3.3.2.4. Hypoplasia

Data on hypoplastic rings and pits and observations of other types of hypoplasia such as missing enamel were collected (Nikiforuk and Fraser 1981, FDI 1982, uckling and Pearce 1984). Labial or buccal surfaces of the teeth were first cleaned with a soft toothbrush and examined macroscopically under the strong and direct ight of a desk lamp.

There was 98 percent agreement between the first and the second macroscopical examination of the entire dental material conducted after two years when the present-absent scoring of hypoplasia among the individuals was used. A magnifying glass was used only in particularly difficult cases and usually to confirm results of the macroscopical examination. In about 96 percent of re-examinations the number of rings observed macroscopically remained the same as observed with the aid of a magnifying glass. The intra-observer error of the present-absent scoring and ring counting was small and similar to those reported by other authors (Goodman et al. 1987, Danforth and Gilberti 1992).

Number of hypoplastic rings on each tooth was counted for each individual. The distinction between clear big rings with deep fossae between them, and small shallow rings in close proximity of each other, and also between smooth and pitted rings was recorded (Goodman and Rose 1990, Donat and Rose 1991). In further analysis however, the distinction into various types of linear hypoplasia was abandoned as researchers proved that such categorisation was unnecessary (small and big defects are of the same aetiology), also impractical and leading to greater inter-observer errors (Goodman et al. 1980, Danforth and Gilberti 1992, Berti and Mahaney 1995). Individuals with pitting randomly distributed on teeth, the kind of tooth with such pitting, and the surface with pitting were recorded on the chart (Appendix 1).

…cation of the hypoplastic pits and missing enamel was described in order to …rentiate the causes of hypoplasia (Nikiforuk and Fraser 1981, Ortner and …schar 1985, Shafer et al. 1983, Jones and Mason 1990).

The computer program written by Murray and Murray (1989a,b) from the …iversity of Kansas in Lawrence, Kansas and University of Arkansas in …etteville, Arkansas was used to calculate the individual's age at a time of a …oplastic ring formation. It is possible to determine the age of the individual by …mparing the position of the hypoplastic lesion on the tooth with data on the dental …evelopment (Schultz and McHenry 1975). In the program, regression equations …ere based on crown formation standards established by Schour and Massler and co-…orkers (Schour and Massler 1940, 1941, Massler et al. 1941, Sarnat and Schour …941) and on mean crown heights published by Swärdstedt (1966) (Murray and …urray 1989a,b). The crown formation standards and the mean crown heights were …stablished for European populations, and despite recent criticism (Hodges and …Vilkinson 1990) are widely used in studies of non-European populations as well, …ecause the differences in crown formation times between populations are rather …mall (Gustafson and Koch 1974, Goodman and Rose 1990, Smith 1991). In this …udy the calculations were not corrected for the specific population crown heights …ecause there were very few unworn teeth in the populations from Metaponto to …velop reliable standards. Also there was less need to make such corrections …cause the studied populations and the standards used in the computer program …ere those of Europeans. The calculations were made for all teeth with hypoplasia. …order to avoid doubling of information, teeth from the left side of the jaws were …ed in further analysis. If the left tooth was missing, the right tooth of the same type …s included in all further calculations.

The typical example of linear hypoplasia - easily observable big rings on the …th surface is presented in the Figure 3.324-1.

Location of the hypoplastic pits and missing enamel was described in order to differentiate the causes of hypoplasia (Nikiforuk and Fraser 1981, Ortner and Putschar 1985, Shafer et al. 1983, Jones and Mason 1990).

The computer program written by Murray and Murray (1989a,b) from the University of Kansas in Lawrence, Kansas and University of Arkansas in Fayetteville, Arkansas was used to calculate the individual's age at a time of a hypoplastic ring formation. It is possible to determine the age of the individual by comparing the position of the hypoplastic lesion on the tooth with data on the dental development (Schultz and McHenry 1975). In the program, regression equations were based on crown formation standards established by Schour and Massler and co-workers (Schour and Massler 1940, 1941, Massler et al. 1941, Sarnat and Schour 1941) and on mean crown heights published by Swärdstedt (1966) (Murray and Murray 1989a,b). The crown formation standards and the mean crown heights were established for European populations, and despite recent criticism (Hodges and Wilkinson 1990) are widely used in studies of non-European populations as well, because the differences in crown formation times between populations are rather small (Gustafson and Koch 1974, Goodman and Rose 1990, Smith 1991). In this study the calculations were not corrected for the specific population crown heights because there were very few unworn teeth in the populations from Metaponto to develop reliable standards. Also there was less need to make such corrections because the studied populations and the standards used in the computer program were those of Europeans. The calculations were made for all teeth with hypoplasia. In order to avoid doubling of information, teeth from the left side of the jaws were used in further analysis. If the left tooth was missing, the right tooth of the same type was included in all further calculations.

The typical example of linear hypoplasia - easily observable big rings on the tooth surface is presented in the Figure 3.324-1.

Figure 3.324-1. Lower and upper canines of a 12-15 years old individual (burial 295) with linear hypoplasia. On each tooth 4-5 horizontal rings are clearly visible indicating thinner and thicker layers of enamel.

3.325. Periodontal disease

To discriminate between physiological increase of the alveolar crest to cemento-enamel distance (AC-CEJ distance) and pathological resorption of alveolar bone called periodontitis, as well as measuring the distance between the cemento-enamel junction and the alveolar crest (see par. 3.312. Root exposure) morphological changes of the alveolar bone were recorded. Observations of pitting on the alveolar bone, shape and general appearance of the alveolar margin, infrabony pockets and presence of periapical abscesses were conducted (Manson and Nicholson 1974, Tyldesley 1978, Costa 1982, Clarke and Hirsch 1991).

The Tooth Cervical Height index (TCH-index) was calculated for individuals with 10 and more teeth in their sockets in order to evaluate periodontal condition of the mouth as a whole. The TCH-index is the mean value of all measurements taken for the individual's AC - CEJ distances. It is calculated as a sum of all measurements divided by the number of measurements for a mouth (Davies et al. 1969). It is also assumed that the use of TCH-indices instead of AC-CEJ values for selected teeth in further analysis will help to reduce at least partially, some of the problems discussed in earlier studies, and associated with the variability of alveolar condition along the tooth row in dry skulls (Molnar and Molnar 1985, Hildebolt and Molnar 1991).

Figure 3.322-1. and Figure 3.323-1 show examples of the probable periodontitis and chronic periodontal disease in the dental sample from Pantanello necropolis.

3.326. Other pathological conditions

Special attention was paid to other pathological causes of tooth loss, disturbed eruption, or pathological changes of alveolar or cortical bone like cysts, tumours, or alveolar bone remodelling, tooth loss or changed colour of enamel and dentine as a result of systemic diseases or trauma, (Shklar and McCarthy 1976, Ortner and Putschar 1985, Shafer et al. 1983, Jones and Mason 1990). Impacted teeth, arrested deciduous teeth, unusual shape of teeth, anodontia, hypodontia and hyperdontia, spacing, crowding and rotated teeth were recorded and the cases described (Appendices 1 and 3).

3.327. Dental wear

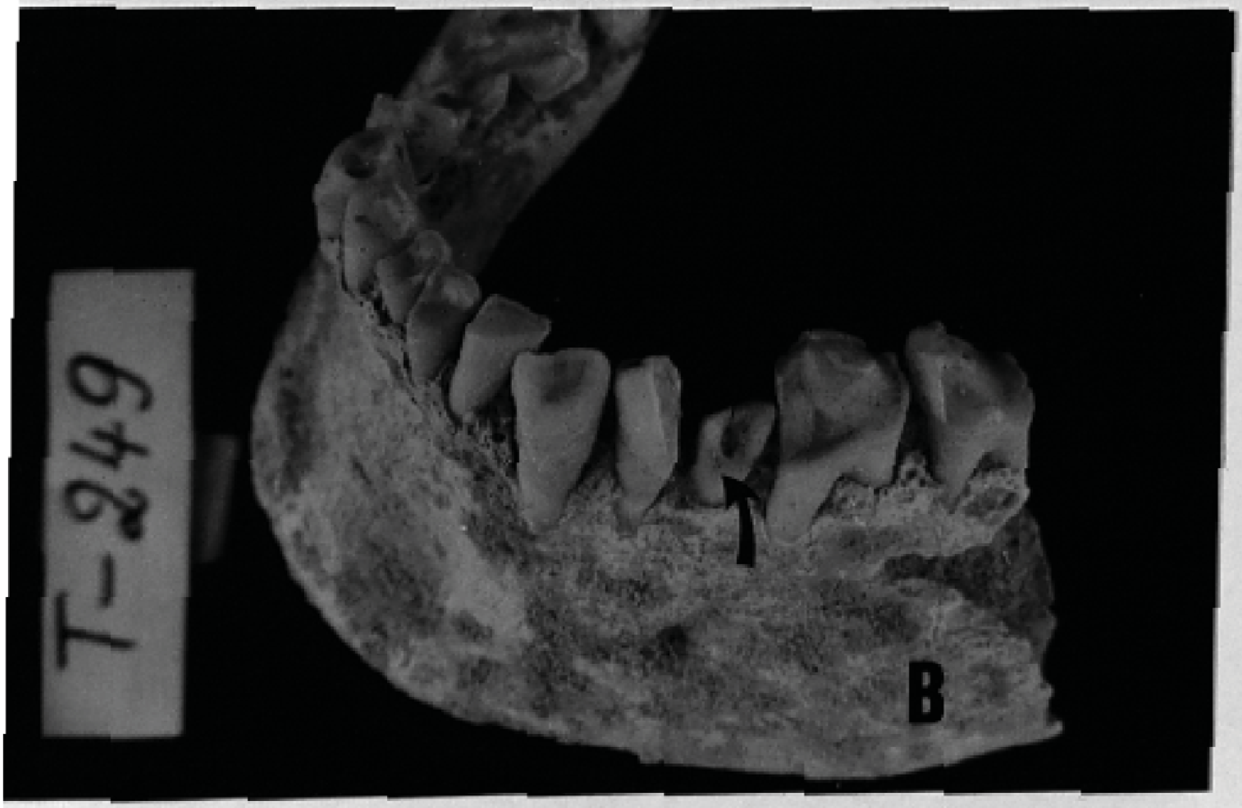
The five degree scale (0-4) of Gustafson (1966) was used to evaluate dental wear during the first examination of the dental material. According to this classification, unworn teeth were scored with zero (0) wear. When wear patches were observed only on enamel, or the enamel was worn down but no dentine was yet visible, the wear was of the first degree (score 1 on the chart). Presence of dentine patches on the worn surface was scored as the second (2) degree. When secondary dentine was present on the occlusal surface of the tooth the third degree of wear was recorded (score 3). The tooth crown completely worn down to the pulp chamber and roots engaged in mastication represented the fourth (4) degree wear. In the second examination Molnar's scale (1971) and Scott's scale (1979a) were also used (Appendix 1, 2 and 4). Molnar's scale was based on subjective principles similar to the Gustafson's classification but attrition was described in eight stages (1-8). The greatest difference between the two methods was that in the Molnar's classification description of intermediate stages of attrition was added to the stages previously described by Gustafson (1966). Molnar's method in which the amount of enamel lost and dentine exposed was evaluated, allowed the investigator more precise and semi-continuous assessment of the magnitude of tooth wear. For example, according to this method there were three stages of attrition with dentine patches described as small and few only (degree 3 in the scale), small dentine patches with one of the bigger size (degree 4), and the third stage where large dentine patches were present and the secondary dentine might be present as well (degree 5). Both methods evaluated attrition on the posterior and anterior dentition.

For purposes of comparisons with the data from the European and American literature, both methods were applied to the dental material in this study. The third scoring technique described by Scott (1979a) was used to complement the above two. The technique was developed to evaluate wear only on molars, and was recommended for studies of rate of attrition where the principal axis method was applied. Scott divided the occlusal surface of molars into four quadrants and scored the amount of enamel still present in each quadrant according to the ten point scale (1-10 points). Scores from each quadrant were then added together and the sum gave the evaluation of the tooth wear in the 4-40 point scale. That scoring technique could also give some information about the way the teeth were used in the jaw by describing in points which side of the tooth was mostly affected by attrition. The technique shows results of an even more semi-continuous nature than the Molnar's procedure, when applied to large samples. As it was discussed by Scott (1979a) the method was easy to use, and produced very low intra- and inter-observer errors. The intra-observer assessment error in this study was indeed low. In ten sets of molars (10 x 6 molars x 4 quadrants) scored again in a year interval, the second score differed from the first one for only 4 teeth, and this only by 1-2 points in the 40 points scale. Further analysis of the intra-observer error was not attempted as the author found the results of repeated scoring satisfactory (93% of teeth had the same scores). The methods of Gustafson and Molnar also gave highly repeatable results (94 and 92 percent agreement between the first and the second assessment respectively within a year interval).

The principal axis method was used to estimate the gradient of relative molar tooth wear in the population (Scott 1979b, Richards 1984). In the case of dental wear the method reflects regression of the wear of M1 on the wear of M2. The slope of the principal axis of such regression measures the average gradient of wear of M1 relative to M2 in a sample of individuals. The method avoids the problem of correlation between the age of individuals and amount of tooth wear in the interpretation of trends in dental wear at the population level.

The principal axis is a line dividing equally the angle between regression lines X on Y and Y on X. The method does not require assumptions regarding measurement error or correlation of variables (Scott 1979b, Sokal and Rohlf 1988). The wear of M1 and M2 was scored according to Scott's scoring system. Scores of M1 and M2 of the same individuals were plotted on a scattergram and the principal axis fitted by regression techniques (Sokal and Rohlf 1988).

The author is aware that it is doubtful whether the principal axis method can be applied to data collected by using non-metric scales. Both Molnar's and Scott's scoring scales are ordinal semi-continuous rather than totally nominal, and were tested for their use in assessing the gradient of dental wear with the principal axis method (Scott 1979b, Benfer and Edwards 1991). Thus, either of them could produce results similar to those obtained by using metric data. The use of a photographic-planimeter technique producing quantitative attrition data for principal axis analysis, as originally described by Richards (1984) was time consuming and impractical in the field-like working conditions in Metaponto. Other existing methods of collecting data as well as other statistical approaches also have their limitations when describing tooth wear rates (Scott 1979b, Richards 1984). As this study is not limited only to the tooth wear, the procedure chosen by the author seemed to be optimal for the purpose of this study and within the working conditions available. It seemed to produce results comparable to those obtained by applying other data collecting techniques and other statistical



re 3.327-1. Unusual wear of teeth in the mandible of a 60-x years old male from burial 249 at Pantanello. All teeth are heavily worn down *with secondary dentine or pulp* exposed. Wear facets run in all directions. Front teeth have a mesio-distal groove through the occlusal surface. Second premolars at both sides of the mandible have pulpal caries (thin arrows) with periapical abscess visible at right side (thick arrow). **A** - right side, **B** - left side of the mandible.

analyses (Smith 1976, Walker 1978, Tomenchuk and Mayhall 1979, Molnar et al. 1983, McKee and Molnar 1988a).

Individuals with unusual tooth wear were listed and the cases described in greater detail. Scoring results on pairs of the first and second molars with unusual attrition were not included in the principal axis analysis. They were also excluded from calculations to estimate an average degree of wear in the population regardless of which scoring method was used.

An example of unusual tooth wear found among the dental remains from the rural Metaponto is shown in the Figure 3.327-1.

3.33. Observations of non-metric traits

Morphological variants on teeth were selected for observation following three criteria: 1) data were collected on variants for which the mode of genetic control was best explained or established (Kraus 1951, Wood and Green 1969, Goose and Lee 1971, Biggerstaff 1973, 1979, Portin and Alvesalo 1974, Alvesalo et al. 1975, Blanco and Chakraborty 1976, Berry 1978, Harris and Bailit 1980, Townsend and Brown 1981, Scott and Potter 1984, Nichol 1989, Townsend and Martin 1992), and 2) the observations were possible on slightly or even moderately used teeth (like number of cusps on upper molars) or variants occurring on teeth usually least used in the mouth (like upper second incisors) in order to have large enough samples for intra- and interpopulation comparisons. In selecting the morphological variants the emphasis was also placed on variants relatively common in European populations, past and present, and also on those specific to various groups within the Mediterranean region (Angel 1944a,b, Carbonell 1963, Suzuki and Sakai 1964, 1973, Kieser 1978, Zubov and Haldeeva 1979, Passarello 1980, Coppa and Macchiarelli 1982, Mallegni et al. 1985, Bermudez de Castro 1989, Pinto-Cisternas et al. 1995, Manzi et al. 1997).

The intra-observer error was not reported for non-metric traits for various reasons. Preliminary scoring sessions on small sample of teeth from the rural sample showed that majority of the weekly repeated results were the same as the first time despite that the scoring was done in much shorter time limit. The intra-observer error seemed to be small and oscillating around 0-5%. The reason that the error could be small was that from the beginning of scoring the grades of expression of the particular characteristic (if appropriate) were recorded, not just its presence or absence. The scoring continued in the same way even that the use of only presence/absence results in further calculations was decided. As it was showed by Nichol and Turner II (1986) greater error was obtained by scoring presence/absence of the trait than when gradation of the trait expression was included in the scoring. Simply it was necessary to look at the tooth for a longer time to decide about the grade. All of the observations were made on original teeth. The errors reported by Nichol and Turner II (1986) were estimated on casts and then dependent also on the quality of the casts. The majority of the non-metric traits selected for this study (number of cusps, shovel shape incisors, winging, hypocone, metacone, etc.) were easy to score and belonged to a high scorability index group (Nichol and Turner II, 1986). Taking into account all factors including limited time of access to the dental material for this study the detailed study of the intra-observer error for each trait separately was not done.

Observations of the selected non-metric traits were recorded in the specially designed chart allowing efficient scoring (Appendix 3). Further description of individual cases was also provided if required (also Appendix 1 and 3).

3.331. Carabelli's trait

The additional feature, a pit, groove or cusp, on the lingual surface of the mesiolingual cusp (cusp 1 or protocone) of upper molars is called Carabelli's trait (Dahlberg 1963, Zubov 1968, Kaczmarek 1979, Scott 1980, Turner et al. 1991). The Carabelli's trait is regarded as a variant characteristic for the European populations and populations descendant from the Europeans (Hanihara 1967, Bang and Hasund 1972, Wajeman and Levy 1979, Scott 1980). The trait is usually most pronounced, and its frequency the highest, on the upper first molars

(Shapiro 1949, Lee and Goose 1972, Liu 1977, Turner and Swindler 1978, Wajeman and Levy 1979, Scott 1980, Lukacs 1983).

The simplest recording system for studying Carabelli's variant is present-absent data collection. This system proved to be the most reliable, the least prone to classification errors and easy to use in statistical calculations, family studies, and interpopulation distances especially when the sample sizes were small (Sofaer et al. 1972, Berry 1978).

The present-absent classification of the Carabelli's trait on the upper first molar was used in this study for calculations of the genetic distances between populations and in testing the hypothesis of the family nuclei existence within the Pantanello burial ground.

All three upper molars were examined and the results recorded for both sides when both antimeres were present. If only one antimere was present the data were also recorded for an individual count. Observations were conducted on unworn teeth or slightly worn teeth where most of the mesiolingual surface of the protocone was still intact (Appendix 3).

For recording the expression of the Carabelli's trait several grading systems were developed (Kraus 1951, 1959, Dahlberg 1963, Zubov 1968). Review of the literature on the Carabelli's trait undertaken in this study revealed that two of the systems, the Kraus's and the Dahlberg's, or the systems based on the classification described by Kraus, were the most frequently used in various studies. Most of the systems in use can be converted to the simpler four degree classification.

For the purpose of easy reference to the world-wide data in the literature the observations of the trait in this study were recorded according to the classification of the trait expression described by Goose and Lee (1971), and according to the Dahlberg classification (1963) using a procedure described by Scott (1980).

In the four-degree system used by Goose and Lee (1971) the development of the Carabelli's trait was described as 1) no evidence of any additional features on the mesiolingual surface of the upper molars, 2) pits or grooves, 3) a cusp without a free tip, 4) a cusp with a free tip present on the surface. Dahlberg (1963) distinguished eight degrees of the Carabelli's variant expression. In this classification lack of any manifestation of the

Carabelli's trait (no pits, ridges or cusps) was scored as zero (0) degree. Grooves and pits were described in four consecutive stages and the development of the cusp was described in three stages from a small tubercle through a broad cusp or a moderate tubercle to a well developed cusp with a free apex often of the same height as the major cusps of the tooth. While there were no difficulties in distinguishing between cusps and other features on the mesiolingual surface of the protocone, and in describing the stage of the cusp development, the classes 1 to 4 of grooves and pits expression were less easy to recognise. In further analysis of the data the frequencies of Carabelli's expression in the 1-4 degrees in the Dahlberg classification were summed up and presented as one degree. Scott (1980) adopted the Dahlberg's Carabelli's trait classification and discussed the results of three counting methods for scoring the trait. The most frequently used scoring methods, total tooth count, unilateral count and individual count gave only slightly different frequencies of the trait presence (or absence). The individual count however, gave the highest results of the trait frequency. According to this method the highest degree of the trait expression was recorded when asymmetry was present assuming that the individual had only one genotype for the trait and could be classified in only one phenotypic category. The method allowed scoring when only one antimere was available for observations which maximised the size of the sample. According to this procedure the highest degree of the trait expression and the data recorded only on one side of the mouth represented an individual in the present study. The individual counts were used in the calculations of the trait frequencies and in the final presentation of the data.

Even when the trait was recorded on both sides of the mouth, if both antimeres were present the analysis of asymmetry of the Carabelli's trait expression was not attempted in this study due to the small sample sizes.

3.332. Shovel-shaped incisors

The incisors with a hollow on the lingual surface and easily defined marginal ridges on both sides surrounding this hollow, were called shovel-shaped incisors because of the resemblance to a coal shovel (Hrdlička 1920). In early publications the trait was described on upper central and distal incisors (Muhlreiter 1870, after Hrdlička 1920) but could be also present on upper canines and lower incisors (Hrdlička 1920, Turner et al. 1991). The highest frequencies of the shovel-shaped teeth were noted among the American Indians and many of the Asian populations while the trait was less common among the Europeans and Africans (Hrdlička 1920, Carbonell 1963, Suzuki and Sakai 1964, Hanihara 1967, Pinto-Cisternas and Figueroa 1968, Zubov and Haldeeva 1979, Turner 1987). Strong inheritance of the shovel variant was confirmed in several studies (Portin and Alvesalo 1974, Blanco and Chakraborty 1976, Berry 1978). Assuming a genetic control of the trait, several authors have used it in estimations of the genetic distances between populations (Sofaer et al. 1972, Berry 1976, Scott et al. 1983, Kirch et al. 1989).

In an attempt to describe the differences in the trait expression Hdrlička (1920) proposed a four-degree classification of the shovelling. According to this classification the teeth were grouped as 1) no shovel-shaped, 2) with a trace of shovelling, 3) semi-shovel teeth where the variant was recognised but less developed than the fully shovel-like version, and 4) shovel-shaped teeth with well marked lingual marginal ridges and a deep hollow between them on the lingual surface of the tooth. This system was adopted by physical anthropologists world-wide and it is still commonly in use. Later, more complicated subjective scales of the trait expression were developed (Turner et al. 1991) and a simpler two-degree classification has been proposed (Hanihara 1967). Other authors tried to describe the trait expression quantitatively by measuring depth of the hollow between the marginal ridges on the lingual surface (Dahlberg and Mikkelsen 1947, Rothhammer et al. 1968, Kirveskari and Alvesalo 1978).

In this study the Hrdlička four-degree scoring system was used and the observations were conducted on all upper first and second incisors except those which were heavily worn down (Appendix 3).

The simpler present-absent scoring (Hanihara 1967) was used in calculations of genetic distances between populations and in comparisons between family groups within the burial ground.

3.333. Number of cusps on molars

One of the manifestations of ongoing evolutionary changes of human dentition is the reduction of tooth size and the reduction in a number of tooth structures (Dahlberg 1945, 1951, Moorrees 1957, Lombardi 1975, Frayer 1978, Scott 1979, Sciulli 1979, Brace et al. 1984, McKee 1984, Calcagno 1986, Turner 1987, Armelagos et al. 1989, Brace et al. 1991). Evolutionary changes towards the less complicated tooth morphology were best documented for the two features, reduction of the cusp size and cusp number in molars.

The most commonly reduced or absent cusp in upper molars is a hypocone (a distolingual cusp or cusp 4). The second molar has the hypocone more often reduced or absent than the first molar and the third molar is the most variable among the molar teeth (Turner et al. 1991). Dahlberg (1963) classified the hypocone reduction in a four-degree scale where the tooth occlusal pattern was described by the number of cusps, and the size of the hypocone was described by adding plus or minus to the number of cusps. According to this classification there were 4, 4-, 3+ and 3 patterns of the occlusal surface of upper molars. The first stage (4) described a molar with all four cusps well developed and of similar size. The 4- stage described a slightly reduced in size hypocone, the 3+ pattern described a molar with three cusps and with only remnants of a hypocone present and, the stage 3 represented a molar with a completely reduced hypocone. Dahlberg's scoring system has been the most commonly used by researchers.

Dahlberg's four-degree system was also used in this study.

Very rarely the reduction of the distobuccal cusp (cusp 3 or metacone) occurs on upper molars. A similar scoring system to the one of the hypocone was developed to describe the development of the metacone (Turner et al. 1991). This scoring system was also applied in the present study.

Observations were conducted on all upper molars on which, despite the attrition, it was still possible to distinguish between cusps and the size of the cusps could be easily estimated. Severely worn teeth with dentine exposed on the entire occlusal surface were automatically excluded from observations.

The numbers of cusps on all lower molars were recorded and the teeth were selected for observation according to similar criteria as for upper molars. Teeth on which the cusps were indistinguishable due to severe attrition were excluded from observation.

3.334. Groove pattern on lower molars

Interrelationship between the five main cusps on lower molars of Primates was first described by Gregory (1916). Its relative evolutionary importance and importance for comparisons between populations have been discussed frequently (Gregory 1916, 1922, Jørgensen 1955, Erdbrink 1965, Greene et al. 1967, Bailit et al. 1968, Biggerstaff 1968, Rosenzweig and Zilberman 1969, Palomino 1977, Berry 1978, Turner and Swindler 1978, Baume and Crawford 1980, Wood et al. 1983, Hillson 1986). Despite a still unclear mode of inheritance, the groove pattern has been included in many classical interpopulation comparisons based on dental morphological characteristics (Turner and Hanihara 1977, Liu 1977, Turner 1987, Lukacs and Hemphill 1991, Townsend 1992).

Jørgensen (1955) gave a classification of the grooves on lower molars according to which there were three main occlusal patterns. The Dryopithecus pattern or Y in five cusped molars occurred when the cusps 2 and 3 were in contact and cusps 1 and 4 were separated from each other by a groove running between cusps 2 and 3. This pattern was found more commonly on the first than the second molars. The fissure configuration where cusps 1,2,3 and 4 were in contact and, the grooves separating them met in the centre of the tooth was described by the + (plus) sign. When the cusps 1 and 4 were in contact and the cusps 2 and 3 were separated by a groove between adjacent 1 and 4 cusps in four cusped molar the pattern was described as X. The Y5 pattern commonly occurred in hominoids and was present in high frequencies on all their lower molars while in humans the second molars usually had more modified and simpler + or X patterns. The Y5 pattern was regarded as the most "primitive" and the X as the most "advanced" one. Other classifications of the groove pattern, also often used by investigators, differed only slightly from the one described by Jorgensen (1955) and, usually did not distinguish between the X combination and the + pattern (Hellman 1928, Biggerstaff 1968).

In this study the Jorgensen classification was applied. The observations were conducted on all three lower molars in strong direct light from a desk lamp. The magnifying glass was used only in difficult cases. Teeth with cusps completely worn down and without clearly visible fissures, especially in the central portion of the occlusal surface, were excluded from observations.

An additional groove on lower first molars, the deflecting wrinkle (Morris 1970), was included in the original scoring chart (Appendix 3), and the presence of the trait was recorded. Later however, the results of the scores were not included into the final analysis in this study for two reasons: 1) most of the teeth were worn down and the trait could not be observed without great uncertainty 2) the sample size of teeth on which the trait was observable was very small.

3.335. Canine distal accessory ridge

The relatively recently noticed trait on upper and lower canines, the distal accessory ridge, was described by Scott (1977) and its expression classified according to a six stage scale. The trait could be defined as an additional ridge on the lingual surface between the apex and the distal marginal ridge of the tooth in closer contact with the latter (Scott 1977, Turner et al. 1991). Up to the present day only a few studies of dental morphology among populations have included the canine distal accessory ridge into the list of recorded traits. However, high frequency of the trait, especially on upper canines has already been shown among the American white population, among various groups of American Indians and among populations from the Pacific islands and Asia (Scott 1977, Turner and Swindler 1978, Turner 1979). Greater differences between populations in the trait frequencies were found for the lower canines. The canine distal accessory ridge displayed the highest sexual dimorphism among dental morphological characteristics (Nichol 1989). The mode of inheritance of the trait has not been fully explained thus further data collection and broader studies were recommended. One of the difficulties in the study of the trait was that, it could only be observed on unworn or slightly worn teeth, greatly limiting the sample sizes.

Because of the initially relatively large sample size of teeth in this study the data on the canine distal accessory ridge were collected and the expression of the trait recorded according to the six-grade scale. Moderately and heavily worn teeth where the attrition extended to the elevation of the distal ridge were not included in the observation. For the interpopulation comparisons the simple absent-present system of scoring was used. The trait was considered present when grades of its expression from trace (score 1 according to the Scott's scale) to very pronounced (grade 5) were recorded.

3.336. Metaconule

The occasionally present additional tubercle or cusp located between cusps 3 and 4 in the distal fovea on the occlusal surface of upper molars has been known since the nineteen century and was used for comparisons in interpopulational studies (Turner and Hanihara 1977, Harris and Bailit 1980, Hillson 1986). The frequency of the metaconule (or cusp 5) among populations was rather low (3-47% after Hillson) and the trait was more often present on the upper first than on the second molar (Harris and Bailit 1980, Scott and Dahlberg 1982, Hillson 1986, Townsend et al. 1986, Nichol 1989). The mode of the metaconule inheritance was discussed in several studies and the results supported the polygenic model (Harris and Bailit 1980, Townsend et al. 1986). In the most recent studies the expression of the trait was usually described in a six-degree scale developed by Harris and Bailit (1980) or the trait was simply scored as present or absent (Scott and Dahlberg 1982).

In this study the Harris-Bailit scoring procedure was adopted. For interpopulation and inter familial comparisons the absent-present system was used due to small sample sizes. All upper molars were examined and only results of observations on unworn or slightly worn teeth with foveae still well visible were recorded.

3.337. Number of premolar cusps

Several authors included in their observations the occlusal variation of lower premolars (Kraus and Furr 1953, Ludwig 1957, Berry 1978, Turner and Swindler

1978, Scott and Dahlberg 1982, Scott et al. 1983). Most authors paid attention to the number of lingual cusps on both lower premolars, as this trait displayed great variability among populations (Hillson 1986). The number of cusps on the lower premolars has been found to be under a strong genetic control (Berry 1978, Scott and Potter 1984, Nichol 1989). Ludwig (1957) described seven different characteristics on the lower second premolar alone and developed scoring systems for each trait. Scott (1973) presented a ten-grade system concerning only counting and description of the cusp development on both lower premolars (Turner et al. 1991).

In this study the simpler scoring system was used in which the number of lingual cusps was recorded without differentiating between their relative sizes. According to this classification lack of the lingual cusp was recorded as 0, and the numbers 1, 2 and 3 corresponded to the number of the lingual cusps observed on the lower premolars. In comparison to the ten-grade Scott's scale the grades 0 and 1 were the same in both scoring systems, the grade 2 in the simpler system included Scott's grades 2-7 and grade 3 corresponded to grades 8-9 in Scott's scale. The simpler system was applied to increase the sample size. The cusps were counted on unworn or only slightly worn teeth when the grooves separating the cusps were easily defined.

3.338. Protostylid

A pit, a secondary groove or a cusp with or without a free tip could be present on the buccal surface of the cusp 1 (protoconid or mesiobuccal cusp) in the lower molars. The trait, protostylid, was rarely found among Europeans or populations of the European descent, but its frequency was higher among some Asiatic populations (Dahlberg 1963, Hanihara 1967, 1977, Mayhall et al. 1982, Scott et al. 1983). A seven-grade classification of the protostylid was compiled by Dahlberg (1963). In his system Dahlberg treated a pit as a separate category from grooves and cusps where the two latter categories were graded in an ordinal way from 1-5. The possibility of a pit being a separate trait not included into scoring was discussed by some investigators (Hanihara 1977, Mayhall et al. 1982). A modified Dahlberg's scale with five degrees of the trait expression or simple absent-present scoring has also been used (Baume and Crawford 1980, Scott and Dahlberg 1982).

It was expected in this study that the frequency of the protostylid among ancient Greeks, Europeans derived from Indo-European stock and originating somewhere in the Caucasus (Griffin 1991) could be very low, thus the scoring of the trait proceeded according to the simpler classification. The grades in this scale were as follows: 0-absent, 1-pit, 2-groves and cusps. In the final presentation of the results the scores for the pit were treated as if the trait was absent. All lower molars were examined for possible presence of the trait with the exclusion of heavily worn teeth or those with a damaged enamel surface on the buccal side. The trait was also chosen in this study to provide a contrast to the scoring of other morphological characteristics found usually in higher frequencies.

3.339. "Etruscan" upper lateral incisor

This variant was first described on the series of Etruscan skulls housed in the Department of Anthropology at the University of Florence (Pinto-Cisternas et al. 1992). The upper lateral incisors displayed the unique form of shovelling with the mesial margin on the crown invaginated (or undercut) toward the long axis of the tooth approximately at the level of the lower second half of the tooth (Figure 3.339-1). The tooth was asymmetrical in the upper half with the significant part of its body pushed mesially. When looking from the front on the teeth in a jaw, between the upper first and second incisors there was a gap or a hole close to the alveolar crest created by the invaginated margin of the second incisor, while the part of the tooth's mesial margin closer to the cutting surface was in contact with the distal margin of the first incisor. Often the invaginated mesial margin was divided into two parts. The trait displayed a continuous variation in expression from slightly progressed mesially upper part of the crown and a trace of invagination of the mesial margin to very pronounced "bent" disto-mesially crown of the tooth with clear undercut mesial margin. The high frequency of the variant was noted in ancient Etruscans and it was postulated that the trait could be common among the native ancient Italians as well as modern Italian populations (Pinto-Cisternas et al. 1992).

In this study the trait was scored according to the four-degree ordinal scale developed by the author. Lack of shovelling or shovel-shaped teeth as described by Hdrlicka with no trace of mesial margin invagination were scored as 0 - trait was absent. Three further consecutive grades (1-3) described slight, moderate and pronounced expression of the trait. The gradation was purely subjective and better description of each grade is needed. In further calculations for interpopulation and inter familial comparisons the simple absent-present system was applied. If present, the trait was easily observable on teeth even with moderate attrition, thus all upper lateral incisors were examined and results recorded. Heavily worn incisors were excluded. The decision to include the newly described trait into the present study was made after most of the data were already collected. For this reason the observations were recorded as shovelling with the specific description and designation as "Etruscan" on the chart with non-metric traits (Appendix 3).

Figure 3.339-1 presents, among other examples of the trait, the teeth of an individual from Saldone, one of the smaller burial grounds of rural area of Metaponto, with a well developed “Etruscan” upper lateral incisor.

Figure 3.339-1. "Etruscan" upper lateral incisors of various grades of expression rom necropoleis of Pantanello and Saldone. The best example of the trait is well developed "Etruscan" incisor of a 25-30 years old male from the burial 24 at Saldone (lingual surface). The tooth has its upper part bent mesially and "undercut" (arrow).

3.340. Other characteristics: sagittal furrow on lower first premolars, winging, other forms of tooth rotation, crowding and spacing, peg shaped teeth, enamel extension on upper and lower molars.

Observations were collected of traits with usually low frequency in the populations but with well documented heritability and reported to occur among Europeans (Meskin and Gorlin 1963, Dahlberg 1963, Alvesalo and Portin 1969, Escobar et al. 1976, Berry 1978).

Sagittal furrow on lower first premolars was defined as the groove separating labial and lingual cusps (Berry 1978). Family studies have revealed its high heritability between parents and children and between siblings (Berry 1978). The trait has rarely been reported in population studies but has been chosen in this study for inter family comparisons. The absent-present scoring system was applied in the study. Observations were carried on unworn or slightly worn teeth where a small dentinal patch was present on only one of the cusps and the attrition did not obliterate the region between cusps.

Rotation of the upper first incisors where distal margins of the teeth were moved labially or lingually from the normal position in the dental arch was called winging or counter winging respectively (Dahlberg 1963, Turner et al. 1991). The phenomenon can occur bilaterally or unilaterally. High frequency of winging was reported among American Indian tribes and Asians but low among American whites (Enoki and Nakamura 1959, Dahlberg 1963, Escobar et al. 1976, Turner and Scott 1977).

In this study any type of winging was recorded and then classified according to Dahlberg (1963).

Variability of the upper lateral incisors was scored according to Montagu (1940) and modified by Turner (Turner et al. 1991) three-grade scale. Teeth of normal size and shape for the second incisors were scored as 0 (no peg trait), grade 1 described the narrower than normal and slightly reduced in size incisors and, grade 2 described peg-shaped incisors of various sizes, barrel like with a tip instead of cutting edge.

The data were also collected on characteristics such as spacing between teeth, various forms of crowding and various rotations other than winging, which are less well documented for the past populations and of less known genetic mechanism (Lavelle 1970, Baume and Crawford 1980). Some of these characteristics such as rotations and crowding were commonly recorded in recent populations and even regarded an almost normal variation (Hillson 1996), but rather rarely occurred in the past (Baume and Crawford 1980). Rotation of any tooth in the dental arch could occur most probably when the length of the dental arch was smaller than the accumulated length of the tooth crowns. In contrast when the accumulated length of dental crowns was smaller than the length of the dental arch allowing for gaps (diastemata) between consecutive teeth, spacing of the teeth was observed (Lavelle 1970). Because rotations and spacing were rare in the dental material from Metaponto, cases were described individually in addition to the frequencies presented in tables.

3.4. Statistical methods and tests

Presence of dental diseases in the population was calculated as frequency in percentages of total number of individuals in the sample and of total number of teeth examined in the sample. Mean values, and standard deviations were calculated if applicable. Results for two sexes and samples from rural and urban area were compared and various hypotheses tested with Student t-test or nonparametric tests such as Kolmogorov-Smirnoff or Chi-squared test (Blalock 1960, Snedecor and Cochran 1982). The Chi-squared test formula for 2x2 contingency tables was chosen for testing hypotheses (Blalock 1960, formula 15.3).

To specific problems, correlation and principal axis analysis was applied (Blalock 1960, Sokal and Rohlf 1988, Scott 1979b, Snedecor and Cochran 1982). Penrose's generalised distance and multivariate Mean Measure of Divergence were used to compare, respectively, metric and non-metric trait frequencies between populations (Penrose 1954, Berry and Berry 1972, Sjøvold 1973, Henneberg 1984, Johnson and Lovell 1994, Steyn and Henneberg 1997). The details concerning specific statistical methods used in this study were explained in the appropriate chapter in this thesis.

Unless specified differently, all hypotheses were tested at the 5% significance level. Bonferroni protection procedure was used to lower the effect of type I error (Miller 1966). Computer programs with statistical package were used if possible. Results were shown in graphs, histograms and tables.

4. PART I. Dental health of the inhabitants of the rural area of Metaponto.

4.1. Introduction

Modern living populations battle with many new and old diseases which plague people even in most developed countries despite constantly improving technology, medical care and preventive measures. With changing environmental conditions, disease-causing micro-organisms undergo evolutionary changes as do their hosts (Motulsky 1960, Cockburn 1963, 1971, Henneberg 1992, Ewald 1994,). Over time human dietary habits have changed dramatically and led to changes in frequency of dental diseases (Brothwell 1959, 1963, Hillson 1979, Turner 1979, Rudney 1983, Gilbert and Mielke 1985, Molnar and Molnar 1985, Clarke et al. 1986, Larsen et al. 1991, Lukacs 1992, Larsen 1995,). Caries and periodontal disease, very frequent today, were rare in the past and gradually spread among populations along with developing technology of food preparation (Keene 1981, Nikiforuk 1985, Clarke et al. 1986, Larsen et al. 1991, Henneberg 1991, Larsen 1997). Because the teeth are an integral part of the human body, many factors, other than diet and food preparation technology, affect the general health of individuals and contribute to the state of their dental health. Systemic diseases and general conditions in which people live, their habits and oral hygiene can affect dentition (Sarnat and Schour 1941, Kreshover 1960, Sweeney et al. 1971, Molnar 1971, Steinbock 1976, Infante and Gillespie 1977, Goodman et al. 1980, Knick III 1981, Rudney 1983, Nikiforuk 1985, Ortner and Putschar 1985, Angel et al 1987, Hildebolt et al. 1988, Scott and Turner 1988, Goodman and Rose 1991, Larsen and Hutchinson 1992, Yamamoto 1992, Mittler et al. 1992).

The value of studies of dental health lies in their ability to reveal changes in general living conditions experienced by the ancient Greeks in the new environment of colonised areas and perhaps to indicate presence of systemic diseases in the population. Also, more can be learnt about the diet and hygienic practices of ancient Greeks to complement and contrast information from historical sources.

In this part of the study the following problems will be addressed and hypotheses tested:

I. Dental pathologies as indicators of general health status of the rural colonial population of Metaponto will be described.

It is expected that the general health of the rural population is 1) poorer than in the urban situation and 2) similar to coeval rural populations from other parts of Mediterranean. Dental health is expected to reflect the same general trend (Angel 1944, Coppa and Macchiarelli 1982, Fornaciari et al.1985-86, Macchiarelli and Salvadei 1986, Mallegni et al. 1979, 1985, Passarello 1980). The above two hypotheses will be tested by comparisons of the prevalence of dental caries, periodontal disease, hypoplasia and other dental pathologies and dental conditions like tooth wear, between populations from rural Metaponto and : 1) urban population of Metaponto, 2) metropolitan Greece, 3) indigenous populations from other parts of Italy, 4) contemporary populations from Europe and world-wide, 5) populations of different dating, but of similar economy, 6) populations that experienced extreme changes in their life-style or were exposed to extreme environmental conditions.

II. Dental conditions will be discussed in relation to the specific diseases of the rural population.

In view of the well documented relationship between dental conditions and systemic diseases (Steinbock 1976, Nikiforuk and Fraser 1981, Nikiforuk 1985, Ortner and Putschar 1985) and presence of systemic diseases among the ancient population from Metaponto (Henneberg and Henneberg 1990, 1994, 1998a, Henneberg et al. 1992) it is hypothesised that these systemic diseases can worsen the dental conditions in the population. This hypothesis will be tested by comparing prevalence of caries, periodontal disease, and hypoplasia and their epidemiological patterns among individuals with and without pathological changes on bones.

4.2. Results and discussion to each sub-subject of the study

Before describing dental health characteristics, the representativeness of the samples used in dental analysis needs to be addressed. The reason is that in the fragmentary material not all individuals excavated at the sites had their teeth preserved.

4.21. Sex ratio and subadults

The results of sex and age determination for the entire skeletal sample from the rural Metaponto are shown in Table 2.13-2. The proportion of females, males, children and unsexed adults is presented in Table 2.13-3. There was nearly twice as many females as males buried in the excavated rural burial ground. The female to male sex ratio differed significantly from an almost 1:1 proportion in living populations. The number of skeletons of children and youth was disproportionally lower than could be expected in pre industrial populations. Deviations from the expected model were discussed elsewhere. For the discussion and possible explanation of the phenomenon see Henneberg and Henneberg (1990, 1998a).

The results of sex and age determination of the individuals in the rural and urban dental samples are presented in Tables 2.2.1 and 2.2-2.

4.22. Sex and age distribution

At the time when the skeletal material from the rural sites had already been described and dental data collected, the reference material from the urban cemetery had been not completely recovered and studies of the later material were still in progress.

To provide an indirect proof that the comparative urban sample is indeed randomly selected, at least with respect to sex and age, life tables for both dental samples were constructed and the results compared.

4.221. In the entire skeletal material (rural and urban samples)

Results of a comparison of selected biometric functions of the life tables constructed for the entire rural sample (all three sites included) and for the urban sample, were shown in Figures 4.221-1 and 4.221-2 and Tables 4.221-1 and 4.221-2. As can be seen in Figure 44.221-2 life expectancy in both populations was very similar for all age categories. An average 20 years old person lived another 22.5 and 23.1 years in the rural and urban samples respectively (Tables 4.221-1 and 4.221-2). This difference is not statistically significant as tested using a method described by Chiang (1960) and further developed by Henneberg and Strzałko (1975). According to this method standard errors of the life expectancy at birth and at 20 years of age were calculated. The standard errors were used to build 95% confidence intervals around each calculated value of life expectancy. Confidence intervals for life expectancies of rural and of urban populations from Metaponto overlapped indicating that there was no statistically significant difference in life expectancy between the two populations (Henneberg and Strzałko 1975). In each age category, a similar