6-2003

# Can Status Be Revealed? Dichotomous Cultural and Physiological Markers of Social Differentiation in Two Pre-Pottery Neolithic B Sites in the Levant

Monika L. Trahe

# CAN STATUS BE REVEALED? DICHOTOMOUS CULTURAL AND PHYSIOLOGICAL MARKERS OF SOCIAL DIFFERENTIATION IN TWO PRE-POTTERY NEOLITHIC B SITES IN THE LEVANT

by

Monika L. Trahe

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Anthropology

Western Michigan University
Kalamazoo, Michigan
June 2003

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to those people who have provided constant inspiration and encouragement throughout the years, especially throughout the completion of this thesis. As my advisor, Dr. Tal Simmons fostered an environment in which I was able to expand upon and develop ideas, gain experience as an educator and researcher, and increase my knowledge and skill in a variety of fields. The appreciation and respect I hold for her extends beyond that of a mentor, but also as a friend. I would also like to thank my other committee members, Dr. Robert Anemone and Dr. Pamela Stone. The insight and assistance received from them in classes and with regard to my thesis is invaluable.

My sincerest thanks also go to Dr. Nigel Goring-Morris, Dr. Israel Hershkovitz, and Dr. Vered Eshed for allowing me access to the Kfar HaHoresh and Yiftahel skeletal collections, and providing assistance when needed.

Further acknowledgements go to my friends who have given me personal and academic encouragement over the years. I especially want to recognize Cassandra Workman, CB Foor, Rory McCarthy, Tim Bober, Randall Case, William Hill, Peter Lawson, Marc Henshaw, and Lauretta Eisenbach. Your wisdom both inspires and motivates me. Finally, I wish to thank my family for their confidence and emotional support throughout all of my academic pursuits.

Monika L. Trahe

# CAN STATUS BE REVEALED? DICHOTOMOUS CULTURAL AND PHYSIOLOGICAL MARKERS OF SOCIAL DIFFERENTIATION IN TWO PRE-POTTERY NEOLITHIC B SITES IN THE LEVANT

Monika L. Trahe, M.A.

Western Michigan University, 2003

Bioarchaeological studies utilize linear enamel hypoplasias (LEH) to discuss and interpret the health among peoples of the past. This research explores the bioarchaeology from two Pre-Pottery Neolithic B (9,000-8,500 BP) sites in south-central Levant, Kfar HaHoresh and Yiftahel, to uncover a record of health and social status in order to understand these sites in the context of the greater Levantine Pre-Pottery Neolithic period.

Archaeological evidence suggests that the Kfar HaHoresh site served as a mortuary complex in which the elite from surrounding communities, such as Yiftahel, are buried (Goring-Morris 2000). This research examines the biological remains alongside the archaeological evidence to determine whether the elite from this region were buried at Kfar HaHoresh; if evidence suggesting social stratification exists within Kfar HaHoresh itself; and if individuals at these two sites experienced similar stressors associated with weaning. LEHs are used as the primary indicator of nutritional status. The data reveals that the individuals at these two sites show no differences in status and rank. Furthermore, the timing of LEH indicates stress events occurred post-weaning. Interestingly, however, the dental evidence from Kfar HaHoresh is consistent with the archaeological evidence indicating social stratification existed within the site, particularly among loci 1003 and 1155.

TABLE OF CONTENTS

Table of Contents—continued

LIST OF TABLES

## LIST OF FIGURES

# CHAPTER 1

# INTRODUCTION

Bioarchaeological studies have utilized the indelible record of health as recorded on the teeth to discuss and interpret the relationships among peoples of the past. The primary dental defects of interest are linear enamel hypoplasias, which represent a period of stress experienced during childhood, but also demonstrate that normal enamel function subsequently resumed (Goodman and Rose 1990, 1991; Hillson 1996). It has been hypothesized that certain factors may contribute to the appearance and prevalence of enamel hypoplasias, in particular weaning and socioeconomic status. For infants, human breastmilk provides protection against infection and disease and supplies the body with essential nutrients needed for healthy growth and development (Oddy 2002). When a child undergoes weaning, certain essential immunities are lost, which may result in a decrease in nutritional health (Larsen 2000). Investigations examining the dental remains of early agrarian cultures have revealed that weaning generally occurred between the ages of 2-4 years (Goodman et al. 1980, 1984). During this time children were introduced to solid and soft foods high in carbohydrates and low in protein (Goodman et al. 1984; Goodman and Rose 1991); thus the protein deficit was a physiological stressor that may have led to the development of enamel defects during the weaning period.

A second factor that can influence the development of enamel hypoplasias is socioeconomic status. Socioeconomic status influences how much access individuals have to food resources. A common belief is that high status individuals are protected from certain stressors that lower status people are exposed to, and thus will exhibit fewer defects as they have more rights, power, and access to resources (Goodman and Rose 1991). An analysis of enamel hypoplasias can provide information, which may contribute to our interpretation of the health and lifeways of past peoples.

By analyzing the permanent and deciduous anterior teeth from two Pre-Pottery Neolithic B sites in lower Galilee, Israel, for the presence of enamel hypoplasia, this research explores the notion that elite individuals suffered less stress during early physiological development as a result of their more privileged status. The archaeological evidence from the first site, Kfar HaHoresh, suggests that it is a mortuary complex in which it is postulated that elite individuals from surrounding communities in the area, such as Yiftahel – the second site – are buried. The primary goal of this research is to determine whether the elite from this region were buried at Kfar HaHoresh, using linear enamel hypoplasias as an indicator of status.

To do this, the following three null hypotheses are tested:

- *There is no difference between the amount and incidence rates of enamel hypoplasia at Kfar HaHoresh and at Yiftahel.* If this is proven, then the individuals buried at both sites were equivalent in social status. If there is a significant difference between the amount of enamel hypoplasias and incidence rates of enamel hypoplasias at Kfar HaHoresh and at Yiftahel, then this supports the contention that the elite were buried at Kfar HaHoresh. If the incidence of enamel hypoplasia between Kfar HaHoresh and Yiftahel is significantly different, then differential access to resources at these sites can be inferred, and may suggest competition for resources among villages.

- *There are no differences in the incidence rates of enamel hypoplasia among the teeth found at Kfar HaHoresh.* Interestingly, the different types of burials for individuals buried at Kfar HaHoresh have prompted the notion of social hierarchy within Kfar HaHoresh (Goring-Morris 2000). Therefore, if the incidence of enamel hypoplasia within Kfar HaHoresh varies significantly, this may indicate the presence of social stratification at Kfar HaHoresh itself.

- *The teeth from Kfar HaHoresh and Yiftahel show no differences in the timing of enamel hypoplasias relative to age at weaning.* If the teeth from both sites show similarities in the appearance of enamel defects, then it can be concluded that the surrounding areas were affected by similar nutritional and physiological disruption as seen in children between the ages of 2-4 years, when weaning generally occurs. Dividing the tooth crown into cervical, middle, and incisal thirds (Goodman and Armelagos 1985a), and documenting the frequency of enamel hypoplasia present for each tooth type will indicate a general age range of enamel defect formation. Furthermore, if it is assumed that marked social stratification exists (e.g. elite, non-elite), then similarities in the occurrence of enamel hypoplasia imply that access to resources was not enough to protect higher-class individuals from environmental stressors that are associated with weaning.

The two sites of interest, Kfar HaHoresh and Yiftahel, represent a time of transition when the local subsistence economy is increasingly becoming dependent upon agricultural resources. Several studies have suggested that differences in the frequencies of enamel hypoplasias between groups of individuals may be related to status differentiation and resources access (Cucina and Iscan 1997; Goodman and Armelagos 1988; Lanphear 1990; Malville 1997; Swärtdstedt 1966). Transitions in subsistence based strategies impact inhabitants, which may be witnessed on skeletal remains. For higher status individuals, a shift from hunting and gathering to herding and farming might have been less problematic due to greater (or better) access to resources and a lighter activity load. From this assumption, it could be hypothesized that a high status child making the transition from breastmilk to regular food would have an easier time than a child in a lower status group.

The Neolithic period in the Levant brought about major changes and transitions to the environment and its inhabitants. This is seen most dramatically in a shift in subsistence strategies from hunting and gathering to more sedentary practices of farming. With this shift, there also came an increase in population size, creating a change in community structure. Ritualistic activity proliferated as a means to regulate and maintain the social complexities that existed (Banning 1998; Bar-Yosef and Belfer-Cohen 1989; Flannery 1972; Goring-Morris 2000; Kuijt 2000a; Kuijt and Goring-Morris 2002). For example, mortuary customs, particularly in the Pre-Pottery Neolithic B period, included postmortem skull removal and the use of lime plaster for both facial modeling and grave coverings, which reflected increasing religious and ritual practices that placed an emphasis on ancestor veneration (Bar-Yosef and Belfer-Cohen 1989; Goring-Morris 2000; Hershkovitz et al. 1995; Kuijt 2000a; Kuijt and Goring-Morris 2002).

As elites with more power, these individuals might not be as severely affected by environmental and nutritional stressors that lower status individuals would. Examination of skeletal material provides evidence as to the degree of stress past populations experienced. In particular, the prevalence of enamel hypoplasias indicates how much and at what times individuals underwent nutritional or environmental stress. The analysis of anterior permanent and deciduous dentition from the Pre-Pottery Neolithic B sites of Kfar HaHoresh and Yiftahel may yield pertinent information regarding these agricultural societies' health and condition in the Levant.

This thesis will examine dental remains from Kfar HaHoresh and Yiftahel to uncover the bioarchaeological record of health and social status in these burials. First, a literature review will engage in a discussion on dental morphology and pathologies, the Neolithic in the Levant, and the archaeology of both of these Pre-Pottery Neolithic B sites. The methodologies employed in examining the dentition from Kfar HaHoresh and Yiftahel will then be presented, followed by the results of the data analyses. These results will then be contextualized within the archaeological framework and null hypotheses to demonstrate how bioarchaeological studies such as this can reveal more about community and socioeconomic status than archaeological or biological investigations alone.

# CHAPTER II

# LITERATURE REVIEW

## Tooth Morphology and Enamel Hypoplasias

Standard tooth formation begins *in utero* and follows a general pattern of dental development, both in regard to the development of particular parts of the tooth and also the order of tooth formation and eruption by type (Schour and Massler 1941; Ubelaker 1999). The process of enamel formation on the crowns of teeth is known as amelogenesis, in which cells called ameloblasts begin forming the enamel matrix the $6^{th}$ week *in utero* and continue till approximately the $8^{th}$ year (Goodman and Rose 1990; Hillson 1996). Wave-like perikymata around the circumference of a crown are common on all adult teeth, and they reflect patterns of crown formation. A number of studies analyzed dental formation and eruption sequences in various populations and revealed the presence of specific dental developmental stages (Anderson et al. 1976; Demirjian et al. 1973; Moorrees et al. 1963; Smith 1991). For example, Ubelaker's (1999) work provides a modified version of the dental development chart first presented by Schour and Massler (1941); by compiling data from a prehistoric Amerindian population he established guidelines for estimating age at dental development stage. Since tooth formation always proceeds directionally from crown to root, age at enamel defect formation can be established by examining the distance of a defect from the tip of the tooth crown (Hillson 1996; Sarnat and Schour 1941, 1942).

Crown surfaces are vulnerable to any disruptions during enamel formation. For example, environmental or nutritional stressors experienced during childhood result in deficiencies in enamel thickness, and cause the appearance of certain hypoplastic defects on the crown surfaces. Zsigmondy first coined the term *enamel hypoplasias* in 1893, but these irregularities were recognized and described as early as the middle 1700s (Sarnat and Schour 1941). When systematic or environmental stressors occur, ameloblasts cease to lay down enamel causing defects on the outer surface of the crown (Hillson 1996). Enamel hypoplasias, then are the observable defects on the other surface of a tooth resulting from growth disruptions interrupting the secretion of the enamel matrix. During dental development, enamel is deposited in a ring-like fashion around the circumference of the tooth. Unlike the ability of bone to remodel and repair itself, new enamel formed does not conceal any dental defects that appear (Massler et al. 1941; May et al. 1993). Hypoplasias thus become a permanent feature on deciduous and adult teeth, and provide evidence of a formative disruption in enamel development. It should be noted that not all enamel hypoplasias, however, are the result of dietary deficiencies or diseases. Although rare, some hypoplastic defects are the result of inherited conditions or trauma (Hillson and Bond 1997; Schultz et al. 1998). High concentrations of fluoride in the water have a negative effect on matrix production of enamel causing, at extreme levels, hypoplastic pitting and grooving (Hillson 1990, 1996).

Though all teeth may exhibit enamel hypoplasias, studies have revealed that anterior teeth, particularly the middle half of the crown, are more susceptible to enamel hypoplasias than posterior teeth (Cucina and Iscan 1997; Goodman and Armelagos 1985a, 1985b). Specifically, deciduous and permanent maxillary central incisors and mandibular canines appear to be more vulnerable to enamel insults (Goodman and Armelagos 1985a; Goodman and Rose 1990; Sweeney 1971). The prevalence of enamel hypoplasias shows the number of incidents of nutritional or environmental stress that occurred during childhood dental development.

When enamel development is taking place, traumatic events during a child's life can leave marks on tooth crowns. One traumatic event is weaning, when a child is being introduced to foods other than breastmilk. Nursing provides an infant with nutrients that protect against nutritional deficiencies even when the caloric and protein content of milk is reduced due to extended nursing (past 12 months according to modern standards) (Tamborlane 1997). Breastmilk also contains protective agents, which strengthens an infant's immunologic system guarding against illness and infection (Oddy 2002). When this is lost, a child experiences a lowered immunity, thus increasing susceptibility to enamel disruptions (Goodman and Rose 1991; Hillson 1996; Larsen 2000). Also, the location and severity of these enamel disruptions indicate the age at which the defects formed, and reveal the overall health of individuals in a population (Blakey et al. 1994; Goodman et al. 1984; Wood 1996).

The prevalence of enamel hypoplasias has been determined to reflect socioeconomic status. Data compiled from research on both prehistoric and underdeveloped populations have shown that the prevalence of enamel hypoplasias is linked to the changing availability and quality of resources (Goodman and Rose 1990; Goodman and Rose 1991; Hutchinson and Larsen 1988; Malville 1997; May et al. 1993; Roosevelt 1984; Wood 1996). The social positioning of an individual or group of people in a society influences how much access they have to food resources. In situations where access is restricted, babies *in utero* and infants experience nutritional stress while enamel is developing; if this stress is chronic it will develop into enamel defects. Research on enamel defects has shown that the frequencies of these defects can be used to understand the health and nutritional status of both expectant women and young children (Larsen 1997; Skinner and Hung 1989). This in turn provides clues about living conditions and overall health of individuals in a given population, which may shed light on socioeconomic and sociopolitical organizations responsible for food distribution.

Few studies of enamel hypoplasias in prehistoric samples have been conducted, thereby limiting the opportunity to compare enamel hypoplasia rates in past population synchronically (Wood 1996). This study of enamel hypoplasias among the Pre-Pottery Neolithic B population found at Kfar HaHoresh, and the comparison of these results to the contemporaneous population of Yiftahel, are significant in understanding Pre-Pottery Neolithic B agricultural societies' health and condition in the Levant region. Did differential access to resources exist between groups (e.g. sites)? Did this unequal access to resources cause more hypoplasias in individuals of a lesser social status than in those of higher social status?

Analyses of mortuary practices at these sites (such as cranial or complete skull removal, full burial treatment, or elaborate treatment of crania or skulls with plaster) have suggested that the type of treatment individuals received was relative to their social status (Goring-Morris 2000; Kuijt 2000a; Rollefson 2000). Examination of the prevalence of enamel hypoplasias on these Pre-Pottery Neolithic B individuals may support this assertion by showing that social stratification within groups is reflected in the presence of hypoplasias in individuals unable to access sufficient nutritional supplementation.

## The Neolithic in the Levant

Beginning about 12,000 years ago, a major transition and transformation impacted the inhabitants and the environment of the Levant. As the collection of wild barley and other grains during the Natufian period shifted to domestication of animals and cultivation of plants during the Neolithic, populations became less mobile, eventually establishing hierarchical communities (Banning 1998; Bar-Yosef and Belfer-Cohen 1989; Byrd 2000; Goring-Morris 2000). Public rituals became more elaborate in order to regulate and maintain the social complexities attributed to increasing population size (Banning 1998; Bar-Yosef and Belfer-Cohen 1989; Goring-Morris 2000; Kuijt 2000a; Kuijt and Goring-Morris 2002). The Neolithic defined the major change in lifeways from hunting and gathering to herding and farming. In particular, two periods of the Neolithic, the Pre-Pottery Neolithic A (PPNA) and Pre-Pottery Neolithic B (PPNB), demonstrated this transition as populations grew from smaller, semi-sedentary villages to larger, settled communities.

The term "Pre-Pottery Neolithic" was dubbed after Kenyon's excavation at Jericho revealed pre-ceramic levels (Banning 1998; Bar-Yosef and Belfer-Cohen 1992; Kenyon 1957). Two distinct periods were evident: Pre-Pottery Neolithic A and Pre-Pottery Neolithic B. Similar to the Natufian, PPNA communities subsisted on a varied diet, as they still relied on hunting, gathering, and fishing. However, domesticated grains, such as lentils and horsebeans were also exploited. PPNA villages were small, but with the continued transition from hunting and gathering to farming communities, the architecture began to shift from oval structures to rectangular forms seen in the later Pre-Pottery Neolithic B (Banning 1998; Bar-Yosef 1995). PPNB sites were larger than the preceding PPNA communities, and though hunting of gazelle and auroch still persisted, animal husbandry became more prevalent (Horwitz 1993). The communities of the Pre-Pottery Neolithic B ranged in size from small (e.g. Yiftahel at 1.5 hectares) (Kuijt 2000b) to large (e.g. 'Ain Ghazal at 12-13 hectares) (Verhoeven 2002), yet certain characteristics carried over in each. The use of plaster in the Pre-Pottery Neolithic B period has its roots in the Natufian, where plaster was adopted in constructing the architecture of these more permanent settlements (Rollefson 1990). PPNB sites provide significant information about the Levant during the first half of the 9$^{th}$ millennium BP, and social organization can be inferred from site attributes, particularly mortuary treatment.

Mortuary customs involved post-mortem skull removal and the utilization of plaster for both facial reconstructions and grave coverings, thus reflecting the increasing religious and ritual practices of the Pre-Pottery Neolithic B (Bar-Yosef and Belfer-Cohen 1989; Goring-Morris 2000; Hershkovitz et al. 1995; Kuijt and Goring-Morris 2002). Several types of burials have been identified as occurring in the PPNB. They include primary burials with skulls intact, primary burials with skulls later removed; infants complete with crania in single primary burials; and secondary burials in which partially articulated or disarticulated postcranial remains of multiple individuals were placed with animal remains (Banning 1998; Goring-Morris 2000; Kuijt 2000a; Rollefson 2000). The interment underneath a lime plaster floor of a single individual without the cranium characterized the typical PPNB burial. The removal and subsequent plastering of the skulls placed an emphasis on ancestor veneration, or what has been called the "cult of the ancestors," whereby those in possession of skulls had more rights, wealth, and power over territories and resources (Bar-Yosef and Belfer-Cohen 1989; Flannery 1972; Goring-Morris 2000; Kuijt 2000a; Kuijt and Goring-Morris 2002; Verhoeven 2002). One complete skull (e.g. Jericho) and many crania are known to have been modeled in overlying plaster with human facial features such as lips, nose, and eyelids (Goring-Morris et al. 1995; Hershkovitz et al. 1995; Kenyon 1957).

Lime plaster production is a labor-intensive process, which involves heating limestone to elevated temperatures of 750°C to 850°C (Banning 1998; Garfinkel 1987; Goren et al. 2001). The time put into this labor and the skull needed to prepare the plaster demonstrate the magnitude of this pyrotechnology and the importance of plaster to these early farmers for ritualized purposes: plastering human skulls, household purposes including the construction of floors and wall coverings, sculptures, and hearths (Banning 1998; Goring-Morris et al. 1995; Hershkovitz et al. 1995).

The structural compositions and the use of plaster in the Pre-Pottery Neolithic B demonstrate that more sedentary populations were increasing in size, while the domestication of plants and animals in an agricultural based subsistence economy led to a reliance on a more restricted diet. The impact of increasing population size, in addition to the changes in lifestyle, contributed to the emergence of social hierarchies and ritual ideologies necessary to maintain social cohesion between groups of people (Goring-Morris 2000; Kuijt and Goring-Morris 2002). The need to control territory and resources was reflected in the developing hierarchy, and a creation of elite and non-elite status was established. Access to essential resources such as food and water is important in maintaining health. If a hierarchical dichotomy exists, some individuals will negatively be affected, and such stressors may be evident in the skeletal remains. The human burials from the Kfar HaHoresh regional mortuary center for the elite provide an excellent sample from which to examine whether power and access to resources contributed to a healthier life during the Pre-Pottery Neolithic B.

## The Site of Kfar HaHoresh

The site of Kfar HaHoresh, dated to the middle part of the Pre-Pottery Neolithic B (9,000-8,500 BP), is a funerary center (0.5 hectares) (Kuijt 2000b) located in the lower Galilee Nazareth Hills of Israel, some 30 kilometers east of the Mediterranean Sea (Goring-Morris 2000; Goring-Morris 1994/95) (Figure 1). Excavations began in 1991 after plowing and reforestation efforts in the fall of 1990 revealed a small, apparent settlement site threatened by sewage seepage directly adjacent to it. Lithic and marine shell assemblages found during preliminary investigations date to the first half of the $9^{th}$ millennium BP, and are similar to those found at the nearby PPNB site of Yiftahel. The Israel Antiquities Authority initiated and funded excavations at Kfar HaHoresh under the direction of Nigel Goring-Morris, as the site provided potential for comparative data concerning changing lifeways during the Pre-Pottery Neolithic B period (Goring-Morris et al. 1995).

The site offered compelling evidence of intensive ritual activity unparalleled at other PPNB sites in the Levant. Due to several factors, Kfar HaHoresh was suspected to be a regional mortuary center rather than a small village community: (1) complete absence of domestic architecture (Goring-Morris et al. 1998); (2) the location of the site in a narrow wadi on a north facing slope not conducive to agriculture within a 5-kilometer radius (Goring-Morris et al. 1994/95); (3) the prevalence of burials, including articulated animal burials in close association with human burials (Goring-Morris 2000). Summer excavations continuing throughout the present have provided further evidence of ritualistic activity, thereby depicting Kfar HaHoresh as a major funerary center for surrounding villages in the area.

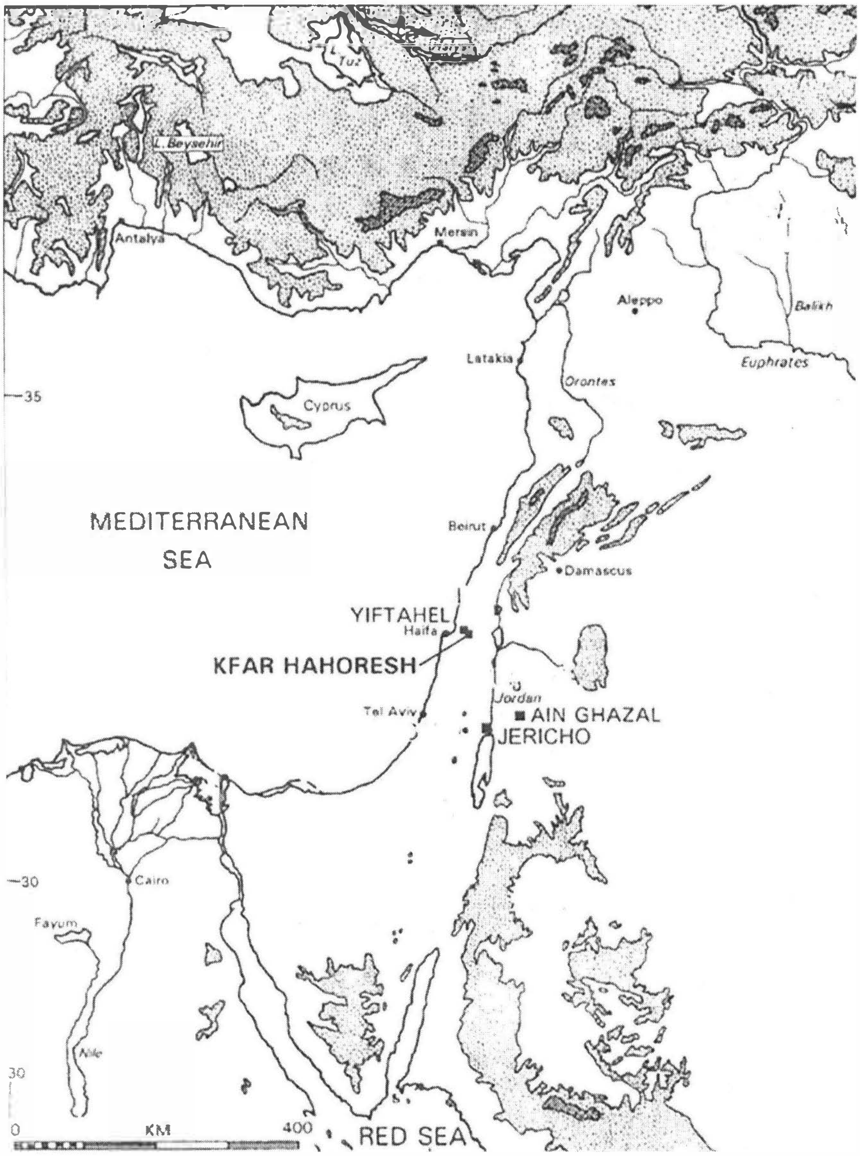


Figure 1. Map Showing the Location of the PPNB Sites of Kfar HaHoresh and Yiftahel in Relation to Other PPNB Sites in South-Central Levant (after Goring-Morris 2000:104)

Excavations at Kfar HaHoresh have revealed several aspects of ceremonial activities characteristic of Pre-Pottery Neolithic B mortuary rituals, signifying the site's function as a mortuary center for select individuals (Goring-Morris et al. 1998; Goring-Morris 2000). Furthermore, differential burial treatment among those buried at Kfar HaHoresh demonstrates a social hierarchy reflective of ascribed and achieved status (Goring-Morris 2000). Men and women, as well as children, were all given similar generalized mortuary treatment in the form of primary interment. Some burials included the partially articulated remains of animals. After enough time passed for decomposition of the soft tissue, secondary burial treatments were undertaken, which involved the removal of human crania (of men, women, *and children*), sometimes with the mandible, and often placing disarticulated or partially articulated human remains with animal remains. Typically, the skulls of young males were afforded more elaborate treatment in the form of skull plastering and facial modeling, which, according to Goring-Morris (2000), possibly reflects additional achieved status.

The majority of human burials at Kfar HaHoresh do not represent the typical PPNB practice of single burials absent of the crania that are buried underneath lime plaster floors (Banning 1998; Goring-Morris 2000; Kuijt 2000a). Instead, human remains are scattered throughout, and precluding the animal remains, few burials are associated with grave goods (Goring-Morris 2000). The co-association of human burials with animal remains, particularly gazelle, auroch, and red fox is unique to Kfar HaHoresh, and represents the symbolic significance of these hunted, wild animals during a time of incipient goat husbandry (Horwitz 1993). Interestingly, goat remains have not been found in any burial contexts at Kfar HaHoresh. Some burials exhibited intentional placement and positioning of both human and animal bones into special configurations, such as the depiction of an animal in profile that had a human skull and mandible to represent the mouth, metapodials for the nostril, a mandible for a hoof, and an articulated human lower limb and foot for the tail (Goring-Morris 2000; Goring-Morris et al. 1998). These, as well as additional findings, increasingly portray Kfar HaHoresh as a ritual center.

The secluded setting of Kfar HaHoresh on non-arable land questions the utility of the site as a village community. Spatial distribution at Kfar HaHoresh indicates that different activity areas were associated with mortuary practices (Goring-Morris et al. 1998; Kuijt and Goring-Morris 2002). Midden deposits of burnt stones and animal bones indicate areas of communal feasting during funerary rituals. The eastern portion of the site contained crude knapping debris, the remains of a lime-kiln, and querns across the lime-plastered floor in which one still retained lime plaster. Lime plastered surfaces overlying burials appear to cap off mortuary interments, rather than serve as floors to structures. Additionally, other lime-plastered features, such as slab-lined post supports, appear to represent grave markers or totems. Such grave markers identified the place where certain individuals were buried so that postmortem skull removal could be carried out at a later date. Though the generalized practice of postmortem skull removal and lime plaster floors are observed at other PPNB sites, those sites exhibit archaeological features indicative of residential villages, a characteristic notably absent at Kfar HaHoresh. In light of that and other evidence described above, Goring-Morris (2002) feels Kfar HaHoresh to be an elite mortuary center serving surrounding PPNB villages, including the smaller village of Yiftahel.

## The PPNB Site of Yiftahel

The contemporaneous Pre-Pottery Neolithic B site of Yiftahel, a small (0.5 hectare) village in central Lower Galilee near Kfar HaHoresh, exhibits the typical PPNB burials of single interments of human remains with and without crania (Braun 1997; Garfinkel 1987; Hershkovitz et al. 1986; Kuijt 2000b). Yet, differences in mortuary contexts between Kfar HaHoresh and Yiftahel suggest that individuals entitled to more elaborate treatment were taken from Yiftahel and buried at Kfar HaHoresh. A total of seven individuals, all buried inside domestic structures, were unearthed at Yiftahel (Hershkovitz et al. 1986). Two of the individuals (Homo 1 and Homo 2) were found in the debris of a collapsed and abandoned structure. Interestingly, Homo1, an adult skull, shows evidence of postmortem deformation. Four individuals (Homo 3, Homo 4, Homo 6, and Homo 7) were buried beneath plaster floors in large structures, and the burial of Homo 5 almost certainly conforms to this pattern. Excavations at Yiftahel only yielded burials in which postmortem skull removal occurred. No instances of plastered skulls were recovered in this small village (Hershkovitz et al. 1986), thereby lending support to the idea that the elite from Yiftahel may have been buried at Kfar HaHoresh – and/or that their crania were.

The presence of Kfar HaHoresh as a regional funerary center offers an excellent opportunity to interpret the health of these individuals by examining their skeletal remains. Specifically, an assessment of the teeth and observance of enamel hypoplasias can provide the researcher with clues concerning the childhood health of these individuals, and whether their delineation as an elite protected them from nutritional stresses generally associated with individuals who lacked access to essential resources and nutrients.

# CHAPTER III

## MATERIALS AND METHODOLOGY

### Dental Sample

A goal of this research is to determine whether elite individuals from the Pre-Pottery Neolithic B period (9,000-8,500 BP) of the lower Galilee region in Israel were interred at the mortuary site of Kfar HaHoresh by examining the anterior permanent and deciduous teeth recovered from Kfar HaHoresh and the nearby village of Yiftahel for the presence of enamel hypoplasias. The principal dental samples derived from the sites of Kfar HaHoresh and Yiftahel are housed at the Department of Anatomy and Anthropology, Sackler School of Medicine at Tel Aviv University in Israel. As excavations are still ongoing at Kfar Hahoresh, anterior teeth catalogued through the year 2000 excavation season were examined (n = 103; 59 left and 44 right; MNI = 17 based on left mandibular canines). The number of anterior teeth from Yiftahel is considerably smaller (n = 24; 16 left and 8 right; MNI = 4 based on left mandibular central incisors). Each tooth is counted as a single specimen, with the position in the tooth row and side known for each. The labial crown surfaces of maxillary and mandibular incisors and canines of adults and juveniles were examined by the researcher at least twice and scored for hypoplastic defects (Table 1); juveniles were differentiated by incomplete root formation and smaller size.

Due to the various burial contexts, the sex of the individual corresponding to each tooth could not be determined. Removal of calculus was prohibited due to microbacterial research being performed by other researcher; this precluded the use of some teeth in both populations. Teeth with more than half of the crown missing because of attrition were also omitted.

Table 1.

Number and Type of Teeth from Kfar HaHoresh and Yiftahel

| | Total | | Central Incisor | Lateral Incisor | Canine |
|---|---|---|---|---|---|
| Kfar HaHoresh | 103 | Mandibular | 17 | 16 | 24 |
| | | Maxillary | 22 | 13 | 11 |
| Yiftahel | 24 | Mandibular | 6 | 5 | 6 |
| | | Maxillary | 3 | 3 | 1 |

## Methodology

According to the Developmental Defects of Enamel Index, four of the nine dental enamel defects coded for permanent and deciduous teeth are characteristic features of enamel hypoplasias: pits, horizontal grooves, vertical grooves, and missing enamel (Commission on Oral Health 1982). This research classified defects as a band/line, pit, or mottled pits, which is a more simplified classification system than that proposed by the Commission on Oral Health (1982). No distinction was made between horizontal and vertical bands or lines; hence, horizontal grooves observed in the dentition represent one type of enamel defect, *band/line* (Figure 2). *Pits*, individual circular depressions in the enamel distinct from bands and lines, were scored when present (Figure 3). The final enamel defect classification is *mottled pits*, which are defined as a series of pits clustered together on a tooth crown (Figure 4).

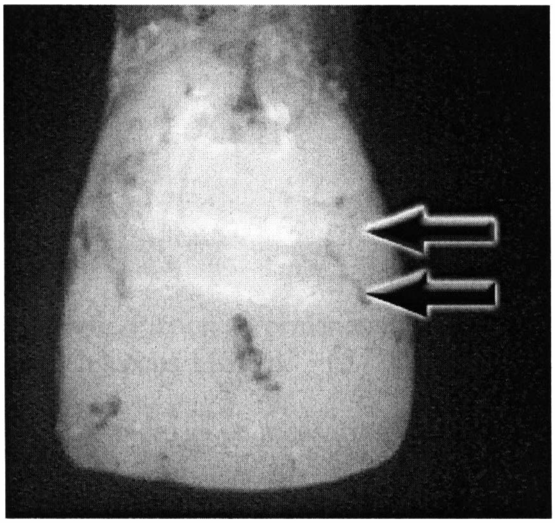

Figure 2. Two B*ands/Lines* on the Enamel Surface of a Permanent Right Maxillary Central Incisor, Kfar HaHoresh Locus 1003, #237

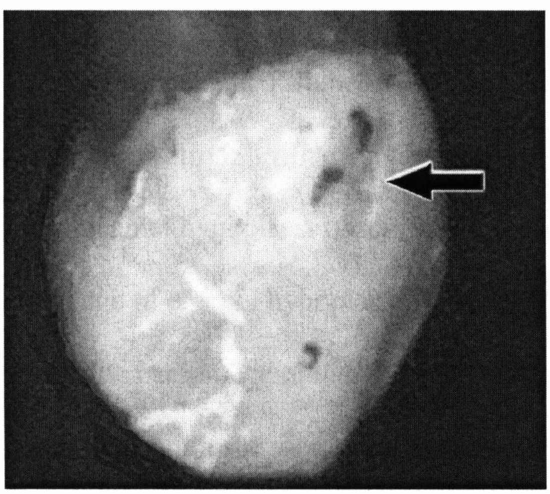

Figure 3. An Example of a *Pit* on a Permanent Right Maxillary Canine, Kfar HaHoresh Locus 1435, a

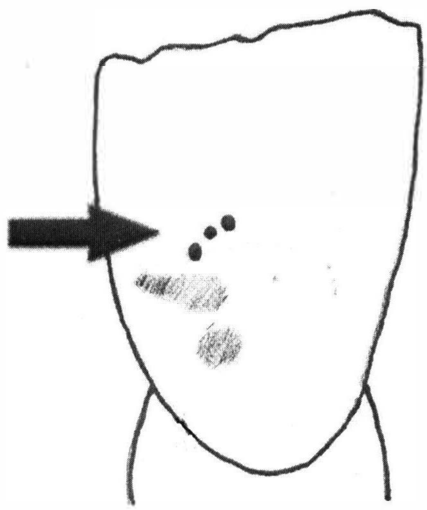

Figure 4. A Drawing of Three *Pits* on a Permanent Mandibular Right Lateral Incisor, Kfar HaHoresh Locus 1155, d

A Carl Zeiss surgical microscope measuring in micrometers was employed to measure the size of the tooth and to determine an approximate location from the dentoenamel junction an enamel defect was, if observed. Each tooth chosen for closer examination was held under the surgical microscope and hand drawn on 1 mm x mm graphing paper. Each square represented one micrometer.

Databases for Kfar HaHoresh and Yiftahel were created in SPSS version 10.0 software to catalog the scored dentition. Primarily, focus was placed on the presence or absence, and quantity of enamel hypoplasia observed for both deciduous and permanent teeth. A percentage of enamel hypoplasia from the total sample of Kfar HaHoresh was compared to the percentage obtained from the total sample of Yiftahel. Furthermore, teeth with single or multiple incidences of enamel hypoplasias were tabulated for both sites.

To test whether elite individuals from surrounding Pre-Pottery Neolithic B communities in the region were buried at Kfar HaHoresh, the difference in the quantity of enamel hypoplasias between Kfar HaHoresh and Yiftahel was examined for significance by using a t-test. If the results prove to be significantly different, then it can be assumed that elite from surrounding PPNB communities, such as Yiftahel, were buried at Kfar HaHoresh.

The incidence of enamel hypoplasia between Kfar HaHoresh and Yiftahel was also examined for significance by employing a Chi-Square test. If the variation between the two PPNB sites is significantly different, then these results offer additional support for the contention that elites from surrounding PPNB communities were interred at Kfar HaHoresh.

Difference in the incidence rates of enamel hypoplasias among the teeth found at Kfar HaHoresh was also examined for significance by using a Chi-Square test. The types of burials at Kfar HaHoresh suggest that social stratification existed at this site. Thus, this method allowed for six loci (1003, 1017, 1020, 1155, 1250, 1435) representing distinct features to be evaluated. If the results reveal significant variation in the incidence of enamel hypoplasia among loci at Kfar HaHoresh, this may indicate the presence of social stratification within Kfar HaHoresh.

One theory concerning the development of enamel hypoplasias involves the belief that a change in diet during weaning contributes to nutritional and physiological disruptions. In a socially stratified society, one assumption is that higher class children (Kfar HaHoresh) will have better access to resources than lower class children (Yiftahel), thus the former will exhibit fewer and less severe enamel defects. If the children buried at Kfar HaHoresh did not have access to better (or more) resources despite their higher status, then teeth from both sites will display enamel defects in the same general locations on crown surfaces.

By documenting the approximate location of enamel hypoplasia, the timing of enamel hypoplasia relative to age at weaning was evaluated for both Kfar HaHoresh and Yiftahel dentition. Since accurate measurements could not be performed, tooth crowns were divided into cervical, middle, and incisal thirds (Goodman and Armelagos 1985a). Based on the timing of anterior tooth growth provided by Reid and Dean (2000), which divided anterior teeth into ten equally spaced zones, each crown third corresponded to an age range in years indicating when enamel hypoplasia formed (Table 2). Only teeth with little or no occlusal wear were included in this analysis ($N_{Kfar\ HaHoresh} = 16$; $N_{Yiftahel} = 5$); teeth exhibiting heavy attrition were omitted ($N_{Kfar\ HaHoresh} = 4$; $N_{Yiftahel} = 3$).

If the dentition shows similarities in the appearance of enamel defects, then presumably one can infer that people in areas surrounding Kfar HaHoresh were subject to similar environmental stressors. Furthermore, if it is established that social stratification exists, then similarities in the timing of enamel hypoplasias suggest that access to resources was not enough to protect higher class individuals from nutritional and physiological disruptions associated with weaning, or that the Kfar HaHoresh individuals did not, in fact, have better access to resources despite the archaeological evidence supporting social stratification.

Table 2.

Age Range (Years) for Enamel Defect Formation for Incisal, Middle, and Cervical Thirds

| | Central Incisor | Lateral Incisor | Canine |
|---|---|---|---|
| *Maxilla* | | | |
| Incisal | 1.1 - 1.8 | 1.8 - 2.4 | 1.7 - 2.4 |
| Middle | 1.8 - 3.4 | 2.4 - 3.7 | 2.4 - 3.8 |
| Cervical | 3.4 - 5.0 | 3.7 - 5.1 | 3.8 - 5.3 |
| *Mandible* | | | |
| Incisal | 1.0 - 1.5 | 1.0 - 1.5 | 1.5 - 2.3 |
| Middle | 1.5 - 2.6 | 1.5 - 2.8 | 2.3 - 4.2 |
| Cervical | 2.6 - 3.8 | 2.8 - 4.2 | 4.2 - 6.2 |

# CHAPTER IV

# RESULTS

## Kfar HaHoresh

From the total sample of Kfar HaHoresh (n = 103), twenty anterior teeth exhibited enamel hypoplasias, corresponding to 19.42% of the sample from this site. Eight teeth had two or more incidences of enamel hypoplasias, while twelve only demonstrated a single enamel insult (Table 3). A total of fourteen incisors displayed enamel hypoplasias. More specifically, nine maxillary central incisors ($I^1$) were affected. The remaining six teeth, canines, all had single incidences of enamel insults. Five were mandibular canines (c). Maxillary central incisors exhibited a considerable greater quantity of hypoplasias (n = 20) over any other tooth type (Figure 5). The most common type of defect observed for all teeth was band/line.

Table 3.

Type of Tooth with Incidence of Hypoplasias from Kfar HaHoresh

| | | Incisors (n=14) | | Canine (n=6) |
|---|---|---|---|---|
| | | Central | Lateral | |
| Single Defect | maxillary | 3 | 0 | 1 |
| | mandibular | 1 | 2 | 5 |
| Multiple Defects | maxillary | 6 | 1 | 0 |
| | mandibular | 1 | 0 | 0 |

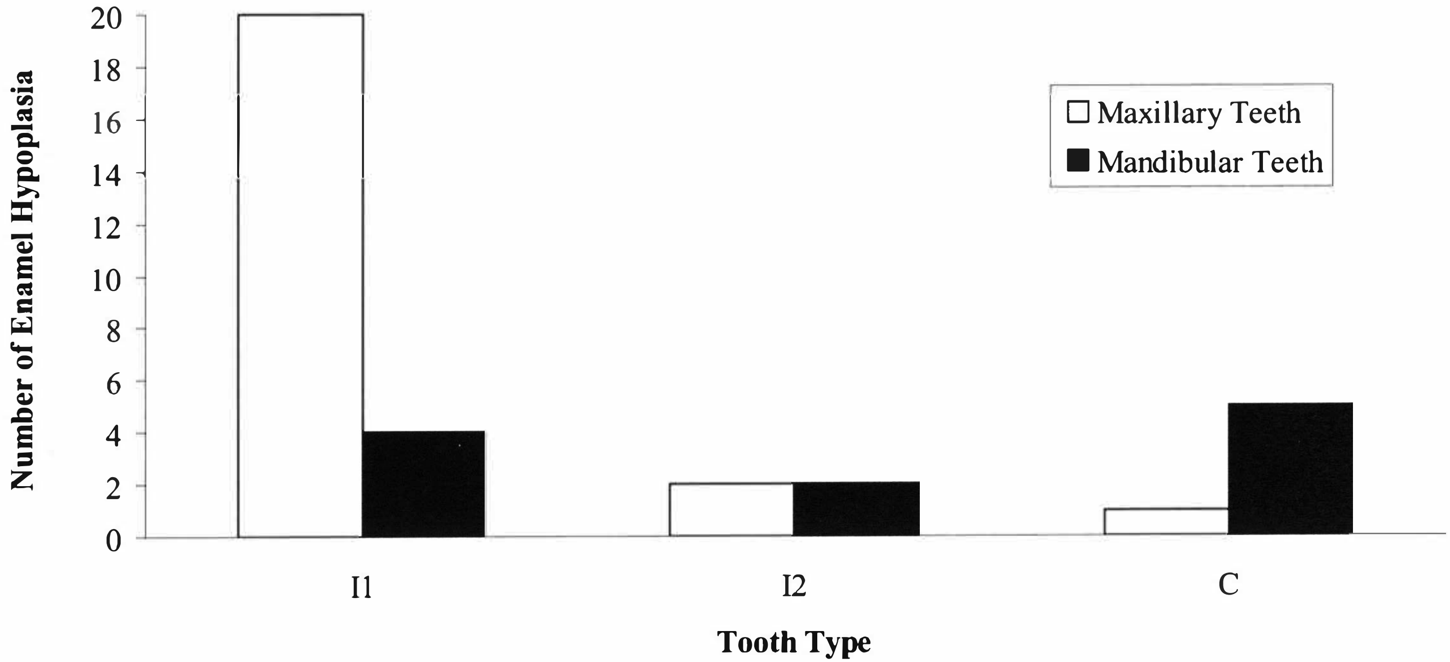


Figure 5. Number of Enamel Hypoplasias for Each Tooth Type at Kfar HaHoresh

## Yiftahel

An analysis of the Yiftahel dentition yielded eight teeth with enamel hypoplasias, which corresponds to 33.33% of the sample (n=24). Five teeth exhibited only one type of defect, and the remaining three had multiple enamel hypoplasias (Table 4). Mandibular central incisors exhibited a greater quantity of enamel hypoplasias (n = 4) over any other tooth type (Figure 6). The most common type of defect observed for all teeth was band/line.

Table 4.

Type of Tooth with Incidence of Hypoplasias from Yiftahel

| | | Incisors (n=6) | | Canine (n=2) |
|---|---|---|---|---|
| | | Central | Lateral | |
| Single Defect | maxillary | 2 | 1 | 0 |
| | mandibular | 0 | 0 | 2 |
| Multiple Defects | maxillary | 0 | 0 | 0 |
| | mandibular | 2 | 1 | 0 |

## Statistical Tests of Significance

A major theory explored in this research is whether elite individuals from surrounding Pre-Pottery Neolithic B sites in the Levant region were buried at Kfar HaHoresh. Furthermore, it is hypothesized that elite individuals will exhibit fewer amounts of enamel defects than lower status individuals as a result of improved

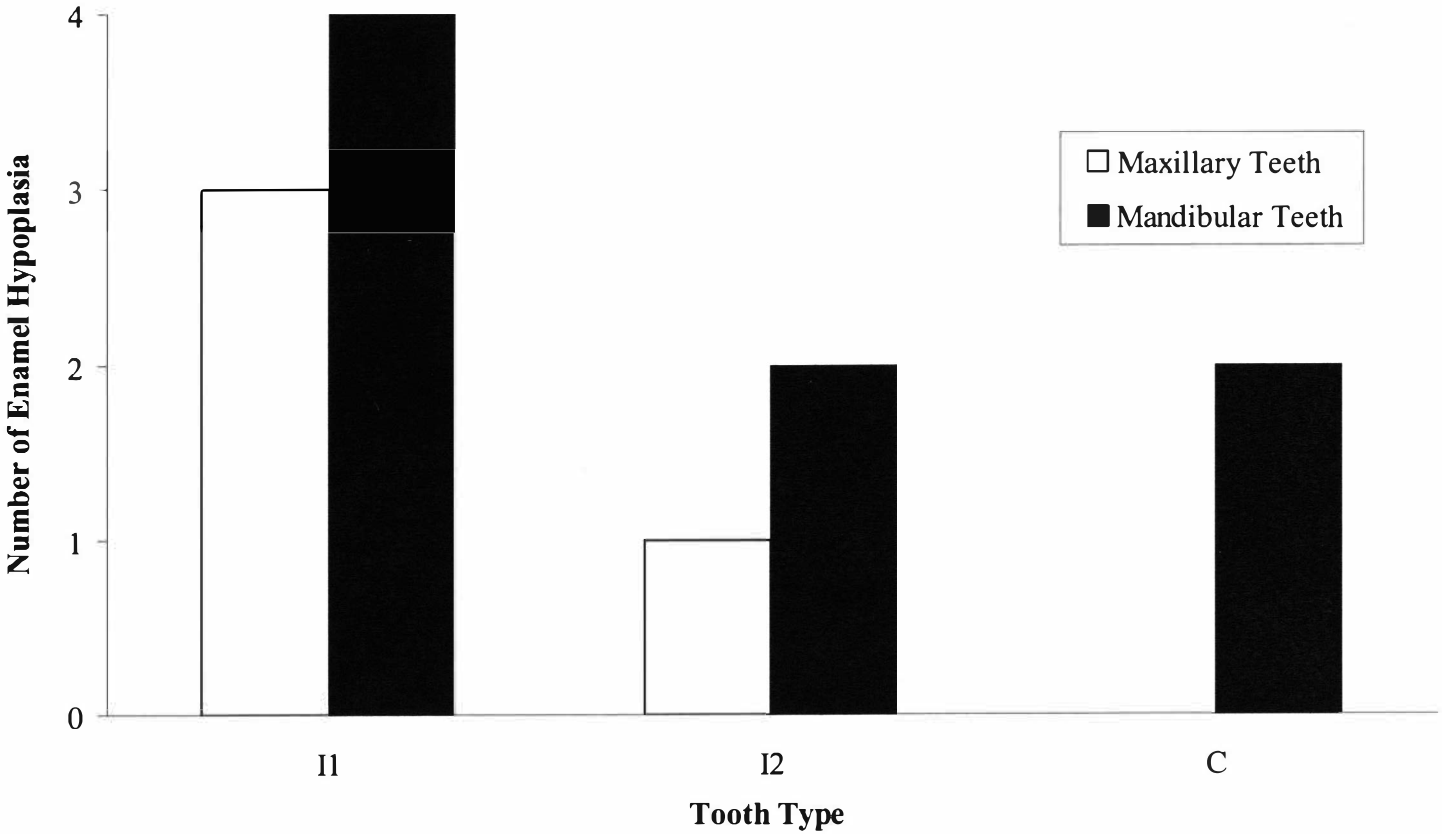


Figure 6. Number of Enamel Hypoplasias for Each Tooth Type at Yiftahel

access to resources. A t-test designed to test this theory examined the differences in the amount of hypoplasias present at Kfar HaHoresh and at Yiftahel. The results reveal that the amount of hypoplasias at Kfar HaHoresh is not significantly different than the amount at Yiftahel (p-value = 0.434). In other words, both sites display similar amounts of enamel hypoplasias.

In a second test, variation in the incidence of enamel hypoplasia between Kfar HaHoresh and Yiftahel was tested to confirm the results from the previous t-test. The Chi-Square test employed shows that the variation between Kfar HaHoresh and Yiftahel are not significantly different (p-value = 0.261). These results are consistent with the results of the t-test.

Although evidence from enamel defects does not support the theory that elite individuals from surrounding PPNB villages were buried at Kfar HaHoresh, established archaeological evidence at the site of Kfar HaHoresh does, however suggest that social stratification exists (Goring-Morris 2000). A Chi-Square test examining the incidence of enamel hypoplasias among six specific loci within Kfar HaHoresh was performed to determine if variation within the site offers support for social stratification. The results demonstrate that there is significant difference in the incidence of enamel hypoplasia among loci (p-value = 0.032). This is due, in part, to the increased incidence of enamel hypoplasia among two loci in particular, Locus 1003 and Locus 1155 (Table 5). Thus, the existence of social stratification, or at least social differentiation within Kfar HaHoresh, may be inferred.

Table 5.

Incidence of Enamel Hypoplasia Among Loci at Kfar HaHoresh

| Locus | Incidence of Hypoplasia |
|---|---|
| 1003 | 14 |
| 1155 | 11 |
| 1435 | 6 |
| 1017 | 1 |
| 1020 | 1 |
| 1250 | 1 |

## Distribution of Enamel Hypoplasias by Crown Thirds

The calculation of enamel hypoplasia frequency by incisal, middle, and cervical thirds indicates which area of the tooth crown was more susceptible to enamel disruptions. By assigning age ranges to these crown thirds, one can infer relative age at which events leading to the development of enamel hypoplasias occurred. Among the Kfar HaHoresh and Yiftahel dentition, central incisors display an increasing frequency of enamel hypoplasias in the middle third of the crown, then decreasing in frequency in the cervical third (Figure 7). The combination of age ranges for maxillary and mandibular central incisors demonstrates that the first wave of enamel defects developed between the ages of 1.5 and 3.4 years.

A closer look at the maxillary central incisors indicates that the highest frequency of enamel hypoplasias occurred in the middle third of the crown at Kfar HaHoresh suggesting that the enamel hypoplasias developed anywhere from 1.8 years to 3.4 years (Figure 8) (Table 6). The maxillary central incisors from Yiftahel show a

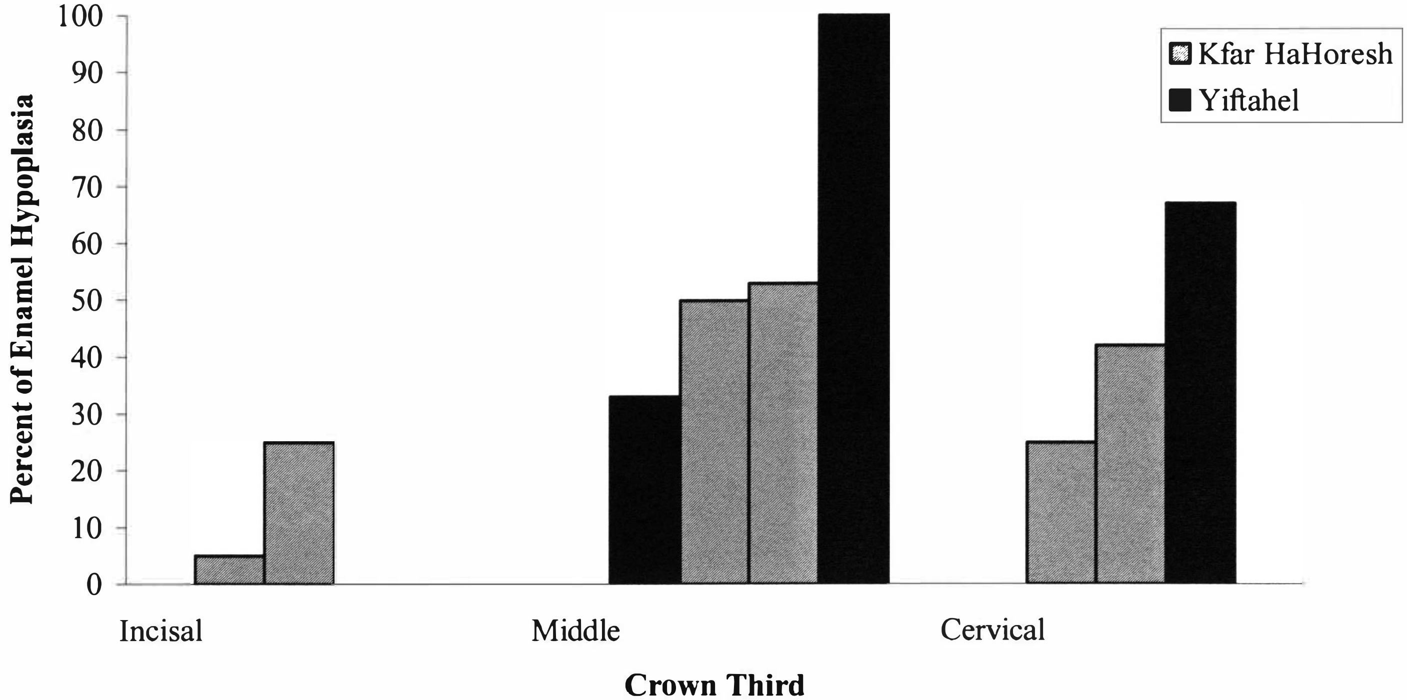


Figure 7. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Central Incisors from Kfar HaHoresh and Yiftahel

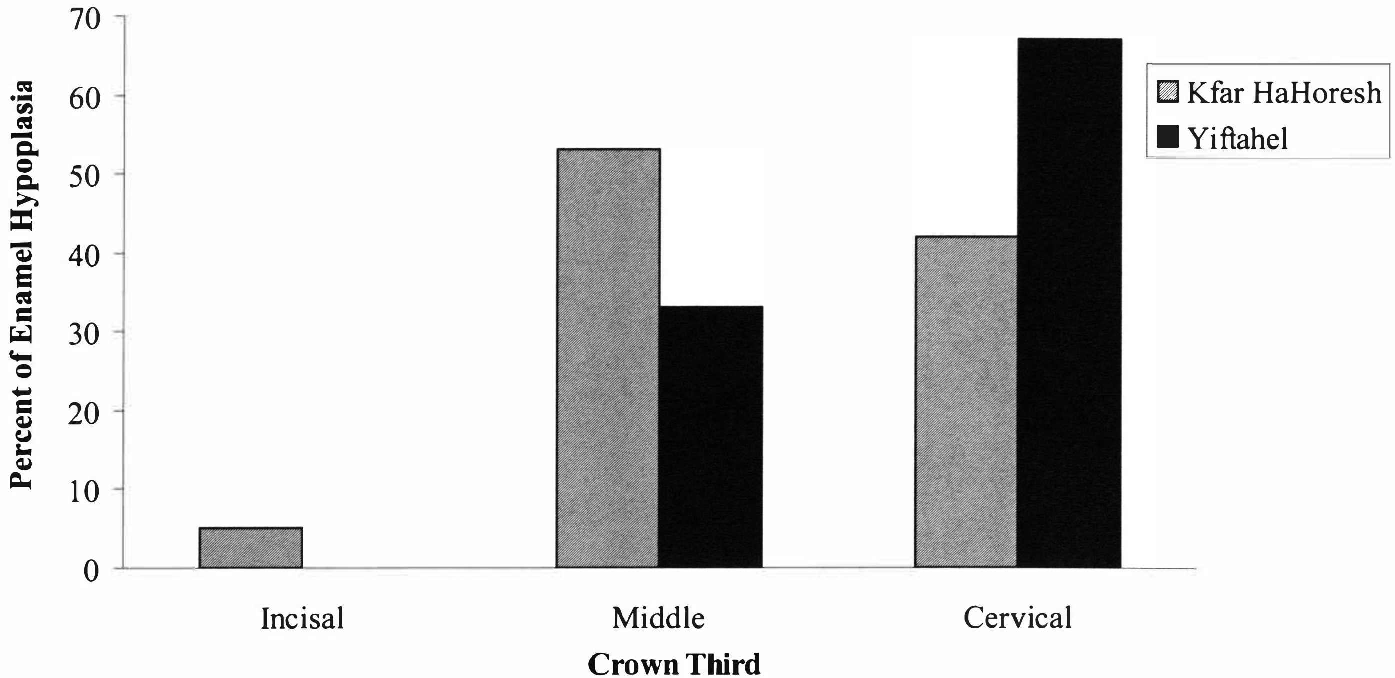


Figure 8. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Maxillary Central Incisors from Kfar HaHoresh and Yiftahel

Table 6.

Comparison of Peak Frequency Age Ranges (Years) for Kfar HaHoresh and Yiftahel Dentition

| | Kfar HaHoresh | Yiftahel |
|---|---|---|
| $I^1$ | 1.8 – 3.4 | 3.4 – 5.0 |
| $I_1$ | 1.5 – 2.6 | 1.5 – 2.6 |
| $I^2$ | 2.4 – 3.7 | 1.8 – 2.4 |
| $I_2$ | 1.0 – 1.5 | 1.5 – 4.2 |
| C | 3.8 – 5.3 | — |
| c | 4.2 – 6.2 | — |

peak frequency of enamel hypoplasia in the cervical third corresponding to an age of development from 3.4 years to 5.0 years.

Peak frequencies of enamel hypoplasias in the lateral incisors of the Kfar HaHoresh and Yiftahel dentition appear in the earlier stages of crown development (e.g. incisal and middle thirds) suggesting a disruption in the enamel formation occurred between 1.0 years and 3.7 years (Figure 9). Only the canines from Kfar HaHoresh exhibited enamel hypoplasias. The highest frequency of enamel defects in the maxillary and mandibular canines was observed in the cervical third of the crown (Figure 10). The age range for the development of these enamel insults is 3.8 years to 6.2 years.

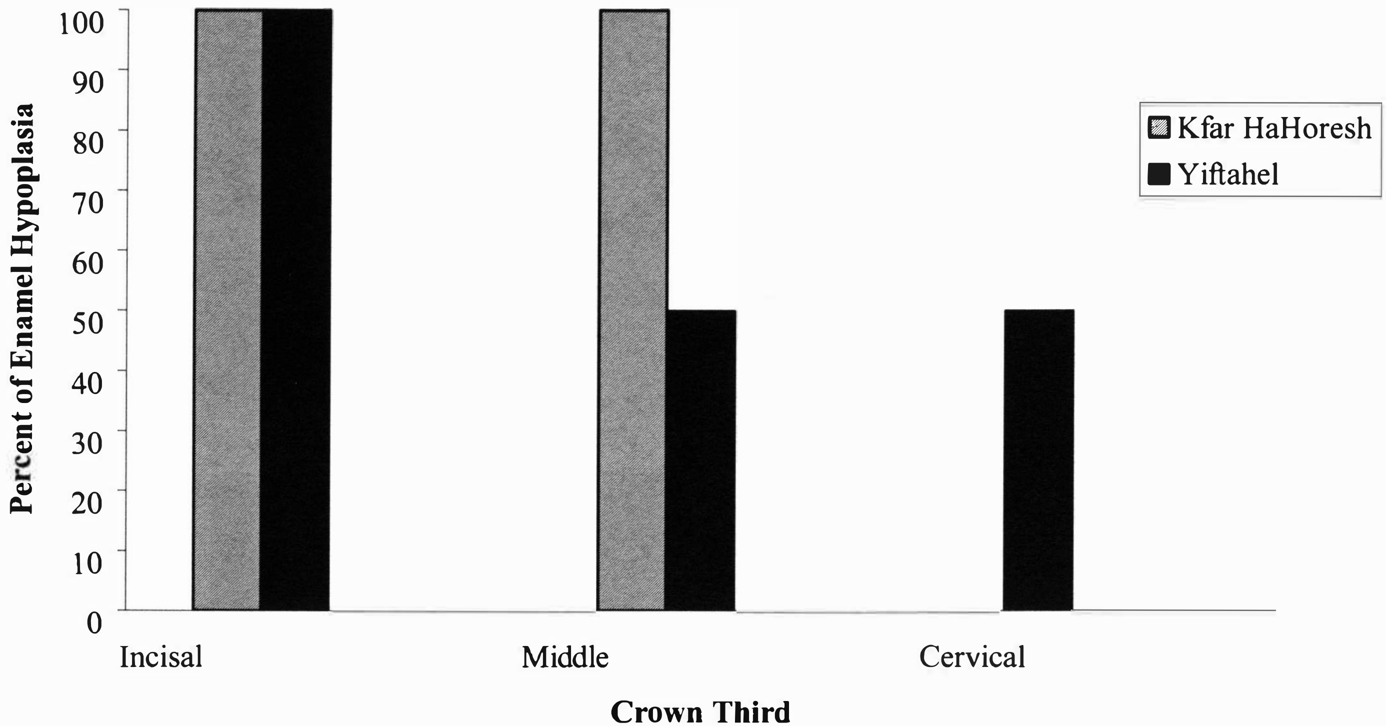


Figure 9. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Lateral Incisors from Kfar HaHoresh and Yiftahel

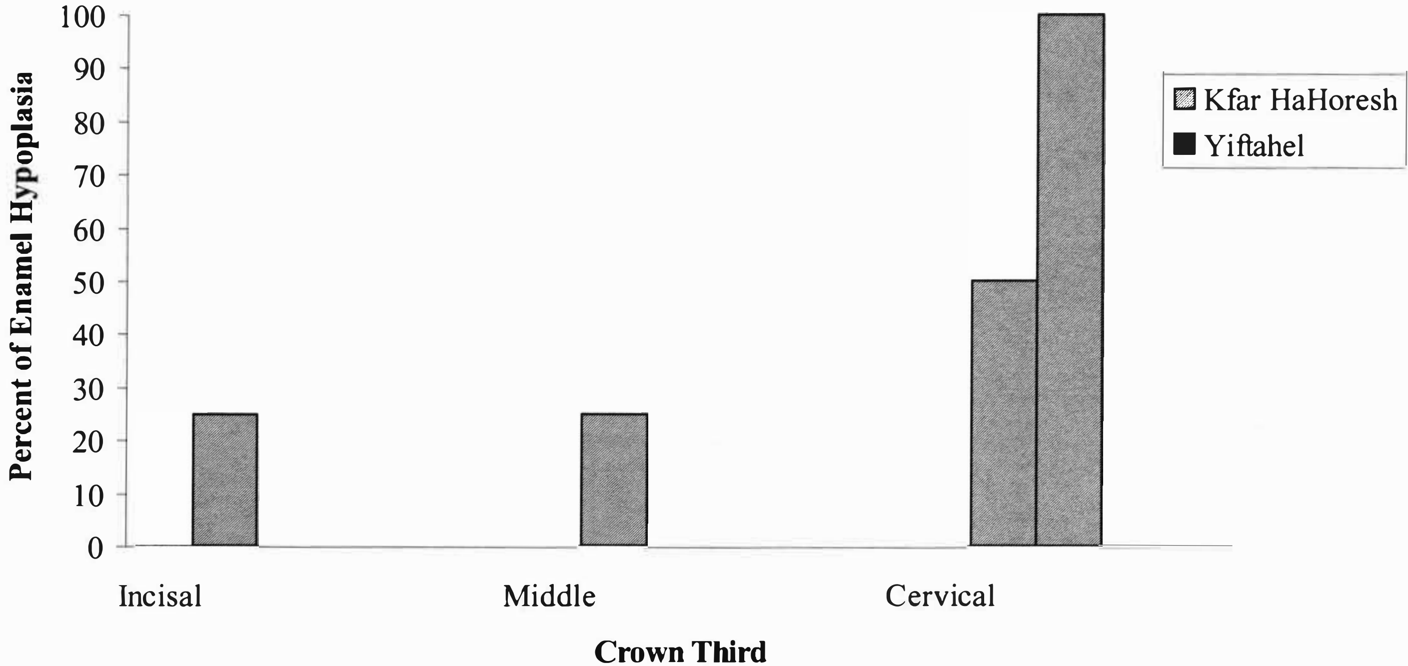


Figure 10. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Canines from Kfar HaHoresh and Yiftahel

Figure 11 presents a precise illustration of the percentage of enamel hypoplasias that occur by incisal, middle, and cervical thirds for the Kfar HaHoresh and Yiftahel dentition. For the Kfar HaHoresh dentition, the distribution of enamel hypoplasias among central incisors show a peak frequency in the middle third of the tooth crown (Figure 12); canines have the highest frequency y of hypoplasia appearing in the cervical third (Figure 13). The middle third of the maxillary central incisors and incisal third of mandibular lateral incisors exhibit 100 percent of enamel hypoplasias (Figure 14).

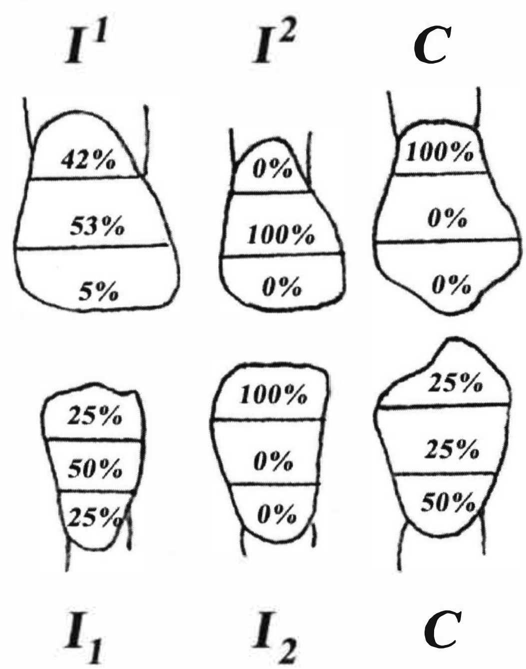


Figure 11. The Frequency of Enamel Hypoplasias by Incisal, Middle, and Cervical Crown Thirds for the Anterior Dentition of Kfar HaHoresh

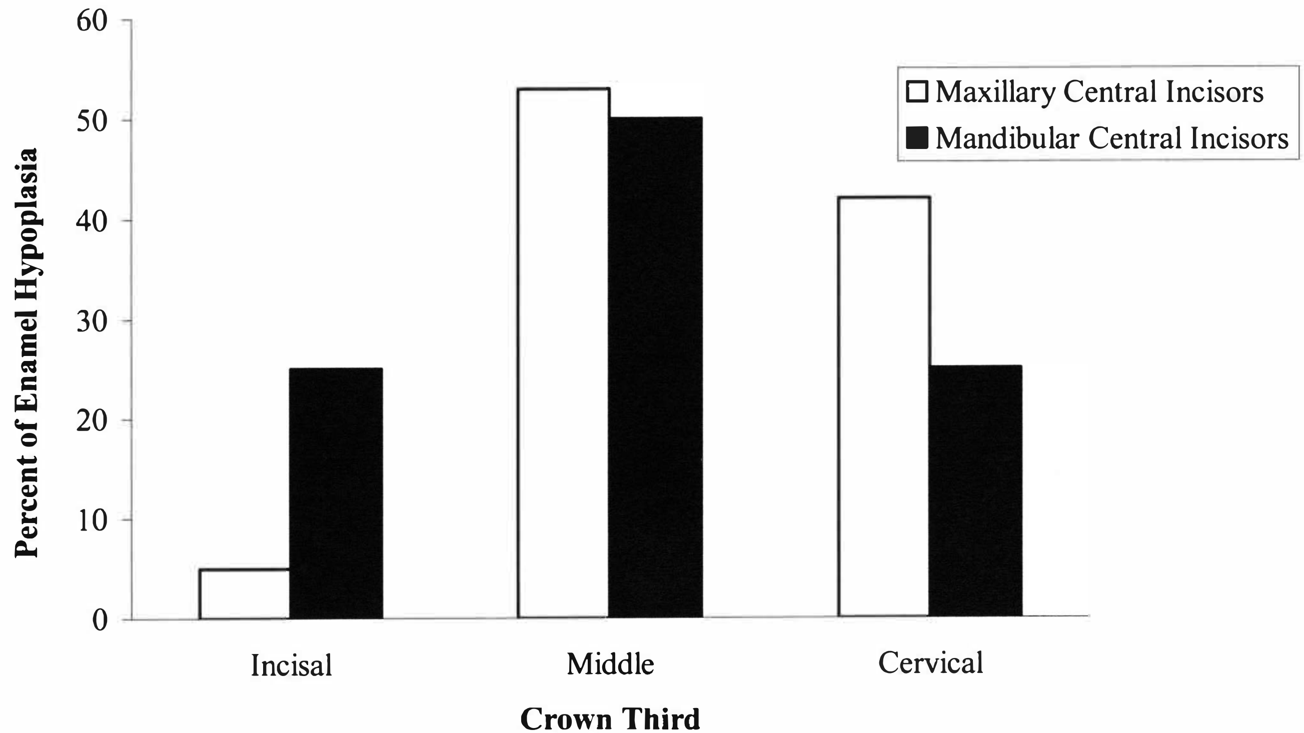


Figure 12. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Central Incisors from Kfar HaHoresh

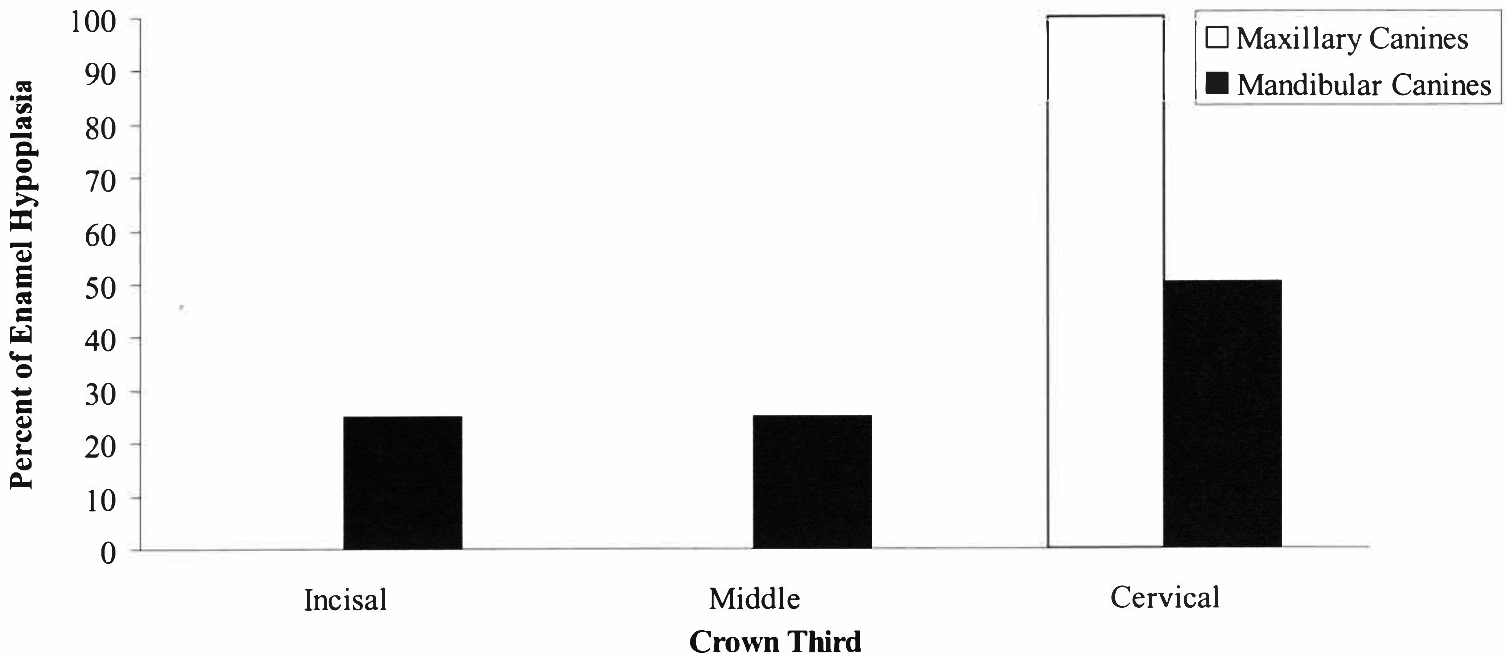


Figure 13. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Canines from Kfar HaHoresh

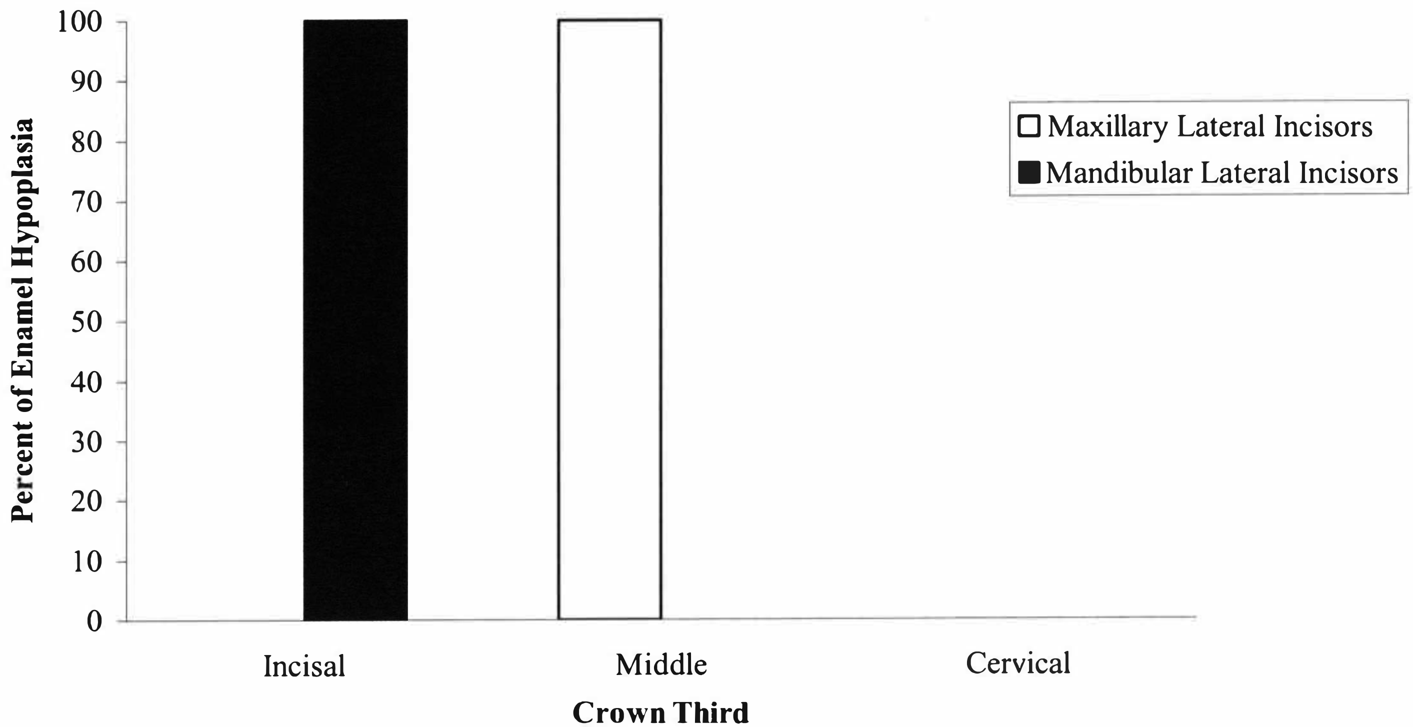


Figure 14. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Lateral Incisors from Kfar HaHoresh

The appearance of enamel hypoplasias among the Yiftahel dentition varies for each tooth type (Figure 15). Mandibular central incisors have enamel hypoplasias occurring only in the middle third of the tooth (Figure 16). The peak frequency in maxillary central incisors is in the cervical third of the tooth. Enamel hypoplasias observed in the maxillary lateral incisors appear in the incisal third of the crown (Figure 17). Mandibular lateral incisors have an equal amount of enamel defects appearing in the middle and cervical thirds. No enamel hypoplasias were observed in the canines.

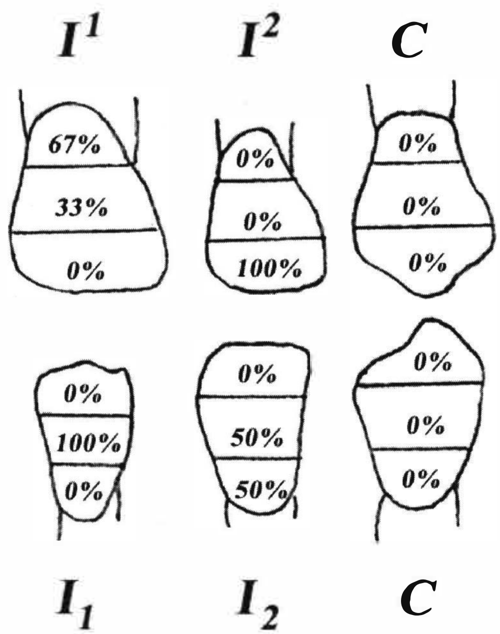


Figure 15. The Frequency of Enamel Hypoplasias by Incisal, Middle, and Cervical Crown Thirds for the Anterior Dentition of Yiftahel

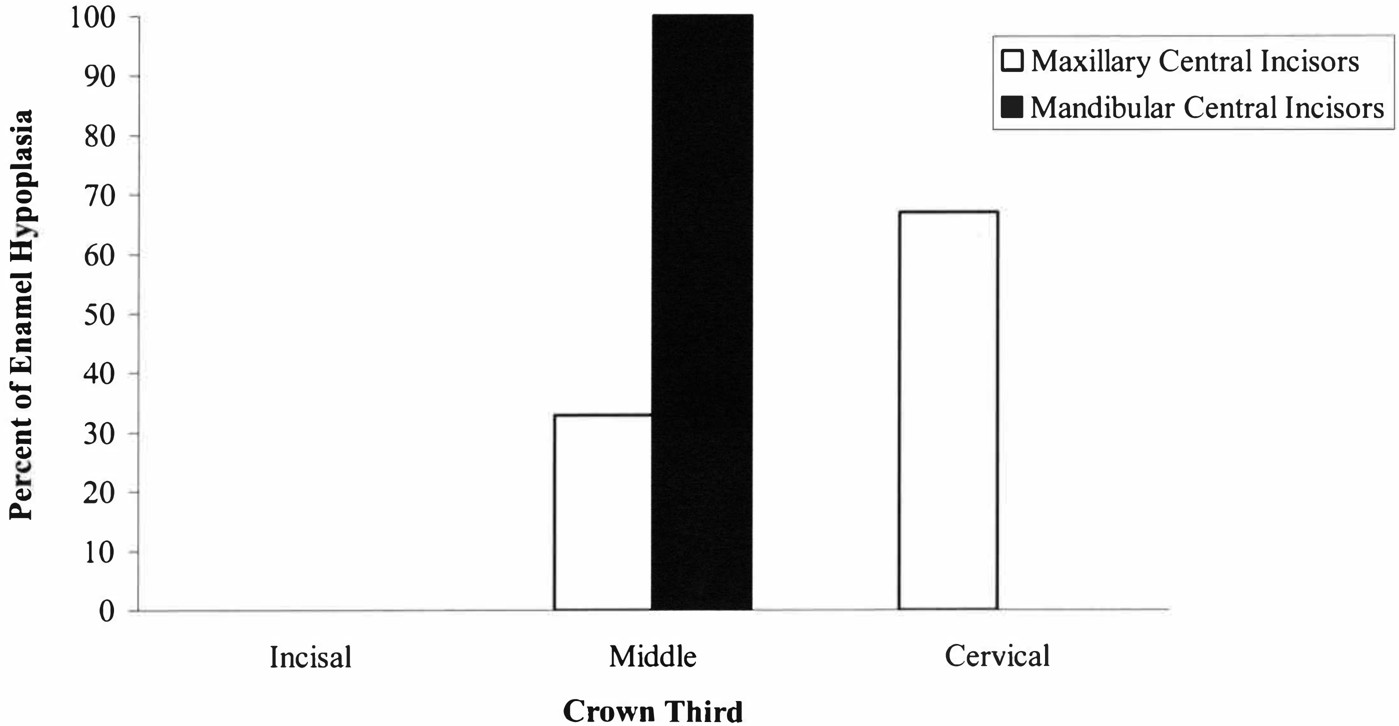


Figure 16. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Central Incisors from Yiftahel

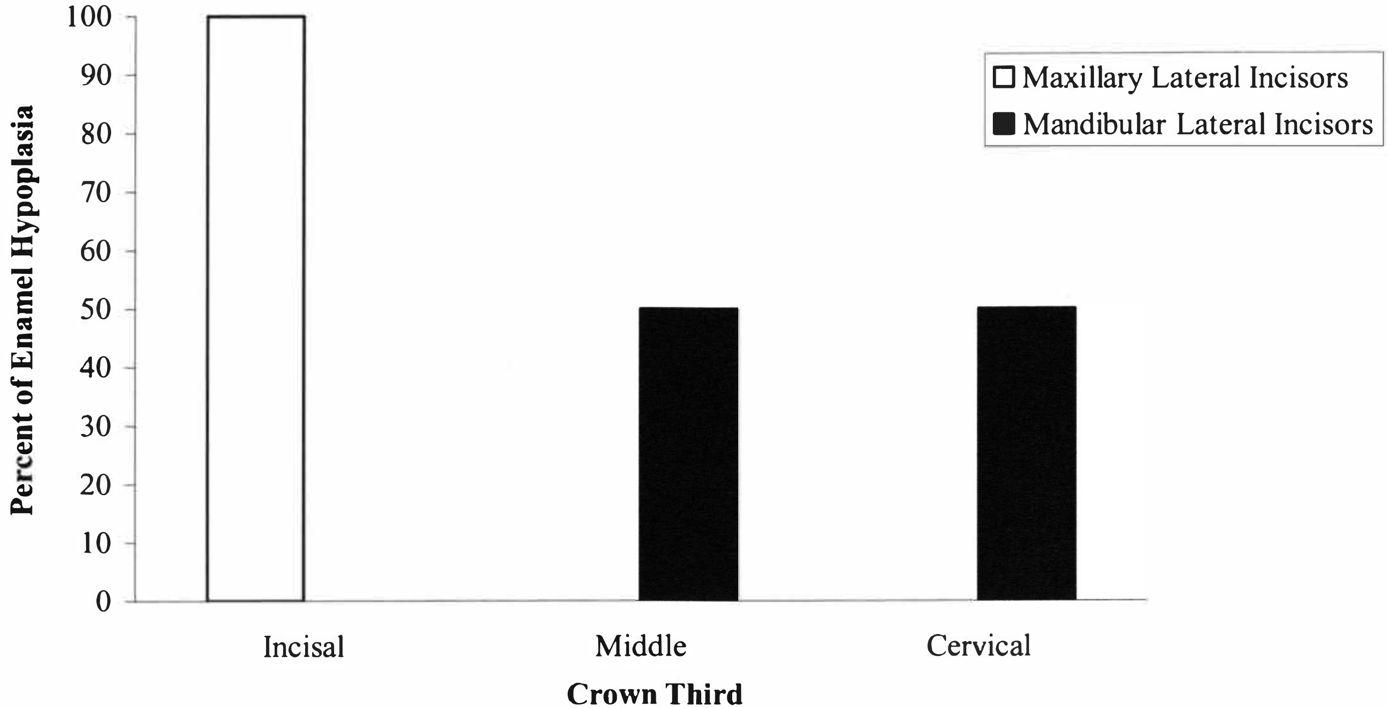


Figure 17. Comparison of the Distribution of Enamel Hypoplasia by Tooth Thirds for Lateral Incisors from Yiftahel

An examination of all of the dentition from Kfar HaHoresh and Yiftahel reveals that enamel hypoplasias are more prevalent in the maxillary central incisors over any other tooth category at both sites (Table 7). The mandibular canines exhibit the next highest frequency of enamel hypoplasias at Kfar HaHoresh (20.83%) and Yiftahel (33.3%).

The first significant finding of this study offers conflicting information between physiological and archaeological evidence. A comparison of Kfar HaHoresh and Yiftahel dentition yields no significant differences in the amount and incidence of enamel hypoplasias between Kfar HaHoresh and Yiftahel, thus implying that no significant social differentiation exists between the two sites. The interpretation of the archaeological record for Kfar HaHoresh (namely with regard to mortuary data), however, indicates social differentiation existed (Goring-Morris 2000). When the dentition for Kfar HaHoresh was examined alone, significant differences in the incidence of enamel hypoplasia among six different loci were revealed. In this respect, social stratification within Kfar HaHoresh may be inferred.

Although enamel hypoplasias are more prevalent in the maxillary central incisors followed by the mandibular canines at both Kfar HaHoresh and Yiftahel, a more detailed analysis of the dentition shows that they appear earlier in the Kfar HaHoresh samples, specifically as seen in the maxillary central incisors (1.8 – 3.4 years of age), than in the Yiftahel sample (3.4 – 5.0 years of age). This seems to indicate that the two populations were subject to stressors of different types, which affected the children at different times (ages). The Kfar HaHoresh ages for enamel hypoplasias correspond to average weaning age, while those at Yiftahel may relate more to subsequent episodes of disease or nutritional stress.

Table 7.

Prevalence of Enamel Hypoplasias by Tooth Type for Kfar HaHoresh and Yiftahel

| | Maxilla | | | Mandible | | |
|---|---|---|---|---|---|---|
| | Central Incisor | Lateral Incisor | Canine | Central Incisor | Lateral Incisor | Canine |
| Kfar HaHoresh | 9/22 (40.91%) | 1/13 (7.69%) | 1/11 (9.09%) | 2/17 (11.76%) | 2/16 (12.5%) | 5/24 (20.83%) |
| Yiftahel | 2/3 (66.67%) | 1/3 (33.33%) | 0/1 (0%) | 2/6 (33.33%) | 1/5 (20%) | 2/6 (33.33%) |

# CHAPTER V

# DISCUSSION

## Social Differentiation

The results of this study have important implications for present investigations concerning the Pre-Pottery Neolithic B societies in south-central Levant. An essential issue explored in this research involves the proposed hypothesis that individuals interred at Kfar HaHoresh represent a select group of individuals from surrounding communities who were afforded more ritualized burial treatment (Goring-Morris 2000). The evidence provided by comparing both the quantity and incidence of enamel hypoplasias at Kfar HaHoresh and Yiftahel indicates, however, that there is no significant difference between the individuals buried at Kfar HaHoresh and those at Yiftahel. This suggests that differential access to resources, if a factor in smaller communities like Yiftahel, did not affect the physiological health of the individual. Despite the mortuary evidence indicating ascribed and achieved status, physiologically there appears to be no difference in the way children of ascribed status were "raised" compared to others.

The assessment of enamel hypoplasias among the teeth within Kfar HaHoresh, however, does suggest that some social differentiation exists at this site itself. This finding is consistent with Goring-Morris (2000) who suggests that funerary treatments for men, women, and children observed at Kfar HaHoresh reflect both ascribed and achieved status. Much of the literature pertaining to the Levantine Neolithic attests to the development of social hierarchies in response to the dynamics associated with increasing population size and transitions in subsistence strategies (Banning 1998; Bar-Yosef and Belfer-Cohen 1989; Byrd 2000; Goring-Morris 2000; Kuijt 2000a, 2000b). (Yet, these cultures maintained an egalitarian worldview.)

Material culture from the PPNB indicates that these societies maintained an egalitarian ethos in which multiple social units, or as what Kuijt (2000a) refers to as "houses", of integrated household and kin-group lines reinforced complex social rules. These rules fostered competition and cooperation, which limited and controlled the accumulation of power and authority by one house and limited the degree of social differentiation among individuals. Ritual behavior, specifically the mortuary tradition of skull removal, upheld this egalitarian ideology by emphasizing communal ancestor veneration, thus encouraging social solidarity among multiple PPNB community households (Byrd 2000; Cauvin 2000; Goring-Morris 2000; Kuijt 2000a, 2000b; Kuijt and Goring-Morris 2002).

The site of Kfar HaHoresh reflects this ideology given the evidence of generalized mortuary treatment for men, women, and children, as well as signs of communal feasting and ancestor veneration, as supported by the collection of skull caches at areas within the site (Goring-Morris 2000). In tandem with this relatively egalitarian tradition, archaeological evidence also demonstrates social differentiation, e.g. ascribed and achieved status, via secondary mortuary ritual contexts and the differential burial treatment of the dead, such as skull plastering complete with facial modeling and placement of animal remains with human bones (Goring-Morris 2000; Kuijt 2000a). Dental evidence in the form of enamel hypoplasias supports the existence of social differentiation among individuals within the funerary site of Kfar HaHoresh.

Two loci in particular (1003 and 1155) are significant burials of multiple individuals that exhibit greater incidences of hypoplasias (14 and 11, respectively) compared to the other four loci, which only have a few incidences of hypoplasias (Figure 18). Interestingly, these two loci have different archaeological interpretations (Table 8). While the human and animal bones appear to have been intentionally placed into both of these pits, recent research has demonstrated that the human bones from these two loci exhibit different postmortem treatment (Simmons 2002). Locus 1003, a multiple use secondary burial pit that includes infant/fetal remains, exhibits a very small percentage (0.02%) of postmortem human modification, but the percentage of teeth with multiple incidences of enamel hypoplasias is quite large (71.4%). Locus 1155, another burial with a skull cache and both human and animal bones arranged to depict an animal in profile (Figure 19), exhibits a greater percentage of postmortem human modification (6.1%); but a smaller percentage of teeth exhibits multiple incidences of enamel hypoplasias (42.9%).

These differences in the loci at Kfar HaHoresh together with the secondary burial contexts may represent locations where different community households placed their dead – where households differentiated themselves from each other. The teeth in Locus 1155 exhibited fewer multiple incidences of enamel insults than those in

Table 8.

Descriptions of Six Loci Examined Within Kfar HaHoresh

| Locus | Description |
|---|---|
| 1003 | Multiple use secondary burial pit that includes at least 12 individuals (based on the mandible); also contains infant/fetal remains. Bones appear to be intentionally placed around the edges of the pit. There are over 1000 bones and bone fragments from this locus, and only a minute percentage exhibits postmortem human modification, as well as animal modification. |
| 1155 | Burial with articulated and disarticulated human and animal bones. Intentional placement of bones to depict an animal in profile; also includes skull cache. Greater percentage of the over 700 bones exhibit human and animal modification. |
| 1435 | Part of a midden deposit. |
| 1017 | Lime plastered structure. |
| 1020 | Supine burial minus the skull (mandible remains). Grave postdates Locus 1017. |
| 1250 | Grave with adult mandible and infant skull. Predates Locus 1017. |

Locus 1003, and based on the taphonomic investigations by Simmons (2002) more attention appears to have been given to the bones in Locus 1155. It is plausible to infer that the individuals, as members of a household community interred in Locus 1155, had better access to resources than those individuals of another household community placed in Locus 1003, and elsewhere in Kfar HaHoresh. It must be noted, however, that the stratigraphic relationship between Locus 1003 and Locus 1155 is unclear; therefore these may be diachronic rather than synchronic differences.

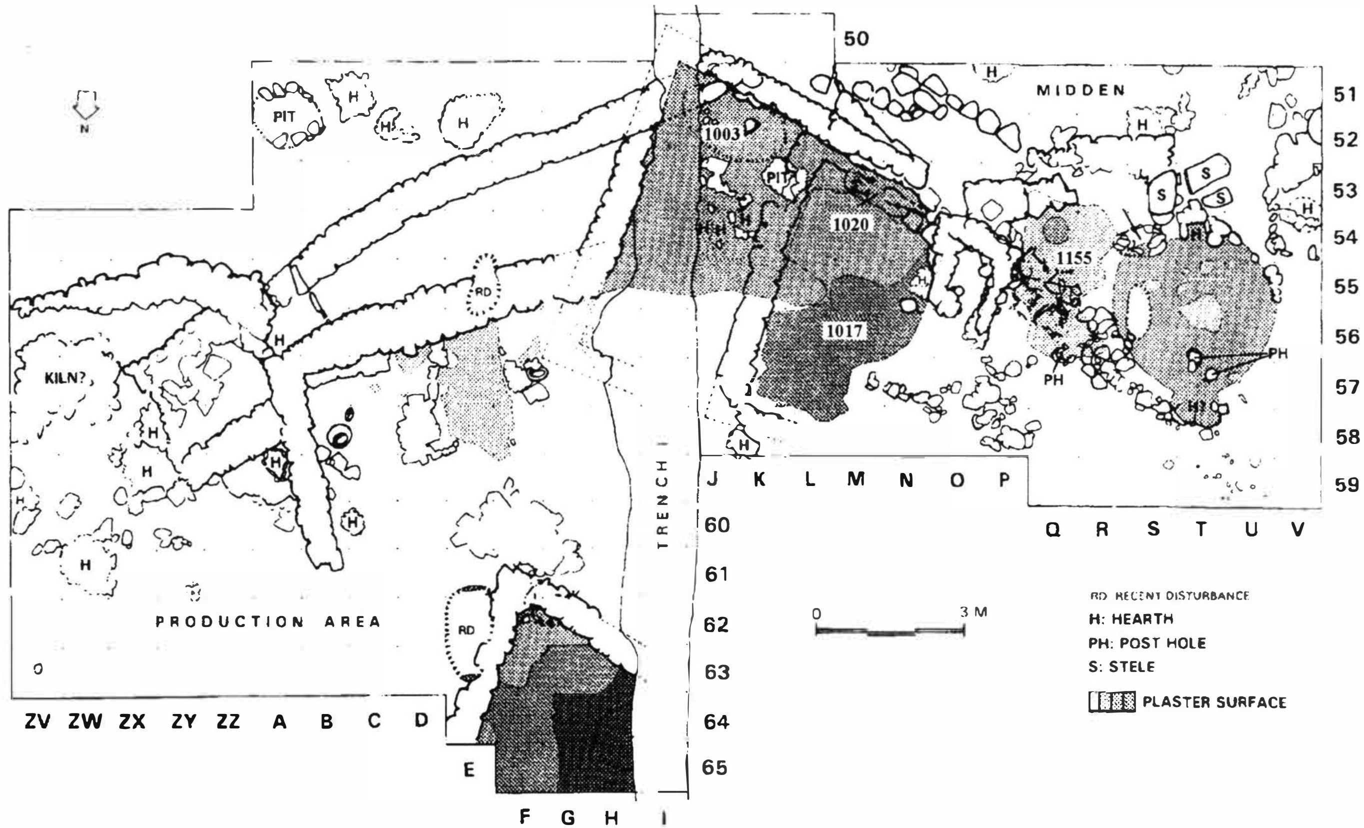


Figure 18. Locations of Four of the Six Loci (1003, 1017, 1020, 1155) Examined at Kfar HaHoresh (after Goring-Morris 2000:111).

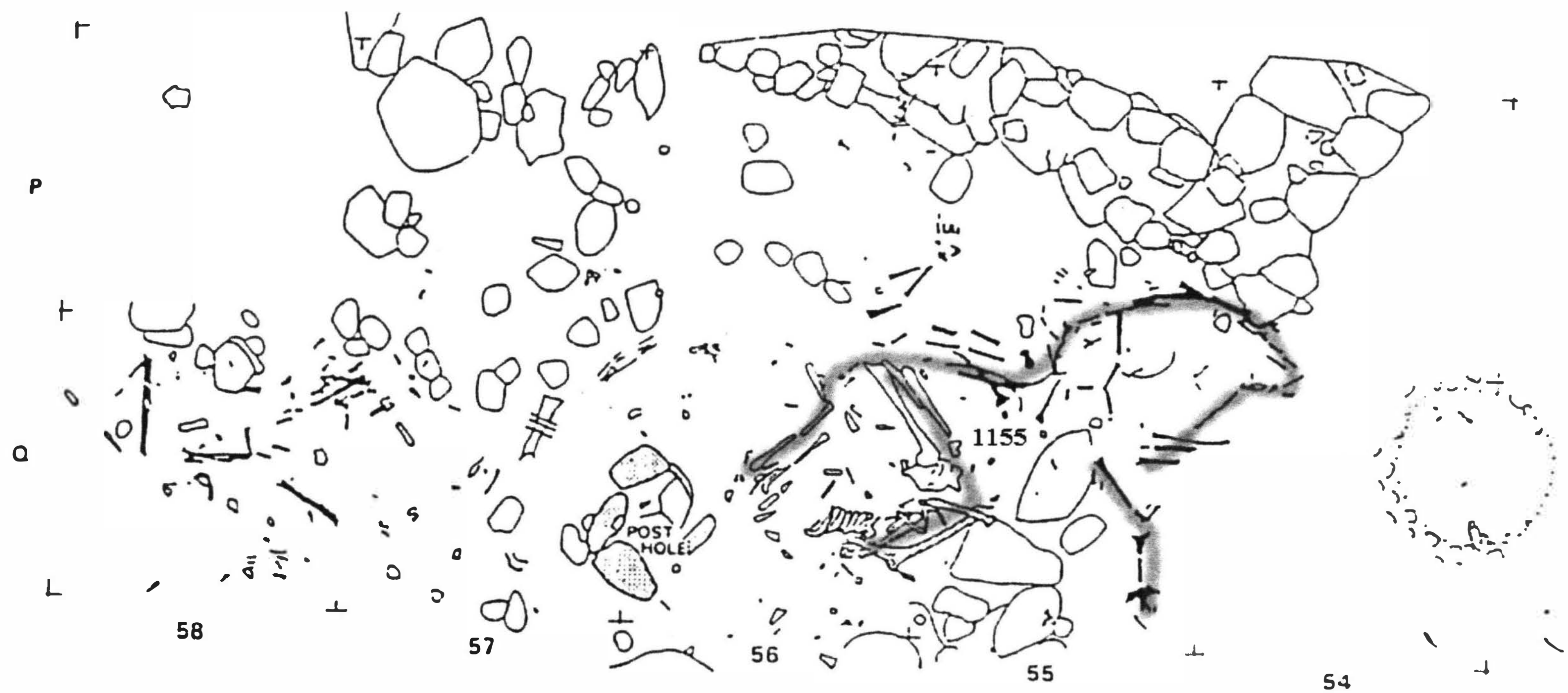


Figure 19. Arrangement of Human and Animal Bones into the "Depiction" of an Animal in Profile in Locus 1155 at Kfar HaHoresh (after Goring-Morris et al. 1998:3).

Especially for smaller PPNB villages, ritual and mortuary practices and beliefs promoted social cohesion, yet competitive relationships between households existed thus producing status or hierarchical differences at the household level rather than at the individual or community level (Goring-Morris 2000; Kuijt 2000a, 2000b; Kuijt and Goring-Morris 2002). This concept is supported by the skull cache found in Locus 1155, which signifies the connection a "house" (Kuijt 2000a) held to ancestors and the resources, land or wealth the ancestors once possessed.

## Enamel Hypoplasias, Weaning and Resource Access

The dentition from both Kfar HaHoresh and Yiftahel show that enamel hypoplasias are more prevalent in the maxillary central incisors followed by the mandibular canines (see Table 7). This is consistent with much of the literature stating that enamel hypoplasias are more commonly found in these tooth categories (Goodman and Armelagos 1985a; Goodman et al. 1984; Lanphear 1990; Wood 1996). Furthermore, the Kfar HaHoresh and Yiftahel dentition show that the highest frequencies of enamel hypoplasias appear in the middle third of central incisors. It can thus be concluded that Yiftahel (and other surrounding areas/communities) were affected by similar nutritional and physiological stressors.

Additionally, much of the literature (Goodman and Armelagos 1985a; Goodman et al. 1984; Lanphear 1990; Wood 1996) reveals that a higher frequency of enamel hypoplasias is present between the ages of 2-4 years, which is associated with the weaning period. A previous account of the Yiftahel dentition (Hershkovitz et al.

1986) revealed that enamel hypoplasias were first found to occur between the ages of 2-3 years, followed by another stress event between the ages of 4-5 years. Without the use of proper measuring instruments, the present examination of maxillary central incisors show peak frequencies of hypoplasias occurring in the middle third of the crown for the Kfar HaHoresh sample correlating to an age of onset between 1.8 and 3.4 years of age; the peak frequency in the Yiftahel sample is in the cervical third, thus translating to a later onset age that is between 3.4 and 5.0 years of age.

The occurrence of enamel hypoplasias on different areas of the crown demonstrates that environmental stress affected dental enamel development at various ages. Since there is a lack of literature describing peak ages at which weaning might have occurred during the PPNB, as well as the fact that proper measuring instruments such as thin-tipped calipers were not utilized in this study, the conclusions made in this thesis regarding weaning stress should be considered preliminary.

Chronological distribution of enamel hypoplasias among some prehistoric and historic populations, e.g. Dickson Mounds, Monroe County Poorhouse, show peak frequencies occurring between the ages of 2-4 years, and this age often correlates with the weaning period (Goodman et al. 1984; Lanphear 1990). If populations during the Neolithic practiced a weaning tradition similar to these prehistoric and historic populations, then one would expect peak frequencies to occur within this age range. The later age range observed among Yiftahel maxillary central incisors possibly indicates post-weaning stress. During this time of transition in subsistence strategies from hunting and gathering to incipient agriculture, it might have taken children longer to adapt to the diet, despite evidence of continued hunting and gathering at Kfar HaHoresh and Yiftahel. If some of the households did happen to have better or more access to resources over others, perhaps it was not enough to entirely protect children from environmental stressors. The possibility also exists that disease or some other stress affecting dental health was responsible for the late occurrence of enamel hypoplasias.

Another matter influencing the chronological distribution of enamel hypoplasias has to do with sample size. Yiftahel has a limited number of teeth exhibiting enamel insults; in fact canines are severely underrepresented. Bearing in mind that Kfar HaHoresh is a funerary center for surrounding communities, the larger sample from Kfar HaHoresh may be a better sample by which to make inferences. It may provide a more collective and diverse sample than the single village of Yiftahel. The peak frequency of enamel defects on the maxillary central incisors appears much earlier in childhood. Explanations for this may include illness or nutritional stress – again, if differential access to resources existed between households at this time during the PPNB, then individuals were not buffered from environmental stressors.

Information available on the PPNB emphasizes an egalitarian way of life for societies in the Levant by which complex social rules and competitive relationships between households prevented "houses" (Kuijt 2000a) from obtaining more power and authority over each other (Goring-Morris 2000; Kuijt 2000a, 2000b; Kuijt and Goring-Morris 2002). These social controls limited the amount of status differences between groups. With this in consideration, it seems questionable, though not impossible, that differential access to resources is a reason for the development of enamel hypoplasias, particularly for the later age range. The peak frequency of enamel hypoplasia for mandibular canines at Kfar HaHoresh also appears later in childhood, between 4.2 and 6.2 years of age. This may support the notion that events leading to the development of enamel hypoplasias are the result of post-weaning stress, rather than the weaning period itself.

# CHAPTER VI

# CONCLUSIONS

The archaeological evidence provided for the Levantine Neolithic reveals a period of change and transition for the region and its populations. As the subsistence based strategy changed from hunting and gathering to herding and farming, group size began to increase as populations became more sedentary. Establishment of hierarchical communities ensued and public rituals became more elaborate, particularly mortuary customs. An analysis of enamel hypoplasias present at Kfar HaHoresh and Yiftahel is an essential element to the study of Neolithic populations in the Levant, and more specifically to the implications that the site of Kfar HaHoresh was a mortuary complex for elite individuals from surrounding Pre-Pottery Neolithic B villages, such as Yiftahel.

The following is a review of the hypotheses tested and their concluding results:

- *There is no difference between the amount and incidence rates of enamel hypoplasias at Kfar HaHoresh and at Yiftahel.* The results of this hypothesis indicate that individuals buried at Kfar HaHoresh show no difference in status and rank than those buried at Yiftahel. Though the beginnings of social differentiation appear in the ritual and ceremonial aspects of mortuary practices, at this stage the effects of social stratification are not negatively affecting the physiological health, as seen in the dentition, of individuals belonging to smaller PPNB villages, such as Yiftahel. Though the present study does not support the proposed hypothesis that elite individuals from surrounding Pre-Pottery Neolithic B villages were buried at Kfar HaHoresh, it is important to note that these results do not disprove this theory. The analysis of dental enamel hypoplasias at Kfar HaHoresh and Yiftahel suggests that at this stage in the Neolithic individuals and communities are not affected physiologically by the changing dynamics of increasing population size and changing subsistence strategies.

- *There are no differences in the incidence rates of enamel hypoplasia among the teeth found at Kfar HaHoresh.* An analysis of the teeth found within Kfar HaHoresh reveals, however, that some degree of social differentiation exists within the site itself; yet, it does not represent an unequivocal division between elites and non-elites wherein differential access to resources contributed to the varying incidences of enamel hypoplasias among the teeth. Rather, the variation within Kfar HaHoresh may be a systematic result of social controls in place by households to limit the control of power and authority by one "house" (Kuijt 2000a) over another. This social order maintained an egalitarian ethos by restricting the accumulation of power by households, but also allowing for some social differentiation. Public rituals, specifically mortuary practices and secondary burial contexts provided the arena in which households could distinguish themselves from others.

By comparing the incidence of enamel hypoplasia among the six loci within Kfar HaHoresh to the archaeological and taphonomic evidence, an intriguing relationship becomes apparent. In the secondary burial pit identified as Locus 1003, many of the teeth have multiple incidences of enamel insults, yet a very small percentage of the substantially large number of bones exhibits postmortem human modification. In Locus 1155, another burial locale, a smaller percentage of teeth display multiple incidences of enamel hypoplasias. What is significant about this locus is the presence of a skull cache, the depiction of an animal in profile arranged in human and animal bones, as well as the greater percentage of human bones that exhibit postmortem human modification. Conceivably, these two loci represent two community households who visited Kfar HaHoresh for ritualized purposes. Locus 1155 may signify achieved status while Locus 1003 may reflect individuals of ascribed status. Kfar HaHoresh, then, was the public domain in which village/community members could strengthen community ties and particular households could connect with ancestors and gain leverage over certain social realms.

- *The teeth from Kfar HaHoresh and Yiftahel show no difference in the timing of enamel hypoplasias relative to age at weaning.* The chronological distribution of enamel hypoplasias among the Kfar HaHoresh and Yiftahel dentition reveals that, like other research, maxillary central incisor and mandibular canines exhibit a greater percentage of enamel defects. Yet, the age range at which enamel insults appear on these teeth does not coincide with the peak frequency of 2-4 years commonly found in prehistoric and historic populations, which corresponds to the weaning period. Rather, the age range for the Kfar HaHoresh and Yiftahel dentition is much later, which may be indicative of post-weaning stress. Again, differential access to resources in not believed to be a factor in the appearance of enamel hypoplasias at these later age ranges.

Suggestions for future research include a similar analysis of the dentition from Kfar HaHoresh as sample size increases with future excavations. Furthermore, an examination of teeth found in the various stratigraphic levels within Kfar HaHoresh may reveal diachronic changes. Teeth found in earlier levels may be more hypoplastic than those in later levels due to a reliance on wild animals and non-domesticated plants in which certain seasons may yield less sustenance with a resulting increase in nutritional stress. On the other hand, teeth in later stratigraphic levels may be more hypoplastic as a consequence of a less varied diet with the adoption of agriculture.

In conclusion, this research reveals a dichotomous relationship between the archaeological evidence and the dental evidence. Despite the archaeological evidence supporting the proposition that elite individuals were buried at Kfar HaHoresh, a comparison of enamel hypoplasias among the Yiftahel and Kfar HaHoresh dentition cannot identify different status groups. The results reveal that individuals at both of these sites appear to have been subject to similar degrees of stress. Consequently, the dental evidence suggests that differential access to resources did not significantly contribute to the social differences among and between community groups from small villages like Yiftahel. Since Yiftahel is a small community, and probably representative of the other communities that might have utilized Kfar HaHoresh as a ritual center, the degree of physiological, nutritional, and environmental stress is not as severe as would be seen in larger PPNB communities with very large population numbers. Furthermore, the greater frequency of enamel hypoplasias occurring later in childhood may be attributable to post-weaning stress, rather than worse or lessened access to resources.

Concerning the site of Kfar HaHoresh itself, however, there is no question that the archaeological record shows markers of social differentiation. A closer examination of enamel hypoplasia incidence among six specific loci within Kfar HaHoresh provides additional support for this. Yet, the differentiation between and among community kin groups and household lines is gained through self-imposed social controls that encourage competitive and ritual behavior, which serves to both strengthen community relations and distinguish households from one another. The emphasis of this social differentiation is placed on affinity ties and household lines rather than on the individual.

This research sought to investigate enamel hypoplasias with the intent of contributing to the larger body of work existing on the Pre-Pottery Neolithic B in south-central Levant. Significant findings were established especially with regard to the two loci within Kfar HaHoresh. This site does indeed offer compelling evidence concerning cultural traditions and behaviors as lived by PPNB societies.

# BIBLIOGRAPHY


Anderson, D. L., G. W. Thompson, and F. Popovich
1976 Age of Attainment of Mineralization Stages of the Permanent Dentition. Journal of Forensic Sciences 21:191-200.

Banning, E. B.
1998 The Neolithic Period: Triumphs of Architecture, Agriculture, and Art. Near Eastern Archaeology 61(4):188-237.

Bar-Yosef, O.
1995 Earliest Food Producers-Pre Pottery Neolithic (8000-5500). In The Archaeology of Society in the Holy Land. T. E. Levy, ed. Pp. 190-204. Leicester: University Press.

Bar-Yosef, O. and A. Belfer-Cohen
1989 The Levantine "PPNB" Interaction Sphere. In People and Culture in Change. Proceedings of the Second Symposium on Upper Paleolithic, Mesolithic, and Neolithic Populations of Europe and the Mediterranean Basin. B.A.R. International Series 508. Pp. 59-72.

1992 From Foraging to Farming in the Mediterranean Levant. In Transitions to Agriculture in Prehistory. A.B. Gebauer and T.D. Price, eds. Pp. 21-48. Madison: Prehistory Press.

Blakey, Michael L., T. E. Leslie, and J. P. Reidy
1994 Frequency and Chronological Distribution of Dental Enamel Hypoplasia in Enslaved African Americans: A Test of the Weaning Hypothesis. American Journal of Physical Anthropology 95:371-383.

Braun, Eliot
1997 Yiftah'el: Salvage and Rescue Excavations at a Prehistoric Village in Lower Galilee, Israel. Jerusalem: Israel Antiquities Authority.

Byrd, Brian F.
2000 Households in Transition: Neolithic Social Organization Within Southwest Asia. In Life in Neolithic Farming Communities. Ian Kuijt, ed. Pp. 63-98. New York: Kluwer Academic/Plenum Publishers.

Cauvin, Jacques
2000 The Symbolic Foundations of the Neolithic Revolution in the Near East. In Life in Neolithic Farming Communities. Ian Kuijt, ed. Pp. 235-252. New York: Kluwer Academic/Plenum Publishers.

Commission on Oral Health, Research and Epidemiology
1982 An Epidemiological Index of Developmental Defects of Dental Enamel (DDE Index). International Dental Journal 32:159-167.

Cucina, Andrea and M. Iscan
1997 Assessment of Enamel Hypoplasia in a High Status Burial Site. American Journal of Physical Anthropology 9:213-222.

Demirjian, A., H. Goldstein, and J. M. Tanner
1973 A New System of Dental Age Assessment. Human Biology 45:211-227.

Flannery, Kent
1972 The Origin of the Village as a Settlement Type in Mesoamerica and the Near East: A Comparative Study. In Man, Settlement and Urbanization. P. Ucko, R. Tringham, and G. Dimbleby, eds. Pp. 23-53. London: Duckworth.

Garfinkel, Y.
1987 Burnt Lime Products and Social Implications in the Pre-Pottery Neolithic B Villages of the Near East. Paleorient 13:69-76.

Goodman, Alan H. and George J. Armelagos
1985a Factors Affecting the Distribution of Enamel Hypoplasias Within the Human Permanent Dentition. American Journal of Physical Anthropology 68:479-493.

1985b The Chronological Distribution of Enamel Hypoplasia in Human Permanent Incisor and Canine Teeth. Archives of Oral Biology 30:503-507.

1988 Childhood Stress and Decreased Longevity in a Prehistoric Population. American Anthropologist 90:936-944.

Goodman, Alan H. and Jerome C. Rose
1990 Assessment of Systemic Physiological Perturbations from Dental Enamel Hypoplasias and Associated Histological Structures. Yearbook of Physical Anthropology 33:59-110.

1991 Dental Enamel Hypoplasias as Indicators of Nutritional Status. In Advances in Dental Anthropology. M. A. Kelley and C. S. Larsen, eds. Pp. 279-293. New York: Wiley-Liss.

Goodman, Alan H., George J. Armelagos, and Jerome C. Rose

1980 Enamel Hypoplasias as Indicators of Stress in Three Prehistoric Populations from Illinois. Human Biology 52:515-528.

1984 The Chronological Distribution of Enamel Hypoplasias from Prehistoric Dickson Mounds Populations. American Journal of Physical Anthropology 65:259-266.

Goren, Yuval, Nigel Goring-Morris, and Irena Segal

2001 The Technology of Skull Modeling in the Pre-Pottery Neolithic B (PPNB): Regional Variability, the Relation of Technology and Iconography and Their Archaeological Implications. Journal of Archaeological Science 28:671-690.

Goring-Morris, Nigel

2000 The Quick and the Dead. In Life in Neolithic Farming Communities. Ian Kuijt, ed. Pp. 103-136. New York: Kluwer Academic/Plenum Publishers.

Goring-Morris, Y. Goren, L.K. Horwitz, I. Hershkovitz, R. Lieberman, J. Sarel, and D. Bar-Yosef

1994/5 The 1992 Season of Excavations at the Pre-Pottery Neolithic B Settlement of Kfar HaHoresh. Journal of the Israel Prehistoric Society 26:74-121.

Goring-Morris, Nigel, Yuval Goren, Liora Kolska Horwitz, Daniella Bar-Yosef, and Israel Hershkovitz

1995 Investigations at an Early Neolithic Settlement in the Lower Galilee: Results of the 1991 Season at Kefar HaHoresh. Atiqot 27:38-62.

Goring-Morris, Nigel, Rosemary Burns, Angela Davidzon, Vered Eshed, Yuval Goren, Israel Hershkovitz, Steve Kangas, and J. Kelecevic

1998 The 1997 Season of Excavations at the Mortuary Site of Kfar HaHoresh, Galilee, Israel. Neo-Lithics: A Newsletter of Southwest Asian Lithics Research 3:1-4.

Hershkovitz, I., Y. Garfinkel, and B. Arensburg

1986 Neolithic Skeletal Remains at Yiftahel, Area C (Israel). Paleorient 12(1):73-81.

Hershkovitz, I., I. Zohar, I. Segal, M.S. Speirs, O. Meirav, U. Sherter, H. Feldman, and N. Goring-Morris
1995 Remedy for an 8500 year-old Plastered Human Skull from Kfar HaHoresh, Israel. Journal of Archaeological Science 22:779-788.

Hillson, Simon
1990 Teeth. Cambridge: Cambridge University Press.

1996 Dental Anthropology. Cambridge: Cambridge University Press.

Hillson, Simon and Sandra Bond
1997 Relationship of Enamel Hypoplasia to the Pattern of Tooth Crown Growth: A Discussion. American Journal of Physical Anthropology 104:89-103.

Horwitz, L.K.
1993 The Development of Ovicaprine Domestication During the PPNB of the Southern Levant. Archaeozoology of the Near East. In Archaeozoology of the Near East 1. H. Buitenhuis and A.T. Clason, eds. Pp. 27-36. Leiden: Universal Book Services.

Hutchinson, Dale L. and Clark Spencer Larsen
1988 Determination of Stress Episode Duration from Linear Enamel Hypoplasias: A Case Study from St. Catherine's Island, Georgia. Human Biology 60:93-110.

Kenyon, Kathleen M.
1957 Digging Up Jericho: The Results of the Jericho Excavations 1952-1956. New York: Frederick A. Praeger, Inc.

Kuijt, Ian
2000a Keeping the Peace. In Life in Neolithic Farming Communities. Ian Kuijt, ed. Pp. 137-164. New York: Kluwer Academic/Plenum Publishers.

2000b People and Space in Early Agricultural Villages: Exploring Daily Lives, Community Size, and Architecture in the Late Pre-Pottery Neolithic. Journal of Anthropological Archaeology 19:75-102.

Kuijt, Ian and Nigel Goring-Morris
2002 Foraging, Farming, and Social Complexity in the Pre-Pottery Neolithic of the Southern Levant: A Review and Synthesis. Journal of World Prehistory 16:361-440.

Lanphear, Kim M.
1990 Frequency and Distribution of Enamel Hypoplasias in a Historic Skeletal Sample. American Journal of Physical Anthropology 81:35-43.

Larsen, Clark Spencer
1997 Bioarchaeology: Interpreting Behavior from the Human Skeleton. Cambridge: Cambridge University Press.

2000 Skeletons in Our Closet. Princeton: Princeton University Press.

Malville, Nancy J.
1997 Enamel Hypoplasias in Ancestral Puebloan Populations from Southwestern Colorado: I. Permanent Dentition. American Journal of Physical Anthropology 102:351-367.

Massler, M., I. Schour, and H.G. Poncher
1941 Developmental Pattern of the Child as Reflected in the Calcification Pattern of the Teeth. American Journal of Diseases of Children 62:33-67.

May, Richard L., Alan H.Goodman, and Richard S. Meindl
1993 Response of Bone and Enamel Formation to Nutritional Supplementation and Morbidity Among Malnourished Guatemalan Children. American Journal of Physical Anthropology 92:37-51.

Moorrees, C.F.A., E.A. Fanning, and E.E. Hunt
1963 Age Variation of Formation Stages for Ten Permanent Teeth. Journal of Dental Research 42:1490-1502.

Oddy, W.H.
2002 The Impact of Breastmilk on Infant and Child Health. Breastfeeding Review: Professional Publication of the Nursing Mothers' Association of Australia 10:5-18.

Reid, D.J. and M.C. Dean
2000 Brief Communication: The Timing of Linear Hypoplasias on Human Anterior Teeth. American Journal of Physical Anthropology 113:135-139.

Rollefson, Gary O.
1990 The Uses of Plaster at Neolithic 'Ain Ghazal, Jordan. Archeomaterials 4:33-54.

2000 Ritual and Social Structure at Neolithic ‘Ain Ghazal. In Life in Neolithic Farming Communities. Ian Kuijt, ed. Pp. 165-190. New York: Kluwer Academic/Plenum Publishers.

Roosevelt, Anna Curtenius
1984 Population, Health, and the Evolution of Subsistence: Conclusions from the Conference. In Paleopathology at the Origins of Agriculture. Mark Nathan Cohen and George J. Armelagos, eds. Pp. 559-583. Orlando: Academic Press.

Sarnat, Bernard G. and Isaac Schour
1941 Enamel Hypoplasia (Chronologic Enamel Aplasia) in Relation to Systemic Disease: A Chronologic, Morphologic and Etiologic Classification. The Journal of the American Dental Association 28:1989-2000.

1942 Enamel Hypoplasias (Chronologic Enamel Aplasia) in Relation to Systemic Disease: A Chronologic, Morphologic, and Etiologic Classification. Journal of the American Dental Association 29:67-76.

Schour, I. and M. Massler
1941 The Development of the Human Dentition. Journal of the American Dental Association 28: 1153-1160.

Schultz, Michael, Petra Carli-Thiele, Tyede H. Schmidt-Schultz, Uwe Kierdorf, Horst Kierdorf, Wolf-Rudiger Teegen and Kerstin Kreutz
1998 Enamel Hypoplasias in Archaeological Skeletal Remains. In Dental Anthropology. Kurt W. Alt, Friedrich W. Rosing, and Maria Teschler-Nicola, eds. Pp. 293-311. New York: Sringer Wien.

Simmons, Tal
2002 What Ceremony Else? Ritual Treatment of the Dead in the Pre-Pottery Neolithic B Mortuary Complex of Kfar HaHoresh, Israel. Abstract, 2002 Annual BARFAA Meeting, Indianapolis, Indiana.

Skinner, M. F. and J. T. Hung
1989 Social and Biological Correlates of Localized Enamel Hypoplasia of the Human Deciduous Canine Tooth. American Journal of Physical Anthropology 79:159-175.

Smith, B. H.
1991 Standards of Human Tooth Formation and Dental Age Assessment. In Advances in Dental Anthropology. M. A. Kelley and C. S. Larsen, eds. Pp. 143-168. New York: Wiley-Liss.

Swärdstedt, T.
1966 Odontological Aspects of a Medieval Population in the Province of Jämtland/Mid-Sweden. Stockholm: Tiden-Barnängen Tryckerier.

Sweeney, Edward A., Arthur J. Saffir, and Romeo de Leon
1971 Linear Hypoplasia of Deciduous Incisor Teeth in Malnourished Children. The American Journal of Clinical Nutrition 24:29-31.

Tamborlane, William V.
1997 The Yale Guide to Children's Nutrition. New Haven: Yale University Press.

Ubelaker, Douglas H.
1999 Human Skeletal Remains. Washington: Taraxacum.

Verhoeven, Marc
2002 Ritual and Ideology in the Pre-Pottery Neolithic B of the Levant and Southeast Anatolia. Cambridge Archaeological Journal 12:233-258.

Wood, Lynda
1996 Frequency and Chronological Distribution of Linear Enamel Hypoplasia in a North American Colonial Skeletal Sample. American Journal of Physical Anthropology 100:247-259.