Table 5.32-4 . Frequency of peg shaped teeth among various populations.

Population	Source	N1 individuals	Frequency %	N2 teeth	% teeth with trait
rural Metaponto 6-3 c BC	**own data**	80	**3.8**	110	**3.6**
urban Metaponto 7-2 c BC	**own data**	63	**3.2**	84	**3.6**
Etruscans, 7-1 c BC	Pinto-Cisternas et al. (1995)	47	2.12		
Florentine, 19 c AD	"	70	2.85		
Lucus Feroniae, 2 c AD	Manzi et al. (1997)			58	1.72
Portus (Isola Sacra), 2 c BC	"			33	0
Modern Americans	Brekhus et al. (1944)	11487	0.52		
American students, Minnesota	Meskin and Gorlin (1963)	8289	0.88		
Modern Finns	Alvesalo & Portin (1969)	306	3.6*		
Eskimos(Igloolik), Canada	Mayhall (1979)			395	1.5**
Modern population of Hawaii	Sofaer et al. (1971)	13599	2.2**		
Modern Mormons, Salt Lake City	Woolf (1971)	918	1.6		
Modern Parisian males	Le Bot & Salmon (1977)	5738	1.58		
Modern Belorussians	Zubov & Haldeeva (1979)	1159	12.3		

* - frequencies of peg shaped and strongly reduced mesio-distally upper second incisor poolled together
** - calculated from the published data

Table 5.32-5. Matrix of standardised mean measures of divergence (MMD) below the diagonal and their standard deviations (above the diagonal) for five populations.

Samples **Sorce**	Rural Metaponto own data	Urban Metaponto own data	Lucus Feroniae Manzi et al. (1997)	Portus Romae Manzi et al. (1997)	Naqada Johnson & Lovell (1994)
Rural Metaponto*	-	0.01	0.013	0.029	0.029
Urban Metaponto*	13.8346	-	0.014	0.029	0.03
Lucus Feroniae*	34.3067	29.9947	-	0.032	0.033
Portus Romae*	12.2522	12.9937	0.7438	-	0.042
Naqada**	26.2624	31.8668	6.6942	6.6934	-

* based on 19 non-metric traits

** based on 7 non-metric traits

Table 5.32-6. Calculation of MMD for the rural and urban populations from Metaponto based on 19 dental non-metric traits.

MMD	0.14715
VAR (MMD)	0.000113
SD	0.010636
SD MMD	13.83461

traits:	Urban size (N)	trait freq.(k)	Rural size (N)	trait freq.(k)	THETA	THETA 2	SAMPLE SIZE CORRECTION		INDIV MMD
Shovelling I1	58	15	73	22	0.49458	0.402733	0.0307	0.00094	-0.0223
I2	66	24	80	46	0.27203	-0.14871	0.02746	0.00075	0.14956
Etruscan upper lateral incisor	63	7	72	29	0.87236	0.192995	0.02954	0.00087	0.432
Peg shaped lateral incisor	63	2	90	3	1.17485	1.176991	0.0268	0.00072	-0.0268
Canine tubercle	82	11	69	39	0.80814	-0.12894	0.02651	0.0007	0.85161
Canine distal accessory ridge	33	24	34	23	-0.4572	-0.35013	0.05884	0.00346	-0.0474
Carabelli's trait a) all grades	54	38	63	51	-0.4116	-0.65542	0.0341	0.00116	0.02535
Number of cusps M1 4	91	84	98	94	-0.992	-1.14174	0.02108	0.00044	0.00134
M2 4	87	12	98	13	0.79806	0.814455	0.02158	0.00047	-0.0213
Canine distal accessory ridge	23	8	29	8	0.29626	0.448517	0.07645	0.00584	-0.0533
Number of lingual cusps P1	71	4	104	19	1.06618	0.679776	0.02356	0.00055	0.12575
P2	62	30	84	26	0.03176	0.386016	0.02783	0.00077	0.09767
Number of cusps M1 5	89	64	87	75	-0.4482	-0.79806	0.0226	0.00051	0.09978
M2 5	98	2	112	4	1.25321	1.16959	0.01904	0.00036	-0.012
M1 groove pattern Y	81	41	79	53	-0.0122	-0.34429	0.02485	0.00062	0.08544
X	81	7	79	1	0.95663	1.299978	0.02485	0.00062	0.09304
M2 groove pattern Y	94	0	103	18	1.46802	0.700084	0.02024	0.00041	0.56948
X	94	14	103	0	0.76816	1.47258	0.02024	0.00041	0.47597
Protostylid M1	65	0	77	0	1.44739	1.457325	0.02817	0.00079	-0.0281

Table 5.32-7. Calculation of MMD for the rural and urban populations based on 34 dental non-metric traits.

MMD	0.12837
VAR (MMD)	7E-05
SD	0.00837
SD MMD	15.3313

traits: (max 30)	Rural size (N)	trait freq.(k)	Urban size (N)	trait freq.(k)	THETA 1	THETA 2	SAMPLE SIZE CORRECTION		INDIV MMD
Winging	34	2	27	0	1.032291	1.380671	0.065349	0.004271	0.056019
Shovelling I1	73	22	58	15	0.402733	0.494583	0.030699	0.000942	-0.02226
I2	80	46	66	24	-0.14871	0.272032	0.02746	0.000754	0.149561
Etruscan upper lateral incisor	72	29	63	7	0.192995	0.872364	0.029541	0.000873	0.432001
Peg shaped lateral incisor	90	3	63	2	1.176991	1.174851	0.026798	0.000718	-0.02679
Canine tubercle	69	39	82	11	-0.12894	0.808137	0.02651	0.000703	0.851607
Canine distal accessory ridge	34	23	33	24	-0.35013	-0.45717	0.058836	0.003462	-0.04738
Carabelli's trait a) all grades	63	51	54	38	-0.65542	-0.4116	0.034097	0.001163	0.025351
b) cusps (5-7)	63	16	54	16	0.505737	0.411603	0.034097	0.001163	-0.02524
Number of cusps M1 4	98	94	91	84	-1.14174	-0.992	0.021081	0.000444	0.001341
M1 4-	98	4	91	7	1.141741	0.992	0.021081	0.000444	0.001341
M2 4	98	13	87	12	0.814455	0.798061	0.021581	0.000466	-0.02131
M2 4-	98	44	87	21	0.101188	0.536823	0.021581	0.000466	0.168197
M2 3+	98	24	87	23	0.529481	0.484705	0.021581	0.000466	-0.01958
M2 3	98	17	87	31	0.703016	0.288079	0.021581	0.000466	0.150592
Metaconule M1	29	10	30	0	0.304885	1.390211	0.066685	0.004447	1.111248
M2	40	12	38	4	0.401045	0.87861	0.050665	0.002567	0.177402
Rotations (I2)	48	5	41	3	0.888166	0.986519	0.044715	0.001999	-0.03504
Canine distal accessory ridge	29	8	23	8	0.448517	0.296259	0.076451	0.005845	-0.05327

Table 5.32-7. Calculation of MMD for the rural and urban populations based on 34 dental non-metric traits. (Continued)

Number of lingual cusps	P1		104	19	71	4	0.679776	1.066183	0.023555	0.000555	0.125755
	P2		84	26	62	30	0.386016	0.031755	0.027834	0.000775	0.097667
Sagittal furrow			75	39	57	30	-0.03949	-0.05175	0.030636	0.000939	-0.03049
Number of cusps	M1	5	87	73	89	63	-0.73493	-0.42371	0.022602	0.000511	0.074257
	M1	4	87	14	89	25	0.734927	0.448225	0.022602	0.000511	0.059597
	M1	6	87	0	89	1	1.463993	1.315562	0.022602	0.000511	-0.00057
	M2	5	112	4	98	2	1.16959	1.253211	0.019041	0.000363	-0.01205
M1 groove pattern		Y	79	53	81	41	-0.34429	-0.0122	0.024849	0.000617	0.085439
		+	79	25	81	33	0.370984	0.183977	0.024849	0.000617	0.010123
		X	79	1	81	7	1.299978	0.956634	0.024849	0.000617	0.093037
M2 groove pattern		Y	103	18	94	0	0.700084	1.468018	0.020244	0.00041	0.569479
		+	103	85	94	80	-0.70008	-0.76816	0.020244	0.00041	-0.01561
		X	103	0	94	14	1.47258	0.768157	0.020244	0.00041	0.475968
Protostylid M1			77	45	65	35	-0.16746	-0.07584	0.02817	0.000794	-0.01978
Rotations and crowding			67	11	71	14	0.72334	0.640145	0.028801	0.000829	-0.02188

Table 5.32-8. Calculation of MMD for the rural population from Metaponto and Lucus Feroniae based on 19 dental non-metric traits.

MMD	0.44299
VAR (MMD)	0.00017
SD	0.01291
SD MMD	34.3067

traits:	Rural size (N)	trait freq.(k)	Lucus Feroniae size (N)	trait freq.(k)	THETA 1	THETA 2	SAMPLE SIZE CORRECTION		INDIV MMD
Shovelling I1	73	22	24	0	0.402733	1.369438	0.054422	0.002962	0.880098
I2	80	46	24	2	-0.14871	0.930298	0.053239	0.002834	1.111014
Etruscan upper lateral incisor	72	29	51	14	0.192995	0.458284	0.033211	0.001103	0.037167
Peg shaped lateral incisor	90	3	58	1	1.176991	1.255066	0.028144	0.000792	-0.02205
Canine tubercle	69	39	50	30	-0.12894	-0.1974	0.03419	0.001169	-0.0295
Canine distal accessory ridge	34	23	18	10	-0.35013	-0.10561	0.08304	0.006896	-0.02325
Carabelli's trait a) all grades	63	51	37	11	-0.65542	0.405958	0.042415	0.001799	1.084111
Number of cusps M1 4	98	94	63	63	-1.14174	-1.44547	0.0259	0.000671	0.06635
M2 4	98	13	56	44	0.814455	-0.59623	0.027851	0.000776	1.96219
Canine distal accessory ridge	29	8	36	4	0.448517	0.859331	0.061296	0.003757	0.107472
Number of lingual cusps P1	104	19	74	4	0.679776	1.076595	0.022992	0.000529	0.134473
P2	84	26	57	7	0.386016	0.835489	0.029226	0.000854	0.1728
Number of cusps M1 5	87	73	59	51	-0.73493	-0.7993	0.028235	0.000797	-0.02409
M2 5	112	4	78	5	1.16959	1.037284	0.021628	0.000468	-0.00412
M1 groove pattern Y	79	53	44	33	-0.34429	-0.511	0.035051	0.001229	-0.00726
X	79	1	44	8	1.299978	0.671899	0.035051	0.001229	0.359434
M2 groove pattern Y	103	18	75	17	0.700084	0.56989	0.022907	0.000525	-0.00596
X	103	0	75	43	1.47258	-0.14526	0.022907	0.000525	2.594501
Protostylid M1	77	0	46	1	1.457325	1.216633	0.034409	0.001184	0.023524

Table 5.32-9. Calculation of MMD for the rural population from Metaponto and Portus Romae based on 19 dental non-metric traits.

MMD	0.35096
VAR (MMD)	0.00082
SD	0.02864
SD MMD	12.2522

traits:		Rural size (N)	trait freq.(k)	Portus Romae size (N)	trait freq.(k)	THETA 1	THETA 2	SAMPLE SIZE CORRECTION		INDIV MMD
Shovelling	I1	73	22	4	1	0.402733	0.42243	0.235828	0.055615	-0.23544
	I2	80	46	9	3	-0.14871	0.306437	0.117686	0.01385	0.089471
Etruscan upper lateral incisor		72	29	27	6	0.192995	0.565922	0.050157	0.002516	0.088918
Peg shaped lateral incisor		90	3	33	0	1.176991	1.398446	0.0409	0.001673	0.008142
Canine tubercle		69	39	15	9	-0.12894	-0.189	0.078905	0.006226	-0.0753
Canine distal accessory ridge		34	23	7	4	-0.35013	-0.12634	0.162319	0.026347	-0.11224
Carabelli's trait a) all grades		63	51	27	5	-0.65542	0.653234	0.052112	0.002716	1.660467
Number of cusps	M1 4	98	94	39	39	-1.14174	-1.41202	0.035469	0.001258	0.03758
	M2 4	98	13	33	27	0.814455	-0.6663	0.040003	0.0016	2.152625
Canine distal accessory ridge		29	8	11	1	0.448517	0.857419	0.120855	0.014606	0.046346
Number of lingual cusps	P1	104	19	33	5	0.679776	0.743694	0.03942	0.001554	-0.03533
	P2	84	26	27	6	0.386016	0.565922	0.048198	0.002323	-0.01583
Number of cusps	M1 5	87	73	27	26	-0.73493	-1.11012	0.047792	0.002284	0.092978
	M2 5	112	4	32	3	1.16959	0.908916	0.039658	0.001573	0.028292
M1 groove pattern	Y	79	53	21	19	-0.34429	-0.88629	0.05909	0.003492	0.234673
	X	79	1	21	1	1.299978	1.049669	0.05909	0.003492	0.003565
M2 groove pattern	Y	103	18	35	9	0.700084	0.492076	0.037831	0.001431	0.005436
	X	103	0	35	21	1.47258	-0.19577	0.037831	0.001431	2.745564
Protostylid	M1	77	0	19	0	1.457325	1.345283	0.064185	0.00412	-0.05163

5.4. General discussion to PART II

Historical documents and archaeological evidence showed the presence of Greeks in the Italian peninsula a few centuries before the colonial expansion (Descaeudres 1990). Earlier contacts of indigenous Italic people with the Greeks have recently been documented by archaeological findings at rural settlements of Incoronata, Termitito and San Vito, at a distance of around 15 km from the city of Metaponto (De Siena 1982, 1990, Carter 1998). Large quantities of Mycenaean pottery dated to Middle Bronze Age (14th - 13th century BC) found in Termitito in the territory of the later chora of Metaponto confirmed trading and cultural contacts between local Italic populations and the Greeks. At Incoronata Lazazzera, one of the sites of a mostly indigenous Incoronata settlement, archaeological findings suggested that a mixed Italic and Greek population lived there in the 7th century. Some of the Greek artefacts from other parts of this settlement were dated to 8th century BC. If trade and cultural contacts between indigenous people and Greeks existed already for several centuries in the territory of Metaponto before the colony was formally founded, it could be expected that the biological contacts would be a natural consequence.

Therefore, it is no surprise that the Metapontines from the rural area of Metaponto were biologically more closely related to the indigenous populations of Italy than to the metropolitan Greeks. It has been postulated that during the 6th - 3rd century the rural burial grounds were used by a population of a mixed indigenous and Greek origin. The analysis of biological distances whether performed on metric or on non-metric dental traits, showed a closer relationship of the rural Metapontines to their coeval Italic populations such as Etruscans and Oscans from Pontecagnano, whose territory expanded to the areas surrounding the chora of Metaponto (Malegni et al. 1985), than to the Greek founders of the colony residing in the city. The rural Metapontines were also closer to other Italic populations such as the coeval population from Alfedena (Abruzzo) in central Italy and to the earlier population from Osteria dell'Osa (near Rome) than to the urban Metapontines. They were closer to the earlier Italic population from Sala Consilina (Salerno) and to the two later dated, the 2nd century AD. Roman populations from Portus Romae and Lucus Feroniae than to the Greek neighbours from the city of Metaponto. The rural people from Metaponto differed from most of other European and world-wide populations as the biological distances between them and these populations were statistically significant and generally greater than between rural Metapontines and Italic populations (Table 5.31-3 and Table 5.31-3A). The MMD results for five populations revealed almost equal distances between the rural and urban Metapontines and the rural Metapontines and Roman Portus Romae (Table 5.32-5). The differences between these populations were highly statistically significant. The MMD distances between the rural Metapontines and Naqada and Lucus Feroniae as well as the MMD distances between the urban Metapontines and Naqada and Lucus Feroniae were more than twice as great as for both populations from Metaponto and Portus Romae. These results suggest that the process of assimilation of the indigenous populations by the colonists (and *vice versa*) within the colony of Metaponto was already advanced probably in both the rural and urban populations. Because different dental characteristics contributed to the results of the rural/indigenous and urban/indigenous comparisons the process leading to the probable biological assimilation of the indigenous people and Greek colonists was also different in the rural and urban populations. The obvious explanation of the differences in this process would be the difference in life styles and in probabilities of external contacts with other populations.

It could be expected that the analysis of the biological distances between the coeval Greeks from the mainland Greece and the rural and urban populations from Metaponto should clearly show the strength of their biological relationship and resolve the problem of the affiliations. Unfortunately, it was difficult to find data on dental metric and non-metric traits from coeval Greeks, who lived in Greece. The pioneering studies of ancient Greeks conducted by Angel on various skeletal samples dated between Neolithic and modern times did not contain data on dental traits. The majority of his work concentrated on dental health (Angel 1942, 1944a,b, 1945, 1946, 1966, 1971, 1972b, 1984,). His studies of metric and non-metric characteristics on skulls revealed great variability within the ancient Greeks (Angel 1942, 1944b, 1945). This finding would make search for affinities of Greeks in colonies more difficult from the biological point of view even when Greek dental samples would be available for study. Some of the Greek skeletal series excavated earlier have not yet been described and some of the larger Greek cemeteries are still under excavation (Agelarakis 1994). The skeletal material from these sites has been either in a preliminary state of examination, or data were presented in the form of reports unavailable to the author of this thesis. The lack of comparative material was also partially due to the specific cultural habits of the Classical Greeks. Many Greek cemeteries contained cremations as another common type of a burial and only a few human dental remains were preserved from such sites (Musgrave 1980).

Evidence of contacts between the local Lucanians and Oscans and Greeks from the Peloponnesos was present in the territory of Metaponto and these contacts dated back to the 14th c. BC (Carter 1998). Lack of biological differences between the rural Metapontines and the indigenous Italic populations in the tooth size and some of the morphological traits such as the "Etruscan" lateral incisor suggests the biological continuity of the population in the region in the rural areas associated with Greek cities.

The present study is the first biological analysis of the rural population of the Greek chora in its complex historical and environmental setting. Thus, the results of the comparisons between populations should be treated as rather preliminary.

5.5. Summary and conclusion

The studies of dental traits showed that rural Metaponto displayed biological continuity between the indigenous populations of the region and the colonists from Greece. Despite the turbulent history of the colony of Metaponto, the rural chora biologically showed more similarities with the indigenous Italic people than with the Greek founders of the colony.

6. PART III. Family clusters - an attempt to use biological characteristics in reconstruction of social burial customs

6.1. Introduction

Burial grounds are yet another expression of customs and social stratification typical for a particular society and have been studied for this reason by archaeologists in all parts of the world for a long time (Binford 1972, Lane and Sublett 1972, Spence 1974a,b, Konigsberg 1988, Morris 1987, 1992, Konigsberg and Buikstra 1995). The biological relationship of people buried at a cemetery to other groups of people, whether on a population or on an individual level, interested physical anthropologists since the beginning of the physical anthropology as a separate discipline (Corruccini 1972, Lane and Sublett 1972, Brothwell 1981, Molto 1983, Grauer 1995). Because a family has been the basic functional unit of every society and every biological population, the interest in establishing family relationships within the burial ground attracted attention of archaeologists and physical anthropologists (Larsen 1997, pp326-329, Alt and Vach 1998). When great multiple burial tombs of ancient civilisations such as Egyptian, Inca, Mayan, Etruscan, Greek and many others, were excavated, one of the immediate questions posed was, if they were family tombs and how the people buried in the tombs were related to each other (Angel 1939, Gejvall and Henschen 1968, Spence 1974b, Alt and Vach 1998). In many cases written historical documents and artefacts answered the questions but "hard evidence" in confirmation of biological relationship between the descendants was desirable or required (Rösing 1986).

Various biological characteristics were used to establish kinship and various techniques were applied to segregate the skeletal material into potential family groups (Alt and Vach 1998).

Among the biological characteristics most commonly used in kinship analysis were metric and non-metric traits on the skull, as they were used in comparisons between populations (Spence 1974b, Sjovold 1976-77, 1977, Rösing 1984, 1986, Saunders 1989, Larsen 1997). Any heritable traits such as rare signs of genetic diseases on bones or anomalies of bones and teeth, blood groups and other substances of genetic value able to be detected in dry bone, including DNA testing, were used to trace family connections (Anderson 1968, Spence 1974a,b, Carpenter 1976, Capasso 1985 , Hagelberg et al. 1989, Bentley 1991, Larsen et al. 1995, Alt et al. 1996).

While DNA testing would be ideal for family studies, application of this technique to badly preserved archaeological material could be difficult (Hagelberg et al. 1989). In collaboration with Professor Bryan Sykes from the Institute of Molecular Medicine at Oxford and his co-workers an attempt has been made to study the selected family groups at the Pantanello necropolis. Unfortunately the skeletal material from tombs of interest was badly preserved, and most of the bone samples yielded very little collagen for further DNA studies, so this analysis was not considered to be feasible, or productive.

Very rarely would skeletal material excavated from areas under intensive agriculture be in a condition suitable for DNA analysis. In that case, the investigation of the biological relationship between deceased buried at the cemetery would be most probably limited to general morphological characteristics. It has been argued recently that dental traits in general are even more suitable for kinship analysis than discrete traits of the skull, because they are easy to observe and for many of them the mode of inheritance is known (Biggerstaff, 1970, Berry 1976, 1978, Harris and Bailit 1980, Townsend et al. 1986, Townsend and Martin 1992, Scott and Turner 1997, Alt and Vach 1995, 1998). Most dental traits are independent of age and sex (Garn et al. 1966, Portin and Alvesalo 1974, Hillson 1996). Needless to say, teeth may remain well preserved despite unfavourable conditions in the soil. A list of dental traits helpful in establishing family relationships was compiled recently by Scott and Turner (1997) and independently by Alt (1997).

6.2. Description of the material used in the analysis

Metric and non-metric traits on permanent dentition were used in establishing family relationships. Buccolingual (BL) and mesiodistal (MD) diameters were included in the metric analysis. All observable non-metric traits on teeth, as well as their position in the dental arch, were initially taken into consideration in establishing genetic relationships. Observations of Carabelli's cusps, shovel- shaped teeth, number of cusps on molars and premolars, groove pattern on molars, canine tubercle, canine distal accessory ridge on both upper and lower canines, cingular nodules, sagittal furrow, protostylid, metaconule, hypocone, "Etruscan" lateral incisor, crowding and rotations of teeth, winging, peg shaped lateral incisors, reduction in size of the third molars, agenesis of the third molars, additional cusps on teeth, retention of teeth, shape of the dental arch were all made on the dentition of individuals already placed by archaeologists into each potential family group. All discrete traits were scored as present or absent. If the trait was present bilaterally it was scored only once and the highest degree of trait expression was used in the analysis. If only one antimere was available for observation, the score was treated as if it were the higher of the two bilaterally observed trait expressions. For practical reasons simple assumption had to be made that the presence or absence of a trait on a tooth was a phenotypic expression of a simple genetic model like, for instance

Mendelian inheritance, despite recent findings suggesting polygenic inheritance or combination of simple and polygenic models (Lee and Goose 1972, Sofaer et al. 1972, Berry 1978, Nichol 1989, Townsend and Martin 1992, Hillson 1996)

6.3. Methods of material grouping and specific statistical tests used in the analysis

A two-step procedure was applied in this study to test the presence of family "clusters" within the burial grounds (Sjovold 1976-77, Alt and Vach 1998). First, potential family groups were identified based on the organisation of the tombs within the necropolis, dating of the individual tombs, similarity of the tomb styles and building material and the similarity of grave goods (Carter 1990b, 1998b, Henneberg and Henneberg 1998b). The second step included the study of metric and non-metric characteristics within a potential family "cluster".

Statistical procedures applied to dental metrics were described in detail in Henneberg and Henneberg (1998b). The published part of the studies of family "clusters" has been included in this thesis (Appendix 5).

There were very few individuals with teeth in every hypothetical family grouping, and those who had some dentition left had just a few measurements on teeth available for further statistical analysis. Thus it was not possible to choose the same set of tooth dimensions for all compared family clusters. Because the dental material was poorly preserved and distributed across family clusters unevenly, comparisons on teeth alone were very difficult. In order to increase the opportunity for comparison, stature reconstructed from long bones was included in the analysis (Henneberg and Henneberg 1998b), although it is known that this feature is strongly environmentally influenced (Komlos 1994).

Mendelian inheritance, despite recent findings suggesting polygenic inheritance or combination of simple and polygenic models (Lee and Goose 1972, Sofaer et al. 1972, Berry 1978, Nichol 1989, Townsend and Martin 1992, Hillson 1996)

6.3. Methods of material grouping and specific statistical tests used in the analysis

A two-step procedure was applied in this study to test the presence of family "clusters" within the burial grounds (Sjovold 1976-77, Alt and Vach 1998). First, potential family groups were identified based on the organisation of the tombs within the necropolis, dating of the individual tombs, similarity of the tomb styles and building material and the similarity of grave goods (Carter 1990b, 1998b, Henneberg and Henneberg 1998b). The second step included the study of metric and non-metric characteristics within a potential family "cluster".

Statistical procedures applied to dental metrics were described in detail in Henneberg and Henneberg (1998b). The published part of the studies of family "clusters" has been included in this thesis (Appendix 5).

There were very few individuals with teeth in every hypothetical family grouping, and those who had some dentition left had just a few measurements on teeth available for further statistical analysis. Thus it was not possible to choose the same set of tooth dimensions for all compared family clusters. Because the dental material was poorly preserved and distributed across family clusters unevenly, comparisons on teeth alone were very difficult. In order to increase the opportunity for comparison, stature reconstructed from long bones was included in the analysis (Henneberg and Henneberg 1998b), although it is known that this feature is strongly environmentally influenced (Komlos 1994).

In order to retain sample sizes as large as possible and to minimise the effect of sex and the effect of differences in direct measurements between teeth and between teeth and stature, the Z-scoring procedure was applied to each tooth and stature measurement. The Z-scoring procedure transformed individual data on tooth dimensions and stature into the values in units of standard deviation calculated for the studied sample. These values represented the position of an individual within the sample and allowed comparison of a variety of metric data.

It was expected that in a biological family the variance of continuous characteristics would be smaller than in the entire sample representing the biological population. The Z-score values for a family cluster would then show reduction in variance. This hypothesis was tested with Snedecor's F-test for the significance of reduction in Z-score variance in the cluster against the 1.00 variance in the general population as defined by Z-scoring procedure (Appendix 5).

Various approaches and statistical techniques were used to segregate the individuals into the potential biological families based on non-metric traits and to confirm or to disprove their genetic similarities. Fisher's exact test (Blalock 1960) was used to test the significance of differences in frequencies of non-metric characteristics in the published part of the kinship analysis (Appendix 5).

Multivariate methods used for interpopulational studies can be applied with success to larger skeletal samples, usually with complete set of information for each individual (Finnegan and Cooprider 1978, Molto 1983, van Vark and Howells 1984, Konigsberg and Ousley 1995). Such conditions were difficult to meet in studies of many archaeological skeletal samples. A common problem was gaps in information on a particular trait (often a different trait in different individuals) because of the state of preservation of the material and small sample size. The same problems were encountered when studying genetic distances between populations and then often the simpler methods of direct comparisons between the groups for each morphological characteristic with appropriate statistical test (Chi-squared, Fisher's exact test, Kolmogorov-Smirnoff test), were preferred (Sciulli 1979). One of the limiting conditions of multivariate methods was that the observed traits should be independent from each other. This condition would be impossible to meet because any characteristic observed on the skeleton would be more or less related to the other one on the skeleton of the same individual. Often several observations of dental traits were made on the same tooth. Selection of the least dependent traits would be essential but often, some valuable and independent from each other traits were indiscernible due to tooth wear, caries or poor preservation.

Because of the fragmentary nature of the material many traits were observed only in one individual in the family clusters or were indiscernible due to the absence of the particular tooth among all individuals from the cluster. In order to unify the conditions of comparisons between clusters, 18 from the initial set of 44 traits were chosen for further calculations. The choice of traits was based on the highest chance that the tooth would be available for observation (premolars were most frequently preserved in the individual dentition), on the variability of the trait within the clusters being high, and, if possible, the independence of traits from each other. The list of traits used in the comparisons between family clusters was presented in the Table 6.4-1.

Despite the limitations associated with the nature of the biological material and the archaeological samples, some multivariate methods and procedures designed for small sample sizes were used, some with better results than others. The statistical procedure for non-metric characteristics, the Mean Measure of Divergence (MMD), used previously in this thesis for measuring distances between populations, was applied to non metric data compiled for the four largest, previously assembled family "clusters" (Berry and Berry 1972, Sjøvold 1973, 1977, Green and Suchey 1976, Johnson and Lovell 1994). This procedure was specifically designed for investigation of family relationships (Sjøvold 1973). Comparison between the remaining 14 hypothetical family clusters distinguished at the Pantanello necropolis on grounds on topographical and cultural criteria was not attempted due to there being too few individuals with teeth in each group.

6.4. Results

The results of comparison between family clusters and the sample as a whole based on dental dimensions are described in the Appendix 5. Table 6.4-2 shows the results of kinship analysis based on dental non-metric traits.

Nine hypothetical family groups, described in detail in the Appendix 5, included members with teeth and their dental dimensions were used in the analysis. In each group the tooth size Z-scores for individuals were determined. In four family groups denoted as N10.2, Nucleus 3, N6.5, and N18.2, the assumption of the family relationship was supported by average Z-score values greater or smaller than zero and standard deviations significantly smaller than 1.0. The frequency of other characteristics, such as complete absence of metopism in N10.2 family group, while the frequency of this trait was high in the general population (about 20%), presence of Carabelli's trait in all those individuals available for observation in this group, the stature taller than average for the population, and lack of parietal foramina, also supported the notion that individuals in this group were related to each other. Combined probability of random presence in this group of individuals with frequencies of various traits different from population averages was 0.005 and suggested a biological relationship between these individuals. Because of fragmentary nature of the material, not all characteristics could be observed on all individuals in the group. Thus the lack of uniformity in observations is one of the reasons for the use of extreme caution in drawing conclusions from the results.

In addition to the Z-scores for tooth size suggesting a biological relationship between individuals in the group N18.2, only the presence of Carabelli's trait and the average stature estimated for two members of this group could support the assumption that relatives were buried in this burial cluster. Two other groups with Z-scores suggesting kinship had no other observations available for analysis.

Instead of combining various metric traits and discrete traits most commonly used in family investigations, a different approach to the question of family relationships being reflected in burial clusters was exercised in the second part of the analysis. The analysis was based entirely on non-metric traits. The same sets of characteristics were observed among individuals from the selected largest family groupings.

The frequencies of 18 discrete dental traits in the four largest family clusters are presented in the Table 6.4-1. The number of observations for each characteristic fluctuated between 2 and 15 but the data on all of the characteristics were represented in each cluster.

Mean measure of divergence (MMD) and standardised MMD were calculated for each pair of family clusters according to the method described in the PART II (this thesis). Standardised MMD values for two pairs of family clusters, when compared for the difference in frequency of 18 non-metric dental traits were greater than 2.0 thus the difference between the groups was statistically significant at the 0.05 level. The group of individuals in the No 6 cluster was significantly different from the No 10 group as measured by standardised MMD value 2.8472 (Table 6.4-2). Standardised MMD value of 2.3035 for the No. 8 and No. 10 family clusters indicated that the two groups were statistically significantly different from each other. The frequencies of the discrete traits observed in these groups were not random and indicated a closer biological relationship between members of each group than that between randomly chosen people from the entire population. Thus the hypothesis that each of the groups contained at least some biological relatives could not be rejected. Comparisons between another four pairs of family clusters produced lower than 2.0 standardised MMD values and the hypothesis that these groups represented different biological families was not supported. The distance between groups No.10 and No. 11 was almost two standard deviations but not formally significant (standardised MMD value 1.8957).

Among six pairs of comparisons, group No. 10 was the most outstanding from the others. The average Z-score value for tooth size calculated for the group N10.2 which included the same individuals as the group No. 10 (No 10 included a few individuals added at a later stage on grounds of grave goods similarities), was greater than zero and the standard deviation was smaller than 1.0. The results of both analyses based on metric and non-metric dental traits supported the hypothesis that at least this family cluster contained biological relatives.

6.5. Discussion

The results of the analyses of distances based on dental morphological traits supported the hypothesis of family relationships between the individuals within at least two groups of tombs assumed to be family burials. It would be unlikely that the individuals from the cluster No. 10 with frequencies of at least eight of the 18 characteristics being zero or much lower than in other groups (among others, canine distal accessory ridge, Carabelli's cusp (grade 5-7), four cusped UM2, UM2 with reduced hypocone 4-, and sagittal furrow, 4 cusped LM1, and 5 cusped LM2) were buried accidentally close to each other at the cemetery. Individuals from the same cluster had teeth smaller than the average tooth size for the general population. It could be argued that the tooth size is not a good indicator of family resemblance because of possible environmental influence, continuous variation in a population and a family, and simply because of too great variation within a population to detect similarities in size between a handful of family members (Rösing 1990). The tooth size differences could indicate differences between populations and show the presence of evolutionary and environmental pressures (Frayer 1978, McKee 1984, Calcagno 1989, y'Edynak 1989, Brace et al. 1991, Henneberg 1995, Manzi et al. 1997, Henneberg this thesis). Similarities in tooth size in a group of individuals could be due to similar environmental conditions and genetic background. The assumption that the family could provide both the same environment and similar genetic background for its members could not be disputed. Thus the use of dental metric traits in kinship analysis could be helpful at least to support the results of the discrete traits analysis.

The use of non-metric traits in kinship analysis has been discussed by many researchers. Sjøvold (1973, 1977) Rösing (1990), Johnson and Lovell (1994), Alt (1996, 1998), and many others argued in favour of the application of dental non-metric traits in family studies. Saunders (1989) warned that because of often complicated models of heritability, the possibility of random occurrence of more common traits, asymmetry influencing the method of collecting data, and the nature of archaeological material itself, the results of family investigations could be altered. However, she also stated that " as long as the investigator simply wishes to test for non randomness in mortuary patterns and not propose complex genetic explanations, then the bounds of allowable theoretical assumptions are not exceeded" (Saunders 1989, p. 106)

It could be argued that even in the nuclear family (a married couple and their children) only a small influence of parental genes could be detected. Half of the family genes come from outside because of exogamous marriages (Lane and Sublett 1972, Spence 1974a,b). However, researchers noticed an unusual homogeneity of traits in the skeletal samples from family tombs and cemeteries (Sjøvold 1973, Bentley 1991, Larsen et al. 1995, Larsen 1997). It was suggested that trait homogeneity represented endogamy on the assumption that traits become homogeneous in biological lineages through time (Konigsberg 1988, Konigsberg and Buikstra 1995, Larsen 1997). Thus, the achieved homogeneity would be reflected in reduced variance of the trait within a group of family members. As Saunders (1989) pointed out, the non random trait patterns within the groups at the cemetery could demonstrate the presence of more common genes or more common environmental conditions and not necessarily the biological family groupings. The results of such studies should be interpreted with great caution.

In our dental material, the small sample of individuals from Saldone, the burial ground associated with the isolated farmhouse located a few kilometres away from the largest necropoleis at Pantanello, most probably represented a family. The obvious topographical isolation of the burials and similarity of grave goods strongly argued in favour of such an assumption. The standard MMD value of the distance between the group of individuals from Saldone and the group No 8 calculated for 10 of the 18 characteristics used previously, was 3.5705 and was significant (greater than 2.0). This value was the highest among calculated standard MMD values in this study.

Johnson and Lovell (1994) in their studies of the Egyptian site of Naqada interpreted the standardised MMD value of similar magnitude (2.8890) calculated for 9 dental non-metric traits as a strong suggestion of the family relationship between the individuals from one of the studied cemeteries. They ruled out the possibility of microevolutionary changes over time because the rate of dental evolution was too slow to produce such divergence of the group of individuals from the general population during the time when the burial ground was used (Turner 1986, Johnson and Lovell 1994). The possibility of the immigrant population being buried at the place was rejected on the grounds that the grave goods were extremely similar to those of the rest of the excavated cemeteries at the Naqada site. The authors suggested that the magnitude of divergence measured with standardised MMD was the indicator of inbreeding and supported the family interpretation.

The presence of the immigrant population at the cemetery could not be rejected in case of the rural population of Metapontines because Metaponto was a Greek colony. Because the hypothetical families were assembled on grounds of grave goods similarities this fact would only increase the possibility of such a group within the cemetery. Because the hypothetical family clusters included on average some 15-25 individuals, the immigrant group could equally well be a family of Greeks settled in the rural part of the colony as a family of newcomers to the area.

In general, the pattern of frequencies of non-metric dental traits in hypothetical family clusters at the Pantanello necropolis indicated the possibility of family relationships between the individuals of at least two tested groups. The results of the kinship analysis based on discrete traits were supported by similar findings when the dental metric traits were tested for family relationships within selected family clusters. For the family cluster No. 10 both dental non-metric and metric traits analysis showed the statistically significant divergence of this group from other groups and from the general population. The results supported the hypothesis that the ancient Greeks from Metaponto buried their relatives in family plots distinguished within the greater cemetery.

6.6. Summary and conclusion

By using morphological markers on teeth it was possible to confirm suggestions made by classical archaeologists that the ancient Greeks buried their dead in organised way at the burial grounds. Biologically closely related individuals were often buried together or in nearby tombs. Thus the notion that the cemetery was somewhat divided into separate quarters used by different families could be supported by the biological findings.

Dental non-metric traits proved to be useful in family studies for many reasons. There is already a long list of dental discrete traits to choose from for such studies. Therefore with the help of statistical methods designed for a small sample size the analysis of kinship based on dental morphology alone could provide results as good as the analysis of other morphological and genetic markers on a skeleton.

Dental metric characteristics could be used to support the genetic distances based on the analysis of non-metric traits. Because they are influenced by the changing environmental conditions to a larger extent than non-metric traits (tooth size correlates with body size) and undergo evolutionary changes detectable within a short time span, greater caution should be applied to interpretation of the genetic distances based on metric characteristics in family studies.

TABLES

Table 6.4-1. Frequencies of dental non-metric traits in four family clusters at the Pantanello necropolis.

Family cluster **Trait**	Cluster No 6 N1/N2	Cluster No 8 N1/N2	Cluster No 10 N1/N2	Cluster No 11 N1/N2
Etruscan upper lateral incisor	7/4	8/5	6/2	7/3
Canine tubercle	7/6	8/3	6/4	5/2
Canine distal accessory ridge	4/4	2/2	4/1	3/1
Carabelli's cusp UM1 (5-7)	4/1	9/2	8/0	3/1
Upper M2 4	13/3	9/1	8/0	10/1
M2 4-	13/4	9/5	8/1	10/4
M2 3+	13/3	9/2	8/4	10/2
M2 3	13/3	9/1	8/3	10/3
Sagittal furrow LP1	8/6	6/4	7/2	6/5
Number of cusps LP1	13/2	13/2	11/0	9/4
LP2	12/3	6/3	8/5	6/0
Lower M1 5	11/8	11/9	8/8	10/8
M1 4	11/3	11/2	8/0	10/2
M2 5	12/2	14/0	8/0	15/0
M2 4	12/10	14/14	8/8	15/15
Groove pattern Y LM1	11/6	10/2	8/6	10/8
LM2	11/2	12/2	9/0	15/2
Protostylid LM1	6/3	7/6	9/4	8/3

N1 - number of individuals in the sample
N2 - number of individuals with the trait

Table 6.4-2. Distances between four hypothetical family clusters at the Pantanello necropolis based on 18 non-metric dental traits.

Family Clusters

Cluster	No 6-No 8	No 6 - No 10	No 6 - No 11	No 8 - No 10	No 8 - No 11	No 10 - No 11
MMD	-0.0444	0.2304	0.0396	0.2027	0.0863	0.1679
SD	0.0842	0.0809	0.0861	0.0880	0.0923	0.0886
Standarised MMD	-0.5274	**2.8472***	0.4605	**2.3035***	0.9349	1.8957

MMD - mean measure of divergence
SD - Standard deviation
* - difference statistically significant at 0.05 level (MMD greater than 2.0)

7. GENERAL SUMMARY AND CONCLUSIONS

Dental health is a sensitive indicator of lifestyle, to the extent of allowing differentiation of subgroups within the same microregion. This sensitivity includes diet and patterns of diseases.

Using dental health indicators such as frequency and incidence of caries, frequency of periodontal disease, abscesses and enamel hypoplasia, and also dental wear it was possible to show that the two populations closely related culturally and living in close proximity within the Greek colony of Metaponto, had different lifestyles.

It was shown that the rural population experienced less physiological stress as measured with the frequency of enamel hypoplasia and generally had better health, less caries and less periodontal diseases than the urban population. This finding falsifies the hypothesis that the urban people were better off than their rural counterparts in Greek antiquity.

Dental health of the rural Metapontines reflected general trend in health in the Mediterranean region but also showed specific differences. Rural Metapontines had higher frequency of caries and also higher frequency of enamel hypoplasia than some of the coeval populations in the region. Their dental health in some of its indicators showed similarities with poor dental health of people living in extreme environmental conditions like slaves and nomads. Higher than expected frequency of enamel hypoplasia was associated with at least two systemic diseases in this population, such as possible treponematosis and thalassemia.

Tooth morphology reflects biological affinity of individuals and populations. Thus, dental morphological traits either metric or non-metric, can be used to study relations between populations and between individuals within a family. Dental metric traits undergo microevolutionary changes already clearly demonstrated. Thus the comparisons between populations should include the interpretation of such changes.

Results of comparisons of dental non-metric traits suggested that Greek colonists in the rural Metaponto were as closely related to indigenous populations of the colonised land as they were to each other. It can be therefore observed that the Greek colonists not only influenced the colonised people culturally but also assimilated themselves biologically.

Angel (1972b) discussing results of his studies of ancient Greeks stated that Greeks benefited from the "incredible heterogeneity and race mixture of the Middle Bronze Age" and it is believed that the same was true after the Bronze Age. This biological strategy was also demonstrated in the present study. Because of it the Greeks were very successful in colonised areas of the Mediterranean despite of often harsh environmental conditions.

Using dental metric traits in comparison between populations it was also shown that the colonists underwent fast microevolutionary changes. These changes complicated the study of affinities of the rural population but the results supported the hypothesis of biological continuity of the region.

Results of comparisons of dental biological characteristics between hypothetical families assembled on grounds of archaeological findings demonstrated that Greeks indeed buried their dead on the cemetery within family plots.

The Greek history is relatively well known and abundance of written documents exists to study many aspects of life of the Greeks and their remarkable influence on the development of Europe and practically and the whole Western World. Archaeological excavations added more detail to the material and also allowed some insights into the spiritual culture of those people. On the other hand the biological studies complemented those two either confirming or disproving assumptions made