1985). Despite the recent heavy agricultural activity in the region the natural springs around Metaponto were not contaminated with other chemicals. Thus it is possible that this natural drinking water had a similar fluoride content in the past as it has recently and could have some effect on the lower incidence of caries in the rural population. However, fluoride prevents further development of already existing caries and has little effect on the initiation of carious lesions (Silverstone et al. 1981, Nikiforuk 1985, Henneberg 1991a). Thus the difference in the distribution of caries according to the degree of tissue penetration between the rural and urban populations, the latter having more of enamel, first degree caries (Table 4.231-4 and Figure 4.231-3), would suggest that the dentition of the urban population showed the effects of fluoride on caries inhibition more clearly than the rural one.

While it is possible that the optimal concentration of fluoride and the fluoride and strontium in seafood lowered the incidence of caries among the rural people, the urban population with easier access to marine foods (Metaponto was a marine port) showed one of the highest caries frequency and incidence values found in coeval populations (Tables 4.213-8 and 4.213-9). Concentration of fluoride higher than 5 ppm weakens the enamel structure, increases the mottling type of hypoplasia of the tooth enamel and increases the frequency of caries (Nikiforuk and Fraser 1981, Nikiforuk 1985). The main source of water in the city was the river Bradano and local springs. The chemical content of the river has obviously been changed recently by intensive modern farming and industry and it is not known if in the past the water in the river could have high fluoride contents. Although a high frequency of enamel hypoplasia was found among the rural, and even higher in the urban population the hypoplasia was of a linear type, not a mottling type, and was associated with different causes. Recent studies of Neolithic population from Mehrgarh in Pakistan showed that a high concentration of fluoride in drinking water in this region had little effect on the frequency or incidence of caries. This population, at the beginning of

agriculture, had a very low incidence of caries (1.32%) characteristic for preagricultural groups (Lukacs 1985, 1992).

The difference between the rural and urban populations in caries incidence could have yet another explanation. Metaponto was a thriving colony for most of the time within the studied period of three centuries (Carter 1998a). Urban people trading with Greece and other Greek colonies, could afford to buy expensive food such as honey, containing mostly sugar. Fresh and also dry fruit such as figs and grapes were part of the diet. This is confirmed by palaeobotanical studies of the organic material found in the storage vessels within the chora of Metaponto (Costantini 1983, Carter 1990b). Raisins (dry grapes) are among the most cariogenic foodstuffs known today (Newbrun 1989, Munzdorff et al. 1990) and together with honey could enhance overall cariogenicity of the urban diet. Moreover, the rural people could have greater access to animal products such as milk and cheese with cariostatic properties (Nikiforuk 1985, Newbrun 1989). While meat was eaten occasionally, milk and cheese could have been a part of the diet more frequently especially on a farm. Barley and wheat could have had better value than animal products as an exchange and export commodity. Thus, the rural people could have used foods other than wheat and barley and the rural diet in general which could have been better balanced than that of the urban people despite the differences in wealth of individuals. The palaeobotanical studies of seeds and other organic material discovered in storage vessels in the chora revealed a rather long list of plants cultivated and used as food and forage (Costantini 1983, Carter 1990b). Along with cereals such as wheat, barley and emmer, there were lentils, peas, beans, fruits such as grapes, figs, olives and a range of wild plants such as wild oats, rye grass and blackberry. Dating of the material showed a proportional increase of wheat and barley and a decrease of figs, olives and grapes in the material through time. The amount of grazing animals within the Metaponto area also diminished through time beginning from the archaic to the

classical times of the colony suggesting greater emphasis on grain production for trade with the city and for export (Scali 1983, Carter 1990b).

Males, especially in the city where the political and social life was concentrated, attended symposia, the Greek meetings with food and wine offered to the participants. Females did not attend the meetings, and while females in the rural chora worked on farms, females in the city were confined to the house (Boardman et al. 1991). Females were considered minors and did not have rights of a citizen, so their social role and activities differed from those of males. Thus, the higher frequency and incidence of caries among urban Metapontines than among the rural people, and even higher results for women especially in this population (Table 4.231-6), could reflect the different life styles for rural and urban people in Metaponto and also for sexes in these populations. Sex differences in caries frequency and incidence have been observed by many authors and were linked to various biological causes such as earlier tooth eruption in females or pregnancy and to many behavioural causes (see Larsen 1997 for comments). Sex differences have been found in relation to different diets associated with different daily activities, and a different social status (Frayer 1984, 1978, Walker and Erlandson 1986, Lukacs 1996, Inoue et al. 1997). In Metaponto the differences in the life styles between the rural and urban populations could be enhanced by local environmental conditions superimposed on them, such as the fluoride content of the drinking water and also perhaps more sophisticated food preparation techniques in the city.

In general, as could be expected, the rural and urban people from Metaponto exhibited frequencies and incidence of caries characteristic for agriculturists (Turner 1979, Larsen 1995). Almost a half of the teeth in the rural population (45.5%) and one third of the teeth in total number of carious teeth in the urban population were lost before death. The high frequency of *ante mortem* tooth loss is associated with farming (Anderson 1965, Cook 1984). A high proportion of proximal caries is

associated with a diet containing well cooked sticky foods high in sugars and is characteristic of modern populations (Hillson 1996). Both populations had a moderate number of mesial and distal caries suggesting a diet based on well cooked starchy food and some consumption of sugars. In both populations the most frequent carious lesions were occlusal caries with a higher percentage of this type among the urban Metapontines. With introduction of sugars into the diet, the percentage of fissure and pit caries rises as does the occlusal caries (Larsen 1997). This fact further supports the notion that the urban Metapontines already displayed a stage of dental caries transitional toward the more modern pattern. Neck caries, associated with agriculture and consumption of cereals (Hillson 1979) were also frequent in both populations with a slightly higher percentage of this type in the urban population . A higher frequency and incidence of caries in females, which is seen especially clearly in the urban population, is also associated with different diets for females and males because of different activities and is typical for agriculturists. In the case of Metaponto, greater differences between females and males in caries frequency and incidence in the urban population may be enhanced by very different activities, dictated by the position of women in Greek society.

Because the colony of Metaponto was founded as a city providing the beginning of modern urban development while also retaining a rural section, the chora, the differences observed in the frequency and the incidence of caries may reflect the slowly progressing division of life styles of both communities within a population with an economy based on agriculture and trade.

The results are in agreement with the general trends in caries frequency and incidence observed through time and according to variation in subsistence (Turner 1979, Cohen and Armelagos 1984, Hillson 1996, Larsen 1995, 1997).

TABLES AND FIGURES

Table 4.231-1. Frequency of dental caries in adults from the rural Metaponto (Pantanello).
A. All individuals with at least one tooth crown preserved
B. All individuals with at least 10 teeth preserved
C. All individuals with at least 16 teeth preserved

	Sex	No of indiv.	No of indiv. with caries	% of indiv. with caries	F/M difference %
A.					
	Females	104	66	63.5	
	Males	55	25	45.5	
					18.0*
	F+M	159	91	**57.2**	
B					
	Females	64	43	67.2	
	Males	34	18	52.9	
					14.3
	F+M	98	61	**62.2**	
C					
	Females	40	28	70.0	
	Males	25	13	52.0	
					18.0
	F+M	65	41	**63.1**	

F - Females, M - Males
* - statistically significant at 0.05 level

Table 4.231-2. *Caries incidence in adults from the rural Metaponto (Pantanello). Comparison between sexes (all adults, F + M = 159 individuals).*

Sex	**Female**		**Male**		**F + M**		F/M difference
	No	%	No	%	No	%	+
Teeth examined *	1399	100.0	779	100.0	2178	100.0	
Carious teeth	81	5.8	40	5.1	121	5.6	
a.m. loss	75	5.4	26	3.3	101	4.6	+
Total caries ***	156	**11.2**	66	**8.5**	222	**10.2**	+
Teeth examined **	1324	%**** 100.0	753	%**** 100.0	2077	%**** 100.0	
Carious teeth	81	**6.1**	40	**5.3**	121	**5.8**	ns

F - Female, M - Male
a.m. loss - teeth lost before death most probably due to caries
* - total number of teeth examined with teeth lost before death included (teeth + a.m. loss)
** - total number of teeth examined without a.m. loss
*** - carious teeth + a.m. loss
**** - percentage of carious teeth (without am. loss) out of total number of teeth available for examination
+- difference statistically significant at least at the level $p < 0.05$
ns - difference not statistically significant

Table 4.231-3. Caries incidence. Frequency of caries per tooth type in %.
Combined values for carious teeth and teeth lost before death (a.m. loss).

	Females							**Males**						**Females + Males**				
	carious		present		%	% carious		present			%	% carious		present			%	%
Tooth type*	U	L	L	L	U	L	L	L	U	L	U	L	U	L	U	L	U	L
I1		4	69	75	0	5.3		1	29	44	0.0	2.3		5	98	119	0	4.2
I2	1	3	69	76	1.4	4.0	2		40	30	5.0	0.0	3	3	109	106	2.8	2.8
C	2	3	84	111	2.4	2.7		1	46	56	0.0	1.8	2	4	130	167	1.5	2.4
P1	3	2	84	103	3.6	1.9	3	1	48	61	6.3	1.6	6	3	132	164	4.6	1.8
P2	3	8	89	100	3.4	8.0	1	6	55	61	1.8	9.8	4	14	144	161	2.8	8.7
M1	8	34	78	108	10.3	31.5	7	16	50	64	14.0	25.0	15	50	128	172	11.7	29.1
M2	14	31	87	113	16.1	28.3	4	15	53	62	7.6	24.2	18	46	140	175	12.9	26.9
M3	13	27	67	86	19.4	32.6	2	7	37	43	5.4	16.3	15	34	104	129	14.4	27.1
Total	44	112	627	772	7	14.5	19	47	358	421	5.3	11.2	63	159	985	1193	6.4	13.3
Total U+L		156		1399		**11.2**		66		779		**8.5**		222		2178		**10.2**

* Left and right sides of the jaw pooled
U - upper dentition, L - Lower dentition
I1 - first incisor, I2 - second incisor, C - canine, P1 - first (third) premolar, P2 - second (fourth) premolar,
M1 - first molar, M2 - second molar, M3 - third molar

Table 4.231-4. Distribution of dental caries in adults from Metaponto according to the degree of caries penetration. Teeth lost before death (a.m. loss) included. Rural - urban comparison.

Degree of caries penetration	Rural Females N	Rural Females %	Rural Males N	Rural Males %	Rural F+M N	Rural F+M %	Urban Females N	Urban Females %	Urban Males N	Urban Males %	Urban F+M N	Urban F+M %	Rural-urban Difference F/M/F+M
1	28	17.9	6	9.1	34	15.3	138	41.2	72	45.3	210	42.5	+/+/+
2	19	12.2	16	24.2	35	15.8	51	15.2	33	20.8	84	17.0	ns/ns/ns
3	26	16.7	14	21.2	40	18.0	27	8.1	8	5.0	35	7.1	+/+/+
4	8	5.1	4	6.1	12	5.4	9	2.7	4	2.5	13	2.6	ns/ns/ns
Total **1+2+3+4**	81	51.9	40	60.6	121	54.5	225	67.2	117	73.6	342	69.2	
a.m. loss	75	48.1	26	39.4	101	45.5	110	32.8	42	26.4	152	30.8	+/+/+
Total	**156**	**100.0**	**66**	**100.0**	**222**	**100.0**	**335**	**100.0**	**159**	**100.0**	**494**	**100.0**	

F - Females, M - Males

Degree of caries penetration 1 - enamel caries
2 - dentinal caries
3 - pulpal caries
4 - crown completely decayed, only root remnants left

a.m. loss - ante mortem tooth loss

+ - difference statistically significant at least at the 0.05 level (Chi-squared test)

ns - not significant

Table 4.231-5. Distribution of caries according to the surface attacked in adults from the rural Metaponto

Surface attacked	Females		Males		F + M		F/M difference
	N	%	N	%	N	%	
Occlusal	63	42.6	25	56.8	88	45.8	ns
Proximal	23	15.5	10	22.7	33	17.2	ns
Neck	16	10.8	1	2.3	17	8.9	-
Buccal + linqual	15	10.1	4	9.1	19	9.9	ns
Mixed	31	20.9	4	9.1	35	18.2	ns
Total*	**148**	**99.9**	**44**	**100.0**	**192**	**100.0**	

F - females, M - males

* - number of carious lesions is greater than number of teeth with caries because some teeth had two or more carious lesions

Table 4.231-6. Frequecy of caries in adults from urban Metaponto (Crucinia).
I. Frequency of individuals with caries in the urban sample.
II.Percentage of carious teeth and teeth lost before death due to caries by sex

	Females			**Males**				**F + M**		
I.	Total no of individuals	No of indiv. with caries	%	Total no of individuals	No of indiv. with caries	%		Total no of individuals	No of indiv. with caries	%
	90	72	80.0	75	48	64.0	***	165	120	72.7
II.	No of teeth examined	No of teeth with caries	%	No of teeth examined	No of teeth with caries	%		No of teeth examined	No of teeth with caries	%
A	1143	335	29.3	950	159	16.7	***	2093	494	23.6
B	1033	225	21.8	908	117	12.9	***	1941	342	17.6

A - calculations made for teeth and alveoli of teeth lost before death
B - calculations made for teeth available for observation and carious teeth
*** - differences between females and males statistically significant

Table 4.231-7. Caries incidence in adults from Metaponto.
Comparison between the rural and urban samples and by sex.

Sex	Rural (Pantanello) Females		Males		F + M		Urban (Crucinia) Females		Males		F + M		Rural/ Urban difference F/M/F+M
	No	%	No	%	No	%	No	%	No	%	No	%	+-
Teeth examined *	1399	100	779	100	2178	100	1143	100	950	100	2093	100	
Total caries**	156	**11.2**	66	**8.5**	222	**10.2**	335	**29.3**	159	**16.7**	494	**23.6**	+/+/+
a.m. loss	75	5.4	26	3.3	101	4.6	110	9.6	42	4.4	152	7.3	+/ns/+
Carious teeth	81	5.8	40	5.1	121	5.6	225	19.7	117	12.3	342	16.3	+/+/+
Teeth examined***		%****		%****		%****		%****		%****		%****	
	1324	100	753	100	2077	100	1033	100	908	100	1941	100	
Carious teeth	81	**6.1**	40	**5.3**	121	**5.8**	225	**21.8**	117	**12.9**	342	**17.6**	+/+/+

F - Female, M - Male
a.m. loss - teeth lost before death most probably due to caries
* - total number of teeth examined with teeth lost before death included (teeth + a.m. loss)
** - carious teeth + a.m. loss
*** - Total number of teeth examined without a.m.loss
**** - percentage of carious teeth (without a.m. loss) out of total number of teeth available for examination
+ - difference statistically significant at least at the level $p<0.05$
ns - difference not statistically significant

Figure 4.231-1. Percentage of carious teeth in each tooth category in the rural population. Upper and lower jaw.

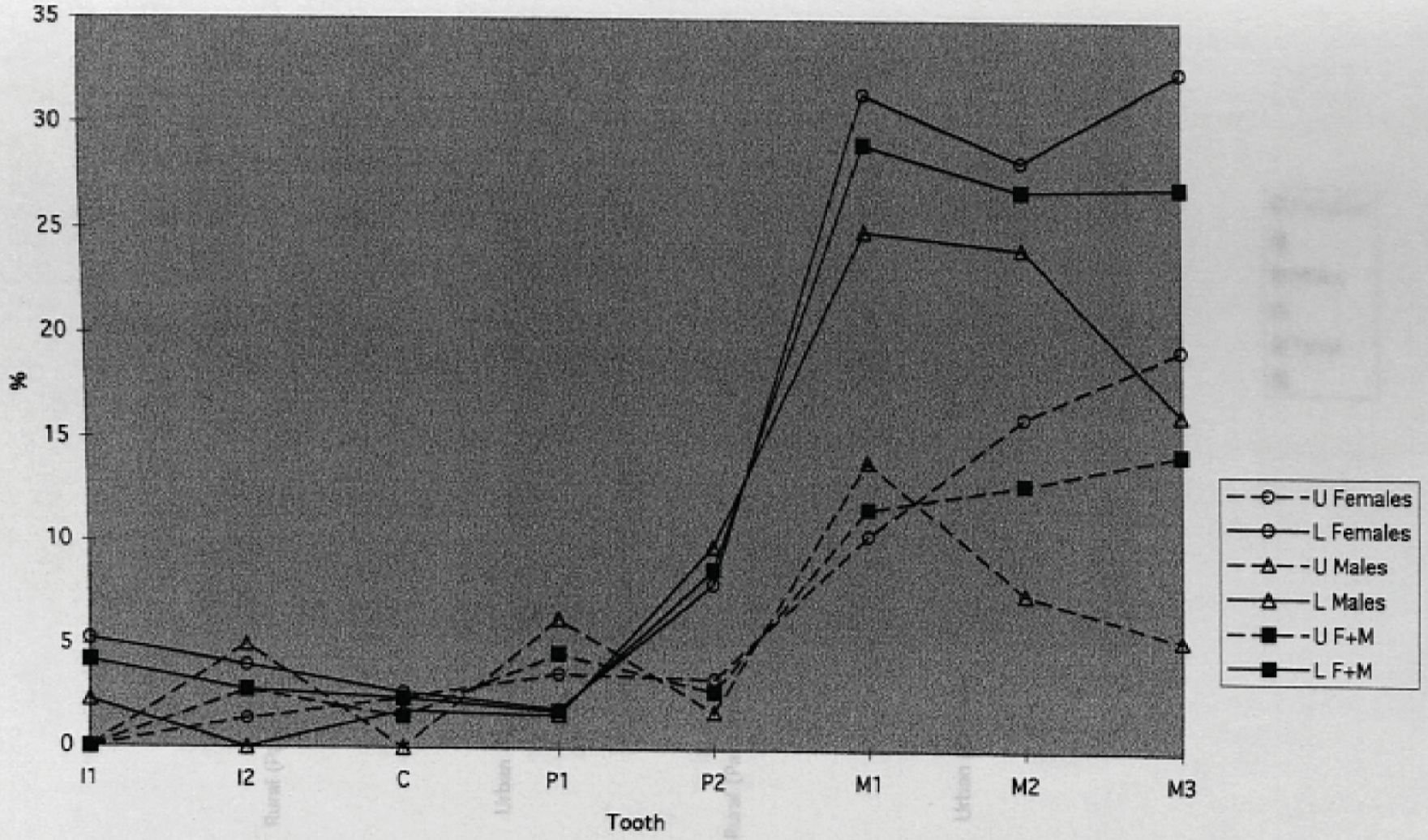

Figure 4.231-2. Frequency of caries in adults from Metaponto. Rural - urban comparison. I - Individuals, II - Teeth. Carious teeth plus a.m. tooth loss.

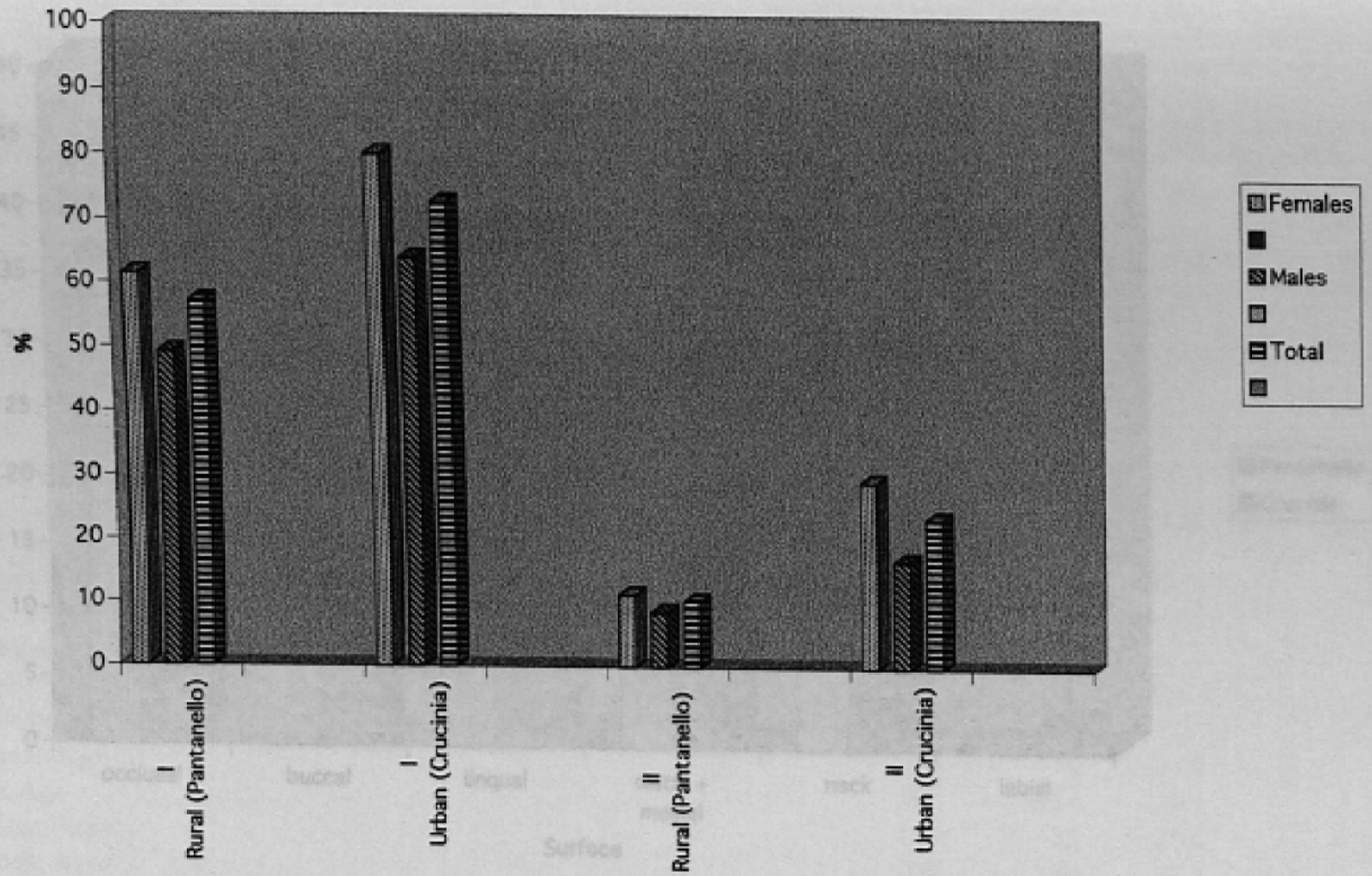

Figure 4.231-3. Distribution of caries according to the surface affected. Rural - urban comparison. Sexes combined.

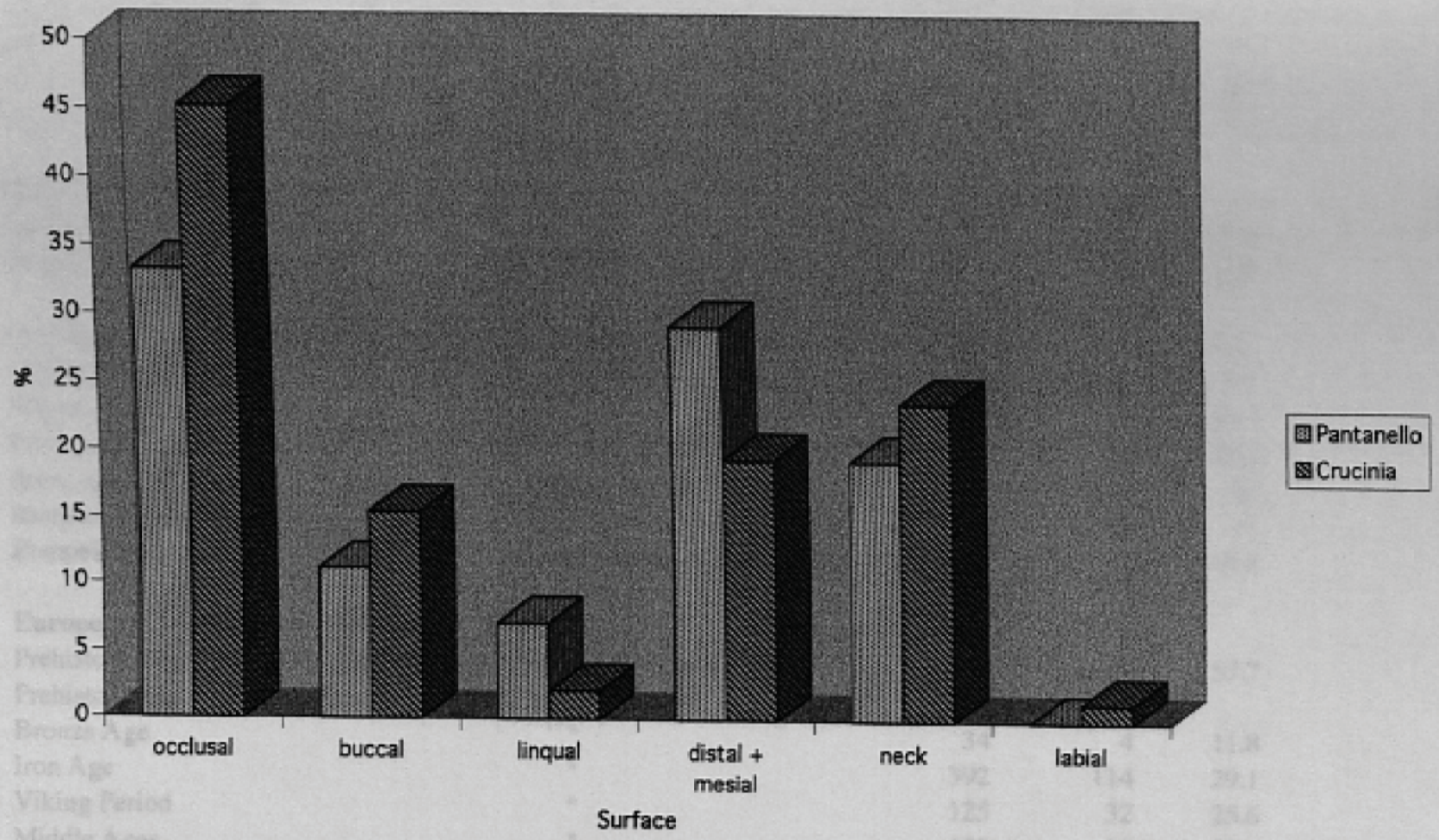

Table 4.231-8. Frequency of dental caries among various populations.

Population	Source	No of individ.	No individ. with caries	%
Mediterranean Region				
Mesolithic Yugoslavia, 6300 BC	y'Edynak (1992)	42	0	0
Neolithic Yugoslavia	y'Edynac (1992)	17	1	5.9
Ardea (Lazio), Italy, 8-6 c. BC	Rubini et al. (1992)	13	2	15.4
Metaponto, Italy,				
Pantanello (rural), 6-3 c. BC	**this study #**	**159**	**91**	**57.2**
Crucinia (urban), 7-2 c. BC	**this study #**	**165**	**120**	**72.7**
Iron Age Greeks, 1150-650 BC	Angel (1944b)	31	14	45.2
Classic Greeks, 650-150 BC	Angel (1944b)	27	10	37
Roman, 150 BC- 450 BC	Angel (1944b)	14	5	35.7
Pontecagnano, Italy, 7-4 c. BC	Fornaciari et al. (1985-6)	123	67	54.5
Jews, Israel, 1-2 c. AD	Smith & Tau (1978)	63	12	20
Romans, Israel, 1-2 c. AD	Smith & Tau (1978)	67	21	31
Pompeii, Italy, 79 AD	Henneberg & Henneberg (1996)	11	7	63.6
Europe				
Prehistoric Hungary, 3000 - 1350 BC	Molnar & Molnar (1985)	162	87	53.7
Prehistoric and Historic Denmark	Bennike (1985)			
Bronze Age	"	34	4	11.8
Iron Age	"	392	114	29.1
Viking Period	"	125	32	25.6
Middle Ages	"	109	30	27.5
Mediaeval Poland	Borysewicz & Otocki (1975)			

Table 4.231-8. Frequency of dental caries among various populations. (Continued)

Chelmska Gora, 12-16 c. AD	"	202	135	67
Slaboszewo, 14-17 c. AD	"	201	166	83
Kolobrzeg, 14-18 c. AD	"	269	211	78
Other Continents				
North America				
Georgia and Florida coast , USA	Larsen et al. (1991)			
Precontact Preagricult. , 1000 BC - 1150 AD	"	201		9
Precontact Agricult. 1150-1550 AD	"	275	18	58.9
Early contact, 1607-1680 AD	"	324	162	34.8
Late contact, 1686 - 1702 AD	"	95	113	82.1
Caddoan, Arkansas, prehistoric Woodlands	Powell (1985)	53	78	90.6
Fourche Maline, Oklahoma, hunter-gathers	"	45	11	24.4
Asia				
Harappa, Pakistan, 2500-2000 BC	Lukacs (1992)	39	17	43.6
Africa				
Mapungubve and K2 (South Africa) 1000-1255 AD	Steyn (1994)	19	8	42.1

 # all adults

Table 4.231-9. Incidence of dental caries among various populations.

Population	Source	No teeth examined	No carious teeth	% caries
Mediterranean Region				
Neolithic Greeks	Carr (1960)	267	32	12
Neolithic Italics, Matera, South Italy	Repetto et al. (1988)	387	35	9
Greece (3000-1000 BC)	Angel (1944b)	1404	116	8.3
Middle Minoans, Crete, 1750-1550 BC	Carr (1960)	1498	135	9
Ancient Egyptians	"	1805	82	4.5
Predynastic Egyptians	Brothwell et al. after Keene (1981)	1742	40	2.3
Toppo Daguzzo, Italy, Bronze Age	Repetto et al. (1988)	164	12	7.3
Ponte della Paolina, Sicily, Bronze Age	Girotti et al. (unpublished manuscript)	709	141	19.7
Ardea , Lazio, Italy, 8-6 c. BC	Rubini et al. (1992)	169	2	1.2
Metaponto, Italy, (permanent dentition)				
Pantanello (rural), 6-3 c. BC	**this study**	**2077**	**121**	**5.8**
Crucinia (urban), 7-2 c. BC	**this study**	**1941**	**342**	**17.6**
Classic Greeks, 650-150 BC	Angel (1944b)	724	36	5
Pontecagnano, Italy, 7-4 c. BC	Fornaciari et al. (1985-6)	2660	228	8.6
Egyptians, 700-300 BC	Brothwell & Carr (1962)	1040	90	8.7
Alfedena, Italy, 4-5 c. BC (upper teeth)	Macchiarelli & Salvadei (1986)	788	157	19.92
Etruscans, Tarquinia, Italy, 3 c. BC	Mallegni et al. (1985)			2.3
Punics, Carthago, 3-2 c. BC	Mallegni et al. (1985)			4.2
Italians, Roman Period	Brothwell & Carr (1962)	103	8	7.7
Pompeii, Italy, 79 AD	Henneberg & Henneberg (1996)	133	12	9

Table 4.231-9. Incidence of dental caries among various populations. (Continued)

Mediaeval Italics, Matera, South Italy	Repetto et al. (1988)	89	8	9
Mediaeval Greeks, 1300 AD	Angel (1944)	3821	1013	26.5
Europe				
Prehistoric Hungary, 3000 - 1350 BC	Molnar & Molnar (1985)	3777	339	9
Neolithic German 3000-1000 BC	Brinch & Moller-Christophersen (1949) after Keene (1981)	1589	27	1.8
Neolithic Swedish	Holmer & Maunsbach (1956) after Keene (1981)	6402	91	1.4
Neolithic French 3000-1000 BC	Hartweg (1945) after Keene (1981)	11717	379	3.2
Neolithic French	Carr (1960)	258	19	7.4
Neolithic British	Carr (1960)	1151	36	3.1
Early Neolithic Denish	Bennike (1985)	320	6	1.9
Middle/Late Neolithic Denish	"	6742	154	2.3
Bronze Age, Denmark	"	433	5	1.2
Bronze Age Chechs, Unetice,	Cechova & Titlbachova (1978)	1022	70	6.8
Bronze Age Scots, 2000-1400 BC	Lunt (1974)	1306	23	1.8
Iron Age, Denmark, 500 BC- 800 AD	"	5552	266	4.8
Viking Period, Denmark, 800-1050 AD	"	1616	55	3.4
Middle Ages, Denmark	"	2283	85	3.7
British Iron Age, 500-50 BC	Brothwell & Carr (1962)	1113	116	10.4
Romano-British, Pounbury, 200-420 AD	Whittaker et al. (1981)			
adults 17-25 yrs		2166	175	8
adults 25-35 yrs		2893	389	13.4

Table. 4.231-9. Incidence of dental caries among various populations. (Continued)

Romano-British	Brothwell (1959) after Hardwick (1960)	870	99	11.4
Saxons	Brothwell (1959) after Hardwick (1960)	1735	97	5.6
Anglo-Saxons, Ca. 6 c. AD	Hardwick (1960)	959	78	8.1
London 17-18 c. AD	Brothwell (1959) after Carr (1960)	892	185	20.7
London , cemetery 1600-1800 AD	Colyer (1922) after Hardwick (1960)	3349	346	10.3
Iron Age Scots, 300 BC - 400 AD	Lunt (1974)	301	20	6.6
Dark Age Scots, 400-1000 AD	"	1041	45	4.3
Mediaeval Scots, St. Andrews 11-15 c. AD	Lunt (1986)	2689	176	6.55
Kirkhill (permanent teeth)				
Mediaeval Scots, 1200-1500 AD	Lunt (1974)	400	24	6
Late Mediaeval Scots, 1300-1600 AD	Kerr et al. (1988)	1088	55	5.1
Mediaeval Poland	Borysewicz & Otocki (1975)			
Chelmska Gora, 12-16 c. AD	"	2881	244	9
Slaboszewo, 14-17 c. AD	"	2562	361	14
Kolobrzeg, 14-18 c. AD	"	2333	495	21
Mediaeval Norwegians, 1300-1600 AD	Klafstad (1978)	3015	38	1.26
Mediaeval Finns, 15-16 c. AD	Varrela (1991)	4581	689	15
Other Continents				
North America				
USA				
Santa Rosa Island Sites, California (adults)	Walker & Erlandson (1986)			
Canada Verde, 3000-4000 BP	"	1718	228	13.3

Table 4.231-9. Incidence of dental caries among various populations. (Continued)

Skull Gulch A, 1820-900 BP	"	251	27	10.8
Skull Gulch B, 1100-1500 AD	"	934	59	6.3
Georgia and Florida coast	Larsen et al. (1991)			
Precontact Preagricult., 1000 BC - 1150 AD	"	2438	32	1.3
Precontact Agricult. 1150-1550 AD	"	4260	486	11.4
Early contact, 1607-1680 AD	"	3274	262	8
Late contact, 1686 - 1702 AD	"	1602	548	34.2
Fourche Maline, Oklahoma, hunter-gathers	Powell (1985)	489	33	6.7
Caddoan, Arkansas, prehistoric Woodlands	Powell (1985)	928	135	25.3
Moundville, Alabama, 1050-1550 AD	Powell (1991)	3375	630	18.7
More data published before 1979 see Turner II (1979)				
South America				
Mexico, skeletal series	Klatsky & Klatell (1943)	3298	153	4.64
Peru, Pachacamac, skeletal series	Stewart (1931)	2727	423	15.5
Asia				
Mehrgarh (MR3), Pakistan, 7000-4000 BC	Lukacs et al. (1985)	755	10	1.32
China, 1766-1122 BC	Mao & Yen (1959) after Keene (1981)	884	38	4.3
Harappa, Pakistan, 2500-2000 BC	Lukacs (1992)	751	51	6.8
China, Shanxi Shangma, around 2700 BP	Inoue et al. (1997)	9556	1160	12.1

Table 4.231-9. Incidence of dental caries among various populations. (Continued)

Taiwan, Henan Anyang Yinxu,3400-3100 BP	Inoue et al. (1997)			
a) citizens		1103	45	4.1
b) slaves		4247	134	3.2
China, Yin-Shang period, 1400-1100 BC	Sakashita et al. (1997)			
a) citizens (males only)		684	25	3.7
b) slaves (males only)		3547	103	2.9
Japan, Jomon 2500-300 BC	calculated from Turner II (1979)	1377	119	8.6
Japan, Yayoi, 200 BC	Sanui (1960) after Turner II (1979)	1205	237	19.7
Japan, Oterayama Site, Edo period Ca. 17 c. AD (rural)	Sakura (1985)	495	4	0.8
Japan, Unco-in, Edo period, (urban)	Sakura (1985)	638	123	19.3
Japan, Joshin-ji, Edo period (urban)	Sakura (1985)	530	108	20.4
Japan, modern Hokkaido Ainu	Turner II (1979)	1635	49	3
Africa				
South Africa, Mapungubve and K2 1000-1255 AD	Steyn (1994)	229	49	16.4
South Africa, Riet River pastoralists	Morris (1984)	1061	46	4.3

4.232. Periapical abscesses

Periapical lesions are defined as inflammation of the tooth pulp that spreads through the apical foramen of the tooth to the surrounding alveolar bone causing destruction of the bone tissue. Periapical granuloma is the destruction of the bone around the tooth apex which progresses slowly and usually without pain producing a hole with a well defined sclerotic border. Chronic periapical abscesses are formed when the border of the periapical granuloma breaks and pus of decomposed bony tissue finds its way outside the bone. If acute inflammation of periapical tissues spread to the entire alveolum, formation of acute alveolar abscesses follows (Tyldesley 1978). Because all three types of abscesses have the same origin and because in some cases it is difficult to distinguish between periapical granuloma and acute alveolar infection without a radiological examination, in further calculations no distinction has been made between the types.

Periapical lesions were rather common in the rural population. Among 130 individuals with at least a fragment of a jaw with a few sockets available for observation 25 had periapical abscesses (19.2%). Because approximately half of the jaws were damaged to various degrees, and many alveoli were not available for examination, it could be expected that the frequency of abscesses was actually higher in this sample than revealed by these observations. The majority of periapical lesions were caused by caries (78.8%). Among 33 lesions associated with roots of one or sometimes two or three teeth 26 were around the roots of the tooth of which crown was completely destroyed by caries (22 lesions), or with cavities present on the crown (4 lesions). Six individuals had multiple periapical lesions. In two cases the inflammation spread diffusely into the bone of the mandible causing osteomyelitis. In one case the inflammatory processes severely remodelled the posterior parts of the

maxilla. At least four of the lesions (all of them multiple) were chronic periapical infections with openings for the pus on the buccal side of the bone. The proportion of males to females with periapical abscesses was 1:1.27 as compared to 1:2.02 in the sample of preserved jaws (sex ratio in the entire skeletal sample from rural area of Metaponto was 1 male to 1.77 females (see Table 2.13-3). The closer to 1:1 sex ratio within the group with abscesses than in the entire sample of preserved fragments of jaws suggested that slightly more males than females had periapical abscesses but the difference was not statistically significant. Mostly adults over 30 years old (84%) developed abscesses.

A total number of 54 teeth showed periapical lesions. Most frequently abscesses formed around the roots of the first molars (21 teeth). The first molar was also most frequently attacked by caries which supported the observation that the major cause of abscesses was caries. Periapical lesions rarely formed around the roots of anterior dentition. In the rural sample the majority of periapical abscesses developed in the mandible (50 lower teeth as opposed to 4 upper teeth were involved).

The frequency of periapical lesions in the urban population was 8.2% (9 individuals among 110 with parts of jaws available for observation) and was statistically significantly lower than in the rural population (Chi-squared = 5.98, df=1, $p<0.05$). Abscesses developed around the roots of 18 teeth. As in the rural population, in the urban sample abscesses formed most frequently in the mandible around the roots of first molars.

Abscesses have frequently been seen in the archaeological skeletal material (Table 4.232-1) (Alexandersen 1967, Molnar and Molnar 1985, Linn et al. 1987, Clarke 1990, Jurmain 1990, Clarke et al. 1995, Larsen 1997). High frequency of abscesses was associated with lack of hygiene and with severe attrition (Jurmain 1990, Clarke et al. 1995). Jurmain (1990) reported 30% frequency of abscesses among prehistoric Californians (Ala-329). He found a very low rate of caries

Table 4.232-1. Frequency of abscesses among various populations.

Population	**Source**	**N** individuals	Frequency %
rural Metaponto, 6-3 c BC	**own data**	130	19.2
urban Metaponto, 7-2 c BC	**own data**	110	8.2
Sarai Khola, Pakistan, 1000-270 BC	Lukacs (1989)	35	14.0
Ala-329, California, 500 AD - pre-European contact	Jurmain (1990)	195	30.0
Ancient Nubia, 3100-2500 BC	Beckett & Lovel (1994)		
Nubian A-Group (earlier)		7	21.2
Nubian C-Group (laterr)		12	36.4
Bronze Age Bahrain	Littleton & Frohlich (1993)	69	14.6
Iron Age Bahrain		98	24.1
Islamic Bahrain		25	31.8
Wadi Halfa, Mesolithic	Greene et al. (1967)	29	27.6

(0.57%) in this population and attributed the high frequency of abscesses to severe attrition in this group (66.1% of individuals with at least one tooth worn down to 8th degree in Molnar's scale). In another study of a population with low caries incidence, from Carrier Mills (Illinois), Clarke and co-workers (1995) also associated periapical abscesses with severe attrition. Other authors found abscesses associated both with high frequency of caries and pulp exposure caused by severe tooth wear (Hartnady and Rose 1991). Maxillary abscesses have been found more frequently than mandibular lesions (Jurmain 1990, Hartnady and Rose 1991). In some populations more females developed abscesses than males in others the situation was opposite (Swardstedt 1966, Hartnady and Rose 1991).

In general, the abscesses have been found associated with a lack of dental hygiene. Specific factors, such as caries, severe attrition, sex and age influenced the frequency of abscesses differently in various populations (Molnar and Molnar 1985, Powell 1985, Jurmain 1990, Hartnady and Rose 1991, Clarke and Hirsch 1991, Clarke et al. 1995).

4.24. Hypoplasia

Enamel hypoplasia is a common developmental abnormality related to generalised growth disturbances, observed on teeth of both past and present day populations (Kreshover 1960, Nikiforuk and Fraser 1981, Goodman and Rose 1990). It demonstrates itself as pits, horizontal and vertical grooves or lines, mottling of various intensity, and partial or total lack of enamel on tooth crowns (Sarnat and Schour 1941, Giro 1947, Pindborg 1970, FDI 1982).

Etiological factors related to enamel hypoplasia include genetic, congenital and systemic non-infectious and infectious diseases, malnutrition, weaning, fluorosis and

even local mechanical trauma (Pindborg 1970, Pindborg 1982, Jones and Mason 1990, Neiburger 1990, Goodman and Rose 1991).

Chronological linear hypoplasia and pitting on buccal or labial and on occlusal surfaces of teeth, are the types of enamel hypoplasia most frequently reported from archaeological sites (Goodman and Capasso 1992). Linear hypoplasia is attributed to hypocalcemia, that is, low concentration of calcium in blood plasma (Nikiforuk and Fraser 1981). It is seen as a non-specific indicator of physiological stress (Goodman and Rose 1990, Larsen 1997). Pitting on enamel surfaces can be related to severe fluorosis (Fejerskov et al. 1988) or to specific diseases such as congenital syphilis and rickets (Schultz et al. 1990, Jones and Mason 1990).

Linear hypoplasia and pitting of the enamel surface of teeth have been found in both rural and urban populations of Metaponto.

4.241. Linear hypoplasia

a) frequency

The percentage of people with linear hypoplasia in the rural population of Metaponto was 78% (Table 4.241-1). Among 113 individuals (71 females, 36 males and 7 youths) with front teeth preserved and only moderately worn, 88 had hypoplastic rings (53 females, 28 males and 7 youths). All juveniles with permanent dentition had hypoplastic rings (100%). There was no difference between sexes in the frequency of hypoplasia in this sample.

The mean number of hypoplastic rings per anterior tooth in the rural dental sample was 2.64. This result derived from a simple calculation where the total sum of hypoplastic rings on upper and lower incisors and canines was divided by the sum of hypoplastic upper and lower incisors and canines in the dental sample. Table 4.241-2, Table 4.241-3, and Figure 4.241-1 show the distribution of mean

numbers of hypoplastic rings for each tooth. Upper first incisors and lower canines had the highest mean number of rings per tooth. Lower second incisor had the lowest mean number of rings. Males had higher mean numbers of rings per tooth than females as shown in Table 4.241-3 for each type of tooth separately. However, the differences between sexes in mean number of hypoplastic rings were not statistically significant.

Frequency of linear hypoplasia among individuals in the entire rural sample was compared with the frequency of linear hypoplasia in the subsample of individuals showing pathological signs (possibly of treponematosis) on bones (Table 4.241-1). Among individuals with pathological changes on bones 94% had linear hypoplasia. The result was statistically significantly higher than in the entire rural dental sample (78%) (Chi-squared=3.92, df=1, $p<0.05$). There was no difference between the two samples in the mean number of hypoplastic rings per tooth in six types of teeth examined (Table 4.241-2).

b) age at the occurrence of hypoplastic rings

Age-specific occurrence of hypoplastic rings, as measured by the position of rings on the crown, in the rural population was the highest for 3 - 3.5 years old children when maxillary incisors were examined (Figure 4.241-2). For mandibular incisors it was slightly lower and the peak was around 2.5 - 3.0 years of age. For lower canines the peak occurred between 4.0 and 5.0 years of life and for upper canines it was between the age of 4.0 and 4.5 years. In general, most of the episodes of physiological stress, disruptive to the enamel formation, occurred between the age of 3 and 5 years. There was no statistical difference between the sexes in the age specific occurrence of hypoplastic rings.

c) rural - urban comparison

The percentage of individuals with linear hypoplasia in the urban sample was 95%. It was statistically significantly higher than in the rural population (Chi-

squared=14.05, df=1, p<0.001) (Table 4.241-1). As in the rural population, the urban females and males were equally frequently affected.

The mean number of hypoplastic rings per tooth in the urban population was higher than in the rural population (2.91 and 2.64 respectively) but the difference was not statistically significant. Urban people showed higher values of mean number of rings for all (except LM1) tooth types than in the rural population but the differences were not statistically significant (Table 4.241-3, Figure 4.241-1). While in the rural sample males had more rings per tooth for all tooth types, although the difference between sexes was not statistically significant, in the urban sample, the females and males did not have any uniform pattern within the examined tooth type (Table 4.241-3).

There was no difference between the rural and urban samples in the distribution of linear hypoplasia by age (Figure 4.241-2, Figure 4.241-3, Figure 4.241-4 and Figure 4.241-5). In both populations the same pattern was observed, that the peak occurrence of hypoplastic rings for the maxillary incisors was around 3 - 3.5 years of age. Most rings on lower canines were formed between 4.0 and 5.0 years of age and on upper canines the peak occurred a half year earlier (Figure 4.241-3 and Figure 4.241-4).

d) as compared to other populations

Frequency of enamel hypoplasia among the rural population of Metaponto was similar to recently published results for other coeval populations in the Mediterranean region (Table 4.241-4). The rural Metapontines had higher prevalence of hypoplasia than the population from Pontecagnano (near Salerno, in relative proximity to Metaponto), but lower than populations from other parts of Italy such as Campovalano di Campli, Riofreddo and Ardea where the frequency of hypoplasia was 100%. The frequency of enamel hypoplasia in the rural population was higher

than in Early Iron Greece, Classical Greece and higher than in Bronze Age Lerna and Cyprus (Table 4.241-4).

Mean numbers of hypoplastic rings per tooth for six types of teeth (upper and lower incisors and canines) in the rural Metaponto were higher than for pre agriculturists and agriculturists from Florida (Figure 4.241-6). They were very similar to the results reported for Ra's al Hamra 5.

In the enamel of teeth of the rural population, most of the hypoplastic rings formed at the age between 2.5 and 4.5 years. These results are similar to those reported for various archaeological samples world-wide and from different historical times (Schulz and McHenry 1975, Blakey and Armelagos 1985, Goodman and Armelagos 1985, Corruccini et al. 1985, Ubelaker 1992, Moggi-Cecchi et al. 1994, Wood 1996).