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Bioarchaeological Analysis of Cultural Transition in the Southern Levant Using Dental Nonmetric Traits

Jaime M. Ullinger,[1]* Susan Guise Sheridan,[2] Diane E. Hawkey,[3] Christy G. Turner II,[3] and Robert Cooley[4]

[1]*Department of Anthropology, Ohio State University, Columbus, Ohio 43210*
[2]*Department of Anthropology, University of Notre Dame, Notre Dame, Indiana 46656*
[3]*Department of Anthropology, Arizona State University, Tempe, Arizona 85287-2402*
[4]*6713 Kilberry Lane, Charlotte, North Carolina 28277*

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ABSTRACT To many Near Eastern archaeologists, the Late Bronze Age-Early Iron Age transition in the southern Levant indicates the emergence of a new ethnicity. The question remains, however, whether changes in the material culture are the result of an invasion of foreigners, or instead arose from shifting cultural and technical practices by indigenous peoples. This study utilized dental morphological traits to assess phenetic relationships between the Late Bronze Age site of Dothan (1500–1100 BC) and the Iron Age II site of Lachish (Tell ed-Duweir, 701 BC). Information on 30 dental crown and root traits was collected for 4,412 teeth, representing 392 individuals from Lachish and a minimum of 121 individuals from Dothan, using the Arizona State University Dental Anthropology System. Seventeen traits from Dothan and Lachish were compared with dentitions from a Byzantine Jerusalem monastery, Iron Age Italy, a Natufian group (early agrarians from the Levant), and a Middle Kingdom Egyptian site using C.A.B. Smith's mean measure of divergence statistic. The findings suggest that there are more similarities between Dothan and Lachish than either of them and other sites. This analysis indicates that the material culture changes were not the result of a foreign invasion. Rather, the Iron Age people of the southern Levant were related to their Bronze Age predecessors. Am J Phys Anthropol 128:466–476, 2005.

The Late Bronze and Early Iron Ages are two of the most studied periods in the southern Levant (i.e., modern day Israel, Palestine, and western Jordan). Archaeological sites dating to this time provide evidence of cultural transition, interpreted as a result of the arrival of foreign peoples (Albright, 1939; Stager, 1985; Redford, 1992; Holladay, 1995). Scholars have argued that the Late Bronze and Early Iron Ages "witnessed widespread international trade, the collapse of empires, and the migration of large population groups" (Dothan, 1985, p. 55), including the Sea Peoples (Phoenicians and Philistines) and Israelites. Proponents of this view link temporal changes in ceramics, tomb types, and architecture to accounts from the Hebrew Bible, which state that a group of people left Egypt and entered Canaan, conquering the local Canaanite towns and rebuilding them. The purpose of this study was to determine whether a biological difference between the Late Bronze Age and Early Iron Age peoples in the southern Levant coincided with culture change.

While there is evidence of destruction in the Late Bronze Age layer at Lachish (Dever, 1990; Mazar, 1990), at least 15 large sites (including Jericho, Jerusalem, Hebron, Gaza, and Ashkelon) show no destruction by the conquering peoples dating to this time period (Mazar, 1990; Redford, 1992; Dever, 1990, 1997). Thus, alternative models concentrating more on archaeological data and less on ancient texts suggest that changes were brought about by indigenous people as the result of an internal sociopolitical transition (Finkelstein, 1995, 1996; Dever, 1997).

ETHNICITY

Several investigators proposed the emergence of a new ethnicity, rather than invasion by an outside force. Dever (1995a, p. 201) proposed that an ethnic group "perpetuates its sense of separate identity by develop-

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*Correspondence to: Jaime Ullinger, Department of Anthropology, 244 Lord Hall, 124 W. 17th Ave., Ohio State University, Columbus, OH 43210. E-mail: Ullinger.1@osu.edu

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ing rules for maintaining 'ethnic boundaries,'" using a shared language and value system that result in biological homeostasis. He saw a significant "ethnic" distinction between Late Bronze Age Canaanites (who would have inhabited Dothan) and Iron Age Israelites (who would have inhabited Lachish) (Dever, 1995a). Some claimed that the Israelites were nomadic pastoralists from southern Transjordan (mentioned in the Amarna documents of the 14th century BC), who entered the hill country and returned to an agrarian lifestyle during the Early Iron Age (Redford, 1992; Mazar, 1990). Redford (1992) stated that although they mimicked Cannanite organization and ceramics, they were not Canaanites. However, Finkelstein (1996) argued that there is little archaeological evidence to identify even an ethnic difference, much less a biological difference, between Bronze and Iron Age inhabitants of the southern Levant.

Bloch-Smith (2001) provoked a heated discussion on the question of ethnicity in this time period by systematically discounting many of the lines of evidence archaeologists presented as ethnic identifiers. She maintained, however, that Iron Age villages were based on kinship, and should be biologically unique (Bloch-Smith, 2001; also see Stager, 1985).

BIOARCHAEOLOGICAL APPROACH

Archaeological investigators studying the southern Levant have focused disproportionately on the Late Bronze and Early Iron Ages; therefore, the use of numerous lines of evidence to explore this transition is warranted. This anaysis thus examined the relationship between inhabitants from these periods by comparing the frequencies of dental morphological traits present at Dothan and Lachish (also known as Tell ed-Duweir).

Nonmetric dental traits are highly controlled by genetics and are relatively free of sex- and age-bias (Scott and Turner, 1997). Therefore, phenetic (phenotypic) similarity can be said to approximate genetic similarity. The analysis of biological relatedness using dental nonmetric traits has proven reliable even in commingled samples when standardized procedures are followed (Scott and Turner, 1997). Frequencies of traits present at Dothan were therefore analyzed for both periods, and compared to those for the Lachish collection. Regional and temporal comparisons were made in order to ascertain variation in southern Levantine groups during the Late Bronze-Early Iron Age transition.

STUDY COLLECTIONS

Tell Dothan

Tell Dothan is one of the largest Late Bronze-Early Iron Age sites in north central Palestine, located 22 km north of Nablus and 10 km south of Jenin (see Figs. 1, 2). Nearly continuous occupation of the site spanned the Chalcolithic to Byzantine periods (approximately 4000 BC–614 AD) (Cooley and Pratico, 1995). Several short preliminary reports were published on the site (Free, 1953, 1954, 1955, 1956, 1958, 1959, 1960), as well as one article about the western cemetery (Cooley and Pratico, 1995). However, no complete publication of the Dothan excavations has appeared in print.

The western cemetery of Tell Dothan is composed of three tombs. Tomb 1 is the largest, and contained numerous interments in a single chamber with eight crypts. According to ceramic evidence (Cooley and Pratico, 1995), it dates from Late Bronze Age IIA (1400–1300 BC) through Iron Age I (1200–1100 BC). This tomb was unusual because it consisted of five clearly stratified layers spanning the Late Bronze-Early Iron Age transition (Table 1), separated by limestone "dividers" of various depths ranging from 5–40 cm. The intermediate layers of limestone also contained soil that may represent a ceiling collapse, or deliberate human action.

Tomb 1 contained approximately 250–300 individuals, and housed more skeletal elements and ceramics than almost any other tomb excavated from this time period in the region (Free, 1960; Cooley and Pratico, 1995). Teeth were available only from levels 1, 3, and 4 of Tomb 1. The location of dental remains from levels 2 and 5 is currently unknown, if they were collected at all.

Gonen (1992) proposed that the tombs at Tell Dothan were foreign, based on the introduction of new burial patterns during the Late Bronze Age. She argued that they reflect immigration into Canaan (Gonen, 1992). Recent research from Akko and Tel Dan supports the idea that a new or unique tomb type may be identified with a new group of people, and analysis of ceramic change likewise hints at ethnic heterogeneity in the region during the Late Bronze Age. Gunneweg and Michel (1999) interpreted variations in trace-element composition of pottery from these tombs as indicative of foreign enclaves of western Mediterranean people in northern Canaan. Although these examples suggest a population influx, biological anthropologists (Arensburg, 1973; Arensburg et al., 1980; Smith, 1995) maintain that skeletal material in the southern Levant demonstrates homogeneity prior to the Hellenistic period (before 332 BC).

Lachish

Tell ed-Duweir (Lachish) is located about 30 km southeast of Ashkelon along Wadi Ghafr (Fig. 1). Like Dothan, the tell sits high above the surrounding plain on a spur of the Judean foothills, 40 m above the valley floor at its summit (Ussishkin, 1977, p. 735). The tell was occupied from the Chalcolithic period (beginning ca. 4000 BC) to the Persian period (ending in 332 BC), although not continuously (Tufnell, 1977).

Tell ed-Duweir was identified as ancient Lachish (Starkey, 1935; Tufnell, 1950, 1953; Ussishkin, 1980, 1990; Davies, 1982, 1985; Dever 1995b; Blakely and Horton, 2001), a major city of Judah east of Philistia in the Iron Age II period (1000–586 BC). Lachish very likely had significant contact with other groups during the Iron Age, located only 6 miles from the nearest Philistine settlement (Starkey, 1935). Traditionally, Philistine occupation was measured by the

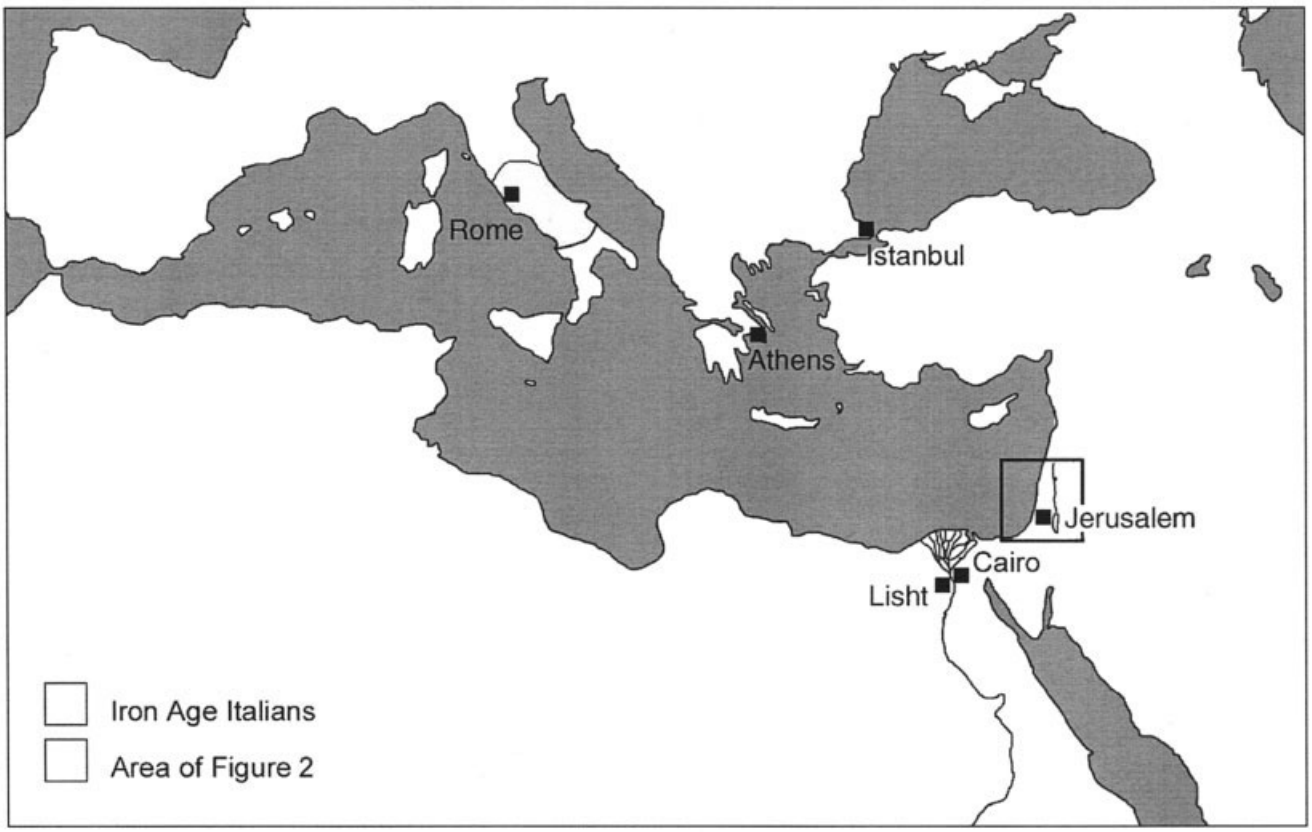

Fig. 1. Map of Mediterranean area.

presence of very distinctive ceramics (Dothan, 1985); however, only three such potsherds (out of many thousands recovered) were found on the tell, making it unlikely that Lachish was inhabited by Sea Peoples (Keith, 1940; Tufnell, 1950, 1953).

Lachish is the subject of large stone reliefs created for the Assyrian king Sennacherib, whose army conquered the area in 701 BC. The excavators believed that the remains of Tombs 107, 108, 116, 117, and 120 (the largest tomb excavated, housing the majority of skulls and dental remains) contained individuals who did not survive the attack on the city (Tufnell, 1953; Mazar, 1990; Ussishkin, 1990).

Risdon (1939) disagreed, because none of the remains (including men, women, and children) demonstrated visible trauma. Rather, he proposed that they were killed by a natural disaster around 700 BC. However, the stone reliefs show men, women, and children being captured, led away, and killed by the Assyrians. The lack of visible trauma might be explained by the fact that crania alone comprise over 80% of the skeletal collection, and that minor trauma-related damage was overlooked.

The Lachish remains represent one of the best-preserved and largest samples of Middle Eastern crania from any time period, with a near-equal distribution of sexes present. Indeed, with renewed religious restrictions against the excavation and study of human skeletons (Shiloh, 1997), the Lachish collection may remain the most representative Iron Age osteological series from the southern Levant.

The first report on the Lachish skulls included a thorough examination of pathology, metrics, artificial deformation, and epigenetic affinity. Utilizing craniometrics, Risdon (1939) concluded that the group was very similar to dynastic Egyptian material. In fact, he stated that the entire population was of foreign origin, representing descendants of a group derived primarily from Upper Egypt. This conclusion was subsequently supported by a craniometric study by Musgrave and Evans (1981). Keita (1988, p. 377) likewise examined the skulls metrically, omitting those that were either "artificially deformed, female, warped, split, [or] juvenile," using only those measurements that he believed were consistent population discriminators. He concluded that the group was fairly heterogeneous, having close relationships to North African, Egyptian, and Nubian groups, thus lending support to an "Egypto-Nubian presence" (Keita, 1988, p. 388).

One of the first to oppose the idea of an Egyptian origin was Keith (1940), who felt that the Lachish inhabitants were markedly different from Egyptians, though his analysis was rather anecdotal. Others have since concurred, arguing that the people of Lachish were indigenous, closely related to pre-Middle Bronze Age skeletons in Palestine and the modern-day Bedouin (Arensburg, 1973; Arensburg et al.,

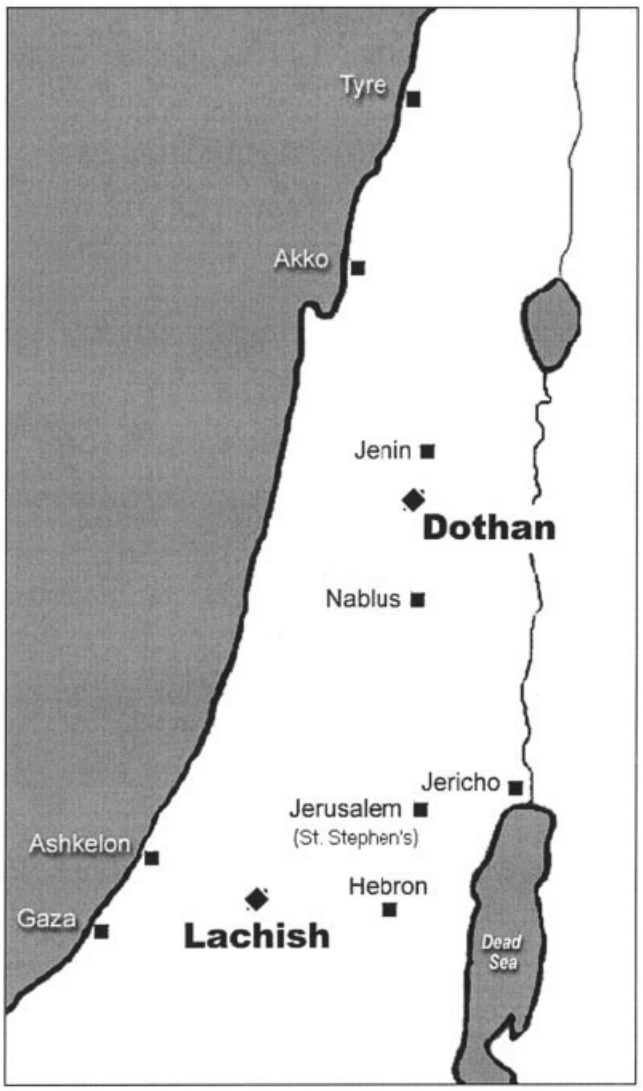

Fig. 2. Map of study area.

TABLE 1. Chronology of Tomb 1 at Tell Dothan[1]

Level	Period
1	Early Iron I, 1200–1100 BC
2	Mix of Late Bronze IIB and Early Iron I, 1300–1100 BC
3	Late Bronze IIB, 300–1200 BC
4	Late Bronze IIA, 1400–1300 BC
5	Late Bronze IIA, 1400–1300 BC

[1] Cooley and Pratico (1995)

1980; Smith, 1995). Arensburg (1982) further stated that although Egypt and Mesopotamia were very influential culturally, they made no biological contribution to the Levant at all. Giles (1953) conducted a craniometric examination of the Bronze Age skulls at Lachish excavated after the initial study of Risdon (1939), and established that the crania were most likely from the same population as the Iron Age people studied by Risdon (1939). Berry and Berry (1972), utilizing nonmetric cranial features, likewise found that the Lachish series was quite distinct from Egyptian collections dating to the Predynastic, Middle Kingdom, and Late Periods.

A limiting factor of the aforementioned studies is their dependence on craniometrics, most of which are susceptible to environmental factors, and hence are often considered poor population discriminators (Smith, 1989). Also, approximately 5% of the Lachish skulls exhibit cranial deformation, an additional hindrance to metric analysis.

In attempts to avoid the difficulties inherent in craniometric analysis, nonmetric traits are often used for affinity assessment. For example, Finkel (1976) concluded that the frequency of accessory (wormian) bones of the lambdoidal suture in the Lachish skulls was rather high (63.4%). He stated that stabilizing selection, inbreeding, and drift led to these frequencies of wormian bone formation. Comparison to Brothwell (1981) showed that the trait frequency from Lachish was similar to that of other groups. Smith and Zias (1980) observed 7 of 10 Hellenistic southern Levantine individuals with wormian bones, and Shanklin and Ghantus (1966) found the trait in approximately one half of 31 Phoenician skulls.

MATERIALS AND METHODS

For the current study, 3,053 teeth were examined from Tell Dothan. Of these, 2,102 could be identified as left or right permanent teeth (Table 2). Approximately one-quarter (29.5%) came from level 1, 16.0% from level 3, and the remaining 54.5% from level 4. The minimum number of individuals (MNI) based on identifiable dentition was 121 for the tomb. The actual number was certainly higher than this, given the large number of teeth whose side or number could not be determined, as well as the missing teeth from levels 2 and 5.

Skulls of 821 individuals from Lachish were also examined by J.M.U. Of these, 392 had at least one tooth that could be scored for a nonmetric trait. One hundred ninety-three skulls (49.2%) were male, 157 (40.1%) were female, 4 (1.0%) were unsexed adults, and 38 (9.7%) were juveniles. The identification of sex followed the designations of Risdon (1939). The distribution of individuals in each tomb is presented in Table 3.

The tooth count method was used to maximize sample size, and increase the likelihood of identifying statistically significant patterns (Sjovold, 1973). A large number of teeth could not be scored in the Dothan collection due to breakage and wear, thereby limiting our ability to accurately determine tooth number and/or type. Chi-square comparisons found no significant difference ($P < 0.05$) between individual and tooth counts for any dental trait from Dothan or Lachish.

The Dothan and Lachish collections were compared with four other dental data sets (Table 4). These included teeth from a tomb at St. Stephen's monastery in Jerusalem, dating from approximately 438–611 AD (Sheridan, 1999); Lisht, an Egyptian 12th Dynasty (1991–1783 BC) site located south of modern-day Cairo (Irish, 1993, and unpublished findings); a combined Iron Age Italian sample from approximately the same

TABLE 2. Distribution of identified teeth from levels of Tomb 1 from Dotha

Tooth class	Level 1	Level 2	Level 3	Total no. of teeth
R upper I1	31	15	75	121
R upper I2	23	10	40	73
R upper C	30	18	63	111
R upper P1	22	11	25	58
R upper P2	18	11	30	59
R upper M1	23	11	33	67
R upper M2	19	11	37	67
R upper M3	15	8	19	42
L upper I1	28	16	75	119
L upper I2	18	11	45	74
L upper C	31	17	59	107
L upper P1	28	6	31	65
L upper P2	12	11	23	46
L upper M1	17	9	19	45
L upper M2	28	10	19	57
L upper M3	11	5	27	43
R lower I1	0	4	33	37
R lower I2	17	7	29	53
R lower C	21	18	61	100
R lower P1	14	7	43	64
R lower P2	20	11	31	62
R lower M1	19	11	32	62
R lower M2	23	20	40	83
R lower M3	9	4	20	33
L lower I1	0	7	30	37
L lower I2	19	11	23	53
L lower C	28	9	49	86
L lower P1	17	10	38	65
L lower P2	12	10	24	46
L lower M1	16	11	43	70
L lower M2	21	10	38	69
L lower M3	8	6	14	28
Total no. of identifiable teeth	598	336	1,168	2,102

TABLE 3. Distribution of Lachish individuals

Tomb no.	n	Period
4029	2	Bronze
216	3	Bronze
4005	7	Bronze
508	1	Bronze
4015	1	Bronze
6027	1	Bronze
4002A	1	Bronze
508A	1	Bronze
6009A	1	Bronze
6009B	1	Bronze
6009C	1	Bronze
6013G	1	Bronze
6013L	1	Bronze
6027B	1	Bronze
6028A	1	Bronze
6028B	1	Bronze
6028D	1	Bronze
6028E	1	Bronze
6028G	1	Bronze
6028H	1	Bronze
6028J	1	Bronze
120A	1	Iron
120B	1	Iron
6006	1	Iron
521	1	Iron
1002	1	Iron
239	1	Iron
107C	2	Iron
108B	2	Iron
189	1	Iron
218	6	Iron
224	8	Iron
106	7	Iron
120	242	Iron
116	30	Iron
107	23	Iron
107B	16	Iron
108	2	Iron
223	2	Iron
Palace	1	Historic
220	1	Unknown
Unknown	13	Unknown
Total	392	

period as the Lachish (Coppa et al., 1998); and Natufian remains from the southern Levant, dating to approximately 10,800–8200 BC (Lipschultz, 1996) (see Fig. 1).

Our study utilized the Arizona State University Dental Anthropology System (ASUDAS) (Turner et al., 1991), which facilitates comparison between observers. All comparative data were also collected using the ASUDAS. Although traits are given numbers corresponding to strength of expression, such scores can be variously adjusted as "present" or "absent," depending on the requirements of the comparative statistic. The breakpoints used for these categories in the current study (Table 5) were the same as those presented in Scott and Turner (1997) and Turner (1987).

Dental morphological traits were particularly useful in the study of Tell Dothan and Lachish, due to the commingled nature of the remains and incomplete excavation of the skeletal material. The majority of traits used in this study have a high inter- and intraobserver scoring concordance when compared to other data collected using ASUDAS (Nichol and Turner, 1986).

Nonmetric traits are largely free of sex- and age-bias (Smith, 1977; Turner et al., 1991; Scott and Turner, 1997; Irish, 1998); therefore, dental data provide reliable comparisons in collections lacking individual information (i.e., sex, age, stature, overall health). There is also a strong genetic component to tooth trait inheritance. Twin and family studies suggest that phenetic (i.e., phenotypic) similarity approximates genetic similarity (Scott, 1973; Harris, 1977; Berry, 1978; Scott et al., 1983; Nichol, 1990; Larsen, 1997; Moskona et al., 1997; Scott and Turner, 1997).

Although dental traits are typically employed to assess larger regional relationships (Scott et al., 1983; Smith and Shegev, 1988; Turner, 1990; Roler, 1992; Irish, 1993, 1998, 2000; Haeussler, 1996; Hawkey, 1998), they facilitate comparison of intersite variability and even intrasite relationships (Bondioli et al., 1986; Turner and Markowitz, 1990; Bentley, 1991; Johnson and Lovell, 1994; Howell and Kintigh, 1996). Since "trait frequencies may be highly group specific even between populations that are closely related" (Smith, 1977, p. 178), these frequencies were used to test genetic similarities and/or differences between Dothan and Lachish, sites which are relatively close both geographically and temporally.

To determine intersite dental similarities, Smith's mean measure of divergence (MMD) statistic was calculated. This multivariate dissimilarity calculation is

TABLE 4. Dental series used for comparison to Dothan and Lachish

Collection	n	Location	Period	Source
St. Stephen's	67	Jerusalem	438–611 AD	Sheridan, 1999
Lisht	61	Egypt	1991–1783 BC	Irish, 1993 unpublished data
Iron Age Italy	1,114	Italy	900–100 BC	Coppa et al., 1998
Natufian	189	Jordan	10,800–8,200 BC	Lipschultz, 1996
Dothan	121	West Bank	1,400–1,000 BC	Present study
Lachish	392	Wadi Ghafr	4,000–332 BC	Present study

TABLE 5. Breakpoints used in MMD analysis

Trait	Tooth	Presence	Absence
Shoveling	UI1	3–7	0–2
Double shoveling	UI1	2–6	0–1
Interruption grooves	UI2	+	–
Tuberculum dentale	UI2	1–6	0
Distal accessory ridge	UC	2–5	0–1
Root number	UP1	2–3	1
Cusp 5	UM1	1–5	0
Carabelli's trait	UM1	2–7	0–1
Hypocone	UM2	2–5	0–1
Parastyle	UM3	1–6	0
Lingual cusps	LP2	2–9	A,0
Protostylid	LM1	1–7	0
Deflecting wrinkle	LM1	3	0–2
Cusp 7	LM1	1–4	0
Cusp 6	LM1	1–5	0
Groove pattern	LM2	Y	+,x
Cusp number	LM2	4	>4

an average of the variance present in a suite of characteristics (Sjovold, 1973). The smaller the value, the more similar the comparative groups. The MMD is considered significant if it is more than twice the standard deviation ($P < 0.025$). A correction for small sample size was added by Freeman and Tukey to adjust for continuity, thereby giving validity to tests with sample sizes as small as 10 individuals (De Souza and Houghton, 1977).

Although more than 30 traits were recorded for the dentitions of Lachish and Dothan, only 17 were available in the published Near Eastern literature for comparative purposes. The dichotomizing breakpoints used for the analysis followed those of Turner (1987), Scott and Turner (1997), and others. Several samples contained actual grade frequencies for each trait so that the breakpoint could be adjusted up or down, a valuable aspect of ASUDAS.

RESULTS AND DISCUSSION

Frequencies of the 17 traits from Dothan and Lachish are presented in Table 6. The anterior teeth were better represented at Dothan, because loose teeth were recovered during screening. Conversely, the Lachish series was represented by crania, thereby providing more posterior teeth retained in their sockets.

Morphology

Dothan and Lachish differed significantly ($P < 0.05$) in shoveling, interruption grooves, the hypocone, maxillary cusp 5, Carabelli's trait, and the protostylid. In each case, Dothan had a significantly higher percentage of individuals with trait presence. Generally speaking, the individuals of Dothan were dentally more complex than the individuals from Lachish, although not necessarily more complex than regional counterparts (Scott and Turner, 1997). The dentition from Lachish was rather simplified, with no evidence of shoveling, double shoveling, cusp 6, or deflecting wrinkle, and a near absence of interruption grooves, canine distal accessory ridge, cusp 5, and cusp 7.

Sexual dimorphism

Previous research showed little to no within-group sexual dimorphism for most dental morphological traits (Smith, 1977; Scott and Turner, 1997). When significant differences between male and female trait frequencies exist within a collection, exogamy may be present.

No such assessment could be made for Dothan because loose teeth do not facilitate sex identification; however, chi-square analysis was used to test for sex differences at Lachish. Between males and females at Lachish, the only significant difference ($P < 0.05$) occurred in the number of roots on the upper first premolar, with two-rooted premolars present in 70.9% (39/55) of males and 40.4% (19/47) of females.

Comparing biological relationships in Southwest Asia during the metal ages, Rathbun (1982) asserted that the region as a whole was fairly homogeneous, although he did note that Syro-Palestinian females differed significantly from all other Southwest Asian regional groups, including Syro-Palestinian males. Dentally, however, the males and females from Lachish were identical and did not reflect this predicted dimorphism.

Temporal comparisons

There were few within-site dental differences between the Bronze and Iron Ages at Dothan and Lachish. Dothan L1 (Early Iron Age) and Dothan L4 (Late Bronze Age) differed significantly ($P < 0.05$) in the occurrence of tuberculum dentale. The combined Iron Age (Dothan L1 and Lachish Iron) and Bronze Age (Dothan L4 and Lachish Bronze) levels differed significantly ($P < 0.05$) for shoveling, tuberculum dentale, UP1 roots, hypocone, and maxillary cusp 5. Three of five traits (shoveling, tuberculum dentale, and maxillary cusp 5) were more often present in the Bronze Age levels, while two (two-rooted UP1, hypocone) were more prevalent in the Iron Age levels.

Statistical comparisons (Table 7) were made within and between the different periods of both Dothan (Dothan level 1, Iron Age, and Dothan level 4, Bronze Age) and Lachish (Bronze and Iron Age tombs). There was

TABLE 6. Frequency of traits at Dothan and Lachish

	Dothan						Lachish					
	All levels		Iron (Lv 1)		Bronze (Lv 4)		All tombs		Iron		Bronze	
Traits	n	%	n	%	n	%	n	%	n	%	n	%
Shoveling (UI1, + = 3–7)	26/176	15	3/38	8	19/111	17	0/23	0	0/17	0	0/6	0
Double shovel (UI1, + = 2 +)	13/177	7	6/40	15	6/111	5	0/23	0	0/17	0	0/6	0
Interruption groove (UI2, +)	21/139	15	4/40	10	12/79	15	1/42	2	1/25	4	0/13	0
Tuberculum dentale (U12, + = 1+)	22/126	17	1/35	3	18/71	25	6/39	15	3/26	12	3/13	23
Distal accessory ridge (UC, + = 1+)	20/53	38	7/19	37	10/24	42	3/13	23	1/10	10	2/3	67
UP1 roots (+ = 2+)	31/75	41	8/14	57	17/49	35	63/114	55	61/107	57	4/9	44
Hypocone (UM2, + = 2–5)	89/110	81	31/41	76	42/49	86	174/248	70	142/207	69	3/26	12
Cusp 5 (UM1, + = 1+)	8/85	9	2/38	5	5/42	12	3/294	1	3/246	1	0/32	0
Carabelli trait (UM1, + = 2–7)	57/88	65	23/37	62	25/37	68	44/170	26	38/151	25	6/19	32
Parastyle (UM3, + = 1+)	2/75	3	1/20	5	1/44	2	4/143	3	4/124	3	0/11	0
Lingual cusps (LP2, + = 2+)	60/74	81	20/24	83	32/37	86	16/21	76	13/17	76	3/3	100
Protostylid (LM1, + = 1+)	50/106	47	14/29	48	28/58	48	16/53	30	14/31	45	2/3	67
Groove pattern (LM2, Y)	32/111	29	13/35	37	14/56	25	15/62	24	13/53	25	2/9	22
Cusp 6 (LM1, + = 1+)	3/101	3	0/25	0	3/59	5	0/59	0	0/48	0	0/9	0
Cusp number (LM2, 4)	121/134	90	33/36	92	63/69	91	99/104	95	86/88	98	8/9	89
Deflecting wrinkle (LM1, + = 3)	4/40	10	1/11	9	3/20	15	0/5	0	0/4	0	0/0	0
Cusp 7 (LM1, + = 1+)	6/118	5	1/34	3	5/67	7	1/82	1	1/68	1	0/10	0

TABLE 7. MMD comparisons within and between Dothan and Lachish time periods[1]

	DL1	DL4	LCI	LCB
DL1				
DL4	0.016			
LCI	0.034	**0.112**		
LCB	0.000	0.034	0.004	

[1] Bold indicates statistical significance at $P < 0.025$. Smaller values indicate greater phenetic similarity. DL1, Dothan level 1 (Iron Age); DL4, Dothan level 4 (Bronze Age); LCI, Lachish Iron Age; LCB, Lachish Bronze Age.

TABLE 8. MMD values for combined Iron and Bronze Ages at Dothan and Lachish[1]

	IDL	BDL	LIS
IDL			
BDL	**0.046**		
LIS	**0.130**	**0.160**	

[1] All values are statistically signficant at $P < 0.025$. Smaller values indicate greater phenetic similarity. IDL, Dothan and Lachish Iron levels combined; BDL, Dothan and Lachish Bronze levels combined; LIS, Lisht.

little difference dentally between individuals from corresponding time periods, although it should be noted that Bronze Age Lachish and Iron Age Dothan were represented by small sample sizes, which may explain the lack of statistically significant MMD values.

The combined Bronze Ages from Dothan and Lachish were compared with the combined Iron Ages for both sites (Table 8). The Bronze Age and the Iron Age were fairly similar, particularly when compared to the Middle Kingdom group from Lisht (corresponding to the Middle Bronze Age of the Levant), which was similarly distant from both the Bronze Age and the Iron Age.

It was argued that populations were biologically homogeneous before the Middle Bronze Age began (ca. 2500 BC) (Hrdlicka, 1938; Smith, 1995; Arensburg and Belfer-Cohen, 1997). Archaeologists postulated that there was cultural homogeneity before the Late Bronze Age, with demographic heterogeneity (Mazar, 1990). In other words, while the ceramic and material culture remain fairly homogeneous in the region, evidence of different group/tribal names suggests a heterogeneity of people (Mazar, 1990).

The frequencies for all sites are listed in Table 9. MMD values for the major groupings included comparisons among Dothan, Lachish, Lisht, Iron Age Italy, the Natufians, and Byzantine St. Stephen's (Table 10). The most similar groups were Dothan and Lachish, and Dothan and Lisht. Dothan was more like Iron Age Italy than was Lachish. However, Lachish was more similar to Byzantine St. Stephen's than was Dothan. Both Dothan and Lachish were most dissimilar from the Natufians. Although there are dental morphological studies similar to this for the greater Levantine area (Bentley, 1987; Roler, 1992), there are no published data on dentition from the Early or Middle Bronze Ages west of the Jordan River, which would allow for direct comparison. Future data collection may aid in the clarification of temporal continuity/discontinuity in this area.

Near eastern regional comparisons

The "distinguishing Jordanian" traits (shoveling, Y-groove pattern, cusp 6, cusp 4, and cusp 7), as found in historical and modern Jordanian groups by Roler (1992), were reflected in similar trait frequencies from Lachish and Dothan. Both collections had much lower frequencies of cusp 7, however. Dothan had a shoveling frequency similar to the Jordanian frequency, although individuals from Lachish demonstrated significantly less shoveling than people from Dothan or Jordan. In general, the trait frequencies for Dothan and Lachish (Table 6) were within the range of regional variation found in previous studies (Bentley, 1987; Smith et al., 1990; Roler, 1992; Smith, 1995).

The proposal that Lachish was comprised of Egyptian immigrants (Risdon, 1939) was not supported. Rather, the current findings support the theory that

TABLE 9. Frequencies of traits, tooth count, and pooled sample by sex[1]

Traits	Dothan		Lachish		St. Stephen's		Iron Age Italy[2]		Natufian[3]		Lisht[4]	
	n	%	n	%	n	%	n	%	n	%	n	%
Shoveling (UI1, + = 3–7)	26/176	14.8	0/23	0.0	2/21	9.5	17/207	8.2	1/59	1.7	0/10	0.0
Double shovel (UI1, + = 2+)	13/177	7.3	0/23	0.0	0/23	0.0	13/215	6.0	12/100	12.0	0/12	0.0
Interruption groove (UI2, +)	21/139	15.1	1/42	2.4	3/30	10.0	213/327	65.1	12/92	13.0	6/19	31.6
Tuberculum dentale (U12, + = 1+)	22/126	17.5	6/39	15.4	6/30	20.0	182/335	54.3	58/61	95.1	10/19	52.6
Distal accessory ridge (UC, + = 1+)	20/53	37.8	3/13	23.1	6/28	21.4	176/257	68.5	8/22	36.4	2/23	8.7
UP1 roots (+ = 2+)	31/75	41.3	63/114	55.3	16/18	88.9	119/336	35.4	22/33	66.7	26/42	61.9
Hypocone (UM2, + = 2–5)	89/110	80.9	174/248	70.2	24/47	51.1	445/539	82.6	139/147	94.6	40/42	95.2
Cusp 5 (UM1, + = 1+)	8/85	9.4	3/294	1.0	3/48	6.3	84/433	19.4	14/189	7.4	4/26	15.4
Carabelli trait (UM1, + = 2–7)	57/88	64.8	44/170	25.9	15/49	30.6	260/414	62.8	73/90	81.1	14/23	60.9
Parastyle (UM3, + = 1+)	2/75	2.7	4/143	2.8	3/16	18.8	50/355	14.1	1/133	0.8	0/32	0.0
Lingual cusps (LP2, + = 2+)	60/74	81.1	16/21	76.2	2/9	22.2	185/389	47.6	59/98	60.2	8/12	66.7
Protostylid (LM1, + = 1+)	50/106	47.2	16/53	30.2	26/61	42.6	256/397	64.5	21/146	14.4	8/15	53.3
Groove pattern (LM2, Y)	32/111	28.8	15/62	24.2	7/51	13.7	125/523	23.9	47/154	30.5	9/24	37.5
Cusp 6 (LM1, + = 1+)	3/101	3.0	0/59	0.0	0/57	0.0	17/462	3.7	16/141	11.3	1/18	5.6
Cusp number (LM2, 4)	121/134	90.3	99/104	95.2	59/67	88.1	369/465	79.4	104/176	59.0	19/24	79.2
Deflecting wrinkle (LM1, + = 3)	4/40	10.0	0/5	0.0	1/19	5.3	25/214	11.7	0/27	0.0	0/9	0.0
Cusp 7 (LM1, + = 1+)	6/118	5.1	1/82	1.2	3/59	5.1	49/524	9.4	6/168	3.6	1/23	4.3

[1] Tooth count for Dothan, Lachish, and St. Stephen's; individual count for Iron Age Italy, Natufian, and Lisht.
[2] From Coppa et al. (1998).
[3] From Lipschultz (1996).
[4] From Irish (1993, unpublished data).

TABLE 10. MMD values for Dothan, Lachish, and comparative dental series[1]

	DOT	LAC	LIS	IAI	BSS	NAT
DOT						
LAC	**0.077**					
LIS	**0.075**	**0.136**				
IAI	**0.175**	**0.366**	**0.150**			
BSS	**0.196**	**0.101**	**0.197**	**0.310**		
NAT	**0.312**	**0.388**	**0.120**	**0.325**	**0.449**	

[1] All MMDs are statistically significant ($P < 0.025$). DOT, Dothan; IAI, Iron Age Italy; LAC, Lachish; BSS, Byzantine St. Stephen's; LIS, Lisht; NAT, Natufian.

the people of Lachish were indigenous to the southern Levant (Keith, 1940; Arensburg, 1973; Arensburg et al., 1980; Smith, 1995), as Dothan and Lachish were both significantly different from Lisht. Dothan, however, may have had slightly more Egyptian genetic influence than Lachish. The location of Dothan along a major international highway between Egypt and Mesopotamia (as well as the Mediterranean and Mesopotamia) during the Late Bronze Age may shed light on this finding (Mullins, 2002).

Teeth from Dothan and Lachish show more resemblance with each other than they did with Iron Age Italy, Byzantine St. Stephen's, or the Natufians. There were significant differences between Dothan and Lachish in individual traits; however, the two sites showed overall similarity. Dentally, there was no evidence of a markedly different foreign population in the Iron Age southern Levant. These data support the view that material culture changes in the Iron Age cannot be explained simply by the arrival of markedly different peoples into the region. Although dentally similar new groups might have introduced novel cultural traits, this issue cannot be fully evaluated with the present database, as other biological systems need to be considered.

Broader regional interaction

Roler (1992) found little dental dissimilarity in Near Eastern people who were close geographically, even if separated temporally. She concluded that variation occurs primarily between groups separated by considerable distance or a geographic barrier. Considering just one dental trait, Moskona et al. (1997) found a high percentage (59%) of moderate and marked shoveling in nine Bedouin tribes from south Sinai practicing strong tribal endogamy. They also noted slight differences among the tribes, although they were relatively closely related. The high percentage of shoveling in the south Sinai Bedouin contrasts with a study by Saini et al. (1990), who found only 7.9% of modern Saudis with shovel-shaped incisors, classified as trace, semishoveled, or shoveled. If there was little interobserver error, this may illustrate that both represent relatively isolated breeding groups due to cultural restrictions, despite their relatively close geographical and temporal proximity.

Interestingly, it may be that the individuals from Lachish were more strongly endogamous than the individuals from Dothan. The trait frequencies for many teeth at Lachish were rather low. Bentley (1991) described a similar pattern of low frequency of dental traits at Early Bronze Age Bab edh-Dhra in Jordan, arguing for a familial pattern in this Jordanian cemetery. Tufnell (1953) believed that Lachish was probably a major administrative center on a thoroughfare between the Mediterranean coastal plain and the foothills of the Judean wilderness. The Late Bronze Age occupation of Dothan has not been fully explored; however, we know that it likely supported a smaller population. As discussed earlier, Dothan's location on a major international highway in the Late Bronze Age

may have led to greater gene flow at the site from more diverse locations.

Nevertheless, in comparisons with Iron Age Italy, Dothan was more similar than Lachish to the Italian group and may have been more heavily influenced by (or influential upon) Europeans from the Mediterranean. Dothan also appears to have been phenetically more similar than Lachish to almost all other samples. Even though Lachish was a larger, more cosmopolitan city (Tufnell, 1953), it may have been more genetically isolated than Dothan.

CONCLUSIONS

The results of this dental morphology study indicate biological continuity in the Late Bronze-Early Iron Age transition in the southern Levant. The similarity between Tell Dothan and Lachish suggests that the two are more closely related to each other than to other sites in the Mediterranean region. There is no dental morphological evidence of major population replacement at either Dothan or Lachish between the Late Bronze and Early Iron Ages. Pooling the time periods from both sites also shows no significant difference. Therefore, these data do not support the model of the "Israelite conquest" or the introduction of a distinct group of immigrants who populated the southern Levant during the Iron Age. It should be noted that the sample sizes are small for some traits from Dothan and Lachish, and that they are only two of the many sites in the region from these time periods. Future bioarchaeological studies in the area are warranted, but current restrictions on skeletal analysis leave few sites for comparison.

The data also indicate that the group at Lachish may be more homogenous than previously thought, while the individuals in the family tomb at Dothan may have been influenced by peoples from the Mediterranean. Further light on the makeup of the Dothan interments may become clearer with the final publication of the Dothan site report.

The current analysis contributes to an understanding of southern Levantine prehistory, using a bioarchaeological approach to test theories about a highly debated period of cultural flux. The Late Bronze-Early Iron Age transition was not previously examined from a biological perspective, much less a dental one. The lack of dental evidence for a group of distinct conquerors can be integrated with archaeological evidence in order to generate a more complete picture of the southern Levant in the Late Bronze and Early Iron Ages.

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