (i.e. males and females; preadolescents and adults).

Once separated, samples of males and females were characterized by a variety of metric and nonmetric data. Techniques used were selected for their utility and applicability to the Ganj Dareh Tepe remains. As this study is intended to be comprehensive, unrelated techniques were used to collect data from various parts of the human skeleton. These, in turn, formed data bases for comparisons within and between skeletal groups. Because comparative data were not generally uniform in describing different populations, it was convenient to make and discuss comparisons under three headings that delineate specific skeletal complexes. These are, a) "The Cranial Complex", b) "The Postcranial Complex", and c), "The Dental Complex". The first category includes the cranium and mandible while the second includes all postcranial bones. The Dental Complex includes all identifiable teeth. Techniques associated with each complex are discussed in Chapter II.

The palaeopathology of the series is considered in Chapter IV. This represents a survey of various bone and dental changes that are traditionally considered to be diagnostic of pathogenesis. In most cases, hard-tissue abnormalities observed occur in various frequencies and with different degrees of severity. Others are rare and have unknown causes. This chapter also details anomalous characteristics at Ganj Dareh Tepe. Most notable is intentional cranial deformation. Frequencies for the more common anomalies and pathologies are used to compare Ganj Dareh to published frequencies for other Near Eastern skeletal series.

The primary bases for comparisons are the metric data particular to the three skeletal complexes. Chapter V, entitled "Analytical Techniques", discusses of the nature of these data. An explanation of techniques used in making inter- and intra-population comparisons also appears in this chapter. The comparative samples were selected primarily for the utility of data. Samples suitable for comparison are discussed in Chapter VI, together with a brief synopsis of their archaeological and cultural associations.

Results obtained from the different analytical techniques are presented in Chapter VII. This chapter is essentially descriptive, with discussions of the different sets of results and brief summaries. The detailed description of results is intended to extract the maximum of information and to illustrate the utility of a multi-faceted analysis. A more general summary of the results of the study is presented in Chapter VIII, "Summary and Conclusions".

The approach taken in this thesis was to treat the study series as as a representative sample of a larger Early Neolithic population. Following this, the Ganj

Dareh sample was compared to other samples, each representing culturally and biologically distinctive populations. It is anticipated that some important conclusions may result from this study, particularly concerning inter- and intra-sample metric variability. It is further anticipated that these results will be useful for both comparative osteology and for prehistoric interpretations.

CHAPTER II

LABORATORY TECHNIQUES

Subsumed under the above heading are two classes of techniques called "preliminary techniques" and "techniques of data collection". The first is the set of procedures required for preparing the Ganj Dareh series for study and include, a) cleaning; b) reconstruction; c) preservation; d) identification; and e) separation of mixed burials. Techniques used for determining age and sex are also considered here.

The second class of techniques includes those presented by various authors explaining procedures for collecting metric and nonmetric data. Authorities were selected to include techniques that would offer the greatest diversity of data, particularly those that would be suitable for comparisons. As a result, techniques of data collection represent a range of more or less traditional procedures, designed first for characterizing the individuals in the skeletal series and, second, for detecting any significant differences.

Preliminary Techniques

Procedures for the preparation of archaelogical human remains are outlined by Bass ('71) and Brothwell ('72). Both of these sources were used as general guides during the preliminary stages.

The condition of the Ganj Dareh remains ranged from poor to good with the majority of individuals showing variable preservation. Few bones had not suffered at least some *post mortem* damage. Most affected were the tabular bones of the cranium and, particularly, the pelvis. Long bone and pelvic epiphyses were poorly represented. Bone frequencies indicate that it is unlikely that burial customs at Ganj Dareh Tepe included the practice of mutilation or disassociation of the skeleton after death. Evidence for this practice has been noted for some sites in the Levant and Anatolia (Burney,'77,p.11).

Elements of the adult dentitions were consistently well preserved, occurring both in the intact alveolar bone or loose. Frequently, teeth from Level D had been blackened and shattered by heat. In addition, bones from this level showed evidence of heat exposure ranging from slight blackening, to calcination. Shattered teeth were rarely identifiable and in many cases, only root fragments were recovered. Subsequently, no attempt at measurement was made for such teeth.

Bones and teeth from the series were cleaned with a brush and dental picks. Many fragments were enveloped by a fire-hardened matrix of soil that was initially difficult to remove. When dried out at room temperature, the matrix could be brushed away. In a few cases, matrix was removed after softening with water. Blocks of bone-containing matrix were either water screened or allowed to soak in tepid water. However, this was found to damage the exposed edges of the fragments and was discontinued for larger blocks. Two of these large blocks, both containing the delicate thoracic elements of two differentt individuals, were not disturbed.

Once free of removable soils, delicate fragments and particularly well preserved bones were immersed in a solution of acetone and Ambroid.

Elements of the skeleton were then identified with the aid of Anderson ('69), Brothwell ('72), Bass ('71) and Gray's Anatomy ('77). Bones were then associated with individual skeletons. Because there were several cases where more than one individual was called by the same burial number (G.D.), or individuals were without a field number, a system of laboratory numbers was devised and new numbers assigned to each identified individual (Table 5). The codes used for these laboratory numbers integrate information concerning vertical provenience, sex and original Ganj Dareh burial designation.

Briefly, the initial number of the five number code refers to the burial provenience. Individuals were coded by one of six possible numbers to correspond with the following system:

Level A, B or C (uncertain provenience)	1
Level B	2
Level C	3
Level D	4
Level E	5
Unknown	6

Burial forms record the recovery of six individuals from slumped earth from the upper levels. These individuals have been coded with the prefix "1" to indicate their lack of a more accurate level association.

The second number of the laboratory code denotes the sex. Individuals whose skeletal development is sufficiently advanced to exhibit morphologically distinctive characteristics associated with secondary sexual development (Acsádi and Nemeskéri,'70) were assigned to sex and coded as male ("1") or female ("2"). When adults failed to consistently display characteristics of either sex, or where an adult was minimally represented, the individual was coded as adult, sex unknown ("0").

Preadolescents, including infants and children, were coded as "3" to indicate that sex determination was not possible due to the absence of the necessary criteria. Individuals showing ambiguous sex characteristics because of skeletal immaturity made determination of sex impossible. In these cases, individuals were coded with the number ("3"). Individuals designated as skeletally immature were not included in metric analyses of the cranial or postcranial complex. However, where preadolescents were represented by permanent teeth, the teeth were measured for inclusion in adult samples.

Age and Sex Determination

Determination of these two characteristics is important for ensuring that metric and non-metric data accurately characterize Ganj Dareh subsamples. Estimations of age and sex relied on comparisons of developmental and morphological characters of the individual skeleton to pre-existing standards developed by a number of authors.

The following techniques were used to determine age. The results of age and sex assessment are presented in Chapter III (Table 5). When teeth from preadolescents were present, age was suggested on the basis of tooth eruption standards (Schour and Massler,'41). The the absence of erupting teeth, age is assessed by measuring long bones and comparing results to standards of known age (Johnston,'62; Sundick,'78). Long bones representing older preadolescents and young adults displaying different degrees of epiphyseal fusion were aged after the techniques of Krogman ('73). In a few cases where adults were represented by teeth alone, Brothwell's standards of attrition were used ('72,p.69). It is important to note that these attrition standards were developed using a British Iron Age population whose attrition rates were influenced by factors not present at Ganj Dareh Tepe. It should be noted, therefore, that this technique gives an estimate that only approximates the true age.

Exocranial (Olivier,'69,p.172) and endocranial synostosis (Gray's Anatomy,'77,p.69) were also criteria for age estimation. These estimations should be regarded with caution as cranial synostosis is weakly correlated with age (Brooks,'55; Singer,'53; Anderson,'69).

The basic techniques for determinations of sex consist of thirty criteria given by Acsádi and Nemeskéri ('70,pp.90-91). These summarize the traditional differences characteristic of sex. These criteria illustrate a variety of sex associated differences in cranial and postcranial development related to size and shape. Of the thirty traits, only 22 were used. Excluded traits include those numbered 13 through 19 because they apply to pelvic examination, and Ganj Dareh Tepe pelves were poorly represented. Criterion 23, cranial capacity, was also omitted because most crania show changes associated with artificial cranial deformation (Chapter IV).

Techniques of Data Collection

Metric and nonmetric data from the adults were collected from three complexes representing the human skeleton. This was done partly to facilitate discussion of the following techniques, but principally to deal with the kinds of results that are expected. The three complexes distinguished here are, a) "The Cranial Compex"; b), "The Postcranial Complex"; and, c), "The Dental Complex".

Metric data were collected with a variety of standard instruments and these are described by Bass ('71), Wolpoff ('71), Brothwell ('72) and Howells ('73). All metrics are reported in millimeters except where noted.

The Cranial Complex

Included here are the techniques used to collect metric and nonmetric data from adult crania and mandibles. Definitions for most of the craniometrics were taken from Howells ('73,p.162) who offers a total of 70 possible definitions. However, not all of these were possible as the cranium must be complete. Subsequently, 26 definitions were used and these appear in Table 1, with corresponding biometric symbols. Some of these definitions had been used by Martin ('26). These are noted by the addition of Martin's corresponding numbering system. Table 2 lists twelve mandibular dimensions from Howells ('73) and Olivier ('69). Three letter biometric designations

TABLE 1

CRANIOMETRIC VARIATES

Dimension	Martin #[1]	Biometric Symbol[2]
glabello-occipital length	1	GOL
basion-nasion length	5	BNL
maximum cranial breadth	8	XCB
maximum frontal breadth	10	XFB
bistephanic breadth	10b	STB
orbital height	52	OBH
bijugal breadth	45(1)	JUB
nasal breadth	54	NLB
palate breadth	61	MAB
bifrontal breadth	-	FMB
biorbital breadth	44	EKB
nasion-bregma chord	29	FRC
nasion-bregma subtense	-	FRS
nasion subtense fraction	-	FRF
bregma-lambda chord	30	PAC
bregma-lambda subtense	-	PAS
bregma subtense fraction	-	PAF
lambda-opisthion chord	31	OCC
lambda-opisthion subtense	-	OCS
lambda subtense fraction	-	OCF
frontal arc	26	FRK
parietal arc	27	PAK

TABLE 1--CONTINUED

Dimension	Martin # [1]	Biometric Symbol [2]
occipital arc	28	OCK
vault thickness @ bregma[3]	-	VTB
vault thickness @ lambda[3]	-	VTL
vault thickness @ glabella[3]	-	VTG

[1] after Martin ('26)

[2] after Howells ('73)

[3] Represents a non-classic estimate of vault thickness at the appropriate landmark taken with spreading calipers. The VTG variate is taken on the frontal bone. VTB is a measure of the average thickness of the two parietal bones VTG is the thickness of the occipital.

TABLE 2

MANDIBULAR VARIATES

Dimension	Original Symbols [a]	Biometric Symbols L	U	R
bicondylar breadth	BCB		BCB	
bigonial breadth	BGB		BGB	
mandibular length	MBL		MBL	
oblique ramus height [b]		RHL		RHR
vertical ramus height	RAH	AVL		AVR
mandibular angle	MAA	ANL		ARM
minimum ramus breadth	WRB	RBL		RBR
breadth of corpus @ M1-M2 [b]		LCM		RCM
breadth of corpus @ P3-P4 [b]		LCP		RCP
symphyseal height	SYH		SYH	
symphyseal angle [b]			ANS	

[a] after Howells ('73)

[b] after Olivier ('69)

were devised for the two variates taken from Olivier ('69). Howells' ('73) set of biometric symbols were modified to include codes that would distinguish between left (l) and right (r) sides, a distinction not made in the originals.

Collection of nonmetric data was based on the list of 30 "epigenetic traits" supplied by Berry and Berry ('67). It was anticipated that the condition of the Ganj Bareh crania would preclude collection of several of these traits. These 30 traits are presented in Table 3.

Six crania, representing adults and pre-adolescents, exhibit changes due to artificial deformation. This and other anomalies and pathologies is discussed in Chapter IV. Because crania from Ganj Dareh were deformed they were not used for metric comparisons.

The Postcranial Complex

Eighty-one dimensions and six circumferences of 21 bones of the postcranial complex were examined (Table 4). Definitions, with two exceptions, are from Oliver ('69). The exceptions were taken from the patellae and served to define the width and height. Definitions are:

> Patellar width – The patella is held so that sliding calipers span the distance between the most lateral projections of the medial and lateral edges. This includes the most lateral projection of bone adjacent to the lateral facet forming the articular surface for the external condyle of the femur on one side and, on the other, includes the medial border of the internal articular facet. This diameter is taken perpendicular to the patellar height.

TABLE 3

EPIGENETIC TRAITS OF THE CRANIUM [1]

1.	Highest nuchal line present	16.	Posterior condylar canal patent
2.	Ossicle at lambda	17.	Condylar facet double
3.	Lambdoid ossicle present	18.	Precondylar tubercle present
4.	Parietal foramen present	19.	Anterior condylar canal double
5.	Bregmatic bone present	20.	Foramen ovale incomplete
6.	Metopism	21.	Foramen spinosum open
7.	Coronal ossicle present	22.	Accessory lesser palatine foramen present
8.	Epipteric bone present	23.	Palatine torus present
9.	Fronto-temporal articulation	24.	Maxillary torus present
10.	Parietal notch bone present	25.	Zygomatico-facial foramen absent
11.	Ossicle at asterion	26.	Supraorbital foramen complete
12.	Auditory torus present	27.	Frontal notch or foramen present
13.	Foramen of Huschke present	28.	Anterior ethmoid foramen extrasutural
14.	Mastoid foramen extrasutural	29.	Posterior ethmoid foramen absent
15.	Mastoid foramen absent	30.	Accessory infraorbital foramen present

[1] Berry and Berry,('67)

TABLE 4

SUMMARY OF POSTCRANIAL VARIATES

Dimensions	Left	Right
HUMERUS		
Maximum length	HXL	HXR
Physiological length	HPL	HPR
Perimeter on deltoid tuberosity	HML	HMD
Perimeter distal to deltoid tuberosity	PML	PMD
Maximum diameter of diaphysis	HLD	HRD
Minimum diameter of diaphysis	HGD	HDD
RADIUS		
Maximum length	RXL	RXR
Physiological length	RPL	RPR
Minimum circumference	PRL	MRL
Maximum transverse diameter of diaphysis	RXG	RXD
Minimum transverse diameter of diaphysis	RLG	RLD
ULNA		
Maximum length	UXL	UXR
Physiological length	UPL	UPR
Minimum circumference	UML	UMR
Transverse diameter at inferior margin of radial notch	UTL	UTR
Antero-posterior diameter	UAP	UAR

TABLE 4 --Continued

Dimensions	Left	Right
FEMUR		
Maximum length	FXL	FXR
Oblique length	FOG	FOR
Trochanteric length	FTL	FTR
Maximum antero-posterior diameter of diaphysis	ALP	ARP
Subtrochanteric antero-post. diameter of diaphysis	FML	FMR
Maximum transverse diameter of diaphysis	FTG	FTD
Minimum transverse diameter of diaphysis	LTF	RTF
Vertical diameter of head	FDL	FDR
Horizontal diameter of head	HDL	HDR
Breadth of lower extremity	CCW	CGW
TIBIA		
Maximum length	TLT	TRT
Physiological length	OTL	OTR
Minimum perimeter	PTG	PTD
Antero-posterior diameter	TTD	TTG
Transverse diameter	CTL	CTR
FIBULA		
Maximum length	IXL	IXR

TABLE 4 -Continued

Dimensions	Left	Right
PATELLA		
Maximum height	PXL	PXR
Maximum breadth	PBL	PBR
AXIS		
Maximum height	XAX	
TALUS		
Maximum length	XTL	XTR
Maximum breadth	TML	TMR
Maximum height	HTL	HTR
CALCANEUS		
Maximum length	CXL	CXR
Maximum breadth	CML	CMR
Maximum height	HCL	HCR
CLAVICLE		
Maximum length	XLC	XRC
Perimeter	LPC	RPC
Maximum lateral breadth	CXG	CXD

[a] Biometric symbols were coded for the postcranial variates using three letters. Right side variates are distinguished by the letter R or the letter D, depending on whether the code conflicted with one of those already in use. Left side variates were distinguished by either the letters L or G.

Patellar height – This dimension is taken in the midline with sliding calipers and is the distance between the superior border of the bone and the most distal projection of bone for the attachment of the ligamentum patellae.

These two measurements have been defined to characterize the patella. Because the patella occupies a position at the tibio-femoral joint, it functions to protect the joint from the front (Gray's Anatomy,'77). Past studies, notably those of Dwight ('04), Parsons ('14) and van Gerven ('72), have shown the width of the distal femoral extremity to be a good sex indicator. Patellar measurements were included to examine its potential utility as a sex indicator.

The Dental Complex

Metric and nonmetric data were collected from permanent teeth. Odontometrics in the form of mesiodistal (m-d) and buccolingual (b-l) diameters were recorded after Goose's definitions ('63) for a total of 81 maxillary teeth and 113 mandibular teeth. These data were used to calculate dental indices for individual teeth. These indices include a) the product of the mesiodistal and buccolingual diameters called, alternatively "crown area", "occlusal surface area" (Wolpoff,'71) or "the index of robusticity" (P. Smith,'70); b) the proportion of length (m-d) to breadth (b-l) expressed as a percentage and termed, "crown index" (Wolpoff,'71); c) the reciprocal proportion of breadth to length, expressed as a percentage and called the "shape index" (P. Smith,'70) and, d) the "crown module", a value that is ten times the average of the sum of the length and breadth of the tooth (Wolpoff,'71). It should be noted that "robusticity" is not properly an index for the reason that a true index is unitless. Instead, robusticity is an approximation of occlusal area and as such, the product of length and breadth is expressed in units^2 (i.e. mm^2). Values for robusticity and the indices described above are presented for each tooth, and each tooth class in the Appendix.

Elements of the dentitions were examined for the presence/absence of several morphological variants. Molars from upper and lower arcades were classified on the basis of cusp number and pattern. The presence of several possible accessory cusps was also noted. These include the Carabelli cusp or tubercle, a trait that sometimes occurs on the side of the mesiolingual cusp (protocone) of maxillary molars (Dahlberg,'63,pp.157-161), the protostylid, found in association with the mesiobuccal cusp (protoconid) of mandibular molars (Dahlberg,'50), and the paramolar tubercle, a more general classification for accessory cusps that may occur on the buccal surfaces of either maxillary or mandibular molars (Dahlberg,'45).

Incisor teeth were examined for shovel-shape, a continuous morphological trait generally associated with mongoloid populatons (Hrdlička,'20; Riesenfield,'56;

Dahlberg,'63). Shovelling is characterized by the presence of an elevated enamel border (cingulum) on the mesio- and/or distolingual sides of the incisor, enclosing a "pronounced hollow on the lingual surface...(Hrdlička,'20,p.430). Less frequently, the cingulum can also occur on the mesio- and/or distolabial sides of the same teeth in association with the above to result in a variant of this trait (double-shovel). Shovelling is found most frequently on upper central incisors with decreasing frequency, on the adjacent lateral teeth, and more rarely, on the lower incisors (Hrdlička,'20,p.437).

Both shovelling and accessory cusps, when present, have been found exhibiting various degrees of expression. In this examination, however, these degrees of expression were not considered because discounting the highly subjective classes of Dahlberg ('63) would both augment the samples for possible analysis and eliminate problems associated with inter-observer error.

Finally, all teeth from Ganj Dareh dentitions were examined for changes. Recognizer pathologies included deposits of salivary calculus (Black,'20) and abnormal deposits of cementum on tooth roots (hypercementosis) Brothwell,'63,pp.282-283; Black,'20). Frequencies of carious lesions were also determined. Other abnormalities such as enamel hypoplasia (Kreshover,'60; McHenry and Schultz,'76; Rose,'77) were also noted.

CHAPTER III

DESCRIPTION OF INDIVIDUALS

This chapter describes the 49 individuals comprising the skeletal series from Ganj Dareh Tepe. Each individual is discussed with respect to its representation, preservation, and when determinable, to age and sex. In cases where a preadolescent is represented by measurable long bones, metrics usable for estimating age are recorded. These appear in the appropriate description. Some reference is made to the observable pathologies shown by the skeletons while a more complete discussion is presented in Chapter IV (Anomalies and Pathologies).

Individual descriptions are given in the order of their discovery in the field. Table 5 shows the summary of vital statistics using this same order. This table also shows the list of corresponding laboratory numbers used in the analysis of the series. These laboratory numbers summarize a) provenience, b) sex, c) age, and d) the original burial number assigned to each individual. Methods used to determine age are noted for each individual in table and text.

TABLE 5

BURIAL DESIGNATIONS AND LABORATORY NUMBERS:
GANJ DAREH TEPE

Burial Number	Level	Estimated Age	Sex	Laboratory Numbers*
G.D. 1	4	15 - 36 mo.[a,b]	-	43001
G.D. 1a	4	0 - 6 mo.[g]	-	43101
G.D. 2	4	5½ - 6½ yr.[b]	-	43002
G.D. 3	4	7 - 9 yr.[a]	-	43003
G.D. 4	2	18 - 23 yr.[c]	f	22004
G.D. 5	1	10 - 12 yr.[a]	-	13005
G.D. 6+	1	?	?	10006
G.D. 7	2	0 - 6 mo.[b]	-	23007
G.D. 8	1	18 - 25 yr.[c,d]	f	12008
G.D. 9	1	< 40 yr.[d]	m	11009
G.D.10	1	10 - 12 yr.[a,b]	-	13010
G.D.11	1	30 - 40 yr.[e]	m	11011
G.D.12	2	0 - 6 mo.[b]	-	23012
G.D.13	6	17 - 21 yr.[c]	f	62013
G.D.13	6	25 - 28 yr.[e]	m	61113
G.D.14	6	5½ - 6½ yr.[a,b]	-	63014
G.D.15	6	12 - 16 yr.[b]	f	62015
G.D.16	6	6 - 8 yr.[a,b]	-	63016
G.D.17	6	15 - 18 yr.[c,e]	m	61017
G.D.18	4	25 - 45 yr.[e]	?	40018

TABLE 5 -Continued

G.D.19	4	< 35 yr.[d]	m	41019
G.D.20	4	20 - 22 yr.[c,f]	m	41020
G.D.21	4	<0 - 12 mo.[b]	-	43021
G.D.22	4	35 yr.[e]	f	42022
G.D.23	6	23 - 25 yr.[a]	f	62023
G.D.24	5	< 20 yr.[c]	m	51024
G.D.25	4	6 - 24 mo.[a,b]	-	43025
G.D.26	4	0 - 6 mo.[b]	-	43026
G.D.27	4	<0 - 6 mo.[a]	-	43027
G.D.28	4	adult [c]	m	40028
G.D.28	4	< 3 yr.[g]	-	43128
G.D.29	4	adult [c]	f	42029
G.D.30	4	adult [c]	f	42030
G.D.31	4	28 - 35 yr.[e]	m	41031
G.D.32	4	0 - 6 mo.[a]	-	43032
G.D.33	4	> 18 yr.[c]	f	42033
G.D.34	5	adult [c]	m	51034
G.D.35	4	30 - 35 yr.[e]	m	41035
G.D.36	4	< 15 mo.[b]	-	43036
G.D.36	4	adult [c]	?	40136
G.D.37	5	< 20 yr.[c]	m	51037
G.D.38	4	15 - 30 mo.[a,b]	-	43038
G.D.39	4	30 - 42 mo.[a,b]	-	43039
G.D.40	4	19 - 24 yr.[c]	f	42040

TABLE 5 -Continued

G.D.41	4	18 - 20 yr. [g]	m	41041
G.D.42	4	adult [g]	?	40042
Excavation Unit 1151	6	25 - 29 yr. [g]	f	62043
	6	18 - 20 yr. [c]	?	60044
	6	infant [g]	-	63045

[a] Schour and Massler,'41,'44
[b] Johnston,'62; Sundick,'78
[c] Krogman,'73
[d] Gray's Anatomy,'77
[e] Brothwell,'72
[f] Anderson,'69
[g] intraseries comparison
[+] unavailable for study
[*] column 3 in the laboratory numbers is reserved for multiple individuals with the same burial number

<u>43001</u> (G.D. 1) This burial included the remains of two young individuals. The first is designated by this laboratory number (43001) and is represented by a nearly complete postcranial skeleton evidencing exposure to heat. Some distortion is apparent in the remains, particularly in the lower limb elements. Postcranial remains include seven cervical, 10 thoracic and five lumbar vertebrae, bones of the hands and feet, both clavicles, and several long bone fragments. The only parts of the cranial complex include a large mandibular fragment and a small part of the basi-cranium. One tooth is still seated in the mandible.

Age estimates were made using long bone measurments (Johnston,'62; Sundick,'78). Measured bones included left and right clavicles (63 mm,est./64 mm), and the right radius (76 mm, est.). From these bones an estimate of 15 - 24 months (Sundick,'78, stage 3) is obtained. An additional estimate is based on the degree of tooth eruption shown by the dm1 in the mandible. A slightly greater age estimate is approximately three years (Schour and Massler,'44). The age of the individual is in the range 15 - 36 months.

<u>43101</u> (G.D. 1a) This individual was distinguished from the former by the presence of a nearly complete but naturally deformed cranium with an associated basi-sphenoid. The proximal right ulna was also present. Both elements were present for Individual 43001. In this case, measurement

was not possible. Age is estimated from the degree of development shown by the proximal ulna in comparison to two more complete individuals for which age could be metrically determined. Development at the site is not as great here as it is for 43001 but there is more development for 42101 than for 23007 (below). Age, therefore, is estimated to be between 6 - 15 months. Sex is not known.

43002 (G.D. 2) This unsexed individual is represented by moderately burned fragments of a cranium, ribs, pelvis and long bones. Lengths of two complete long bones, a right femur (231 mm) and a right humerus (163 mm) suggest an age of ca. 5½ - 6½ years (Sundick,'78, stage 8).

43003 (G.D. 3) The majority of a severely calcined and fragmentary skeleton represents this young unsexed individual. Reconstruction offers the distal third of the left humerus, a badly deformed fragment of the left tibia, a portion of the left ischium and three teeth. No epiphyseal fusions are apparent in the skeleton. Two teeth were identified as the right maxillary canine and second incisor.

Age is estimated from the degree of wear on the identified teeth. From the times suggested for the respective eruption and occlusion of the canine and incisor (Schour and Massler,'44), an age of 7 - 9 years is suggested.

22004 (G.D. 4) This young adult is represented by several large bone fragments and loose teeth. Several centers of epiphyseal fusion located on the distal humerus (left), distal radius (right) and the femoral head (right) suggest an age between 18 and 23 years at death (Krogman,'73).

Seventeen permanent teeth associated with this individual consistently show deposits of hypercementosis. Also present were traces of enamel hypoplasia and deposits of salivary calculus.

13005 (G.D. 5) This individual is represented by a fragment of the left mandible with the canine still seated. The tooth is not fully erupted and since full eruption occurs at age 12 years ± 6 months (Schour and Massler,'44), the individual is less than 12 years. The degree of eruption itself suggests an age of between 10 and 12 years. Sex is indeterminate.

10006 (G.D. 6) This burial is represented by a single tooth that was apparently lost since 1970. Further information is not available.

23007 (G.D. 7) Largely complete, this individual is either a foetus or a neonate assessed using a number of bone measurements. These include the following: paired left and right femora (65 mm/ 64mm); tibiae (57 mm/ 58mm); a left humerus (57 mm); a right radius (45 mm) and ulna (52 mm); and a left ilium (30 mm). These results establish an age between birth and six months (Sundick,'78, stage 1). As these measurements are at the lower range for stage 1 or fall below it, the burial may be foetal. Sex is indeterminate.

10008 (G.D. 8) This individual is represented by two mandibular fragments, from the areas of the mandibular angles. The left fragment incorporates condyloid and coronoid processes and part of the corpus. The other fragment includes a complete M3 alveolus that serves as the criterion for age estimation. Tentatively, the degree of bone activity indicates that the tooth was erupting at the time of death. *Gray's Anatomy* ('77) suggests an age range for this as 18 - 25 years. Schour and Massler ('44) give an estimate of 21 $\pm$ 3 months. Because of the instability of the M3 eruption time, both of these estimates should be regarded as tentative. Age for this individual is, therefore, more accurate using the broader range (18 - 25 years).

Determination of sex is based on the gracile appearance of the bones and the lack of marked muscle markings. The individual is likely a female.

11009 (G.D. 9) This individual is represented by an isolated cranial fragment. This fragment incorporates a portion of the right parietal and temporal bones in the area posterior to the mastoid angle. The squamosal suture between them is reported to fuse at about 37 years of age (*Gray's Anatomy*,'77). On this basis, age is probably less than 40 years at death. The size and rugged appearance of of this bone is taken as the criterion for sexing. Features of this cranial fragment suggests that a male is represented.

<u>13010</u> (G.D. 10) Represented by a fairly complete but fragmentary skeleton, this individual is assigned an age of 10 years ± 9 months based on the eruption of the mandibular teeth (Schour and Massler,'44). An estimated measurement from an incomplete fibula (260 mm, est.) suggests that the age may be higher at 12 - 15 years (Sundick,'78). The final age estimate for this individual is given as 10 - 12 years at death.

Enamel hypoplasia is present on all intact teeth in conjunction with unusual blue-green staining. Further discussion of this appears in Chapter IV.

<u>11011</u> (G.D. 11) This individual is represented by a few cranial fragments and a mandibular permanent M2. Age is between 30 - 40 based on the degree of attrition. Deposits of salivary calculus are present on buccal and lingual tooth surfaces.

There is a depression fracture located on the outer table of the posterior portion of the right parietal. The inner table shows no signs of trauma. The outer table has healed making it unlikely that the wound contributed to this individual's death. Sex is male based on the robust appearance of the cranial remains.

<u>23012</u> (G.D. 12) A nearly complete skeleton without the cranium or mandible represents this unsexed preadolescent.

Age is estimated from the following osteometrics (Sundick,'78): humeri (66 mm/ 66 mm, est.); tibiae (69 mm/ 69 mm); fibulae (63.5 mm/ 63.5 mm); ulnae (59 mm, est./ 59 mm); right clavicle (43 mm); and left femur (74 mm, est.). All measurements fall within the range for Sundick's ('78) stage 1. Age, therefore, is between birth and 6 months.

62013 (G.D. 13) Two individuals were initially identified by this burial number. The first to be considered is a young adult represented by a portion of the cranium, parts of the tibiae and fibulae, the proximal end of the humerus and several unfused epiphyses. The partial union of the humeral head suggests an age of ca. 21 years as a maximum while the nonunion of the femoral epicondyles suggests that the above age estimate is high. Krogman ('73) suggests that the femoral epicondyles are united to the femur at ca. 17 years of age. Together, age is taken to be between 18 and 21 years.

Sex is determined on the basis of mastoid size, cranial shape and features and the general size and rugosity of the postcranial elements. Individual 62013 is probably a female.

61113 (G.D. 13) The second individual in burial 13 is distinguished by the presence of a complete mandible. Its robustness suggests that it is from a male whose age exceeds that estimated for the female. For the male, age

age is based on the degree of attrition (Brothwell,'72) and an age of ca. 25 - 30 years is suggested from the second molars. The right M1 shows unusual wear in the form of a mesiodistal trough along the axis and the loss of the buccal side of the tooth. Adjacent teeth show no such changes. The left I2 and canine have been lost and their alveoli have been subsequently obliterated by resorption. Both features are discussed more fully in Chapter IV.

63014 (G.D. 14) Elements of this individual include the majority of an artificially deformed cranium, a nearly complete mandible, several vertebrae and numerous long bone and rib fragments. Age is determined using the dental eruption shown by mandibular teeth (Schour and Massler,'41,'44) and using osteometrics (Sundick,'78). The dental eruption pattern corresponds to age 6 years ± 9 months while bone measurements give an age of 5½ to 6½ years. The following measurements were used: right femur; length (215 mm), head (24 mm), maximum width of distal extremity (left, 46 mm, est./ right, 46 mm). All of these measurements fall in or near Sundick's ('78) stage 8. This concordance of age estimates from the two separate techniques indicates their utility, particularly in cases where remains are unsuited to using both.

62015 (G.D. 15) This skeleton was one of three excavated from inside a mud-brick sarcophagus. Several intact long bones and several other fragments represent an adult. Reconstruction of the cranium offered an almost complete example of an artificially deformed skull.

Sex of this individual is female based on the general size of elements and the slight development of muscle markings.

All teeth present are seated in the alveolar bone of the maxilla and mandible. They are fully erupted and show some wear. The degree of wear suggests an age of between 17 - 15 years (Brothwell,'72,p.69). Another assessment of age is 12 - 16 years (Sundick,'78). Measurements from several bones are presented here.

humerus - maximum length with epiphyses fused (290 mm/ -)
- maximum width of the epiphysis for capitulum (25 mm/)

radius - maximum length without epiphyses (215 mm,est./ -)

ulna - maximum length with proximal epiphysis (245 mm/ -)

femur - width of the distal epiphysis (59 mm/ -)
- maximum diameter of the head (43 mm-est./ 43 mm)
- maximum width of the greater trochanter (- / 27 mm)

tibia - maximum width of the proximal epiphysis (- / 54 mm)

Several age stages are represented by the above measurements. These include stages 11 (width of the distal femoral epiphysis) through stages 15 and 16 (radial maximum length). Consideration of all of these possibilities indicates a probable age range of 12 - 16 years.

63016 (G.D. 16) The second individual from the sarcophagus is a preadolescent of undetermined sex. Elements include a well preserved mandible, both maxillae, the cranium, a number of intact teeth and several major postcranial bones. The cranium is deformed both artificially and from ground forces. Age is determined from the degree of tooth eruption shown by the wear on the lower right M1 and the occluding upper molars. An estimate of ca. 7 years results (Schour and Massler,'44). This estimate falls in the range of 5½ - 8 years (Sundick,'78, stages 8 - 9) resulting from osteometric comparisons. Measurements were as follows: left humerus (185 mm,est.); right radius (128 mm); clavicle (90 mm, est.); and ilium (78 mm, est.). An age between 6 and 8 years is suggested for this individual.

61017 (G.D. 17) This individual is the third of the sarcophagus burial group and is complete except for several vertebrae and portions of the skull and pelvis. The mandible and both maxillae are well preserved. Generally, large and rugged musculature suggest that this is a male whose age estimated from epiphyseal fusions (Krogman,'73) is ca. 15 - 18 years at death. Another estimate of age is based on the degree of dental attrition (Brothwell,'72) and a comparable age results. Several criteria are present for an age estimate using Krogman's techniques. These include the proximal radius, the proximal humerus and distal ulna. Fusion at the two proximal sites indicates an age of about 18 years of age while Krogman ('73) suggests an age of 19 years for the degree of fusion shown by the distal ulna. Brothwell's ('72) technique gives an age between 16 and 19 years from the wear on M1 and M2 teeth. Third mandibular molars are partially erupted. Gray's Anatomy ('77) gives an age between 18 - 25.

The reconstructed cranium is complete except for the basal elements. The vault is deformed artificially and is the best example of the Ganj Dareh deformation style (Chapter IV, Cranial Complex; Anomalies, fig. 4).

Teeth show deposits of salivary calculus in the anterior arcades but no other pathology is present.

40018 (G.D. 18) A single rootless left molar and a left lateral incisor were excavated from Unit 661. The molar is likely a lower first. Both teeth show advanced attrition and this suggests an age of between 25 - 45 years (Brothwell, '72). Estimation of sex was not attempted.

41019 (G.D. 19) This individual is represented by an isolated fragment of the cranium incorporating parts of the occipital and right parietal bones. The lambdoidal suture between them is closed endocranially suggesting an age of less than 35 years (Gray's Anatomy,'77). Both the thickness and the rugged appearance of the bone suggests that sex is male.

41020 (G.D. 20) The remains of an apparently complete but highly fragmented skeleton represents a male individual of ca. 20 - 22 years of age. Age is determined from the degree of development of the left clavicle (Krogman,'73,p.34) and the degree of fusion of the left femoral lateral epicondyle (Anderson,'69). Sex assessment is based on the robust appearance of the cranial fragments.

Several loose teeth and two still in their alveoli represent both arcades. All teeth show advanced attrition with the exception of the third molars from the mandible. These show no occlusal wear. One of these from the right side has fused roots. Hypercementosis is visible on all exfoliated teeth. There is some variation in the size of these deposits. A single right(?) maxillary central incisor shows traces of a cingulum and is classed as shovel-shaped.

43021 (G.D. 21) Either foetal or infant, this individual from Level D is represented by a cranium and many elements from the postcranial skeleton. The entire skeleton is calcined and some distortion is apparent, particularly in the cranium. Age is determined on the bases of tooth development and osteometric comparison (Sundick,'78). In the mandible, undeveloped teeth include the left deciduous first and second molars, premolar and incisors as well as the right dm2. None of these teeth showed any signs of eruption. Measurements of the less severely deformed postcranial elements all gave results smaller than Sundick's stage 1 ('78). Therefore, this individual is likely foetal. Right side measurements are from the tibia (57 mm,est.), fibula (54 mm), humerus (54 mm,est.), and clavicle (33 mm,est.). A single left ulna (50 mm) and the paired ilia (25 mm,est./27 mm) yield measurements.

<u>42022</u> (G.D. 22) This older individual is represented by cranial fragments, teeth, vertebrae, long bones and elements of the hands and feet. A partial innominate is also present. Sex is determined to be female from the broad sciatic notch and the gracile morphology in areas of muscle attachment. Age is estimated from the wear on 12 teeth and the slight degree of alveolar resorption in the maxilla. Generally, tooth wear is extreme for this individual and age is 25 - 35 years (Brothwell,'72). Because alveolar resorption is present and the maxillary central incisor has been lost <u>ante mortem</u>, it is likely that the true age is closer to the upper end of the range.

The maxillary first molar from this individual shows unusual wear similar to that noted for Individual 61113 except in this case the mesiodistal trough is present on the upper tooth. Both examples are described more fully in Chapter IV.

<u>62023</u> (G.D. 23) Most of the elements of this skeleton are represented by fragments while the right femur, tibia and fibula are absent. Several loose teeth evidence slight wear.

Age is determined from the degree of fusion observed at the proximal end of the left femur. This gives an age of 23 - 25 years (Krogman,'73). Sex from the partially preserved face and right side of the cranium is probably female.

51024 (G.D. 24) This individual is minimally represented by small fragments of the pelvis, femora, tibiae and the left radius and ulna. Also present are a talus and calcaneus. The generally heavy muscle markings on the femur and fibula suggest that this is a male.

Age is suggested to be *ca.* 20 years using Krogman's technique ('73). Sites of epiphyseal fusion include the iliac crest, the femoral head and the proximal ends of the radius and ulna.

43025 (G.D. 25) This darkened but unburned skeleton is nearly complete. A well preserved mandible in which teeth are present suggests an age of *ca.* 1 - 2 years (Schour and Massler,'44). An additional estimate of age is based on measurements of the right ilium (47 mm). This represents Sundick's stage 2 ('78) for an age of 6 - 15 months. These two estimates suggest an age range of 6 - 24 months.

43025 (G.D. 26) This individual, represented by a nearly complete skeleton, is severely calcined and brittle. Long bone lengths from the femora (80 mm,est./ 80 mm,est.), the right humerus (79 mm,est.) and ulna (63 mm,est.) suggest an age between 0 - 6 months (Sundick,'78, stage 1). Sex is indeterminate.

43027 (G.D. 27) This very young individual is also severely calcined and fragmentary. Long bones are present but not sufficiently complete for estimating age. Most useful is the complete mandible. Because it is edentulous, age is estimated from its size in comparison to several other more complete individuals from the series. This mandible is much smaller than mandibles from either 43025 or 43026. On this basis, age is estimated to be new born or foetal.

41028 (G.D. 28) This skeleton is poorly preserved and represented by fragments of the mandible, vertebrae and long bones. Several teeth are still seated in the mandible but the tooth crowns have been lost *post mortem*. The rugged appearance of the available fragments indicates the presence of a male individual. No attempt was made to determine the age of the individual as there were no reliable elements still intact. It is called "adult".

43128 (G.D. 28) Labelled in the field as either G.D. 28 or G.D.T. 28/ 29, this infant is represented by several small articulating cranial fragments. Sex is indeterminate. Age is *ca.* 3 years or less based on comparisons with other members of the series.

42029 (G.D. 29) This individual is incomplete and fragmentary. Long bones are poorly represented while the skull and pelvis are missing. Among the long bone fragments are the distal end of the right humerus, part of the tibia and part of the right femur. Fusion of the associated epiphyses was difficult to assess and no attempt to age can be made. It is called "adult" and is likely a female.

<u>42030</u> (G.D. 30) This is a female of advanced age. The remains are partially burned but they are not calcined like several other specimens. Bones present include a portion of the pelvis incorporating the sciatic notch. From its breadth sex is probably female. The reconstructed cranium, minus face and dentition, also shows some female traits. The skull is artificially deformed and the vault appears to be abnormally thickened. The mandible is present but the few remaining teeth are unidentifiable. Here an accurate age estimate cannot be made for this "adult".

<u>41031</u> (G.D. 31) With the exception of the flattened cranium, the condition of this skeleton is excellent. The cranium is severely broken and reconstruction is not possible. The size of the fragments and the nearly intact long bones indicates that this individual is male. An age of 28 - 35 years is assessed on the basis of tooth wear (Brothwell,'72) because all epiphyses are fused. The stature of the individual is <u>ca</u>. 177 cm using the formula for white males (Trotter and Gleser,'52).

An additional feature of this skeleton is the presence of osteophytes associated with degenerative joint disease. This is discussed in Chapter IV.

43032 (G.D. 32) This is a heavily calcined and fragmentary preadolescent individual. Several fragments represented long bones but no measurements can be taken as these have been badly deformed *post mortem*. Both ilia are well preserved and measurements are possible here. These are 34 mm and 34 mm,est. and suggest an age of 0 - 6 months (Sundick,'78, stage 1). Sex is indeterminate.

42033 (G.D. 33) An adult female is represented by a number of small fragments from an incomplete skeleton. Age is based on the degree of fusion of the proximal fibular epiphysis (Krogman,'73). These standards suggest an age of *ca.* 18 years at death. Generally small bone size and mild development of muscle markings indicate the sex.

51034 (G.D. 34) This fragmentary burial includes a large portion of a single innominate and a distorted, but almost complete cranium showing intentional deformation. The narrow sciatic notch and a well developed mastoid process indicates a male individual. No accurate age can be suggested and the individual is called "adult".

41035 (G.D. 35) Reconstruction of this fragmented individual results in a nearly complete cranial vault, parts of the maxillae, a fragment of the left mandible with seven seated teeth and several postcranial bones with fused epiphyses. The skull is characterized by pronounced thickening and massivness, possibly due to anemia. The thickness may have been exaggerated by exposure to heat (Lubell et al.,'75).

From the size and shape of the mastoid process, this individual is probably male.

Examination of the dentition shows that the wear on the teeth from both arcades is pronounced and even. This individual is likely between the ages of 35 - 45 years (Brothwell,'72).

43036 (G.D. 36) This skeleton was recovered from a matrix of fired earth. The thoracic elements (ribs and vertebrae) still remain in the earth block. Elements recovered include the right side of the mandible with several deciduous teeth and two measurable femora (95 - 100 mm,est.). These estimated measurements suggest an age of less than 15 months (Sundick,'78, stage 2). The degree of tooth development suggests a slightly younger age of ca. 6 months on the basis of intra-series comparisons.

40136 (G.D. 36) This individual was originally associated with the above burial but is distinguishable because several phalanges from an adult are present. The sex is not known.

53037 (G.D. 37) Remains of this unsexed adult include fragments from the entire skeleton. Most of these, and particularly those from the long bones are severely crushed. The only element useful for age determination is the distal end of the humerus and associated epiphysis. Age from this site is ca. 20 years (Krogman,'73).

43038 (G.D. 38) This individual is represented by a poorly preserved, but apparently complete skeleton. Measurements from several reconstructed long bones give an age between 6 and 30 months (Sundick,'78,stages 2 - 4). Measurements included lengths of the paired humeri (112 mm/ 112 mm), the left femur (150 mm) and the left ulna (98 mm). Sex is indeterminate. The mandibular dm1 is fully erupted while the first incisor is partially erupted. This suggests that the age of this preadolescent may be closer to age 4 years (Schour and Massler,'44). However, since these two teeth are the only ones present, the estimate obtained from osteometrics is preferable.

43039 (G.D. 39) The cranium, face and most of the postcranial skeleton for this individual have been badly crushed *in situ*. The mandible is comparatively well preserved and all teeth are present. This dentition is developed to the same degree as that representing 43038 and suggests the age of 4 years ± 6 months (Schour and Massler,'44). One measurement for the length of the humerus (128 mm,est.) is slightly greater than those for the humeri from 43038. Age is estimated to be *ca*. 30 - 42 months (Sundick,'78, stage 5). Sex is indeterminate.

42040 (G.D. 40) This burial represents the complete skeleton and dentition of a young female adult. Most of the postcranial skeleton is well preserved but the skull is badly broken and flattened. The length of the clavicle (130 mm) suggests an age of *ca*. 21 years (Sundick,'78). Its developmental stage suggests an age of ca. 19 - 24 years (Krogman,'73). The degree of fusion of the humeral proximal epiphyses gives an additional estimate of 18 - 20 years.

Sex is determined as female from the small sizes of the skeletal elements and the lack of well developed muscle markings.

The dentition shows a variety of notable features including, a) pronounced maxillary overjet (overbite), b) tooth crowding in the anterior teeth of both arcades, c) heavy anterior tooth involvement with calculus, particularly in the lower arcade, d) enamel hypoplasia, and e) one loose maxillary M3 showing hypercementosis.

41041 (G.D. 41) This individual was initially designated in the field as G.D. 41a, b and c because of apparent mixing *in situ*. Because fragments from each designation were subsequently found to articulate, all three were combined under the single laboratory designation. The condition of the remains is very poor as the bone fragments are completely calcined and delicate. Only the mandible could be removed from the enclosing matrix and this element is used for determining age and sex. The size of this element strongly suggests it to be male.

Age is determined from the wear on the right second premolar, the only tooth still intact in the arcade. The very slight attrition indicates an age of ca. 18 - 20 years at death. While the M3 teeth are missing, their alveoli are sharply defined indicating that they were both erupted when lost (Schour and Massler,'44; Brothwell,'72).

40042 (G.D. 42) This individual is identified by a single tooth that was originally thought to belong to the faunal component of the recoveries. Dr. D. Perkins' findings are given as, "Tooth upper right premolar, Adult". This premolar shows "medium wear" but in the absence of other skeletal remains, is not useful for determining age or sex.

62043 (Excavation Unit 1151) This individual is the first of three not designated by burial numbers. Rather, they were labelled with the provenience number 1151. Individual 62043 is poorly represented by a single large fragment of the skull. Age, determined from intraseries comparison, is likely between 25 and 30 years. The sex is probably female from the slight morphological development of the cranial fragment. A small portion of the left distal humerus is also present and may belong to this individual.

60044 (Excavation Units 1151-1150) Burial forms indicate that this unsexed adult was recovered from the two units mentioned. While several elements are available for study, they are badly crushed and broken. Age is determined from the degree of fusion of the left humeral epicondyle as 18 - 20 years (Krogman,'73).

63045 (Excavation Unit 1151) The third individual with this provenience is an unsexed infant represented by several small articulating cranial fragments. The age is estimated to be less than 3 years on the basis of intra-series comparisons.

CHAPTER IV

ANOMALIES AND PATHOLOGIES

Several different anomalies and pathologies were observed on individuals from the Ganj Dareh Tepe series. The various types are reported in this chapter by complex in the form of individual occurrences and frequencies. Anomalies include variations in growth and development represented by epigenetic traits from the cranium, abnormalities in the postcranial skeleton and non-metric traits from the dentition. Pathologies were identified by the presence of hard tissue modification resulting from infection due to the action of septic organisms, or resulting from dietary or metabolic disorders. Cases of physical traumata were considered to be pathological and are discussed under this heading.

The Cranial Complex (Table 6)

Anomalies

Intentional Deformation

Six individuals represented by largely complete calvaria showed changes associated with artificial cranial

TABLE 6

DISTRIBUTION AND FREQUENCIES OF CRANIAL ANOMALIES AND PATHOLOGIES

	11011	63014	62015	63016	61017	62023	41028	42030	41031	51034	41035	F
ANOMALIES												
Deformation	/	+	+	+	+	-	-	+	-	+	-	6/10
-postcoronal depression		+	+	+	+			+		+		6/6
-parietal elevation		+	+	+	+			+		-		5/6
-lambdoidal flattening		+	+	+	+			+		-		5/6
Sutures												
-metopism	-	-	-	-	-	+	-	-	-	-	-	1/11
-synostosis (abnormal)	/	-	-	-	+	-	+	-	-	-	-	2/10
Wormians												
-coronal	/	-	+	-	-	-	-	-	-	+	/	2/9
-sagittal	/	-	+	-	-	-	-	+	-	-	+	3/10
-lambdoidal	+	+	+	-	-	-	-	-	+	+	+	6/10
PATHOLOGIES												
-osteoporotic pitting	/	-	-	-	-	-	+	+	+	+	+	5/10
-traumata	+	-	-	-	-	-	-	-	-	-	-	1/10
-osteolysis	/	-	-	-	-	-	-	+	-	-	-	1/11

+ present; - absent; / no observation

deformation (Table 6). Two of these individuals associated with radiocarbon dates are securely dated Level D (Individual 42030 and Individual 51034). Deformed crania, representing adults of both sexes and preadolescents, consistently show at least one of three bony changes that, together, characterize the Ganj Dareh style of deformation (figs. 2 - 4).

All deformed crania exhibit a postcoronal depression that runs slightly posterior to the coronal suture. This depression is linear, running bilaterally from the area behind bregma to a point slightly superior to the temporal fossae. At this point, the depression becomes indistinct.

The second character is shown by five crania as an elevated area of bone that runs parallel and posterior to the postcoronal depression. This elevation, running bilaterally from apex to the area superior to the area of attachment for the temporalis muscles, is apparently a variation in the direction of parietal growth, rather than a manifestation of hyperostotic modification (see Pathologies, Systemic disorders).

The third character, a vertical flattening in the area of lambda, is seen in the lateral view. Expression of this feature varies from a slight concavity on Individual 42030 to absence on Individual 51034. The area at lambda on the skull of Individual 63014 (fig. 3) also

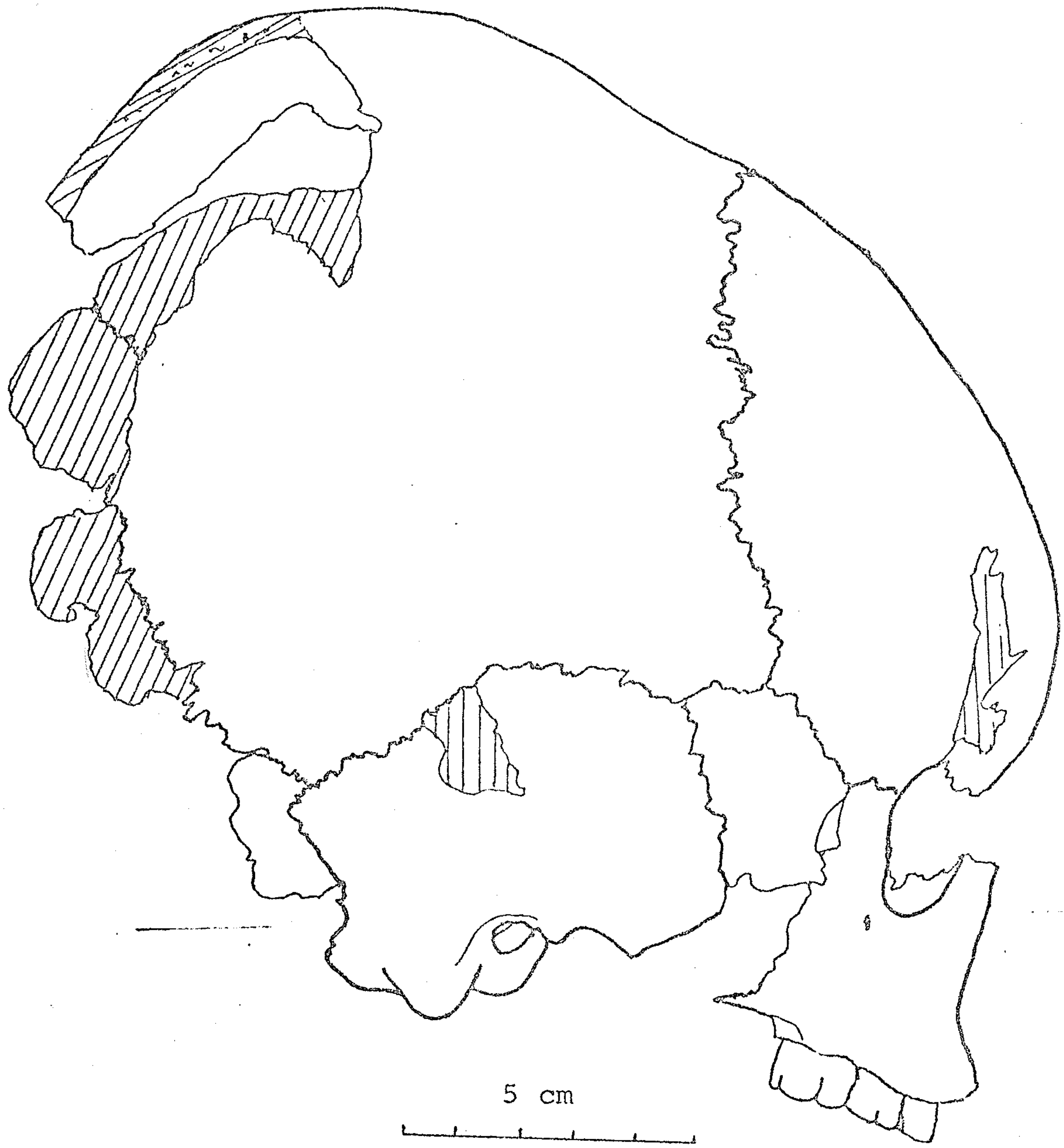


Fig. 2 Cranial deformation on Individual 63016, an unsexed preadolescent. Elevation of the vault is apparent in conjunction with the postcoronal depression. (Drawn from photograph.) P.L.

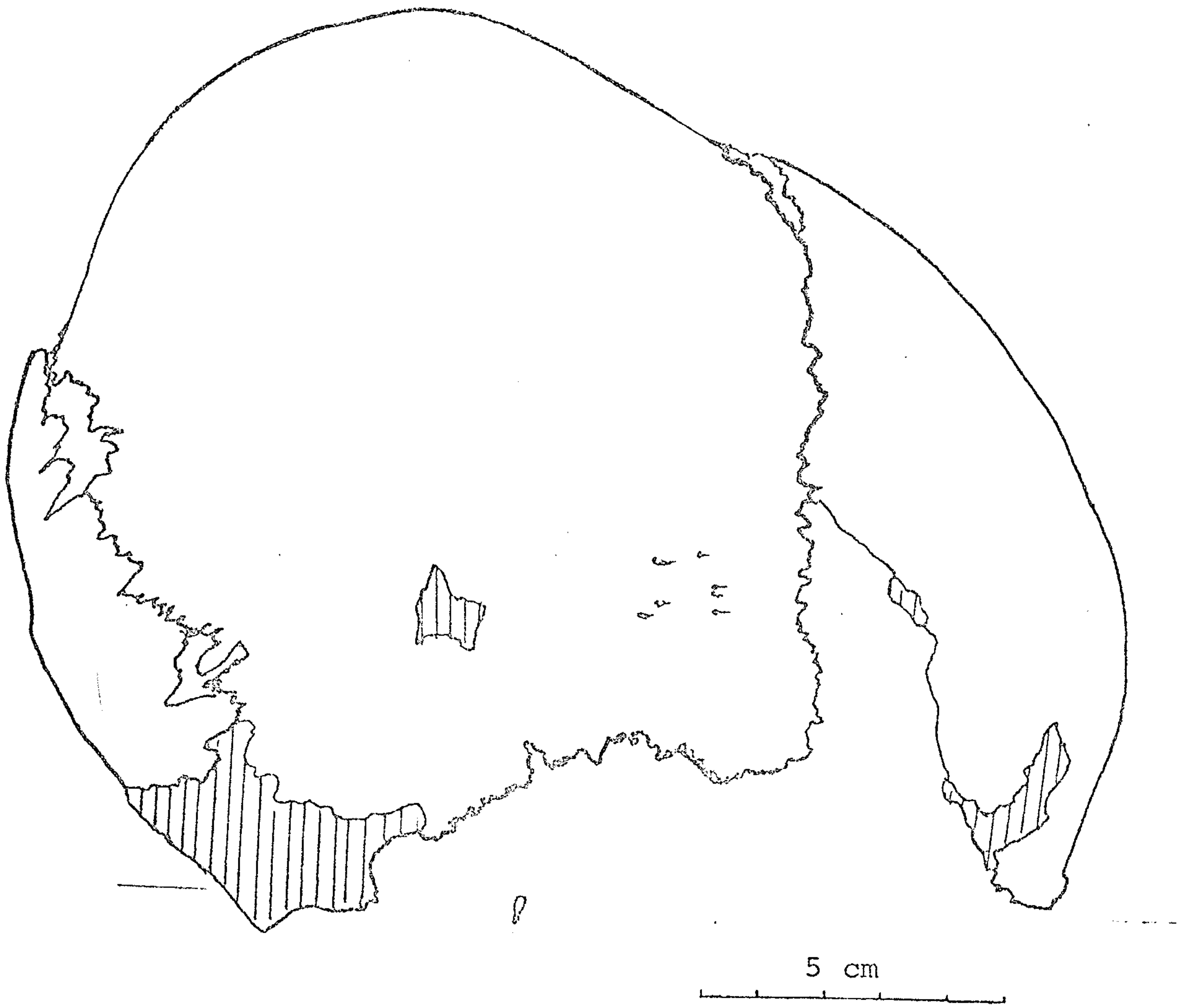


Fig. 3 Cranial deformation on Individual 63014, an unsexed preadolescent. Anomalous foramina are shown in the lower anterior part of the right parietal. Misalignment of the parietals and the occipital is evident in the area of lambda. (Drawn from photograph.)

appears misaligned at the juncture of the occipital and parietals. In this case, the parietals seem "pulled" towards the front of the skull and away from the occipital bone. This has resulted in the slight overlapping of the parietals by the occipital. The good fit at the suture lines in the reconstruction, suggests that post mortem deformation was not responsible for this feature.

Classification of crania showing culturally induced variations in shape has been attempted by a number of authors using different typologies (Broca, 1875; Oetteking,'30; Aichel,'33; Falkenburger,'38; Stewart,'41; and Neumann,'41). The resulting shape of a deformed specimen depends upon the interaction of cultural and mechanical variables, including the required or preferred shape the head must assume, the type and force of the deforming apparatus, the age of the individual at the time of the initial attempts to deform the skull, and the length of time the device is worn (Falkenburger,'38; Stewart,'41; Neumann,'41). None of the following typologies is considered, by itself, to be adequate for accurate description or crosscultural comparisons. There is, however, some utility in discussing them in light of the criteria used in developing them.

In 1839, Morton (in Falkenburger,'38,p.2) developed a deformation typology based upon the resulting shape of the deformed cranium. Four modal variants were distinguished including, 1) occipital-frontal; 2) frontalsincipital-parietal; 3) irregular compression; and, 4) quadrangular. The four types were intended to classify any deformation type but lacked the precision required for classification of skulls showing mild degrees of expression or changes characteristic of other types of deformations. This typology was modified by Goss (1899; in Falkenburger,'38) to include some of the other possible deformation types. However, this newer classification still could not account for variations from the modal forms.

As early as 1875, Broca (in Falkenburger,'38) established a different typology based on the process involved in deforming the bones, particularly the frontal bone. Categories included deformation types called 1) simple; 2) annular; 3) frontal simple; 4) frontal tabular (flattened); and, 5) frontal elevated. In Broca's opinion, process was restricted to producing two major groups of deformation; annular and tabular. One shortcoming of this typology was its lack of incision in defining the deformation devices. Nevertheless, this classification has the advantage of including variations from modal shapes.

In a recent study on Bronze Age series from Byblos, Özbek ('74) noted the exclusive deformation of female crania. Two annular types variations were identified and designated as 'Byblos type a' and 'Byblos type b'. The mechanism involved was a bandage, used singly for 'type b', or with another bandage to cause type a.

Byblos 'type a' involves the use of two narrow bandages, the first running from the area of bregma on both sides of the coronal suture, parallel to the suture, and underneath the body of the mandible. The forces applied by this bandage caused depressions in parts of the bones not covered by muscle, i.e., above the temporalis muscles, on the frontal bone and on the inferior part of the mandibular body. The second bandage runs across the forehead to the nuchal area. Depressions are evident in both areas of bandage attachment (Özbek,'74).

The 'type b' variant was caused by a single bandage running from a broad area of attachment on the frontal bone to the nuchal area. Özbek illustrates a single depression in the occipital area, but no change on the frontal area (Özbek,'74, fig. 5).

Modifications to the Ganj Dareh Tepe crania were likely caused by the 'type a' bandage pattern. Two minor differences are, a) the positioning of the postcoronal depression, and b) the lack of change in the mandible. The postcoronal depression in the Byblos 'type a' variant incorporates the coronal suture whereas, this depression is posterior to the suture for the Ganj Dareh specimens. Mandibular involvement for Ganj Dareh is not apparent though the orientation of the postcoronal depression suggests that the gonial areas were used to attach the bandage.

The occipital flattening on the Ganj Dareh crania is best explained with reference to a second bandage running from lambda and covering a large area of the frontal bone (fig. 4). While the frontal bone shows no trace of depression it is likely that a bandage spread over a large area of bone would exert only a slight force on the bone per unit area, relative to a bandage covering less area while exerting the same force.

It is apparent that the deformation of the Ganj Dareh crania is due to the action of two bandages, the first running antero-posterior and connected at the occipital and frontal bones, and the second, approximately perpendicular to the first, with attachment behind the coronal suture and beneath the mandible (fig. 4). Cranial deformation is known to involve a compensatory deformation of the mandible either through direct application of a device (Özbek,'74), or, indirectly (Björk and Björk,'64; Rogers,'75). None was observed at Ganj Dareh Tepe. Direct mandibular involvement is inferred by the position of the postcoronal depression, the one characteristic found consistently on the specimens from Ganj Dareh. Frontal bandage attachment is inferred from the changes at lambda. The antero-posterior forces exerted by this bandage were responsible for the lamboidal flattening and the parietal elevation. Because the normal growth of the parietals was impeded by the bandage, elevated growth was promoted because this vector was

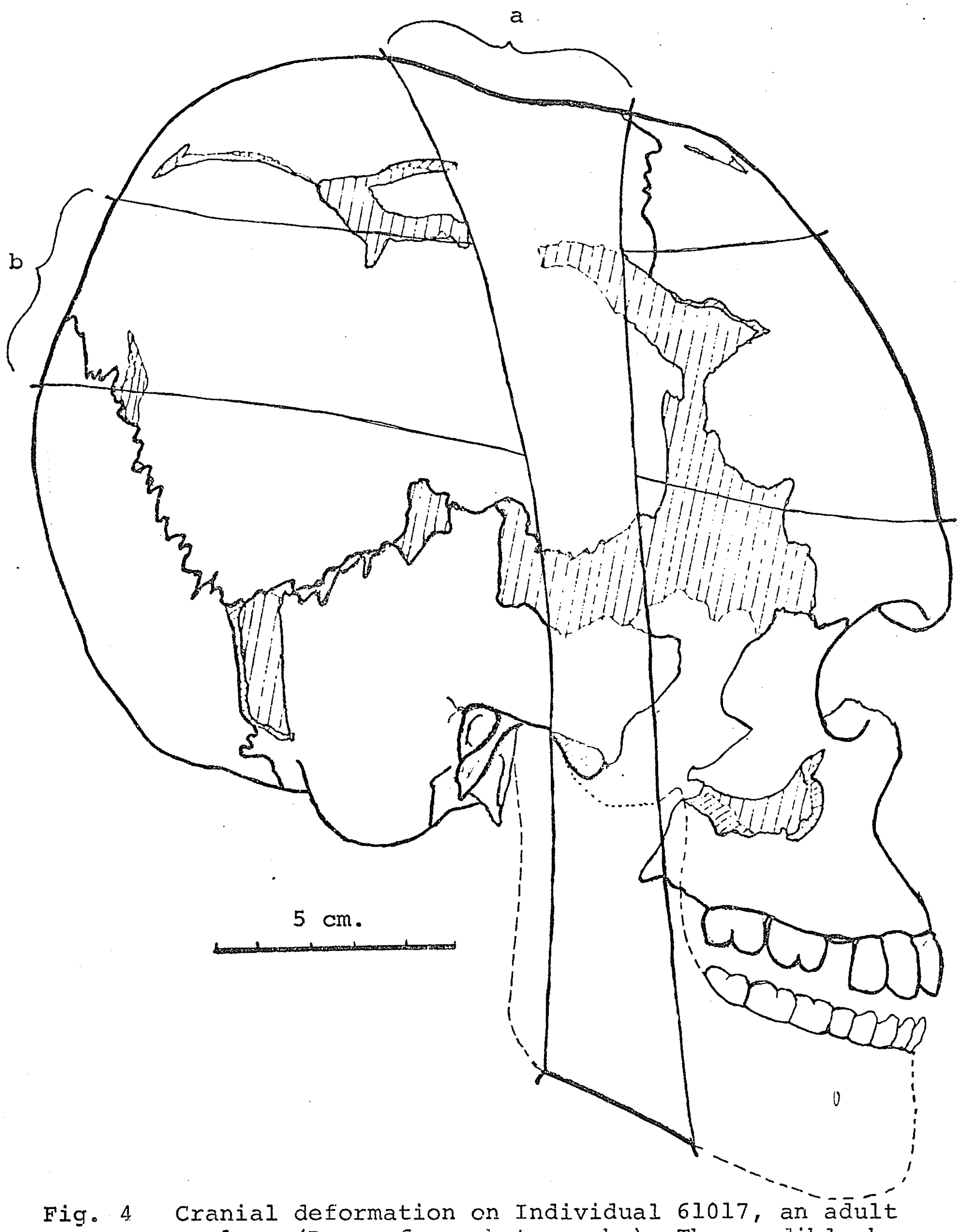


Fig. 4 Cranial deformation on Individual 61017, an adult male. (Drawn from photograph.) The mandible has been added to show the probable area of bandage attachment (bandage a). Bandage b is also shown.

least impeded by bandage forces.

At least two other sites from the Near East have associated deformed cranial remains. These are the Iranian sites of Seh Gabi and Ali Kosh. Date for Seh Gabi of ca. 4000 years B. C. makes these burials contemporaneous with those from Byblos (Meiklejohn, pers. comm.). Dates from Ali Kosh range from 6750 - 6000 years B.C. (Hole, Flannery and Neely,'69,p.347). Crania with annular deformations have been recovered from both Seh Gabi and Ali Kosh. At the later site, several preadolescents show deformation caused by a single bandage involving fronto-occipital binding (Meiklejohn, pers. comm.). At least two adult individuals from Ali Kosh, a female from Level B2 (burial 34) and an unsexed individual from the same level (burial 33), show an unspecified type of deformation. This is apparently annular (Hole, Flannery and Neely,'69,Plate 12b). Other burials were apparently unaffected.

Chronologically, dates from Ali Kosh, Level B2, are only slightly younger with those from Ganj Dareh for Level A (ca. B.C.). Thus, Ganj Dareh specimens from Levels D and E are approximately 1500 years earlier than those from Ali Kosh. Relative to Seh Gabi and Byblos, deformation at Ganj Dareh Tepe predates these two sites by as much as 4500 years as these two are dated ca. 4000 B.C. (Özbek,'74, p.455; Meiklejohn, pers. comm.; Young and Levine,'74,p.15).

Epigenetic Traits

Epigenetic traits are difficult to compare between populations (Pardoe, pers. comm.). Thirty traits (Berry and Berry,'67) comprised the set of observations examined for Ganj Dareh Tepe adult crania. Results are tabulated in Table 7 as ratios of presence to absence of each trait for each sex. Traits not observed because of damage to the bones were eliminated from the list in column 1. The results were examined for the occurrence of any significant between-sex differences using the Fisher exact test (Sokal and Rohlf,'69). No significant differences were found (at the $p = 0.05$ level).

Sutural Variations

The final stages of fusion of the cranial bones to their proximate elements is termed "cranial synostosis" (Olivier,'69). Researchers have attempted to develop standards for age estimation on the degrees of synostosis shown by the various cranial sutures (Todd and Lyon,'24; Krogman,'73). In assessing the reliability of these techniques, subsequent researchers have noted the extreme variability of suture closure and have stressed its lack of utility in age determination (Singer,'53; Brooks,'55; Brothwell,'72; Sundick,'78). It follows that any variability in suture closure should be regarded as normal in the context of the population, rather than as anomalous. However, cranial deformation has been known to influence the growth and develop-

TABLE 7

EPIGENETIC FREQUENCIES
FROM THE CRANIUM

Trait[a] Number	MALES present	MALES absent	FEMALES present	FEMALES absent
1	3	0	1	4
2	1	0	1	2
3	2	0	0	3
4	2	0	4	1
5	0	5	0	1
6	1	4	0	1
7	1	4	1	1
8	0	2	0	1
9	-	-	0	1
10	0	3	-	-
11	-	-	0	4
12	0	2	1	3
13	-	-	2	0
14	1	0	2	2
15	0	1	0	4
17	-	-	0	1
22	-	-	1	0
23	-	-	1	1
24	0	1	1	1
25	-	-	1	2
26	1	0	2	1
27	2	0	4	1
30	-	-	0	3

[a] After Berry and Berry ('67)

ment of the skull (Moss,'54; Ossenberg,'70; Gottlieb,'78; El-Najjar et al.,'77), and, particularly, the development of the sutures and intersutural (wormian) bones (El-Najjar et al.,'77; Gottlieb,'78). Therefore, more obvious synostotic variation is examined in the context of cranial deformation in the Ganj Dareh Tepe series.

Three of the more complete crania from the series show unusual sutural variation (Table 6). Two of these cases involve sagittal closure while a third case involves the metopic suture. Individual 61017, a deformed specimen, exhibits sagittal suture variation involving an open anterior aspect and a fully obliterated posterior aspect. Synostosis in the suture begins _ca_. 18 mm posterior to bregma and continues from this point to lambda. The point of initial closure is approximately half way across the postcoronal depression. A second deformed specimen, Individual 42030, shows a very different pattern in sagittal suture closure. In this case, the point of initial closure is _ca_. 25 mm posterior to bregma, but synostosis continues for only 18 - 20 mm. After this point, the suture is open to lambda. Contrasting to the former specimen, suture closure has not occurred in the postcoronal depression. However, in both specimens, the suture is fused where it traverses the parietal elevation. No other sagittal variations were observed from the remainder of the series.

The metopic suture is the forward extension of the interparietal or sagittal suture (Gray's Anatomy,'77, p.101). The two halves of the frontal bone are usually fused by about six years of age (Anderson,'69) and the suture obliterated shortly after. The metopic suture has persisted on Individual 62023, an adult female with no apparent deformation changes. The suture begins at nasion and continues superiorly for about 20 mm. After this point, the suture is completely obliterated.

Wormian Bones

Wormian bones or ossa triqueta are small irregular bones that interpose between the bones of the cranium within the sutures. As the skull develops, they interdigitate with adjoining bones. They are found most frequently in the lambdoidal suture. Wormians are formed from separate centers of ossification, and are of various shapes and sizes. Sometimes called "joint mice", these become synostosed with the suture. While wormians occur most frequently in the lambdoid suture, they can occur in the sagittal suture and more rarely in the coronal suture. They are not known to occur in the metopic suture. Some of the possible variations that can occur in the lambdoid suture when wormians are present have been illustrated by Brothwell ('72,fig.15,p.41).

Wormian bones were present in seven of the Ganj Dareh Tepe series (Table 6). Of the five individuals with well preserved lambdoidal, sagittal and coronal sutures, wormians were observed in the lambdoidal suture four times, in the sagittal suture twice, and in the frontal twice. There was apparently no interdependence for wormians and in one case, they were exclusively present in the sagittal suture. One skull exhibited them in the coronal and lambdoid sutures only.

Other Anomalies

Seven small foramina on the right parietal of Inidividual 63014 represents a cranial anomaly that is best explained with reference to artificial cranial deformation. The foramina enter the outer table of the parietal bone in a postero-medial direction from a small area within and anterior to the postcoronal depression (fig. 3). The affected area is approximately 22 mm by 12 mm. Foramina are not patent and do not reemerge from the outer table of the bone.

The position and orientation of the foramina suggest that they were alternative pathways for venous transmission or nerves normally found in the scalp. Further, it is suggested that the bandage causing the postcoronal depression was also responsible for redirecting the blood vessels and/or nerves by truncating their normal paths. This modification to the parietal was not bilateral and was not observed in any of the other crania.

Pathologies

Eight crania exhibit bony changes associated with physical traumata, infectious agents, or systemic disorders (see Table 6).

Physical Traumata

Evidence of cranial injuries consists of a single healed depression fracture found on the posterior portion of the right parietal (Individual 11011). Steinbock ('76,p.24) suggests that such an injury can be caused by accidental falls or by blows from heavy objects. As there is only one other case of a healed fracture (Postcranial Complex; Pathologies), it is likely that bone fractures were rarely sustained by members of the Ganj Dareh Tepe group.

Systemic Disorders

Porotic hyperostosis, symmetrical osteoporosis, hyperostosis symmetrica, and hyperostosis spogiosa (spongy hyperostosis) are terms used by various authors to describe the abnormal bone changes associated with anemia (Zaino,'64, '67; Armelagos,'67; Carlson et al.,'74; El-Najjar et al.,'76; Lallo et al.'77). Structural changes occurring in the cranium are caused by hyperplastic growth of the interposed marrow reflecting increased production of red cells and red cell precursors within the diplöic spaces. Marrow proliferation results in expansion of the active diplöe and rarification of the outer table of the bone. In cases showing complete destruction of the outer table, the underlying diplöe is exposed as an irregular area of round or oval holes joining a series of hypoplastic trabeculae representing diplöic proliferation. Zaino ('64) and others have pointed out that suture lines are not involved in this process.

While exposed diplöe presents a gross "spongy" appearance, radiographs reveal a "hair-on-end" pattern typical of a number of the anemias (Steinbock,'76). In severe cases, porotic hyperostosis implicates other parts of the cranium and the postcranial skeleton not normally associated with red cell production. These include the maxillae, zygomatic bones, the greater wing of the sphenoid, the orbital plate of the frontal bone, the sternum and the scapulae (Angel,'67,p.379 and p.381). Also the long bones and ribs of young individuals may show changes consistent with marrow expansion (Angel,'67,p.381).

Porotic hyperostosis has been accepted by some authors as the definitive term to describe the phenomenon of diplöic proliferation and tabular rarification in bone (Lallo, et al.,'77). Thus, the occurrence of these changes in the superior orbital borders (cribra orbitalia), or on the parietal, occipital and, sometimes, on the frontal bones (cribra cranii) are all regarded as variations of porotic hyperostosis, "whose lesions should all be distinguished from generalized osteoporosis in which...rapid bone involution takes place (Armelagos,'67,p.7)". Following the suggestion that lesion severity should be taken into account when making diagnoses (Nathan and Haas,'66), Armelagos ('67) subdivides cases of cribra cranii on this basis. Simple pitting of the surface of the bone should be called "osteoporotic pitting" to distinguish such cases from more severe kinds with attendant growth of new diplöe and table destruction. These should be called hyperostosis spongiosa (Putschar,'66, in Armelagos,'67,p.7).

Bone changes consistent with the above descriptions have been observed in both Old and New World prehistoric populations. In the Old World, porotic hyperostosis incidence has been primarily associated with two of the hereditary hemolytic anemias; thalassemia (Cooley's Anemia) (Motulsky,'60; Zaino,'64; Angel,'67); and sickle-cell anemia (sicklemia) (Motulsky,'60; Angel,'67). Both of these anemias are caused by the presence of abnormal hemoglobins in the human population. These balanced polymorphisms confer an advantage to individuals who are heterozygous for the trait by protecting against malarial (*Plasmodium falciparum*) infection. It has been noted that the geographical distributions of malaria and hemoglobinopathies, thalassemia and sicklemia, are very similar (Angel,'66; Zaino,'64,fig.1; Motulsky,'60).

Researchers concerned with the occurrence of porotic hyperostosis in geographic areas without endemic malaria have determined that deficiencies of iron are also responsible for bone changes similar to those encountered in association with malaria. Inadequate intake of dietary iron has been suggested for prehistoric populations whose subsistence included a heavy dependence on maize or cereals. Dependence on maize was noted for a number of Eastern Woodland groups from the New World (Lallo et al.,'77), and for Anasazi and Pueblo Indians from the Southwest (El-Najjar et al.,'76; Zaino,'67). In the Old World, dependence on cereals contributed to low iron in both prehistoric and historic Nubian groups (Carlson et al.,'74). The presence of fluctuating frequencies of the lesions in Mediterranean populations led Angel ('66) to suggest that iron deficiency anemia contributed to these fluctuations, and that the deficiency was related to the adoption of farming. Even in the presence of marginal dietary sources iron deficiency anemia can result from, or become exacerbated by, cultural factors including multiparity, weanling diarrhea and prolonged suckling, or by environmental factors such as the parasitic infections involving hookworm and bacillary dysentery (Angel,'66; Lallo et al.,'77; Carlson et al.,'74).

Authors have noted the prevalence of porotic hyperostosis in young individuals in various populations; from the Americas (Williams,'29; Hrdlička,'14; Zaino,'67;

Hooton,'30; El-Najjar et al.,'76; Lallo et al.,'77); the Pacific (Zaino and Zaino,'75); and, the Eastern Mediterranean and the Lower Nile areas (Hrdlička,'14; Angel,'64,'66, '67; Zaino,'67; Carlson et al.,'74), in association with either hemolytic or iron deficiency anemia. Lallo and his coworkers ('77) suggest that iron deficient individuals from an Ohian population who were "below the age of 5 are most likely to develop porotic hyperostosis, and those above the age of 10 least likely. The age class 1 to 1.9 years is the most crucial period with respect to the likelihood of developing the cranial lesions ('77,p.478)". In cases where females reach parity and the foetus has been exposed to iron-rich intrauterine supplies, the neonate is born with reserves of iron that compensate, for a short period, for any lack of the metal obtained through suckling. These reserves are normally depleted at about the sixth month, at which time, the infant becomes dependent upon dietary sources of iron for normal development (Carlson et al.,'74, p.408).

With decreasing milk intake and more solid food, the infant is susceptible to weanling diahrrea. This further depletes the store of iron while preventing the infant from absorbing the iron in the foods. Paradoxically, iron deficiency leads to anemia while conferring some immunity from infection ("nutritional immunity") (Weinberg,'74).

In the presence of the hemolytic anemias, young individuals who are homozygous for the abnormal hemoglobin do not live to reproductive age (Angel,'66). There are no data available to compare the frequencies of infant and child infection due to thalassemia or sicklemia to the prevalence of hyperostotic lesions at ages of less than ten years. Presumably, younger individuals with thalassemia or sicklemia in the heterozygous state would develop bone changes in childhood, as indicated by frequencies presented by Angel for Greece and Cyprus (Angel,'66,Table 1).

Five adult crania, four males and one female, from Ganj Dareh Tepe showed bony changes that were classified as "osteoporotic pitting". These consisted of relatively minor changes on the parietals superior to the temporal lines, and on the occipitals superior to the nuchal lines. No cases of either cribra orbitalia or severe spongy hyperostosis were observed and notably, none of the preadolescents showed any cranial aberrations.

Zaino ('64,p.403,fig.1) documents the modern distribution of thalassemia showing that the polymorphism exists in the general area where Ganj Dareh Tepe is situated. This shows that the modern environment is favorable to Plasmodium sp., but it is unknown whether this was the case when the site was occupied.

The osteoporotic pitting in this series is likely the result of iron deficiency anemia for several reasons.

First, if any metabolic polymorphisms were implicated, then we should expect that abnormal bone changes, (e.g. cribra orbitalia), would be present for young individuals. The same should be true if Ganj Dareh individuals were subject to iron deficiency during their lifetimes. However, bone changes at Ganj Dareh Tepe occur only in the adults, suggesting that adults ingested quantities insufficient to prevent the onset of anemia. The distribution suggests that the cause was a postadolescent dietary shift. As only one female cranium shows osteoporotic pitting, it seems unlikely that pregnancy or lactation is involved. Multiparity cannot, however, be discounted as the age of female, 42030, is greater than Ganj Dareh females showing no bony changes (62015, 62023).

Ages of the four affected males range from more than 16 (51034) to approximately 30 (41031 and 41035). One individual (41028) is designated only as "adult". Slight contrast is offered by a single unaffected male (61017) aged between 15 and 18 years.

Another reason for suggesting that iron-deficiency anemia caused osteoporotic pitting comes from the archaeobotanical analysis from which several cereal grains were identified (P.E.L. Smith,'78). This finding in the context of a permanent habitation site, suggests the presence of incipient agriculture (Chapter I) and at least some dependence upon cereals.

Isolated Pathologies

A number of small, sharply defined irregular lesions on the frontal, parietal and occipital bones of Individual 42030 identify several areas of localized infection. These are best described as osteolytic as erosion of the outer table has exposed the underlying diplöe. These areas of exposed diplöe show some remodelling. No cause of these lesions is suggested.

The Postcranial Complex

Anomalies

Only a single anomaly from the postcranial skeleton of 43001 was observed. For this individual, aging techniques give conflicting results. Both dental eruption sequence (Schour and Massler,'41,'44) long bone metrics (Sundick,'78), provided consistence with estimates of 15 - 36 months. However, these did not agree with an age based on vertebral fusion. The neural arches of the cervical vertebrae are almost completely fused to their centra, a developmental stage more usually found between the third and sixth year (Gray's Anatomy,'77,p.131). This discrepancy is abnormal in terms of the age results from the two other techniques, but may represent a simple developmental variation in the Ganj Dareh population.

Pathologies

Three different isolated pathologies were observed in the postcranial complex. The first of these abnormalities is attributed to trauma suffered by a humerus and reflects the response during bone growth. The second case affects a tibial diaphysis and response to infection. The third example is degenerative in nature, affecting two adjacent vertebrae. Two related diseases may be distinguished in this last case.

Physical Taumata

Individual 62015, a female age *ca*. 20 years, is represented by paired humeri, radii and ulnae. The radii and ulnae are incomplete at their distal ends while the humeri are intact. All of these bones, with the exception of the right humerus, are gracile showing little development in the areas of muscle attachment. In contrast, the right humerus is markedly robust. Insertions for the deltoid and *latissimus dorsi* muscles are more developed and rugged in comparison to those on the left humerus. Differences are illustrated metrically, as the maximum length of the right humerus (HXR) is *ca*. 30 mm shorter than the left. Right side width measurements exceed those from the left by as much as 20 mm (HMD). The shaft of the right humerus shows some degree of bowing in comparison to the left. Also, it is possible that the right ulna has been broken as well as it is also slightly bowed relative to the left.

Radiographs of these bones show a line of fracture on the right humerus *ca*. 18 mm distal to the head (Byrne, pers. comm.). Bowing of the shaft may be due to the growth response subsequent to breakage. In addition, a second fracture has been suggested, although radiographs do not appear to show this clearly. No fracture line was observed on the ulna.

Infection

The second case of postcranial pathology occurs on the tibia of Individual 63014. The right tibia is represented by the greater part of the diaphysis but lacks both proximal and distal ends. The proximal end of the shaft incorporates the nutrient foramen on the medial surface and, directly opposite, a large hole in the cortical bone. This hole measures *ca*. 15 by 8 mm and runs longitudinally down the shaft. Its anterior and posterior edges are sharp and characteristic of a *post mortem* break.

At the proximal and distal edges, the bone shows reactive areas characteristic of osteomyelitis. At the distal edge, there is an area showing a sub-cortical bone bridge. At the proximal edge there is a small, but distinct, nodule of bone beneath the periosteum. A large number of microscopic cloacae for drainage can be observed in the involucrum.

Steinbock ('76,pp.60-74) distinguishes two kinds of osteomyelitis. The first is characterized by the absence of localized trauma that would indicate skin perforation fracture. This is hematogenous osteomyelitis as septic microorganisms causing bone reaction have spread from the location of the fracture to other areas of the body. One highly susceptible area is a growing metaphysis, in this case, of the proximal tibia. The origin of the infectious bacteria may also be introduced through skin lesions, subcutaneous abcess, or furuncles. The avenue of transmission, as implied by the term, is the circulatory system (Steinbock,'76,p.60; Brothwell,'72,pp.134-135; Morse,'69,pp.17-19). The circulatory system carries pus-producing organisms from these areas of primary infection and often several bones can be infected. Pyogenic micro-organisms include staphylococci, thought to be responsible for 90 percent of all cases of osteomyelitis, streptococci, meningococci, pneumococci, typhoid and colon bacilli which cause the remainder (Morse,'69,p.18; Steinbock,'76,p.61).

Osteomyelitis can also be caused by direct infection at the point of skin perforation caused by a compound fracture. The organisms causing inflammation of the bone are the same but remain at the site of the insult.

In this case, it is not clear whether infection resulted from hematogenous or direct infection. However, there are several reasons for suggesting the former. First, the lesion is near the growing end of the tibia. The metaphysis is most frequently implicated in cases of hematogenous infection. Usually, lesions caused by direct infection are found at the site of a compound fracture (Steinbock,'76,p.73), and no evidence for such a wound could be found. Second, a high percentage of acute osteomyelitis due to direct infection is found in adult individuals. This is due to the higher incidence of long bone fractures, chronic soft tissue infections and periodontal disease in older individuals (Steinbock, '76,p.73; Wilensky,'34). This contrasts to high frequencies of acute hematogenous infection for age 3 - 15 years (Steinbock,'76). Finally, the close proximity of the nutrient foramen to the lesion is highly suggestive of the hematogenous route of infection outlined by Steinbock ('76,fig.26).

Degeneration

The third pathology is degenerative, occurring on two adjacent lumbar vertebrae from Individual 41031. Osteophytes were present on the superior and inferior central margins of L2 and L3, and on the inferior articular processes of L2. These processes were lost from L3. No other vertebrae from this individual were recovered.

Osteophytes are characteristic of two types of pathology. Both are degenerative and are termed osteoarthritis and osteophytosis. The distinction between the two is based upon the site of irritation. Osteoarthritis, or degenerative joint disease (Morse,'69,p.12), identifies degenerative changes in true synovial joints (Morse,'69; Steinbock,'76,p.287). Osteophytosis, on the other hand, describes similar morphological alterations at sites lacking a synovial membrane (Morse,'69,p.13). In this case, such "joints" are represented by the membranous intervertebral discs interposed between the vertebral centra.

Morse ('69) points out that the degenerative diseases, osteoarthritis and osteophytosis, frequently occur together ('69,p.13). Two lumbar vertebrae from Individual 41031 show both of these diseases in the form of osteophytes on the centra (osteophytosis) and on the articular processes of L2 (osteoarthritis). The osteoarthritis is bilateral but osteophytes are more developed on the left facet. It has been suggested that the greater left side of involvement is due to the presence of a minor infection or irritation on the facet (Pardoe, pers. com.). A small area in the center of the facet appears to be reactive bone, the cause of which is unknown. While eburnation can occur in more serious cases of osteoarthritis (Morse,'69,p.12), none was observed.

As both osteoarthritis and osteophytosis are degenerative diseases, they are commonly found on older individuals. The former occurs after age 50 and the latter after age 30 (Steinbock,'76,p.278, p. 287). The age of 41031 is estimated between ca. 28 and 35 years from dental attrition (Brothwell,'72). As osteoarthritis and osteophytosis most frequently occur in robust, well-muscled individuals in association with strenuous exercise (Steinbock,'76,p.287,p.278), then the incidence of both diseases is not unexpected for this male.

The Dental Complex

Anomalies

Molar Cusp Patterns

To examine cusp patterns, it is necessary that the occlusal surfaces be relatively free from wear caused by attrition. Heavy use of the teeth, in conjunction with a coarse or gritty diet, and factors such as bruxism, can reduce and obscure cusps and fissures. Extreme examples of molar wear are characterized by dental pulp exposure and deposits of secondary dentine. Frequently, pulp exposure results in infection and eventual tooth loss. Molars not showing moderately distinct cusp patterns were not considered here.

An additional problem in defining cusp patterns is that sometimes measurable teeth are not suitable for classification. This is because part or parts of the tooth crown, not required for measurement, have been broken away and lost. This occurred when shattered teeth were only partially reconstructed, or when helicoidal wear was extreme.

Helicoidal wear is characterized by planed occlusal surfaces. The angled occlusion planes bring teeth together to form a grinding surface more efficient than the original surface (Molnar,'71). The helicoidal plane is produced through cuspal attrition on lingual surfaces of maxillary teeth and occluding buccal surfaces of mandibular teeth. Several cases were observed on mandibular molars from Ganj Dareh Tepe. These teeth display distinct cusps on the lingual side of the occlusal surface and pulp exposure on the buccal side. These have been noted in the description of individuals (Chapter II). Because the cusps have been destroyed, no attempt was made to determine surface patterns.

A final sample of 44 molar teeth from Ganj Dareh Tepe were selected from a possible 69. Turner ('67) lists a number of precise categories describing morphological variability in molar teeth. However, as very few of the 44 teeth were free from wear and cuspal modification, Turner's categories were modified to classify teeth that had lost precise diagnostic features. The categories are given with their subsumed variants (Turner,'67) as follows. Tritubercular maxillary teeth were grouped as "3" to include 3 and 3+ variants. In the mandibular molars, +5 and

X5 patterns were grouped as "5"; Y6, +6 and X6 patterns as "6"; and Y4 and X4 patterns as "4". Two patterns, the Y5 and +4, were retained because they could be accurately discerned in relatively high frequencies.

This sample of 44 teeth was also examined for primary accessory cusp formations. These included the Carabelli tubercle found on the maxillary molars, and the protostylid on the lower molars. Paramolar tubercles were not encountered.

Not included in the following tables are frequencies of incisal shovelling. The trait was observed only once in a sample of 25 central incisors (41020) and not at all in a sample of 21 lateral incisors.

Table 8 shows the incidence of molar cusp patterns using the above categories. The frequencies show whether the pattern occurred in one or both antimeres (u and b); the number of teeth showing the pattern (fo); and the percent of these teeth of the total number examined (%o). In addition, frequencies are supplied to show the number (fi) and percent (%i) of individuals with specific cusp patterns for a given molar tooth. Thus, considering the 4+ pattern for the first molar, there was one case each observed unilaterally and bilaterally on two of five individual skeletons (fi), with three of eight first molars showing the same pattern (fo).

TABLE 8

MOLAR CUSP MORPHOLOGY

Maxillary

	(4+)						(4)						(3)					
	u	b	fo	%o	fi	%i	u	b	fo	%o	fi	%i	u	b	fo	%o	fi	%i
M3	-	1	2/4	50	1/2	50	-	-	0/4	0	0/2	0	-	1	2/4	50	1/2	50
M2	-	3	6/9	67	3/5	60	-	-	0/9	0	0/5	0	1	1	3/9	33	2/5	40
M1	1	1	3/8	38	2/5	40	1	2	5/8	62	3/5	60	-	-	0/8	0	0/5	0

Mandibular

	(Y5)						(5)						(6)					
	u	b	fo	%o	fi	%i	u	b	fo	%o	fi	%i	u	b	fo	%o	fi	%i
M3	2	-	2/6	33	2/4	50	-	-	0/6	0	0/4	0	-	-	0/6	0	0/4	0
M2	-	-	0/10	0	0/6	0	-	-	0/10	0	0/6	0	1	-	1/10	10	1/6	17
M1	-	2	4/8	50	2/5	40	-	-	0/8	0	0/5	0	-	-	0/8	0	0/5	0

	(+4)						(4)					
	u	b	fo	%o	fi	%i	u	b	fo	%o	fi	%i
M3	-	1	2/6	33	1/4	25	-	1	2/6	33	1/4	25
M2	-	3	6/10	60	3/6	50	1	1	3/10	30	2/6	33
M1	1	-	1/8	13	1/5	20	1	1	3/8	38	2/5	40

The incidence of Carabelli's tubercle and the protostylid on molars is shown in Table 9 using the same format.

Pathologies

A variety of pathologies was observed on the permanent teeth from the Ganj Dareh series. Some, such as the deposits of cementum on the tooth roots (hypercementosis) and calculus on the perienamel surfaces, were fairly common. Others, including dental caries, enamel hypoplasia and abnormal attrition occurred less frequently. These pathologies and their etiologies are discussed below.

The incidence of each pathology is presented based upon the number of possible observations. These sample sizes normally represented the number of intact and identified teeth in the arcade as in the case of dental caries or calculus, corresponding to the sample sizes used in the metric analyses. However, sample sizes used to determine the incidence of hypercementosis were reduced for two reasons. First, loose teeth are required for observing the deposits. Second, tooth roots with deposits but without association with a morphologically identifiable crown could not be positioned in the arcade. As a result, frequencies of hypercementosis only approximate the true frequencies observable only through the use of radiographs.

TABLE 9

ACCESSORY CUSPS

	Maxillary						Mandibular					
	Carabelli's Cusp						Protostylid					
	u	b	fo	%o	fi	%i	u	b	fo	%o	fi	%i
M3	–	–	0/4	0	0/2	0	–	–	0/6	0	0/4	0
M2	2	–	2/9	22	2/5	40	–	–	0/10	0	0/6	0
M1	–	1	2/8	25	1/5	20	–	–	0/5	0	0/5	0

Frequencies of the three most common dental pathologies are presented in Table 10. Four aspects of the examination are reported as follows:

1) fo labels the frequency of infected teeth from a specified position in the arcade compared to the total from this position. The corresponding percentage is given as %o.

2) fO reports the frequency of infected teeth in the arcade compared to the total from the 16 positions in that arcade. The percentage is labelled as %O.

3) FO reports the frequency of infected teeth from both arcades compared to the total sample. The percentage is shown as F%.

4) fi represents the number of individuals having infected teeth, compared to the number of individuals represented by teeth. The percentage is shown as %i.

<u>Calculus</u>

Calculus (salivary calculus) affected teeth from four individuals (6113,22004,61017 and 42040). When both antimeres were available, calculus was seen bilaterally. Calculus deposits are extremely durable salivary precipitates whose primary composition is calcium phosphate and calcium carbonate (Black,'20,p.73). These irregular formations are found in the area of the cervical neck above the gingival line. Initially deposited as a soft "agglutinin" (Black,'20,p.73), calculus hardens after

TABLE 10

FREQUENCIES[a] OF DENTAL PATHOLOGIES IN GANJ DAREH PERMANENT TEETH

	CALCULUS				HYPERCEMENTOSIS				CARIES			
	maxilla		mandible		maxilla		mandible		maxilla		mandible	
	(fo)	(%o)	(fo)	(%o)	(fo)	(%o)	(fo)	(%o)	(fo)	(%o)	(fo)	(%o)
M3	0/ 4	0	0/ 9	0	0/ 1	0	3/ 6	50	0/ 4	0	2/ 9	22
M2	0/ 1	0	1/16	6	0/ 4	0	6/10	60	0/11	0	1/16	6
M1	1/ 7	4	1/22	5	0/ 3	0	4/ 5	80	0/ 7	0	0/22	0
P4	0/11	0	0/14	0	2/ 4	50	2/ 3	67	0/11	0	0/14	0
P3	2/ 9	22	0/15	0	1/ 3	33	2/ 6	33	0/ 9	0	2/15	13
C	2/13	15	4/12	33	1/ 5	20	2/ 5	40	0/13	0	0/12	0
I2	1/ 9	11	4/12	33	0/ 4	0	2/ 7	29	0/ 9	0	0/12	0
I1	2/14	14	4/11	36	1/ 4	25	2/ 6	33	0/14	0	0/11	0
	(fO)	(%O)	(fO)	(%O)	(fO)	(%O)	(fO)	(%O)	(fO)	(%O)	(fO)	(%O)
	8/78	10.3	14/111	12.6	5/28	17.9	23/48	47.9	0/78	0	5/111	4.5
	(fi)	(%i)	(fi)	(%i)	(fi)	(%i)	(fi)	(%i)	(fi)	(%i)	(fi)	(%i)
	4/9	44.4	2/14	14.3	4/7	57.1	4/7	57.1	0/9	0	2/14	14.3
	(FO)		(F%)		(FO)		(F%)		(FO)		(%O)	
	22/189		11.6		28/72		38.8		5/189		2.6	

[a] See text for explanation of frequencies

24 hours. Subsequently, "it continues to increase in hardness for one or two months, and at this time is fully hard" (Black,'20,p.74).

Deposits of salivary calculus were observed on 11.6 percent of all teeth examined (10.3 percent maxillary and 12.6 percent mandibular) representing 44.4 percent of individuals (maxillary %i). Generally, deposits were concentrated in the anterior dentitions. The prevalence of calculus on anterior teeth is unexpected as these would be relatively easy to clean. The cheek teeth, particularly the buccal aspect, would be more difficult to clean.

Hypercementosis

Irregular incremental formations of cementum in the periapical areas of the tooth roots were observed on the loose teeth from four individuals (2204,41020,42022 and 53037). These are deposits of avascular cementum laid down in response to movement of the root in the alveolus (Black, '20,p.33). Cementoclasts from the periodontal membrane are responsible for resorption of cementum, dentin, and tooth pulp, as well as the membrane itself, during exfoliation of deciduous teeth. Resorption also occurs when permanent tooth roots move against the periodontal membrane securing them within the alveolus, or when a partial detachment of the tooth from the membrane occurs (Black,'20, p.33). Subsequent repair is made by cementoblasts from the membrane by depositing cementum around the traumatized area. Deposits may obscure the root of individual teeth, or may more extend to roots of adjacent teeth. This latter condition requires considerable destruction of the inter-dental alveolar bone and usually occurs in the premolar-molar area of the arcade.

Table 10 shows that four of seven individuals examined had deposits of hypercementosis in both arcades. Deposits were found most frequently in mandibular teeth, with only sporadic infection in maxillary teeth. Lower two-rooted molars show between 80 and 50 percent involvement (%o; M1 and M3), while the more securely rooted maxillary molars show no trace of hypercementosis. The total frequency (F%) shows that 38.8 percent of loose teeth had been traumatized to some degree.

Caries

Enamel destruction caused by cariopathic micro-organisms was observed for two adult individuals. Individual 61113, represented by a complete mandible, has lesions on both third molars and on the left M2 and P3. These lesions and another on a lower P3 from Individual 41020 were found in the occlusal sulci of the teeth and no case of interproximal caries were observed. Examination of deciduous teeth showed two small occlusal caries on the dm1 of Individual 13010. This observation was not included in calculation of frequencies.

Concerning the etiology of caries, Hartles and Leach ('75) suggest that lesions are caused by microorganism metabolism biproducts produced at the plaque-enamel interface. Plaque formations are essentially food residue and present an ideal medium for the proliferation of cariogenic microorganisms, especially if the residue contains particles of "those carbohydrates capable of being fermented to acid by the bacterial aggregates...(Hartles and Leach,'75,p.137)". Other factors influencing caries frequencies, consist of the types of food, the length of time it is retained in the mouth (P. Smith,'70,p.23), food texture, repeated actions of traumata, and ethnic factors (*i.e.*, cooking techniques) (Janssens,'70,p.94).

In populations dating before and after the Neolithic, there is little evidence to show that an increased dependence on cereal foods was directly responsible for any increase in caries. This is based on data from the Levant, the area for which there is most information (P. Smith,'70). Data for six Natufian sites show caries frequencies ranging from 6.8 percent for Nahal Oren, to 0.0 percent for HaYonim, with an average incidence of 2.5 percent. Incidence for Jericho Pre-Pottery Neolithic B and the later Jericho Bronze Age components are slightly lower than the Natufian average, at 1.7 and 2.3 percent, respectively (P. Smith,'70, Table 16). Ganj Dareh Tepe is comparable to the Natufian average at 2.6 percent (Table 10).

Collectively, these sites are quite similar and show a contrast to Tepe Hissar whose frequencies for individual tooth groups range from 5.8 to 41.2 percent (Krogman,'38, p.53).

Isolated Dental Pathologies

Connsidered under this heading are several pathologies observed in low frequencies and for which comparative data are unavailable. These include idiosyncratic tooth wear, enamel hypoplasia and tooth colouration.

Wear, Tooth Loss and Alveolar Resorption

As mentioned above in the section on molar cusp morphology, advanced attrition removes the enamel from the occluding tooth surfaces. In such cases there is progressive exposure of the dentin and the pulp chamber. In itself, this exposure of the underlying tooth structures is not pathological but may lead to sepsis. Advanced attrition is is common in populations whose diet includes coarse or gritty food, sand or clay particles (Wolpoff,'71; Scott,'79), or in populations showing longevity.

The normal response to dentin exposure is the formation of secondary dentin. This acts as a buffering tissue to seal avanues to the pulp chamber against invasion by septic organisms. Secondary dentin also provides an efficient, though less durable replacement for lost enamel.

Abnormal attrition patterns were observed on teeth from two individuals from Ganj Dareh Tepe. Individual

61113 shows excessive wear on the buccal sides of the front molars and the right second molar. Exposed areas are covered by well polished secondary dentin while lingual aspects of the occlusal surfaces show only slight wear. A similar pattern is evident on the right mandibular molar from Individual 42022. Again, the lingual surface of the tooth shows little wear on the surface. The buccal side of this tooth is represented by a thin enamel ridge rising to just below the original occlusal plane. A deep depression runs parallel to the mesio-distal axis berween the intact lingual cusps and the buccal enamel ridge. Polished secondary dentin is present in this depression protecting the pulp chamber.

Both individuals show some evidence of alveolar resorption causing exfoliation of permanent teeth. Individual 61113 has lost the left canine and adjacent incisor. Both alveoli have been obliterated by subsequent resorption. This individual is between 25 and 28 years of age. The second individual is between 30 and 35 years of age. In this case the left central incisor has been lost and some resorption is apparent. These were the only cases of *ante mortem* tooth loss.

Enamel Hypoplasia and Banding

Enamel hypoplasia is characterized by horizontally aligned pits of grooves, or both, in the sides of teeth (McHenry and Schultz,'76). It is regarded as a response to an array of systemic disorders caused by infection. In nonhuman animals, the enamel defect occurs in mice and guinea pigs with tuberculosis, and in dogs and swine with rickets (Kreshover,'60,pp.163-164). In humans, defects occur in conjunction with rickets, scarlet fever, rubella, varicella, rubeola and herpes zoster (Kreshover,'60, pp.163-164; Brothwell,'72,p.152). Trauma experienced by the foetus before or during birth might also be implicated (Black,'20). However, El-Najjar and his coworkers ('78) suggest that enamel hypoplasia is idiopathic and, therefore, not the result of, nor symptomatic of, other diseases.

Dentitions from three individuals show changes characteristic of hypoplasia. These include a 10 year old preadolescent (13010) and an 18 year old female (22004). Individual (42040), with a variety of other dental abnormalities (Chapter III), also shows enamel hypoplasia. The permanent teeth have enamel in the form of multiple horizontal ridges. Ridges were not well developed and no pitting was observed. Molars were not affected.

All teeth from Individual 13010 with enamel hypoplasia also show distinct bands of blue-green colouration, both interspersed between the enamel ridges and in the area of the cervical neck. No explanation is offered for this colouration but it may better result of a metabolic abnormality.

Ground and stained (Prussian Blue) transverse thin sections were obtained from an affected premolar fragment. While the original colour was removed through decalcification, microscpoic examination revealed numerous brown coloured club-like projections radiating through the dentin from the pulp chamber. These are of various lengths and the majority stop just short of the inner margin of the enamel. They are generally in the same orientation as the dentin tubules but are consistently many times the diameter suggesting that the projections are not simply the result of tubule sclerosis. While their origin appears to be the pulp chamber (Dr. R.J. Trott, Dr. R. Holland, pers. comms.), the cause of these projections is not yet known and this type of tooth restructuring has not been previously reported.

One suggestion for the cause of these projections is that they are the result of some metabolic disturbance, possibly the same disturbance responsible for the presence of enamel hypoplasia on the same teeth. Examination of the unerupted mandibular canine shows that both conditions are present slightly above the cemento-enamel junction. This indicates that the cause of each was operating simultaneously. It is not likely that the colouration occurs as the result of teeth being exposed to a colouring agent post mortem because the canine is still well below the level of the alveolar bone in which it is seated.

CHAPTER V

ANALYTICAL TECHNIQUES

Samples of mandibular and postcranial variates from males and females, and odontometric samples with sexes pooled are used to examine between-sex, within-sex and between-site differences and similarities. It is assumed that the Ganj Dareh samples are sufficiently large to examine the ubiquitous differences associated with sexual dimorphism within and between populations, as well as those associated with the relative development of each sex from different sites. Samples of Ganj Dareh Tepe tooth measurements and their derived indices are also used in comparison with similar samples representing other biological populations. The various techniques used in these separate analyses are discussed below by anatomical complex.

Composition of Samples

Because of the small sample sizes, the following procedure was used to augment the number of observations. Previous studies have shown no significant differences between bilateral measurements (Parsons,'14' Trotter and Gleser,'58; van Gerven,'74). This relationship is assumed for bilateral measurements from Ganj Dareh Tepe. Observations from the right side comprise the base sample for each variate. When observations were bilateral, left side measurements were excluded. When a measurement was observed only for left side, it was included in the sample. The final number of observations in any sample represents a maximum number of skeletons.

Following this procedure, mandibular and postcranial summary statistics were calculated for each variate. These are termed "modified summary statistics" to distinguish them from the sample statistics calculated for each side separately ("unmodified summary statistics", Appendix B). Modified statistics are shown in Tables 11 - 14, and, for bilateral variates, are denoted by the biometric symbols for the right side. Odontometric statistics are also modified and are shown in Chapter VI (Comparative Samples).

The Cranial And Postcranial Complexes

Student's t-Test

The Student's t-test, or t-statistic, is a parametric statistic designed for use with small samples (Sokal and Rohlf,'69). The test determines a score that estimates the probability that the samples have been drawn from different populations. The weighted distributions of the samples are considered by the test in determining the

TABLE 11

MODIFIED MANDIBULAR SUMMARY STATISTICS
GANJ DAREH TEPE, MALES

Dimension	n	$\bar{x}$	s.d.	min	max
BCB	2	111.5	10.61	104	119
BGB	2	91.0	8.49	85	97
MBL	3	84.3	8.74	77	94
RHR*	2	60.5	6.36	56	65
AVR*	3	59.0	5.57	53	64
ARM*	2	114.3	5.30	111	118
RBR*	4	35.5	3.79	33	41
RCM*	4	26.0	2.00	23	27
RCP*	4	32.8	6.24	29	42
SYN	4	34.8	2.36	33	38
ANS	5	83.0	5.70	75	90

*left side only

TABLE 12

MODIFIED MANDIBULAR SUMMARY STATISTICS
GANJ DAREH TEPE, FEMALES

Dimension	n	$\bar{x}$	s.d.	min	max
BCB	0	-	-	-	-
BGB	1	94	-	-	-
MBL	0	-	-	-	-
RHR	0	-	-	-	-
AVR	0	-	-	-	-
ARM	0	-	-	-	-
RBR*	1	32	-	-	-
RCM	2	23.5	3.54	21	26
RCP*	1	31	-	-	-
SYN	0	-	-	-	-
ANS	1	84	-	-	-

*left side only

TABLE 13

MODIFIED POSTCRANIAL SUMMARY STATISTICS
GANJ DAREH TEPE, MALES

Dimension	n	$\bar{x}$	s.d.	min	max
HUMERUS					
HXR*	1	329	-	-	-
HPR*	1	324	-	-	-
HMR	4	69.0	9.56	61	80
PMD	4	64.3	8.69	55	75
HRD	4	23.5	3.51	20	26
HDD	4	19.0	3.16	16	23
RADIUS					
RXR*	1	258	-	-	-
RPR*	1	247	-	-	-
PRL	4	40.3	5.06	34	46
RXD	2	15.0	4.24	12	18
RLD	2	12.0	1.41	11	13
ULNA					
UXR*	1	279	-	-	-
UPR*	1	248	-	-	-
UMR	4	39.3	2.99	35	42
UTR	5	20.8	3.11	18	26
UAR	5	23.4	2.61	20	27
FEMUR					
FXR	0	-	-	-	-
FOR	0	-	-	-	-
FTR	0	-	-	-	-
ARP	2	31.0	4.24	28	34

TABLE 13 --*Continued*

Dimension	n	$\bar{x}$	s.d.	min	max
FEMUR (Cont.)					
FMR	3	27.7	4.04	24	32
FTD	2	33.0	7.07	28	38
RTF	2	24.0	4.24	21	27
FDR*	2	47.0	0.00	(47)	
HDR	2	49.5	3.54	47	52
CGW	0	-	-	-	-
TIBIA					
TRT	0	-	-	-	-
OTR	0	-	-	-	-
PTD	0	-	-	-	-
TTD	0	-	-	-	-
CTR	0	-	-	-	-
PATELLA					
PXR	4	41.8	3.40	39	46
PBR	4	44.8	2.50	42	48
AXIS					
XAX	1	36	-	-	-
TALUS					
XTR	6	57.5	3.89	52	62
TMR	6	43.5	4.37	38	50
HTR	6	30.0	1.55	29	33
CALCANEUS					
CXR	2	77.0	5.65	73	81
CMR	2	26.0	4.24	23	29
HCR	2	39.0	7.07	34	44

TABLE 13 --Continued

Dimension	n	$\bar{x}$	s.d.	min	max
CLAVICLE					
XRG	0	-	-	-	-
RPC	0	-	-	-	-
CXD	0	-	-	-	-

*left side only

TABLE 14

MODIFIED POSTCRANIAL SUMMARY STATISTICS
GANJ DAREH TEPE, FEMALES

Dimension	n	$\bar{x}$	s.d.	min	max
HUMERUS					
HXR	2	308.0	19.80	294	322
HPR	2	304.0	19.80	290	318
HMD	6	58.5	6.92	50	64
PMD	7	56.1	5.40	50	67
HRD	7	20.3	2.63	18	25
HDD	7	15.6	1.51	13	17
RADIUS					
RXR*	1	233	-	-	-
RPR*	1	226	-	-	-
PRL	5	37.2	1.79	35	40
RXD	5	14.4	2.07	12	17
RLD	5	10.4	1.14	9	12
ULNA					
UXR	3	258.7	15.01	250	270
UPR	3	222.7	8.15	217	232
UMR	5	32.8	2.28	30	35
UTR	5	18.4	1.14	17	20
UAR	6	20.5	2.35	17	23
FEMUR					
FXR*	1	446	-	-	-
FOR*	1	440	-	-	-
FTR*	1	420	-	-	-
ARP	7	27.7	3.09	23	30
FMR	6	23.8	1.33	23	26

TABLE 14--Continued

Dimension	n	$\bar{x}$	s.d.	min	max
FEMUR (Cont.)					
FTD	5	29.4	2.70	26	33
RTF	5	24.0	1.23	22	25
FDR*	4	42.3	2.50	39	45
HDR*	3	42.3	2.89	39	44
CGW*	1	74	-	-	-
TIBIA*					
TRT	1	370	-	-	-
OTR	1	367	-	-	-
PTD	1	33	-	-	-
TTD	1	25	-	-	-
CTR	1	72	-	-	-
FIBULA*					
IXR	2	345.0	7.07	340	350
PATELLA					
PXR	6	38.0	2.00	35	41
PBR	6	39.0	2.20	35	41
AXIS					
XAX	1	35	-	-	-
TALUS					
XTR	5	52.8	3.63	49	55
TMR	5	41.4	4.62	35	48
HTR	5	27.8	2.28	25	30
CLAVICLE					
XRC*	1	134	-	-	-
RPC*	2	33.0	2.83	31	35
CXD*	1	19	-	-	-

*left side only

t score. The smaller the value of "t", the more likely that the samples represent the same population.

It is conventional to accept a probability of 0.05 or less as a critical level for rejection of the null hypothesis. The $p \leq 0.05$ level is used for all comparisons involving the t-test and mandibular and postcranial variates.

Two formulae for calculation of t-scores are shown in Table 15. Formula 1 is used when the number of observations in neither sample is less than two ($n_1 \geq n_2 \geq 1$). Formula 2 is used when one of two samples is comprised of a single observation.

As the numerator for both formulae is the difference between male and female sample means, the value from the test can be either negative or positive. Therefore, in testing for differences between sexes, the female mean is subtracted from the male sample mean. In comparisons to determine differences between samples of the same sex from different sites, the comparative mean value is subtracted from the mean representing Ganj Dareh Tepe. Positive and negative values of t, degrees of freedom for the test, and exact probabilities to three decimals are presented in later tables.

Index of Sexual Dimorphism

In cases where metric data are available for both sexes and the same variate, between-sex comparisons are made using Formula 3 (after Black,'78,p.78). This

TABLE 15

FORMULAE

1 Student's t-Test: comparison of two samples with known distributions indicated by variance (σ^2).

$$t_{(d.f.)} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1-1)\sigma_1^2 + (n_2-1)\sigma_2^2}{(n_1 + n_2) - 2} \cdot \frac{n_1 + n_2}{n_1 \times n_2}}}$$

2 t-Test variant: comparison of a single observation with a sample with known distribution.

$$t_{(d.f.)} = \frac{\bar{x}_{sample} - \text{Observation}_i}{s.d._{sample}}$$

3 I_{SD} : Index of Sexual Dimorphism.

$$I_{SD} = ((\bar{x}_{male} / \bar{x}_{female}) \times 100) - 100.$$

4 I_{SC} : Index of Sexual Difference.

$$I_{SC} = ((\bar{x}_{sex_1} / \bar{x}_{same\ sex_2}) \times 100) - 100.$$

5 Formula for determining s.d. from the SE_M:

$$\sigma = \sqrt{n(SE_M)}$$

results in a value for "the Index of Sexual Dimorphism" (I_{SD}), a measure of the difference between male and female sample means for a class of variates, expressed as a percent difference from 0.0 percent. This latter value represents the result from a comparison of identical means and signifies no sex difference. The I_{SD} is expressed as either positive or negative according to the value for the quotient. Positive values result when the male mean is the larger of the two means, while a negative index results when the female mean is the larger.

The Index of Sexual Dimorphism differs from the t-test in several ways. Results are not affected by sample sizes, nor is sample variation considered. In addition, the problems associated with Type 1 and Type 2 errors and levels of significance are eliminated.

For comparative purposes, the Index is used to compare Ganj Dareh to Tepe Hissar and Lerna using modified data for the mandible (representing the cranial complex) and for the postcranial complex. Comparisons are made when indices can be calculated for Ganj Dareh Tepe and at least one comparative sample. In several cases, the absence of data from Ganj Dareh Tepe precludes making a number of comparisons.

Index of Sexual Difference

Metric data from the mandible and postcranial skeleton are used to compare variates from one sex from

Ganj Dareh Tepe to the same sex from Tepe Hissar and Lerna. The Index of Sexual Difference (I_{SC}) is used for this purpose. The I_{SC} differs from the I_{SD} because here comparisons are made between the same sex, represented by male and female samples, and between different sites. Calculation of the I_{SC} quantifies metric differences (or similarities) that may be the result of cultural and/or environmental influences experienced by the various populations under study (Brues,'59; Stini,'71).

The Index of Sexual Difference is a non-classic measure with regard to the data it compares. It is calculated using the same basic formula as that used for the I_{SD}, except that the standardized mean in the denominator is that for the compared Ganj Dareh Tepe variate (Formula 4, sex_1). Here, percent difference is evaluated with respect to Ganj Dareh Tepe sample means in each case. Like the I_{SD}, comparison of two identical means results in a percent difference of 0.0. In addition, positive and negative results are possible. A negative index indicates a smaller mean for Ganj Dareh Tepe. A positive result indicates the opposite relationship.

The Dental Complex

Distributions of p

Samples of teeth from Ganj Dareh are compared to samples reported by P. Smith ('70) and Dahlberg ('60) using the t statistic. The values of t and the corresponding probabilities are calculated, but instead of examining only significant results, all probabilities are treated as indicators of relative distance between Ganj Dareh and the comparative sample. Positive and negative signs, indicating the direction of difference, are determined from the value of the numerator that results from subtracting the comparative sample mean from the appropriate Ganj Dareh mean.

Probabilities are graphed and the positions of Ganj Dareh samples are assessed relative to the positions of selected comparative samples. The results of examination of the distributions are presented in Chapter VII.

Dental Shape and Robusticity

Indices of shape and robusticity are calculated for samples of individual upper and lower teeth. Results are presented in Table 40, accompanied by the results from Natufian and Jericho samples presented by P. Smith ('70, Table 8).

The formula used by P. Smith ('70) for the shape index appears in Table 39. The resulting computation is the reciprocal result of that used by Wolpoff ('71) for the index of shape. The index of robusticity (P.Smith,'70) is the product of multiplying the mesiodistal dimension by the buccolingual dimension. This operation is the same as that for Wolpoff's 'crown area' ('71). These index values are presented in Appendix A (Tables A-10 and A-11).

Because raw data for Smith's samples are unavailable, comparisons are made between averaged Natufian indices for each tooth and samples from Ganj Dareh Tepe, Jericho PPNB, Jericho Bronze, and the Natufian sample from Erq el Ahmar. This last sample is excluded in calculation of Natufian group means because Erq el Ahmar indices are consistently outside the range of the combined Natufian groups. The two Jericho groups are included because they post-date the Natufian and are culturally different. Also, the skeletal morphology of the PPNB group is different from Natufian finds (P. Smith,'70, citing McCown,'39). The Jericho Bronze group is compared in order to examine any biological relationships that it may have to the PPNB group. Data for the calculation of indices for Jarmo are unavailable.

In this analysis, differences are suggested when a comparative index is larger or smaller than the Natufian group mean by more than two standard deviations. Because the Natufian group is approximately two millenia earlier than the comparative samples, differences should be expected.

CHAPTER VI

COMPARATIVE SAMPLES

Data describing the three anatomical complexes were taken from several sources dealing with different skeletal samples. With the exception of a modern sample from Chicago (Dahlberg,'60), samples represent prehistoric populations living between 10,000 B.C. and 6000 B.C. (Table 16), in the Near East and the Mediterranean (fig. 5). During this period, several major changes occurred in the Near East in technology (Braidwood,'58; Dyson,'68), settlement patterns (Mortensen,'72) and subsistence (Cohen,'77). The latter shift was from a long tradition of hunting and gathering, dating from pre-Würm times to ca. 8500 - 8000 B.C. (Braidwood,'58; Wright,'76), to an economy based on plant (Harlan,'75) and animal (Protsch and Berger,'73) domesticates. Lithic technology was replaced by metallurgy and invention of pottery.

In the selection of comparative samples, preference was given to sources describing skeletal material from sites in the Near East dating near the beginning of the Holocene. As several examinations carried out in this

TABLE 16

MATERIAL STUDIED

YEARS B.C.	REGION*				
	Iran	Iraq	Israel	Greece	New World
2000- 500				Lerna [3]	Chicago [2] (modern)
4000-2000	Tepe [4] Hissar		Jericho [1] Bronze		
6000-4000					
8500-6000	Ganj Dareh Tepe	Jarmo [2]	Jericho [1] PPNB		
10,000-8000			Natufian [1,2] sites (8)		

1 Smith, P. ('70)
2 Dahlberg ('60)
3 Angel ('71)
4 Krogman ('40)

*modified after P.Smith ('70)

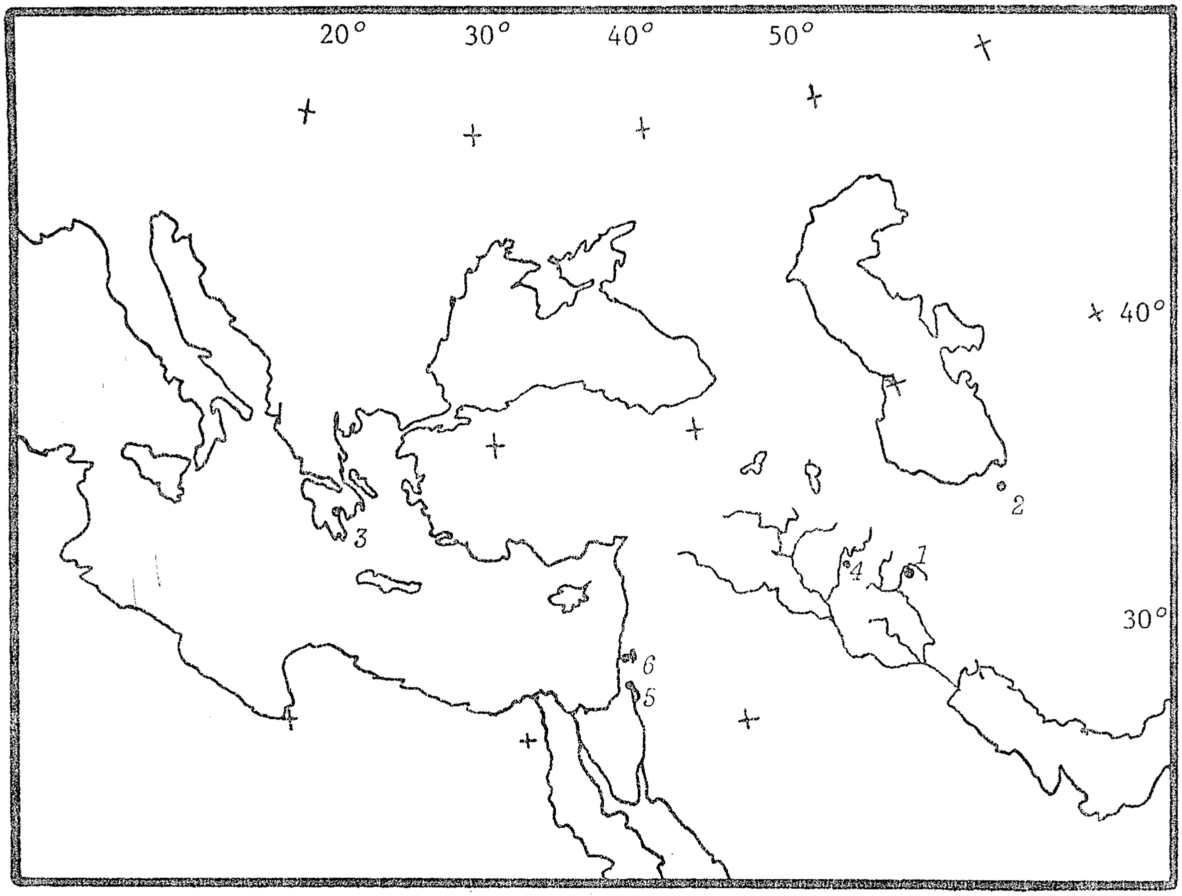


Fig. 5 LOCATIONS OF GANJ DAREH TEPE AND COMPARATIVE SITES

1 Ganj Dareh Tepe

2 Tepe Hissar

3 Lerna

4 Jarmo

5 Jericho
- PPNB
- Bronze

6 Natufian Sites
- El Wad
- Eynan
- Kebara
- Erq el Ahmar
- Shukba
- HaYonim
- Nahal Oren

work involve between-sex comparison, information concerning age and sex estimates was necessary. Zawi Chemi Shanidar was excluded because these data were not supplied (Ferembach,'70). Finally, it was desirable to use sources when some data manipulation was required such as was the case in following the procedure for maximizing sample sizes and standardization of classes (Chapter II). Yet the data supplied by these sources were sometimes not directly comparable to those from Ganj Dareh. These have been modified following the techniques appearing below in descriptions of the appropriate samples.

It should be noted that craniometric comparisons were not attempted in this work. Despite the previous work on crania from the Near East (Finkel,'76) and Greece (Angel, '71 on Lerna), there are no studies concerning artificially deformed specimens. Ganj Dareh craniometrics are reported in appendices. The mandible represents the cranial complex in subsequent comparisons.

No comparisons were made using cranial epigenetic traits or dental non-metrics. For Ganj Dareh, these were represented by very small frequencies and have not been systematically collected for other Near Eastern samples.

Sites With Cranial and Postcranial Data

Bronze Age Samples

Tepe Hissar, Iran

Tepe Hissar is located near Damghan, north-eastern Iran, near the south shore of the Caspian Sea. The extensive Iranian Central Plateau impedes contact with the east, while strong western influences, characterized by stylistic changes in pottery at the beginning of the Hissar II Level, are apparent (Bray and Trump,'75,p.104).

Three periods have been identified from Tepe Hissar by Schmidt ('37,p.320; in Krogman,'40a,p.6; Dyson, '72,p.312), as follows:

Hissar I - _ca_. 4000 B.C. to _ca_. 3000 B.C.
Hissar II - _ca_. 3000 B.C. to _ca_. 2600 B.C.
Hissar III - _ca_. 2600 B.C. to _ca_. 2000 B.C.

Burney ('77,p.149) suggests that Hissar III began with an invasion that came from the area of the Turkoman Steppe. This change of cultural influence is marked by sudden replacement of the previous pottery by Gurgan grey-ware. Schmidt recovered skeletal remains representing in excess of 1600 individuals from these three cultural periods. However, Nowell ('78,p.271) points out that fewer than 250 individuals comprised the sample used by Krogman ('40a,b,c). Nowell ('78) suggests that Schmidt's excavation techniques were inadequate as many skeletons were surface finds and the remainder, found below the ground surface, were excavated without sufficient control.

Krogman ('40a) provides mandibular and postcranial measurements for this sample (Krogman,'40a, Tables A - D). A total of 89 adult males and 44 adult females were represented. Summary statistics for right side variates, by sex, are presented in Tables 17 - 18 for the mandible and Tables 19 - 20 for the postcranial complex.

Lerna, Greece

Lerna is located near Argos in the Peloponnese (fig. 5, site 3). Levels from this site represent components of a continuous occupation dating from the Neolithic Age (ca. 6000 B.C.) to Roman times (ca. 200 A.D.) (Caskey, '56, Angel,'71). The majority of human remains from Lerna date to the Middle Bronze Age (ca. 2000 B.C. and 1600 B.C.) (Angel,'71). This subsample is comprised of 65 adults representing 39 males and 26 females. These results were supplied as raw data (Angel,'71, Tables 14 - 15). Data from the right side were used to calculate summary statistics by sex for comparisons with Ganj Dareh. Sample parameters are reported in Tables 17 through 20 for both sexes.

Sites With Dental Data

Measurements for comparative samples are supplied by (Dahlberg,'60) and P. Smith ('70). Twelve samples were used including 11 from archaeological sites dating between 10,000 and 4000 B.C. and one modern North American sample of European derivation (Table 16,p.114). Figure 5 shows the location of the archaeological sites. They are distributed over a large geographical area whose past environment and resources were similar. Vegetation included large stands of potential domesticates, particularly

TABLE 17

SUMMARY STATISTICS FOR MANDIBULAR MEASUREMENTS; TEPE HISSAR AND LERNA, MALES

Dimension	TEPE HISSAR					LERNA				
	n	$\bar{x}$	s.d.	min.	max.	n	$\bar{x}$	s.d.	min.	max.
BCB	71	115.6	5.94	96	133	29	118.3	7.29	100	139
BGB	88	92.7	6.61	68	105	39	98.2	5.20	90	108
MBL	79	108.4	4.57	98	123	-	-	-	-	-
SYH	44	32.1	3.03	25	39	24	29.2	1.96	26	33
RBR	89	33.4	2.46	27	40	39	32.2	2.51	28	37

TABLE 18

SUMMARY STATISTICS FOR MANDIBULAR MEASUREMENTS;
TEPE HISSAR AND LERNA, FEMALES

Dimension	TEPE HISSAR					LERNA				
	n	$\bar{x}$	s.d.	min.	max.	n	$\bar{x}$	s.d.	min.	max.
BCB	40	109.6	4.88	102	126	13	113.2	8.87	94	127
BGB	41	87.1	5.73	73	97	18	90.3	7.94	83	112
MBL	41	100.7	5.80	86	113	-	-	-	-	-
SYH	44	32.1	3.03	25	39	24	29.2	1.96	26	33
RBR	43	31.2	2.78	26	36	19	29.0	2.42	24	33

TABLE 19

SUMMARY STATISTICS FOR POSTCRANIAL MEASUREMENTS;
TEPE HISSAR AND LERNA, MALES

Dimension		TEPE HISSAR					LERNA				
		n	$\bar{x}$	s.d.	min.	max.	n	$\bar{x}$	s.d.	min.	max.
HUMERUS	HXR	36	314.4	14.50	292	347	20	310.3	11.27	290	340
	HRD	-	-	-	-	-	27	22.7	1.23	18	25
	HDD	-	-	-	-	-	27	18.0	1.13	16	20
RADIUS	RXR	37	232.3	14.05	208	260	19	238.2	11.31	217	254
ULNA	UXR	35	267.9	14.64	243	308	17	259.1	11.99	232	278
FEMUR	FXR	33	449.3	22.56	421	508	22	431.2	22.37	383	473
	ARP	33	25.8	3.06	22	31	30	25.2	2.55	20	31
	FMR	-	-	-	-	-	32	32.7	2.38	24	37
	FTD	33	32.5	2.98	24	41	33	27.1	1.65	24	31
	RTF	-	-	-	-	-	34	27.0	1.70	24	31

TABLE 19--*Continued*

Dimension		TEPE HISSAR					LERNA				
		n	$\bar{x}$	s.d.	min.	max.	n	$\bar{x}$	s.d.	min.	max.
FIBULA	IXR	27	363.4	20.36	333	405	6	340.5	12.23	327	355
TALUS	XTR	-	-	-	-	-	25	52.1	2.34	49	57
	TMR	-	-	-	-	-	26	42.4	2.12	40	47
	HTR	-	-	-	-	-	25	30.2	1.45	27	34
CALCANEUS	CXR	-	-	-	-	-	19	79.7	3.45	73	85
	CMR	-	-	-	-	-	-	-	-	-	-
	HCR	-	-	-	-	-	-	-	-	-	-
CLAVICLE	XRC	12	148.2	10.66	133	170	17	144.3	7.41	133	157

TABLE 20

SUMMARY STATISTICS FOR POSTCRANIAL MEASUREMENTS;
TEPE HISSAR AND LERNA, FEMALES

Dimension		TEPE HISSAR					LERNA				
		n	$\bar{x}$	s.d.	min.	max.	n	$\bar{x}$	s.d.	min.	max.
HUMERUS	HXR	8	289.6	12.67	269	305	19	283.1	15.22	248	312
	HRD	–	–	–	–	–	26	20.3	1.40	18	23
	HDD	–	–	–	–	–	26	15.1	1.18	14	18
RADIUS	RXR	7	212.4	12.50	197	228	17	212.2	13.48	190	235
ULNA	UXR	9	244.2	13.85	224	260	9	233.3	10.49	218	248
FEMUR	FXR	7	421.7	17.39	403	437	10	390.4	26.18	360	434
	ARP	9	23.7	1.80	22	27	13	23.5	1.71	22	27
	FMR	–	–	–	–	–	13	28.9	2.63	22	31
	FTD	7	31.3	1.89	29	34	14	24.9	2.14	21	28
	RTF	–	–	–	–	–	16	24.2	1.96	22	29

TABLE 20 --Continued

Dimension		TEPE HISSAR					LERNA				
		n	$\bar{x}$	s.d.	min.	max.	n	$\bar{x}$	s.d.	min.	max.
TIBIA	TRT	10	328.9	18.44	300	358					
	OTR	-	-	-	-	-					
	PTD	-	-	-	-	-			-		
	TTD	10	31.6	3.06	27	37					
	CTR	10	22.2	2.15	18	26					
FIBULA	IXR	6	340.2	16.19	323	362	3	305.3	4.15	302	310
TALUS	XTR	-	-	-	-	-	14	48.5	2.79	45	55
	TMR	-	-	-	-	-	15	38.9	2.14	36	44
	HTR	-	-	-	-	-	14	26.8	1.01	24	28
CALCANEUS	CXR	-	-	-	-	-	13	70.7	5.53	63	85
	CMR	-	-	-	-	-	-	-	-	-	-
	HCR	-	-	-	-	-	-	-	-	-	-

TABLE 20--Continued

Dimension	TEPE HISSAR					LERNA				
	n	$\bar{x}$	s.d.	min.	max.	n	$\bar{x}$	s.d.	min.	max.
CLAVICLE XRC	3	130.7	11.58	120	143	11	130.6	6.95	120	144

barley (Hordeum sp.)(van Zeist,'67; Harlan and Zohary,'66; Wright,'66). Animals included goats and sheep. The palaeoclimatic evidence suggests that the cool, moist conditions in the Levant and southern Iran persisted from 20,000 B.C. onwards (Butzer,'75,p.404).

P. Smith ('70, Tables 4 - 7) supplies summary data from nine Levantine samples. These data are not subdivided by sex. Reported statistics include frequencies, means and standard deviations for mesiodistal and buccolingual measurements. Mean values for size and shape indices were also provided (P. Smith,'70, Table 8). The raw data, however, were not available.

Dahlberg ('60, Table 1) provides data for mesiodistal and buccolingual diameters for three samples. These presented as sample sizes and means for two samples, measures of dispersion using the standard error of the mean (S_{EM}) are supplied. This statistic was not provided for the Jarmo sample.

P. Smith ('70) reports data from both sides of the arcade separately. Dahlberg ('60) reports data only for the right side. Tables 20 - 23 reproduce right side data from P. Smith ('70) and Dahlberg ('60) with Ganj Dareh statistics.

The samples of teeth, representing archaeological populations, are discussed below with reference to the characteristics of their individual cultural contexts.

Each comparative sample is designated by an alphabetical symbol that serves as an abbreviation of the site name in some subsequent figures and tables.

Epipalaeolithic Samples

Natufian Sites

A total of eight epipalaeolithic sites yielded dentitions suitable for examinations by P. Smith ('70) and Dahlberg ('60). Seven of these were reported by the former and include the following: El Wad or Mugharet el Wad (W); Shukba (S); Kebara (K); Eynan (E); Nahal Oren (O); Erq el Ahmar (A); and, HaYonim (H). [One further sample, from an unspecified site, is termed "Natufian" by Dahlberg ('60).]

Representing a common culture, the Natufian sites contained artifacts indicative of a subsistence base dependent upon a broad spectrum of resources (Braidwood,'58; Butzer,'71; Cohen,'77). Sickle blades have been reported from all sites while mortars and pestles were absent only from Shukba. The presence of these artifacts strongly suggests that plant processing was performed at these sites.

There is no evidence to show that plants were domesticated by the Natufian (Harlan,'75; Cohen,'77,pp.136-137), despite the availability of wild cereals. While Harlan ('67) has promoted acceptance of the idea that the numerous sickleblades could have been used for cereal harvesting, other artifacts such as mortars, pestles and, particulary, subsurface pits and bins have received some attention outside the context of plants and plant domestication (Braidwood,'69; Butzer,'71; Binford,'68; Cohen,'77). Alternate suggestion for their use include *in situ* roasting and the storage of invertebrates (Cohen,'77,p.135).

As well as exploitation of wild plants, Natufians subsisted by hunting a variety of hoofed animals such as sheep, goat and, especially, gazelle, and supplemented their diets with marine resources. Evidence for fishing comes from barbed spears or harpoons and bone fishhooks from Nahal Oren, Kebara, El Wad, Erq el Ahmar and Eynan (Ain Mallaha) (P. Smith,'70; Burney,'77; Cohen,'77; also Garrod, '58; Perrot,'68). This broad-spectrum resource base represents a much reduced dependence on large game animals that were characteristically utilized by Upper Palaeolithic groups in the Levant (Butzer,'71; Cohen,'77). However, despite this diversification, species are generally believed to be wild rather than domesticated. It should be noted that this opinion is held in spite of the recovery of wheat from Nahal Oren (Noy et al.,'73) showing morphological changes from the wild type (Cohen,'77,p.135).

Aceramic Neolithic Samples

Jericho PPNB

Sites with assemblages characteristic of a food-producing economy in the absence of a ceramic tradition fall under the above classification. In the Levant, several levels at Jericho and Beida are Pre-Pottery or Aceramic Neolithic on this basis (Burney,'77; Cohen,'77). These aceramic levels date between ca. 9000 and 6000 B.C. (Burney, '77; Cohen,'77,pp.139-140), and are roughly contemporaneous with the occupation at Ganj Dareh Tepe.

Two levels at Jericho are designated as PPNA and PPNB, signifying the absence of ceramics. The earlier of these, the PPNA, is dated to ca. 9000 B.C. and is characterized by houses with circular floor-plans, brick construction and low frequencies of stone projectile points and blades. During the 7th millenium B.C., architectural style suddenly altered with multi-roomed rectilinear structures replacing the circular style. This level also contained greated frequencies of denticulate blades, sickles and arrow-heads of both flint and obsidian (Burney,'77,pp.17-18). In the absence of ceramics, the later PPNB occupation is thought by some to represent part of the Tahunian culture (Burney,'77,pp.17-18). This group is thought to have been from the north from the vicinity of Tell Ramad.

Other lithics associated with plant processing found in the PPNB level included ground-stone querns, stone rubbers and flaked-stone sickles. Emmer and einkorn wheats were also recovered with two-rowed barley all of which showed morphological changes from the wild types and taken as evidence for domestication. Other potential domesticants were peas, lentils and horsebeans (Harlan,'75, Table 1; Cohen,'77, and citing Hopf,'69). Similar finds have been reported from Beida II and III in Jordan and Ha ilar (Cohen,'77, p.140).

Nine individuals represent the early PPNB agricultural population. In an earlier study by McCown ('39), these remains were compared to the Natufian, represented by a sample from Mugharet el Wad. The PPNB sample was found to be "more developed and finer than the typical Natufians...(McCown,'39, cited by P. Smith,'70,p.7)."

Statistics for mesiodistal and buccolingual dimensions representing the PPNB are supplied by P. Smith ('70, Tables 4-7). Derived dental indices are also supplied. As there is no provenience for individuals comprising the sample, it is not known whether they are the same plastered skulls reported by Kenyon ('72), or a combination of these and other individuals.

Ceramic Neolithic Samples

Qalat Jarmo

Jarmo (J) is situated on the bank of one of the numerous *wadis* on the Chemchemal intermontane plain in Iraqi Kurdistan (fig. 5, site 4) (Braidwood and Howe,'60,p.26). Though radiocarbon dates first suggested that the site had been occupied for a duration of *ca.* 7000 years, these have been questioned by most authors, including Briadwood ('74, p.77), as inaccurate. An alternative duration, based on bone collagen assays (Protsch and Berger,'73,p.235) is about two millenia. Braidwood also rejects this estimate, preferring to accept an initial date of *ca*. 6000 B.C. and a duration of only 500 years (Braidwood,'74,p.77), apparently because the artifact assemblage at Jarmo is very similar to that from the securely dated Turkish site of Cayönü.

Prior to the initial date for Jarmo, several sites were occupied in this general area by groups characterized by big-game hunting in the Upper Palaeolithic tradition. This is called Zarzian after the site where it was first identified (Garrod,'30). The Zarzian is characterized by a microlithic industry and the presence of some groundstone artifacts (Braidwood and Howe,'60). Subsurface pits have also been found in association with the Zarzian (Cohen, '77). Other sites with typically Zarzian assemblages include Palegawra (Braidwood and Howe,'60), Shanidar (Solecki, '64) and Zawi Shemi (Solecki,'69) in Iraq, and in Natufian sites (Cohen,'77 citing various authors,p.135). Faunal remains from these sites included undomesticated pig, goat, cattle, sheep, gazelle and deer. These were identified from the Palegawran Zarzian (Braidwood and Howe,'60) dating *ca*. 7000 years before Jarmo (Braidwood, '74).

Later, during the Jarmo occupation, subsistence resources included domesticated einkorn , emmer and hulled two-row barley and domesticated goat, sheep, pig, and possibly, dog (Harlan,'75,pp.179-180 and Table 1). This is the earliest domesticated pig find for the Near East. Lithics at the Jarmo site also differ from the Zarzian with microliths occurring in reduced frequencies and chipped-stone tools in greater frequencies. Numerous celts, mortars, pestles and elaborate bowls represented various utilitarian aspects of a well developed ground-stone industry that included bracelets, rings and beads (Braidwood and Howe,'60, pp.45-46).

Ceramics in the form of pottery, nonportable basin rims and figurines were found in the upper one-third of the site (Braidwood and Howe,'60; Meiklejohn, pers. comm.).

Excavations through 16 levels of <u>tauf</u> construction recovered remains of seven individuals. Braidwood and Howe ('60,p.194) suggest that these flexed sub-floor interments were probably killed by roof cave-in. Successive structures had been built over the rubble. They also suggest that the inhabitants normally buried their dead outside the limits of the seven acre mound (Braidwood and Howe,'60,p.46).

A total of 96 permanent teeth represent the Jarmo (J) sample used in this study. Dahlberg ('60, Table 1) reports mesiodistal and buccolingual measurements in summary form. Because raw data are made by treating the reported mean values as observations representing individuals (Chapter V, formula 2). Indices were not calculated for this sample.

Bronze Age Samples

Jericho Bronze

The latest prehistoric sample from the Near East is from Bronze Age levels at Jericho. This component is divided into Early (E.B.), Middle (M.B.) and Late Bronze Age Periods on the basis of architectural changes (Burney, '77). An intrusion of Hurrian peoples from eastern Anatolia marked an end of the E.B. period. These people may have come through Syria into the Plain of Antioch and the Levant (Burney,'77,p.101; Meiklejohn, pers. comm.). The Jericho settlement is dated from ca. 4000 to 1000 B.C. during which time, Jericho represented an important center of Hyksos resistance of Egyptian expansion during the 18th Dynasty (Burney'77,p.101).

During the Bronze Age, Jericho was an important economic center controlling the Dead Sea salt resources (Burney,'77; Whitehouse and Whitehouse,'75). There is also evidence for Jericho's importance as a trade center. This is based on the presence of a variety of clay tokens and bullae at Jericho and at a large number of other sites to the west and south. Tokens and bullae similar to these have been reported from Ganj Dareh Tepe (Schmandt-Besserat, '78).

Odontometrics supplied by P. Smith ('70) represent 10 individuals from the Early Bronze Age component at Jericho (*ca.* the beginning of the Fourth Millenium B.C.). The dentitions from this level sample the population living just prior to the Hurrian intrusion marking the beginning of the Middle Bronze period. Summary statistics from tooth diameters and derived indices are used in comparisons with Ganj Dareh Tepe.

Modern Samples

Chicago

Dahlberg ('60) offers no information concerning either the basis for selection or the genetic and socio-economic backgrounds of the white male individuals comprising his Chicago sample. Presumably, all of these individuals were hybridized to some extent as undoubtedly the population of Chicago was originally derived rrom a number of different areas in Europe. The Chicago sample (C) is used in comparison with the segregated male sample from Ganj Dareh Tepe.

TABLE 21

SUMMARY STATISTICS FOR MAXILLARY MESIODISTAL DIAMETERS, ALL SAMPLES

	M3					M2					M1				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	3	9.8	0.6	9.1	10.3	7	10.8	0.7	10.0	11.7	4	11.4	0.4	11.2	12.0
El Wad	11	8.8	0.5	-	-	21	9.8	0.5	-	-	22	10.2	1.0	-	-
Shukba	2	8.2	1.0	-	-	2	9.7	0.3	-	-	3	10.4	0.5	-	-
Kebara	7	8.6	0.7	-	-	12	9.8	0.6	-	-	11	10.5	0.4	-	-
Eynan	5	8.9	0.4	-	-	7	9.7	0.5	-	-	8	10.9	0.7	-	-
Nahal Oren	6	8.9	1.0	-	-	7	9.7	0.5	-	-	8	10.6	0.7	-	-
Erq el Ahmar	1	9.5	-	-	-	1	10.9	-	-	-	1	10.3	-	-	-
HaYonim	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natufian	8	9.3	0.5	-	-	11	10.5	0.3	-	-	14	10.9	0.5	-	-
Jarmo	1	8.4	-	-	-	5	10.2	-	-	-	5	10.8	-	-	-
Jericho PPNB	1	8.6	-	-	-	4	10.5	0.4	-	-	9	10.6	0.6	-	-
Jericho Bronze	3	8.1	0.5	-	-	9	9.3	0.5	-	-	8	10.0	0.4	-	-
Ganj Dareh Tepe ♂	1	9.1	-	-	-	2	10.3	0.4	10.0	10.6	2	10.5	2.1	9.1	12.0
Chicago ♂	9	8.9	1.2	-	-	55	10.0	0.006	-	-	79	10.5	0.3	-	-

TABLE 21 -Continued

	P4					P3					C				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	8	7.1	0.2	6.8	7.4	6	7.5	0.5	6.9	7.9	8	7.7	1.0	6.3	8.7
El Wad	22	6.6	0.4	-	-	20	7.0	0.5	-	-	16	7.7	0.5	-	-
Shukba	2	6.5	0.4	-	-	2	6.0	0.2	-	-	2	7.4	0.4	-	-
Kebara	9	6.8	0.4	-	-	9	7.1	0.3	-	-	8	8.8	0.3	-	-
Eynan	7	6.8	0.3	-	-	7	7.3	0.2	-	-	6	8.0	0.3	-	-
Nahal Oren	6	6.6	0.6	-	-	6	7.0	0.6	-	-	5	8.0	0.3	-	-
Erq el Ahmar	1	6.5	-	-	-	1	6.5	-	-	-	1	8.3	-	-	-
HaYonim	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natufian	15	6.9	0.1	-	-	13	7.0	0.1	-	-	10	7.7	0.2	-	-
Jarmo	3	7.8	-	-	-	2	7.5	-	-	-	5	8.3	-	-	-
Jericho PPNB	4	7.0	0.7	-	-	4	7.3	1.0	-	-	1	7.6	-	-	-
Jericho Bronze	8	6.7	0.5	-	-	7	6.6	0.2	-	-	3	7.8	0.5	-	-
Ganj Dareh Tepe ♂	2	7.0	0.3	6.8	7.2	3	7.5	0.6	6.9	7.9	3	7.4	1.2	6.6	8.7
Chicago ♂	71	6.7	0.3	-	-	74	6.9	0.3	-	-	76	7.9	0.3	-	-

TABLE 21 -Continued

	I2					I1				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	6	7.3	0.6	6.4	8.1	9	8.9	0.6	7.9	9.4
El Wad	11	7.1	0.8	-	-	9	9.2	0.4	-	-
Shukba	1	6.5	-	-	-	-	-	-	-	-
Kebara	6	6.5	0.7	-	-	3	8.9	0.8	-	-
Eynan	2	7.1	0.4	-	-	2	8.6	0.1	-	-
Nahal Oren	4	7.0	0.5	-	-	4	9.2	0.3	-	-
Erq el Ahmar	1	6.9	-	-	-	1	8.8	-	-	-
HaYonim	-	-	-	-	-	-	-	-	-	-
Natufian	8	6.7	0.2	-	-	9	8.9	0.3	-	-
Jarmo	4	6.7	-	-	-	2	8.8	-	-	-
Jericho PPNB	1	6.4	-	-	-	1	8.9	-	-	-
Jericho Bronze	4	6.7	0.1	-	-	3	8.6	0.4	-	-
Ganj Dareh Tepe ♂	3	7.3	0.9	6.4	8.1	3	8.7	0.7	8.0	9.3
Chicago ♂	92	6.8	0.3	-	-	104	8.8	0.4	-	-

TABLE 22

SUMMARY STATISTICS FOR MAXILLARY BUCCULINGUAL DIAMETERS, ALL SAMPLES

	M3					M2					M1				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	3	12.6	0.6	12.2	13.2	7	12.3	0.7	11.2	13.1	4	12.3	1.0	11.2	13.4
El Wad	10	11.6	0.6	-	-	19	12.4	0.7	-	-	20	12.2	0.8	-	-
Shukba	2	10.5	1.6	-	-	2	11.1	1.0	-	-	2	12.2	0.8	-	-
Kebara	5	10.7	2.1	-	-	12	12.2	0.7	-	-	11	12.3	0.6	-	-
Eynan	5	11.2	0.7	-	-	7	11.9	0.7	-	-	7	12.4	0.4	-	-
Nahal Oren	6	11.4	1.0	-	-	7	12.1	0.7	-	-	8	12.3	0.7	-	-
Erq el Ahmar	1	11.0	-	-	-	1	12.0	-	-	-	1	12.5	-	-	-
HaYonim	5	11.5	0.4	-	-	7	12.6	0.6	-	-	6	12.4	0.3	-	-
Natufian	8	11.3	0.5	-	-	11	12.1	0.2	-	-	14	12.3	1.3	-	-
Jarmo	1	10.7	-	-	-	5	11.4	-	-	-	5	11.4	-	-	-
Jericho PPNB	1	9.4	-	-	-	1	12.3	-	-	-	1	11.9	-	-	-
Jericho Bronze	3	9.6	0.4	-	-	8	11.4	0.9	-	-	8	11.5	0.4	-	-
Ganj Dareh Tepe ♂	1	12.3	-	-	-	2	12.1	0.6	-	-	2	12.3	1.6	11.2	12.4
Chicago ♂	12	10	0.7	-	-	71	11.3	1.4	-	-	90	11.3	0.6	-	-

TABLE 22 -Continued

	P4					P3					C				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	8	9.6	0.7	8.5	10.7	5	9.9	0.4	9.3	10.4	8	8.6	1.0	7.0	10.3
El Wad	21	9.8	0.5	-	-	19	9.7	0.5	-	-	16	8.6	0.6	-	-
Shukba	2	9.4	0.6	-	-	2	9.5	0.5	-	-	1	8.2	-	-	-
Kebara	8	9.6	0.6	-	-	8	9.6	0.4	-	-	7	8.8	0.7	-	-
Eynan	7	9.8	0.6	-	-	7	9.9	0.5	-	-	6	9.0	0.4	-	-
Nahal Oren	6	9.7	0.6	-	-	6	9.8	0.8	-	-	4	8.8	0.3	-	-
Erq el Ahmar	1	9.4	-	-	-	1	9.3	-	-	-	1	8.8	-	-	-
HaYonim	6	9.6	0.5	-	-	6	10.0	0.3	-	-	4	9.2	0.3	-	-
Natufian	15	9.5	0.3	-	-	13	9.4	0.3	-	-	9	8.6	0.3	-	-
Jarmo	2	9.8	-	-	-	2	9.5	-	-	-	5	8.4	-	-	-
Jericho PPNB	1	9.8	-	-	-	1	9.5	-	-	-	1	9.4	-	-	-
Jericho Bronze	8	9.1	0.6	-	-	7	8.9	0.2	-	-	3	8.7	1.0	-	-
Ganj Dareh Tepe ♂	2	9.8	1.3	8.8	10.7	4	9.9	0.5	9.3	10.4	4	9.6	0.8	8.8	10.3
Chicago ♂	83	9.4	0.4	-	-	84	9.2	0.4	-	-	68	8.4	0.6	-	-

TABLE 22 -Continued

	I2					I1				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	7	6.9	0.3	6.5	7.3	9	7.7	0.9	6.7	9.1
El Wad	11	6.7	0.3	-	-	9	7.3	0.4	-	-
Shukba	1	6.7	-	-	-	-	-	-	-	-
Kebara	5	6.6	0.6	-	-	2	6.9	0.5	-	-
Eynan	2	6.6	0.4	-	-	2	7.1	0.2	-	-
Nahal Oren	4	6.4	0.4	-	-	4	7.5	0.1	-	-
Erq el Ahmar	1	6.8	-	-	-	1	7.5	-	-	-
HaYonim	5	6.4	0.6	-	-	4	7.4	0.3	-	-
Natufian	8	6.8	0.2	-	-	8	7.3	0.2	-	-
Jarmo	4	6.0	-	-	-	2	6.6	-	-	-
Jericho PPNB	1	6.4	-	-	-	1	6.9	-	-	-
Jericho Bronze	4	6.3	0.5	-	-	3	6.8	0.4	-	-
Ganj Dareh Tepe ♂	2	6.8	0.3	6.6	7.0	3	8.3	1.2	7.0	9.1
Chicago ♂	83	6.3	0.3	-	-	98	7.1	0.4	-	-

TABLE 23

SUMMARY STATISTICS FOR MANDIBULAR MESIODISTAL DIAMETERS, ALL SAMPLES

	M3					M2					M1				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	6	10.9	0.4	10.4	11.6	10	11.2	0.5	10.4	12.0	14	11.1	0.6	10.1	11.8
El Wad	15	10.7	0.5	-	-	19	10.8	0.4	-	-	20	11.3	0.5	-	-
Shukba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	7	10.7	0.5	-	-	12	11.0	0.7	-	-	11	11.5	0.5	-	-
Eynan	11	10.5	0.6	-	-	16	10.9	0.7	-	-	12	11.3	0.7	-	-
Nahal Oren	6	9.8	1.0	-	-	7	10.8	0.5	-	-	8	11.5	0.7	-	-
Erq el Ahmar	1	11.0	-	-	-	1	11.3	-	-	-	1	11.5	-	-	-
HaYonim	3	10.2	0.9	-	-	6	11.0	0.9	-	-	9	11.5	0.9	-	-
Natufian	14	10.9	0.2	-	-	16	11.1	0.2	-	-	16	11.5	0.2	-	-
Jarmo	2	11.1	-	-	-	6	11.0	-	-	-	6	11.4	-	-	-
Jericho PPNB	4	10.8	0.6	-	-	8	10.7	0.6	-	-	7	11.1	0.4	-	-
Jericho Bronze	6	9.9	0.6	-	-	9	10.2	0.5	-	-	8	10.4	0.5	-	-
Ganj Dareh Tepe ♂	2	10.9	0.4	10.6	11.1	3	11.1	0.6	10.5	11.5	6	11.2	0.5	10.3	11.8
Chicago ♂	7	10.2	2.4	-	-	53	10.8	0.9	-	-	80	11.0	0.5	-	-

TABLE 23 -Continued

	P4					P3					C				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	9	7.8	0.6	7.0	9.1	12	7.3	0.5	6.2	8.2	8	7.4	0.7	6.6	8.8
El Wad	16	7.4	1.0	-	-	16	7.1	0.5	-	-	14	6.9	0.5	-	-
Shukba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	9	7.3	0.4	-	-	9	7.0	0.3	-	-	8	6.9	0.6	-	-
Eynan	11	7.2	0.6	-	-	11	7.1	0.6	-	-	10	7.1	0.3	-	-
Nahal Oren	6	7.6	0.6	-	-	6	6.9	0.6	-	-	5	6.9	0.3	-	-
Erq el Ahmar	1	7.1	-	-	-	1	7.2	-	-	-	1	7.2	-	-	-
HaYonim	7	7.3	0.4	-	-	6	7.2	0.3	-	-	6	6.9	0.5	-	-
Natufian	14	7.2	0.1	-	-	16	7.1	0.2	-	-	13	7.0	0.2	-	-
Jarmo	3	8.3	-	-	-	3	8.0	-	-	-	4	7.1	-	-	-
Jericho PPNB	6	7.5	0.8	-	-	4	7.2	0.3	-	-	4	7.4	0.4	-	-
Jericho Bronze	7	6.7	0.3	-	-	6	6.7	0.2	-	-	4	6.5	0.1	-	-
Ganj Dareh Tepe ♂	4	7.9	0.9	7.0	9.1	4	7.2	0.9	6.2	8.2	5	7.4	0.9	6.6	8.8
Chicago ♂	70	7.1	0.2	-	-	90	7.0	0.3	-	-	96	6.9	0.2	-	-

TABLE 23 -Continued

	I2					I1				
	n	x	s.d.	min	max	n	x	s.d.	min	max
Ganj Dareh Tepe	7	5.9	0.7	4.9	7.1	6	6.6	0.6	5.8	7.7
El Wad	14	5.9	0.5	-	-	12	5.3	0.5	-	-
Shukba	-	-	-	-	-	-	-	-	-	-
Kebara	6	5.9	0.4	-	-	3	5.2	0.2	-	-
Eynan	9	6.3	0.3	-	-	7	5.5	0.3	-	-
Nahal Oren	4	6.3	0.5	-	-	4	5.5	0.3	-	-
Erq el Ahmar	1	5.8	-	-	-	-	-	-	-	-
HaYonim	6	6.3	0.4	-	-	5	5.5	0.3	-	-
Natufian	13	6.0	0.3	-	-	10	5.4	0.1	-	-
Jarmo	3	6.0	-	-	-	3	5.3	-	-	-
Jericho PPNB	3	6.5	0.3	-	-	1	5.7	-	-	-
Jericho Bronze	1	6.0	-	-	-	2	5.2	0.3	-	-
Ganj Dareh Tepe ♂	4	5.9	0.9	4.9	7.1	2	5.8	1.1	5.0	6.5
Chicago ♂	105	6.0	0.3	-	-	104	5.4	0.2	-	-

TABLE 24

SUMMARY STATISTICS FOR MANDIBULAR BUCCOLINGUAL DIAMETERS, ALL SAMPLES

	M3					M2					M1				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	6	10.4	0.2	10.1	10.5	10	10.7	0.6	9.5	11.4	14	11.2	0.7	9.5	12.1
El Wad	15	10.4	0.6	-	-	20	10.7	0.5	-	-	20	11.0	0.4	-	-
Shukba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	11	10.6	0.4	-	-	16	10.8	0.5	-	-	16	11.0	0.5	-	-
Eynan	5	10.4	0.7	-	-.	7	10.6	0.7	-	-	7	10.9	0.4	-	-
Nahal Oren	9	10.2	0.9	-	-	9	11.0	0.7	-	-	11	11.3	0.5	-	-
Erq el Ahmar	1	11.0	-	-	-	1	11.3	-	-	-	1	11.5	-	-	-
HaYonim	3	10.2	0.5	-	-	6	10.5	0.6	-	-	9	11.0	0.5	-	-
Natufian	13	10.4	0.3	-	-	16	10.6	0.1	-	-	16	10.7	0.1	-	-
Jarmo	2	10.8	-	-	-	6	10.1	-	-	-	6	10.5	-	-	-
Jericho PPNB	4	10.4	0.6	-	-	7	10.5	0.5	-	-	7	10.8	0.3	-	-
Jericho Bronze	6	9.4	0.9	-	-	9	10.0	0.6	-	-	8	10.3	0.4	-	-
Ganj Dareh Tepe ♂	2	10.5	0.1	10.4	10.5	3	10.7	0.4			6	11.2	0.9	9.5	11.9
Chicago ♂	12	10.2	0.7	-	-	62	10.5	1.4	-	-	90	10.6	0.6	-	-

TABLE 24 -Continued

	P4					P3					C				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	9	8.8	1.0	7.2	10.1	12	8.4	0.8	7.3	9.7	8	7.8	0.6	7.1	8.7
El Wad	16	8.2	0.7	-	-	16	7.9	0.5	-	-	14	7.6	0.5	-	-
Shukba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	10	8.4	0.5	-	-	9	8.2	0.4	-	-	4	8.1	0.8	-	-
Eynan	7	8.4	0.6	-	-	7	8.2	0.5	-	-	6	8.0	0.4	-	-
Nahal Oren	10	8.2	0.6	-	-	10	8.2	0.3	-	-	6	7.7	0.4	-	-
Erq el Ahmar	1	8.0	-	-	-	1	7.9	-	-	-	1	7.9	-	-	-
HaYonim	5	8.3	0.5	-	-	4	8.3	0.4	-	-	5	7.9	0.7	-	-
Natufian	14	8.2	2.2	-	-	16	7.8	0.2	-	-	13	7.9	0.2	-	-
Jarmo	3	8.6	-	-	-	3	7.4	-	-	-	4	7.7	-	-	-
Jericho PPNB	6	8.4	0.5	-	-	4	8.2	0.4	-	-	3	7.8	0.5	-	-
Jericho Bronze	6	8.0	0.4	-	-	6	7.6	0.3	-	-	4	7.4	0.8	-	-
Ganj Dareh Tepe ♂	4	9.2	0.8	8.5	10.1	4	8.4	0.4	7.8	8.8	5	7.9	0.7	7.2	8.7
Chicago ♂	79	8.2	0.4	-	-	88	7.6	0.4	-	-	90	7.5	0.6	-	-

TABLE 24 -Continued

	I2					I1				
	n	$\bar{x}$	s.d.	min	max	n	$\bar{x}$	s.d.	min	max
Ganj Dareh Tepe	7	6.5	0.6	5.9	7.9	6	6.2	0.9	5.0	7.8
El Wad	14	6.3	0.2	-	-	14	6.1	0.5	-	-
Shukba	-	-	-	-	-	-	-	-	-	-
Kebara	5	6.4	0.8	-	-	3	6.3	0.5	-	-
Eynan	2	6.6	0.4	-	-	2	6.0	0.2	-	-
Nahal Oren	6	6.6	0.2	-	-	9	6.1	0.2	-	-
Erq el Ahmar	1	6.7	-	-	-	-	-	-	-	-
HaYonim	5	6.5	0.4	-	-	2	5.8	-	-	-
Natufian	13	6.6	0.2	-	-	10	6.2	0.3	-	-
Jarmo	3	6.1	-	-	-	3	5.8	-	-	-
Jericho PPNB	1	6.5	-	-	-	1	6.5	-	-	-
Jericho Bronze	1	6.0	-	-	-	2	5.9	0.6	-	-
Ganj Dareh Tepe ♂	4	6.8	0.8	6.4	7.9	2	7.2	0.8	6.6	7.7
Chicago ♂	103	6.3	0.3	-	-	102	5.9	0.4	-	-

CHAPTER VII

RESULTS

Preliminary discussion of results pursuant to the various techniques described in Chapter V is presented in this chapter. Emphasis is placed on description with attention to details contained in the resulting information. A more general summary and discussion is presented in Chapter VIII. It has been noted that data from Ganj Dareh and from selected comparative series were examined for similarities and differences using the Student's t-test and indices; the index of sexual dimorphism and the index of sexual difference, I_{SD} and I_{SC}, respectively.

In tables containing t-test (results), parameters of each test (t-score and degrees of freedom) are given with the resulting exact probability. Between sample differences are denoted by a single asterisk when significant at the level $p \leq 0.05$ and by two asterisks when significant at level $p \leq 0.001$.

In tables showing the results of calculations using either the index of sexual dimorphism or the index of sexual difference, signs are used to denote direction.

Each index is displayed with no sign when positive (i.e. when males are larger than females for I_{SD} and when Ganj Dareh Tepe is larger than Tepe Hissar or Lerna for the appropriate sex), and with a negative sign for the opposite situations. Signs shown for the indices correspond to t-values for the same variates.

In tables illustrating results the I_{SD} comparisons, the last column shows values for the range established by the high and low index values in each comparison. These are accompanied by one of three possible symbols showing the position for Ganj Dareh relative to those from Tepe Hissar or Lerna, or both. If the Ganj Dareh value is the highest, the symbol used is a plus (+). If median, the range is given with an asterisk (*), If the Ganj Dareh index is the lowest, a minus sign (-) is used. This system is not used with the index of sexual difference as the I_{SC} compares the relative position of Ganj Dareh in calculation (formula 4, Table 15).

Sexual Dimorphism

The Cranial Complex

Mandibular variates were examined using t-tests to determine the presence of significant between-sex differences (Table 25). In addition, variates were examined for metric differences between means using the I_{SD}. The results appear in Table 25.

TABLE 25

SEXUAL DIMORPHISM OF MANDIBULAR VARIATES FOR THREE POPULATIONS

	Ganj Dareh Tepe			Tepe Hissar			Lerna		
	t	d.f.	p	t	d.f.	p	t	d.f.	p
Dimension									
BGB	0.354	1	0.800	4.662	127	0.001**	4.486	55	0.001**
RBR	0.924	3	0.424	4.613	130	0.001**	4.609	56	0.001**
RCM	0.020	4	0.985	-	-	-	-	-	-
RCP	0.128	3	0.906	-	-	-	-	-	-
ANS	0.175	4	0.870	-	-	-	--	-	-

*$p \leq 0.05$
**$p \leq 0.001$

Results of t-tests

Two mandibular variates, bigonial width (BGB) and maximum ramus breadth (RBR) were available for all three sites. While there were no differences at Ganj Dareh, both were highly significant at Hissar and Lerna ($p < 0.001$). None of the other four Ganj Dareh variates were significant.

Results of comparisons using I_{SD}

Indices of sexual dimorphism were calculated for mandibular variates (Table 26). At Ganj Dareh, the female bigonial width is slightly larger than for males. Olivier ('69,p.186) has suggested that this is not uncommon. In this case, the index is slightly biased for females (-3.2 percent). At both Hissar and Lerna, males are slightly larger. The index for the minimum ramus breadth (RBR) is positive for Ganj Dareh with Ganj Dareh and Lerna showing similar values. At both sites, males are larger than females by about eleven percent. At Tepe Hissar, the index for this variate is also positive though slightly reduced in value. It should be noted that deformation influences were not observed on the Ganj Dareh mandibles even though mandibular shape is commonly modified in the context of cranial deformation (Björk and Björk,'64; Rogers,'75).

The Postcranial Complex

Results of t-tests

In Table 27, three variates from Ganj Dareh

TABLE 26

INDICES OF SEXUAL DIMORPHISM FOR MANDIBULAR VARIATES FOR THREE POPULATIONS

Dimension	Ganj Dareh Tepe	Tepe Hissar	Lerna	
BGB	- 3.2	6.4	8.7	11.9-
RBR	10.9	7.1	11.0	3.9*
RCM	-16.1	-	-	
RCP	5.8	-	-	
SYN	- 1.2	-	-	

TABLE 27

SEXUAL DIMORPHISM IN POSTCRANIAL VARIATES
FOR THREE POPULATIONS

Element	Dimension	Ganj Dareh Tepe			Tepe Hissar			Lerna		
		t	d.f.	p	t	d.f.	p	t	d.f.	p
Humerus	HXR	1.061	1	0.481	4.465	42	$<0.001^{**}$	6.365	37	$<0.001^{**}$
	HPR	1.010	1	0.496	-	-	-	-	-	-
	HMD	2.030	8	0.076	-	-	-	-	-	-
	PMD	1.959	9	0.082	-	-	-	-	-	-
	HDD	1.729	9	0.118	-	-	-	6.637	51	$<0.001^{**}$
	HRD	2.461	9	0.036^{*}	-	-	-	9.140	51	$<0.001^{**}$
Radius	RXR	1.292	7	0.237	3.489	43	$>0.001^{**}$	6.291	35	$<0.001^{**}$
	RXD	0.270	5	0.789	-	-	-	-	-	-
	RLD	1.594	5	0.172	-	-	-	-	-	-
Ulna	UXR	1.352	3	0.269	4.375	43	$<0.001^{**}$	5.437	25	$<0.001^{**}$
Femur	ARP	1.254	7	0.250	1.990	40	0.053	2.192	41	$<0.001^{**}$
	FMR	2.361	8	0.046^{*}	-	-	-	4.710	43	$<0.001^{**}$
	FTD	1.081	5	0.329	1.017	39	0.315	3.800	45	$<0.001^{**}$
	RTF	0.000	6	>0.999	-	-	-	5.156	48	$<0.001^{**}$
	FDR	1.880	3	0.156	-	-	-	-	-	-
	HDR	2.524	3	0.085	-	-	-	-	-	-
Talus	XTR	2.056	9	0.069	-	-	-	4.295	37	$<0.001^{**}$
	TMR	0.774	9	0.098	-	-	-	5.793	39	$<0.001^{**}$
	HTR	1.903	9	0.089	-	-	-	7.722	39	$<0.001^{**}$
Patella	PXR	2.250	8	0.058	-	-	-	-	-	-
	PBR	3.878	8	$<0.004^{**}$	-	-	-	-	-	-

$^{*}p \leq 0.05$
$^{**}p \leq 0.001$

Tepe are significant. These are the humeral minimum diameter (p (HRD) $= 0.036$), the femoral antero-posterior subtrochanteric diameter (p (FMR) $= 0.046$) and the maximum patellar width (p (PBR) < 0.004). Probabilities from Tepe Hissar and Lerna are highly significant for the majority of comparisons. At Tepe Hissar, the ARP probability is not significant, but approaches the critical level of $p \leq 0.05$ (p (ARP) $= 0.053$).

Many significant differences at Lerna are not significant at Ganj Dareh Tepe. These include, humeral HXR and HDD; radial RXR; ulnar UXR; femoral ARP, FTD and RTF; and talar XTR, TMR and HTR. At Tepe Hissar, three upper long bone lengths are significant (HXR, RXR and UXR) below the level $p \leq 0.001$.

Results of comparisons using I_{SD}

Five comparisons were common to all three sites including HXR, RXR, UXR, ARP and FTD variates. The first three are lengths while ARP maximum femoral antero-posterior and FTD maximum femoral transverse diaphyseal are the breadths. In two lengths, Ganj Dareh Tepe consistently shows the least dimorphism while the radial RXR is approximately midrange. Sexual dimorphism at Ganj Dareh Tepe is greatest in the femoral diameters (ARP and FTD, Table 28).

Indices representing Ganj Dareh - Lerna comparisons shows that Ganj Dareh exhibits the greatest dimorphism for three long bone diameters (HDD, HRD and FMR),

TABLE 28

INDICES OF SEXUAL DIMORPHISM IN POSTCRANIAL VARIATES FOR THREE POPULATIONS

Element	Dimension	Ganj Dareh Tepe	Tepe Hissar	Lerna	range
Humerus	HXR	6.8	8.6	9.6	2.8-
	HPR	6.6	-	-	
	HMD	17.9	-	-	
	PMD	14.4	-	-	
	HDD	15.8	-	12.2	3.6+
	HRD	22.0	-	19.3	2.7+
Radius	RXR	10.7	9.4	12.2	2.8*
	RPR	9.3	-	-	
	PRL	8.2	-	-	
	RXD	14.6	-	-	
	RLD	15.4	-	-	
Ulna	UXR	7.8	9.7	11.0	3.8-
	UPR	11.4	-	-	
	UMR	19.8	-	-	
	UTR	13.0	-	-	
	UAR	14.2	-	-	
Femur	ARP	11.9	8.8	7.2	4.7+
	FMR	16.4	-	13.1	3.3-
	FTD	12.2	3.8	8.8	8.4+
	RTF	0.0	-	11.6	11.6-
	FDR	11.1	-	-	
	HDR	17.0	-	-	
Talus	XTR	8.9	-	7.4	1.5+
	TMR	5.1	-	10.2	5.1-
	HTR	7.9	-	12.6	4.7-
Patella	PXR	10.0	-	-	
	PBR	14.9	-	-	

while one index (RTF) is reduced relative to Lerna. Three other variates common to both Ganj Dareh and Lerna are from the talus. The length (XTR) at Ganj Dareh is slightly greater while breadth (TMR) and height (HTR) indices are slightly smaller.

Summary, Sexual Dimorphism

Comparisons of mandibular and postcranial variates made between the sexes from Ganj Dareh, Tepe Hissar and Lerna show several important differences. These distinguish Ganj Dareh from the two Bronze Age samples. The Ganj Dareh series is characterized by slight sexual dimorphism for the majority of postcranial variates with few significant differences. In later samples, significant differences between the sexes were common. These significant differences and the generally larger index values indicate that sexual dimorphism is marked for the Bronze Age populations and is slight for Ganj Dareh Tepe. The frequency of significant differences encountered at Tepe Hissar and Lerna suggests that sample variances from these two samples are relatively smaller, indicating a greater statistical separation of males and females.

Mandibular comparisons show less dramatic sexual dimorphism for all three sites. While more sexual homogeneity is apparent, indices for Tepe Hissar and Lerna still show relatively greater dimorphism.

Comparisons using I_{SD} show sexual dimorphism to be much less than suggested by use of the t-test alone. Relative to Lerna, indices show the sexual dimorphism at Ganj Dareh as slight for long bone lengths and, conversely, as marked for transverse and antero-posterior breadths. Even in the absence of significant differences, these variates for Ganj Dareh show greater dimorphism when sample means are used without reference to sample distributions (s.d.). Therefore, indices indicate that, relative to Lerna, where long bones tend to be relatively longer and more narrow, long bones from Ganj Dareh are shorter and broader. While observations from Tepe Hissar are limited, the same relationship is maintained, though to a lesser degree.

Cross-Sample Sex Differences

The Cranial Complex

Results of t-tests

Males Five variates were available for males from the three sites. These include the bicondylar breadth (BCB), bigonial breadth (BGB), mandibular length (MBL), minimum ramus breadth (RBR) and symphyseal height (SYN). The first three of these variates (Table 29) show probabilities calculated from negative t-scores. Only the MBL comparison is significant with males from Ganj Dareh shorter than those from Tepe Hissar. This variate was not available for Lerna. The remaining probabilities are

TABLE 29

SIGNIFICANT SEXUAL DIFFERENCES[a] IN MANDIBULAR VARIATES FOR TWO POPULATIONS AND GANJ DAREH

	Tepe Hissar			Lerna		
Dimension	t	d.f.	p	t	d.f.	p
			males			
BCB	-0.948	71	< 0.40	-1.252	29	< 0.20
BGB	-1.185	88	0.239	-1.866	39	0.070
MBL	-8.682	80	< 0.001**	-	-	-
SYN	1.729	46	< 0.10	5.158	26	< 0.001**
RBR	1.634	91	< 0.20	2.395	41	< 0.02 *
			females			
BGB	1.204	40	0.236	0.466	17	0.647
RBR	2.878	42	≤ 0.01 *	1.240	18	< 0.20

[a]underlined probabilities are estimated from Table Q (Rohlf and Sokal,'69,pp.160-161).

* $p \leq 0.05$
** $p \leq 0.001$

calculated from positive t-scores with two from Ganj Dareh Lerna comparisons (SYN and RBR) being significant.

Females Two variates each from Tepe Hissar and Lerna were available for between sample female comparisons. The resulting t-scores were positive and the Ganj Dareh Tepe/Tepe Hissar RBR comparison was significant ($p \leq 0.01$ estimated). This shows that the female minimum ramus breadth for Ganj Dareh is broader than that for Tepe Hissar.

Results of comparisons using I_{SC}

Males Indices of sexual difference calculated for mandibular variates (Table 30) show males from comparative sites to be consistently larger than Ganj Dareh males in the following: mandibular length (MBL), and bigonial and bicondylar breadths (BGB and BCB). Males at Ganj Dareh are larger in the two remaining comparisons (SYH and RBR).

Females The two available indices for females in comparison are positive (Table 30). This illustrates that Ganj Dareh madibles tend to be slightly wider (BGB) and longer (RBR) for females.

The Postcranial Complex

Results of t-tests

Males Postcranial comparisons for males (Table 31) show several significant results ($p \leq 0.05$). These occur in femoral and calcaneal variates from Tepe

TABLE 30

INDICES OF SEXUAL DIFFERENCE IN MANDIBULAR VARIATES FOR TWO POPULATIONS AND GANJ DAREH TEPE

	Tepe Hissar		Lerna	
	males	females	males	females
BCB	- 3.5	-	- 5.7	-
BGB	- 1.8	7.9	- 7.3	4.1
MBL	-22.2	-	-	-
SYH	8.4	-	19.2	-
RBR	4.8	2.6	8.7	10.3

TABLE 31

SIGNIFICANT SEXUAL DIFFERENCES IN POSTCRANIAL VARIATES FOR TWO POPULATIONS AND GANJ DAREH TEPE, MALES

		Tepe Hissar			Lerna		
		t	d.f.	p	t	d.f.	p
HUMERUS	HXR	1.007	36	0.320	1.659	20	0.112
	HRD	-	-	-	0.920	30	0.364
	HDD	-	-	-	1.264	30	0.216
RADIUS	RXR	1.829	37	0.075	1.751	19	0.097
ULNA	UXR	0.758	35	0.453	1.660	17	0.115
FEMUR	FRX	-	-	-	-	-	-
	ARP	2.302	34	0.027 *	3.027	31	0.004*
	FMR	-	-	-	-3.296	34	0.002*
	FTD	0.216	34	0.830	3.970	34	< 0.001**
	RTF	-	-	-	-2.252	35	0.030 *
TALUS	XTR	-	-	-	1.215	29	0.234
	TMR	-	-	-	1.192	30	0.243
	HTR	-	-	-	-0.666	29	0.511
CALCANEUS	CXR	-	-	-	-2.676	19	0.015*

* $p \leq 0.05$
** $p \leq 0.001$

Hissar and Lerna in comparison with Ganj Dareh Tepe. In the femur, the ARP variate is significant for Tepe Hissar ($p = 0.027$) and for Lerna ($p = 0.004$). These two t-scores are positive. The FTD variate is positive for both sites but, in this case, is only significant at Lerna ($p \leq 0.001$). FMR and RTF probabilities at Lerna are significant and their t-scores negative.

The CXR variate from Lerna is derived from a negative t-score. The probability ($p = 0.015$) indicates that the length of the calcaneus is significantly longer for Ganj Dareh.

Females Female postcranial comparisons show several differences occurring for the Hissar ARP ($p < 0.004$) and the Lerna ARP, FMR, FTD, RTF, UXR, IXL and XTR. A few of these significant differences are common to males and females. These include Lerna ARP, FMR, FTD and RTF from the femur, and Hissar ARP. Most common comparisons to both females and males, are not significantly different. A single variate, the maximum length of the ulna (UXR), shows a significant female value at Lerna (Table 32).

Results of comparisons using I_{SC}

Differences between the Ganj Dareh males and females and the comparative samples of males and females were also examined using the index of sexual difference (I_{SC}) (Table 33).

TABLE 32

SIGNIFICANT DIFFERENCES IN POSTCRANIAL VARIATES FOR TWO POPULATIONS AND GANJ DAREH TEPE, FEMALES

	Dimension	Tepe Hissar			Lerna		
		t	d.f.	p	t	d.f.	p
HUMERUS	HXR	1.691	9	0.129	1.597	20	0.126
	HRD	-	-	-	0.000	31	> 0.999
	HDD	-	-	-	0.939	14	0.142
RADIUS	RXR	1.648	7	0.150	1.543	17	0.142
ULNA	UXR	1.047	11	0.320	2.421	11	0.036*
FEMUR	FRX	1.397	7	0.212	2.124	10	0.062
	ARP	3.504	15	< 0.004**	3.952	18	< 0.001**
	FMR	-	-	-	-4.441	18	< 0.001**
	FTD	-1.612	11	0.138	3.781	18	< 0.001**
	RTF	-	-	-	-2.228	20	0.036*
FIBULA	IXL	0.510	7	0.628	8.189	4	< 0.003**

TABLE 32—Continued

	Dimension	Tepe Hissar			Lerna		
		t	d.f.	p	t	d.f.	p
TALUS	XTR	–	–	–	2.742	18	0.014*
	TMR	–	–	–	1.677	19	0.110
	HTR	–	–	–	1.357	18	0.192
CLAVICLE	XRC	0.285	3	0.802	0.489	11	0.635

* $p \leq 0.05$
** $p \leq 0.001$

TABLE 33

INDICES OF SEXUAL DIFFERENCE IN POSTCRANIAL VARIATES FOR MALES AND FEMALES FROM TWO POPULATIONS AND GANJ DAREH TEPE

Element	Tepe Hissar		Lerna	
	males	females	males	females
Humerus				
HXR	4.6	6.4	6.0	8.8
HRD	-	-	3.5	0.0
HDD	-	-	5.6	3.3
Radius				
RXR	11.1	9.7	8.3	9.8
Ulna				
UXR	4.1	5.9	7.6	0.9
Femur				
FRX	-	5.8	-	14.2
ARP	20.2	16.9	23.0	17.9
FMR	-	-	-15.9	-17.6
FTD	1.5	- 6.1	21.8	18.0
RTF	-	-	-11.1	- 0.8
Fibula				
IXR	-	1.4	-	13.0
Talus				
XTR	-	-	10.4	8.8
TMR	-	-	2.6	6.4
HTR	-	-	- 0.7	3.7
Calcaneus				
CXR	-	-	- 3.4	-
Clavicle				
XCR	-	2.5	-	2.6

Males Generally, long bone indices comparable between Tepe Hissar and are positive. Ganj Dareh Tepe males are consistently larger in the maximum lengths of the humerus, radius and ulna, and in the humeral width measurements. However, some variation is encountered in the femoral variate FTD, the diaphyseal transverse diameter. Whereas Hissar and Lerna variates for males tend to be positive in their indices by similar magnitudes, the FTD for Tepe Hissar is greatly reduced relative to the index for Lerna. The ARP comparison for both sites illustrates Bronze Age site similarly. In this case, both ARP indices are very close and different from the larger Ganj Dareh males.

Females Females show some of the same trends mentioned for the males. For the humerus, radius and ulna, indices are positive and, in most cases, differ by approximately the same magnitude as in males. In the femur, the ARP variates from Tepe Hissar and Lerna differs by approximately the same magnitude (16.9 and 17.9, respectively). The FTD variate shows a different relationship in comparison to Ganj Dareh compared to Lerna. Here, the Hissar variate is small showing Tepe Hissar females to have markedly large femoral transverse diameters.

Summary, sexual difference

Significant differences were encountered in comparisons of mandibular variates for males and females. These were not necessarily showed by both sexes from one site, nor by the same sex between sites. Male breadth measurements (BCB and BGB) appear similar for all three populations but, there were significant differences for males in MBL, SYN and RBR comparisons.

There were also significant differences for both sexes in femoral variates at Tepe Hissar and, more frequently, at Lerna. Comparisons of the upper long bone variates were notably not significant with the exception of the Lerna female UXR.

Values of t and the indices for several femoral variates show some negative signs that are common to both sexes at Lerna.

Generally, results show Ganj Dareh males to be slightly larger than either comparative site in measurements of the upper limbs. This is also apparent for females. Indices from the femur indicate marked divergence between the three groups. The levels of significance and the sign changes suggest that femora from both males and females representing all three sites are very different in their overall shape.

The Dental Complex

Results of t-tests

Student's t-test was used to examine relationships between Ganj Dareh Tepe tooth samples and those representing eleven other populations described in Chapter IV (Tables 21 - 24). Results of the comparisons appear in Tables 34 - 37 for tooth groups in both mesiodistal and buccolingual dimensions. As before, probabilities are shown to be significant by the addition of asterisks for $p \leq 0.05$ and $p \leq 0.001$. Discussion of these results is limited to Ganj Dareh - Natufian and Ganj Dareh - Jarmo comparisons.

To illustrate the relationships, exact probabilities shown in Tables 34 - 37 are also plotted in figures 6 through 9. Natufian samples are retained for comparison because their dates are similar to those from Ganj Dareh Tepe, and because the Natufian samples represent a range of biological variation within a geographically finite area. The Erq el Ahmar sample is treated as though it were not Natufian. Later, it will be compared to, rather than integrated with, the larger and more certain Natufian group.

The Jarmo sample is also retained for comparison with the Natufian group. For comparative purposes, it is assumed that Jarmoites represent a population that is biologically different from either the Natufians or the inhabitants of Ganj Dareh Tepe. At the same time, the location and the artifactual remains of Jarmo appear to be similar to Ganj Dareh Tepe.

TABLE 34

SIGNIFICANT DIFFERENCES IN MAXILLARY TEETH:
MESIODISTAL (m-d) DIMENSION (d.f. = n-2).

	M3			M2			M1			P4		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	2.863	12	0.013*	4.232	26	<0.001**	2.394	24	0.024*	2.161	28	0.390
Shukba	1.492	3	0.209	2.204	7	0.063	3.099	5	0.021*	2.631	8	0.027*
Kebara	3.223	8	0.010*	3.379	17	<0.003*	4.014	13	<0.001**	1.589	15	0.131
Eynan	2.478	6	0.042*	3.511	12	<0.003*	1.390	10	0.192	1.815	13	0.091
Nahal Oren	1.358	7	0.211	3.511	6	<0.009*	2.177	10	0.054	1.980	12	0.069
Erq el Ahmar	0.442	2	0.688	-0.151	6	0.884	2.927	3	0.042*	2.286	7	0.056
Natufian	1.140	9	0.280	1.253	16	0.227	2.234	16	0.039*	2.773	21	0.011*
Jarmo	2.242	2	0.110	0.908	6	0.394	1.632	3	0.178	-3.020	9	0.014*
Jericho PPNB	1.915	2	0.151	0.815	9	0.434	2.511	11	0.027*	0.225	10	0.826
Jericho Bronze	3.663	4	0.014*	4.998	13	<0.001**	5.899	10	<0.001**	1.829	14	0.087
Chicago ♂	0.197	8	0.848	6.284	55	<0.001**	-0.153	79	0.878	-1.469	71	0.146

TABLE 34 --Continued

	P3			C			I2			I1		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	1.351	24	0.188	-0.136	22	0.893	0.586	15	0.566	-1.348	16	0.195
Shukba	1.797	6	0.115	0.363	8	0.724	1.364	5	0.222	-	-	-
Kebara	1.982	13	0.067	-3.218	14	< 0.006*	2.177	10	0.054	-0.024	10	0.981
Eynan	1.163	11	0.267	-0.833	12	0.419	0.471	6	0.652	0.699	9	0.502
Nahal Oren	1.693	10	0.118	-0.761	11	0.461	0.877	8	0.403	-1.023	11	0.326
Erq el Ahmar	2.247	5	0.065	-0.669	7	0.522	0.699	5	0.510	0.160	8	0.876
Natufian	6.300	21	< 0.001**	-0.196	16	0.846	2.924	12	0.012*	-0.142	16	0.888
Jarmo	0.044	5	0.966	-0.669	7	0.522	1.032	5	0.342	0.160	8	0.876
Jericho PPNB	0.480	8	0.642	0.063	7	0.951	1.531	5	0.176	-0.018	8	0.986
Jericho Bronze	4.865	11	< 0.001**	-0.236	9	0.818	2.005	8	0.076	0.815	10	0.432
Chicago ♂	2.985	75	< 0.003*	-0.304	77	0.761	2.528	93	0.013*	-0.313	105	0.754

* $p \leq 0.05$
**$p \leq 0.001$

TABLE 35

SIGNIFICANT DIFFERENCES IN MAXILLARY TEETH:
BUCCOLINGUAL DIMENSION (b-1) (d.f. = n-2).

	M3			M2			M1			P4		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	2.749	11	0.018*	-3.247	24	0.074	0.286	22	0.777	-0.841	27	0.407
Shukba	2.207	3	0.092	1.892	7	0.095	0.183	5	0.860	-0.349	8	0.735
Kebara	1.468	6	0.186	0.179	17	0.860	0.072	13	0.943	0.000	14	0.999
Eynan	2.868	6	0.024*	0.950	12	0.359	-0.163	7	0.870	-0.569	13	0.578
Nahal Oren	1.849	7	0.102	0.422	12	0.680	0.061	10	0.952	-0.270	12	0.791
Erq el Ahmar	2.849	2	0.065	0.362	6	0.728	-0.169	3	0.874	0.270	7	0.794
HaYonim	3.214	6	0.014*	-0.961	12	0.354	-0.164	8	0.873	0.000	12	0.999
Natufian	3.888	9	<0.004*	0.543	16	0.594	0.044	16	0.965	0.336	21	0.740
Jarmo	3.394	2	0.042*	1.198	10	0.256	0.925	3	0.407	0.270	7	0.794
Jericho PPNB	5.753	2	0.028*	-0.056	6	0.956	0.428	3	0.690	0.270	7	0.794
Jericho Bronze	7.556	4	<0.002*	2.024	13	0.062	2.104	10	0.059	1.483	14	0.158
Chicago ♂	2.098	11	0.057	0.776	71	0.440	2.300	90	0.024*	1.201	83	0.233

TABLE 35 --Continued

	P3			C			I2			I1		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	2.095	26	0.046	0.637	20	0.531	1.243	19	0.228	0.414	18	0.684
Shukba	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	0.713	19	0.484	-0.869	10	0.403	0.312	10	0.760	-0.121	7	0.906
Eynan	0.617	15	0.546	-0.896	12	0.386	-0.141	7	0.891	0.335	6	0.747
Nahal Oren	0.778	20	0.445	0.179	12	0.860	-0.253	11	0.804	1.242	13	0.234
Erq el Ahmar	0.655	11	0.524	-0.256	7	0.804	-0.263	6	0.800	-	-	-
HaYonim	1.000	14	0.333	-0.418	11	0.683	0.091	10	0.929	0.469	6	0.653
Natufian	2.818	26	<0.008*	-0.924	21	0.366	-0.423	18	0.677	0.265	14	0.794
Jarmo	1.311	11	0.214	0.085	7	0.934	0.665	6	0.527	0.469	5	0.656
Jericho PPNB	0.494	14	0.628	-0.130	9	0.899	0.046*	6	0.964	-0.295	5	0.778
Jericho Bronze	2.445	16	0.026*	0.869	10	0.403	0.819	6	0.440	0.464	5	0.659
Chicago ♂	3.371	90	< 0.001**	1.605	93	0.112	3.030	105	<0.003*	3.365	102	<0.001**

* $p \leq 0.05$
**$p \leq 0.001$

TABLE 36

SIGNIFICANT DIFFERENCES IN MANDIBULAR TEETH:
MESIODISTAL DIMENSION (d.f. = n-2)

	M3			M2			M1			P4		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	0.862	19	0.138	2.250	27	0.032*	-0.861	32	0.395	1.021	33	0.314
Shukba	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	1.545	11	0.148	0.709	20	0.486	-1.620	23	0.118	1.895	16	0.075
Eynan	1.442	15	0.168	1.127	24	0.270	-0.638	24	0.529	2.078	18	0.052
Nahal Oren	2.484	10	0.030*	1.545	15	0.142	-1.302	20	0.207	0.496	13	0.628
Erq el Ahmar	-0.238	6	0.818	-0.057	9	0.956	-0.622	13	0.544	1.053	8	0.320
HaYonim	1.656	7	0.136	0.541	14	0.596	-1.173	21	0.253	1.719	14	0.106
Natufian	4.000	18	< 0.001**	0.983	24	0.335	-2.421	28	0.023*	3.437	21	< 0.002*
Jarmo	-0.476	5	0.650	0.365	9	0.722	-0.449	13	0.660	-0.805	8	0.442
Jericho PPNB	0.307	8	0.766	2.905	16	< 0.009*	0.163	10	0.872	0.749	13	0.466
Jericho Bronze	3.345	10	< 0.006*	6.130	17	< 0.001**	2.967	20	< 0.007**	4.071	14	< 0.001**
Chicago ♂	0.871	7	0.409	0.662	54	0.510	1.060	84	0.292	6.719	72	< 0.001**

TABLE 36 --Continued

	P3			C			I2			I1		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	1.166	27	0.254	1.839	21	0.080	0.116	20	0.908	4.821	15	<0.001**
Shukba	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	1.651	20	0.114	1.441	15	0.170	0.096	12	0.925	3.642	8	<0.006*
Eynan	0.969	22	0.343	1.113	17	0.281	-1.496	15	0.155	4.254	12	<0.001**
Nahal Oren	1.541	16	0.142	1.388	12	0.190	0.960	10	0.360	3.223	9	0.010*
Erq el Ahmar	0.242	12	0.812	0.248	8	0.810	0.195	7	0.850	-	-	-
HaYonim	0.546	16	0.592	1.385	13	0.189	1.187	12	0.253	3.576	10	<0.005*
Natufian	1.788	27	0.085	1.701	20	0.104	-0.091	19	0.928	6.059	15	<0.001**
Jarmo	-1.245	12	0.236	0.386	8	0.710	0.105	7	0.919	2.063	6	0.084
Jericho PPNB	0.453	15	0.657	-0.051	11	0.960	-1.388	9	0.198	1.438	6	0.200
Jericho Bronze	2.740	17	0.014*	2.356	11	< 0.038*	-0.105	7	0.919	2.913	7	0.022*
Chicago ♂	1.369	93	0.174	3.545	100	< 0.001**	-0.718	108	0.474	0.892	105	0.374

* $p \leq 0.05$
**$p \leq 0.001$

TABLE 37

SIGNIFICANT DIFFERENCES IN MANDIBULAR TEETH: BUCCOLINGUAL DIMENSION (d.f. = n-2)

	M3			M2			M1			P4		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	-0.198	19	0.845	-0.243	28	0.810	1.082	32	0.287	1.777	23	0.088
Shukba	-	-	-	-	-	-	-	-	-	-	-	-
Kebara	-1.449	15	0.166	-0.900	24	0.376	0.931	28	0.360	1.131	17	0.272
Eynan	-0.171	9	0.868	0.159	15	0.876	1.042	19	0.310	0.941	14	0.362
Nahal Oren	0.399	13	0.696	-1.182	17	0.252	-0.350	23	0.729	1.655	17	0.115
Erq el Ahmar	3.963	5	0.742	-1.100	9	0.297	-0.398	13	0.696	0.863	8	0.421
HaYonim	0.705	7	0.500	0.489	14	0.632	0.755	21	0.458	1.076	12	0.301
Natufian	-0.387	17	0.763	0.201	24	0.842	3.229	28	<0.003	0.672	21	0.508
Jarmo	-2.744	5	0.034	0.931	9	0.374	0.975	13	0.346	0.191	8	0.852
Jericho PPNB	-0.199	8	0.846	0.547	15	0.582	1.311	19	0.204	0.917	13	0.374
Jericho Bronze	-2.544	10	0.027*	0.377	17	0.028*	3.244	20	<0.004*	1.968	13	0.069
Chicago ♂	0.435	12	.670	0.210	63	0.834	2.176	94	0.032*	3.931	81	<0.001**

TABLE 37 --Continued

	P3			C			I2			I1		
	t	d.f.	p	t	d.f.	p	t	d.f.	p	t	d.f.	p
El Wad	0.754	22	0.458	-0.121	22	0.904	1.527	16	0.145	0.110	16	0.914
Shukba	1.091	5	0.317	0.347	7	0.738	0.697	6	0.508	-	-	-
Kebara	1.245	11	0.236	-0.508	13	0.619	0.232	10	0.244	1.156	9	0.274
Eynan	-1.047	10	0.318	-0.979	12	0.345	1.208	7	0.262	0.877	9	0.401
Nahal Oren	0.210	7	0.838	-0.534	10	0.604	2.383	7	0.038*	0.406	11	0.692
Erq el Ahmar	1.469	2	0.202	-0.232	7	0.822	0.394	6	0.705	0.209	8	0.839
HaYonim	-0.558	9	0.589	-1.185	10	0.260	1.978	10	0.074	0.610	11	0.553
Natufian	2.835	16	0.011*	-0.140	15	0.890	0.756	13	0.462	1.315	15	0.207
Jarmo	0.965	4	0.378	0.152	7	0.881	2.818	6	0.026*	1.198	8	0.262
Jericho PPNB	0.965	4	0.378	-0.811	7	0.440	1.606	6	0.152	0.868	8	0.408
Jericho Bronze	5.692	10	<0.001**	-0.201	9	0.844	2.546	9	0.029*	1.602	10	0.137
Chicago ♂	3.539	86	<0.001**	3.880	70	<0.001**	2.245	83	0.027*	5.388	9	<0.001**

* $p \leq 0.05$
**$p \leq 0.001$

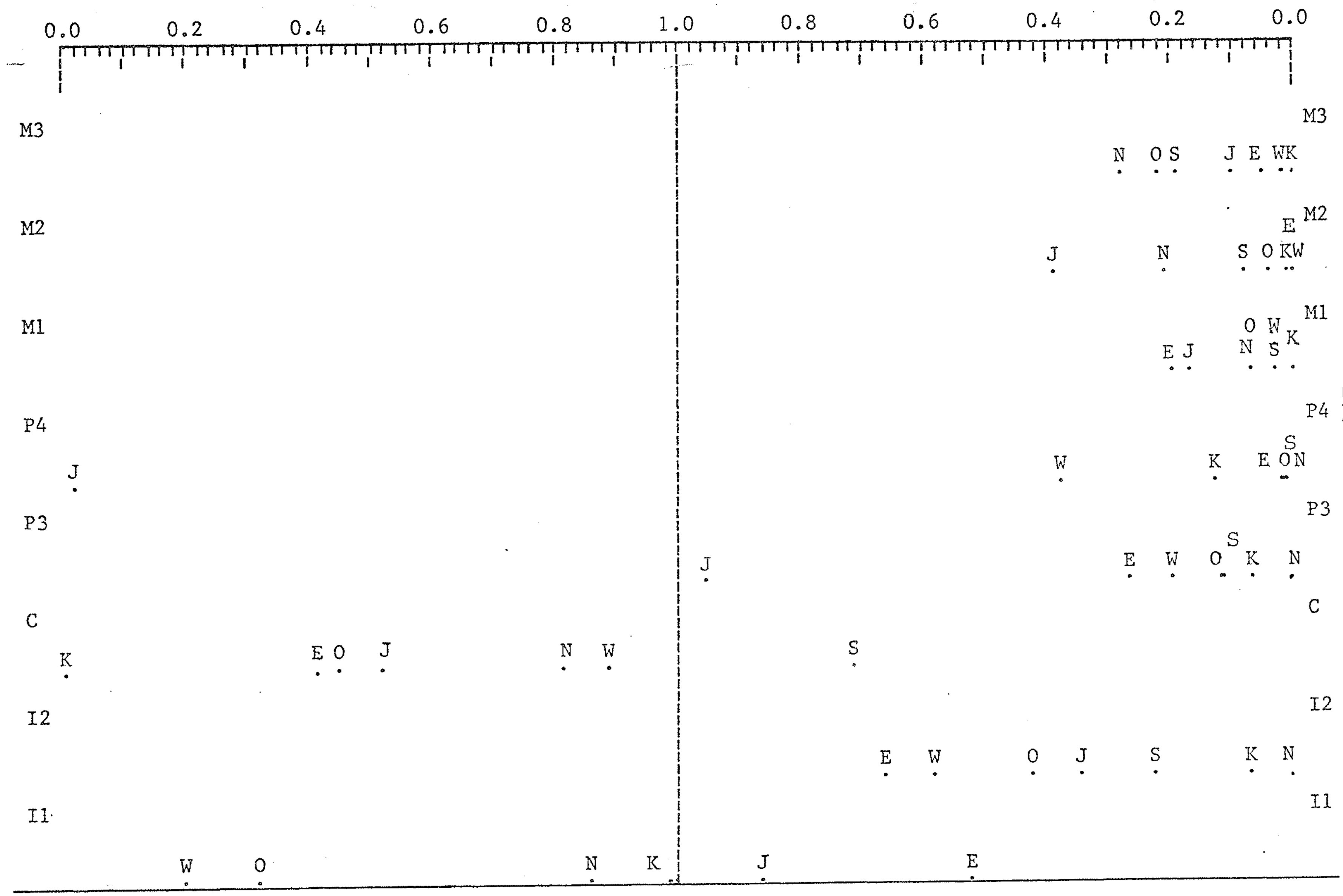
The following figures show samples positioned according to probabilities and directional signs resulting from t-test comparisons. Each figure is concerned with the relative positions of the individual samples compared to the position of Ganj Dareh Tepe in upper and lower mesiodistal and buccolingual dimensions.

The position of sample plots shows a general relationship to the central axis representing Ganj Dareh Tepe. In addition, plots show a tendency to cluster according to their presumed temporal, geographical and cultural affinities. Samples showing statistically significant differences are plotted to the extreme left and right of the graph for each tooth measurement. Plots to the left of the graph represent negative t-scores while those to the extreme left are highly significant. Plots to the right of the graph represent the opposite.

<u>Maxillary mesiodistal dimensions</u> Figure 6 illustrates plotted probabilities from comparisons of maxillary mesiodistal dimensions. The graphs for M3-P4, and the P3 and I1 indicate that Ganj Dareh mean tooth size is generally larger than comparative sites excepting Jarmo. The P4 plot for Jarmo was derived from a negative t-score and is significant. Molars, for Jarmo and the Natufian samples cluster to the right of the axis and many are significant. For the Natufian samples, this relationship

Fig. 6

SIGNIFCANCE LEVELS OF MESIODISTAL MAXILLARY COMPARISONS



obtains in the premolars contrasting to the Jarmo P3, located close to the p = 1.000 axis (p (JP3) = 0.966).

The relationships mentioned above alter for the canine and first incisor. Probabilities for these are rarely significant. The canine is larger for all but Shukba where small canines are present. The I2 distribution is similar to those shown by the molars and the P3. Again Jarmo is the exception falling within the middle of the Natufian M2 cluster.

Maxillary buccolingual dimensions Figure 7 illustrates the positions of plots of maxillary breadths. With the exception of the M3, graphs for the molars, premolars and the canine show plots on both sides of the axis. Therefore, the majority of the maxillary samples express a large range of breadth variation. Jarmo teeth are consistently narrower than Ganj Dareh and all Natufian first molars and lateral incisors.

The third molars and incisors show distributions similar to those observed in the preceding figure for cheek teeth and the first incisor. Buccolingual plots for incisors show moderate ranges to the right of the axis with no significance. M3 plots are also placed to the right but, in this case, four Natufian samples and the Jarmo sample are significantly different.

Mandibular mesiodistal dimensions Plots for M2, C, I2 and I1 teeth are all positive (fig. 8). The Jarmo

Fig. 7

SIGNIFICANCE LEVELS OF BUCCOLINGUAL MAXILLARY COMPARISONS

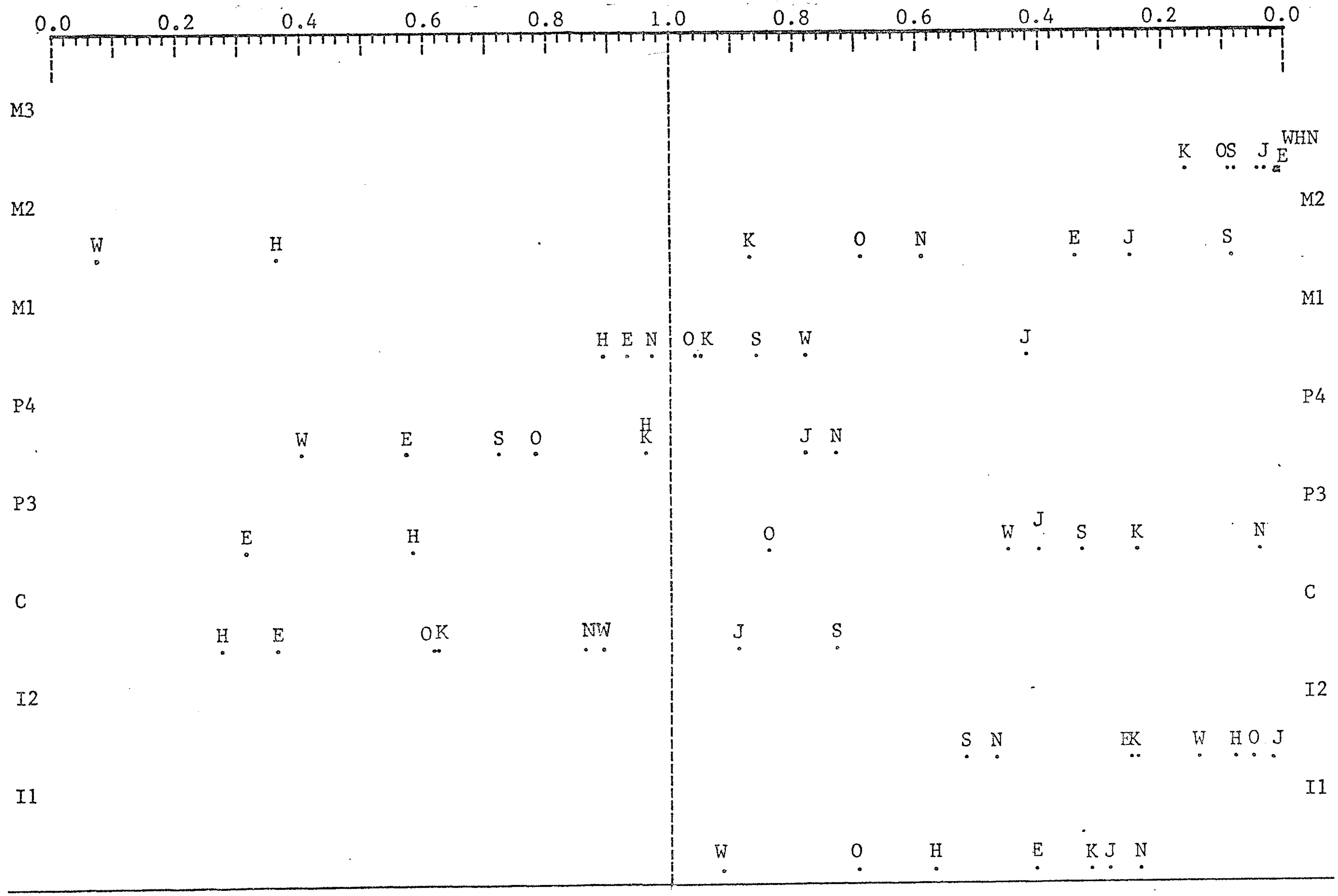
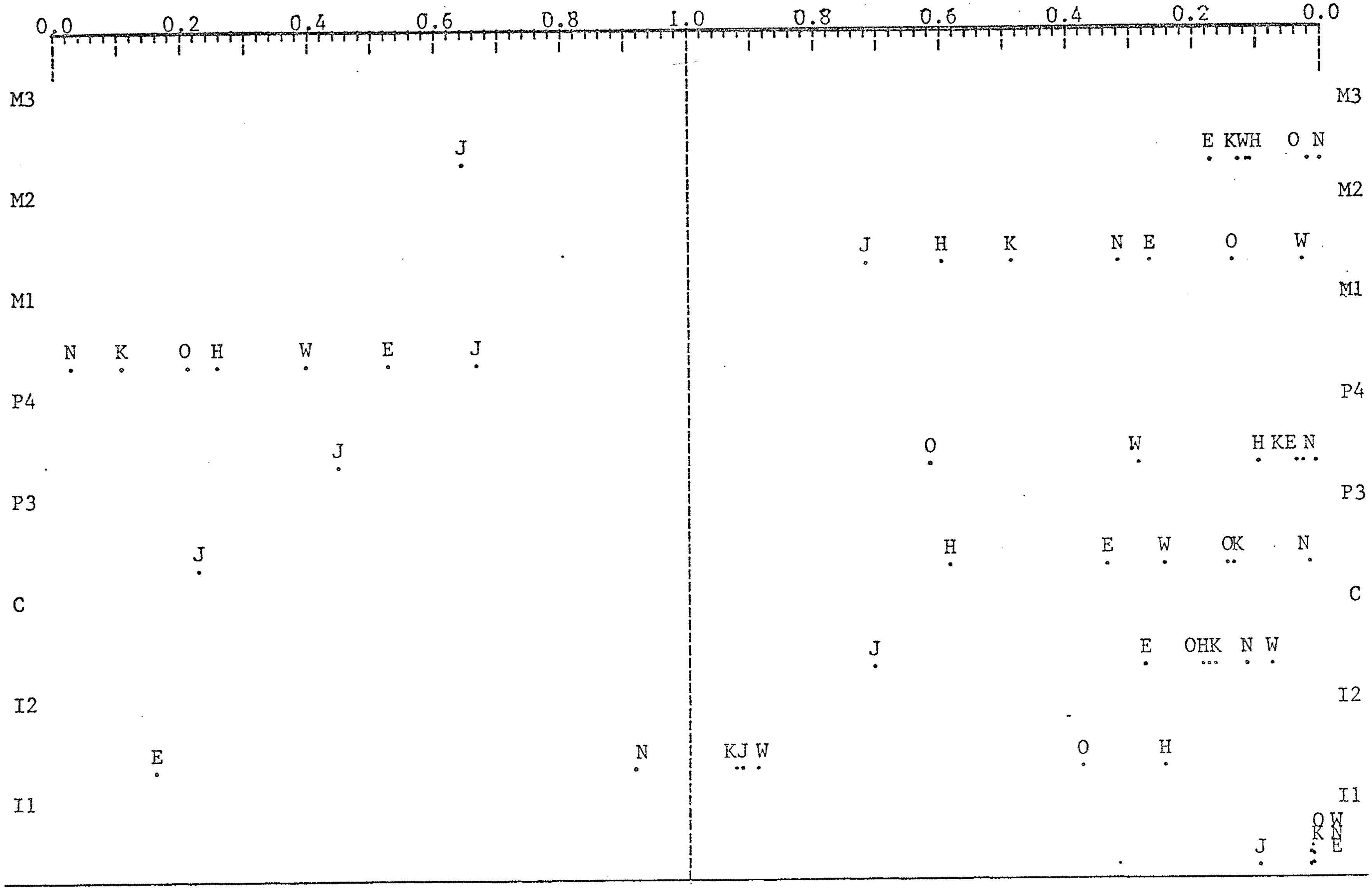


Fig. 8

SIGNIFICANCE LEVELS OF MESIODISTAL MANDIBULAR COMPARISONS



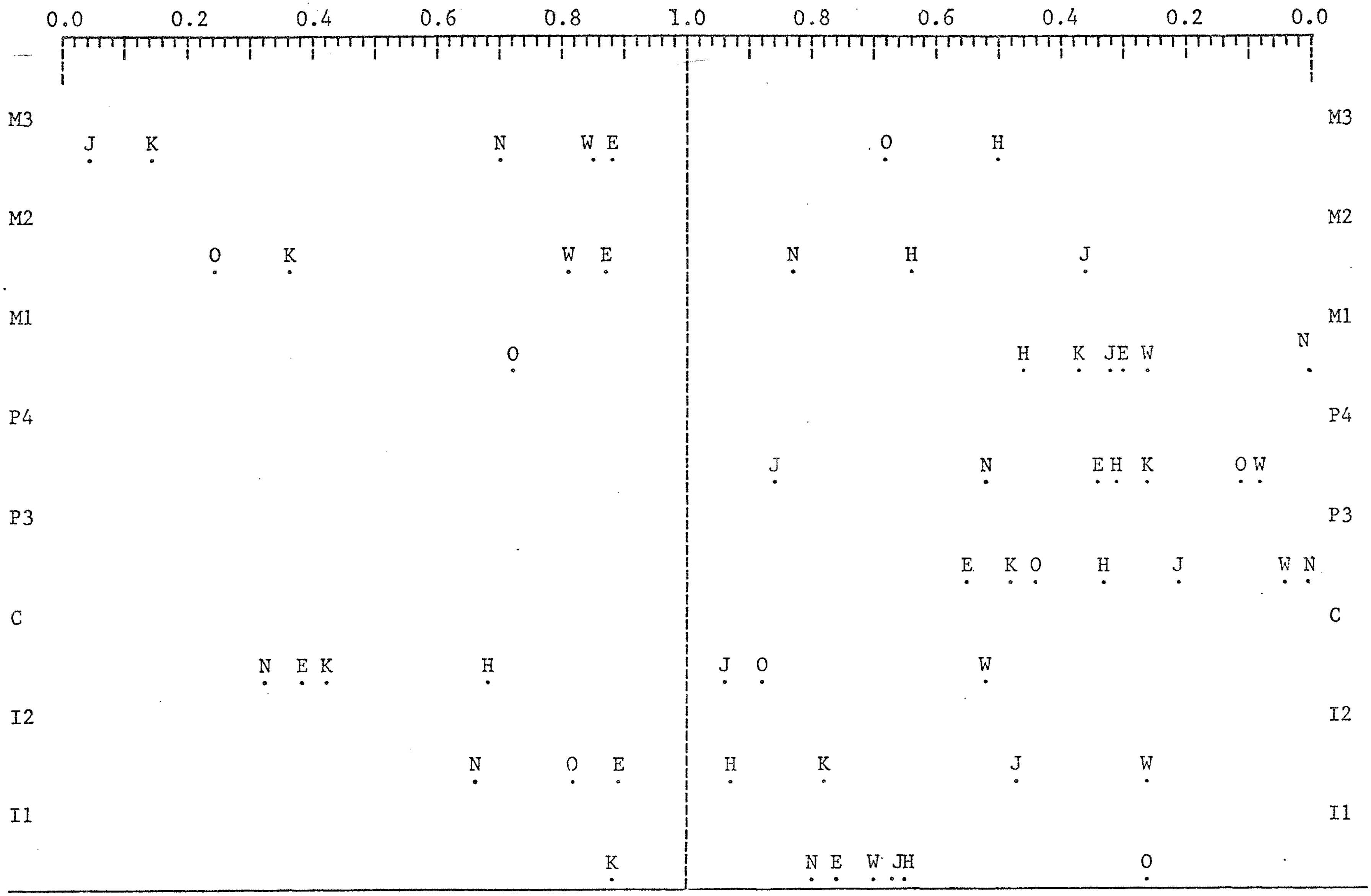
values for M3, M1, P4 and P3 teeth are negative. In relation to the ranges for Natufian M3, M2, P4, P3, C and I1, plots for Jarmo indicate that teeth from this site are relatively shorter. In three cases, (M3, P4 and P3), Jarmo teeth are shorter than corresponding teeth from Ganj Dareh Tepe. For Jarmo, the first molar is longer than those from the Natufian samples, but is smaller than Ganj Dareh. The plot for the lateral incisor from Jarmo is within the Natufian range. Part this range lies close to the central axis. It is apparent that the I2 length is the most variable of mandibular teeth.

Considering the ranges for individual teeth, the central incisor exhibits the least variability. The plots for the Natufian lateral incisor are not significant but the range shows the most variability. Jarmo plots frequently approximate the position of Ganj Dareh Tepe. In one case, the I2, the Jarmo plot is positioned within the distribution formed by remaining I2 plots. The same range also incorporates Ganj Dareh Tepe.

<u>Mandibular buccolingual dimensions</u> Figure 9 shows the plots for comparisons of mandibular breadths. Ranges for molars canine and I2 are extensive. Plots for all Jarmo teeth, excepting M3, are on the right side of the graph, indicating that these teeth are narrower relative to Ganj Dareh. In addition, Jarmo canine and P4 plots

Fig. 9

SIGNIFICANCE LEVELS OF BUCCOLINGUAL MANDIBULAR COMPARISONS



are close to the axis indicating some similarity in size between the two samples. Jarmo teeth are commonly found within the range formed by the Natufian plots. Only three tooth plots from Jarmo are found outside the Natufian range; M3, M2 and P3. In general, there is no difference between Natufian and Jarmo in the anterior dentitions.

In contrast, only the premolars from Ganj Dareh are not within the Natufian range. This range is extended, however, by the somewhat isolated plots for Kebara (I1) and Nahal Oren (M1) and these two cases may be anomalous. If these are excluded, then the Natufian range for each tooth is substantially diminished and the Ganj Dareh teeth are no longer incorpoated into the ranges.

<u>Summary, odontometric comparisons</u>

The four preceding figures (figs. 6 - 9) show the positions of probability plots resulting from comparisons made between several Natufian samples and Ganj Dareh Tepe and between Jarmo and Ganj Dareh Tepe. Probabilities are taken to reflect the similarities and differences encountered in these comparisons whether significant or not.

Table 38 serves to illustrate the relative differences between Natufian samples and Jarmo by examining the frequencies of similarities and differences according to whether plots for a given tooth are a) significant, b) not significant, c) computed from a positive t-score, or d) computed from a negative t-score. Four classes are shown.

TABLE 38

DIMENSIONAL DIRECTIONALITY AND SIGNIFICANCE
FOR NATUFIAN AND JARMO POPULATIONS

		NATUFIAN								JARMO							
		>	%	<	%	*>	%	*<	%	>	%	<	%	*>	%	*<	%
MAXILLA M3-M1	m-d	0 (18)	0	18 (18)	100	0 (0)	0	10 (18)	56	0 (3)	0	3 (3)	100	0 (0)	0	0 (3)	0
	b-l	4 (21)	19	17 (21)	81	0 (4)	0	4 (17)	24	0 (3)	0	3 (3)	100	0 (0)	0	0 (3)	0
P4-P3	m-d	0 (12)	0	12 (12)	100	0 (0)	0	3 (12)	25	1 (2)	50	1 (2)	50	0 (1)	0	0 (1)	0
	b-l	7 (14)	50	7 (14)	50	0 (7)	0	1 (7)	14	0 (2)	0	2 (2)	100	0 (0)	0	0 (2)	0
C	m-d	5 (6)	83	1 (6)	17	1 (5)	20	0 (1)	0	1 (1)	100	0 (1)	0	0 (1)	0	0 (0)	0
	b-l	6 (7)	86	1 (7)	14	0 (6)	0	0 (1)	0	0 (1)	0	1 (1)	100	0 (0)	0	0 (1)	0
I2-I1	m-d	4 (11)	36	7 (11)	64	0 (4)	0	1 (7)	14	0 (2)	0	2 (2)	100	0 (0)	0	0 (2)	0
	b-l	0 (13)	0	13 (13)	100	0 (0)	0	0 (13)	0	0 (2)	0	2 (2)	100	0 (0)	0	0 (2)	0
Total	m-d	9 (47)	19	38 (47)	81	1 (9)	11	14 (38)	37	2 (8)	25	6 (8)	75	0 (2)	0	0 (6)	0
	b-l	17 (55)	31	38 (55)	69	0 (17)	0	5 (38)	13	0 (8)	0	8 (8)	100	0 (0)	0	0 (8)	0
MANDIBLE M3-M1	m-d	6 (18)	33	12 (18)	67	1 (6)	17	3 (12)	25	2 (3)	67	1 (3)	33	0 (2)	0	0 (1)	0
	b-l	8 (18)	44	10 (18)	56	0 (8)	0	1 (10)	10	1 (3)	33	2 (3)	67	0 (1)	0	0 (2)	0
P4-P3	m-d	0 (12)	0	12 (12)	100	0 (0)	0	0 (12)	0	2 (2)	100	0 (2)	0	0 (2)	0	0 (0)	0
	b-l	0 (12)	0	12 (12)	100	0 (0)	0	0 (12)	0	0 (2)	0	2 (2)	100	0 (0)	0	0 (2)	0
C	m-d	0 (6)	0	6 (6)	100	0 (0)	0	0 (6)	0	0 (1)	0	1 (1)	100	0 (0)	0	0 (1)	0
	b-l	4 (6)	67	2 (6)	33	0 (4)	0	0 (2)	0	0 (1)	0	1 (1)	100	0 (0)	0	0 (1)	0
I2-I1	m-d	2 (12)	17	10 (12)	83	0 (2)	0	6 (10)	60	0 (2)	0	2 (2)	100	0 (0)	0	0 (2)	0
	b-l	4 (12)	33	8 (12)	67	0 (4)	0	0 (8)	0	0 (2)	0	2 (2)	100	0 (0)	0	0 (2)	0
Total	m-d	8 (48)	17	40 (48)	83	1 (8)	13	9 (40)	23	4 (8)	50	4 (8)	50	0 (4)	0	0 (4)	0
	b-l	16 (48)	33	32 (48)	67	0 (16)	0	1 (32)	3	1 (8)	13	7 (8)	88	0 (1)	0	0 (7)	0

The first class is denoted by the column heading > and the second by the heading < . These classes are further subdivided by the addition of an asterisk to denote two subclasses of significant directional differences. These are denoted by >* and <* to represent frequencies of significantly longer or narrower teeth and conversely, significantly shorter or broader teeth.

Table 38 shows that Natufian maxillary samples are shorter in M3 through P3 with the incisors showing a similar tendency. In contrast the canine is slightly longer in relation to Ganj Dareh. Overall, mesiodistal and buccolingual dimensions are significantly smaller in all maxillary teeth excepting the canine.

Natufian mandibular teeth show considerable variation in both dimensions of molars and incisors. Generally, molars appear to be significantly short while breadths are only slightly small. The premolars are small in both length and breadth dimensions but not significantly. Canines show some breadth variation while lengths for all Natufian samples is reduced. Incisal lengths are significantly small while breadths exhibit no consistent differences relative to Ganj Dareh. Both the upper and lower canines are markedly small lengths.

It is apparent that the generally small maxillary arcade is due to the collectively small sizes of molars and premolars in conjunction with small incisors. In the mandible, teeth contributing to a decreased arcade are the premolars, the canine, and, notably, the incisors. Conversely, upper canines and lower molars are the largest components in their respective arcades. Frequency totals and percentages show a marked similarity between upper and lower frequencies in mesiodistal and buccolingual dimensions. For the Natufian, frequencies differ by no more than two percent for directionality, and between two and fourteen percent for significance.

Generally, maxillary teeth from Jarmo are smaller than either Natufian or Ganj Dareh teeth. However, the consistently small molars and incisors are not significantly different and are comparable to Ganj Dareh Tepe. In the mandible, consistently shorter and narrower canines and incisors are encountered. Breadths are small for premolars and molars. Molars and premolars are generally longer than either Ganj Dareh or Natufian samples.

In comparison, Ganj Dareh is characterized by longer and broader teeth. Relative to the Natufian Group, many teeth are significantly larger in the maxilla and anterior mandible. Such contrasts are much less apparent for Jarmo. While Ganj Dareh dentitions are generally larger, exceptions were encountered once each for the upper canine length, and the lower molar length in which cases the Natufian Group was larger (column 3). No teeth were significantly long or broad for the Jarmo dentitions (col. 7).

Differences in the maxilla compared to the mandible were similar for the cumulative directionality exhibited by the Natufian dentition. The pattern of no differences for Jarmo still obtains for the mandibular teeth.

Results of analysis of dental shape and robusticity

Mean indices describing tooth shape and estimating tooth size (robusticity) are reproduced in Table 39 for all prehistoric samples. Values for Natufian and Jericho samples have been taken from P. Smith ('70). In addition, Table 39 shows mean index values together with maximum and minimum values for each tooth class from Ganj Dareh Tepe.

For the individual Natufian samples, indices were treated as representing six discrete observations for use in computing a grand mean for the Natufian Group. These values together with associated sample parameters, n and standard deviation appear in Table 40. This composite sample constitutes a comparative base for examinations of Ganj Dareh Tepe, the individual from Erq el Ahmar and the Jerichos.

Indices representing these samples (Table 39) were examined for differences using two separate criteria. When an index was greater or less than the corresponding Natufian Group index, it was regarded as a directional difference. Further, when an index value differed from the Natufian index by more than two standard deviations, it was

TABLE 39

SHAPE INDICES AND ROBUSTICITY FOR TEN SAMPLES

	Shape (b-l/m-d)								Robusticity (b-l x m-d)							
	M3	M2	M1	P4	P3	C	I2	I1	M3	M2	M1	P4	P3	C	I2	I1
Maxilla																
W.	130	126	119	148	137	112	96	79	100	118	127	66	67	66	46	67
S.	128	114	118	143	137	113	/	/	82	117	126	61	65	61	44	/
K.	125	124	117	140	135	114	100	76	100	120	129	66	69	67	44	65
E.	126	123	113	145	135	112	94	82	97	117	132	67	72	72	48	65
O.	125	123	116	151	137	112	94	84	105	118	130	65	70	67	47	69
H.	132	128	117	141	136	117	97	87	98	118	132	64	73	73	48	70
A.	115-	120	121+	144	143+	106-	99	84	104	120+	128	61	60-	73	49	67
B.	100-	117	115	142	130-	115	100	77	88	129+	125-	67	69	77+	41-	61-
Z.	120-	123	115	137	136	111	91-	77	77-	113-	118	62	59-	64	44	60-
GDT	129	113-	107-	136	130-	113	98	83	122+	133+	142+	68	74	66	50+	69
min	123	107	97	118	125	93	86	75	111	116	129	60	64	44	42	53
max	135	116	114	148	136	145	110	95	135	153	161	77	80	90	57	83
Mandible																
W.	98	98	97	113	114	112	108	116	109	116	126	61	55	51	39	32
K.	101	98	97	117	116	114	105	123	115	118	128	61	58	58	38	32
E.	99	97	97	118	115	116	108	111	110	118	125	61	58	57	41	33
O.	100	102	97	115	119	113	103	110	101	116	126	60	57	53	42	34
H.	102	95	95	114	118	115	106	118	112	117	132	61	57	58	42	34
A.	100	99	100+	119	108-	100-	/	/	121+	126+	132	60-	56	52	/	/
B.	94-	100	97	118	115	113	102	110	113	122+	126	60-	59	61	42	37+
Z.	95-	102	110+	115	116	119+	100-	108	92-	103-	110-	55-	51-	49-	36-	27-
GDT	97	95	101+	113	115	106-	110+	95-	113	119+	125	68+	62+	51	39	41+
min	91	87	86	86	95	94	100	76	105	100	108	60	53	48	30	33
max	106	110	119	133	137	121	124	134	121	133	140	92	72	77	56	50

\+ Index significantly larger than Natufian
\- Index significantly smaller than Natufian

TABLE 40

SHAPE INDICES AND ROBUSTICITY FOR THE NATUFIAN GROUP

		M3	M2	M1	P4	P3	C	I2	I1
		SHAPE							
Maxilla	n	6	6	6	6	6	6	5	5
	$\bar{x}$	127.7	123.0	116.7	144.7	136.2	113.3	96.2	81.6
	s.d.	2.624	4.397	1.886	3.859	0.898	1.795	2.227	3.826
Mandible	n	5	5	5	5	5	5	5	5
	$\bar{x}$	100.0	98.0	96.5	115.4	116.4	114.0	106.0	115.6
	s.d.	1.414	2.280	0.800	1.855	1.855	1.414	1.897	4.758
		ROBUSTICITY							
Maxilla	n	6	6	6	6	6	6	6	5
	$\bar{x}$	97.0	118.0	129.3	64.8	69.3	67.7	42.6	67.2
	s.d.	7.165	1.000	2.285	1.951	2.749	3.986	1.675	2.040
Mandible	n	5	5	5	5	5	5	5	5
	$\bar{x}$	109.4	117.0	127.4	60.8	57.0	55.4	40.4	33.0
	s.d.	4.673	0.894	2.500	0.400	1.095	2.871	1.625	0.894

regarded as significant. When an index is greater and significant, a plus sign is used, while a minus sign indicates the opposite relationship.

Comparisons show that none of the non-Natufian samples nor Erq el Ahmar is similar to the Natufian Group. Also, comparative samples are themselves dissimilar based on frequencies for the occurrence of significantly different directional indices (Table 41).

Robusticity Values approximating occlusal surface areas differentially show directional significance for each of the four sites. Frequencies for each site, shown as Total Differences in Table 41, indicate the extent to which the sample differs from the Natufian Group. These vary from nearly nineteen percent (18.75) for Jericho PPNB, 37.5 percent for Jericho Bronze, 44 percent for Ganj Dareh to 50.0 percent for Erq el Ahmar. Differences for Erq el Ahmar occur in both directions more frequently than for any other site. This was unexpected as Erq el Ahmar has generally been regarded as culturally and biologically Natufian (P. Smith,'70).

Robusticity values in Table 41 show similarities between arcades Erq el Ahmar and Jericho PPNB. Contrasting results, however, are exhibited by Ganj Dareh Tepe and Jericho Bronze. The latter site is represented by 12/16 smaller differences, and the former, by 8/16 larger differences.

TABLE 41

FREQUENCIES OF DIRECTIONAL DIFFERENCES IN DENTAL ARCADES

	SHAPE				ROBUSTICITY			
	Obs.	+	-	Total Differences	Obs.	+	-	Total Differences
Erq el Ahmar (A)								
maxilla	8	2	2	7/14	8	1	1	5/14
mandible	6	1	2		6	2	1	
		3/14	4/14			3/14	2/14	
Jericho PPNB (B)								
maxilla	8	0	2	3/16	8	2	3	8/16
mandible	8	1	0		8	2	1	
		1/16	2/16			4/16	4/16	
Jericho Bronze (Z)								
maxilla	8	0	2	6/16	8	0	4	12/16
mandible	8	2	2		8	0	8	
		2/16	4/16			0/16	12/16	
Ganj Dareh Tepe (GDT)								
maxilla	8	0	3	6/16	8	4	0	8/16
mandible	8	1	2		8	4	0	
		1/16	5/16			8/16	0/16	

Figure 10 lists directional signs for each comparative sample. Juxtaposition of signs for occluding teeth shows that significantly small teeth are present at Erq el Ahmar and Jericho PPNB. For significant teeth from Ganj Dareh Tepe and Jericho Bronze, teeth demonstrate opposite directionality. The Ganj Dareh dentition has four maxillary and four mandibular teeth (8/16) showing significantly large robusticity values. At Jericho Bronze, significantly small teeth are represented by four mandibular and eight maxillary differences (12/16).

Shape Significantly different shape indices are also presented in fig. 10. All show some relative differences. Frequencies (Table 41) for Jericho PPNB represent only 3/16 differences while Erq el Ahmar shows the greatest number (7/14). In comparison to Ganj Dareh maxillary teeth and those from the two Jericho samples, the M1 and P3 from Erq el Ahmar both show significance.

Summary, size and shape

Robusticity Indices from Erq el Ahmar, Jericho PPNB, Jericho Bronze and Ganj Dareh Tepe were compared to the Natufian Group. A number of significant differences were found (Tables 39-42; fig. 10) in this comparison as well as between these four samples.

Previous researchers have recently shown evidence for the occurrence of two different dental metric

FIGURE 10

DISTRIBUTION OF SIGNIFICANTLY DIFFERENT TEETH

	ROBUSTICITY								SHAPE INDEX							
	M3	M2	M1	P4	P3	C	I2	I1	M3	M2	M1	P4	P3	C	I2	I1
Ganj Dareh Tepe																
maxilla	+	+	+				+			-	-		-			
mandible		+		+	+			+			+		-		+	-
Erq el Ahmar																
maxilla		+			-				-		+		+	-		
mandible	+	+		-			/	/			+		-	-	/	/
Jericho PPNB																
maxilla		+	-			+	-	-	-				-			
mandible		+		-				+	-							
Jericho Bronze																
maxilla	-	-			-	-		-	-						-	
mandible	-	-	-	-	-	-	-	-	-	+		+	-			

trends, characterized by size decrease or increase through time. The former was demonstrated by Wolpoff ('71) following Dahlberg ('45), Brothwell ('63), Brace ('67) and others as dental size reduction. This hypothesis was later supported by Frayer ('77). The reverse was suggested by Scott ('79), and characterized, not by a size reduction but, rather, by an increase.

Generally, the changes observed indicate a dental size reduction through the period delineated by the dates for the Natufian samples and those for the Jericho Bronze occupation (Table 16, Chapter VI). The distribution of large and small differences (Table 42) in upper and lower arcades indicate progressively smaller teeth in chronologically later populations. In addition, the size of some teeth is relatively stable, characterized by the absence of significant size differences.

Teeth showing small size, relative to Natufian and Ganj Dareh Tepe, include molars (particularly the M2), the premolars and the incisors from both arcades. Teeth with few or no indicators of size changes in robusticity include the lower M1, upper and lower canines and the lateral incisors.

Shape In comparison to the Natufian Group, tooth proportions of the comparative samples alter randomly through time. Previous studies have not considered tooth shape and its utility is not fully understood. However, the shape index may help discriminate between dissimilar populations as in the case of Erq el Ahmar. Results presented earlier strongly suggest that the teeth from the Erq el Ahmar burial are sufficiently different from Natufian teeth and it should be considered as non-Natufian.

Assuming that the shape index discriminates successfully, then the two Jericho samples may be compared for evidence of biological affinity. Comparisons show a certain consistency in patterns of significantly different shapes of teeth. The Jericho upper and lower M3 teeth are both significantly different in breadth, while the M2, P4 and I1 differences are not significant (fig. 10). The remaining differences between the Jericho samples are unexpected assuming that reduction affect the arcade, rather than specific teeth. Specifically, lengths for the lower M1 and P3 increased relative to their breadths over time. This is also the case for the upper P3 whose length increases from PPNB to Bronze Age. Initially, this tooth is significantly different in proportion but in the later sample, length relative to breadth has reduced, making the shape value insignificant. Thus, while small dental diameters are apparent for the later sample (Table 42), significant differences are unidirectional (fig. 10) suggesting that the two samples may be from the same population, but from different times.

TABLE 42

PERCENT DIFFERENCE[a] BETWEEN JERICHO PPNB AND JERICHO BRONZE: DENTAL DIMENSIONS

		maxillary	mandibular
M3	m-d	- 5.8	- 8.3
	b-l	2.1	- 1.0
M2	m-d	-11.4	- 4.7
	b-l	- 7.3	- 4.8
M1	m-d	- 5.7	- 6.3
	b-l	- 3.4	- 4.6
P4	m-d	- 4.3	-10.7
	b-l	- 7.1	- 4.8
P3	m-d	- 9.6	- 6.9
	b-l	- 6.3	- 7.3
C	m-d	2.6	-12.2
	b-l	- 7.4	- 5.1
I2	m-d	4.7	- 7.7
	b-l	- 1.6	- 7.5
I1	m-d	- 3.4	- 8.8
	b-l	- 1.4	- 9.2

[a] percent difference calculated as $((L\overline{X} - E\overline{X}) \times 100/E\overline{X})$ after Scott('79).

CHAPTER VIII

SUMMARY AND CONCLUSION

This study has placed emphasis on a broad range of metric and nonmetric data describing the Neolithic population from Ganj Dareh Tepe. Individuals comprising the sample were described according to age and sex and were characterized collectively by frequencies of anomalous and pathological conditions. Males and females were compared separately to samples of similar make-up from two other populations from later cultural periods to assess morphological changes over time. These same samples were also compared to examine the relative differences resulting from sexual dimorphism. Other comparisons were made for Ganj Dareh with several other populations using odontometrics and dental indices. General summaries for each area of investigation appear below.

The Ganj Dareh Tepe Series

Forty-nine individuals are represented in the Ganj Dareh series. Of 28 adults, 13 males and 11 females were aged. Also present were 20 preadolescents. Provenience was ascertained for 39 individuals representing 80 percent of the skeletal series. Of these, 27 individuals or 69 percent originated from Level D.

The series was characterized by intentional cranial deformation on several males, females and preadolescents. Deformation was accomplished by bandages producing an annular variant. Cranial nonmetric traits were tested for significant associations by sex but no associations were found.

Pathologies included mild hyperostosis symmetrica, probably caused by iron deficiency anemia, on 50 percent of the adults. No preadolescents were affected. In the post-cranial complex, there was a single case of osteomyelitis and a single case showing both osteoarthritis and osteophytosis. Physical traumata were seen in a single adult cranium and in the humerus of a different adult. Both fractures were healed. Dental traumata were from hypercementosis and enamel breakage, both caused by mastication. Dentitions were characterized by a low incidence of dental caries and a high incidence of calculus. Isolated cases of alveolar resorption and _ante mortem_ tooth loss were found. One case of enamel hypoplasia occurred in association with _ante mortem_ staining in cervical areas.

Morphological variations in adult dentitions were frequently bilateral. In upper molars, the 4+ cusp pattern occurred with greatest frequency in M3 and M2. For the M1, 4 and 4+ patterns occurred equally. Tritubercular teeth were observed only in second and third molars. In the lower molars, M3 patterns include Y5, +4 and 4 variants in the same proportion. M2 patterns, in order of descending frequency, were +4, 4 and 6. For the first molars, patterns were similar to those for the M3 with patterns of Y5, 4 and +4. Carabelli's cusp was observed in forty percent of second molars and twenty percent of first molars. None was observed on third molars and the protostylid was completely absent. A single maxillary I1 was shovel-shaped.

Differences Based On Sex

Differences attributed to sexual dimorphism were observed for each population but particularly for Ganj Dareh and Lerna. There was an insufficient number of variates for Tepe Hissar for intensive comparisons to be made (figs. 11-12).

Comparisons of male and female variates shows a significant amount of sexual dimorphism at both Ganj Dareh Tepe and Lerna. However, there are differences between these populations in the magnitude of individual variates as shown by their respective indices. The dimorphism between males and females from Ganj Dareh is far less marked than dimorphism for the Bronze Age populations. For both these sites, comparisons for males and females were often significant using the t-test while only three variates from Ganj Dareh were moderatly so. Patellar breadth appears to be a good sex indicator with $p = 0.004$.

Figures 11 and 12 illustrate plotted index values for individual bones with two or more compared variates (fig. 11) and for lengths and widths from bones examined collectively according to the defined anatomical orientation of the bone for taking the measurement (fig. 12). Figure 11 shows the

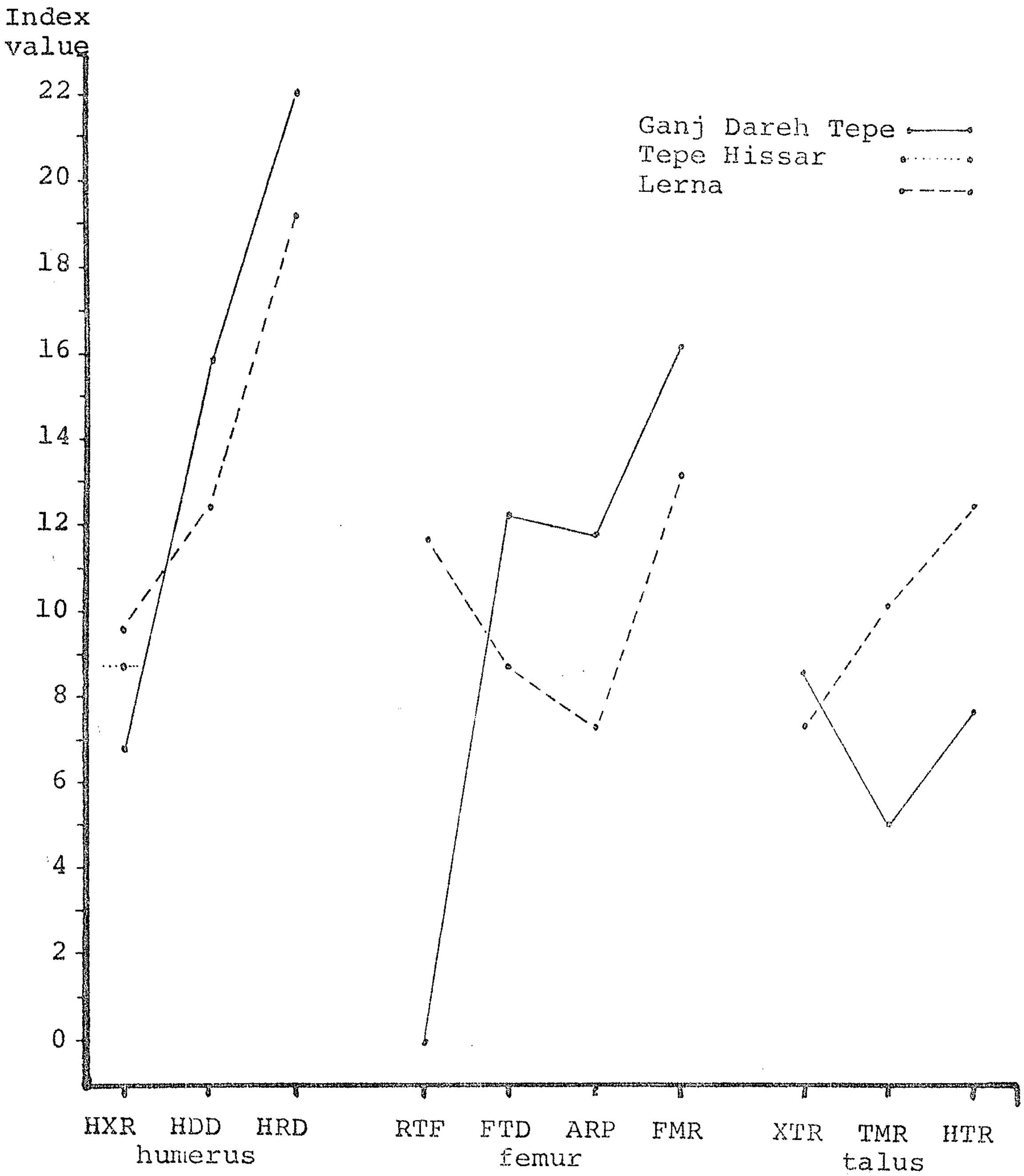


fig. 11 Plots of I_{SD} values for individual bones from Ganj Dareh Tepe, Lerna and Tepe Hissar.

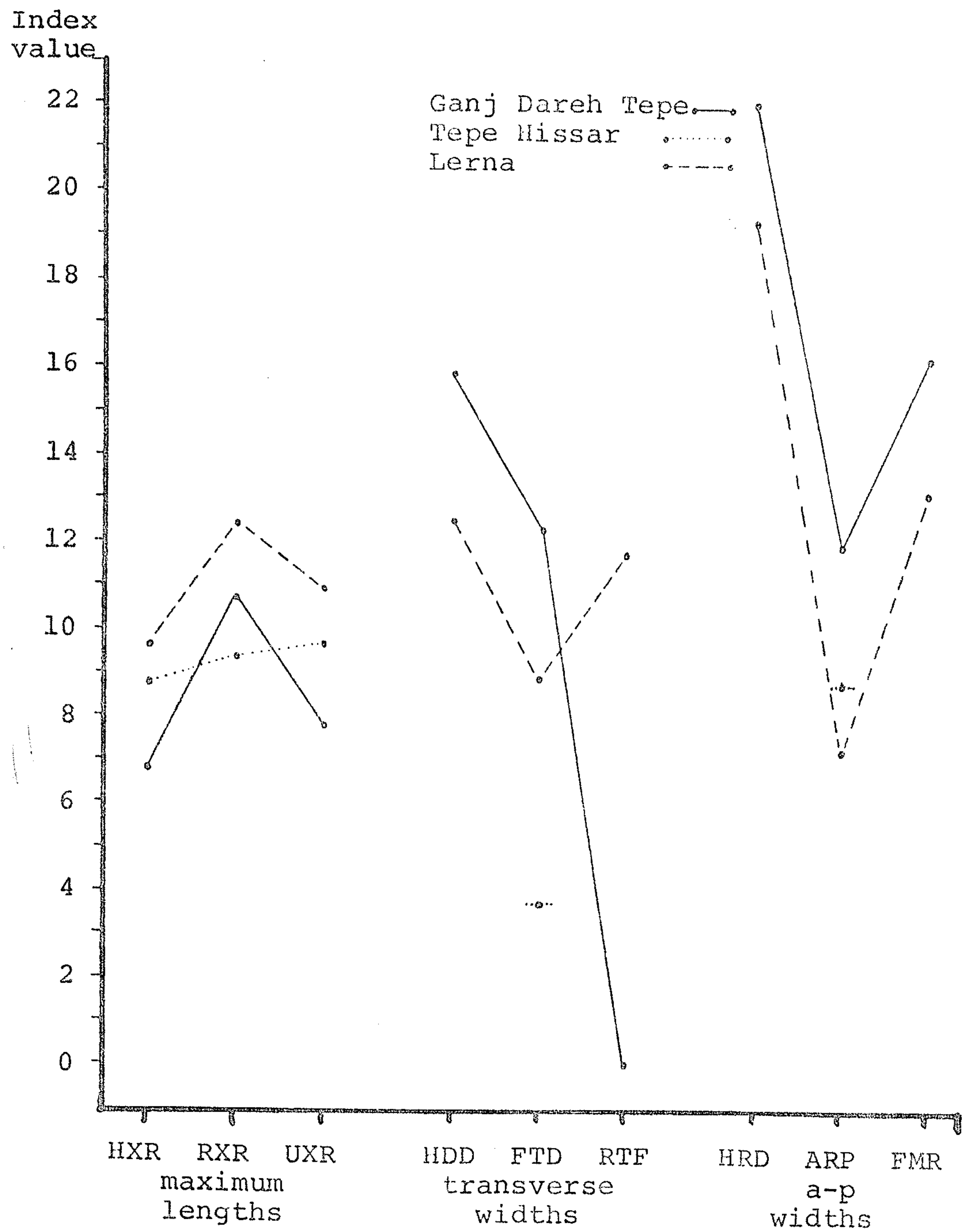


fig. 12 Plots of I_{SD} values for long bone lengths and transverse and anteroposterior widths in comparison.

difference in the humeral length to be less at Ganj Dareh while breadths show greater dimorphism. With the exception of the RTF discrepancy, femoral diameters differ proportionately with Ganj Dareh, again, showing greater dimorphism in these breadths. In the talus, the length-breath relationship noted for the humerus and femur is reversed with greater dimorphism for Ganj Dareh occurring in the length.

In the second figure, sexual dimorphism at Ganj Dareh is small for lengths and generally greater in transverse and anteroposterior breaths. The corresponding Lerna variates show the same results but with greater and lesser magnitude, respectively, for lengths and breadths.

Differences Independent of Sex

Figures 13 and 14 illustrate plots of the I_{SC} for male and female variates compared separately. Long bone lengths and talar dimensions are reduced relative to Ganj Dareh Tepe. This is common to both sexes with the only difference being one of magnitude. There is some distinction between Hissar and Lerna in the two femoral widths. Here trends show by both sexes are virtually identical, but the FTD for females is, not smaller, but larger than Ganj Dareh (fig. 14). Other comparisons are mainly between Ganj Dareh and Lerna. As above, males and females from Lerna show the same general tendencies to proportionally larger or smaller size. These occur in humeral widths and femoral widths, respectively. Therefore, smaller upper long bones fig. 13 Plots of male I_{SC} for Tepe Hissar and Lerna in relation to Ganj Dareh Tepe

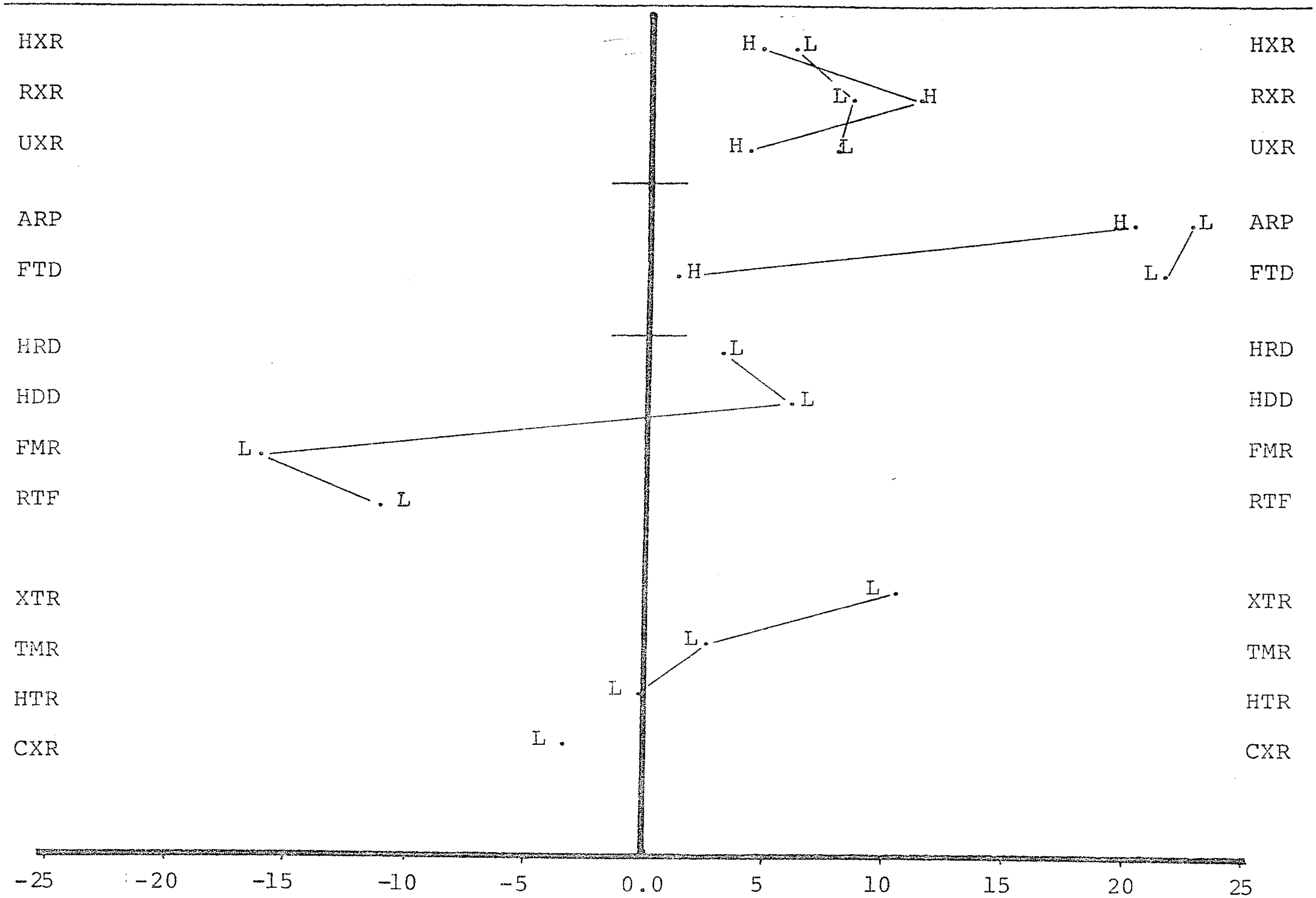
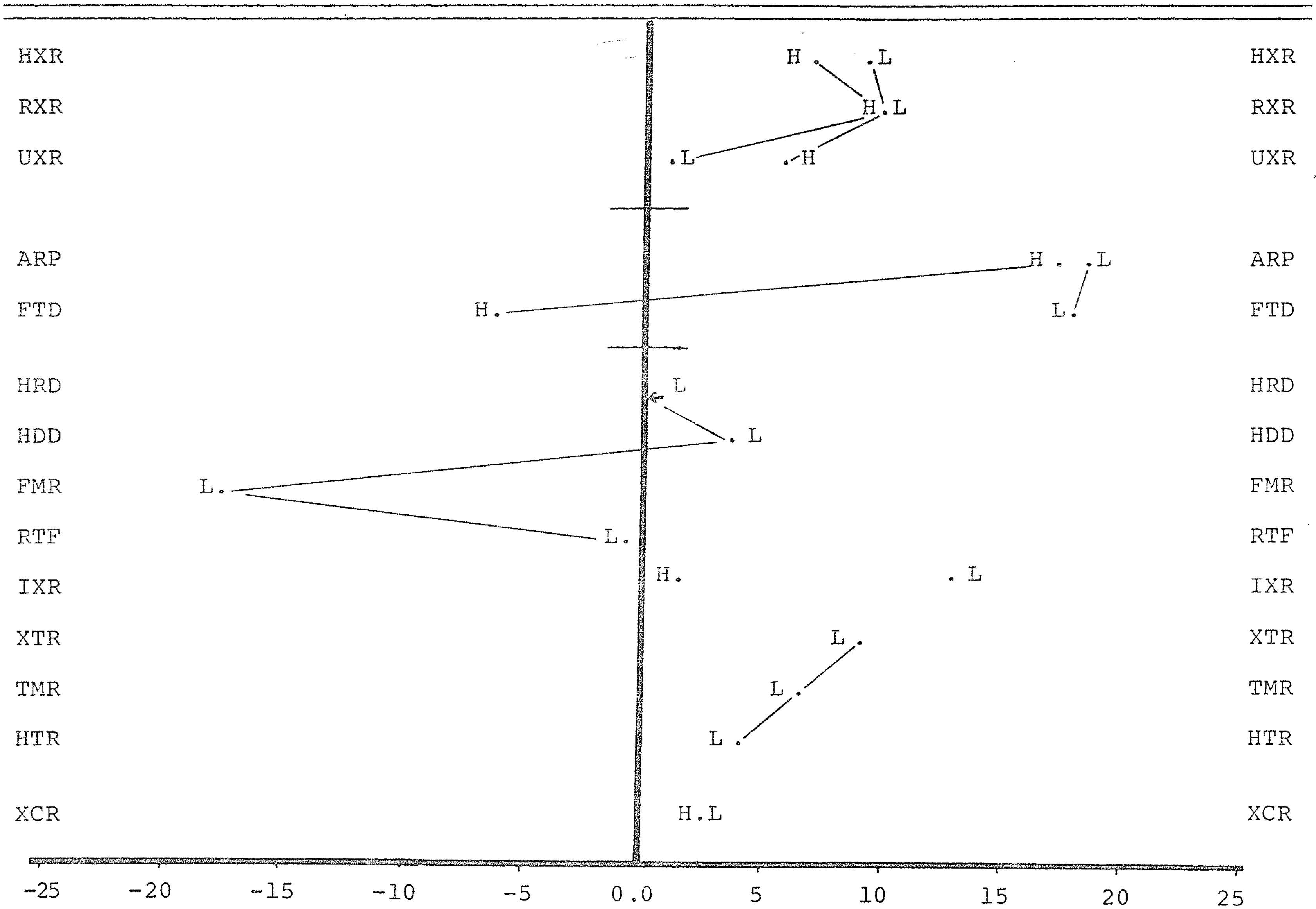


fig. 14 Plots of female I_{SC} for Tepe Hissar and Lerna in relation to Ganj Dareh Tepe



sizes are present at the later sites. Also, the later sites have wider lower long bones.

Metric Dental Trends

It is generally held that during hominid evolution, there has been an overall reduction in the size of teeth (Dahlberg,'45; Brothwell,'63; Brace,'67; Brace and Mahler,'71; Sofaer,'71; Wolpoff,'71; Sofaer et al.,'73; Frayer,'77; but c.f. Scott,'78). Tooth reduction appears to have been accomplished by simplification of molar cusp patterns with a corresponding loss of occlusal surface area (Greene,'70,p.278), and by selection for large early developing teeth at the expense of small early developing homologues (Sofaer et al.,'71; Sofaer,'73). Dental reduction appears to have been pleiotropic to some degree as Sofaer ('73) and his co-workers ('71) have suggested. Thus, tooth size diminuation occurred harmoniously with jaw reduction (Sofaer,'73,p.427). Such changes in mandibular teeth have been observed in Nubian populations by Carlson and van Gerven ('77). Jaw size diminuation occurs in the Nubians in association with repositioning of the facial skeleton in relation to the cranial vault. Carlson and van Gerven ('77) suggested that size reduction has implications for reduction in dental caries while simultaneously reflecting decreased dependency on a coarse or gritty diet and increasing reliance on softer, more highly processed foods (also Greene,'70). However, despite sma-ler tooth size in more recent samples, Brothwell ('72) notes an increase in caries incidence. This is due to the introduction and continued use of what Greene ('70) calls "cariogenic carbohydrate-cooked foods". Armelagos ('68) acknowledged that "teeth with complex fissure patterns and five cusps have a higher incidence of lesions in a caries - producing environment than simpler teeth" (greene,'70). This observation was also made in a later study by Anderson and Popovich ('77).

In several studies exploring the relationship between dental attrition and tooth size, P. Smith ('76; '77a,b) questions the hypothesis that size reduction in the teeth operated in response to functional demands. Using tooth samples from the Riss, Riss-Würm, Würm I-II and Würm III-IV, and distinguished by geographic location (the Near East, Western and Central Europe), P. Smith attempted to show that size reduction is not closely associated with a reduction in the severity of functional stress. P. Smith's attrition data lead her to suggest that "...observed reduction in tooth size...has outstripped...any concomitant reduction in functional demands made on teeth (P. Smith,'76, p.150)". This implies that reduction trends observed by other researchers are independent of, rather than the result of masticatory function. The Nubian dietary shift from gritty to softer foods (Carlson and van Gerven,'77) may not, therefore, have prompted dental size reduction, despite the reduction of functional demands (Greene,'70; Carlson and van Gerven,'77).

P. Smith's study of functional demands examines dental attrition in a population relative to the average attrition shown by the second molar (P. Smith,'76). This tooth is used as a constant against which other teeth in the arcade are gauged for their degrees of attrition. This presupposes, however, that the eruption time of this tooth and the entire eruption sequence of any comparative population are the same. Therefore, it should be cautioned that conclusions based upon this technique should be tentatively expressed in light of the results presented by Carlson and van Gerven ('77), Sofaer et al. ('71), and Sofaer ('73).

In comparison to the Natufian group and the Jericho samples, Ganj Dareh shows a minor but distinct tendency to have larger maxillary teeth, excepting the canine (fig. 15), and larger madibular premolars and central incisors (fig. 16). Excepting maxillary molars and the mandibular premolars, the modal Ganj Dareh dentition is most similar to the Natufian dentition. This is indicated by the interrelationships of the teeth comprising each comparative arcade. The molars and premolars mentioned above are interesting because they constitute the milling or grinding surface. In both upper and lower milling areas, smaller sizes are apparent, but only differences are general-

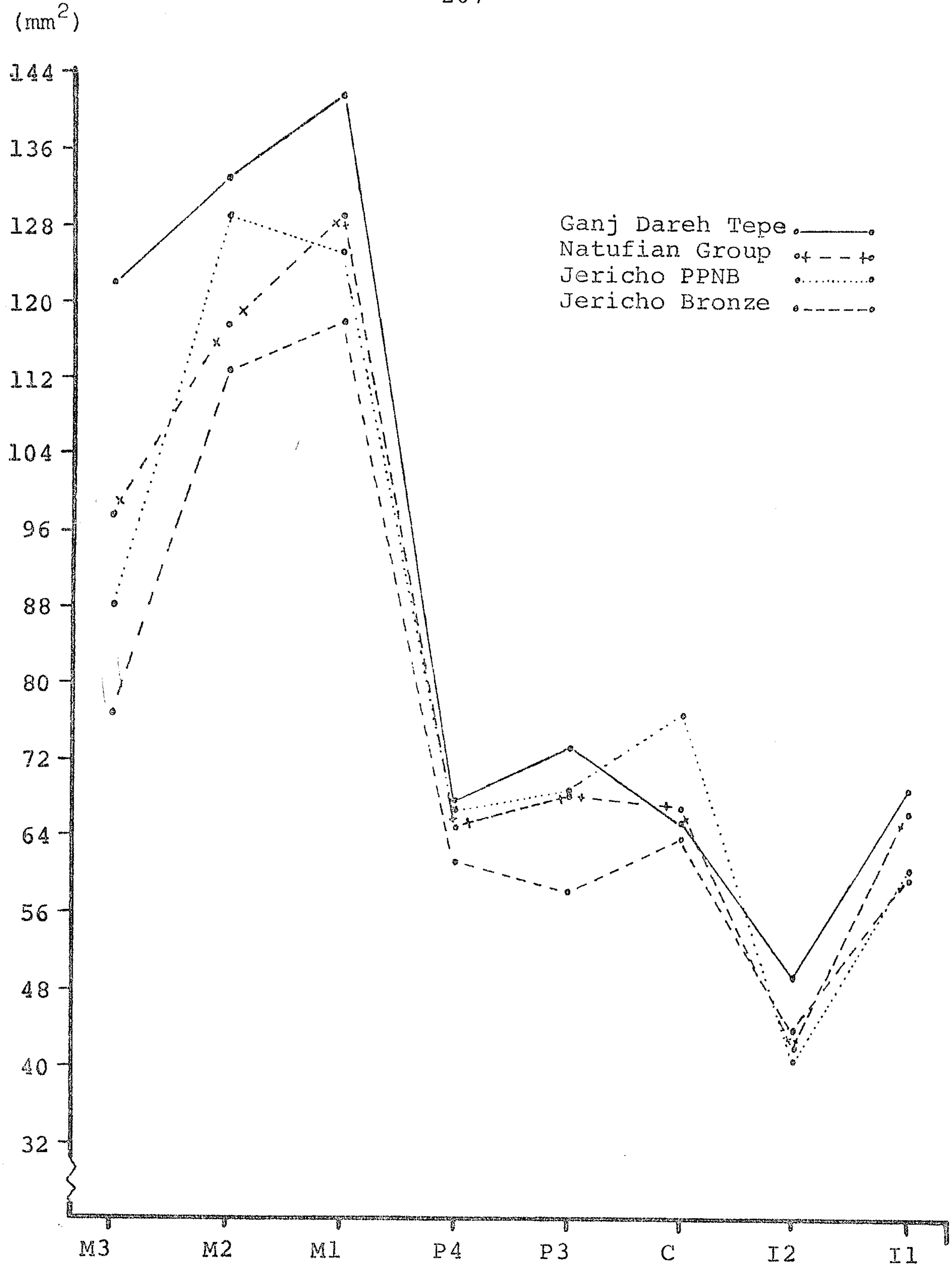


fig. 15 Average occlusal surface areas of maxillary teeth

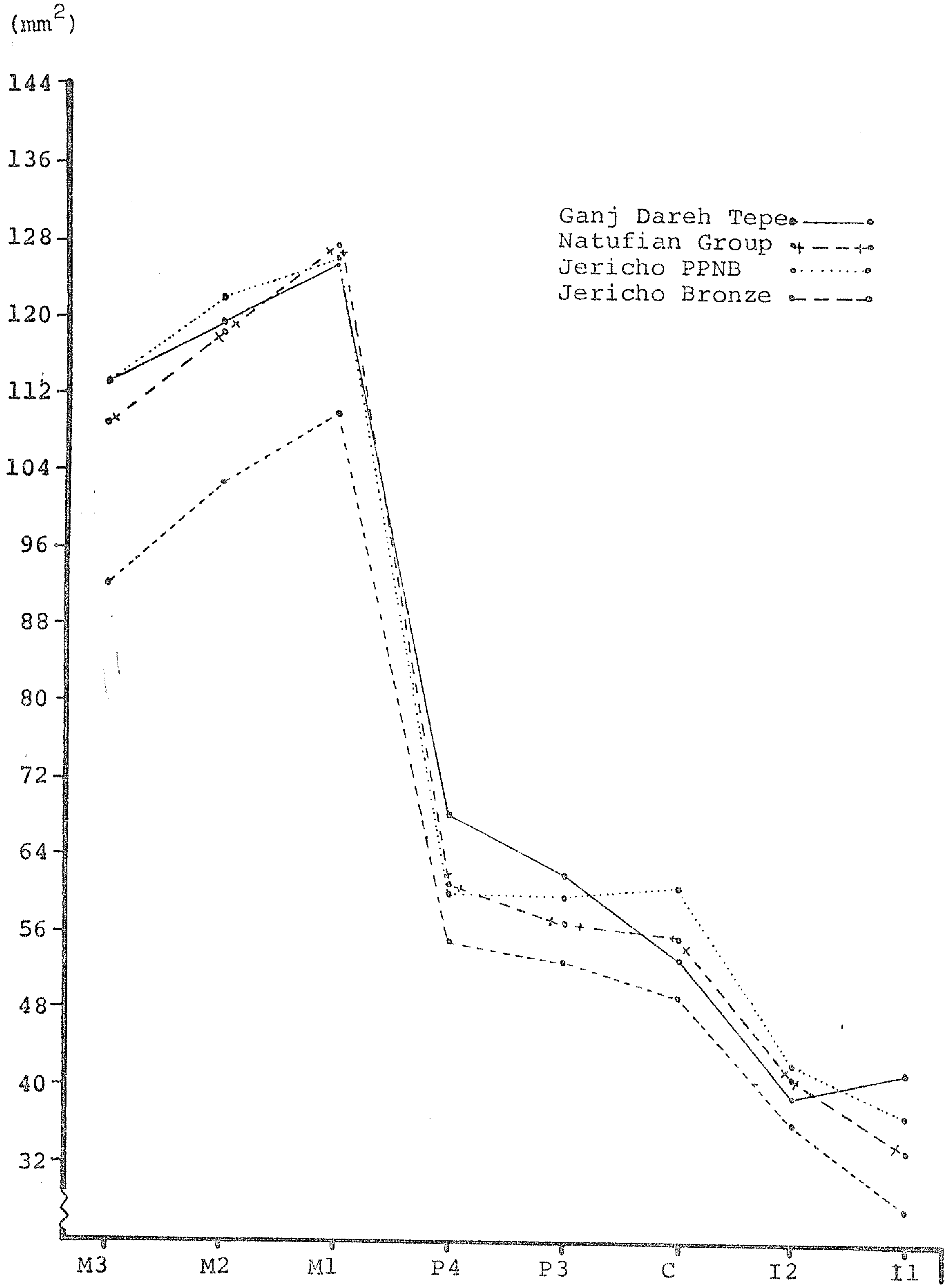


fig. 16 Average occlusal surface areas of mandibular teeth

slight and affecting in different teeth. The total occlusal area in the Ganj Dareh maxillary arcade is maintained by large molars (M3,M2 and M1) and moderately large premolars. In the mandible, premolars maintain the large milling surface, while molar sizes are similar to both Natufian and Jericho samples. Even though the specific teeth responsible for maintaining a large occlusal area in maxillary and mandibular arcades are different, a generally large milling surface is apparent.

Conclusions

The conclusions that may be drawn from this study are as follows.

1. In comparison to unrelated later populations from Tepe Hissar and Lerna, the population from Ganj Dareh Tepe is characterized by an almost complete lack of metric sexual dimorphism.

2. In the later populations, both sexes have short upper limbs and different long bone shapes in comparison to Ganj Dareh males and females. This characterizes both Bronze Age groups. While there are some differences between Tepe Hissar and Lerna when their respective sexes are compared, the differences shown by one sex are strongly parelleled by the other sex from the same site. This tends to indicate the operation of similar environmental stresses rather than similarities resulting from genetic affinities.

3. Odontometric comparisons show Jarmo to be the most closely related to Ganj Dareh Tepe of sites considered. However, similarities are remote in many of the comparisons involving dental diameters. There are even fewer similarities between Ganj Dareh and the Jericho populations. In relation to the Natufian population, Ganj Dareh dentitions are least similar. Comparisons of tooth shape and robusticity indicate that Ganj Dareh Tepe is unrelated to groups from Erq el Ahmar, the Jerichos or the Natufian.

4. All comparisons involving Erq el Ahmar and the Natufian population indicate that the former is not related to the latter. As such, Erq el Ahmar should not be included as Natufian in future studies until it has been re-examined.

5. Comparisons of dental indices from Jericho PPNB and Jericho Bronze groups indicate that the later Bronze Age group might have descended from either the Jericho PPNB group or from the earlier Natufians. If it is assumed that dental size reduction was operant for these groups, then evidence points to the Natufians as the ancestors of the Jericho Bronze population as some of the Jericho PPNB teeth increase in size relative to both of the other populations.

APPENDIX A

RAW METRIC DATA
AND
DENTAL INDICES

TABLE A-1

ADULT CRANIOMETRICS

Individual	GOL	XCB	BNL	XFB	STB	OBH	JOB	NLB	MAB	FMB	EKB	FRC
62013	176	129	–	116	–	–	–	–	–	–	–	106
62015	180	142	–	112	–	–	–	–	–	–	–	101
61017	188	131	–	116	–	38	121	22	65	101	100	114
41028	–	–	–	–	–	–	–	–	–	95	–	–
42030	176	121	–	116	–	–	–	–	–	–	–	102
41031	–	–	–	–	–	–	–	–	–	–	–	–
51034	175	125	–	109	–	–	–	–	–	–	–	–
41035	181	124	–	117	115	–	–	–	–	–	–	–
62043	174	–	–	–	–	–	–	–	–	–	–	–

TABLE A-1 Continued

Individual	FRS	FRF	PAC	PAS	PAF	OCC	OCS	OCF	FRK	PAK	OCK	VTB	VTL
62013	20	62	114	32	60	89	15	31	122	119	111	7	7
62015	17	40	116	27	54	102	29	50	111	133	120	–	–
61017	22	58	119	26	70	–	–	–	–	132	–	–	–
41028	–	–	–	–	–	–	–	–	–	–	–	6	6
42030	22	51	115	24	64	–	–	–	125	135	–	8	8
41031	–	–	126	31	70	–	–	–	–	137	–	–	–
51034	–	–	–	–	–	–	–	–	–	–	–	6	7
41035	–	–	114	29	–	95	27	–	–	115	95	8	8
62043	–	–	116	22	–	–	–	–	–	130	–	–	–

TABLE A-2

ADULT MANDIBULAR DIMENSIONS AND ANGLES

Individual	BCB/	BGB/	MBL/	RHL	RHR/	RVL	AVR/	ANM ARM* Average
22004	–	–	–	–	–	–	–	–
61017	119	97	94	–	56	–	53	118
41020	–	–	–	–	–	–	–	–
41028	–	–	–	–	–	–	–	–
41031	–	–	82	–	–	–	–	–
41035	–	–	–	–	–	–	–	–
42040	–	94	–	–	–	–	–	–
41041	–	–	–	–	–	60	–	–
61113	104	85	77	65	63	64	64	110.5

TABLE A-2 Continued

Individual	RBL	RBR/	LCM	RCM/	LCP	RCP/	SYN/	ANS*
22004	–	–	–	26	–	–	–	–
61017	33	31	27	26	29	29	33	85
41020	–	–	23	–	–	–	–	–
41029	–	–	–	–	–	–	–	75
41031	35	–	–	–	42	–	38	80
41035	–	–	–	–	–	–	35	90
42040	32	–	21	29	31	32	–	84
41041	–	41	27	–	31	31	–	–
61113	33	31	27	26	29	29	33	85

*measured in degrees

TABLE A-3

ADULT HUMERAL DIMENSIONS

Individual	/HXL	HXR/	HPL	HPR/	HML	HMD/	PML	PMD/	HLD	HRD/	HGD	HDD/
22004	-	-	-	-	64	67	58	62	22	23	15	15
62013	-	-	-	-	-	-	-	56	-	21	-	15
62015	294	262	290	258	54	74	53	60	18	21	17	18
61017	-	-	-	-	61	65	60	62	21	23	16	16
42022	-	-	-	-	68	65	67	69	25	22	17	19
62023	-	-	-	-	50	57	50	55	18	20	13	13
42030	-	-	-	-	61	61	55	55	20	20	15	17
41031	329	-	324	-	74	76	67	70	27	25	23	19
51034	-	-	-	-	61	-	55	60	20	-	17	-
51037	-	-	-	-	-	80	-	75	-	26	-	20
42040	322	-	318	-	54	55	54	55	18	16	17	17

TABLE A-4

ADULT RADIAL DIMENSIONS

Individual	RXL	RXR/	RPL	RPR/	PRL	MRL/	RXG	RXD/	RLG	RLD
22004	-	-	-	-	-	40	17	17	12	11
62015	233	-	226	-	37	38	14	15	11	10
61017	-	-	-	-	-	42	-	15	-	11
62023	-	-	-	-	35	36	13	12	9	9
41028	-	-	-	-	-	34	-	-	-	-
42030	-	-	-	-	37	37	16	16	10	9
41031	258	-	247	-	46	46	18	18	13	13
42040	-	-	-	-	37	35	-	12	-	10
41041	-	-	-	-	39	-	-	-	-	-

TABLE A-5

ADULT ULNAR DIMENSIONS

Individual	UXL	UXR/	UPL	UPR/	UML	UMR/	UTL	UTR/	UAP	UAR
22004	-	250	-	219	-	35	-	19	-	22
62015	250	-	217	-	30	-	18	19	17	22
61017	-	-	-	-	-	-	20	20	20	20
41020	-	-	-	-	-	42	26	25	24	24
42022	-	-	-	-	-	33	19	21	23	23
62023	-	-	-	-	-	35	18	-	19	-
41028	-	-	-	-	-	-	-	19	-	22
42030	-	-	-	-	-	-	-	17	-	23
41031	279	-	248	-	40	41	21	22	27	27
51034	-	-	-	-	-	35	18	19	24	26
42040	-	276	232	234	31	32	20	20	20	21

TABLE A-6

ADULT FEMORAL DIMENSIONS

Individual	FXL	FXR/	FOG	FOR/	FTL	FTR/	ALP	ARP/	FML	FMR
22004	–	–	–	–	–	–	30	25	25	25
62013	–	–	–	–	–	–	23	–	23	–
62015	446	–	440	–	420	–	27	–	23	23
61017	–	–	–	–	–	–	28	28	24	–
41020	–	–	–	–	–	–	–	30	32	–
42022	–	–	–	–	–	–	30	31	26	–
41031	–	–	–	–	–	–	34	31	27	26
42033	–	–	–	–	–	–	24	–	23	–
42040	–	–	–	–	–	–	30	29	23	23
60044	–	–	–	–	–	–	24	–	–	–

TABLE A-6 Continued

Individual	FTG	FTD/	LTF	RTF/	FDL	FDR/	HDL	HDR/	CCW	CGW
22004	33	33	25	25	42	–	44	–	–	–
62013	–	–	24	–	43	–	44	–	74	–
62015	26	26	22	–	39	–	39	–	–	–
61017	–	28	21	21	–	–	–	–	–	–
41020	–	–	27	24	47	–	47	50	–	–
42022	31	–	25	23	45	–	–	–	–	–
41031	38	36	–	–	47	–	52	–	–	–
42033	28	–	–	–	–	–	–	–	–	–
42040	29	29	24	24	–	–	–	–	–	–
60044	–	–	–	–	–	–	–	–	–	–

TABLE A-7

ADULT TIBIAL AND FIBULAR DIMENSIONS

Individual	TIBIA										FIBULA	
	TLT	TRT/	OTL	OTR/	PTG	PTD/	TTG	TTD/	CTL	CTR	IXL	IXR
62013	370	-	367	-	33	-	25	-	72	-	350	-
62015	-	-	-	-	-	-	-	-	-	-	-	340

TABLE A-8

ADULT PATELLAR, AXIAL, AND CLAVICULAR DIMENSIONS

	PATELLA				AXIS	CLAVICLE					
Individual	PXL	PXR/	PBL	PBR	XAX	XLC	XRC/	LPC	RPC/	CXG	CXD
22004	41	41	40	40	-	-	-	-	-	-	-
62013	-	38	-	41	35	-	-	-	-	-	-
62015	37	-	41	-	-	-	-	-	-	-	-
61017	39	-	42	-	-	-	-	-	-	-	-
41020	-	43	-	45	-	-	-	-	-	-	-
62023	35	32	35	34	-	-	-	-	-	-	-
42030	38	39	38	39	-	-	-	35	-	-	-
41031	46	47	48	48	-	-	-	-	-	-	-
51034	-	39	-	44	-	-	-	-	-	-	-
42040	39	37	39	38	-	134	-	31	-	19	-
41041	-	-	-	-	36	-	-	-	-	-	-

TABLE A-9

ADULT TARSAL DIMENSIONS

Individual	TALUS						CALCANEUS					
	XTL	XTR/	TML	TMR/	HTL	HTR	CXL	CXR/	CML	CMR/	HCL	HCR
62013	54	53	42	41	30	30	–	–	–	–	–	–
61017	–	61	–	45	–	30	–	–	–	–	–	–
41020	62	–	50	–	30	–	–	–	–	–	–	–
42022	57	58	41	42	30	29	–	–	–	–	–	–
62023	49	–	48	–	25	–	–	–	–	–	–	–
41028	52	52	38	40	29	29	73	75	23	24	34	34
42029	49	–	35	–	28	–	–	–	–	–	–	–
42030	55	56	41	38	–	26	–	–	–	–	–	–
41031	58	–	46	–	33	–	81	–	29	–	44	–
51034	54	53	40	39	29	29	–	–	–	–	–	–
41041	–	58	–	42	–	29	–	–	–	–	–	–

TABLE A-10

RAW DATA AND INDICES FROM GANJ DAREH MAXILLARY PERMANENT TEETH

Tooth	Individual		Length (m-d)	Breadth (b-l)	Robusticity (L*B)	Crown Index ((L/B) x 100)	Module ((L+B/2) x 10)	Shape Index ((B/L) x 100)
M3	62015	l.	10.9	13.8	150.42	78.99	123.5	126.6
		r.	10.3	13.2	135.96	78.03	117.5	128.2
	41031	l.	9.1	12.3	111.93	73.98	107.0	135.2
	42040	r.	9.9	12.2	120.78	81.25	110.5	123.2
M2	40003	r.	11.7	13.1	153.27	89.31	124.0	112.0
	22004	r.	10.4	11.2	116.48	92.86	108.0	107.6
	62015	l.	11.9	13.1	155.89	90.84	125.0	110.0
		r.	11.7	13.1	153.27	89.31	124.0	112.0
	61017	l.	10.1	13.6	137.36	74.26	118.5	134.6
		r.	10.6	12.5	132.50	84.80	115.0	118.0
	62023	l.	10.7	12.9	138.03	82.95	118.0	120.6
		r.	10.4	12.0	124.80	86.67	112.0	115.4
	41031	l.	11.5	11.7	134.55	98.29	116.0	101.7
		r.	10.0	11.6	116.00	86.21	108.0	116.0
	42040	r.	10.8	12.3	132.84	87.80	115.5	113.8
M1	61017	l.	10.1	13.8	139.38	73.29	119.5	136.6
		r.	12.0	13.4	160.80	89.65	127.0	111.6
	62023	l.	11.8	11.5	128.80	102.68	113.5	97.4
		r.	11.2	11.8	132.20	94.92	115.0	105.4
	41031	l.	11.5	11.2	128.80	102.68	113.5	97.4
	42040	l.	11.9	12.8	152.32	93.97	123.5	107.6
		r.	11.3	12.9	145.77	87.60	[illegible]1.0	114.2
P4	40003	r.	7.2	8.5	61.20	84.71	78.5	121.4
	22004	l.	6.5	9.1	59.15	71.43	78.0	140.0
		r.	6.8	9.1	61.88	74.73	79.5	133.8
	62015	l.	7.1	9.9	70.29	71.72	85.0	139.4
		r.	7.4	9.8	72.52	75.51	86.0	132.4
	61017	l.	7.2	10.7	77.04	67.29	89.5	148.6
	62023	l.	7.9	10.0	79.00	79.00	89.5	126.6
		r.	7.3	10.2	74.46	71.67	87.5	139.7
	41035	r.	6.8	8.8	59.84	77.27	78.0	129.4
	42040	l.	6.8	9.8	66.64	69.39	83.0	144.1
	40042	r.	7.0	9.9	69.30	70.71	84.5	141.4
P3	62015	l.	7.8	9.3	72.54	83.89	85.5	119.2
		r.	7.6	9.6	73.00	79.27	88.0	126.3

TABLE A-10--Continued

Tooth	Individual		Length (m-d)	Breadth (b-l)	Robusticity (L*B)	Crown Index ((L/B) x 100)	Module ((L+B/2) x 10)	Shape Index ((B/L) x 100)
	61017	l.	7.7	10.5	80.85	73.33	91.0	136.4
		r.	7.9	10.1	79.79	78.22	90.0	127.8
	62023	l.	7.9	9.0	71.10	87.78	84.5	113.9
		r.	7.9	10.1	79.79	78.22	90.0	127.8
	41035	l.	7.8	9.8	76.44	79.59	88.0	125.6
	42040	l.	7.0	9.7	67.90	72.16	83.5	138.6
	62013	r.	6.9	9.3	64.17	74.19	81.0	134.8
C	40003	r.	7.8	8.6	67.08	90.70	82.0	110.3
	22004	r.	6.3	7.0	44.10	90.00	66.5	111.1
	62015	l.	7.6	7.9	60.04	96.20	77.5	104.0
		r.	8.2	8.4	68.88	97.62	83.0	102.4
	61017	l.	8.2	10.5	86.10	78.10	93.5	128.0
		r.	8.7	10.3	89.61	84.47	95.0	118.4
	62023	l.	8.3	8.9	73.87	93.26	86.0	107.2
		r.	8.0	8.6	68.80	93.02	83.0	107.5
	41031	l.	8.0	9.2	73.60	86.96	86.0	115.0
		r.	6.6	9.6	63.36	68.75	81.0	145.4
	41035	r.	6.8	8.8	59.84	77.27	78.0	129.4
	42040	l.	7.9	8.2	64.78	96.34	80.5	103.8
		r.	8.3	7.8	64.74	106.40	80.5	94.0
I2	61017	r.	7.0	8.1	56.70	86.42	75.5	115.7
	42022	l.	6.5	7.0	45.50	92.86	67.5	107.6
	62023	l.	6.7	7.5	50.25	89.30	72.5	111.9
		r.	7.2	7.3	52.56	98.63	72.5	101.4
	41031	l.	7.1	7.4	52.54	95.90	72.5	104.2
		r.	6.5	7.2	46.80	90.28	68.5	110.8
	41035	l.	6.4	6.6	42.24	96.97	65.0	103.0
	42040	l.	7.1	7.9	56.09	89.87	75.0	111.2
		r.	7.3	7.8	56.94	93.58	75.5	106.8
I1	22004	r.	7.9	6.7	52.93	117.93	73.0	84.8
	62015	l.	9.1	7.0	63.70	130.00	80.5	76.9
		r.	9.3	7.0	65.10	132.86	81.5	75.2
	61017	l.	9.8	9.3	91.14	105.38	95.5	94.9
		r.	9.3	8.9	82.77	104.49	91.0	95.6
	62023	l.	9.2	7.7	70.84	119.48	84.5	83.6
		r.	9.2	8.0	73.60	115.00	86.0	87.0
	41031	r.	9.1	8.0	72.80	113.75	85.5	87.9

TABLE A-10--Continued

Tooth	Individual		Length (m-d)	Breadth (b-l)	Robusticity (L*B)	Crown Index ((L/B) x 100)	Module ((L+B/2) x 10)	Shape Index ((B/L) x 100)
	50037	r.	9.4	8.3	78.02	113.25	88.5	88.2
	42040	l.	9.0	7.2	64.80	125.00	81.0	80.0
		r.	9.0	7.3	66.43	123.29	81.5	81.1
	62043	r.	9.1	6.9	62.79	131.88	80.5	75.8
	62013	l.	9.1	7.3	66.43	124.66	82.0	80.2
		r.	8.8	7.0	61.60	125.71	79.0	79.5

TABLE A-11

RAW DATA AND INDICES FROM GANJ DAREH MANDIBULAR PERMANENT TEETH

Tooth	Individual		Length (m-d)	Breadth (b-l)	Robusticity (L*B)	Crown Index ((L/B) x 100)	Module ((L+B/2) x 10)	Shape Index ((B/L) x 100)
M3	62015	l.	11.2	10.6	118.72	105.66	109.0	94.6
		r.	10.9	10.2	111.18	106.86	105.5	93.6
	42022	l.	11.6	10.5	121.80	110.48	110.5	90.5
	62023	l.	10.3	10.3	106.09	100.00	103.0	100.0
		r.	10.4	10.1	105.04	102.97	102.5	97.1
	41031	l.	10.6	10.5	111.30	100.95	105.5	99.0
	42040	r.	10.8	10.4	112.32	103.85	106.0	96.2
	61113	l.	11.1	10.6	117.66	104.72	108.5	95.4
		r.	11.1	10.4	115.44	106.73	107.5	93.6
M2	22004	l.	10.5	10.8	113.40	97.22	106.5	102.8
		r.	11.1	10.1	112.11	109.90	106.0	91.0
	10010	l.	12.0	10.4	124.80	115.38	112.0	86.6
	62015	l.	11.5	11.0	126.50	104.55	112.5	95.6
		r.	11.8	11.3	133.34	104.42	115.5	95.8
	61017	l.	11.5	11.1	127.65	103.60	113.0	96.5
		r.	11.5	11.1	127.65	103.60	113.0	96.5
	42022	l.	11.4	10.4	118.56	109.60	109.0	93.6
	62023	l.	11.2	11.3	126.56	99.12	112.5	100.8
		r.	11.4	11.1	126.54	102.70	112.5	97.4
	41031	l.	11.4	10.6	120.84	115.38	112.0	93.0
	50037	l.	11.3	10.7	116.63	105.60	110.0	94.6
		r.	10.6	10.4	110.24	101.92	105.0	98.1
	42040	r.	10.9	10.6	115.54	102.83	107.5	100.1
	62043	l.	10.5	9.2	96.60	114.13	98.5	87.6
		r.	10.8	9.5	99.75	113.68	101.5	88.0
M1	22004	l.	11.5	10.0	115.00	115.00	107.5	87.0
		r.	10.1	10.7	108.07	94.39	104.0	105.9
	10010	l.	11.7	11.6	135.72	100.87	116.5	99.1
	11011	r.	11.1	9.5	105.45	116.84	103.0	85.6
	62015	l.	12.2	11.8	143.96	103.39	120.0	96.7
		r.	11.8	11.9	140.42	99.16	118.5	100.8
	61017	l.	12.0	11.7	140.40	102.56	118.5	97.5
		r.	11.5	11.7	134.55	98.29	116.0	101.7
	41020	l.	11.3	11.6	131.08	97.41	114.5	102.6
	42022	l.	11.2	10.9	122.08	102.75	110.5	97.3

TABLE A-11--Continued

Tooth	Individual		Length (m-d)	Breadth (b-l)	Robusticity (L*B)	Crown Index ((L/B) x 100)	Module ((L+B/2) x 10)	Shape Index ((B/L) x 100)
	62023	l.	12.4	11.2	138.88	110.71	118.0	90.3
		r.	10.2	12.1	123.42	84.29	111.5	118.6
	41031	l.	11.6	11.9	138.04	97.48	117.5	102.6
	41035	l.	11.1	11.5	127.65	96.52	113.0	103.6
	50037	l.	11.2	11.0	129.80	101.82	111.0	98.2
		r.	11.4	10.8	123.12	105.56	111.0	94.7
	42040	l.	11.8	11.3	133.34	104.42	110.5	95.8
		r.	11.8	11.6	136.88	101.72	117.0	98.3
	62043	l.	11.1	10.1	112.11	109.90	106.0	91.0
		r.	10.9	10.3	112.27	105.83	106.0	94.4
	61113	l.	11.4	11.2	127.68	101.79	113.0	98.2
		r.	10.3	10.9	112.27	94.50	106.0	105.8
P4	62015	l.	8.0	8.3	66.40	96.39	81.5	103.8
		r.	7.6	7.9	60.04	96.20	77.5	103.9
	61017	l.	8.2	9.4	77.08	87.23	88.0	114.6
		r.	8.0	9.5	76.00	84.21	87.5	118.8
	42022	l.	7.2	9.6	69.12	75.00	84.0	133.3
	62023	l.	7.9	10.0	79.00	79.00	89.5	126.6
		r.	7.7	8.6	66.22	89.53	81.5	111.6
	41031	l.	7.0	8.6	60.20	81.40	78.0	122.8
	42040	l.	7.5	8.4	63.00	89.29	79.5	112.0
		r.	7.4	8.9	65.86	83.15	81.5	120.3
	41041	l.	9.1	10.1	91.91	90.10	96.0	111.0
	62043	l.	6.9	8.3	57.27	83.13	76.0	120.2
		r.	7.2	8.4	60.48	85.7	78.0	116.6
	61113	r.	7.6	8.5	64.60	89.41	80.5	111.8
P3	22004	l.	7.1	7.5	53.25	94.67	73.0	105.6
	10010	l.	7.2	9.7	69.84	74.23	84.5	134.7
	62015	l.	7.6	8.4	63.84	90.48	80.0	110.5
	61017	l.	7.7	9.3	71.61	82.80	85.0	120.8
		r.	8.2	8.8	72.16	93.18	85.0	107.3
	40018	l.	7.7	7.3	56.21	105.50	75.0	94.8
	41020	l.	7.7	7.8	60.06	98.71	77.5	101.2
	42022	l.	7.1	9.7	68.87	73.20	84.0	136.6
	62023	l.	7.6	8.4	63.84	90.48	80.0	110.5
		r.	7.6	8.8	66.88	86.36	82.0	115.8
	41031	l.	6.2	8.4	52.08	73.80	73.0	135.4

TABLE A-11--Continued

Tooth	Individual		Length (m-d)	Breadth (b-l)	Robusticity (L*B)	Crown Index ((L/B) x 100)	Module ((L+B/2) x 10)	Shape Index ((B/L) x 100)
	42040	l.	7.8	8.0	62.40	97.50	79.0	102.6
		r.	7.8	8.0	62.40	97.50	79.0	102.6
	62043	l.	7.0	8.0	56.00	87.50	75.0	114.2
	61113	r.	6.8	8.4	57.12	80.95	76.0	123.5
C	62015	r.	8.0	7.5	60.00	106.67	77.5	93.8
	61017	l.	8.2	9.2	75.44	89.13	87.0	112.2
		r.	8.8	8.7	76.56	101.15	87.5	98.8
	41020	l.	7.6	7.2	54.72	105.56	74.0	94.7
	62023	l.	7.7	7.7	59.29	100.00	77.0	100.0
		r.	7.3	7.7	56.21	94.81	75.0	105.4
	41031	l.	6.8	8.2	55.76	82.93	75.0	120.6
	41035	l.	7.4	8.3	61.42	89.16	78.5	112.2
		r.	7.0	8.3	58.10	84.34	75.5	118.6
	42040	l.	7.2	7.7	55.44	93.51	74.5	106.9
		r.	7.0	7.1	49.70	98.59	70.5	101.4
	61113	r.	6.6	7.3	48.18	90.41	69.5	110.6
I2	10010	r.	5.9	5.9	34.81	100.00	59.0	100.0
	61017	l.	8.0	8.2	65.60	97.56	81.0	102.5
		r.	7.1	7.9	56.09	89.87	75.0	111.2
	41020	l.	7.1	6.5	46.15	109.23	68.0	91.5
		r.	5.8	6.4	37.12	90.63	61.0	110.3
	62023	l.	6.4	6.2	39.68	103.23	63.0	96.8
		r.	5.8	6.4	37.12	90.63	61.0	110.3
	41035	l.	5.9	6.8	40.12	86.76	63.5	115.3
		r.	5.7	6.6	37.62	86.36	62.0	115.8
	42040	l.	6.1	6.7	40.87	91.04	64.0	109.8
		r.	6.3	6.4	40.32	98.44	63.5	101.6
	61113	r.	4.9	6.1	29.89	80.33	55.0	124.4
I1	10010	l.	6.7	6.0	40.20	111.67	63.5	89.6
		r.	6.8	6.1	41.48	111.48	64.5	89.7
	62015	l.	5.8	7.8	45.24	74.36	68.0	134.4
	61017	l.	8.0	6.6	52.80	121.21	73.0	82.5
		r.	7.7	6.5	50.05	118.46	71.0	84.4
	62023	l.	7.2	6.6	47.52	109.10	69.0	91.6
		r.	6.2	5.9	36.58	105.08	60.5	95.2

TABLE A-11--Continued

Tooth	Individual		Length (m-d)	Breadth (b-l)	Robusticity (L*B)	Crown Index ((L/B) x 100)	Module ((L+B/2) x 10)	Shape Index ((B/L) x 100)
	41035	l.	6.2	5.5	34.10	112.73	58.5	88.7
		r.	6.6	5.0	33.00	132.00	58.0	75.8
	42040	l.	6.6	6.0	39.60	110.00	63.0	90.9
		r.	6.6	6.1	40.26	108.20	63.5	92.4

APPENDIX B

UNMODIFIED SUMMARY STATISTICS

TABLE B-1

MALE CRANIOMETRICS: MEAN ($\bar{x}$), STANDARD DEVIATION (s.d.), MINIMUM AND MAXIMUM VALUES, GANJ DAREH TEPE

Dimension	n	$\bar{x}$	s.d	min.	max.
GOL	3	181.3	6.5	175	188
XCB	3	126.7	3.7	124	131
XFB	3	114.0	4.3	109	117
STB	1	115.0	–	–	–
OBH	1	38.0	–	–	–
JUB	1	121.0	–	–	–
NLB	1	22.0	–	–	–
MAB	1	65.0	–	–	–
FMB	2	98.0	4.2	95	101
EKB	1	100.0	–	–	–
FRC	1	114.0	–	–	–
FRS	1	22.0	–	–	–
FRF	1	58.0	–	–	–
PAC	4	118.8	5.2	114	126
PAS	4	27.0	3.9	22	31
PAF	2	70.0	0.0	(70)	
OCC	1	95.0	–	–	–
OCS	1	27.0	–	–	–
OCF	0	–	–	–	–
FRK	0	–	–	–	–
PAK	4	128.5	9.4	115	137
OCK	1	95.0	–	–	–

TABLE B-1 Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
VTB	2	8.0	0.0	(8)	
VTL	2	7.0	1.4	6	8
VTG	0	–	–	–	–

TABLE B-2

MALE MANDIBULAR METRICS: MEAN ($\bar{x}$), STANDARD DEVIATION (s.d.), MINIMUM AND MAXIMUM VALUES, GANJ DAREH TEPE

Dimension	n	x	s.d.	min.	max.
BCB	2	111.5	7.5	104	119
BGB	2	91.0	6.0	85	97
MBL	2	85.5	8.5	77	94
RHR	1	65	-	-	-
AVR	2	59.0	4.5	53	64
ARM	2	114.3	3.8	110.5	118
RBR	4	34.5	4.1	31	41
RCM	4	25.5	1.5	23	27
RCP	4	32.8	5.4	29	42
SYN	4	24.8	2.0	33	38
ANS	5	83.0	5.1	75	90

TABLE B-3

MALE POSTCRANIAL METRICS; MEAN ($\bar{x}$), STANDARD DEVIATION (s.d.), AND MINIMUM AND MAXIMUM VALUES: GANJ DAREH TEPE

Dimension	n	$\bar{x}$	s.d.	min.	max.
HUMERUS					
HXL	1	329	-	-	-
HXR	0	-	-	-	-
HPL	1	324	-	-	-
HPR	0	-	-	-	-
HML	3	65.3	7.5	61	74
HMR	2	70.5	7.8	65	76
PML	3	57.3	8.7	50	67
PMD	3	60.7	6.0	55	70
HLD	3	22.6	3.7	20	27
HDR	2	24.0	1.4	23	25
HGD	3	18.7	3.7	16	23
HDD	2	17.5	2.1	16	19
RADIUS					
RXL	1	258	-	-	-
RXR	0	-	-	-	-
RPL	1	247	-	-	-
RPR	0	-	-	-	-
RPL	2	42.5	4.9	39	46
MRL	3	40.7	6.1	34	46
RXG	1	13	-	-	-
RXD	2	16.5	2.1	15	18

TABLE B-3 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
RLG	1	13.0	–	–	–
RLD	2	12.0	1.4	11	13
ULNA					
UXL	1	279	–	–	–
UXR	0	–	–	–	–
UPL	1	248	–	–	–
UPR	0	–	–	–	–
UML	1	40	–	–	–
UMR	3	39.3	3.7	35	42
UTL	4	21.3	3.4	18	26
UTR	5	21.0	2.5	19	25
UAP	4	23.8	2.8	20	27
UAR	6	23.7	2.5	20	27
FEMUR					
FXL	0	–	–	–	–
FXR	0	–	–	–	–
FOG	0	–	–	–	–
FOR	0	–	–	–	–
FTL	0	–	–	–	–
FTR	0	–	–	–	–
ALP	2	31.0	4.2	28	34
ARP	3	29.7	1.5	28	31
FML	3	27.7	4.0	24	32
FMR	1	26	–	–	–

TABLE B-3 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
FTG	1	38	–	–	–
FTD	2	32.0	5.6	28	36
LTF	2	24.0	4.2	21	27
RTF	2	22.5	2.1	21	24
FDL	2	47	0.0	(47)	
FDR	0	–	–	–	–
HDL	2	49.0	3.5	47	52
HDR	1	50	–	–	–
CCW	0	–	–	–	–
CGW	0	–	–	–	–
TIBIA					
TLT	0	–	–	–	–
TRT	0	–	–	–	–
OTL	0	–	–	–	–
OTR	0	–	–	–	–
PTG	0	–	–	–	–
PTD	0	–	–	–	–
TTD	0	–	–	–	–
TTG	0	–	–	–	–
CTL	0	–	–	–	–
CTR	0	–	–	–	–
FIBULA					
IXL	0	–	–	–	–
IXR	0	–	–	–	–

TABLE B-3 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
PATELLA					
PXL	2	42.5	4.9	39	46
PXR	2	45.0	2.8	43	47
PBL	2	45.0	4.2	42	48
PBR	3	45.7	2.0	44	48
AXIS					
XAX	1	36	-	-	-
TALUS					
XTL	4	56.5	4.4	52	62
XTR	4	56.0	4.2	52	61
TML	4	43.5	5.5	38	50
TMR	4	41.5	2.6	39	45
HTL	4	30.3	1.8	29	33
HTR	4	29.3	0.5	29	30
CALCANEUS					
CXL	2	77.0	5.6	73	81
CXR	1	75	-	-	-
CML	2	26.0	4.2	23	29
CMR	1	24	-	-	-
HCL	1	34	-	-	-
HCR	1	34	-	-	-

TABLE B-3 -Continued

Dimension	n	x	s.d.	min.	max.
CLAVICLE					
XLC	0	–	–	–	–
XRC	0	–	–	–	–
LPC	0	–	–	–	–
RPC	0	–	–	–	–
CXG	0	–	–	–	–
CXD	0	–	–	–	–

TABLE B-4

FEMALE CRANIOMETRICS: MEAN ($\bar{x}$), STANDARD DEVIATION (s.d.), MINIMUM AND MAXIMUM VALUES, GANJ DAREH TEPE

Dimension	n	$\bar{x}$	s.d.	min.	max.
GOL	4	176.5	2.5	174	180
XCB	3	130.7	10.6	121	142
XFB	3	114.7	2.3	112	116
STB	0	–	–	–	–
OBH	0	–	–	–	–
JUB	0	–	–	–	–
NLB	0	–	–	–	–
MAB	0	–	–	–	–
FMB	0	–	–	–	–
EKB	0	–	–	–	–
FRC	3	103.0	2.6	101	106
FRS	3	19.7	2.5	17	22
FRF	3	51.0	11.0	40	62
PAC	3	115.0	1.0	114	116
PAS	3	27.7	4.0	24	32
PAF	3	59.3	5.0	54	60
OCC	2	100.5	2.1	99	102
OCS	2	22.0	9.9	15	29
OCF	2	40.5	13.4	31	50
FRK	3	119.3	7.3	111	125
PAK	3	129.0	8.7	119	135
OCK	2	115.5	6.3	111	120

TABLE B-4 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
VTB	3	5.7	1.5	4	7
VTL	3	6.7	0.5	6	7
VTG	1	16.0	-	-	-

TABLE B-5

FEMALE MANDIBULAR METRICS: MEAN ($\bar{x}$), STANDARD DEVIATION (s.d.), MINIMUM AND MAXIMUM VALUES, GANJ DAREH TEPE

Dimension	n	x	s.d.	min.	max.
BCB	0	–	–	–	–
BGB	1	94	–	–	–
MBL	0	–	–	–	–
RHR	0	–	–	–	–
AVR	0	–	–	–	–
ARM	0	–	–	–	–
RBR	1	32	–	–	–
RCM	2	27.5	1.5	26	29
RCP	1	32	–	–	–
SYN	0	–	–	–	–
ANS	1	84	–	–	–

TABLE B-6

FEMALE POSTCRANIAL METRICS; MEAN ($\bar{x}$), STANDARD DEVIATION (s.d.), AND MINIMUM AND MAXIMUM VALUES: GANJ DAREH TEPE

Dimension	n	$\bar{x}$	s.d.	min.	max.
HUMERUS					
HXL	2	308.0	19.8	294	322
HXR	1	262	–	–	–
HPL	2	304.0	19.8	290	318
HPR	1	258	–	–	–
HML	7	57.4	6.9	50	68
HMR	6	63.2	7.0	55	74
PML	6	56.2	5.9	50	67
PMD	6	56.2	5.9	55	69
HLD	6	20.2	2.8	18	25
HRD	7	20.4	2.2	16	23
HGD	6	15.7	1.6	13	17
HDD	7	16.3	2.0	13	19
RADIUS					
RXL	1	233	–	–	–
RXR	0	–	–	–	–
RPL	1	226	–	–	–
RPR	0	–	–	–	–
PRL	4	36.5	1.0	35	37
MRL	5	37.2	1.9	35	40
RXG	4	15.0	1.8	13	17
RXD	5	14.4	2.3	12	17

TABLE B-6 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
RLG	4	10.5	1.2	9	12
RLD	5	9.8	0.8	9	11
ULNA					
UXL	1	250			
UXR	2	263.0	18.3	250	276
UPL	2	224.5	10.6	217	232
UPR	2	226.5	10.6	219	234
UML	2	30.5	0.7	30	31
UMR	4	33.8	1.5	32	35
UTL	4	18.8	0.9	18	20
UTR	5	19.2	1.4	17	21
UAP	4	19.8	2.5	17	23
UAR	4	22.0	0.8	21	23
FEMUR					
FXL	1	446	-	-	-
FXR	0	-	-	-	-
FOG	1	440	-	-	-
FOR	0	-	-	-	-
FTL	1	420	-	-	-
FTR	0	-	-	-	-
ALP	6	27.3	3.2	23	30
ARP	3	28.3	3.0	25	31

TABLE B-6 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
FML	6	23.8	1.3	23	26
FMR	3	23.7	1.1	23	25
FTG	5	29.2	2.3	26	32
FTD	3	29.0	3.0	26	32
LTF	5	24.0	1.2	22	25
RTF	3	24.0	1.0	23	25
FDL	4	42.3	2.5	39	45
FDR	0	-	-	-	-
HDL	3	42.3	2.8	39	44
HDR	0	-	-	-	-
CCW	1	74	-	-	-
CGW	0	-	-	-	-
TIBIA					
TLT	1	370	-	-	-
TRT	0	-	-	-	-
OTL	1	367	-	-	-
OTR	0	-	-	-	-
PTG	1	33	-	-	-
PTD	0	-	-	-	-
TTG	1	25	-	-	-
TTD	0	-	-	-	-
CTL	1	72	-	-	-
CTR	0	-	-	-	-

TABLE B-6 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
FIBULA					
IXL	1	350	–	–	–
IXR	1	340	–	–	–
PATELLA					
PXL	5	38.0	2.2	35	41
PXR	5	37.4	3.3	32	41
PBL	5	38.6	2.3	35	41
PBR	5	38.4	2.7	34	41
AXIS					
XAX	1	35	–	–	–
TALUS					
XTL	5	52.8	3.6	49	57
XTR	3	55.7	2.5	53	58
TML	5	41.4	4.6	35	48
TMR	3	40.3	2.0	38	42
HTL	4	28.3	2.3	25	30
HTR	3	28.3	2.0	26	30
CALCANEUS					
CXL	0	–	–	–	–
CXR	0	–	–	–	–
CML	0	–	–	–	–
CMR	0	–	–	–	–

TABLE B-6 -Continued

Dimension	n	$\bar{x}$	s.d.	min.	max.
HCL	0	–	–	–	–
HCR	0	–	–	–	–
CLAVICLE					
XLC	1	134	–	–	–
XRC	0	–	–	–	–
LPC	2	33	2.8	31	35
RPC	0	–	–	–	–
CXG	1	19	–	–	–
CXD	0	–	–	–	–

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