DENTAL CARIES AND SOCIAL ROLES IN THREE IROQUOIAN OSSUARIES

AN EXAMINATION OF THE LINK BETWEEN
SOCIAL ROLES AND DENTAL HEALTH:
A STUDY AMONG THREE ONTARIO IROQUOIAN OSSUARY POPULATIONS

By

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ABSTRACT

Learning about the individual in a past society can be an interesting and important, yet often difficult, endeavour. Although the many different classes of artifacts recovered from archaeological sites provide varying lines of evidence, the skeletal remains of the people themselves teach us the most about pre-contact health and nutrition. The focus of this study was to examine individuals from three Ontario Iroquoian ossuaries and evaluate their dental disease. Comparisons between individuals were based upon each person's sex status and age category, in order to determine whether or not adult females and males in these populations differed in their dental health. Mandibles and maxillae were examined from 158 adults interred at the Uxbridge (BbGs-3), Kleinburg (AlGv-1) and Syers (no Borden designation) ossuaries. These people lived during the Late Ontario Iroquoian period (circa AD 1350-1600), subsisting primarily on maize, beans and squash cultigens.

As expected for their subsistence economy, most individuals exhibited high levels of dental disease, ascertained by caries, pulp exposures, antemortem tooth loss and abscesses. Results for the Observed Caries Rate, the Diseased Missing Index and the Corrected Caries Rate did, in some cases, differ between the male and female adults, although a common pattern in these differences was not evident when the three distinct ossuary populations were compared with one another.

Variations in dental disease may have been caused by the chemistry, texture and amounts of foods eaten, and the frequency and duration of meals. The ethnohistoric, ethnographic and archaeological records were consulted to determine whether or not the adult males and females in these Iroquoian communities may have eaten differently on a regular basis. It is probable that their daily activities determined access to certain types of foods and the number of meals eaten. Iroquoian women may have been inadvertently placed at a higher risk for long-term dental disease which would have influenced their overall health. Research of this nature yields much about the lives of past peoples and illustrates the importance of studying skeletal remains and interpreting the results by utilizing the ethnohistoric and archaeological records.

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To the people I have studied - you may be protesting research that involves your bones, we cannot tell. But you have taught us, and given of yourselves even after death. I hope you and your descendants are at peace with this; proud of your trials, accomplishments, hardships and happiness in life.

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This research project is dedicated to the memory of my father, Frederick Michael Crinnion, and to my grandfather, Joseph Collins, who believed in educational accomplishments and the power of the written word.

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Chapter 1: Introduction to the Investigation of Dental Health Within Iroquoian Communities

The historic Wendat (or Huron, as they were known to the first Europeans) communities of southern Ontario are well-known due to the accessibility of historic written records and the controlled excavations of many archaeological sites. Settlement patterns and artifact seriation of ceramics and lithic tools have allowed for some understanding of behaviour to be extrapolated for pre-contact sites (MacNeish 1952; Wright 1972; Ramsden 1977; Ellis and Ferris 1990). More direct investigations via skeletal analyses have contributed an essential dimension for understanding the lives of the Wendat as well as pre-contact Ontario Iroquoian groups.

Pathology and subsistence are two main areas of focus in studies of Ontario Iroquoian skeletal populations. Macroscopic and microscopic analyses of skeletal lesions and other anomalies provide information about the traumas and illnesses sustained by individuals, and of the overall health status of entire populations (Anderson 1964, 1969; Ossenberg 1969; Saunders *et al.* 1974; Jerkic 1975; Jackes 1977; Pfeiffer 1984, 1986; Crinnion 1997a; Merrett and Pfeiffer 2000). More recently, chemical analyses have been conducted to research dietary patterns (Schwarcz *et al.* 1985; Katzenberg and Schwarcz 1986; Katzenberg *et al.* 1995). Macroscopic examinations of teeth and related oral pathological conditions, in the form of caries, attrition, abscessing and periodontal disease affecting the underlying alveolus, have resulted in inferences about subsistence practices (Kenyon and Cameron 1960; Anderson 1968; Cybulski 1966; Winnicki 1969; Hartney 1978; Melbye 1983; Molto 1983; Patterson 1984; Crinnion 1997b; Wright 1997). Patterson (1984) has provided a thorough review of studies relating to the dental health of Ontario Pre-Iroquoian and Iroquoian skeletal populations up to the early 1980s.

During the past several decades, the prevalence of dental caries has been examined and utilized as a fundamental indicator of dental health among skeletal populations from pre- and post-contact periods. However, for the majority of these studies, caries represented one pathological condition among many being investigated and, therefore, the specific etiology for caries in each distinctive situation could not be thoroughly assessed. Methods that have been more recently refined aid in the data collection and interpretations of caries prevalence. For instance, the dental community continues to explore the combinations of factors that lead to the onset of a carious lesion under specific dietary and hygienic conditions (Winter 1990; van Houte 1994; van Houte *et al.* 1996; van Palenstein Helderman *et al.* 1996). The information generated from these studies enables new questions to be asked and explored, adding to the valuable information already obtained by detailed studies of dental palaeopathology and subsistence. The primary hypothesis being tested in this study is that variations in dietary patterns are produced by social behaviour and will provide an indication about the roles filled by the members of pre-contact Ontario Iroquoian populations.

Dentitions recovered from Ontario Iroquoian ossuary burials have the potential to provide information not only about the foods consumed and health, but also the types of utensils used in food preparation, age and sex estimations, and individual behaviour. The nature of an ossuary is such that the skeletal elements from all individuals were purposefully commingled during the interment ceremony (Thwaites 1898 10:279-305), some so thoroughly that few articulations are likely to be found (Melbye 1983:15; Jackes 1986:34; Pfeiffer 1986:24). This led Melbye (1983:15) to refer to ossuaries as "'populations of bones' rather than populations of people." Both skeletal biologists and archaeologists, such as Jackes (1986), Sutton (1988), Wood and colleagues (1992) and Saunders and colleagues (1995), have questioned the reliability of information obtained from ossuary style burials, and skeletal samples in general, for reconstructing the ancient life ways of living people. In this light, dentitions, the teeth together with the surrounding alveolar tissue, are quite unique. Dentitions are often associated with crania; the most useful skeletal element for age and sex estimations with the exception of the pelvic region (Buikstra and Ubelaker 1994:16,21). In some cases, mandibles may be associated with the crania, either through articulations observed during excavation or through pathological characteristics of the temporomandibular joint.

The individuals analyzed for this research were among those buried at the Uxbridge Ossuary (BbGs-3), the Kleinburg Ossuary (AlGv-1) and the Syers Ossuary (no Borden designation) from southern Ontario. This study is intended to determine and compare the oral health status experienced among individuals within the same ossuary population. These three skeletal populations are unusually well preserved, so that figures of less than 50 percent postmortem tooth loss were frequently observed. The individuals chosen for analysis demonstrated the most complete states of preservation within each ossuary population. The Uxbridge Ossuary, containing the largest minimum number of individuals of the three, will be used to illustrate the methods employed. The Kleinburg and Syers Ossuary samples, although they are not being compared directly to the Uxbridge Ossuary results, are intended to present comparisons for the methodology.

Studies of past populations are often compelled to make assumptions in order to interpret the relevant data. Assumptions, when required, are best dealt with outright, in order to better understand the biases involved as well as the conclusions of the research. Studies of biological affinities among Ontario Iroquoian skeletal populations have been accused of incorporating naïve assumptions regarding who is buried in an ossuary (Sutton 1988:43). The results of the current research are not dependent upon the biological relatedness of those buried in the three ossuaries. However, should individuals *not* associated with the primary contributing village have been buried in the ossuary, it is here presumed that those 'foreign' individuals were raised in communities with similar social roles and daily activities as defined by their sex or age group. If the ossuary populations do not account for all those who had died since the previous Feast of the Dead, it is assumed that the missing individuals experienced the same dental health as their cohorts within the ossuaries. It is inferred that, when focussing on teeth, the individuals buried in the ossuaries *do* in fact represent the living populations from which they came. It is unlikely that many of the deaths occurred directly due to dental disease, but in cases where they had, partial evidence would be manifest in the dentition in the form of pulp exposures or alveolar abscessing. This type of assumption has been generally cautioned for analyses involving skeletal lesions, which may not appear in the hard tissue if the disease has killed too quickly (Wood *et al.* 1992:343-344; Saunders *et al.* 1995:73).

Several difficulties are encountered when carrying out analyses of individuals through their dentitions which should be addressed. Ideally, each dentition should contain all of the teeth which were present at death. The single-rooted anterior teeth tend to be lost once the soft tissue decomposes, which is problematic since anterior teeth differ in their susceptibility to caries than do the premolars and molars. Also, infants and juveniles will inherently be omitted from such a study due to their lack of erupted teeth. Jackes (1986:34) has identified the problems with estimating age for adults over 25 years, and problems with confusing young males for females or old females for males. For this study, age estimations from both complete skulls and fragmentary dentitions are general: juvenile estimations are based upon Ubelaker's (1989) eruption sequence and adults are placed into young (20-34 years), middle (35-49 years) and older (50+ years) groups. The caries process is age related, so that the teeth from older individuals generally contain more carious lesions than the teeth from young individuals. This trend could potentially create a bias when comparing, for instance, male adults with female adults, if one group is older than the other. This problem can be overcome by comparing the various age groups from the two sexes separately, such as young males versus young females. Finally, it is assumed that dental caries reflect dietary patterns.

This research is intended to investigate specific indicators of dental health which may be utilized as indirect evidence of the social structure of Late Ontario Iroquoian villages and that particular structure's impact on the health of the inhabitants of those settlements. The following chapters address the chosen skeletal samples and methods for analysis, the results of the data collection, and the framework of previous knowledge that is drawn upon to interpret the findings.

Chapter 2 provides the relevant information on the etiology of dental caries taken from a survey of the dental literature. Several issues are key to this analysis, such as common microflora which reside within the oral cavity, the foods that are most likely to attract those bacteria, the effects of the acids produced by the bacteria upon enamel surfaces, the contribution of calculus (tartar) buildup to the initiation of carious lesions, the pH levels of the saliva after consumption of certain foods, the relationship between wear and caries, and the process by which a carious lesion may ultimately affect the bloodstream.

Current knowledge regarding the dental health and dietary patterns of pre-contact Ontario Iroquoian groups is discussed in Chapter 3. Previous dental assessments and stable isotope analyses are consulted for data involving the Uxbridge and Kleinburg Ossuary samples, as well as similar populations from southern Ontario. Contrary to the other two ossuaries, no previous work relating to skeletal pathology has been published for the Syers population. The benefits of studying these three particular ossuary samples are explained. Next, relevant information derived from the archaeological record is discussed, such as artifacts recovered which directly relate to food and its preparation. Faunal and palaeobotanical studies provide inventories of the animal and plant resources in the local environs which may have been chosen for food sources. Analyses of soil and water components may provide insight about minerals and trace elements that were likely ingested and which may have affected tooth composition. In addition, ethnohistoric and ethnographic sources are consulted for information pertaining to foods eaten, dietary habits, social roles, and daily activities of the members of historic Wendat and other Iroquoian communities. The purpose is to establish a basis for interpreting the dental data from the three pre-contact ossuary populations.

Chapter 4 outlines the methodology used to investigate the dental health of the individuals from the three ossuary samples. The data collected primarily consist of inventories of teeth remaining *in situ*, losses of teeth either antemortem or postmortem, alveolar abscessing, the presence and severity of calculus, and caries. The caries data describe the number of caries per tooth and their individual locations on the six tooth surfaces, plus the number of carious teeth per person. This section also describes the standards utilized for recording dental wear, general periodontal disease, hypercementosis of the tooth roots and dental enamel hypoplasia, each of which are, or potentially may be, related to the dental caries experienced by each person. Since age and sex status are critical for the interpretations of this study, the methods for estimating these are also presented. All of these methods were drawn from previous studies, and many were compiled by Buikstra and Ubelaker (1994) in an attempt to standardize skeletal investigations such as this one. Intraobserver error tests were administered and, when possible, interobserver data comparisons were consulted to judge the integrity of the results. Finally, an outline of the statistical analyses conducted with the data is presented.

Results are presented in Chapter 5. These focus on the data collected from those adult individuals whose sex estimations resulted in confident assessments of female or male status. Statistical comparisons of these results are then presented.

Additional data, made available in the appendices, is presented for all individuals (including those adults and juveniles excluded from comparisons due to indeterminate age and sex estimations) and organized by tooth type, in order to assist other studies of dental health.

A general discussion follows in Chapter 6, which ties the results from these three samples into a broader framework of caries prevalence among the individuals of a single Late Iroquoian community. The results from the Uxbridge Ossuary, the Kleinburg Ossuary and the Syers Ossuary are compared, to determine if caries differences among the individuals of these three burial populations are consistent. An intra-site evaluation of caries prevalence is related to the prevailing social roles and the differing daily activities which accompany them, among the various demographic groups. Concluding thoughts for this investigation are also offered. It is hoped that the techniques employed and subsequent results are complete enough, and are presented in such a manner, as to be of use in comparisons of the dental health of populations from southern Ontario and elsewhere. Conclusions are drawn based upon this multi-disciplinary approach to questions involving life in the pre-contact period of southern Ontario.

Chapter 2: Structure and Disease of the Human Dentition

Introduction

Macroscopic studies of dental caries have proven to be accurate, nondestructive and inexpensive, and allow for replication in subsequent studies. Dental decay in the form of caries occurs on the crowns and/or roots of teeth, and in the enamel or cementum (**Figure 2.1, Plates 1** and **2**). Oral bacteria, inhabiting the plaque that clings to tooth surfaces and under the gumline (gingiva), feed upon fermentable carbohydrates and produce organic acid waste products. These acids include lactic, acetic and propionic acids which diffuse into the tooth and dissolve the minerals from the crystals within the tooth's structure (Featherstone 1987:11). The resulting lesion, if not remineralized, will expand and spread into the underlying dentin layer, and can ultimately enter the pulp chamber causing infection and potential tooth loss. Once the infection enters the pulp chamber, it can rapidly spread to remote areas of the body through the bloodstream. For past populations, the process of dental decay and its consequences posed a serious health threat. The analysis of teeth from archaeological sites represents one of the most direct methods of learning about the health, diet and food preparation techniques of deceased populations.

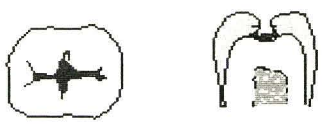


Figure 2.1 A carious lesion affecting the enamel and which is entering the dentine; occlusal (left) and cross-sectional (right) views.

The analysis of dental caries within any population, either living or deceased, requires the examination of three main factors. The characteristics of tooth structure, the oral flora, and the substrate entering the oral environment are all equally critical and interrelated in the development of caries. Each are complex and involve dynamic biological and cultural processes that are dependent upon the food and other objects entering the mouth, and the degree and rate at which foods pass through the oral environment. This chapter surveys endogenous factors of host susceptibility to caries (tooth composition and morphology, oral bacteria colonization, and the role of saliva in the oral environment), and briefly outlines the exogenous factors that share an equally important role in the process of caries formation.

The Chemical Composition of Teeth

Tooth structure varies between teeth as well as within different areas of each individual tooth. Prior to the tooth's eruption, systemic influences, such as nutritional and infectious factors, act on the formation of the tooth, whereas after eruption, local features of the oral environment act directly on the tooth surface (Harris 1970:3-4). The degree of hardness of the enamel, which serves as a protective layer against decay, may be influenced by vitamin deficiencies, particularly A and D (Harris 1970:4). Since the surface structure of the tooth is determined by the enamel's internal structure (Gustafson and Gustafson 1967:78), a brief discussion of its composition and internal elements is warranted.

The structure of enamel remains unaltered under most archaeological contexts, with the exception of very acidic soil and intense fire (Hillson 1996:181). Mature enamel consists of 96% by weight of an inorganic component (almost entirely calcium phosphate), which makes it a very durable, though not invulnerable, protective barrier against dental caries (Featherstone 1987:11; Hillson 1996:217). Only 2-5% of the carbonate is incorporated into the enamel apatite, which makes the enamel vulnerable to the acids produced by oral bacteria (Featherstone 1987:11). The remainder of the enamel is organic, composed of proteins (such as amelogenin), lipids and water, which serve to make the enamel somewhat porous, since they form diffusion channels that enable acids and minerals to enter or exit the interior of the tooth (Featherstone 1987:11; Hillson 1996:227). Often, between 10-50% of the minerals are removed from the enamel due to the action of acids in the saliva (Featherstone 1987:11). Dentine and cementum are more like bone than enamel in that the organic component of these incorporates the protein collagen (Hillson 1996:226).

Ameloblast cells form the 1-2 millimetre-thick layer of enamel (Gustafson and Gustafson 1967:76; Featherstone 1987:10). The ameloblasts secrete an organic matrix composed of submicroscopic fibrils that are oriented in a certain manner depending upon their location within the enamel (Gustafson and Gustafson 1967:76). During calcification, apatite crystals almost entirely replace the matrix along a pattern influenced by the directions of the former fibrils (Gustafson and Gustafson 1967:76; Rose *et al.* 1985:283). A short-term systemic disturbance during this process, such as an infection, can disrupt ameloblast metabolism, affecting the chemical composition of the protein matrix and the enamel prisms (Rose *et al.* 1985:284). Long-term infections or vitamin D deficiency can cause the ameloblasts to halt their activity altogether, creating a reduction in enamel thickness, known as a hypoplasia (Hillson 1979:149; Rose *et al.* 1985:284) (**Figure 2.2**). Congenital syphilis is known to cause hypoplasias between birth and one year of age (Jacobi *et al.* 1992 cited from Hillson 1996:171). Widespread and localized enamel defects are also known to be genetically inherited. These rare genetic disorders vary between populations, ranging from 1 in 1,000 to 1 in 14,000 people affected (Winter and Brook 1975 and Bäckmann 1989 cited from Hillson 1996:165). Otherwise, the composition of the enamel is consistent between individuals. The presence of an enamel defect likely increases the potential for caries to form at that location on the tooth once eruption has initiated. Among past populations, enamel defects induced by fever or malnutrition may have increased an individual's susceptibility to caries.

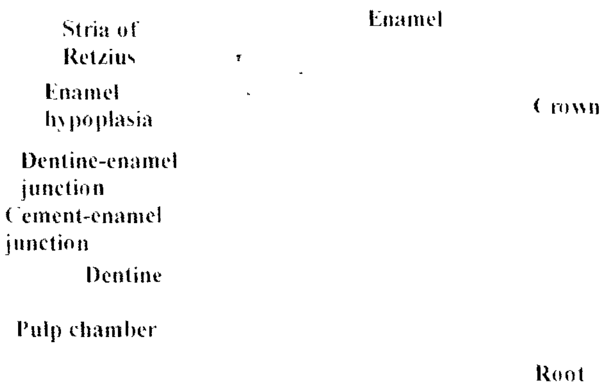


Figure 2.2 Representation of a canine in cross-sectional view which illustrates linear enamel hypoplasia.

The Internal Structure of Teeth

The *enamel prisms* are one of the main internal structures, which run from the dentine-enamel junction to the outer surface (Scott and Symons 1974:193). The prisms may be viewed through transmitted light microscopy or a scanning electron microscope (Hillson 1996:149). The prisms lie in layers in a wavy arrangement, particularly near the cusps. In the cusp area, this arrangement is referred to as 'gnarled enamel,' which seems to add strength to the enamel (Scott and Symons 1974:193). Enamel prisms generally lie perpendicular to the dentine surface, changing in orientation and shape only at the incisive edges, the cuspal tips and near the dentine-enamel junction (Scott and Symons 1974:195,202). Anomalies in prism direction may create zones of developmental hypomineralization immediately beneath the surface layer of the enamel, particularly near the cervical region of the tooth (Gustafson and Gustafson 1967:120).

The *Hunter-Schreger Bands* also originate at the dentine-enamel junction, but terminate halfway to the surface of the enamel (Gustafson and Gustafson 1967:101). These appear as alternating dark and light coloured bands, as seen through polarized light microscopy, due to the orientation of the enamel prisms (Gustafson and Gustafson 1967:102). It is possible that these bands are slightly different in mineral content when compared with other enamel areas (Gustafson and Gustafson 1967:103).

The *Brown Striae of Retzius* are incremental growth layers that represent successive stages of enamel formation; the first layer, which would become the incisive edge, having been deposited at the dentine-enamel junction (Scott and Symons 1974:200). They are discernable by their brown colour when viewed by polarizing microscopy. The Retzius lines do not reach the surface at the tips of the cusps, but curve around the dentine in that region, and can disappear through the process of wear (Scott and Symons 1974:200). At the side of the tooth, these lines reach the surface at an angle, and appear as slight grooves in the enamel surface (**Figure 2.2**). These grooves, called *perikymata*, are closer together near the cervix (Gustafson and Gustafson 1967:112). Retzius lines can be pathologic due to a mineralization defect, and they can be either hypermineralized or hypomineralized (of which the latter are more common) when compared with the surrounding enamel (Gustafson and Gustafson 1967:90-95). If two Retzius lines should meet, an unusually large depression (a hypoplasia) is created on the enamel surface (Gustafson and Gustafson 1967:114), which might be more susceptible to food entrapment, bacterial activity, and a resulting carious lesion.

The *enamel lamellae* extend from the enamel surface some distance into the enamel and are independent of the prism orientation (Scott and Symons 1974:203). Lamellae are produced by cracks in the enamel, which can occur either in the pre-eruptive stage or after eruption, and fill up with organic material (Scott and Symons 1974:203). The organic material is provided from the saliva or dentine, and can include bacteria (Scott and Symons 1974:203). Referred to as 'fault planes,' the lamellae are areas of poorly mineralized material which allow for fractures and loss of enamel resulting from diagenic effects in archaeological material (Hillson 1996:163).

Enamel tufts begin at the dentine-enamel junction and reach approximately one-third through the enamel towards the surface (Scott and Symons 1974:203). Their wavy course matches that of the enamel prisms and, like the lamellae, these are organic (protein) structures (Scott and Symons 1974:203; Hillson 1996:228).

Enamel spindles are tubules which extend into the enamel layer for short distances, especially in the cusp regions, from the dentine layer (Scott and Symons 1974:202). These do not conform to prism directions, and are thought to be produced by the odontoblasts before either the dentine or the enamel is laid down (Scott and Symons 1974:203).

Finally, the *enamel cuticle* has been said by some specialists to compose the surface layer of the enamel, which seems to be replaced once worn away (Gustafson and Gustafson 1967:111). It is described to be about one micron in thickness and deposited by the ameloblasts at the end of the enamel formation process, although it is found to be present on erupted teeth only (Scott and Symons 1974:186). Scott and Symons (1974:186) suspect that the cuticle is an optical phenomenon resulting from the process of thin sectioning for light microscopy.

To summarize, the internal structures of the enamel and the degree of mineralization of the enamel are subject to systemic and local disturbances which may cause a tooth to be more susceptible to dental caries. Gustafson and Gustafson (1967:114) suggested that the surface characteristics (the prism direction, the perikymata and the lamellae) are particularly important with respect to this susceptibility. While there is no turn-over of enamel as there is with bone, enamel does not remain static during one's lifetime. Although a dense tissue, ions can be transferred from the saliva to and from the outer enamel layers, and some amount of transfer from the pulpal blood supply across the dentine can occur (Scott and Symons 1974:205).

The Morphology of Teeth

The external morphology of the tooth is also an important factor for the development of dental caries. In general, premolars and molars are more susceptible to carious lesions than are incisors and canines, due to the relative abundance of pits and fissures on their occlusal surfaces (Powell 1985:313) (**Figure 2.3**). Food particles are easily trapped in narrow pits and grooves, thus allowing more time for oral bacteria to feed and produce the acids which demineralize the enamel surface (Powell 1985:315). This process is affected by the interactions of several factors, such as the rate at which saliva clears the food from the tooth surface, the chemical composition and degree of hardness of the enamel, and the characteristics of the oral bacteria. Extra cusps which tend to occur on molars serve to increase the grooves available for caries formation. An example is the 'deflecting wrinkle' of the

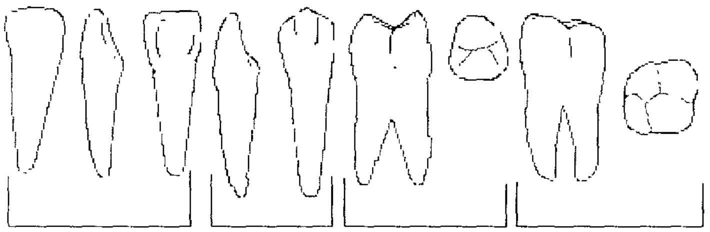


Figure 2.3 Permanent tooth morphology (from left to right): an incisor (buccal, profile, and lingual views), a canine (profile and buccal views), an upper premolar (buccal and occlusal views) and a lower molar (buccal and occlusal views).

mesiolingual cusp of permanent first molars which can occur with a frequency of up to 86 percent in Sinodont dentitions (including Native American populations) (Hillson 1996:96,101,102).

Tooth morphology is a product of genetics, although attrition and abrasion (dental wear) will alter the tooth surfaces throughout an individual's lifetime (Paynter and Grainger 1962 cited from Powell 1985:315). The degree of tooth crowding and overlap can also affect the areas between the teeth where food particles may be trapped and ferment. Unlike the chemical composition and internal structures of the teeth, morphology can differ significantly between individuals. A dental arch containing supernumerary teeth, extra cusps on the molars, plus crowding and malalignment, would be at a higher risk for developing caries than one experiencing congenital absence of the third molars, with simple cusp patterns, and an abundance of interproximal spaces. As an individual ages, the occlusal surfaces are expected to be altered by the effects of wear, and teeth may be lost. These factors differ between individuals and serve to alter the individual's risk to caries.

The Role of Saliva

Laboratory testing and visual observations by dental practitioners have demonstrated that salivary dysfunction, due to disease or certain medications, places an individual at a higher risk for developing caries (Featherstone 1987:10). Causes of permanent salivary dysfunction which may have affected ancient populations include congenitally absent or malformed salivary glands, although this is rare amongst contemporary populations (Goldman and Marder 1982:208). Acute viral infection, mental stress and depression, however, can trigger a temporary form of this condition. The World Health Organization (WHO 1992:5-7) has explained the benefits of salivary action for caries resistance as a buffering agent and as a catalyst for the remineralization of early lesions. Saliva produces a protective layer, known as the salivary pellicle, which adheres firmly to the tooth surface. The pellicle contains proteins such as calcium, phosphate and fluorine, "the necessary ingredients to maintain supersaturation and inhibit demineralization, or to provide these minerals for remineralization of partly dissolved tooth material" by at least partially regrowing the depleted crystals in the region of the lesion (Featherstone 1987:14).

Some of the proteins contained in the saliva are antibacterial, including immunoglobins (Featherstone 1987:14). Lymph cells generate antibodies that travel through the circulatory system and become released into the mouth through the saliva (WHO 1992:7). Although cariogenic compounds, such as sugars, can re-enter the mouth through the saliva (Harris 1970:3), the saliva contains organic bases (bicarbonate and phosphate) which, to a certain degree, counteract the organic acids produced by the oral flora (Featherstone 1987:14). Featherstone (1987:13) notes, "As the saliva flows over the plaque its constituents neutralize the plaque acids raising the pH again and reversing the process" of demineralization by the bacterial acids. In addition, the flow of the saliva, together with the movement of the tongue and cheeks, aids in physically dislodging food particles from tooth crevices, which further protects the teeth against bacterial metabolites.

Pathogenic Agents - The Oral Bacteria

Oral bacteria live primarily in plaque, a relatively thick substance that consists of bacteria, food particles, and the acidic bacterial waste produced from the bacteria's metabolism of the fermenting food particles (Powell 1985:313). With the exception of a relatively small number of individuals who are genetically immune to oral bacteria, all human mouths become inhabited by oral flora shortly after birth (van Palenstein Helderman *et al.* 1996:535). Microbes were first implicated in caries etiology in 1917, when *Lactobacillus acidophilus* was associated with oral acid production (White-Graves and Schiller 1986:242). However, from the mid-1950s to the present, *Streptococcus mutans* has been the most heavily studied microorganism involved in the initiation of the carious lesion (White-Graves and Schiller 1986:242).

Studies by van Houte and colleagues (1994, 1996) examined the role of streptococcal species, lactobacilli, and other microorganisms, and their production of acids within the oral environment. van Houte (1994:673) has found that oral bacteria form a hierarchy within the plaque based upon their acid-producing and acid-tolerant qualities. Mutans streptococci and lactobacilli were found to rank highly in this hierarchy, meaning that they produce a lot of acid (which lowers pH values) and can tolerate the low pH values in plaque that seem to be produced following sugar exposure (van Houte 1994:673-674). Studies examining the effect of different foods on oral pH levels have found that cooked starch produces a greater pH drop than uncooked starch, and that starch combined with sucrose will sustain the pH drop for long periods (White-Graves and Schiller 1986:243). In general, the simple sugars, monosaccharides and disaccharides (such as the glucose contained in fruits, and sucrose), diffuse rapidly through the plaque and are consumed by the bacteria preferentially over the complex sugars (including the starch in maize) that have larger molecular weights (Powell 1985:314; Le Vay 1993:25). The more complex sugars and starches need to be retained in the oral cavity for longer periods of time in order to ferment adequately and become metabolized by the bacteria (Powell 1985:314).

Other organisms found to be numerically predominant with acidogenic potential include non-mutans streptococci, *Actinomyces*, *Bifidobacterium* and *Villonella* species (van Houte 1994:674; van Houte *et al.* 1996:1012). Each of the organisms found within the oral cavity differ with respect to the acids they produce, their own tolerance to acid levels and their cariogenic potential as demonstrated in animal and human tests (van Houte 1994:674). Thus, the pH lowering ability of these bacteria varies so that "acidogenic organisms are not necessarily cariogenic" (van Houte 1994:674). These studies concluded that while other, generally less-studied, bacteria likely play a role in acid production and enamel demineralization, *Streptococcus mutans* seems most crucial for the formation and progression of all carious lesions, while lactobacilli seem to play a significant role in the progression of carious lesions on certain tooth sites (van Houte 1994:673,674).

Although it is generally thought that *Streptococcus mutans* is one of the most cariogenic bacterial factors, van Palenstein Helderman and colleagues (1996:535) argue that once all of the contributing factors are weighed, the diet is the most crucial factor in caries etiology. They stress that "frequent drops in pH caused by carbohydrate metabolism may play a more significant role in the ecology of mutans streptococci in dental plaque" (van Palenstein Helderman *et al.* 1996:538). Presently, there is controversy in the dental literature regarding the bacteria needed for acidogenesis. It is recognized that the specific interactions between different food compounds, the pH level in plaque and different species of oral bacteria need to be investigated further.

Environmental Factors and Exogenous Factors for Host Susceptibility

Environmental factors such as the trace minerals in soils and water, as well as abrasive materials that may contaminate foods, also play a role in an individual's susceptibility to caries (Powell 1985:317). The minerals found in local soil and water supplies vary across geographical areas, and may come in contact with the teeth directly as water and the plants grown in the soil are consumed.

Fluorine is one such mineral that has been studied in great detail by the dental community. Fluorine has been found to have an antibacterial action, particularly at lower pH levels. As the fluorine enters the bacteria, it serves to interfere with the enzymes and slow down the process of acid production (Featherstone 1987:13). Fluorine also inhibits the demineralization process and enhances the remineralization process directly by speeding up new crystal growth at the lesion site, and actually causes the new crystals to be more stable and resistant to further attacks (Featherstone 1987:13). While the dentine and cementum layers continue to accumulate fluorine via the bloodstream throughout life, enamel, once formed, only absorbs small amounts from the water and food entering the oral environment (Hillson 1996:220). Overall, the dentine, particularly the secondary dentine, and the cementum contain higher concentrations of fluorine than the enamel. Within enamel, the highest levels of fluorine are located at the crown surface (Hillson 1996:220). Natural fluorine levels in the soils of northeastern North America are known to be low (Shaw 1985 cited from Saunders *et al.* 1997:80), less than the 0.8 to 1.0 ppm which is generally added to contemporary fluoridated drinking water (Hillson 1996:220).

Several exogenous factors of significant importance to the caries experience for agricultural populations include the diet (chemical composition, texture, methods of preparation, frequency and mode of consumption), oral hygiene, degree and rate of dental wear and non-alimentary oral habits (Powell 1985:317). The cariogenicity of the diet can be tentatively assessed based upon sucrose content, physical properties and consumption patterns (White-Graves and Schiller 1986:244). Burt and Ismail (1986:1475) suggest that there is a low threshold effect regarding sugar for the initiation of caries. It is not crucial for the diet to contain a large amount of sucrose, as long as the other basic factors (poor oral hygiene and low fluorine exposure) are right for the initiation of carious lesions (Burt and Ismail 1986:1477). Other compounds found in foods, such as fats, phosphates, phytates and certain trace elements, seem to be cariostatic agents (White-Graves and Schiller 1986:243). Calcium lactate has been observed to inhibit acid production, and other foods actually raise the pH level in the oral environment once it has been lowered by previously consumed foods (White-Graves and Schiller 1986:243). A dietary reconstruction for a past population should attempt to determine the relative proportions of cariogenic foods (containing starches and sugars such as maize and fruits) and cariostatic foods (containing proteins and fats such as meat and milk) that may have been consumed by individuals in order to assess their experience of dental decay (Pollard 1995: Vacca-Smith and Bowen 1995). While comparing dental decay between individuals, attention should be given to potential differences in the consumption of cariogenic and cariostatic foods.

Additional exogenous factors influence host susceptibility to dental caries. The texture of foods is important, for sticky foods that remain on and around tooth surfaces for long periods are more cariogenic than hard foods, such as raw vegetables, that aid in the mechanical cleansing of tooth surfaces (White-Graves and Schiller 1986:241). Winter (1990:5S) points out that dental hygiene practices are often found to dominate over dietary habits, so that effective oral hygiene can counteract even the most cariogenic of diets. Methods of preparation, such as cooking and refining, also affect cariogenicity. Burt and Ismail (1986:1478) suggest that the length of the interval between eating, rather than the frequency, is an important factor for caries incidence. This argument is based upon the observation that the pH levels in the saliva will not have a chance to rebound to more protective levels (low pH levels encourage the production of acids by some bacteria) if short time intervals are left between meals and snacks. It is clear that the development of caries is complex and multi-factorial, and that the aforementioned exogenous factors require attention.

Dental Disease Resulting from Endogenous and Exogenous Factors

Plaque formation inevitably occurs within every oral environment that contains bacteria. This sticky film, composed of multiple bacterial species, dietary components and the byproducts of bacterial metabolism, adheres to the exposed surfaces of the teeth (Goldman and Marder 1982:18). The byproducts include the organic acids which cause the pH level in the plaque to fall, creating the potential for the demineralization of a tooth surface (Featherstone 1987:12). The presence of plaque also irritates the soft gingival tissues. If the irritation is not temporary, inflammation of the tissue can lead to a loss of attachment between the periodontal ligament and the tooth. This forms a periodontal pocket between the gingiva and the tooth where plaque and calculus may collect, adding to the inflammation. Eventually, alveolar bone loss will occur, and the tooth surfaces at the cement-enamel junction and the roots will become exposed and vulnerable to bacterial attack (Hillson 1996:262-3) (**Figure 2.4**). Alveolar resorption is generally considered to be age-related, but it varies between individuals based upon their oral hygiene (Mayhall 1992:74). It is also possible that systemic diseases and hormonal changes (for instance, during pregnancy) might serve to irritate gingivitis (Goldman and Marder 1982:21), although there is some controversy regarding the actual effects of pregnancy on dental disease (Larsen *et al.* 1991:194).

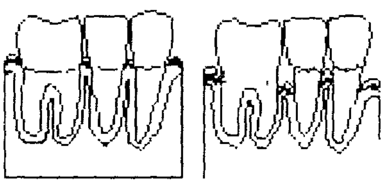


Figure 2.4 Alveolar resorption

Plaque may become mineralized to form calculus on any tooth surface. Calculus forms as a cream or light-brown coloured band which marks the position of the gingival margin (Hillson 1996:256). The roots of the tooth may become affected as the gingiva recedes. Calculus may serve to trap food particles and encourage plaque formation to some extent, but it does not necessarily encourage the formation of caries due to its mineralization properties (Hillson 1996:260). Sites closest to the salivary gland ducts (the origin of the minerals) are the most vulnerable, including the buccal surfaces of the maxillary first and second molars and the lingual surfaces of mandibular anterior teeth (Goldman and Marder 1982:19). Calculus formation is encouraged by large plaque deposits, poor oral hygiene and carbohydrate consumption (Hillson 1996:259).

Dental caries represents one of the main pathological conditions affecting the oral cavity. This disease is linked with age, as the probability for developing carious lesions increases with the amount of time that the teeth are exposed to the oral environment. Since teeth tend to erupt earlier in females than in males, certain females might expect to experience the onset of dental caries at younger ages than their male counterparts (Larsen *et al.* 1991:194). A variety of factors contribute to the formation of caries on any given tooth surface, including: the amount and species of oral bacteria, the amount and frequency of cariogenic foods eaten, the combination of different foods eaten, the rate at which the food exits the oral cavity, the levels of natural tooth cleansing, the levels of mechanical cleansing, and the morphological and chemical characteristics of the teeth. **Occlusal caries** tend to occur in agricultural communities that consume sticky, carbohydrate-rich foods (Hillson 1996:283). These most often develop in the pits and fissures of the cusps of molars and premolars.

Interproximal caries develop below the contact points of adjoining teeth, on either the enamel or the cementum, due to the food and plaque build-up which is not likely to be removed by the natural cleansing actions of the tongue, cheeks and saliva. **Cervical caries** originate at the cement-enamel junction on the buccal and lingual surfaces of the tooth. These, as well as caries on the **roots**, are found in adults, as they develop once the gingiva and underlying alveolar tissue begin to recede (Hillson 1996:274). Caries on the **smooth surfaces** of the teeth are the least frequent type, as these aspects of the buccal and lingual crowns tend to be cleansed naturally (Hillson 1996:274).

The initial stage of caries formation involves a small zone of demineralization on the enamel or cementum surface which is no longer considered to be 'sound' (Hillson 1996:269). Should this location become free from the acid byproducts of bacteria, development of the lesion may be arrested or the area might even be remineralized through the natural transfer of calcium, phosphate and fluorine from the saliva (Featherstone 1987:13). Alternatively, lesions can continue to grow, at varying rates, until the surface crumbles and a recognizable cavity becomes exposed. Once enamel caries have formed, bacteria are able to travel along the microscopic enamel prisms to the dentine-enamel junction (Harris 1970:5). Cementum caries spread relatively rapidly to the dentine layer (Hillson 1996:271). The dentine contains a smaller proportion of minerals compared to the enamel layer, and although carious lesions invading the dentine may be arrested, the bacteria will eventually proceed to the secondary dentine and, finally, to the pulp chamber.

Once the carious lesion grows too large for a surface of origin to be determined, it is referred to as a **'gross' lesion**. These often spread inward far enough to reach the pulp chamber and initiate pulpitis. Pulpitis is an inflammatory response to the toxins from the bacteria, which enter the chamber due to caries, severe wear or trauma. Pressure from the inflammatory discharge builds within the pulp chamber causing pus and local pulp death (Hillson 1996:284). A growing mass of responsive tissue (a periapical granuloma) forms around the root apex, which may remain at a low level of inflammation, with little surface swelling, for a period of years. However, the granuloma generally develops into an abscess due to pressure from the pus. The alveolar bone forms a channel for the release of the pus, which drains to the buccal or lingual sides of the alveolus, into the nasal cavity or the maxillary sinus in the maxilla, or into the mandibular canal (Buikstra and Ubelaker 1994:55; Hillson 1996:285). Once pulp death occurs, the nerves and blood supply are removed, and the probability for tooth loss increases. Chronic abscessing may serve to spread the infection to the roots of adjacent teeth or into the body's general blood supply. Dental disease affecting the alveolus can be fatal, should the infection reach the plexus of veins which transport blood from the face to the brain (Shafer *et al.* 1983:517).

Caries Rates in the Archaeological Record

Through examination of the archaeological record, dental caries has been identified as an ancient disease that has been a geographically widespread problem (Leigh 1925; Patterson 1984; Kelley *et al.* 1991; Larsen *et al.* 1991; Mandel 1993).

Substantial differences in caries rates have been identified based upon subsistence patterns. Overall, gathering and hunting societies have the lowest incidence in caries rates, followed by increased rates for societies with a mixed economy, followed by a marked increase in caries rates among agricultural populations. This significant rise in dental caries in agricultural populations is suspected to be linked to the increased importance of cooked, starchy foods (such as maize), as well as an increase in the processing of these foods into more highly refined forms which would be metabolized more rapidly by the oral bacteria (Bibby and Sohrweide 1991:24). Certain food preparation techniques, such as premastication, provide intriguing examples of possible circumstances whereby caries rates might be enhanced among some members (for instance, the food-preparers) of a population. Leigh (1925:188), upon examining the teeth from a sample of Zuni crania, found that "No tooth in the series was immune to caries" among this agricultural group. Mandel (1993:2-3) suggested that the Zuni's practice of partial mastication of food, for the purpose of allowing it to mix with saliva and ferment overnight to form a more sweetened mixture, could help to explain their extremely high rate of caries.

Summary

Examinations of the dental health of prehistoric agricultural populations must account for as many of the factors as possible relating to host susceptibility and the environment in order to formulate a complete understanding of dental caries and its potential as an indicator of subsistence and health patterns. Since the formation and patterns of dental caries within the oral cavity involve a multitude of interrelated factors, examinations are required to be precise and descriptive in order to make meaningful comparisons between individuals. Once this is accomplished, information regarding dental disease experiences within different members of a single community will become available.

Chapter 3: The Late Ontario Iroquoian People

> By the time of contact with Euro-Americans, Great Lakes Indians (sic) had developed means of gaining a living by methods that were the cumulation of thousands of years of trial and error in which countless choices for the investment of human effort were balanced against possible yield of food resources. Although making a living depended to some degree on the caprice of nature, the evidence suggests that a stable balance was reached in which population, group size, seasonal movements, and the division of labor (sic) combined to produce a successful accommodation to specific sets of environmental resources (Tanner 1987:18).

Introduction

Unlike studies of historic period cultures, no written record exists which recounts direct information about the Late Ontario Iroquoian peoples' individual roles in society, their eating habits or their health status. A complex multi-disciplinary approach is essential to gain some understanding of these aspects of pre-contact Iroquoian life.

Certain characteristics, that may have varied slightly through time and space, have been cited to describe the lives of Iroquoian-speaking peoples in southern Ontario and southwestern New York state. Trigger (1976:132-133) summarized these qualities, including: a subsistence base primarily dependent on horticulture, with fishing following in importance; a division of labour in which the men performed the majority of the tilling, hunting, building, trading, and defence, while the women were responsible for the crops, cooking, and tending the children; residence in longhouses, generally clustered in fortified villages; and, a matrilineal and matrilocal social system with membership in clans. This chapter reviews the information gained through archaeological investigations (material culture, floral and faunal remains), seventeenth century ethnohistoric records, twentieth century ethnographic studies, Iroquoian skeletal remains, and the natural environment (soils, indigenous flora and fauna) in order to create a framework for the interpretation of the dental evidence from the three analyzed skeletal populations. These sources of information have been collected throughout the past three hundred years, and should be integrated to form a relatively detailed picture of the lives of pre-contact Iroquoian peoples.

The Uxbridge, Kleinburg and Syers ossuaries were situated spatially in southern Ontario (**Figure 3.1**) and temporally during the three centuries prior to direct European contact. These three burial populations were chosen for this analysis due to their well-preserved condition with respect to their dental remains. Although no written record exists to describe these people and their settlements, much information is known in general about their culture, and to a certain extent, the archaeological record and previous skeletal analyses offer specific information about each of these populations.

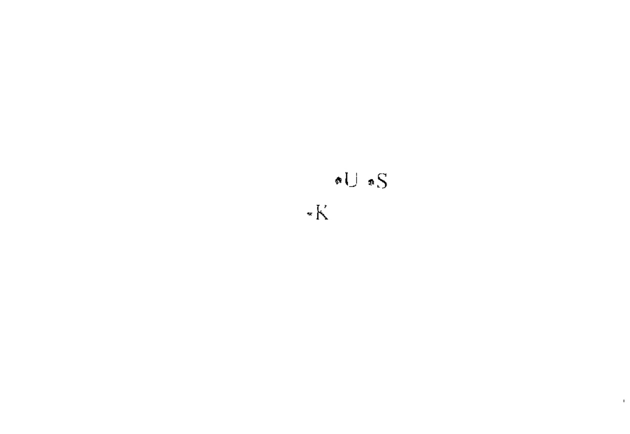


Figure 3.1 Approximate locations of the Kleinburg (K), Uxbridge (U) and Syers (S) Ossuaries in Ontario. Adapted from Katzenberg *et al.* 1993:269

Archaeology I - Material Culture

The Syers Ossuary has been broadly dated to the time in which ossuary-style burial was most widespread; roughly between AD 1300 and 1550. The complete absence of material goods in the ossuary (Boyle 1896:42) eliminates the possibility for assigning a narrower time range, but does infer that the burial took place prior to the introduction of European trade goods to the area. A lack of known related archaeological sites suggests that this section of the Trent River drainage system had been abandoned before the historic period (Wright 1966:68-Map 5). This broad date for Syers denotes that these people lived in either the Middle or the Late Ontario Iroquoian phase of southern Ontario history.

The Middle Ontario Iroquoian phase, dating from AD 1300 to 1400, is characterized by a "widespread and relatively homogeneous [cultural] complex" (Wright 1966:64). People tended to live in small camp-sites, although the occasional large village site, occupied by perhaps hundreds of people, has been recovered. Reliance upon maize horticulture seems to be correlated with a rapid population increase at this time (Wright 1966:59). Noble (1975:37) has suggested that maize horticulture was integral to the formation of large Iroquoian villages. The majority of maize analyzed by Sykes (1981:30) from Middle phase (and later) sites consisted of the 8-rowed Northern Flint variety, for which he suggests that, at best, 14.5 bushels of shelled maize per acre were produced. In addition to maize, the sunflower was a domesticated food source (Wright 1966:98). A wide range of wild faunal species were hunted for food, with perhaps an emphasis on fish (Wright 1966:64). Dogs were domesticated and sometimes eaten (Wright 1966:60,99).

Large ossuary-style burials were in use by the latter half of the fourteenth century. These communal secondary burial pits were generally smaller than those in the Late phase and were located fairly close to villages, which possibly indicates that they were intended exclusively for the dead of the nearest village (Wright 1966:99). Boyle (1896:42) states that "a village site may be traced in a field only a few hundred yards from the [Syers] grave." However, Boyle's (1896:42) population size estimation for the Syers Ossuary, of approximately six hundred individuals, may indicate that the people were interred during the Late phase, when ossuaries were larger, "probably containing the dead of a number of villages of one clan" (Wright 1966:99). A radiocarbon date is required in order to assign this burial population to a specific phase in Ontario's history.

The Uxbridge and Kleinburg ossuaries are thought to be more recent than the time estimate for the Syers burial. As there were virtually no grave goods recovered from the Uxbridge Ossuary (Pfeiffer 1983:9), its age was assessed through radiocarbon dating, which resulted in a calibrated date of AD 1440 ± 80 years (Pfeiffer pers. comm. 1997; Merrett and Pfeiffer 2000:306). A small site, located approximately 150 metres to the east of the ossuary, may have been the village of some or all of those interred. The artifact seriation from this small site indicated a Middle or Late phase occupation (Cook 1976 cited from Molto 1983:92).

The presence of French iron axes, glass beads and iron knives in the Kleinburg Ossuary indicates that these people had access to European trade goods, if not direct contact with the actual explorers (Melbye pers. comm. 1998). The additional recovery of a Late Ontario Iroquoian ceramic pipe and lithic projectile points suggests that this burial took place on the verge of European contact, circa AD 1585 to 1615 (Patterson 1984:228). It is considered here that the Kleinburg Ossuary was situated near the terminus of the Late phase, as it is most probable that these people lived according to the Late period characteristics, having not been greatly affected with respect to subsistence patterns and social roles by the presence of Europeans.

The village affiliation for the Kleinburg Ossuary has long been debated. The nearest known village is the Seed-Barker site (AkGv-1), located less than three kilometres to the south of the ossuary. At present, no associated ossuary has been located for the Seed-Barker site (Burgar pers. comm. 2001). The seriation of diagnostic rimsherds has implied a Late phase habitation dating to AD 1530 to1560 (Burgar 1996:67). Despite the earlier date for the village site, it is still possible that the two sites actually overlap temporally, or that some individuals interred at Kleinburg were raised at the Seed-Barker village. Thus, the material record of the Seed-Barker site will be used as a model for Late Ontario Iroquoian village life, pertaining to this analysis of the individuals interred at the Uxbridge and Kleinburg ossuaries.

The archaeological record indicates regional differentiation of settlements and a gradual movement of groups towards Huronia during the Late Ontario Iroquoian phase (circa AD 1400 to 1649) (Wright 1966:66; Ramsden 1990:382). During this phase, the geographic locations of the Syers, Uxbridge and Kleinburg ossuaries all fall into the area which Wright (1966:67-Map 4) identifies as the Southern Division of the

Huron-Petun branch. Wright (1966:91) described the general similarities found amongst villages excavated from this time period, including:

> ...palisaded villages set in defensive positions distant from navigable waters. Subsistence was based upon corn agriculture with the supplementary crops of beans and squash. Hunting, fishing, and gathering still contribute to the food supply but to a far lesser degree than noted in the earlier stages. Cannibalism and the use of the dog as a food animal appear to reach their peak around the first half of the 16th century. Ossuary burial becomes the accepted way of disposing the dead...

Domesticated forms of beans and squash appear in the archaeological record shortly after AD 1400 (Wright 1966:98). Large longhouses continued to be the primary domestic structure, and seem to reflect the preferred habitation of matrilineal clans (Wright 1966:98).

It is probable that the vast majority, if not all, of the individuals interred in the Late period ossuaries (including Uxbridge and Kleinburg, and possibly Syers) lived in villages populated by more than one thousand people. Based upon the number of longhouses and approximated acreage of the Seed-Barker site, Burgar (1996:17) estimated a population of up to 3,000 individuals. Waste products left behind by the inhabitants, which have since been incorporated into the archaeological record, primarily include ceramic pottery and pipes, lithic tools and debitage, faunal remains, carbonized floral material and a small quantity of Native copper artifacts (Burgar 1996:19). The recovered lithic artifacts provide indirect evidence of the general subsistence practices. The projectile points generally measure between two and four centimetres in length (Burgar 1996:22-26), which suggests that they were designed for hunting relatively small mammals (up to deer-sized) and birds. Anvil stones, used for grinding maize kernels, seeds and nuts, have also been recovered (Burgar 1996:21). Bone fish hooks have occasionally been found intact, indicating that fish were caught, most likely from the nearby East Humber River, by the hook-and-line technique (Burgar 1996:76).

Unworked faunal remains represents the second largest class of artifacts found at the Seed-Barker village, generally around 40 % of the total artifacts recovered per field season (Burgar 1996:19). Both charred and uncharred remains from the classes Mammalia (such as deer, domesticated dog, wolf, elk, bear, groundhog, fox, squirrel, raccoon, beaver, muskrat, chipmunk, moose, vole), Aves (such as pigeon, wild turkey, crane, grouse), Osteichthyes (such as perch, trout, sucker, whitefish, bullhead), Reptilia (turtle and snake) and Amphibia (frog), and from the order Mollusca (freshwater clam) have all been recovered (Burgar 1993:49).

As for floral remains, varying quantities of charred maize kernels, beans, possible wild rice, and the seeds of cucurbit (squash and/or pumpkin) and sunflower have been recovered (author's personal observation). Crawford (1982:5,6) also identified noncultigens such as strawberry, raspberry, black nightshade (a fleshy fruit), chenopod and knotweed (greens with fleshy leaves), bedstraw (which produces fruit, and the seeds may have been utilized for medicinal purposes), plus hornbeam and ironwood (members of the birch family which produce nutlets). The soil samples examined by Crawford (1982:7) indicate that nuts were not utilized much by the inhabitants. Crawford (1982:6) identified one seed of wild rice, which he considered fairly significant as it was the first known report of this plant from an Ontario archaeological site. This plant, however, did not likely form a reliable component of the diet. It is possible that problems with preservation, identification and recovery techniques have impeded the collection of larger quantities of floral remains, including the smaller seeds from wild plants.

Archaeological and ethnohistoric evidence led Heidenreich (1971) to estimate that maize accounted for approximately 65 % while meat and fish comprised 15 % of the historic Wendat (Huron) people's daily caloric intake. Needs-Howarth (1995) outlined the difficulties inherent when attempting to quantify the actual amounts of animal species consumed by the people living on an Iroquoian site. Prevec and Noble (1983), in their analysis of historic Neutral exploitations of faunal resources, demonstrate that a considerable amount of data need to be synthesized in order to attempt a reconstruction of this aspect of pre-contact subsistence. From the Seed-Barker site, spiral fractures have been found on some of the larger mammalian and avian longbones, indicating purposeful human breakage for access to the marrow. In other cases, it may be difficult to decide if the bones recovered from a site represent the remains of an animal used for food or as another type of resource for the human occupants. For instance, certain birds may have been hunted for feathers rather than for consumption (Ramsden 1990:380), or for both purposes. Animals may have been brought onto the site by dogs, and some may have inconspicuously died within the limits of the village (either during or after occupation), and become incorporated into the archaeological record.

Monckton (1992) has attempted to weigh the complexity of factors that lead to plant preservation and recovery within the archaeological record in order to attempt a reconstruction of this aspect of the Wendat diet. He analyzed the palaeobotanical remains from four historic village sites. The edible cultigens identified were maize, beans, cucurbit and sunflower (Monckton 1992:27). Seeds of noncultigens were found in great numbers, including fleshy fruits, greens and grains. The following fleshy fruits were generally abundant on the sites and are identified as being "typical of forest edge successional plant communities:" bramble, strawberry, cherry species, plum, hawthorne, black nightshade, elderberry and blueberry (Monckton 1992:44-5). Next in abundance are the greens and grains, including taxa which bear seeds and/or fleshy leaves, such as chenopod, knotweed, pepper-grass and purslane (Monckton 1992:46-51). The cultural significance of these plants is probable, as they may have been used as condiments or for medicinal purposes.

Other plants identified were probably used as condiments or for making beverages or medicines, such as sumac, evening primrose, spikenard, bedstraw, mountain ash and ironwood. It is noted that modern seeds were present and, in some cases, were not easily distinguished from culturally significant material (Monckton 1992:55). Maize was estimated to have contributed a maximum of 58 % of the general daily caloric intake and fleshy fruits 24 % (Monckton 1992:86). Beans and sunflower barely register as contributors to daily caloric intake, at 2 % and less than 1 % respectively (Monckton 1992:86-87). Monckton (1992:84) points out that plant foods lose water-soluble vitamins during drying and cooking, which were processes employed during Wendat food preparation.

Due to inherent limitations affecting the preservation and recovery of animal and plant remains, the archaeological record cannot provide a precise reconstruction of the daily food items consumed by pre-contact peoples, and certainly not of those consumed by specific individuals. The types of foods eaten in combination with one another, the frequency of foods eaten, the methods of preparation, and the texture of the food are just some of the factors that contribute to the dental health of an individual as reflected by dental caries. The archaeological record does not represent the full material remains of any culture, nor does it presume to offer many direct insights into the beliefs and ideologies shared by the members of a pre-contact village group. Post-contact ethnographic sources have traditionally been consulted for their potential to provide different perspectives on the available information.

Seventeenth Century Ethnohistoric Accounts

Ethnohistoric sources may be consulted in order to obtain an understanding of post-contact dietary practices and social roles, which may then be used to extrapolate information pertaining to pre-contact populations. Documents written by early French explorers, such as Samuel de Champlain, and missionaries, such as Gabriel Sagard and the Jesuits, conveyed their observations and impressions of Native groups during the first half of the seventeenth century. These were among the first literate men to learn about the lifestyles of the peoples in what is presently southern Ontario. Although precious by virtue of their rarity, these early resources should be consulted with a measure of critical scrutiny. The events described in these accounts should not be accepted as truth without a careful examination for the individual author's motives, expectations, intended audience, frame of reference, relation to the event in time and space, observational skills, narrative ability and knowledge of the language, among other considerations which may be difficult to assess (Gottschalk 1969; Ramsden 1996:104-105). The primary works by Champlain (Grant 1907, edited volume) and Sagard (Wrong 1968, edited volume) have been evaluated elsewhere for their potential to relate the 'historical facts' about the people whom they observed (Crinnion 1998). For the purpose of this review, observations made by Champlain, Sagard and Jesuit Father Le Jeune, will be explored regarding the dietary patterns and social roles of the Wendat.

Champlain lived among the Wendat (Huron) for most of the winter of 1615-16. In Champlain's words, he used this time "to observe their country, customs, dress, manner of living, the character of their assemblies, and other things which I should like to describe" (Grant 1907:310). According to Trudel (1966b:193), Champlain "has left us a detailed description of them which is an ethnographical compendium of the Huron country." In his *Voyages of 1604-1618*, Champlain lists many of the animals found in the Great Lakes region, and implies that the people were hunting "stags, caribous, elks, does, buffaloes, bears, wolves, beavers, foxes, minxes, weasels, and many other kinds," as well as catching many varieties of fish and hunting many types of birds (Grant 1907:311). Their principal food items were 'Indian corn' and 'Brazilian beans,' prepared in many different ways (Grant 1907:314). He noted that, normally, the majority of the Wendat ate two meals per day (Grant 1907:316).

Once the maize kernels were crushed in a wooden mortar, the flour was used to make either bread or soup. Ingredients, added to the maize mixture when available, included beans, blueberries, raspberries, or pieces of deer fat. The bread was either baked in the ashes of the fire, or wrapped in maize leaves and boiled (Grant 1907:314,315). Champlain identified *sagamité* as the most common maize dish, which was made by boiling the pounded maize with either fresh or dry fish for flavour. He noted that the bran was left in the maize, and that all parts of the fish were included, although the appendages, scales and "inwards" were not to his personal taste (Grant 1907:315). The fish could be substituted with venison. The resulting mixture was thin in consistency and doubled as a beverage. Another recipe, also referred to as *sagamité*, was prepared by roasting unripened maize, then cooking it with fish or meat, if available (Grant 1907:315).

Maize could also be prepared for cooking by soaking it in muddy water for two to three months. It was then either roasted or boiled with meat or fish. According to Champlain (Grant 1907:316), "the women and children take it and suck it like sugar-cane, nothing seeming to them to taste better, as they show by their manner." Besides maize, Champlain (Grant 1907:317) recorded that the Wendat "eat many squashes," once they were boiled and roasted in the ashes. Dog and bear were reserved for banquets (Grant 1907:316). His narrative also indicates that, at times, the warriors ate their prisoners (Grant 1907:309).

Champlain was primarily present for a period of four months' worth of meals during the winter of 1615-16. He did not mention who was responsible for preparing the maize flour or who actually cooked the food; he simply referred to the chefs as "they" (Grant 1907:315). Neither did he mention whether or not all people in the village ate the same diet. It might be that children ate different foods than adults, or that adult women ate differently than adult men. These relationships are not alluded to in Champlain's account. These omissions cause one to question Champlain's direct presence during the preparation and cooking of meals. It may be that he partook in the eating of the food with the adult men only, and perhaps asked them how the food was made or what ingredients were included. If Champlain did not directly witness the preparation stage, it is possible that subtle methods or less obvious ingredients may have been omitted from his accounts. In addition, due to the timing of Champlain's visit (during the winter months), he probably missed the potential range of foods that were eaten by the Wendat throughout the remainder of the seasons.

Champlain discussed only a handful of Wendat dishes, and it seems likely that he recorded those food items that he noticed were most common or those that caught his attention. He may have failed to mention some of the less frequently eaten dishes, or ingredients that were used only on occasion. In general, Champlain likely recorded those events and details which he thought were most important to the point he was trying to present. While attempting to extract the 'historical facts' about Wendat food as conveyed in Champlain's work, it is difficult to conceive of any reason that Champlain might have had for intentionally distorting his observations about this aspect of their daily lives. Champlain does, however, offer an apparent predisposed opinion of Wendat life in general: "Their life is a miserable one in comparison with our own; but they are happy among themselves, not having experienced anything better, and not imagining that anything more excellent is to be found" (Grant 1907:314). In this same train of thought, Champlain begins to describe Wendat food and some of their methods of food preparation. This leads the reader to wonder if, perhaps, he was not expecting to find interesting culinary dishes and, therefore, did not spend much effort in attempting a thorough and accurate investigation of this facet of life within the settlements that he visited.

The prospect of discovering access to Asia in the west had spurred Champlain to explore the St. Lawrence and other inland river systems. He seemed to hold prosperous plans for the future of this area. "Gradually Champlain became a colonizer. His explorations in 1609 and 1613, his winter season with the Huron country in 1615-16, and the evidence of the other European settlements, convinced him of the rich potentiality of a vast empire" (Trudel 1966a:29). It seems apparent that Champlain's main driving force was colonization and profit-making through the exploitation of resources, and the goal of discovering the passage to the Western sea. Despite this, Champlain's visit to Wendat settlements during the winter of 1615-16 did enable him to produce a brief, but valuable, account of dishes that were eaten, along with modes of preparation. His accounts should also be evaluated based upon independent testimony, such as that produced by Sagard and several of the Jesuit missionaries.

Gabriel Sagard, a Recollet friar, lived among the Wendat in 1623-24. Chapter VIII in Sagard's *The Long Journey to the Country of the Hurons* is entitled "How they clear, sow, and cultivate the land and then how they bestow the corn and meal, and their mode of preparing food" (Wrong 1968:103). Despite the title, Sagard explained in more detail that each family subsisted on fishing and hunting as well as planting (Wrong 1968:103). Once harvested, the maize was hung to dry inside the longhouse, and then shelled, cleaned and stored in casks. Sagard's description of the making of boiled bread (*sagamité*), and the extra ingredients added for flavouring, was similar to Champlain's account, except that Sagard also mentioned pumpkin, strawberries, blackberries, "and other small fruits, dried and fresh" (Wrong 1968: 105,107). Once cooked, a little melted fat was sometimes added on top (Wrong 1968:107). Sagard, like Champlain, described the maize that had been soaked in water for two to three months, calling it "stinking corn," and associated the Wendat's enjoyment of it with a European eating sugar-cane. This was a special dish, saved for "feasts of great importance" (Wrong 1968:108). Sagard's personal opinion of this recipe was that "the taste and smell are very strong, and the stink worse even than sewers" (Wrong 1968:108).

Another maize bread recipe observed by Sagard was described as 'chewed bread.' The women, girls and children bit off unripened kernels and spit these into pots. These kernels were pounded, wrapped in maize leaves and baked under the ashes of the fire:

> This chewed bread is the kind they themselves prize most, but for my part I only ate it of necessity and reluctantly, because the corn had in this way been half chewed, bruised, and kneaded by the teeth of the women, girls, and little children (Wrong 1968:105).

Other foods eaten by the Wendat during Sagard's 1623-24 visit included boiled acorns and some types of roots. Certain tree bark, likely from one of the maple species, was sometimes eaten (Wrong 1968:108). In order to cook fish or meat, heated stones were placed into water in a kettle until the water was heated "and so cooked the meat to some extent" (Wrong 1968:109). Sagard seems to infer that this process was insufficient to completely cook the meat. Sagard mentioned that meat was rarely eaten, and that fish was only eaten in small quantities (Wrong 1968:106).

Sagard's work is frequently cited as one of the 'top three' primary sources of information about the early post-contact Wendat. Regarding precise experiences, Rioux (1966:591) noted that Sagard described events "which to a large extent" he witnessed. Here. Rioux provides a clue as to the authenticity of Sagard's information, as he notes that Sagard was not necessarily a primary witness for some of the details that he relates in his works. In fact, Sagard had read Champlain's earlier accounts of the Native settlements in the area, and he tended to use Champlain's words in his own accounts without mentioning Champlain's name in association (Tooker 1991:6). However, Tooker (1991:6) clarifies: "This copying was not simple plagiarism: Sagard probably omitted those data he did not observe, expanding, contracting, and rearranging the text to suit his purpose." This tendency can be seen in relation to Wendat food concerning the two mens' descriptions of the 'stinking corn.' As Champlain described, "The women and children take it and suck it like sugar-cane, nothing seeming to taste better, as they show by their manner" (Grant 1907:316), while eight years later, Sagard wrote, "...licking their fingers as they handle these stinking ears, just as if they were sugar-cane" (Wrong 1968:108). If Tooker is correct, and Sagard witnessed this mode of preparation, then his words actually corroborate Champlain's account. Although ears left soaking in muddy puddles would not survive in the archaeological record to offer additional evidence, it seems likely that the Wendat did practice this custom during the early post-contact period, and possibly prior to European contact as well.

During Sagard's winter with the Wendat, he was apparently fairly dedicated to his journal. Wrong (1968:xiv-xv) relates, "[Sagard] was interested in everything. ... He must have made notes from day to day. Some he lost, but others were preserved, and he had besides a retentive and, on the whole, accurate memory." This statement is revealing. Wrong seems to feel that Sagard's attention to detail was great, and he concludes that Sagard must have made notes on a daily basis to achieve this precision. At the same time, we are told that some of Sagard's notes were lost at some point, and that he was required to rely on his memory in some cases. This problem likely resulted in the loss of detail, and possibly means that Sagard turned to the available writings of other travellers, such as Champlain or Lescarbot, to fill in the gaps in his accounts. Although Sagard's work can be perceived as accurate for the most part, it is not free of problems.

Sagard seems to have been well-read, as he frequently quoted from a wide range of authors, such as Aristotle, Tacitus, Pliny, and Marcus Aurelius (Wrong 1968:xiv). It is probable, however, that his Franciscan training did not specifically include topics such as identification of the indigenous flora and fauna of North

America, but careful attention to the actions of his hosts and persistent questioning may have helped him to overcome this problem. His (at least) rudimentary knowledge of the Wendat language would have greatly assisted him in his efforts to understand the actions of the food gatherers and food preparers (Wrong 1968:xvi). Sagard's narrative skill may have resulted from his enjoyment of literature. Since Sagard had read the published works by travellers like Champlain and Lescarbot (Rioux 1966:591), it is likely that he carried some preconceived notions of what he would find when he arrived in the New World. However, his observations regarding food practices were more detailed than Champlain's, which indicates that Sagard initiated his own study of this subject. In this regard, his account is conducive to relating general dietary practices of the Wendat.

It is clear that Sagard's primary motivation was to aid in the conversion of the Wendat to Christianity and thus "free them from enslavement to the devil...and to civilize their savagery with the refinement of moral principles" (Wrong 1968:18). Sagard was not completely centred on the religious aspects of Wendat life, however, as was the tendency of the Jesuits. In fact, Tooker (1991:6, emphasis added) relates that "Champlain's and Sagard's accounts of religion are grossly inadequate, but...both deal extensively with aspects of Huron culture slighted by the Jesuits (particularly the life cycle, descent, *and subsistence techniques*)." Heidenreich (1972:8) felt that Sagard's writings were "almost free of moralizing." Relatively speaking, for his day, Sagard seemed to be a fairly objective observer. Tooker (1991:6) adds that "Unlike Champlain, [Sagard] did not seek to lead men or change their destinities, but rather recounted only what he saw and did." She describes Sagard as a participant-observer and, most flatteringly, states: "Sagard perhaps resembled most closely the modern anthropologist" (Tooker 1991:6). Regarding dietary practices, Sagard was the more thorough of the two, although he had the advantage of prior exposure to the sort of account that he intended to produce.

Trigger (1976) and Tooker (1991) have both compiled information from early historic period writers in order to portray the lives of the members of Wendat communities. They have both related aspects of subsistence and the division of labour as described by the Jesuit missionaries in the *Jesuit Relations* (*JR*). The *Jesuit Relations* consists of 73 edited volumes of the accounts and letters written by the Jesuits who were posted in North America between AD 1610 and 1791. The goal of the missionaries was to convert the inhabitants of New France to Christianity. This frequently involved travelling through largely unknown territory, meeting and living with unknown Native groups, learning their languages and recording any and all information which might be valuable to their superiors and to other missionaries in the area, including the "physical, political, social, and moral conditions of Indian life" (Kennedy 1971:91). By 1640, there were approximately 16,000 Jesuits in New France. Due to their numbers, individual missionaries were often assigned to tasks which interested them and capitalized on their personal abilities (Kennedy 1971: 80,81). For the purposes of this synopsis, the writings of Father Le Jeune will be analyzed, as he chose to live and work among Wendat communities during the first half of the seventeenth century.

Le Jeune's Relations of the 1630s contain entries pertaining to food eaten both within the village and during travels. The Jesuits tended to prepare their own "Sagamités" and, Le Jeune explained, they were given ample amounts of food, including maize and dried fish (*JR* 8:111, 10:101). The Wendat usually ate meals in the morning and evening, although they were known to eat at other times and would share the Jesuits' food (*JR* 8:113). Maize was described as the "only grain of the Country" and "sufficient nourishment," and that the Wendat prepared it "in more than twenty ways and yet employ only fire and water; it is true that the best sauce is that which it carries with it" (*JR* 10:103). Foods reported to be eaten besides maize included strawberries, raspberries and blackberries "in almost incredible quantities," grapes, squashes "so abundant that they are to be had almost for nothing," and fish, although "we do not ordinarily procure them" (*JR* 10:103). Although Le Jeune stated that they rarely saw meat (*JR* 10:103), he did mention that the Wendat hunted deer, moose and other animals (*JR* 8:121, 10:167). Some of the fresh meats and fruits were smoked or dried to preserve them for later consumption (*JR* 10:103).

Le Jeune described the "ordinary food" of travel as "a little Indian corn coarsely broken between two stones, and sometimes taken whole in pure water" (*JR* 8:77-79, 10:89). Only occasionally did they eat fish while journeying (*JR* 8:79). He noted that this diet often left them hungry and, frequently, they had to fast altogether (*JR* 8:77). Le Jeune felt that the Wendat appeared to be somewhat accustomed to a lack of food as he mentioned that "they endure hunger much better than we," keeping active even after two or three days without food (*JR* 8:127). On the other hand, they were described as "gluttons" during feasts, "even to disgorging," while eating fish, deer and bear (*JR* 8:127, 10:179). Food was an essential part of feasts, including the Feast of the Dead, during which they sometimes broiled and ate turtledoves, believing these to represent the souls of the deceased (*JR* 10:143).

The majority of information supplied by the Jesuit writers overlaps and corroborates that given in other early accounts. It remains important, however, to attempt an understanding of the Jesuits' situations and to keep in mind the factors which may have contributed bias to their records. The Jesuits were all educated and trained "with a general attitude of Catholic humanism" (Kennedy 1971:81). Since their mission was primarily to teach and convert, most met hardships with a sense of self-sacrifice. They often focussed on the moral actions of the Native people, although many were interested in the environment and secular activities (Kennedy 1971:82). A secondary task for the missionaries was to record the novel plants, animals and climate which might serve to attract colonists (Kennedy 1971:93). As Kennedy (1971:97,109) notes, each Jesuit would have had preconceived ideas about the Native people, and their positions and worldview would serve to add varying degrees of subjectivity and moral judgements to their reports. The early missionaries, such as Le Jeune, generally felt that the Native people were "savages" and backwards due to their ignorance of Christianity, comparing them to Europeans who were "no more civilized before they became Christians" (*JR* 7:6-8; Kennedy 1971:100). In general, the Jesuits were more occupied with observations pertaining to spirituality and moral behaviour than with subsistence. It is more likely that misrepresentations and omissions in their descriptions of food would reflect a lack of interest as opposed to intentional deception. Although Le Jeune's account, for instance, is not as detailed regarding food as Champlain's or Sagard's, his observations are valuable and tend to differ mostly with estimations of the amounts of animal products eaten, which would have varied in importance perhaps by season, on an annual basis, or between localized environments.

The information recorded by Samuel de Champlain, Gabriel Sagard and the Jesuit missionaries pertaining to the food and social roles of the Wendat is invaluable. As a result of their efforts, a considerable amount of information is available with which to compare complementary data sources, as provided by the archaeological record, twentieth century ethnographic analogy and the chemical analyses that study the remains of the people themselves.

Ethnographic Analogy

Ethnographic studies among early twentieth century Seneca and Iroquois societies by Harrington (1908), Parker (1910, edited by Fenton 1968) and Waugh (1916) potentially add to the information regarding pre-contact dietary habits in southern Ontario. These authors expressed the belief that many of the recipes and techniques for preparation were shared among Iroquoian groups and that many of these remained constant through the contact period (Harrington 1908:575; Waugh 1916:1 Fenton 1968:45,62:), demonstrating in their publications that they were each familiar with the seventeenth century accounts relating to Iroquoian subsistence.

Ethnographic studies were not possible among historic Wendat groups, since the Iroquoians living in southern Ontario were decimated by a combination of epidemic diseases spread from the French settlements and wars with the New York state Five Nations Iroquois. By 1653, any individuals who had survived were either assimilated by Iroquois, Seneca and Mohawk communities or scattered and fled, so that southern Ontario was essentially deserted (Heidenreich 1990:487-490).

During the first decade of the twentieth century, Harrington introduced Parker to archaeology and, in turn, was introduced to Seneca communities by Parker, the two men making some ethnographic field trips together (Fenton 1968:8-9). Harrington (1908:575) was interested in recording "the principal native methods of corn preparation still in use among the Seneca" as described and illustrated by his informants from several western New York reserves. Parker was a "folklorist, ethnologist, archeologist, museologist (a word he coined), defender of Indian rights, writer of children's books, historian, and museum director," with both Seneca and British ancestry (Fenton 1968:2). He was educated by the formal school system, as well as through the oral traditions of his family, and learned the Seneca language at a fairly early age (Fenton 1968:5,6). His research for *Iroquois Uses of Maize and Other Food Plants* (published 1910) was conducted during a ten year period at the New York Iroquois reservations and at Six Nations Reserve in Brantford, Ontario, during which time he observed and participated in their eating customs (Fenton 1968:26,27). Waugh's (1916:1) intent was to document the diet and methods of food preparation among several Iroquois societies in New York State, Quebec and Ontario, recognizing that similar, although not as comprehensive, works had recently been published by Harrington and Parker. Waugh (1916) combined his own observations with a fairly thorough examination of ethnohistoric records, including those by Champlain, Sagard and the Jesuits, plus archaeological data.

Wooden and, less frequently, stone mortars and pestles were used to pulverize the maize kernels into meal form for making soup or porridge (Harrington 1908:576,578; Waugh 1916:58-60; Fenton 1968:46-48). Hominy sifters were used to locate the coarser grains that would be pounded a second time (Harrington 1908:578; Waugh 1916:63; Fenton 1968:50). In other cases, a hulling basket was utilized to separate the hulls and outer skins of the kernels after they had been boiled in weak lye (Harrington 1908:577; Waugh 1916:62; Fenton 1968:49). Bowls, paddles and spoons were made from bark or wood (Harrington 1908:579,580; Waugh 1916:64,66,67,70; Fenton 1968:54-55). Wooden eating-sticks were sometimes used to spear pieces of cooked meat (Waugh 1916:70). Waugh (1916:71) also mentions that bark, chert or clam shell knives were likely employed for cutting food, in addition to their other cutting functions.

Food was generally cooked in the late morning, for the one regular meal per day, although the food was kept warm to be eaten many more times throughout the day, if desired (Waugh 1916:46; Fenton 1968:61). The wives prepared this meal and the entire family returned from their morning activities to eat together (Waugh 1916:46; Fenton 1968:62). Gorging at meals was disdained, unless for ceremonial reasons, and "children were trained to eat frugally and taught that overeating was far worse than undereating" (Fenton 1968:64). Parker observed that there were "innumerable" ways to combine different foods and to cook each variety, as he understood was always the case through history (Fenton 1968:65). Both the green and ripened maize meals could be baked, boiled either briefly or down to a paste, fried in oil, or roasted (Waugh 1916:80,85,98; Fenton 1968:66-78). Several varieties of maize were eaten including the soft, flint, sweet and pod subspecies of *Zea mays* (Harrington 1908:575-576; Fenton 1968:43). Waugh (1916:72-75) did not mention the soft variety, but included dent and starchy, and noted that differences in the varieties were primarily based upon size, colour, the presence or absence of starch and the production of podded grains. Various ingredients would be added, depending on the recipe, such as sunflower and bear oil, berries, beans, bird, deer and bear meat, nut meal or nut milk, and pumpkin or squash (salt, refined sugar, butter and pork being post-contact ingredients) (Harrington 1908:576; Waugh 1916:80-103; Fenton 1968: 66-78).

Hominy (*sagamité*, hulled-corn soup), one of the most common daily meals, was prepared from a quart of flint kernels to feed a family of five (Harrington 1908:586-587; Waugh 1916:92; Fenton 1968:73-74). The kernels were pounded in a mortar with a ladleful of water and a teaspoonful of white ashes. The kernels were pounded until cracked, sifted and winnowed to remove the hulls. More water was added to the meal and boiled for a period of two to four hours (in the historic period iron or tin kettles), often with meat and beans for flavouring. A favoured food for invalids, known as 'early bread,' was made from unhulled, not fully dried, kernels mixed with water in a mortar until it turned to paste. Boiled loaves were then made from this paste (Waugh 1916:93-94; Fenton 1968:72). Parched corn meal (or corn pudding), having been shelled, de-husked, roasted and pounded, was a convenient travel food (noted as the staple food for warriors and hunters). Once mixed with water or, more extravagantly, boiled with fish, meat or dried berries, it would become a relatively nourishing meal (Harrington 1908:587; Waugh 1916:88; Fenton 1968:75-77). Fried meat, maple sugar, and sunflower and bear oils were often mixed with maize meal to form pudding for ceremonial dishes (Waugh 1916:78,102,103; Fenton 1968:78-79). Parker stated that beverages were more often comprised of the liquid created from boiling the maize (which included the starch and gluten) or herbal drinks, than plain water (Fenton 1968:70,71,77). Waugh (1916:145-150), however, believed water to be the most common beverage, although he discussed beverages made from the by-products of boiled maize and meat, and also those made by crushing and boiling various berries, fruit, sunflower seeds, nuts, tree sap, leaves, roots, twigs, bark and flowers.

Many non-maize food items were eaten in season or dried for storage, such as beans, squash and pumpkins, melons (often reserved for the sick) and 'husk tomatoes,' used either to make dishes on their own or added to maize recipes (Harrington 1908:576; Waugh 1916:103-116; Fenton 1968:89-92). Various greens, fruits, berries and nuts were eaten raw in season, or added to maize dishes (Harrington 1908:576; Waugh 1916:122-129; Fenton 1968:93,94-102). Fungi (mushrooms and puffballs) were readily added to soups, and lichens were remembered by informants as a hunger food (Waugh 1916:121-122; Fenton 1968:93-94). Parker (Fenton 1968:103) related that "in early times" sap from the maple tree was collected and boiled in clay vessels, and was sometimes drank either unaltered or fermented. Waugh (1916:140) felt that the sap of maple, birch and perhaps other trees was collected during pre-contact times to be used as a beverage, having been boiled as much as the technology would allow, to thicken somewhat. The bark of certain trees was occasionally eaten as emergency food, such as elm and basswood, as were wild roots, such as artichokes, wild onions, wild leek and milkweed (Waugh 1916:119; Fenton 1968:104-105). Although gathered occasionally, wild rice did not appear to be an important food source of the historic Iroquois (Waugh 1916:78; Fenton 1968:109).

In addition, Waugh (1916:130-140) discussed the varieties of animal foods utilized, including most small wild mammals and domesticated dogs, birds (and their eggs), amphibians (bullfrog, leopard frog), reptiles (snakes, turtles and their eggs), molluscs (clams, land and water snails), crustaceans (crayfish) and insects (ants, locust larvae, and lice). Certain animals were said to be avoided by Waugh's informants due to disagreeable flavour or special powers that they possessed, including porcupines, star-nosed moles, turtles (although their meat was considered good), wood frogs, night-hawks and chickadees, among others (Waugh 1916:131-133).

Natural Environment

The climate, physiography and ecology of southern Ontario during the fourteenth to sixteenth centuries governed the varieties of plant and animal species available, as well as the limits of agricultural potential, for the people interred at the Uxbridge, Kleinburg and Syers ossuaries. This geographic area combines the characteristics of the Carolinian and Canadian biotic provinces (or communities). Within this transitional zone, the mean annual temperature varies from 6 to 10 degrees Celsius, and the annual precipitation varies from 71 to 91 centimetres (Cleland 1966:8). The topography is level to gently rolling, with glacial moraines found in some areas. The temperate forests have generated grayish-brown and brown podzolic soils, although variations from sand to clay, and occasionally bog soils, occur (Cleland 1966:7). Shaw (1985 cited from Saunders *et al.* 1997:80) noted that the natural fluorine content in the soils of this region is low.

Favourable climatic conditions appear to have helped shape the culture of the Iroquoian peoples between AD 1400 and 1600. An exception to the generally favourable conditions occurred between AD 1665 and 1685, the coldest period during the "Little Ice Age," which caused average temperatures to be slightly lower and growing seasons to be slightly shorter than normal (Dean 1994:7). Aside from this, the Great Lakes minimize the seasonal extremes in temperature in southern Ontario and provide relatively uniform precipitation throughout the year, thereby dictating the plant and animal resources available to the people in the Late Iroquoian period (Cleland 1966:35; Dean 1994:7). The growing season, averaging 120 to 180 frost-free days, and soils enabled the maize/bean/squash horticulture to become an important aspect of the subsistence economy of the Late Ontario Iroquoians (Cleland 1966:8). The Iroquoian peoples living in and travelling around southern Ontario must have benefited from the resources available in the transitional area between the Carolinian and Canadian biotic zones.

The Carolinian forest was generally dominated by oak species, hickories, sugar maple, beech, walnut, butternut, elm, tulip, ash, basswood, cedar and tamarack (Cleland 1966:8). The Canadian zone, to the north, was similarly dominated by sugar maple and oak species, but also hemlock and white pine, and contained more coniferous species than the Carolinian forest (Dean 1994:12). As may be expected, these forests were inhabited by hundreds of species of wild mammals, birds, amphibians and reptiles. An abbreviated list of such animals includes the beaver, vole, muskrat, gray wolf, black bear, chipmunk, skunk, shrew, mole, cottontail rabbit, squirrel, fox, raccoon, elk, white-tailed deer, mink, otter, hawk, eagle, owl, robin, mallard, woodpecker, great blue heron, Canada goose, cardinal, turkey, passenger pigeon, sparrow, toad, frog, salamander, turtle and snake species (Cleland 1966:224-244; Dean 1994:15-17). Freshwater fish, such as sturgeon and lake trout, and clam species would have been important to most villages (Cleland 1966:73). "Most species - from the mosquito to the moose - were in one way or another vital for food, clothing, shelter, containers, and tools, or played a prominent role in Native religion and mythology" (Dean 1994:15). The tremendous variety of animal and plant resources, together with the geographic and climatic conditions, made southern Ontario a very attractive place to situate year-round villages.

Archaeology II - Skeletal Studies

Evidence regarding the dietary components of pre-contact Iroquoians may also be gathered through chemical analyses of human skeletal remains. While the ratios of stable carbon isotopes found in bony tissues provide the specialist with information about the proportions of certain plant types in the diet, stable nitrogen isotopes reveal information about sources of protein, such as beans and animal flesh (Katzenberg *et al.* 1995:336).

Carbon isotopes indicate that southern Ontario populations steadily increased their consumption of maize from its introduction around AD 700 to peak reliance at around AD1400 (Katzenberg *et al.* 1995:341,345). Prior to this, bone chemical analyses and the archaeological record agree that fish and gathered plants and berries were very important food resources (Katzenberg *et al.* 1995:343). Analysis of the bone tissue from individuals who lived at the Late period Woodbridge-McKenzie site (located in the same cluster of villages as the aforementioned Seed-Barker site) indicated that, by AD 1500, maize was the principal food source and that these people seemed to eat a higher proportion of beans than meat, the latter indicated by $\delta^{15}N$ values (Katzenberg *et al.* 1995:345,347). Isotopic data from the early historic period Kleinburg and Ossossané ossuaries indicates that the diets of these people contained C_4 plants (of which maize would be the principal source) in the proportion of 51 % which, considering the variability in the sources of information, was not seen by Schwarcz and colleagues (1985:201) to be a significant departure from the 65 % cited by Heidenreich (1971) or the 58 % estimated by Monckton (1992).

Most isotopic studies of Ontario Iroquoians have analyzed bone samples from a small number of individuals from within a site, working under the educated assumption that diets on the whole were very similar among individuals in any one community (Katzenberg *et al.* 1993:268). However, some interest has been shown for comparing isotopic samples based upon sex, as demonstrated by Katzenberg and colleagues (1993). Several standard methods for estimating age and sex were conducted on samples from 29 individuals from the MacPherson site, which has been identified as a Neutral village, dating to AD 1530-1580 (Katzenberg *et al.* 1993: 267.272). Although the adult males (n=6) in this study had on average slightly higher $\delta^{13}C$ values than the adult females (n=9), the results are not statistically significant (Katzenberg *et al.* 1993:273). The females scored slightly more positive $\delta^{15}N$ values than the males, but again with no significant difference (Katzenberg *et al.* 1993:274). The largest intra-site difference in carbon and nitrogen isotope values was seen between infants and adults. With regard to dental caries, two children were found to have experienced a rare form among pre-contact Ontario Iroquoians, referred to as circular caries. The overall caries rate (presumably the Observed Caries Rate) was reported to be high, exceeding 25 %, among the adults at the MacPherson site (Katzenberg *et al.* 1993:276).

As described by Katzenberg and colleagues (1995:335), "Stable isotope data provide one source of evidence for changes in human subsistence patterns and their interpretation relies on complementary data from sources such as the analysis of faunal and botanical remains, settlement patterns, and material culture." It can also be suggested that ethnohistoric sources should be included in this list of complementary sources. The resulting data can be used to confirm or reject hypotheses about the relative proportions of food components in the Wendat diet, and is particularly useful for tracing changes through time.

Macroscopic studies of skeletal remains have uncovered relationships between general dietary patterns and dental disease. Patterson (1984) studied the teeth from several Ontario Iroquoian populations, focussing on the relationships between dental health and subsistence strategy. Patterson's intent was not to examine intra-site differences, but rather to compare the sites chronologically. He found significant differences in the overall dental health of the populations through time, with the highest caries rates among the later, maize-dependent, populations. The high carbohydrate content of the maize and the sticky, adhesive texture of the most commonly eaten maize dishes were cited as the main causes of the dental caries (Patterson 1984:3.17).

As a result of his examination of the Kleinburg ossuary dentitions, Patterson (1984:268) felt that the large amount and locations of carious lesions were indicative of poor dental hygiene. Although his analysis included the observation and recording of tooth trauma, Patterson did not find any trauma that might be associated with mechanical cleansing, such as grooves formed on the interproximal surfaces due to habitual food removal with a thin object (such as a stick).

The advantages and contributions of macroscopic skeletal analyses to research questions relating to differential dental disease between individuals will be the primary focus of the remainder of this study.

Summary

Some degree of change in methods of food preparation and ingredients resulted from the spread of ideas and objects between Native communities and Europeans. It is interesting to note these changes as well as the similarities that persisted through the course of the past three hundred years. Recipes contribute evidence about the combinations of foods eaten and special foods not eaten on a daily basis. Clues regarding sex and age differences that might have affected who ate what and when are rarely discussed. This specific information would be useful for estimating whether or not social roles, as defined by demographic groups, would have affected the amount, frequency and types of foods eaten. Differences in diets and eating habits could mean that certain people may have consumed a more cariogenic, or caries-forming, diet than others within the same social group. Although ethnohistoric sources are often quite detailed regarding the tremendous variety of foods that were likely consumed by pre-contact Iroquoian peoples, the analysis of skeletal remains may provide the only way to adequately distinguish between the dietary health of individuals.

Chapter 4: The Studied People, Methods and Definitions

Introduction

The individuals analyzed for this study were deemed appropriate by their degree of preservation. Extensive ante- and postmortem tooth loss renders many collections inappropriate for comparisons between individuals. The three ossuary populations chosen for this study contain adequate numbers of individuals with relatively high percentages of teeth remaining *in situ*, either naturally or aided by reconstruction. The Uxbridge Ossuary contains the largest minimum number of individuals of the three, and was the focus of the methods employed. All intact crania with associated dentitions were analyzed, as were 'loose' mandibles (those not associated with crania) experiencing 50 % postmortem tooth loss (PMTL) or less. Maxillae not associated with crania were eliminated from the sample, due to the lack of appropriate features for sex estimation. The Kleinburg and Syers Ossuary samples, although they are not being compared directly to the Uxbridge Ossuary results, are intended to present comparisons for the methodology. Therefore, for greater confidence regarding age and sex estimations, only crania with associated dentitions form these two samples. More specifically, only those crania with dentitions experiencing 75 % PMTL or less were analyzed. Each of the three ossuary sites were located geographically within southern Ontario (**Figure 4.1**).

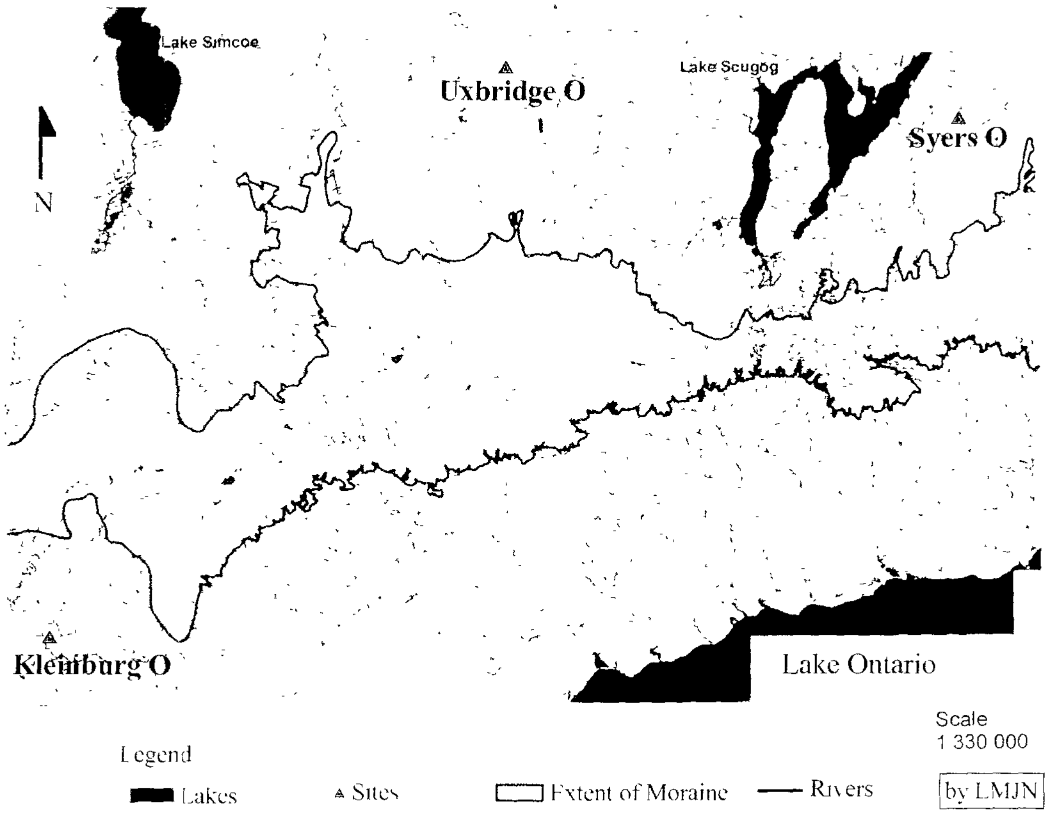


Figure 4.1 Map of southern Ontario showing the locations of the Kleinburg, Uxbridge and Syers Ossuary sites in relation to waterways and the Oak Ridges Moraine.

The Studied People

The **Uxbridge Ossuary** (BbGs-3) was located northeast of Toronto, in Uxbridge Township. The calibrated radiocarbon date of the site is AD 1440 ± 80 years (Pfeiffer pers. comm. 1997; Merrett and Pfeiffer 2000:306). A small habitation site located approximately 300 metres to the east may have contributed their dead to the ossuary (Cook 1976 cited from Molto 1983:92). Although largely commingled in the burial pit, the minimum number of individuals was calculated to be 457, including 312 adults and 145 subadults, based upon the presence of the genial tubercles of the mandible (Pfeiffer 1983:9-10). The adult sex ratio, based upon pelvic indicators, is 1.54:1.00. Pfeiffer (1983:12) feels that this surplus of males may reflect differential preservation of the male pelvic cortical bone, creating a skewed sex ratio. Life expectancy at birth of 25 years was calculated using pubic symphysis remodelling for the adults and dental emergence for the subadults. No adjustment was made for the possibility of underrepresentation of newborns (Pfeiffer 1983:10).

The prevalence of caries among individuals in the Uxbridge population has not been previously reported. On a per-tooth basis, the percent of permanent teeth containing carious lesions was calculated to be 20.9 by Gagné (1990 cited from Pfeiffer and Fairgrieve 1994:56). The Uxbridge Ossuary sample analyzed for the current study included all crania with associated dentitions, in part or in whole, totalling to 51 adults and 9 juveniles (<15 years of age). Mandibles showing 50.0 % postmortem tooth loss (PMTL) or less were analyzed, including 40 adults and 3 juveniles. These samples represent 22.5 % of the estimated total population. It is possible, since only 8 crania had associated mandibles, that some of the disassociated mandibles in the sample may belong to some of the crania analyzed.

The **Kleinburg Ossuary** (AlGv-1) was located in the township of Vaughan, approximately 600 metres east of the village of Kleinburg, near the East Humber River (Patterson 1984:227). The time frame for this ossuary is circa AD 1585 to AD 1615, during the Late Ontario Iroquois period just prior to French contact, although some European trade goods were recovered (Patterson 1984:228). A corresponding habitation site has not yet been identified, but the cultural affiliation is suspected to be a southern component of the Huron-Petun branch (Patterson 1984:228). Patterson

(1984:227-8) notes that the bone in the ossuary was distributed in a random fashion, aside from one concentration of skulls and several individual burials. The minimum number of individuals represented by the recovered remains consists of 404 adults and 157 subadults, totalling to 561 individuals (Pfeiffer 1974 cited from Patterson 1984: 230; Pfeiffer and Fairgrieve 1994:51).

Pfeiffer (1979) and Patterson (1984) have reported the prevalence of caries within the Kleinburg Ossuary population, the former in relation to caries in the buccal pits found on the molars of certain individuals, and the latter in terms of the overall adult and subadult prevalence. When calculated for the total number of teeth, Patterson (1984:247) found 40.6 % of the permanent teeth to be carious and 29.2 % of the deciduous teeth containing caries. The current study of the Kleinburg Ossuary incorporates 7.8 % of the total estimated population, resulting in a sample of 44 adult individuals. Of these, 5 had associated mandibles and 3 of those 5 individuals had associated pelvic elements.

The **Syers Ossuary** (no Borden designation) was located to the east of Lake Scugog in Manvers Township, Victoria County. Boyle (1896:42) mentions that "A village site may be traced in a field only a few hundred yards from the grave," but does not give an estimated date of occupation. Since there were no artifacts recovered from the ossuary (Boyle 1896:42), the site has been assigned a broad date of AD 1300-1500 (Pfeiffer and Fairgrieve 1994:50). At the time of excavation, Boyle roughly estimated the number of individuals based upon whole and fragmentary skulls and reported that they "could not have been far short of six hundred" (1896:41).

Boyle (1896:41-2) noted that the skulls were generally placed in groups, the longbones had been bundled and the ribs, vertebrae and smaller bones "appeared in confused masses." Only 57 of the "very good crania" were reported to have been procured for the collection. For the current study, 2 mandibles met the preservation requirements, and a total of 23 individuals, including 3 subadults, were analyzed. This sample represents 40.4 % of the collection, or approximately 4.0 % of Boyle's estimated total for the burial. While Molto (1983) analyzed the cranial morphology of collection, no dental analyses have yet been conducted.

Methodological Approach

The recorded observations included dental conditions, and sex and age indicators. Several conditions were observed in order to evaluate dental health including tooth status, caries, wear, alveolar abscessing, calculus, alveolar resorption (a symptom of periodontal disease), hypercementosis and enamel hypoplasia. Sex estimations were based upon morphological characteristics of the adult cranium and mandible, as appropriate for each specimen, including the nuchal crest, the glabella, the supraorbital margins, the mastoid processes, the general size and robusticity, the orbits, the zygomatic and posterior temporal crest, the mental eminence, the mandibular (gonial) angle and molar crown size. Adult estimation of age included the amount of dental wear in all cases with teeth *in situ*, and the degree of ectocranial, endocranial and palatal suture closure for the crania. Subadult (or juvenile) dentitions are defined as those in which the third molar had not yet erupted to the occlusal plane at the time of death. For these individuals, age estimation was based upon dental formation and eruption.

The data collection forms utilized in this study are presented in **Appendix A**. In addition to numerical data, visual data were also collected for the presence and condition of the teeth and the associated alveolar tissue, following the recommendations of Buikstra and Ubelaker (1994:47). Detailed comments were also added whenever appropriate, to facilitate clarity in the descriptions of the pathological conditions and of the age and sex indicators.

Tooth Status

The tooth inventory represents the primary data for any dental analysis. This is particularly crucial when studying archaeological dentitions from ossuaries, since the potential is great for postmortem damage resulting from the physical mixing of the skeletal elements. The mixing process aids in the separation of teeth from alveolar bone, as well as the mandibles (and, in some cases, the maxillae) from the crania. Although much data may still be collected for the whole population by tooth type, these depositional factors lead to a loss of information at the level of the individual. The ante- and postmortem status of the teeth in the jaw is essential for the age estimation of subadults and for calculating the prevalence of caries among individuals in an archaeological sample.

The dental inventory procedure was identical for each of the three collections, and was repeated for the samples used for the intraobserver error analyses. The inventory categories follow those described by Buikstra and Ubelaker (1994:48-9) and include:

Present, but not in occlusion - Teeth in this category largely belonged to subadults for whom one or more teeth had begun to erupt beyond the alveolar margin at the time of death. These teeth may or may not have erupted beyond the gingival margin. A small percentage of adult teeth belonging in this category had stopped erupting short of the occlusal surface, generally due to malocclusion. These teeth exhibited no signs of occlusal surface wear. For the teeth that had been erupting, Buikstra and Ubelaker (1994:48) advised including the stage in the formation sequence. The stages have been correlated to chronological age (Moorrees *et al.* 1963:206-7). This was generally only observable with cases of localized postmortem alveolar damage, as radiographs were not utilized for this analysis.

Present, development completed, in occlusion - Teeth in this category had finished erupting, although the root or apex might still have been forming. Some of these teeth were rotated or displaced relative to the tooth row, but still exhibit some occlusal surface wear. Supernumerary teeth were also recorded, including retained deciduous teeth, regarding position in the dental arch and any appropriate dental conditions.

Missing, with no associated alveolar bone - No information was available for a tooth in cases where sections of the alveolar bone were lost postmortem. In cases of reconstructed dentitions, this might mean that the information from one tooth was lost, while the alveolus to the anterior and posterior of that region was present.

Breakage often occurred at the midpoint of a socket, so that one wall of the socket was present, and the tooth status could be determined to have been lost postmortem.

Missing, with alveolus resorbing or fully resorbed: antemortem loss - The alveolus generally exhibits unmistakable signs of resorption when a tooth is lost during life, although active apical abscessing and severe periodontal disease could resemble a partially remodelled socket. Signs of remodelling do not appear until approximately one week subsequent to tooth loss, so those teeth lost within the week prior to death will be mistaken for teeth lost postmortem (Lukacs 1995:151-152). Lukacs (1995:152) judges that the error created by this situation should have a negligible effect on calculations of lesion frequency. Antemortem loss can also have an effect on adjacent teeth, so that they migrate slightly or tilt in the direction of the empty socket.

Missing, with no alveolar resorption: postmortem loss - Teeth lost after death are evident by the condition of the surrounding alveolus. The sockets retain the shape of the tooth roots. This condition tends to affect the anterior (single-rooted) teeth more often than the relatively stable molars. This bias can cause interpretive error for calculations of lesion prevalence. Certain cases were noted when the tooth was absent, but the alveolus demonstrated distinct signs that the tooth had been within the crypt or was erupting but had not yet reached occlusion. For the former, a crypt was identified by the presence of a pocket within the alveolus and, for the latter, the alveolus appeared flared as though the widest portion of the tooth crown had not yet erupted beyond the alveolar margin.

Missing, congenital absence - Teeth in this category never formed. It is possible to mistake these for impacted teeth when radiographs are not taken, although impacted teeth can create an unusual bulge along the buccal or lingual aspect of the alveolus. Some cases of antemortem loss may be mistaken for congenital absence if the socket has completely resorbed and the usual signs of remodelling or adjacent tooth reaction are vague. Within modern human populations, the most commonly congenitally absent teeth are the third molars and the maxillary second incisors (Hillson 1996:113).

Present, damage renders measurement impossible, but other observations are recorded - This is generally a product of postmortem damage. This damage may range from the loss of the entire crown to the loss of small sections of enamel with or without the loss of the underlying dentine. Other causes include severe wear, to the point of functional roots, and gross caries, where the lesion has destroyed most or all of the crown.

Present, but unobservable - This category pertains to deciduous or permanent teeth remaining within their crypts. To be included within this category, the tooth had to be observed visually (generally through the sockets of adjacent teeth lost postmortem) but the formation stage remained indeterminate.

Occlusal Surface Wear

Surface wear provides information about an individual's age at death and general dietary pattern, and it has an effect on the caries process (Melbye 1983;

Patterson 1984; Smith 1984; Powell 1985). Attrition data for the current study was collected according to the method suggested by Buikstra and Ubelaker (1994:52), which utilized a combination of the Smith (1984) system for scoring incisors, canines and premolars and the Scott (1979) system for scoring molars. Both systems require the observer to judge the size of the wear facets and/or the amount of exposed dentine. Smith's (1984:45-6) system modified Murphy's (1959) design, and records the amount of wear through 8 stages. For descriptive purposes in the present study, stages 1-2 were considered to reflect mild occlusal wear, stages 3-4 moderate wear, stages 5-6 heavy wear and stages 7-8 severe wear. Although Smith's (1984) system included permanent molars, Buikstra and Ubelaker (1994:52) prefer Scott's (1979) more detailed method for the posterior tooth class. The Scott (1979:214) system divides the molar into quadrants and scores each separately according to 10 stages. Cross and colleagues (1986 cited from Hillson 1996:233) comment that "Despite its complexity, this method shows little intra- and interobserver variability." In the present study, stages 0-3 were described as reflecting mild wear, stages 4-6 moderate wear, stages 7-8 heavy wear and stages 9-10 severe wear.

Due to acknowledged subjectivity problems, the Scott (1979) and Smith (1984) scoring systems for occlusal surface wear have not been the only ones developed and employed on archaeological populations (Hillson 1996:235-6). However, these macroscopic methods are relatively descriptive and easy to apply. Although Buikstra and Ubelaker (1994:51-2) suggest that only the teeth from the left side of the dental arch need to be scored, all teeth *in situ* were analyzed for the current study due to the frequency of postmortem loss. Tests of intraobserver error have been conducted to assess the reliability of these methods among the three collections analyzed for this study.

Caries

Caries are one of the most conspicuous signs of dental disease. Carious lesions have been recorded macroscopically with particular attention to tooth class and location, since these two factors reflect differential susceptibilities to caries. The development of the various types of caries (by location) is closely related to an individual's age and rate of dental attrition or abrasion. This relationship was considered for interpreting an individual's caries experience.

There are several ways to recognize a carious lesion. Recognition may be accomplished through the use of radiographs, visual inspection plus a dental probe, or visual inspection alone. Rudney and coworkers (1983:246) determined that interobserver reliability is greatest with visual examination without using a probe. Thus, for the present study, visual examination alone was used to identify a carious lesion, as Buikstra and Ubelaker (1994:55) also recommend. A 60 watt light was used to facilitate recognition. A carious lesion was identified if the enamel appeared dark and eroded, with irregular lesion margins. The lesion may or may not have penetrated the enamel to reach the dentine or pulp chamber. The formation of a definite indentation in the enamel surface is described as the sixth of six stages of development of an enamel lesion (Hillson 1996:271). The surface remains intact throughout the previous five stages, which are much more difficult to consistently identify. Although this technique might limit comparability with some studies, many researchers utilizing the visual method of identification recommend defining a carious lesion in this manner (Rudney *et al.* 1983:244; Patterson 1984:75; Buikstra and Ubelaker 1994:54; Hillson 1996:279). While Hillson (1996:279) advises that some proportion of caries in the sample should be verified through thin sectioning, this check was not carried out in the present study.

Caries were recorded for each of the 32 permanent and 20 deciduous teeth by tooth surface. The possible locale for each carious lesion followed those proposed by Buikstra and Ubelaker (1994:55), which they based upon Moore and Corbett's (1971) system:

No lesion present - The tooth surface was considered sound.

Occlusal surface - This represents the chewing surface of the tooth, which is more complex for the molars and premolars than for the incisors and canines. It includes all grooves, pits, cusps and dentine exposures, plus the buccal and lingual grooves or pits on the molars.

Interproximal surface - These surfaces include the mesial and distal cervical regions, whether on the enamel or on the cementum.

Smooth surface - These are the buccal and lingual surfaces other than grooves associated with the occlusal surface.

Cervical caries - These lesions originate at the cement-enamel junction (CEJ) on the buccal and lingual surfaces only (i.e. excluding the interproximal surfaces).

Root caries - These occur below the CEJ on any side and tend to form once the alveolar margin and associated gingival margin begin to recede (Hillson 1996:282).

Gross or large caries - These cavities have spread to destroy more than one tooth surface, so that a surface of origin is indeterminable. In some cases, the entire crown has been destroyed, leaving only a carious root.

Noncarious pulp exposure - These appear as round holes within the middle of the tooth or at the cusp centre and are caused by rapid wear. They may be confused for caries, although their presence on adjacent teeth is a clear sign of attrition or abrasion. These are not included in the calculations for caries prevalence.

Based upon these criteria, all tooth classes are considered to have 8 distinct surfaces. Each tooth could potentially contain one carious lesion per surface, or even multiple lesions on some surfaces. The size of the lesion was not a factor, since size is time-related and not dependent on tooth site or species of bacteria (Buikstra and Ubelaker 1994:55). The postmortem damage of some enamel and dentine obstructed the identification of sound versus carious surfaces. These sites were distinguished as unobservable on the visual record of the data forms.

The prevalence of caries within an individual and among the entire sample may be calculated using a number of methods, particularly in light of the volume of information provided by the observations outlined above. The Caries Index, also known as the Observed Caries Rate, equals: Total Number of Carious Teeth / Total Number of Teeth x 100 (Moore and Corbett 1971). As Sutter (1995:186) points out, a bias will occur due to the premortem loss of teeth containing caries that may no longer be analysed. The Diseased-Missing Index (Moore and Corbett 1971) was designed to overcome this bias.

$$\text{The Diseased-Missing Index} = \frac{\text{total number of carious teeth} + \text{AMTL}}{\text{total number of teeth } \textit{in situ} + \text{AMTL}} \times 100$$

An inherent assumption is that premortem tooth loss is related solely to caries, excluding other factors such as excessive wear, periodontal disease and tooth extraction (Sutter 1995:186). Lukacs (1995:153) formulated a Corrected Caries Rate, a four-step calculation which estimates the number of teeth lost antemortem due to caries, based upon the number of observable teeth with pulp exposure caused by caries within each demographic group:

1. Estimated number of teeth lost due to caries.

   [number of teeth lost antemortem] x [proportion of teeth with pulp exposure due to caries]

2. Total estimated number of teeth with caries.

   [estimated number of teeth lost due to caries (step 1)] + [number of carious teeth observed]

3. Total number of original teeth. [note: does not include pmtl]

   [number of teeth observed] + [number of teeth lost antemortem]

4. Corrected Caries Rate.

   [total estimated number of teeth with caries (step 2)] ÷ [total number of original teeth (step 3)]

The Corrected Caries Rate is considered to be a very comprehensive indicator. However, Erdal and Duyar (1999) refined the procedure even further by developing a method to account for differential postmortem loss and relative lack of occlusal caries generally experienced in archaeological situations by the single-rooted and simple cusp tooth classes, which is referred to as the Proportional Correction:

5. Corrected Caries Rate for anterior teeth x 3/8
6. Corrected Caries Rate for posterior teeth x 5/8
7. step 5 + step 6 = Proportional Corrected Caries Rate

Abscesses

Alveolar abscessing most often results from pus drainage through the root apex following inflammation caused by dental caries or excessive wear (Buikstra and Ubelaker 1994:55). These abscesses are accompanied by a periapical pocket of resorbed bone where the pus collects. The resulting pressure is usually relieved through the formation of a fistula, which acts as a tunnel to channel the pus to the buccal or lingual side of the alveolus, into the nasal cavity or maxillary sinus in the maxilla, or into the mandibular canal in the mandible (**Plate 3**). Buikstra and Ubelaker (1994:55) recommend recording buccal and lingual channels numerically. In addition, perforations into the maxillary sinus and mandibular canal were recorded when visible, as was the presence of apical abscesses which had not yet developed drainage channels.

Calculus

Calculus is mineralized plaque which can form on the occlusal, buccal, lingual, interproximal, cervical and root surfaces of the tooth. Sites closest to the salivary gland ducts are the most vulnerable, including the buccal surfaces of molars and the lingual surfaces of anterior teeth (Hillson 1996:255). Calculus forms in a cream or light brown coloured band which marks the position of the gingival margin (Hillson 1996:256). Calculus may serve to trap food particles and encourage plaque formation to some extent, but it does not necessarily encourage the formation of caries due to its mineralization properties (Hillson 1996:260). Degrees of calculus were recorded based upon Brothwell's (1981) three-point scoring system, as suggested by Buikstra and Ubelaker (1994:56). The presence of calculus was reported as a small amount (thin strip), a moderate amount (approximately half of the surface) or a large amount (covering over half of the affected surface). The location of the calculus was noted as buccal or lingual (Buikstra and Ubelaker 1994:56) and also as interproximal or a combination of the three sites. No samples of calculus were taken during this analysis.

Hypercementosis

Hypercementosis is an overproduction of cement which can result in an irregularly shaped or bulging root. Although the cause is unknown, it is thought to be related to malocclusion, as it has been observed in non-erupted teeth, or it may result from excessive wear (Hillson 1996:205). Hypercementosis has been incorporated into some schemes of dental age estimation, as a progressive deposition of cementum layers (Gustafson 1950). In the present study, hypercementosis was recorded on the data collection forms if it was identified on a particular tooth.

Alveolar Resorption

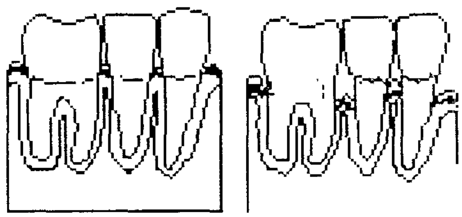


Figure 4.2 Alveolar resorption.

Alveolar resorption is generally considered to be age-related, but is also closely associated with periodontal disease (Mayhall 1992:74). The most common form is referred to as 'horizontal' bone loss (**Figure 4.2**), in which the alveolar margin recedes around the tooth socket at a similar rate for several adjacent teeth or the entire dentition (Hillson 1996:263). There are several ways to determine the amount of bone loss based upon different reference points. For the present study, the intact superior margin of the alveolus was measured with a MANOSTAT digital caliper in tenths of millimetres below the CEJ. Mayhall (1992:74) notes that the alveolar margin is normally 1-2 millimetres apical to the CEJ. When available, this measurement was recorded at the left first molar, the right first molar, the left second molar or the right second molar, in order of preference. When no molars were present, loss of height was described qualitatively as slight, moderate or high. A large loss in alveolar height results in the loss of the periodontal ligament attachment, which creates the potential for tooth loss (Hillson 1996:266). Loss of alveolar height serves to expose the thin layer of cementum which is very vulnerable to carious lesions.

Enamel Hypoplasia

Enamel hypoplasia is a defect in the enamel which can be detected macroscopically, and which has been widely used to study nutritional deficiencies and periods of physiological stress among both pre-contact and living populations (Rose *et al.* 1978; Cook and Buikstra 1979; Goodman *et al.* 1980; Patterson 1984; Skinner and Hung 1989; Crinnion 1997b). Enamel hypoplasia is caused by a disruption of the ameloblast activity as these cells are depositing enamel during the formation of the tooth crown (Hillson 1996:165) (**Figure 4.3**). The enamel being deposited during the disruption is reduced in thickness compared to the surrounding enamel, and appears either as a groove (the linear form), a pit, or a small area of discolouration. This defect provides a permanent record of childhood stress upon the buccal/labial surface of a tooth, provided that wear does not obliterate the evidence. For the present study, hypoplastic features were described as either pits or grooves and their location was measured with a MANOSTAT digital caliper to the tenth of a millimetre from the midpoint of the buccal CEJ to the midpoint of the hypoplasia. Standards developed by Swardstedt (1966 cited from Goodman *et al.* 1980:520) assist in converting each measurement into a chronological age of occurrence.

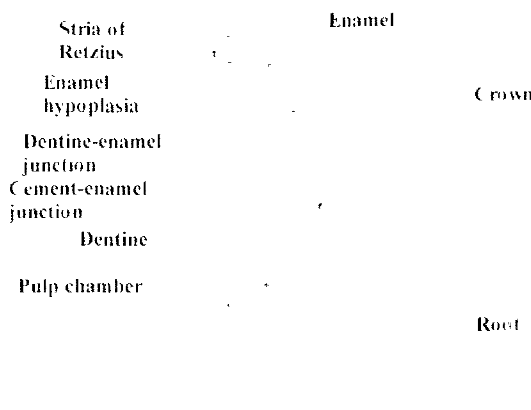


Figure 4.3 Representation of a canine in cross-sectional view which illustrates linear enamel hypoplasia.

Sex Estimation

Reliable estimation of the sex of an individual is relatively complex, and is dependent upon certain dimorphic features that are measurable and others that are morphological. The degree of sexual dimorphism varies among populations, with body size in extant humans averaging to 10 % (Hillson 1996:80). Standards considered reliable for one group will most likely require modification or may not be applicable at all to a second. A set of standards may be considered reliable if they have been developed around a large sample of known sex individuals. For many pre-contact archaeological samples, either this criterion does not exist or credibility may be lost due to inadequate levels of preservation.

The pelvic region is generally considered to be the most variable between the sexes, followed by traits on the cranium (Buikstra and Ubelaker 1994:16). Due to the intense mixing of skeletal elements within an ossuary burial, the innominates become disassociated from the crania. For this reason, sex estimation techniques pertaining to the cranial region were relied upon for the cranial samples under investigation, mandibular traits were utilized for those individuals with associated mandibles and for the Uxbridge 'loose' mandibular sample, and pelvic indicators were consulted where possible. Although the adolescent subadults were likely subject to adult sexual division of labour, it is probable that sexual maturity of the skeleton does not become evident until post-puberty, at approximately age 18-20 years (Krogman and Iscan 1986:190-1).

Buikstra and Ubelaker (1994:19-20) advise the use of five morphological features of the adult cranium (**Plates 4** and **5**), providing descriptions and visual guides to assess their size, shape and robusticity:

Nuchal Crest - The relative robusticity of the nuchal crest can vary considerably from smooth with no bony projections (feminine) to a roughened, muscle-marked area with a well-defined bony ledge or hook (masculine).

Mastoid Process - The size of the processes were compared with surrounding features such as the external auditory meatus and the zygomatic process. The volume of the mastoid process varies from very small (feminine) to massive with lengths and widths several times that of the external auditory meatus (masculine).

Supraorbital Margin - The thickness of the supraorbital margin was determined by holding the edge of the orbit between the thumb and forefinger. The minimal (feminine) expression is characterized by an extremely sharp border (comparable to a butter knife), while a thickened and rounded margin with a curvature similar to a pencil is typical of the maximal (masculine) expression. It has been observed that the supraorbital margin may thicken with age in females.

Glabella - The prominence of the supraorbital region varies considerably from a smooth contour with little or no projection at the midline (feminine) to a massive prominence, forming a rounded, loaf-shaped projection (masculine).

Mental Eminence - The lateral borders of the mental eminence on the chin were identified by moving the thumbs medially. Little or no projection is typical of a minimal expression (feminine) and a massive projection occupying most of the anterior portion of the mandible is considered a maximal expression (masculine).

When appropriate (that is, applicable due to morphology and/or degree of preservation), each feature was scored on the left side of the cranium. Each of these features were scored on a scale of 1-5, producing a numerical sum for each individual. Once the sum was divided by the number of traits scored, each individual was assigned to one of the following: 0, indeterminate sex, where there was insufficient data available for a sex estimation; 1, female, where there was little doubt that the features represent a female; 2, probable female, where the structures taken together indicate that the individual was more likely female than male; 3, ambiguous sex, where the dimorphic features were scored in the mid-range, or where there was a clear mix of masculine and feminine features; 4, probable male, where the structures taken together indicate that the individual was more likely male than female; and, 5, male, where there was little doubt that the features represent a male. For the purposes of comparing the dental health between the sexes, each individual was reassigned to female (from categories 1 and 2), male (from categories 4 and 5), or ambiguous (from category 3) groupings. These ultimate groupings were subjected to intra- and interobserver testing.

Additional dimorphic features were considered (described as more masculine versus more feminine respectively), which could influence the final sex estimation of each individual. These include general size (large versus small), muscle markings (rugged versus smooth), orbit shape (squared versus rounded), forehead contour (steeper, less rounded versus more vertical, rounded), zygomatic process size, shape and length (heavier, more laterally arched, extending posterior to the external auditory meatus versus lighter, more compressed, terminating at or anterior to the external auditory meatus), posterior temporal crest (present and sharply defined versus little or no presence), mandibular angle and gonion shape and incline (flares outward and is less than 125° versus does not flare outward and is greater than 125°), and first and second molar crown size (large versus small) (Krogman and Iscan 1986:192; Steele and Bramblett 1988:54; Mayhall 1992). The mandibular angle was measured with a mandibulometer to the nearest 0.5° with pressure held on the area of the second molars for orientation.

Hillson (1996:81) suggests that while dimorphism seems most prominent in the canines, a multi tooth analysis would be preferable. Due to the frequency of postmortem loss of anterior teeth, molar size was chosen for the present study. Hillson (1996:82) advises intra- and interobserver verification, as the actual size differences might be as small as 0.4 to 0.5 millimetres. Mayhall (1992:64) cautions that the degree of sexual dimorphism reflected by tooth size is generally small, between 2-6 %, but that this dimorphism is population-specific. Thus, it was decided to test this potentially dimorphic feature within the three samples in the present study.

To calculate molar crown size, three sets of measurements were taken to the nearest hundredth of a millimetre with a MANOSTAT digital caliper. The technique chosen to determine the mesiodistal diameter measured the maximum width of the crown in the mesiodistal plane, which will be wider and is easier to employ than the method which measures the distance between the two contact points of the tooth (Mayhall 1992:60). The buccolingual diameter was measured as the widest diameter of the tooth perpendicular to the mesiodistal plane and parallel to the occlusal plane (Mayhall 1992:60-1) (**Figure 4.4**). Crown height, more a measure of mesiobuccal occlusal surface wear, was also measured along a line parallel to the tooth's long axis between the CEJ and the tip of the mesiobuccal cusp (**Figure 4.5**). It is recognized that obtaining tooth crown measurements can be difficult, since some points of measurement are located more medially or distally than their corresponding points (Mayhall 1992:61). To estimate the margin of error, these measurements were all subject to intraobserver error testing.

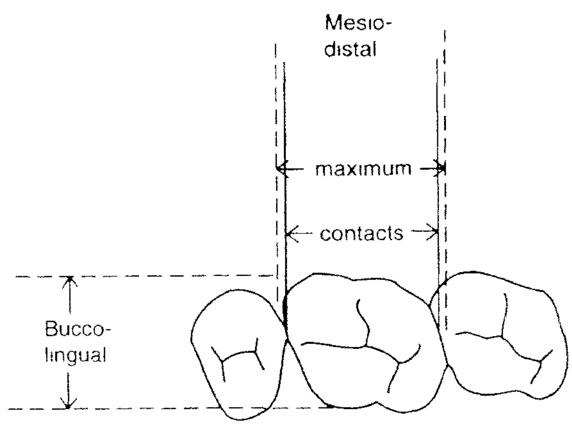


Figure 4.4 Measurement of mesiodistal and buccolingual diameters on molars (Buikstra and Ubelaker 1994, Figure 31 after Mayhall 1992, Figure 1).

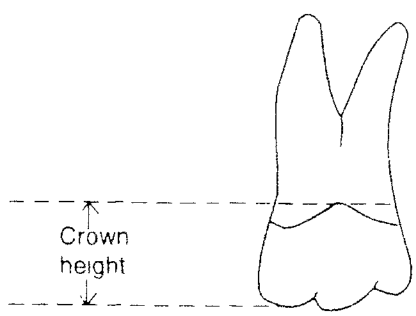


Figure 4.5 Measurement of molar crown height (Buikstra and Ubelaker 1994, Figure 33 after Rogers 1984, Figure 27).

Partial or complete os coxae were present for three of the Kleinburg Ossuary individuals, each interred in bundle burials. These enabled certain observations of the morphology of the subpubic region which can assist in sex estimation. Females tend to demonstrate the following characteristics: a ventral arc, a subpubic concavity and a ridge on the medial surface of the subpubic region, as well as a broad greater sciatic notch, and a positive expression of a preauricular sulcus (Buikstra and Ubelaker

1994). Males tend to demonstrate different characteristics in these areas, such as: a slight ridge rather than a ventral arc, the lack of a subpubic concavity and a broad medial surface to the subpubic region, a narrow greater sciatic notch, and an infrequent appearance of the preauricular sulcus (Buikstra and Ubelaker 1994:17-18). These indicators were simply observed rather than being relied upon for sex estimations, however, as the vast majority of individuals did not have associated pelvic bones, precluding intra-population comparisons and intra-observer reliability.

Age Estimation

Several indicators of skeletal age-related changes have been intensively studied. Relatively reliable standards have been developed for the dentition and epiphyseal-diaphyseal unions primarily for subadults, and for the pelvic region and the calvarium for adults. As with sexually dimorphic features, skeletal age estimation of adults generally relies upon changes to the pelvic region initially, and secondarily from the cranium (Buikstra and Ubelaker 1994:21). Due to the mixing of skeletal elements in ossuary burials, the techniques relied upon in the present analysis involve dental formation and eruption for the subadults and cranial suture closure and dental attrition for the adults (Buikstra and Ubelaker 1994:32-6,38,50-1).

In the present study, an individual was considered a subadult until the third molars had erupted to the level of the occlusal surface. This event should have occurred at approximately age 18 years (± 36 months), according to Ubelaker's (1989) sequence of dental formation and eruption among Native North American populations. The stages of formation as outlined by Moorrees and colleagues (1963) were consulted to aid in the recognition of each stage in the sequence. A range in months is associated with each chronological age to allow for developmental differences between any tested sample and the reference population, and to factor in the degree of subjectivity on behalf of the researcher. Individual developmental differences may be caused by genetics, environmental conditions, nutritional status and overall health (Hillson 1996:146).

The primary focus of adult age estimation was the degree of suture closure at 10 ectocranial, 4 palatal and 3 endocranial sites. Buikstra and Ubelaker (1994:32-36,38) recommend this technique which represents a composite of several methods. Descriptions and visual diagrams were provided to assess the degree of closure, ranging from unobservable, to minimal closure, to significant closure and to complete obliteration for the following suture sites: midlambdoid, lambda, obelion, anterior sagittal, bregma, midcoronal, pterion, sphenofrontal, inferior sphenotemporal and superior sphenotemporal (ectocranial sutures); incisive, anterior median palatine, posterior median palatine and transverse palatine (palatal sutures); and, sagittal, left lambdoid and left coronal (endocranial sutures). For the bilateral sutures, the left side was scored unless limited by poor preservation.

Composite scores for the ectocranial sutures were then devised for the seven vault sites and the five lateral-anterior sites, which fit into ranges of chronological ages (Meindl and Lovejoy 1985:63). Meindl and Lovejoy (1985:63) concluded from their study that "the best estimate for a skull of unknown age is determined by the five values of the lateral-anterior system." However, consideration of all of the ectocranial, palatal and endocranial sutures creates separate estimated age ranges that generally overlap, and can assist in narrowing the final estimated age range. For instance, Mann and colleagues' (1987:152) analysis of maxillae uncovered evidence that suggests certain ages for varying stages and combinations of palatal suture closure. Still, variability in suture closure between individuals and populations has been demonstrated. Therefore, the adults included in the present study were assessed in age ranges and were subsequently grouped into young adult (18-34 years), middle adult (35-49 years) and older adult (50+ years), as suggested by Buikstra and Ubelaker (1994:36). These categories are considered sufficient to allow for comparisons between the various age and sex demographic groups. Sex does not appear to affect age-related suture changes (Krogman and Iscan 1986:120,123).

Dental attrition was analyzed in order to supplement the cranial age estimates for the adults in the three samples. The wear evident on the occlusal surfaces of teeth should increase naturally with age: more rapidly for individuals who eat a diet of coarse or gritty foods or whose teeth are used for occupational functions. Brothwell's (1981) standards, based upon prehistoric to early medieval British reference populations, may be applicable to horticultural populations from North America. This system divides permanent molar wear patterns into four age ranges (about 17-25, 25-35, 35-45 and about 45 years) depending on the amount of dentine exposure on the three molars (Brothwell 1981). Dentitions from the present study were compared with the three gradients in each of Brothwell's (1981) groupings to estimate the roughly 10-year age range. This system becomes problematic if any of the three permanent molars are missing through ante- or postmortem loss.

Melbye (1983) has attempted to formulate standards based upon an Ontario Iroquoian reference population. The system involves nine stages relating to wear facets and dentine exposure, and each of the molars *in situ* are assigned a stage (Melbye 1983:28). The various stages have been linked to chronological age based upon independent age estimations of each individual in the reference population. Since the oldest individual was assessed to be 46 ± 4 years, the attrition system ends there (Melbye 1983:29). The identified assumptions are that the third molar erupts at age 18 and that all molars wear at an equal rate once they reach the occlusal plane (Melbye 1983:29). This system does not require that all molars be *in situ*, which assists in estimation of incomplete dentitions from archaeological samples. However, it can potentially result in differing age ranges for different teeth within one dentition if that individual does not exhibit the same wear pattern as the reference population. This system of age estimation was applied to the three samples in this study, to compare the results with the Brothwell (1981) system as well as the independent suture closure estimations.

Age-related changes in the pubic symphyses were recorded for three individuals interred in bundle burials near the main pit at the Kleinburg Ossuary. To document changes in rugosity of the pubic symphysis over time, the 10-phase Todd (1921a, 1921b) and the 6-phase Suchey-Brooks (Brooks and Suchey 1990) methods have been recommended by Buikstra and Ubelaker (1994:21-32). As the auricular surface of the os coxae is often better preserved in archaeological situations, Meindl and Lovejoy (1989) refined an 8-phase technique for ageing this complex region. As with the sex-related observation of the pelvic region, these observations were noted, but not relied upon for age estimations of these few Kleinburg individuals.

Comparisons of dental conditions between the adult sexes are presented by age groupings (young, middle and older) with consistent age midpoints. This eliminates any differences in caries rates caused by differential ages-at-death between the sexes.

Intra- and Inter-observer Error Analyses

Intra-observer error testing was conducted for all criteria analyzed and among all three samples. Due to the differing sample sizes, this aspect of the analysis incorporated 19.2 % (20 of 104) of the total Uxbridge sample, 34.1 % (15 of 44) of the Kleinburg sample and 52.2 % (12 of 23) of the Syers sample. These figures are equal to or larger than the minimum sample size of 10-20 % recommended by Buikstra and Ubelaker (1994:183). Individuals were chosen via a random number generator.

Inter-observer error testing of the age and sex estimations was possible for the Kleinburg crania, courtesy of F.J. Melbye (pers. comm. 1997), as well as for the Uxbridge dentitions associated with crania, using independent analyses made available by Deborah Merrett (pers. comm. 1998) and Allison Wright (pers. comm. 1998).

Statistical Testing

Due to the relatively small sample sizes inherent in archaeological studies when compared to modern investigations, statistical testing is an essential component of the data interpretation process. For the purposes of the present study, comparisons between adult male and female dental conditions were evaluated using the Chi-Square test (on raw data) and the non-parametric Mann-Whitney *U* test (to compare indices) for independence of two variables. The Chi-Square analysis incorporates the Yates' correction for continuity for 2x2 tables that contain frequencies of 5 or less. In addition, one-way analysis of variance (ANOVA) tests were employed in order to compare means between two groups. These analyses have all been suggested and demonstrated for small-sized anthropological samples by Madrigal (1998).

Summary

The particular methodology for the present analysis was chosen to facilitate the collection of detailed information regarding the dental health of various demographic groups within each sample. New methods of data collection are not introduced, but instead were adapted from previous studies. The chosen methods are considered reliable since they have been previously tested and are simple to conduct, on the whole. These factors help minimize the occurrence of intra- and interobserver error.

Chapter 5: Results

Introduction

Analysis began with the 60 adult, subadult and juvenile crania containing teeth and/or resorbed sockets from the Uxbridge Ossuary. This subset of individuals represents the most intact (with respect to dental conditions) group of individuals from the burial collection whose age and sex estimations are considered accurate. Hypothetically, their dental characteristics, mainly from the maxillary arch, will provide the most information with regard to their specific demographic groups, and can be used to compare with those of undetermined age and/or sex. For 7 of these individuals, the maxillae and the mandibles are both present, and for one individual, only the mandible is present. Two individuals, one adult and one juvenile, had been interred in bundle burials which were associated with the ossuary pit. Maxillae not associated with crania were not analyzed due to uncertainties with current methods of sex estimation. Mandibles not associated with crania were chosen from the remainder of the Uxbridge Ossuary population based upon the criterion of a maximum of 50 percent postmortem loss of teeth (**Table 5.1**).

The Syers and Kleinburg Ossuary samples are intended as comparisons for the Uxbridge results, for the purpose of examining widespread trends in daily practices which may have influenced dental health. Analyses were limited to adult and subadult crania experiencing no more than 75 percent postmortem tooth loss (**Table 5.1**). The upper limit of tolerable postmortem loss was extended for these two ossuary samples due to low numbers of individuals demonstrating less than 50 percent postmortem loss. Five of the Kleinburg individuals had been interred in bundle burials associated with the ossuary pit. Analyses of the pubic symphyses from three of these individuals was possible, which aids in their sex estimations. Juveniles from the Kleinburg Ossuary were not analyzed due to difficulties with sex estimation. There are no juveniles present in the Syers Ossuary collection.

Table 5.1: Number of Individuals Examined for Dental Conditions

Postmortem Tooth Loss	Syers Ossuary	Kleinburg	Uxbridge	Total
0 - 25 %	0	3	18	21
26 - 50 %	6	17	44	67
51 - 75 %	17	24	34	75
76 - 100 %	n/a	n/a	7	7
Total Number of Individuals	**23**	**44**	**103**	**170**

Demographic Profile

Sexing results, estimated for 77 of the 91 Uxbridge adults, 35 of the 44 Kleinburg individuals and 20 of the 23 Syers individuals, are presented in **Table 5.2**. **Table 5.3** separates the Uxbridge Ossuary results into cranial sample, mandibular sample and combined total sample. Sex estimations were not assigned for many of these individuals due to postmortem damage of key features on the cranium or mandible, or due to ambiguity in dimorphic characteristics.

Adult individuals were assigned to broad age categories of young (18-34 years), middle (35-49 years) and older (50+ years), rather than specific skeletal age-at-death estimations, in an attempt to minimize errors. Histograms showing the percentage of males versus females in each age category illustrate that the males from each of the three samples appear to have lived longer than the females within the same ossuary population (**Figures 5.1**, **5.2** and **5.3**). Age estimations, possible for 79 of the 103 Uxbridge individuals, all 44 of the Kleinburg individuals and each of the 23 Syers individuals, are also reported in **Table 5.2**. Twenty-four (24) of the 43 individuals in the Uxbridge mandibular sample could not be assigned age estimations more specific than adult, or 18+ years. In these cases, there were no molars present, having been lost either antemortem or postmortem, for the comparisons required with Brothwell's (1981) and Melbye's (1983) standards. **Table 5.3** presents the results from the Uxbridge Ossuary, divided into crania sample, mandibular sample and combined total sample.

Table 5.2: Age and Sex Distribution - Syers, Kleinburg and Uxbridge Samples

	Syers			Kleinburg			Uxbridge			
Age	male	female	?	male	female	?	male	female	?	**Total**
3 years ± 12 mos.	--	--	--	--	--	--	--	--	1	**1**
4 years ± 12 mos.	--	--	--	--	--	--	--	--	1	**1**
5 years ± 15 mos.	--	--	--	--	--	--	--	--	2	**2**
6 years ± 24 mos.	--	--	--	--	--	--	--	--	1	**1**
7 years ± 24 mos.	--	--	--	--	--	--	--	--	2	**2**
8 years ± 24 mos.	--	--	--	--	--	--	--	--	1	**1**
9 years ± 24 mos.	--	--	--	--	--	--	--	--	2	**2**
10 years ± 30 mos.	--	--	--	--	--	--	--	--	2	**2**
young adult (includes subadults)	3	6	2	5	13	5	15	18	8	**75**
middle adult	3	1	1	1	5	3	8	10	1	**33**
older adult	7	0	0	8	3	1	6	1	0	**26**
undeter-mined adult	--	--	--	--	--	--	10	9	5	**24**
Total	**13**	**7**	**3**	**14**	**21**	**9**	**39**	**38**	**26**	**170**

Table 5.3: Age and Sex Distribution - Uxbridge Ossuary Samples

Age	Crania			Mandibles			Total		
	male	female	?	male	female	?	male	female	?
3 years ± 12 mos.	--	--	0	--	--	1	--	--	1
4 years ± 12 mos.	--	--	0	--	--	1	--	--	1
5 years ± 16 mos.	--	--	1	--	--	1	--	--	2
6 years ± 24 mos.	--	--	1	--	--	0	--	--	1
7 years ± 24 mos	--	--	2	--	--	0	--	--	2
8 years ± 24 mos.	--	--	1	--	--	0	--	--	1
9 years ± 24 mos.	--	--	2	--	--	0	--	--	2
10 years ± 30 mos.	--	--	2	--	--	0	--	--	2
young + subadult	8	15	4	7	3	4	15	18	8
middle adult	7	9	1	1	1	0	8	10	1
older adult	6	1	0	0	0	0	6	1	0
undetermined adult	--	--	--	10	9	5	10	9	5
Total	**21**	**25**	**14**	**18**	**13**	**12**	**39**	**38**	**26**

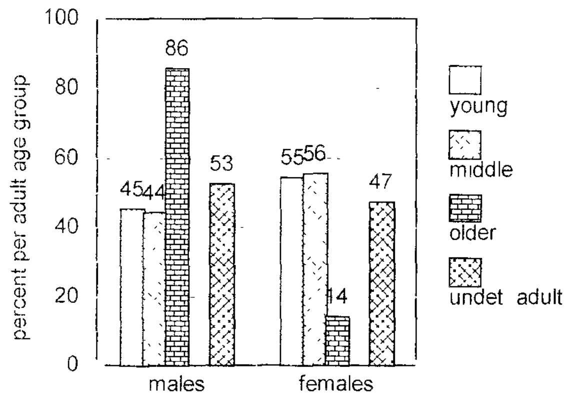


Figure 5.1 Uxbridge Ossuary cranial and mandibular samples: percentages of male and female individuals in each adult age group.

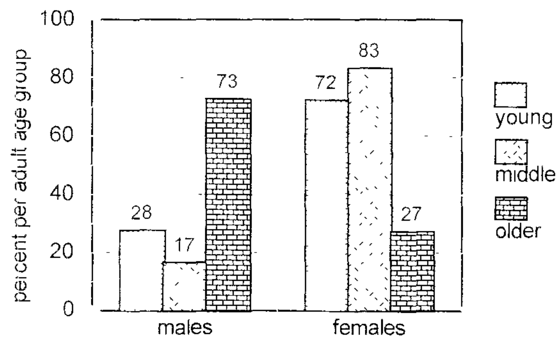


Figure 5.2 Kleinburg Ossuary sample: percentages of male and female individuals in each adult age group.

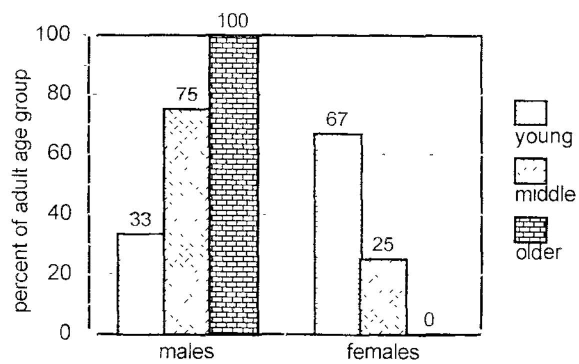


Figure 5.3 Syers Ossuary sample: percentages of male and female individuals in each adult age group.

Sex Estimation By Molar Size

An attempt to increase sexing reliability was made by comparing the surface areas of the first and second permanent molars of those individuals confidently judged to be male and female by the standard estimation techniques. Fifty-one (51) of the 103 individuals comprising the total Uxbridge sample contain at least one light-to-moderately worn molar *in situ*. While there seems to be a statistically significant trend for the males to have larger molar surface areas, the areas of overlap between the sexes are quite large (**Table 5.4**). Of the 36 maxillae and mandibles with previous sex estimations, 23 fall within the range for their sex, while 11 are located within the areas of overlap between the sexes. The molar sizes of the remaining two individuals fall within the ranges for the opposite sex for one of the molars examined.

Table 5.4: Uxbridge Ossuary Cranial and Mandibular Samples: Molar Surface Area Comparisons

	Maxillary M^1 (mm^2) (range / mean)	Maxillary M^2 (mm^2) (range / mean)	Mandibular M_1 (mm^2) (range / mean)	Mandibular M_2 (mm^2) (range / mean)
Males	120.43 - 147.22 $\bar{x}$=136.18, n=10	116.14 - 145.85 $\bar{x}$=127.24, n=8	131.06 - 146.50 $\bar{x}$=137.45, n=5	126.14 - 146.69 $\bar{x}$=136.46, n=4
Females	107.57 - 160.50 $\bar{x}$=125.77, n=12	93.04 - 131.02 $\bar{x}$=112.38, n=11	115.56 - 129.91 $\bar{x}$=122.74, n=2	109.19 - 115.45 $\bar{x}$=112.32, n=2
F ratio, *P* value[1]	4.323, .051	9.154, .008	6.039, .057	13.309, .022

[1] all P values listed here are statistically significant

Of the seven individuals in the adult ambiguous category, a revised sex estimation might become possible using the measurements from at least one of their molars. Eight juveniles from the Uxbridge samples are also eligible for molar size examinations. Of these, four have molar sizes which fall into the female ranges, while the four others fall into the overlap ranges between the sexes. Small sample sizes for this procedure were unavoidable, following the exclusion of those teeth experiencing heavy or severe occlusal surface wear affecting maximum crown dimensions. For this reason, sex estimations which might be revised by this method have not been incorporated into the demographic groupings for the calculations of caries prevalence.

Due to the relative lack of individuals with associated mandibles in the Syers and Kleinburg samples, molar size comparisons for these two ossuary groups involve only the maxillary first and second molars. Thirty-one (31) of the 44 individuals included in the Kleinburg Ossuary sample contained at least one light-to-moderately worn molar *in situ*. An analysis of the upper first molars indicates that there is no clear separation between the sexes. The mean surface area for the male and female groups is nearly identical, being 124.42 mm^2 and 123.23 mm^2, respectively. A large overlap exists, allowing for only a clear indication of an exclusive male size above approximately 142 mm^2. Male teeth range from 98.96 mm^2 to 147.15 mm^2, and female teeth range from 107.48 mm^2 to 142.12 mm^2. As would be expected, there is no statistical difference between these male and female first maxillary molar sizes.

Among the second molars from the Kleinburg Ossuary sample, the overlap between the sexes is smaller, and exclusive male and female ranges are apparent. Male teeth range from 104.90 mm^2 to 141.72 mm^2 with a mean of 121.45 mm^2, and female teeth range from 81.64 mm^2 to 123.83 mm^2 with a mean of 109.76 mm^2. This is a statistically significant difference (ANOVA F ratio=8.519, *P* value=.006). Despite the relatively large areas of overlap, it may be possible to assign tentative sex estimations to three of the five individuals who were previously assigned to the ambiguous category. However, it is unfortunate that only one molar was available for these comparisons for each of these individuals; a confident sex estimation cannot be made solely by the size of one molar crown.

Of the 23 individuals comprising the Syers Ossuary sample, 16 contain at least one light-to-moderately worn molar *in situ*. As with the Kleinburg sample, the majority of measurements for both sexes fall within an area of overlap. For the first maxillary molars, males range from 108.35 mm^2 to 169.78 mm^2 with a mean of 134.32 mm^2, while females range from 107.69 mm^2 to 133.74 mm^2 with a mean of 125.01 mm^2. For the second maxillary molars, males range from 104.73 mm^2 to 148.29 mm^2 with a mean of 123.71 mm^2, and females range from 100.83 mm^2 to 132.57 mm^2 with a mean of 116.60 mm^2. Very few individuals fall within those ranges that are exclusive to one sex, and there are no statistically significant differences for the measurements of these two molar types. One of the three individuals previously classified as ambiguous with regard to sex can tentatively be placed into the female category, but are not included in calculations of caries prevalence with regard to sex groups for the purposes of this study.

In general, the results from the maxillary molar size comparison within all three ossuary samples yield little new information. The proportions of the observations which fall into the overlap between the sexes range from 52 percent for the Uxbridge sample to 75 and 77 percent for the Syers and Kleinburg samples, respectively. Only two cases (7 percent) among the Uxbridge mandibles, however, fall within the overlap area. Of note are the statistically significant differences between male and female first and second molars in the Uxbridge samples, as well as between male and female second molars in the Kleinburg sample. Despite these differences, those individuals identified as ambiguous by traditional sexing methods using cranial and mandibular morphological features are not included with the sexed samples for the calculations of caries prevalence for the current study.

Dental Inventory: Uxbridge Ossuary Samples

Crania: Postmortem tooth loss by individual for the subset of Uxbridge crania ranged from 6.3 to 100.0 percent, with an average of 55.7 percent (55.0 percent among the adults and subadults and 60.6 percent among the juveniles). As would be expected for the adults in this agricultural population, postmortem loss is highest among the anterior teeth, antemortem loss is highest among the molars and the majority of teeth found *in situ* are molars and premolars. (See **Appendix B** for a dental inventory by tooth type). Those individuals placed within the middle and older age categories experienced proportionally lower amounts of postmortem loss, having lost more teeth during life than those placed in the young age category. While postmortem loss is similar among the maxillae and mandibles in the adult cranial subset, the occurrence of teeth lost antemortem and those found *in situ* is reversed between the dental arches, with the maxillae containing more observable teeth than resorbed sockets.

The proportion of teeth lost postmortem is only slightly higher for the adult females in this subset than for the males (54.4 % versus 52.4 %) (**Table 5.5**). This difference is not significant, as differences between numbers of observable teeth (*in situ*) and those lost before death (antemortem tooth loss) among the adult males and females are not significant (using one-way ANOVA tests). Within this cranial sample, both of these groups contained a mean number of 4 teeth *in situ*.

Only three teeth were congenitally absent, all from adult individuals of ambiguous sex. No antemortem loss has occurred among the juveniles other than the natural shedding of deciduous teeth. All but one of these children exhibit a mixed dentition (see **Appendix C** for data regarding the dental status of these juveniles).

Table 5.5: Dental Inventory - Uxbridge, Kleinburg and Syers Adult Samples

Sample		Teeth *in situ* (a)	Antemortem loss (b)	Postmortem loss (c)	Percentage of Postmortem loss [c/(a+b+c)]
Uxbridge crania	females n=25	120	70	227	54.4
	males n=21	96	101	219	52.6
Uxbridge mandibles	females n=13	47	92	69	33.2
	males n=18	78	103	106	36.9
Uxbridge total	females n=38	167	162	296	47.4
	males n=39	175	205	325	46.1
Kleinburg total	females n=21	150	46	199	49.6[1]
	males n=14	90	41	110	45.6
Syers total	females n=7	36	4	71	64.0
	males n=13	58	29	121	58.2

[1] includes congenital absences

Mandibles: The prescribed maximum limitation of 50 percent postmortem loss for the Uxbridge Ossuary mandibles resulted in the analysis of 43 individuals: 40 adults and subadults and 3 juveniles. Of these, 9 have experienced 25 percent or less postmortem loss, indicating that at least three-quarters of their teeth are either present for analysis of caries, wear and size or were lost antemortem. Contrary to the pattern observed among the cranial sample, the males exhibit proportionally more postmortem loss than do the females (36.8 % versus 33.2 %) and, overall, postmortem loss is lower for the mandibular sample. Similar to the mandibles from the cranial subset, these mandibles exhibit more postmortem loss in the anterior region than in the posterior and more antemortem loss in the posterior region than in the anterior. (See **Appendix B** for a dental inventory by tooth type). The locations of teeth *in situ* are relatively uniform throughout the dental arch. Only one congenitally absent tooth was noted (for an individual of ambiguous sex). The dental inventory for the three juvenile mandibles not associated with crania is presented in **Appendix C**.

Comparisons between the cranial and mandibular samples from the Uxbridge Ossuary indicates that the dental arches show similar patterns of disease. Among the adult males in these two samples (n=21 crania, n=18 mandibles), differences in the amounts of observable teeth, carious teeth per person, antemortem tooth losses and pulp exposures caused by carious lesions did not reach statistical significance. Similarly, the numbers of teeth *in situ* and carious pulp exposures did not differ statistically between the adult females in the two samples. However, it appears that the females in the cranial sample experienced more carious teeth per person, with a mean of 2.40, than those in the mandibular sample, with a mean of 1.08 (F ratio = 4.385, *P* value=.043). The females in the mandibular sample lost more teeth prior to death, with a mean of 7.08 per person, than those in the cranial sample, with a mean of 2.80 per person (F ratio=9.596, *P* value=.004). When these two variables are combined, as they are for calculations of the Diseased-Missing Index or the Corrected Caries Rate, the females in the mandibular sample still exhibit higher levels of these reactions to disease: 8.15 per person versus 5.20 per person in the cranial sample (F ratio=5.169, *P* value=.029). Since the females in these two samples differ in regards to these two important variables, they are not combined when exploring differences between males and females from the Uxbridge Ossuary. Rather, data are compared from all males (crania plus mandibles) with the female crania.

Dental Inventory: Kleinburg Ossuary Sample

The Kleinburg sample contains 44 individuals. Three individuals show 25 percent or less postmortem loss and seventeen have between 26 and 50 percent postmortem loss. The average postmortem loss for all individuals is 50.0 percent. The females have higher proportions of postmortem loss and slightly lower proportions of antemortem loss per individual when compared with the males. This does not seem significant, however, as there is no statistical separation between the sexes with regard to numbers of observable teeth or antemortem tooth losses (**Table 5.5**). The Kleinburg sample also exhibits the pattern of high postmortem loss for the anterior tooth classes, and high antemortem loss for the molars and posterior tooth classes remaining *in situ* (see **Appendix D** for dental inventory by tooth type). The Kleinburg sample experienced lower levels of antemortem loss relative to postmortem loss and observable teeth when compared with the Uxbridge samples (16.2 % for all Kleinburg adult males and females versus 27.6 % for all Uxbridge adult males and females). Six of the third molars among the females in the Kleinburg sample were missing due to congenital absence.

Dental Inventory: Syers Ossuary Sample

The Syers sample contains 23 individuals, 6 of whom experienced 50 percent or less postmortem tooth loss. The average postmortem loss is 59.8 percent. The females have slightly higher proportions of postmortem loss and lower proportions of antemortem loss per individual when compared with the males. Despite this, there is no statistical separation between the sexes with regard to numbers of observable teeth or antemortem tooth losses (**Table 5.5**). The pattern of high postmortem loss for the anterior tooth classes, and high antemortem loss for the molars and posterior tooth classes remaining *in situ* seen in the Uxbridge samples is also found in the Syers sample (see **Appendix E** for dental inventory by tooth type). The Syers sample shows lower levels of antemortem loss relative to postmortem loss and observable teeth compared to the Uxbridge samples (10.3 % for all Syers males and females versus 27.6 % for all Uxbridge adult males and females). The individuals included in the Syers sample do not exhibit signs of congenital absence.

Dental Caries: Uxbridge Ossuary Samples

Crania: Among the permanent dentition from the cranial sample, the Observed Caries Rate (# carious teeth / teeth *in situ* x100) ranges from: 0.0 - 42.9 % (n=55 observed) for the anterior (incisor and canine classes) maxillary teeth, 29.4 - 71.4 % (n=164 observed) for the posterior (premolar and molar classes) maxillary teeth, 0.0 % (n=3 observed) for the anterior mandibular teeth (no incisors remained *in situ*) and 0.0 - 100.0 % (n=15 observed) for the posterior mandibular teeth. While caries among the anterior teeth take the form of gross lesions in 50 % (6 of 12) of the cases, the vast majority of the carious lesions on the posterior teeth occur on the occlusal surfaces. Fifteen cases of carious pulp exposure were noted.

Mandibles: Among the permanent dentition from the mandibular sample, the Observed Caries Rate ranges from: 0.0 - 16.7 % for the anterior teeth (n=69 observed) and 14.3 - 100.0 % for the posterior teeth (n=104 observed). While caries on the anterior teeth occur most frequently on interproximal surfaces, the vast majority of the carious lesions on the posterior teeth occur on the occlusal surfaces. One case of carious pulp exposure was noted.

Dental caries prevalence for the Uxbridge Ossuary individuals is reported here by total adult sample (**Appendix F**), juveniles (**Appendix C**), all male adults versus all female adults (**Table 5.6**), and male and female adults in the three age groupings (**Table 5.7**). The distribution of dental caries by tooth class and dental arch is presented in **Appendix B**. Caries prevalence for the total Uxbridge Ossuary sample (consisting of 91 adults and 12 juveniles) may be described using a variety of calculations, including:

Average number of caries per tooth = 0.70

Observed Caries Rate = 39.0 %

Diseased Missing Index = 69.7 %

Corrected Caries Rate = 54.4 %, and

Corrected Caries Rate with a Proportional Correction = 56.5 %.

Table 5.6: Summary of Caries Prevalence - Uxbridge Ossuary Adult Samples

	Females			Males		
	crania	mandibles	total	crania	mandibles	total
Number of individuals	25	13	38	21	18	39
Age category at death - young	15	3	18	8	7	15
- middle	9	1	10	7	1	8
-older	1	0	1	6	0	6
- undetermined	0	9	9	0	10	10
Number of postmortem losses	227	69	296	219	106	325
Number of teeth *in situ*	120	47	167	96	78	175
Number of carious teeth *in situ*	60	14	74	39	33	72
Avg # carious teeth/ individual	2.4	1.1	1.9	1.9	1.8	1.8
Number of antemortem losses	70	92	162	101	103	205
Number of pulp exposures	12	3	15	8	11	19
# Pulp exposures due to caries	11	3	14	5	6	11
Average # of caries per tooth	0.77	0.72	0.75	0.68	0.88	0.77
Estimated # teeth with caries	116	106	220	102	85	179
Number of original teeth	184	139	323	197	177	374
Observed Caries Rate (%)	50.0	29.8	44.3	40.6	42.3	41.1
Diseased Missing Index (%)	68.4	76 3	71.7	71.1	75.3	72.9
Corrected Caries Rate[1] (%)						
- anterior	33.3	4.7	39.8	27.7	27.8	28.9
- posterior	74.1	87.5	79.6	75.3	53.9	57.4
- overall	**63.0**	**76.3**	**68.1**	**51.8**	**48.0**	**47.9**
Proportional Correction (%)						
-anterior[2]	12.5	1.7	14.9	10.4	10.4	10.8
- posterior[3]	46.3	54.7	49.7	47.1	33.7	35.9
- overall (anterior + posterior)	**58.8**	**56.4**	**64.6**	**57.5**	**44.1**	**46.7**

[1]Lukacs (1995)
[2]CCR x 3/8 (Erdal and Duyar 1999:239)
[3]CCR x 5/8 (Erdal and Duyar 1999:239)

Table 5.7: Summary of Caries Prevalence - Uxbridge Ossuary Demographic Samples

	Young		Middle		Older	
	Female[1]	Male[2]	Female[1]	Male[2]	Female[1]	Male[2]
Number of individuals	15	15	9	8	1	6
Number of postmortem losses	144	135	74	82	9	48
Number of teeth *in situ*	75	98	41	43	4	9
Number of carious teeth *in situ*	41	43	18	20	2	0
Avg # carious teeth / individual	2.7	2.9	2.0	2.5	2.0	0.0
Number lost antemortem (amtl)	21	19	46	49	3	55
Number of pulp exposures	6	3	5	6	1	0
# Pulp exposures due to caries	6	3	5	3	0	0
Average # of caries per tooth	0.93	0.89	0.49	0.76	0.50	0.00
Estimated # of teeth with caries (carious teeth + amtl)	62	62	64	41	2	0
Number of original teeth (teeth *in situ* + amtl)	96	117	87	92	7	64
Observed Caries Rate (%)	54.7	43.9	43.9	46.5	50.0	0.0
Diseased Missing Index (%)	64.6	53.0	73.6	75.0	71.4	85.9
Corrected Caries Rate[3] (%) (CCR) - anterior	14.3	4.2	65.2	26.1	0.0	0.0
- posterior	73.3	62.4	76.6	55.1	33.3	0.0
- overall	**64.6**	**53.0**	**73.6**	**44.6**	**28.6**	**0.0**
Proportional Correction (%) - anterior[4]	5.4	1.6	24.5	9.8	0.0	0.0
- posterior[5]	45.8	39.0	47 9	34.4	20.8	0.0
- overall (anterior + posterior)	**51.2**	**40.6**	**72.4**	**44.2**	**20.8**	**0.0**

[1]Cranial sample only
[2]Cranial plus mandibular samples
[3]Lukacs (1995)
[4]CCR x 3/8 (Erdal and Duyar 1999:239)
[5]CCR x 5/8 (Erdal and Duyar 1999:239)

Statistical Testing of Differences Between Uxbridge Ossuary Males and Females

Variables which are critical to the caries formulae, such as the numbers of sound and carious teeth, teeth lost antemortem, and pulp exposures caused by caries, have been tested by one-way ANOVA, and by non-parametric tests such as Mann-Whitney U and Chi-Square (X^2) analyses (as described in Madrigal 1998).

The mean numbers of carious teeth per individual are similar when the 25 female crania are compared with the 39 male crania and mandibles in the samples (2.40 versus 2.17, respectively). Divided by age category, the 15 young males experienced nearly equal, but slightly higher, numbers of carious teeth per individual than the 15 young females (2.87 versus 2.67, respectively), as did the 8 middle aged males when compared to the 9 middle aged females (2.50 versus 2.00, respectively). Of the older individuals in the Uxbridge sample, the 6 males did not show any carious lesions in the teeth that were remaining *in situ*, while the single female contained 2 carious teeth. None of these differences in mean numbers of carious teeth per individual are statistically significant by the one-way ANOVA. Regardless, it is interesting to note that the males in the younger and middle age groups tend to exhibit slightly higher means than the females within the same age categories.

The Observed Caries Rate (OCR) and the Diseased Missing Index (DMI) evaluate combinations of the proportions of observed carious teeth per individual and sockets exhibiting antemortem tooth loss relative to the numbers of sound teeth observed. While it appears that the young female group experienced more caries than males of the same age from the calculations of the OCR and DMI (refer to **Table**

5.7), there are no statistically significant differences (**Tables 5.8**, **5.9** and **5.10**). With regard to those individuals who died during their middle years, it is the males who score slightly higher OCR and DMI figures, reflecting their higher (although not significantly) numbers of teeth lost before death (6.13 versus 5.11 for the females). As with the young males and females, there are no statistically significant differences in the OCR and DMI figures between the sexes in the middle aged group (**Tables 5.8**, **5.9** and **5.10**).

Table 5.8: Analyses of Observed Caries Rates: Uxbridge Ossuary Females versus Males

	Chi-Square test (using raw data)		**Mann-Whitney *U* test**	
	Result	**Significance**	**Result**	**Significance**
Young Individuals (n=15 females, n=15 males)	1.315	not significant (ns)	95.5	.479 (ns)
Middle Individuals (n=9 females, n=8 males)	0.058	not significant	33.5	.808 (ns)

Table 5.9 Analyses of Diseased Missing Indices: Uxbridge Ossuary Females versus Males

	Chi-Square test (using raw data)		**Mann-Whitney *U* test**	
Sample	**Result**	**Significance**	**Result**	**Significance**
Young Individuals (n=15 females, n=15 males)	1.315	not significant (ns)	95.5	.479 (ns)
Middle Individuals (n=9 females, n=8 males)	0.058	not significant (ns)	33.5	.808 (ns)

Table 5.10: One-Way ANOVA Analyses of Observed Caries Rates and Diseased Missing Indices: Uxbridge Ossuary Females and Males

Sample	Analysis	Source of Variation	df	Sum of Squares	Mean Square	F	*P* (sig.)
Young Males vs. Young Females	OCR (carious teeth)	between groups	1	204.311	204 311	.214	.647 (ns)
		within groups	28	26767.991	956.000	--	--
		total	29	26972.302	--	--	--
Young Males vs. Young Females	DMI (carious teeth + amtl)	between groups	1	753.604	753.604	.818	.374 (ns)
		within groups	28	25798.292	921 368	--	--
		total	29	26551.896	--	--	--
Middle Males vs. Middle Females	OCR (carious teeth)	between groups	1	111.014	111.014	.075	788 (ns)
		within groups	15	22298.530	1486.569	--	--
		total	16	22409.544	--	--	--
Middle Males vs. Middle Females	DMI (carious teeth + amtl)	between groups	1	334.808	334.808	454	.511 (ns)
		within groups	15	11061 041	737.403	--	--
		total	16	11395.849	--	--	--

The fact that there is one lone female in the older age category prohibits statistical comparisons between the two sexes. As seen in **Table 5.7**, these older adults experienced a high proportion of antemortem losses and that, combined with the expected amount of postmortem tooth loss, resulted in a very low number of teeth *in situ* which could be examined for carious lesions.

Differences between the mean numbers of carious pulp exposures per individual have also been tested statistically. Although the mean among adult female crania in the Uxbridge sample is higher than that among all adult males (0.44 versus 0.24), the difference is not statistically significant (**Table 5.11**). Although not statistically significant, the separation observed between the sexes in the young age group (mean numbers per individual are 0.40 for the females and 0.20 for the males) is reduced dramatically by the middle years (means are 0.56 for the females and 0.50 for the males). No carious pulp exposures were observed among the female and males in the older age category. It is expected that these individuals had experienced these during life, however the high numbers of teeth lost both ante- and postmortem make it less likely that these, as well as pulp exposures caused by occlusal surface wear, will be observed in an ossuary situation.

Pulp exposures caused by severe wear (attrition) were less frequent than those caused by advanced stage caries. Although not a statistically significant difference, the males did experience more of this on average, particularly in the middle age group. Two of the middle males had one pulp exposure caused by wear and one male had two. The females in this group had none, which equated to a statistically significant difference by a one-way ANOVA (F=3.971, P=.065). Among the older individuals, one female had one such pulp exposure, while none of the males showed evidence of this level of severe or occupational attrition. Again, these observations are dependent upon teeth being *in situ* for observations of such a condition.

Table 5.11: Analyses of Carious Pulp Exposures: Uxbridge Ossuary Females versus Males

Sample	Source of Variation	df	Sum of Squares	Mean Square	F	*P* (sig.)
All Adult Males vs. Adult Females (Cranial)	between groups	1	.530	.530	1.283	.263 (ns)
	within groups	52	21.470	.413	--	--
	total	53	22.000	--	--	--

The Corrected Caries Rate (CCR) incorporates all of the variables discussed above (carious teeth *in situ*, antemortem losses and the proportion of pulp exposures caused by caries) into a relatively complex 4-step calculation which is difficult to assess as a whole with standard statistical techniques. However, when its components are considered separately, certain trends in the data may become apparent. **Table 5.12** presents basic comparisons, such as numbers of *observed* sound versus carious teeth, as well as some of the calculated figures, such as the *estimated* number of teeth with caries (Step 2 in the CCR formula from Lukacs 1995:153). Of note, is that the difference in the numbers of carious pulp exposures versus those caused by wear is statistically significant when comparing all (crania plus mandibles) adult females with all adult males in the Uxbridge sample. The relative proportions of the two causes of pulp exposure influence the numbers of estimated carious teeth among the members of a demographic group. This may be the reason for the statistical separations between the sexes with regard to the estimated numbers of carious versus sound teeth seen in **Table 5.12**. It appears that this separation is most dramatic between the sexes in the middle age group. For the same reasons as discussed above for the other statistical analyses, the female mandibular sample was omitted from the Chi-Square comparisons when divided into the specific age groupings.

Table 5.12: Uxbridge Ossuary Chi-Square Analyses, alpha level = 0.05, df=1

Samples	Variables	Chi-Square	Critical Value	Result
all female crania vs. all male crania	observed sound vs. carious teeth	1.888	3.841	ns[1]
all female mandibles vs. all male mandibles	observed sound vs. carious teeth	1.960	3.841	ns[1]
all female crania + mandibles vs. all male crania + mandibles	observed sound vs. carious teeth	0.351	3.841	ns[1]
all female crania + mandibles vs. all male crania + mandibles	observed carious pulp exposures vs. attritional pulp exposures	5.663 Yates' correction	3.841	significant .05-.025
all female crania vs. all male crania	# estimated carious teeth vs. # estimated sound teeth	4.934	3.841	significant .05-.025
all female mandibles vs. all male mandibles	# estimated carious teeth vs. # estimated sound teeth	25.963	3.841	significant .005
all female crania + mandibles vs all male crania + mandibles	# estimated carious teeth vs. # estimated sound teeth	29.039	3.841	significant .005
young female crania vs. young male crania + mandibles	# estimated carious teeth vs. # estimated sound teeth	2.913	3.841	ns
middle female crania vs. middle male crania + mandibles	# estimated carious teeth vs. # estimated sound teeth	15.505	3.841	significant .005

Samples	Variables	Chi-Square	Critical Value	Result
older female crania vs. older male crania + mandibles	# estimated carious teeth vs. # estimated sound teeth	12.356 Yates' correction	3.841	ns, due to a zero factor[3]

[1] These comparisons will not be further subdivided into the various age groups since the results from the overall comparisons were not statistically significant.
[2] This will not be further subdivided into the various age groups since the numbers are extremely small.
[3] The presence of zeroes skew the result of this calculation and, therefore, the apparent statistically significant difference is disregarded.

Dental Caries: Kleinburg Ossuary

The overall Observed Caries Rate among the Kleinburg individuals examined for this study is 45.3 %, with a rate of 45.0 % for the maxillary teeth (the majority of those examined). The Observed Caries Rate ranges from 17.8 % (n=45 observed) for the anterior maxillary teeth to 54.1 % (n=185 observed) for the posterior maxillary teeth, and from 31.3 % (n=16 observed) for the anterior mandibular teeth to 61.1 % (n=18 observed) for the posterior mandibular teeth. Caries prevalence for the total Kleinburg Ossuary sample of 44 individuals (14 males, 21 females and 9 of ambiguous sex) may be described using a variety of calculations, including:

Average number of caries per tooth = 0.75

Observed Caries Rate = 45.3 %

Diseased Missing Index = 61.2 %

Corrected Caries Rate = 50.9 %, and

Corrected Caries Rate with a Proportional Correction = 48.8 %.

Appendix D lists observations by tooth type, and **Appendix G** indicates the distribution of carious lesions on the various tooth surfaces throughout the dentitions.

Statistical Differences Between Kleinburg Ossuary Males and Females

The results from comparisons of caries prevalence between the sexes have been subjected to statistical testing. This analytical procedure is necessary to account for differences when the sample sizes are small, as is the case in particular once the individuals from the Kleinburg Ossuary are divided into their various age and sex groups. Variables which are critical to the caries formulae, such as the numbers of sound and carious teeth, teeth lost antemortem, and pulp exposures caused by caries, have been tested by one-way ANOVA, and by non-parametric tests such as Mann-Whitney *U* and Chi-Square (X^2) analyses (as described in Madrigal 1998).

Table 5.13 reports dental caries prevalence and other related observations for all males versus all females in the Kleinburg Ossuary sample. The mean number of carious teeth per individual is higher for the entire female group (n=21, sample mean = 3.43) than among the males (n=14, sample mean = 2.57), although this difference is not statistically significant (F=.986, *P*=.328). Divided by age category, the 5 young males experienced nearly equal, but slightly higher, numbers of carious teeth per individual than the 13 young females (3.60 versus 3.23, respectively). Although the lone male in the middle age group scored higher than the 5 females (4.00 versus 3.20, respectively), this comparison does not represent a statistically significant separation. Among the older individuals, the 3 females possessed higher numbers of carious teeth per person than the 8 males (4.67 versus 1.75, respectively), however even this difference did not produce significant results (F=1.939, *P*=.197).

Table 5.13: Summary of Caries Prevalence - Kleinburg Ossuary

	Females	Males
Number of individuals	21	14
Age category at death - young	13	5
- middle	5	1
- older	3	8
Number of postmortem losses	199	110
Number of teeth *in situ*	150	90
Number of carious teeth *in situ*	72	36
Avg # carious teeth / individual	3.4	2.6
Number of antemortem losses	46	41
Number of pulp exposures	27	7
# Pulp exposures due to caries	17	4
Average # of caries per tooth	0.81	0.63
Estimated # of teeth with caries	101	59
Number of original teeth	196	131
Observed Caries Rate (%)	48.0	40.0
Diseased Missing Index (%)	60.2	58.8
Corrected Caries Rate[1] (%)		
- anterior	20.5	23.3
- posterior	65.0	53.5
- overall	**51.5**	**45.0**
Proportional Correction (%)		
- anterior[2]	7.7	8.8
- posterior[3]	40.6	33.4
- overall (anterior + posterior)	**48.3**	**42.2**

[1]Lukacs (1995)
[2]CCR x 3/8 (Erdal and Duyar 1999:239)
[3]CCR x 5/8 (Erdal and Duyar 1999:239)

It is essential to control for age, as the severity of dental disease tends to increase. **Table 5.14** presents dental observations divided into each of the three adult age categories: young (18-34 years), middle (35-49 years) and older (50+ years).

Table 5.14: Summary of Caries Prevalence - Kleinburg Ossuary Demographic Samples

	Young		Middle		Older	
	Female	Male	Female	Male	Female	Male
Number of individuals	13	5	5	1	3	8
Number of postmortem losses	127	38	46	6	26	66
Number of teeth *in situ*	100	43	28	10	22	37
Number of carious teeth *in situ*	42	18	16	4	14	14
Avg # carious teeth / individual	3.2	3.6	3.2	4.0	4.7	1.8
Number lost antemortem (amtl)	8	0	22	0	16	41
Number of pulp exposures	9	1	6	0	13	6
# Pulp exposures due to caries	5	0	6	0	6	4
Average # of caries per tooth	0.77	0.67	0.79	0.50	1.00	0.62
Estimated # of teeth with caries (carious teeth + amtl)	46	18	38	4	22	41
Number of original teeth (teeth *in situ* + amtl)	108	43	50	10	38	78
Observed Caries Rate (%)	42.0	41.9	57.1	40.0	63.6	37.8
Diseased Missing Index (%)	46.3	41.9	76.0	40.0	78.9	70.5
Corrected Caries Rate[1] (%)						
- anterior	4.8	14.3	50.0	33.3	37.5	25.0
- posterior	57.5	47.2	82.5	42.9	66.7	70.7
- overall	**42.6**	**41.9**	**76.0**	**40.0**	**57.9**	**52.6**
Proportional Correction (%)						
-anterior[2]	1.8	5.4	18.8	12.5	14.1	9.4
- posterior[3]	35.9	29.5	51.6	26.8	41.7	44.2
- overall (anterior + posterior)	**37.7**	**34.9**	**70.4**	**55.4**	**57.6**	**53.6**

[1]Lukacs (1995)
[2]CCR x 3/8 (Erdal and Duyar 1999:239)
[3]CCR x 5/8 (Erdal and Duyar 1999:239)

The Observed Caries Rates (OCR) between the females and the males are equal among the young individuals, but tend to be higher among the middle and older females than among the males of the same ages (**Table 5.15**). For the middle age group, this difference is not significant, due to the presence of the single male in the sample. Among the older individuals, the difference does not appear to be significant when analyzed with the non-parametric Mann-Whitney *U* statistic, although it approaches significance with the Chi-Square test.

Table 5.15: Analyses of Observed Caries Rates: Kleinburg Ossuary Females versus Males

	Chi-Square test (using raw data)		**Mann-Whitney *U* test**	
	Result	**Significance**	**Result**	**Significance**
Young Individuals (n=13 females, n=5 males)	0.000	not significant (ns)	31.0	.882 (ns)
Middle Individuals (n=5 females, n=1 male)	0.988 (Yates' correction)	not significant	1.5	.546 (ns)
Older Individuals (n=3 females, n=8 males)	3.683	1->.05	10.5	.753 (ns)

The relative scores for the Diseased Missing Index (DMI), on the other hand, are dependent upon the proportions of teeth lost before death. The females score higher for this calculation in all age groups, although statistical significance is only reached in the middle group (**Table 5.16**). The apparent statistically significant difference found among the older group for OCR is negated by the high number of antemortem losses among the males when the DMI is calculated. **Table 5.17** presents the results of the one-way ANOVA analyses for the comparisons of the Kleinburg female and male Observed Caries Rates and Diseased Missing Indices.

Table 5.16 Analyses of Diseased Missing Indices: Kleinburg Ossuary Females versus Males

	Chi-Square test (using raw data)		**Mann-Whitney *U* test**	
Sample	**Result**	**Significance**	**Result**	**Significance**
Young Individuals (n=13 females, n=5 males)	0.244	not significant (ns)	27.0	.587 (ns)
Middle Individuals (n=5 females, n=1 male)	4.829	.05>.025	0.5	.235 (ns)
Older Individuals (n=3 females, n=8 males)	0.928	not significant	10.0	.668 (ns)

Table 5.17 One-Way ANOVA Analyses of Observed Caries Rates and Diseased Missing Indices: Kleinburg Ossuary Females and Males

Sample	**Analysis**	**Source of Variation**	**df**	**Sum of Squares**	**Mean Square**	**F**	***P* (sig.)**
Young Males vs Young Females	OCR (carious teeth)	between groups	1	17.701	17.701	.033	.859 (ns)
		within groups	16	8687.783	542.986	--	--
		total	17	8705.484	--	--	--
Young Males vs. Young Females	DMI (carious teeth + amtl)	between groups	1	75.235	75.235	.157	.697 (ns)
		within groups	16	7660.504	478.782	--	--
		total	17	7735.739	--	--	--

Sample	Analysis	Source of Variation	df	Sum of Squares	Mean Square	F	*P* (sig.)
Middle Males vs. Middle Females	OCR (carious teeth)	between groups	1	41.890	41.890	.044	.845 (ns)
		within groups	4	3828.362	957.091	--	--
		total	5	3870.252	--	--	--
Middle Males vs. Middle Females	DMI (carious teeth + amtl)	between groups	1	763.662	763.662	1.066	.360 (ns)
		within groups	4	2864.561	716.140	--	--
		total	5	3628.223	--	--	--
Older Males vs. Older Females	OCR (carious teeth)	between groups	1	75.307	75.307	.045	.837 (ns)
		within groups	9	15190.703	1687.856	--	--
		total	10	15266.010	--	--	--
Older Males vs. Older Females	DMI (carious teeth + amtl)	between groups	1	506.910	506.910	.457	.516 (ns)
		within groups	9	9975.671	1108.408	--	--
		total	10	10482.581	--	--	-

The two comparisons that have statistically significant differences when tested with the Chi-Square analysis were the Diseased Missing Index between the middle age groups and the Observed Caries Rate between the older groups. As **Table 5.17** illustrates, the more sensitive one-way ANOVA analysis indicates that these differences with these sample sizes are not truly significant.

The number of pulp exposures among the adult females from the Kleinburg Ossuary is high in contrast to the numbers experienced by the males. Among the females, pulp exposures were recorded fairly evenly across the three age groups, while the older group contained all but one of the pulp exposures witnessed among the males (**Table 5.14**). As is typical of agriculturalists, the majority of pulp exposures were caused by carious lesions. Although the mean number of carious pulp exposures among the adult females is higher than that among the adult males (0.81 versus 0.29), the difference is not statistically significant (**Table 5.18**). None of the comparisons for carious pulp exposures reaches statistical significance.

Table 5.18: Analyses of Carious Pulp Exposures: Kleinburg Ossuary Females versus Males

Sample	Sample Mean	Source of Variation	df	Sum of Squares	Mean Square	F	*P* (sig.)
All Adult Males vs. Adult Females	males 0.29	between groups	1	2.305	2.305	1.406	.244 (ns)
	females 0.81	within groups	33	54.095	1.639	--	--
		total	34	56.400	--	--	--
Young Males vs. Young Females	males 0.00	between groups	1	.534	.534	2.778	.115 (ns)
	females 0.38	within groups	16	3.077	.192	--	--
		total	17	3.611	--	--	--
Middle Males vs. Middle Females	males 0.00	between groups	1	1.200	1.200	.375	.573 (ns)
	females 1.20	within groups	4	12.800	3.200	--	--
		total	5	14.000	--	--	--
Older Males vs. Older Females	males 0.50	between groups	1	4.909	4.909	1.473	.256 (ns)
	females 2.00	within groups	9	30.000	3.333	--	--
		total	10	34.909	--	--	--

Pulp exposures caused by severe occlusal wear were relatively rare among the Kleinburg adult males and females. While there were no statistically significant differences in the comparisons among the sexes of the various age groups, the older group experienced the largest difference. The mean number of attritional pulp exposures for the 3 older females was 2.33, while that for the 8 older males was 0.25 (F=2.357, *P*=.159). This difference is largely due to the fact that one of these older females experienced 7 pulp exposures due to severe wear (as well as 6 carious pulp exposures). This individual's dental health may have been compromised by an occupational habit that produced severe localized wear to her incisors, canines and premolars over the course of her adult life.

The Corrected Caries Rate (CCR) incorporates all of the variables discussed above (observable carious teeth, antemortem losses and the proportion of pulp exposures caused by caries) into a 4-step calculation which is difficult to assess as a whole with standard statistical techniques. However, when its components are considered separately, certain trends in the data may become apparent. **Table 5.19** presents basic comparisons, such as numbers of *observed* sound versus carious teeth, as well as some of the calculated figures, such as the *estimated* number of teeth with caries (Step 2 in the CCR formula from Lukacs 1995:153). In the case of the Kleinburg adults, these comparisons confirm that both the observed and estimated numbers of carious versus sound teeth are statistically similar between the sexes. Chi-Square analysis using the raw data (as in **Table 5.19**) revealed a significant difference between the sexes with regard to carious versus attritional pulp exposures, while the one-way ANOVA (see **Table 5.18**) for this same group of individuals did not when comparing the numbers of carious pulp exposures per sex group.

Table 5.19: Kleinburg Ossuary Chi-Square Analyses, alpha level = 0.05, df=1

Samples	Variables	Chi-Square	Critical Value	Result
all females vs. all males	observed sound vs. carious teeth	1.445	3.841	ns
young females vs. young males	observed sound vs. carious teeth	0.00	3.841	ns
middle females vs. middle males	observed sound vs. carious teeth	0.988 Yates' correction	3.841	ns
older females vs. older males	observed sound vs. carious teeth	3.683	3.841	ns
all females vs. all males	carious pulp exposures vs. attritional pulp exposures	8.627 Yates' correction	3.841	significant difference
young females vs. young males	carious pulp exposures vs. attritional pulp exposures	2.222 Yates' correction	3.841	ns
middle females vs middle males	carious pulp exposures vs. attritional pulp exposures	cannot calculate[1]	3.841	n/a
older females vs. older males	carious pulp exposures vs. attritional pulp exposures	0.953 Yates' correction	3.841	ns
all females vs. all males	# estimated carious teeth vs. # estimated sound teeth	1.128	3.841	ns
young females vs. young males	# estimated carious teeth vs. # estimated sound teeth	0.007	3.841	ns
middle females vs. middle males	# estimated carious teeth vs. # estimated sound teeth	4.829 Yates' correction	3.841	ns[2]
older females vs. older males	# estimated carious teeth vs. # estimated sound teeth	0.293	3.841	ns

[1] The presence of too many zeroes creates an error in this calculation.
[2] This result is discounted since there is only one male involved in the calculation.

Dental Caries: Syers Ossuary

The overall Observed Caries Rate among the Syers individuals is 38.2 %, with a rate of 38.1 % for the maxillary teeth (the majority of those examined). The Observed Caries Rate ranges from 20.0 % (n=10 observed) for the anterior maxillary teeth to 40.0 % (n=95 observed) for the posterior maxillary teeth, and from 0.0 % (n=1 observed) for the anterior mandibular teeth to 50.0 % (n=4 observed) for the posterior mandibular teeth. Caries prevalence for the total Syers Ossuary sample of 23 individuals (13 males, 7 females and 3 of ambiguous sex) may be described using a variety of calculations, including:

Average number of caries per tooth = 0.53

Observed Caries Rate = 38.9 %

Diseased Missing Index = 54.8 %

Corrected Caries Rate = 47.3 %, and

Corrected Caries Rate with a Proportional Correction = 41.2 %.

Appendix E lists observations by tooth type, and **Appendix H** indicates the distribution of carious lesions on the various tooth surfaces throughout the dentitions.

Statistical Differences Between Syers Ossuary Males and Females

The results from comparisons of caries prevalence between the sexes have been subjected to statistical testing. This analytical procedure is necessary to account for differences when the sample sizes are small, as is the case in particular once the individuals from the Syers Ossuary are divided into their various age and sex groups.

Variables which are critical to the caries formulae, such as the numbers of sound and carious teeth, teeth lost antemortem, and pulp exposures caused by caries, have been tested by one-way ANOVA, and by non-parametric tests such as Mann-Whitney *U* and Chi-Square (X^2) analyses (as described in Madrigal 1998).

Calculations of caries prevalence and other related observations for the adult female and male Syers groups are presented in **Table 5.20**. The mean number of carious teeth per individual was essentially the same for the entire male group (n=13), with a sample mean of 1.85, as for the female group (n=7), with a sample mean of 1.71 (F=.025, *P*=.876, not significant). Subtle differences were detectable when these groups were divided into the three age categories. The 3 young males experienced a mean of 1.67 carious teeth per individual, while that for the 6 young females was 1.33 (F=.086, *P*=.777, not significant). Although the lone female in the middle age group scored higher than the 3 males (4.00 versus 2.67, respectively), this comparison did not represent a statistically significant separation (F=.143, *P*=.742). The seven older individuals from the Syers sample have all been assessed as male, and their mean number of carious teeth per individual equated to 1.57.

Table 5.21 presents dental observations divided into each of the three adult age categories; young (18-34 years), middle (35-49 years) and older (50+ years).

Table 5.20: Summary of Caries Prevalence - Syers Ossuary

		Females	Males
Number of individuals		7	13
Age category at death	- young	6	3
	- middle	1	3
	- older	0	7
Number of postmortem losses		71	121
Number of teeth *in situ*		36	58
Number of carious teeth *in situ*		12	24
Avg # carious teeth / individual		1.7	1.8
Number of antemortem losses		4	29
Number of pulp exposures		5	9
# Pulp exposures due to caries		5	5
Average # of caries per tooth		0.46	0.52
Estimated # of teeth with caries		16	40
Number of original teeth		41	87
Observed Caries Rate (%)		32.4	41.4
Diseased Missing Index (%)		39.0	60.5
Corrected Caries Rate[1] (%)			
	- anterior	0.0	23.1
	- posterior	42.1	55.4
	- overall	**39.0**	**46.0**
Proportional Correction (%)			
	- anterior[2]	0.0	8.7
	- posterior[3]	26.3	34.6
	- overall (anterior + posterior)	**26.3**	**43.3**

[1]Lukacs (1995)
[2]CCR x 3/8 (Erdal and Duyar 1999:239)
[3]CCR x 5/8 (Erdal and Duyar 1999:239)

Table 5.21: Summary of Caries Prevalence - Syers Ossuary Demographic Samples

	Young		Middle		Older	
	Female	Male	Female	Male	Female	Male
Number of individuals	6	3	1	3	0	7
Number of postmortem losses	63	31	8	24	0	66
Number of teeth *in situ*	33	14	4	12	0	32
Number of carious teeth *in situ*	8	5	4	8	0	11
Avg # carious teeth / individual	1.3	1.7	4.0	2.7	0.0	1.6
Number lost antemortem (amtl)	0	3	4	12	0	14
Number of pulp exposures	2	1	3	2	0	6
# Pulp exposures due to caries	2	1	3	1	0	3
Average # of caries per tooth	0.39	0.43	1.00	0.83	0.00	0.44
Estimated # of teeth with caries (carious teeth + amtl)	8	8	8	14	0	18
Number of original teeth (teeth *in situ* + amtl)	33	17	8	24	0	46
Observed Caries Rate (%)	24.2	35.7	100.0	66.7	0.0	34.4
Diseased Missing Index (%)	24.2	47.1	100.0	83.3	0.0	54.3
Corrected Caries Rate[1] (%)						
- anterior	0.0	0.0	0.0	0.0	0.0	22.2
- posterior	26.7	47.1	100.0	65.0	0.0	56.8
- overall	**24.2**	**47.1**	**100.0**	**58.3**	**0.0**	**39.1**
Proportional Correction (%)						
-anterior[2]	0.0	0.0	0.0	0.0	0.0	8.3
- posterior[3]	16.7	29.4	62.5	40.6	0.0	35.5
- overall (anterior + posterior)	**16.7**	**29.4**	**62.5**	**40.6**	**0.0**	**43.8**

[1]Lukacs (1995)
[2]CCR x 3/8 (Erdal and Duyar 1999:239)
[3]CCR x 5/8 (Erdal and Duyar 1999:239)

The Observed Caries Rates (OCR) are higher among the young males than their female counterparts, but are higher for the lone middle aged female than the middle males. However, when tested statistically, these differences are not significant. Among the middle age group, while the Chi-Square result does approach significance at the 95 % confidence interval, the fact that there is only one female involved in this comparison creates uncertainty regarding the true difference between these individuals. **Table 5.22** presents the results from the statistical analyses of the OCR among the young and middle age groups. The OCR for the older males is relatively low when compared to the middle males.

Table 5.22: Analyses of Observed Caries Rates: Syers Ossuary Females versus Males

	Chi-Square test (using raw data)		**Mann-Whitney *U* test**	
	Result	**Significance**	**Result**	**Significance**
Young Individuals (n=6 females, n=3 males)	0.588 (Yates' correction)	not significant (ns)	6.0	.435 (ns)
Middle Individuals (n=1 female, n=3 males)	2.667 (Yates' correction)	not significant	0.0	.180 (ns)

The scores for the Diseased Missing Index (DMI) are very similar to the OCR for the young individuals, primarily due to the fact that none of the females experienced any antemortem tooth loss. The males did, however, which serves to inflate their DMI in relation to their OCR. A similar situation occurred among the middle aged adults, although the lone female in this age group had lost teeth before death as well as the males. However, when tested statistically, these differences are not significant, although the Chi-Square results approach significance at the 95 % confidence interval. **Table 5.23** presents the results from the statistical analyses of the DMI among the young and middle age groups. As with the OCR, the middle males scored higher for the DMI than either the young males or the older males.

Table 5.23: Analyses of Diseased Missing Indices: Syers Ossuary Females versus Males

	Chi-Square test (using raw data)		**Mann-Whitney *U* test**	
Sample	**Result**	**Significance**	**Result**	**Significance**
Young Individuals (n=6 females, n=3 males)	2.457	not significant (ns)	6.0	.435 (ns)
Middle Individuals (n=1 female, n=3 males)	2.476 (Yates' correction)	not significant	0.50	.346 (ns)

Table 5.24 presents the results of the one-way ANOVA analyses for the comparisons of the Syers female and male Observed Caries Rates and Diseased Missing Indices. This sensitive method for analyzing the variation between groups reinforces the Chi-Square and Mann-Whitney *U* results discussed above and indicates that the differences between the sexes in these small samples are not large enough to be statistically significant.

Table 5.24: One-Way ANOVA Analyses of Observed Caries Rates and Diseased Missing Indices: Syers Ossuary Females and Males

Sample	Analysis	Source of Variation	df	Sum of Squares	Mean Square	F	*P* (sig.)
Young Males vs. Young Females	OCR (carious teeth)	between groups	1	1659.840	1659.840	1.670	.237 (ns)
		within groups	7	6958.207	994.030	--	--
		total	8	8618.047	--	--	--
Young Males vs. Young Females	DMI (carious teeth + amtl)	between groups	1	1659.840	1659.840	1.670	.237 (ns)
		within groups	7	6958.207	994.030	--	--
		total	8	8618.047	--	--	--
Middle Males vs. Middle Females	OCR (carious teeth)	between groups	1	2531.417	2531.417	1.376	362 (ns)
		within groups	2	3678.536	1839.268	--	--
		total	3	6209.953	--	--	--
Middle Males vs. Middle Females	DMI (carious teeth + amtl)	between groups	1	438.021	438.021	.437	.576 (ns)
		within groups	2	2004.167	1002.083	--	--
		total	3	2442.188	--	--	--

Differences between the numbers of pulp exposures per individual have also been tested statistically, although there were only 14 observed among this sample of males and females from the Syers Ossuary. However, the presence of these forms of dental disease are important to record, as they directly affect calculations of the Corrected Caries Rate. Regarding the numbers of carious pulp exposures per individual in the young group, two of the six females had experienced one while one of the three males had experienced one (thus, the sample mean for both the females and the males was 0.33), which was statistically equivalent (F=.000, *P*=1.000). No pulp exposures caused by severe occlusal wear were noted among the young group. Among the three middle aged males, one dentition contained one carious pulp exposure while another contained one caused by attrition; thus, the sample mean for these males for both causes of pulp exposure was 0.33. The lone female retained four teeth *in situ*, three of which contained carious pulp exposures. According to the one-way ANOVA, the difference between the number of carious pulp exposures in the middle group was significant (F=16.000, *P*=.057) due to the high number experienced by the female. One of the older males had two carious pulp exposures, while another had one carious and three attritional pulp exposures. The sample means for this group in both of these cases was therefore 0.43.

The Corrected Caries Rate (CCR) incorporates all of the variables discussed above (observable carious teeth, antemortem losses and the proportion of pulp exposures caused by caries) into a 4-step calculation which is difficult to assess as a whole with standard statistical techniques. However, when its components are considered separately, certain trends in the data may become apparent. **Table 5.25** presents basic comparisons, such as numbers of observed sound versus carious teeth, as well as some of the calculated figures, such as the estimated number of teeth with caries (Step 2 in the CCR formula from Lukacs 1995:153). In the case of this sample of Syers individuals, it would seem that the extremely poor dental health of the lone middle aged female has created significant differences in the comparisons of pulp exposures and estimated numbers of carious teeth (the sum of observed carious teeth plus antemortem losses), which in turn would directly affect the Corrected Caries Rate for that age group. Otherwise, it would seem that the differences among these small sample sizes are minimal.

Table 5.25: Syers Ossuary Chi-Square Analyses, alpha level = 0.05, df=1

Samples	Variables	Chi-Square	Critical Value	Result
all females vs. all males	observed sound vs. carious teeth	0.609	3.841	ns
young females vs. young males	observed sound vs. carious teeth	0.588 Yates' correction	3.841	ns
middle females vs middle males	observed sound vs. carious teeth	2.667 Yates' correction	3.841	ns
all females vs. all males	carious pulp exposures vs. attritional pulp exposures	3.759 Yates' correction	3.841	ns (.1>.05)
young females vs. young males	carious pulp exposures vs. attritional pulp exposures	n/a[1]	3.841	n.a
middle females vs. middle males	carious pulp exposures vs. attritional pulp exposures	2.802	3.841	ns (.1>.05)
all females vs. all males	# estimated sound teeth vs. # estimated carious teeth	.547	3.841	ns
young females vs. young males	# estimated sound teeth vs. # estimated carious teeth	2.684	3.841	ns
middle females vs. middle males	# estimated sound teeth vs. # estimated carious teeth	5.406	3.841	significant difference

[1] Zeroes in 2 of the 4 cells results in an error in this calculation.

Alveolar Abscessing

Alveolar abscessing was recorded and described in terms of its location in the dentitions. The potential drainage locations included buccal or lingual (which applied to both maxillary and mandibular cases), maxillary sinus/nasal cavity or mandibular canal. In addition to these four types, cases were noted where a pocket had formed around the roots of the tooth, but no drainage channel had yet been defined. Areas of notable porosity on the alveolar tissue were also recorded, but were not included in the totals for active abscesses, although they would either relate to some form of periodontal disease or they may indicate an area where an abscess or other form of infection was virtually healed. It is likely that some areas that had contained alveolar abscesses during life had resorbed along with the surrounding alveolus following an antemortem tooth loss. Active alveolar abscesses were observed within each of the three ossuary samples analyzed in this study.

Uxbridge Ossuary samples: In total, 52 alveolar abscesses were observed among 32 adult individuals in the following locations: 32 buccal, 5 lingual, 2 into the maxillary sinus and 13 with no visible drainage canal. The sample means of abscesses is 0.69 for the females and 0.70 for the males, which is virtually equivalent (one-way ANOVA results are $F=.001$, $P=.972$). The observations of alveolar abscessing from the Uxbridge samples are presented in detail in **Table 5.26**. No abscesses were found among the young female mandibular, the middle aged female mandibular or the middle aged male mandibular samples. Neither were there any alveolar abscesses observed among the juvenile individuals included in this analysis.

Table 5.26: Alveolar Abscesses: Uxbridge Ossuary Samples

Sample	Number of People	Location/Type of Abscess					
		Buccal	Lingual	Maxillary Sinus	Mandibular Canal	No Drainage Channel	Total
young female CR[1]	5	6	--	2	--	--	8
middle female CR	4	6	--	--	--	--	6
older female CR	1	--	--	--	--	4	4
female MN[2] of un-known age	3	2	--	--	--	2	4
young male CR	2	2	--	--	--	--	2
young male MN	3	3	--	--	--	--	3
middle male CR	2	3	--	--	--	2	5
older male CR	3	4	1	--	--	--	5
male MN of un-known age	4	5	1	--	--	2	8
un-known sex	5	1	3	--	--	3	7
Totals	**32**	**32**	**5**	**2**	**0**	**13**	**52**

[1] Cranial sample.
[2] Mandibular sample.

Kleinburg Ossuary: In total, 30 alveolar abscesses were observed among 17 adult individuals in the following locations: 22 buccal, 1 lingual, 5 into the maxillary sinus, 1 into the mandibular canal and 1 with no visible drainage channel. The sample means of abscesses is 0.76 for the females and 0.43 for the males, which is not a statistically significant separation (one-way ANOVA results are F=.874, P=.357). The observations of alveolar abscessing from the Kleinburg sample are presented in detail in **Table 5.27**. No abscesses were found among the middle aged male group.

Table 5.27: Alveolar Abscesses: Kleinburg Ossuary

Sample	Number of People	Location/Type of Abscess					
		Buccal	Lingual	Maxillary Sinus	Mandibular Canal	No Drainage Channel	Total
young females	4	3	--	1	1	1	6
middle females	2	4	--	3	--	--	7
older females	3	3	--	--	--	--	3
young males	2	2	1	1	--	--	4
older males	2	2	--	--	--	--	2
un-known sex	4	8	--	--	--	--	8
Totals	**17**	**22**	**1**	**5**	**1**	**1**	**30**

Syers Ossuary: In total, 8 alveolar abscesses were observed among 5 adult individuals in the following locations: 6 buccal, 1 lingual and 1 with no visible drainage channel. The sample means of abscesses is 0.29 for the females and 0.38 for the males, which is not a statistically significant difference (one-way ANOVA results are F=.076, *P*=.786). The observations of alveolar abscessing from the Syers sample are presented in detail in **Table 5.28**. No abscesses were found among the young females or the middle aged males.

Table 5.28: Alveolar Abscesses: Syers Ossuary

Sample	Number of People	Location/Type of Abscess					
		Buccal	Lingual	Maxillary Sinus	Mandibular Canal	No Drainage Channel	Total
middle females	1	2	--	--	--	--	2
young males	1	--	1	--	--	1	2
older males	2	3	--	--	--	--	3
un-known sex	1	1	--	--	--	--	1
Totals	**5**	**6**	**1**	**0**	**0**	**1**	**8**

Occlusal Surface Wear

Occlusal surface wear was scored for all teeth *in situ*, with the exception of those with large carious lesions or broken enamel that obliterated part of the cusp, or in cases where the tooth did not meet the occlusal plane. The amount of wear on each tooth was scored according to the Smith (1984) system for incisors, canines and premolars, while the amount of cuspal wear was scored according to the Scott (1979) system for the molars. Subsequent to applying these scoring procedures, teeth were determined to have experienced mild, moderate, heavy or severe wear, depending upon the amount of dentine that had become exposed. Tooth wear is reported here by tooth type for each of the demographic groups in each ossuary sample as well as the average wear per tooth type for all of the adult individuals regardless of sex. Ante- and postmortem loss hinders analyses of wear, particularly for anterior teeth.

Uxbridge Ossuary - Cranial Sample Maxillary Teeth: Overall, the average wear on the maxillary molars and second premolars falls into the mild category. The averages for the first premolars, canines and incisors range from mild to moderate, with the exception of tooth 8 (the left central incisor) which falls into the heavy category on average. Two central incisors experienced wear severe enough to expose the pulp chamber (one among the middle aged males and the other belonging to the older female). **Table 5.29** presents the results of this analysis.

Table 5.29: Occlusal Surface Wear: Uxbridge Ossuary Adult Maxillary Teeth

Tooth	Obs	Males Young n=8	Males Middle n=6	Males Older n=6	Females Young n=15	Females Middle n=9	Females Older n=1	Total[1] Crania n=50
1 (rt M^3)	avg	4.0 mi[2]	6.0 mi	--	4.0 mi	--	--	4.7 mi
	min	4	6	--	4	--	--	4
	max	4	6	--	4	--	--	6
	# in situ[3]	1	1	0	1	0	0	3
2 (rt M^2)	avg	11.0 mi	12.0 mi	--	9.7 mi	23.0 mo[4]	--	11.1 mi
	min	8	12	--	8	23	--	4
	max	13	12	--	12	23	--	23
	# in situ	5	1	0	3	1	0	12

Tooth	Obs	Males			Females			Total[1] Crania
		Young n=8	Middle n=6	Older n=6	Young n=15	Middle n=9	Older n=1	n=50
3 (rt M^1)	avg	13.2 mi	17.5 mi	15.0 mi	12.4 mi	13.7 mi	--	13.2 mi
	min	11	11	15	10	10	--	5
	max	15	24	15	16	16	--	24
	# *in situ*	5	2	1	5	3	0	19
4 (rt P^4)	avg	1.8 mi	2.0 mi	2.0 mi	3.0 mo	3.8 mo	--	2.7 mi
	min	1	2	2	3	3	--	1
	max	3	2	2	3	5	--	5
	# *in situ*	5	1	1	4	4	0	15
5 (rt P^3)	avg	2.7 mi	1.0 mi	2.0 mi	2.7 mi	4.4 mo	--	3.0 mo
	min	1	1	2	2	3	--	1
	max	4	1	2	4	6	--	6
	# *in situ*	6	1	1	6	5	0	21
6 (rt C)	avg	4.3 mo	2.0 mi	--	3.3 mo	4.5 mo	--	3.6 mo
	min	4	2	--	1	4	--	1
	max	5	2	--	5	5	--	5
	# *in situ*	4	1	0	7	2	0	16
7 (rt I^2)	avg	1.0 mi	--	--	2.0 mi	3.0 mo	--	2.0 mi
	min	1	--	--	1	3	--	1
	max	1	--	--	3	3	--	3
	# *in situ*	1	0	0	2	1	0	6
8 (rt I^1)	avg	--	7 se[6]	--	4.0 mo	4.0 mo	8.0 se	5.8 hv[5]
	min	--	7	--	4	4	8	4
	max	--	7	--	4	4	8	8
	# *in situ*	0	1	0	1	1	1	4

Tooth	Obs	Males			Females			Total[1] Crania n=50
		Young n=8	Middle n=6	Older n=6	Young n=15	Middle n=9	Older n=1	
9 (lt I[1])	avg	--	4.0 mo	--	6.0 hv	--	--	4.7 mo
	min	--	4	--	6	--	--	4
	max	--	4	--	6	--	--	6
	# *in situ*	0	2	0	1	0	0	3
10 (lt I[2])	avg	1.0 mi	4.0 mo	2.0 mi	3.5 mo	--	--	2.8 mi
	min	1	4	2	3	--	--	1
	max	1	4	2	4	--	--	4
	# *in situ*	1	1	1	2	0	0	6
11 (lt C)	avg	3.3 mo	4.0 mo	--	3.8 mo	5.0 hv	--	3.9 mo
	min	3	4	--	3	4	--	3
	max	4	4	--	4	6	--	6
	# *in situ*	3	2	0	4	3	0	13
12 (lt P[3])	avg	2.5 mi	3.0 mo	--	4.0 mo	3.8 mo	--	3.5 mo
	min	2	2	--	2	3	--	2
	max	3	4	--	7	5	--	7
	# *in situ*	2	2	0	5	4	0	13
13 (lt P[4])	avg	2.3 mi	2.0 mi	3.5 mo	3.2 mo	2.7 mi	2.0 mi	2.8 mi
	min	2	2	2	2	2	2	2
	max	3	2	5	4	3	2	5
	# *in situ*	3	1	2	5	3	1	15
14 (lt M[1])	avg	14.0 mi	14.0 mi	23.0 mo	13.4 mi	13.0 mi	17.0mi	14.3 mi
	min	11	14	14	9	11	17	4
	max	17	14	32	18	15	17	32
	# *in situ*	4	1	2	7	2	1	20

Tooth	Obs	Males Young n=8	Males Middle n=6	Males Older n=6	Females Young n=15	Females Middle n=9	Females Older n=1	Total[1] Crania n=50
15 (lt M²)	avg	10.7 mi	14.0 mi	11.0 mi	10.6 mi	21.3 mo	27.0mo	12.9 mi
	min	10	11	11	5	16	27	4
	max	11	17	11	15	32	27	32
	# *in situ*	3	2	1	9	3	1	21
16 (lt M³)	avg	7.0 mi	17.0 mi	--	7.7 mi	--	--	10.6 mi
	min	6	6	--	4	--	--	4
	max	9	33	--	14	--	--	33
	# *in situ*	3	3	0	3	0	0	9
Total number of teeth		46	22	9	65	32	4	196

[1] Total of all males, females and individuals of ambiguous sex in the adult cranial sample.
[2] Includes only code 2 (present with crown intact) teeth, not code 7 (present but crown is broken), and is therefore a subset of the total number of observable teeth.
[3] mild wear (mi) = score range for molars is 4.0-19.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 1.0-2.9
[4] moderate wear (mo) = score range for molars is 20.0-27.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 3.0-4.9
[5] heavy wear (hv) = score range for molars is 28.0-35.9 (total for all cusps)
= incisor, canine and premolar score range is 5.0-6.9
[6] severe wear (se) = score range for molars is 36.0-40.0 (total for all cusps)
= incisor, canine and premolar score range is 7.0-8.0

Uxbridge Ossuary - Cranial Sample Mandibular Teeth: Only 8 crania in this sample were associated with mandibles, which resulted in a total of 14 mandibular teeth that were present and intact for the purposes of occlusal surface wear analysis. The demographic profile of these 8 individuals is as follows: one young male, 4 middle aged males (2 had no teeth *in situ*), one older male (no teeth *in situ*), one middle aged female (no teeth *in situ*) and one young person of ambiguous sex. The wear patterns observed for the individual of ambiguous sex will not be discussed in this report, as this wear data is meant to be viewed in light of the influences of attrition on dental caries among this ossuary population, and specifically the differences in dental caries experienced by adult males and females.

The mandible belonging to the cranium which was identified as a young male contained only one intact tooth. This single tooth was a moderately worn right first molar (tooth 30), with a total wear score of 21 (out of a possible score of 40). One of the 4 middle aged males only had his mandible remaining in association with his cranium, the maxilla having been broken postmortem and mixed with the remainder of the ossuary remains. This male, as well as one other, had no teeth *in situ* due to a combination of antemortem losses and postmortem alveolus and tooth loss. The two remaining middle aged males contained a total of 9 intact mandibular teeth, which were scored as follows: the left first molar was moderately worn; the left second molar, the left second premolar and the left first premolar were heavily worn; and, the left canine, the right canine and the right second premolar were severely worn. As the severe ratings indicate, both of these males had experienced pulp exposures due to tooth wear, one of which being the same male whose attritional pulp exposure was noted among the cranial maxillary results. The details of the wear from these teeth are included in **Table 5.30** along with the results from the mandibular sample.

Uxbridge Ossuary - Mandibular Sample: In total, 136 intact teeth were available for wear analysis among the mandibles that are not associated with crania. This figure includes those individuals of ambiguous sex as well as the females and the males. The average wear on the majority of these mandibular teeth fall within the mild and moderate ranges. The molars and premolars tend to be mildly to moderately worn, when present, while the canines and incisors are moderately worn on average. The details of these results, as well as the exceptions to the average experiences, are presented in **Table 5.30**. Note that the individuals placed into the undetermined age categories were missing all molars. It is the molar wear that provides the most reliable macroscopic evidence for age-at-death estimations on mandibles.

Table 5.30: Occlusal Surface Wear: Uxbridge Ossuary Adult Mandibular Teeth

Tooth	Obs	'Loose' Mandibular Sample						Mandibular Teeth with the Crania n=7
		Males			Females			
		Young n=7	Middle n=1	Undet.[1] n=10	Young n=3	Middle n=1	Undet. n=9	
17 (lt M_3)	avg	11.5mi[2]	--	--	6.0 mi	--	--	--
	min	6	--	--	6	--	--	--
	max	17	--	--	6	--	--	--
	# in situ[3]	2	0	0	1	0	0	0
18 (lt M_2)	avg	11.5 mi	--	--	10.0mi	--	--	29.0 hv[5]
	min	10	--	--	9	--	--	29
	max	13	--	--	11	--	--	29
	# in situ	2	0	0	2	0	0	1
19 (lt M_1)	avg	13.8 mi	--	--	13.0 mi	--	--	21.7mo[4]
	min	11	--	--	11	--	--	10
	max	16	--	--	15	--	--	29
	# in situ	4	0	0	2	0	0	3
20 (lt P_4)	avg	2.3 mi	--	--	1.7 mi	--	--	4.0 mo
	min	2	--	--	1	--	--	2
	max	3	--	--	2	--	--	6
	# in situ	4	0	0	3	0	0	2

Tooth	Obs	'Loose' Mandibular Sample						Mandibular Teeth with the Crania n=7
		Males			Females			
		Young n=7	Middle n=1	Undet.[1] n=10	Young n=3	Middle n=1	Undet. n=9	
21 (lt P_3)	avg	2.3 mi	--	6.0 hv	1.7 mi	--	2.0 mi	6.0 hv
	min	2	--	6	1	--	2	6
	max	3	--	6	2	--	2	6
	# *in situ*	3	0	1	3	0	1	1
22 (lt C)	avg	4.0 mo	6.0 hv	6.7 hv	2.0 mi	--	4.0 mo	7.0 se[2]
	min	4	6	5	1	--	3	6
	max	4	6	8	3	--	5	8
	# *in situ*	1	1	3	2	0	2	2
23 (lt I_2)	avg	3.3 mo	--	8.0 se	3.0 mo	--	3.5 mo	--
	min	2	--	8	3	--	3	--
	max	4	--	8	3	--	4	--
	# *in situ*	4	0	1	1	0	2	0
24 (lt I_1)	avg	4.0 mo	--	5.0 hv	2.0 mi	--	4.3 mo	--
	min	4	--	5	2	--	4	--
	max	4	--	5	2	--	5	--
	# *in situ*	1	0	1	1	0	3	0
25 (rt I_1)	avg	4.0 mo	--	5.0 hv	2.5 mi	--	4.0 mo	--
	min	4	--	5	2	--	4	--
	max	4	--	5	3	--	4	--
	# *in situ*	1	0	1	2	0	1	0

Tooth	Obs	'Loose' Mandibular Sample						Mand-ibular Teeth with the Crania
		Males			Females			
		Young n=7	Middle n=1	Undet.[1] n=10	Young n=3	Middle n=1	Undet. n=9	n=7
26 (rt I_2)	avg	4.0 mo	--	8.0 se	2.5 mi	--	2.5 mi	--
	min	4	--	8	2	--	2	--
	max	4	--	8	3	--	3	--
	# *in situ*	1	0	1	2	0	2	0
27 (rt C)	avg	4.0 mo	--	6.5 hv	1.7 mi	--	3.0 mo	7.0 se
	min	4	--	6	1	--	3	7
	max	4	--	7	3	--	3	7
	# *in situ*	2	0	2	3	0	2	1
28 (rt P_3)	avg	2.0 mi	7.0 se	5.0 hv	1.0 mi	--	2.0 mi	--
	min	1	7	2	1	--	2	--
	max	3	7	7	1	--	2	--
	# *in situ*	4	1	3	1	0	1	0
29 (rt P_4)	avg	2.3 mi	6.0 hv	5.0 hv	2.0 mi	--	3.0 mo	7.0 se
	min	2	6	5	2	--	3	7
	max	3	6	5	2	--	3	7
	# *in situ*	4	1	1	1	0	1	1
30 (rt M_1)	avg	14.8 mi	27.0mo	--	--	--	--	16.5 mi
	min	10	27	--	--	--	--	12
	max	22	27	--	--	--	--	21
	# *in situ*	4	1	0	0	0	0	2

		'Loose' Mandibular Sample						Mand-ibular Teeth with the Crania
		Males			Females			
Tooth	Obs	Young n=7	Middle n=1	Undet.[1] n=10	Young n=3	Middle n=1	Undet. n=9	n=7
31 (rt M_2)	avg	14.8 mi	34.0 hv	--	11.0 mi	26.0 mo	--	10.0 mi
	min	11	34	--	11	26	--	10
	max	20	34	--	11	26	--	10
	# in situ	5	1	0	1	1	0	1
32 (rt M_3)	avg	12.5 mi	--	--	5.0 mi	--	--	--
	min	6	--	--	5	--	--	--
	max	19	--	--	5	--	--	--
	# in situ	2	0	0	1	0	0	0
Total number of teeth		44	5	14	26	1	16	14

[1] 'Undet.' refers to an adult individual with an undetermined age at death.
[2] Includes only code 2 (present with crown intact) teeth, not code 7 (present but crown is broken), and is therefore a subset of the total number of observable teeth.
[3] mild wear (mi) = score range for molars is 4.0-19.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 1.0-2.9
[4] moderate wear (mo) = score range for molars is 20.0-27.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 3.0-4.9
[5] heavy wear (hv) = score range for molars is 28.0-35.9 (total for all cusps)
= incisor, canine and premolar score range is 5.0-6.9
[6] severe wear (se) = score range for molars is 36.0-40.0 (total for all cusps)
= incisor, canine and premolar score range is 7.0-8.0

Kleinburg Ossuary - Maxillary and Mandibular Wear: As with the Uxbridge Ossuary maxillary molars, those among the entire Kleinburg sample were found to have mild occlusal surface wear on average. These numbers are presented in the column labelled 'Total' in **Table 5.31**, and presents the ranges and averages for wear among the males, the females and the 3 individuals of undetermined sex. There were some exceptions to this average wear pattern, as seen among the young males' right first molar and the older males' first molars, which scored moderate wear on average. Among the anterior maxillary teeth, being the premolars, canines and incisors for this scoring system, average tooth wear tended to increase in severity with age, as would be expected. The young males and females primarily had mildly worn teeth, with some showing moderate and a few with heavy wear. The few older individuals present in this sample, however, had moderately, heavily and severely worn anterior maxillary teeth. Although few mandibles were found to be associated with specific crania from the Kleinburg Ossuary, those that were available were also examined for occlusal surface wear. The relatively few intact teeth in this sample did demonstrate that wear was increasing through time in the individuals' lives, but was slow enough that abrasion was not likely hindering the formation of caries among these teeth.

Table 5.31 presents the details regarding these generalizations for occlusal surface wear on the maxillary and mandibular teeth, as well as the numbers of intact teeth that were found *in situ* for each demographic group. The problems of small sample sizes and high postmortem loss of the anterior tooth classes prevents statistical comparisons between the demographic groups.

Table 5.31: Occlusal Surface Wear: Kleinburg Ossuary

		Males			**Females**			
Tooth	**Obs**	**Young n=5**	**Middle n=1**	**Older n=8**	**Young n=13**	**Middle n=5**	**Older n=3**	**Total[1] n=44**
1 (rt M^3)	avg	13.0mi[3]	--	13.0 mi	8.0 mi	15.0 mi	11.0mi	10 2mi
	min	13	--	13	4	15	11	4
	max	13	--	13	14	15	11	15
	# *in situ*[2]	1	0	1	5	1	1	10
2 (rt M^2)	avg	12.8 mi	13.0mi	12.7 mi	11.2mi	16.0 mi	15.0mi	11 9 mi
	min	10	13	11	9	16	15	6
	max	15	13	14	18	16	15	18
	# *in situ*	4	1	3	9	1	1	23
3 (rt M^1)	avg	23.6mo[4]	19.0 mi	21.0mo	14.5mi	17.0 mi	15.0mi	17.6 mi
	min	16	19	18	11	16	15	10
	max	40	19	25	19	18	15	40
	# *in situ*	5	1	4	10	2	1	30
4 (rt P^4)	avg	2.8 mi	2.0 mi	4.0 mo	2.0 mi	3.0 mo	6.5 hv[5]	3.2 mo
	min	2	2	3	1	3	5	1
	max	4	2	5	3	3	8	8
	# *in situ*	4	1	3	4	1	2	17
5 (rt P^3)	avg	3.5 mo	2.0 mi	5.0 hv	2.5 mi	4.0 mo	--	3.4 mo
	min	3	2	4	2	3	--	2
	max	4	2	6	3	5	--	6
	# *in situ*	2	1	2	4	2	0	11
6 (rt C)	avg	3.7 mo	4.0 mo	5.0 hv	3.3 mo	4.5 mo	8.0 se[6]	4.3 mo
	min	2	4	5	2	4	8	2
	max	5	4	5	5	5	8	8
	# *in situ*	3	1	2	4	2	1	15
7 (rt I^2)	avg	5 0 hv	3.0 mo	--	2.0 mi	--	--	3.0 mo
	min	5	3	--	1	--	--	1
	max	5	3	--	3	--	--	5
	# *in situ*	1	1	0	3	0	0	7

Tooth	Obs	Males Young n=5	Males Middle n=1	Males Older n=8	Females Young n=13	Females Middle n=5	Females Older n=3	Total[1] n=44
8 (rt I^1)	avg	--	--	--	3.5 mo	--	8.0 se	5.0 hv
	min	--	--	--	2	--	8	2
	max	--	--	--	5	--	8	8
	# in situ	0	0	0	2	0	1	3
9 (lt I^1)	avg	--	--	--	2.0 mi	--	--	2.0 mi
	min	--	--	--	2	--	--	2
	max	--	--	--	2	--	--	2
	# in situ	0	0	0	1	0	0	1
10 (lt I^2)	avg	--	--	--	2.0 mi	--	--	2.7 mi
	min	--	--	--	1	--	--	1
	max	--	--	--	3	--	--	4
	# in situ	0	0	0	2	0	0	3
11 (lt C)	avg	4.5 mo	4.0 mo	5.0 hv	5.0 hv	4.0 mo	--	4.6 mo
	min	4	4	5	5	4	--	4
	max	5	4	5	5	4	--	5
	# in situ	2	1	1	1	1	0	8
12 (lt P^3)	avg	2.3 mi	1.0 mi	4.0 mo	2.7 mi	3.0 mo	--	2.7 mi
	min	2	1	3	2	2	--	1
	max	3	1	5	5	4	--	5
	# in situ	4	1	2	6	2	0	18
13 (lt P^4)	avg	2.0 mi	2.0 mi	3.7 mo	2.3 mi	2.5 mi	7.0 se	2.8 mi
	min	2	2	3	2	2	7	2
	max	2	2	5	3	3	7	7
	# in situ	4	1	3	7	2	1	19
14 (lt M^1)	avg	18.0 mi	18.0 mi	22.0mo	13.3mi	19.0 mi	16.5 mi	16.3 mi
	min	13	18	20	8	19	15	8
	max	21	18	23	18	19	18	23
	# in situ	5	1	3	10	2	2	28

Tooth	Obs	Males			Females			Total[1]
		Young n=5	Middle n=1	Older n=8	Young n=13	Middle n=5	Older n=3	n=44
15 (lt M^2)	avg	11.5 mi	--	14.5 mi	10.7mi	11.0 mi	--	11.4 mi
	min	10	--	13	7	8	--	6
	max	13	--	16	13	14	--	16
	# *in situ*	4	0	2	7	2	0	20
16 (lt M^3)	avg	12.0 mi	--	13.0 mi	10.0mi	7.5 mi	--	10.4 mi
	min	12	--	11	8	5	--	5
	max	12	--	15	12	10	--	15
	# *in situ*	1	0	2	2	2	0	7
Total number of maxillary teeth		**40**	**10**	**30**	**77**	**20**	**10**	**220**
17 (lt M_3)	avg	--	--	--	13.0mi	--	--	13.0 mi
	min	--	--	--	13	--	--	13
	max	--	--	--	13	--	--	13
	# *in situ*	0	0	0	1	0	0	1
18 (lt M_2)	avg	--	--	--	10.0mi	--	--	10.0 mi
	min	--	--	--	10	--	--	10
	max	--	--	--	10	--	--	10
	# *in situ*	0	0	0	1	0	0	1
19 (lt M_1)	avg	--	--	--	--	--	--	--
	min	--	--	--	--	--	--	--
	max	--	--	--	--	--	--	--
	# *in situ*	0	0	0	0	0	0	0
20 (lt P_4)	avg	--	--	--	--	--	7.0 se	7.0 se
	min	--	--	--	--	--	7	7
	max	--	--	--	--	--	7	7
	# *in situ*	0	0	0	0	0	1	1
21 (lt P_3)	avg	--	--	--	2.5 mi	--	6.0 hv	3.7 mo
	min	--	--	--	2	--	6	2
	max	--	--	--	3	--	6	6
	# *in situ*	0	0	0	2	0	1	3

Tooth	Obs	Males: Young n=5	Males: Middle n=1	Males: Older n=8	Females: Young n=13	Females: Middle n=5	Females: Older n=3	Total[1] n=44
22 (lt C)	avg	--	--	--	3.0 mo	--	6.0 hv	4.5 mo
	min	--	--	--	3	--	6	3
	max	--	--	--	3	--	6	6
	# *in situ*	0	0	0	1	0	1	2
23 (lt I_2)	avg	--	--	--	5.0 hv	6.0 hv	8.0 se	6.3 hv
	min	--	--	--	5	6	8	5
	max	--	--	--	5	6	8	8
	# *in situ*	0	0	0	1	1	1	3
24 (lt I_1)	avg	--	--	--	5.0 hv	6.0 hv	8.0 se	6.3 hv
	min	--	--	--	5	6	8	5
	max	--	--	--	5	6	8	8
	# *in situ*	0	0	0	1	1	1	3
25 (rt I_1)	avg	--	--	--	5.0 hv	7.0 se	--	6.0 hv
	min	--	--	--	5	7	--	5
	max	--	--	--	5	7	--	7
	# *in situ*	0	0	0	1	1	0	2
26 (rt I_2)	avg	--	--	--	2.0 mi	--	--	2.0 mi
	min	--	--	--	2	--	--	2
	max	--	--	--	2	--	--	2
	# *in situ*	0	0	0	1	0	0	1
27 (rt C)	avg	--	--	--	5.0 hv	--	5.0 hv	5.0 hv
	min	--	--	--	5	--	5	5
	max	--	--	--	5	--	5	5
	# *in situ*	0	0	0	1	0	1	2
28 (rt P)	avg	--	--	--	3.0 mo	--	6.0 hv	4.0 mo
	min	--	--	--	2	--	6	2
	max	--	--	--	4	--	6	6
	# *in situ*	0	0	0	2	0	1	3

Tooth	Obs	Males Young n=5	Males Middle n=1	Males Older n=8	Females Young n=13	Females Middle n=5	Females Older n=3	Total[1] n=44
29 (rt P_1)	avg	--	--	--	2.0 mi	--	6.0 hv	4.0 mo
	min	--	--	--	2	--	6	2
	max	--	--	--	2	--	6	6
	# *in situ*	0	0	0	1	0	1	2
30 (rt M_1)	avg	--	--	23.0	14.0mi	--	25.0mo	20.7mo
	min	--	--	23	14	--	25	14
	max	--	--	23	14	--	25	25
	# *in situ*	0	0	1	1	0	1	3
31 (rt M_2)	avg	--	--	--	12.0mi	--	--	12.0 mi
	min	--	--	--	12	--	--	12
	max	--	--	--	12	--	--	12
	# *in situ*	0	0	0	1	0	0	1
32 (rt M_3)	avg	--	--	--	--	--	--	--
	min	--	--	--	--	--	--	--
	max	--	--	--	--	--	--	--
	# *in situ*	0	0	0	0	0	0	0
Total number of mandibular teeth		**0**	**0**	**1**	**15**	**3**	**9**	**28**

[1] Total of all males, females and individuals of ambiguous sex in the adult cranial sample.
[2] Includes only code 2 (present with crown intact) teeth, not code 7 (present but crown is broken), and is therefore a subset of the total number of observable teeth.
[3] mild wear (mi) = score range for molars is 4.0-19.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 1.0-2.9
[4] moderate wear (mo) = score range for molars is 20.0-27.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 3.0-4.9
[5] heavy wear (hv) = score range for molars is 28.0-35.9 (total for all cusps)
= incisor, canine and premolar score range is 5.0-6.9
[6] severe wear (se) = score range for molars is 36.0-40.0 (total for all cusps)
= incisor, canine and premolar score range is 7.0-8.0

Syers Ossuary - Maxillary and Mandibular Wear: The general occlusal surface wear observed for the Uxbridge and Kleinburg teeth is consistent among the individuals in the Syers sample. On average, molar wear is mild, while the wear on the intact premolars, canines and incisors is mild or moderate. The exception to this is seen on the single left central incisor present in the sample. This belongs to an older male and is severely worn, possibly due to the habitual placement of a pipe stem at this particular point in the mouth. The Syers sample, involving the fewest number of individuals of the three ossuaries, contains the fewest number of intact teeth available for wear analysis. Enough teeth are present to suggest that occlusal surface wear was experienced in a similar fashion as among the individuals from the Uxbridge and Kleinburg samples, and that attrition likely was not rapid enough to disturb the natural formation of caries. **Table 5.32** presents the averages and the ranges of wear per tooth class among the various demographic groups present from the Syers Ossuary.

Table 5.32: Occlusal Surface Wear: Syers Ossuary

		Males			Females		
Tooth	**Obs**	**Young n=3**	**Middle n=3**	**Older n=7**	**Young n=6**	**Middle n=1**	**Total[1] n=23**
1 (rt M^3)	avg	--	--	6.0 mi[3]	8.5 mi	--	9.0 mi
	min	--	--	6	6	--	6
	max	--	--	6	11	--	13
	# in situ[2]	0	0	1	2	0	5
2 (rt M^2)	avg	12.0 mi	20.0mo[4]	12.7 mi	11.3 mi	9.0 mi	12.8 mi
	min	11	20	9	6	9	6
	max	13	20	17	14	9	20
	# in situ	2	1	3	4	1	13

Tooth	Obs	Males			Females		Total[1]
		Young n=3	Middle n=3	Older n=7	Young n=6	Middle n=1	n=23
3 (rt M^1)	avg	12.5 mi	28.0hv[5]	16.0 mi	13.3 mi	--	15.9 mi
	min	10	28	8	10	--	8
	max	15	28	22	17	--	28
	# *in situ*	2	1	4	3	0	11
4 (rt P^4)	avg	3.0 mo	4.0 mo	2.0 mi	--	--	3.0 mo
	min	3	4	2	--	--	2
	max	3	4	2	--	--	4
	# *in situ*	1	1	1	0	0	3
5 (rt P^3)	avg	2.0 mi	4.0 mo	4.3 mo	4.0 mo	--	3.9 mo
	min	2	4	3	4	--	2
	max	2	4	5	4	--	5
	# *in situ*	1	1	4	1	0	7
6 (rt C)	avg	--	--	5.5 hv	2.0 mi	--	4.3 mo
	min	--	--	5	2	--	2
	max	--	--	6	2	--	6
	# *in situ*	0	0	2	1	0	3
7 (rt I^2)	avg	--	--	--	--	--	--
	min	--	--	--	--	--	--
	max	--	--	--	--	--	--
	# *in situ*	0	0	0	0	0	0
8 (rt I^1)	avg	--	--	--	--	--	--
	min	--	--	--	--	--	--
	max	--	--	--	--	--	--
	# *in situ*	0	0	0	0	0	0
9 (lt I^1)	avg	--	--	7.0 se[6]	--	--	7.0 se
	min	--	--	7	--	--	7
	max	--	--	7	--	--	7
	# *in situ*	0	0	1	0	0	1

Tooth	Obs	Males Young n=3	Males Middle n=3	Males Older n=7	Females Young n=6	Females Middle n=1	Total[1] n=23
10 (lt I^2)	avg	--	--	--	--	--	--
	min	--	--	--	--	--	--
	max	--	--	--	--	--	--
	# *in situ*	0	0	0	0	0	0
11 (lt C)	avg	--	5.0 hv	5.5 hv	2.0 mi	--	4.6 mo
	min	--	5	5	2	--	2
	max	--	5	6	2	--	6
	# *in situ*	0	1	2	1	0	5
12 (lt P^3)	avg	5.0 hv	4.5 mo	4.3 mo	1.0 mi	--	4.1 mo
	min	5	4	3	1	--	1
	max	5	5	5	1	--	5
	# *in situ*	1	2	3	1	0	9
13 (lt P^4)	avg	5.0 hv	5.0 hv	3.3 mo	2.0 mi	--	2.9 mi
	min	5	5	3	1	--	1
	max	5	5	4	3	--	5
	# *in situ*	1	1	3	4	0	11
14 (lt M^1)	avg	17.5 mi	26.0mo	15.8 mi	10.5 mi	--	14.8 mi
	min	17	26	8	6	--	6
	max	18	26	20	13	--	26
	# *in situ*	2	1	4	4	0	14
15 (lt M^2)	avg	13.0 mi	--	10.0 mi	8.4 mi	--	9.8 mi
	min	12	--	10	4	--	4
	max	14	--	10	13	--	14
	# *in situ*	2	0	1	5	0	8
16 (lt M^3)	avg	5.0 mi	18.0 mi	--	23.0 mo	--	15.3 mi
	min	5	18	--	23	--	5
	max	5	18	--	23	--	23
	# *in situ*	1	1	0	1	0	3

Tooth	Obs	Males Young n=3	Males Middle n=3	Males Older n=7	Females Young n=6	Females Middle n=1	Total[1] n=23
Total number of maxillary teeth		**13**	**10**	**29**	**27**	**1**	**93**
20 (lt P_4)	avg	--	--	--	2.0 mi	--	2.0 mi
	min	--	--	--	2	--	2
	max	--	--	--	2	--	2
	# in situ	0	0	0	1	0	1
27 (rt C)	avg	--	--	--	3.0 mo	--	3.0 mo
	min	--	--	--	3	--	3
	max	--	--	--	3	--	3
	# in situ	0	0	0	1	0	1
Total number of mandibular teeth		**0**	**0**	**0**	**2**	**0**	**2**

[1] Total of all males, females and individuals of ambiguous sex in the adult cranial sample.
[2] Includes only code 2 (present with crown intact) teeth, not code 7 (present but crown is broken), and is therefore a subset of the total number of observable teeth.
[3] mild wear (mi) = score range for molars is 4.0-19.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 1.0-2.9
[4] moderate wear (mo) = score range for molars is 20.0-27.9 (total for all 4 cusps)
= incisor, canine and premolar score range is 3.0-4.9
[5] heavy wear (hv) = score range for molars is 28.0-35.9 (total for all cusps)
= incisor, canine and premolar score range is 5.0-6.9
[6] severe wear (se) = score range for molars is 36.0-40.0 (total for all cusps)
= incisor, canine and premolar score range is 7.0-8.0

Testing for Error

Intraobserver error testing was conducted for all observations for 20 of the 103 Uxbridge individuals (19.4 %): 10 of the 60 crania (16.7 %) and 10 of the 43 mandibles (23.3 %). The relatively small sizes of the other two ossuary groups required that higher percentages of randomly sampled individuals be re-examined.

This roughly numbered to half of the Syers individuals (12 of 23 = 52.2 %) and one-third of the Kleinburg individuals (15 of 44 = 34.1 %).

A sufficient amount of time was allowed to pass in order for the observer's short-term memory to be cleared. Upon examination of the two sets of results, differences were apparent between some of the observations recorded initially and some of those recorded upon return. In order to evaluate the significance of such differences to the results of this study, data is compared between the first sets of observations (obs1) and the second sets (obs2) that would factor into the age and sex estimations, and the dental caries formulae. These factors include: number of teeth *in situ*, number of antemortem tooth losses, number of carious teeth, number of carious pulp exposures, number of pulp exposures caused by attrition, age category, sex category, number of abscesses and average occlusal surface wear.

Percentage of agreement between the two sets of observations for dental conditions is calculated by one of two means: straight division (for example, total number of carious teeth (obs1) / total number carious teeth (obs2) x100) when all differences between observations were uni-directional; or, when differences between the two sets were bi-directional and served to cancel each other, the amount of difference was divided by the original total (obs1). Age and sex categories and average wear differences are calculated by dividing the number of differences by the number of individuals who were well enough preserved to be included in each particular observation. Refer to **Appendix I** for examples of each method.

Uxbridge Ossuary: Of the 10 crania that were randomly chosen for intra-observer error testing, 8 were adults and 2 were children, and of the 10 mandibles selected, one was a child. There was 85 to 100 percent agreement among 4 of the 9 factors that were recorded during the second set of observations (obs2) when compared with the results from obs1 (**Appendix I**). These 4 factors involved teeth *in situ*, carious pulp exposures, antemortem tooth losses and occlusal surface wear. The remaining 5 critical factors, carious teeth, pulp exposures caused by severe wear, abscesses, age category and sex category, varied more considerably from obs1 to obs2. Details regarding the two sets of observations are discussed below.

There was a 97.5 percent agreement between the observations for the number of teeth *in situ*: 119 teeth (obs1) versus 116 teeth (obs2). While it was expected that it should be obvious whether or not a tooth was present, these 3 differences lie with only one case. This was an adult of ambiguous sex (referred to as #82/x174/mn452) whose right half of the maxilla was broken and disarticulated from the skull. During obs2, this broken right half was missed and the 3 teeth that were present in this half of the dental arch were not recorded.

Regarding antemortem tooth losses, there was a 93.5 percent agreement between obs1 (62 amtl) and obs2 (58 amtl). These 4 cases involve 4 individuals and in each case, the antemortem loss was judged to be a postmortem loss for obs2. This tended to occur when either postmortem alveolar breakage or severe alveolar resorption obscured landmarks and masked the status of the socket at the time of death. Regardless, the agreement between the two sets of observations is good, and the slight differences would not have made a significant impact on calculations of caries prevalence.

The number of carious teeth observed among the two separate recording events was found to have 63.8 percent agreement. While 47 carious teeth were found among the intraobserver sample at obs1, 58 were recorded during obs2. For the majority of these cases, a small or 'pin-prick' lesion was identified at obs2 that was missing during obs1, turning a formerly sound tooth into one containing a carious lesion. It seems that as the researcher gained experience, the smallest of lesions that penetrated the enamel were able to be identified. However, for the purposes of the caries formulae, the results from obs1 were used for the calculations, and so produced a conservative estimate of caries prevalence for these individuals.

While the number of abscesses found within each individual's mouth does not influence the caries formulae, it does reflect dental disease. Agreement between obs1 and obs2 reached 66.7 percent. Although there were 12 abscesses recorded for obs1 and 12 at obs2, there were 4 differences regarding the locations of these abscesses. Two additional abscesses were recorded at obs2 that were missed during the initial observation, both classed as an abscess with no drainage channel. Two abscesses with buccal drainage were recorded at obs1, whereas they were missed or noted as porous alveolus rather than an active abscess at obs2.

Discrepancies regarding observations of pulp exposures, critical to Lukacs's Corrected Caries Rate, varied between the two recording events. While there were no differences noted for carious pulp exposures (10 at obs1 and the same 10 at obs2), there were 2 pulp exposures caused by severe occlusal wear recorded for obs1 and 4 at obs2. This variation lies in the difficulty to distinguish severe secondary dentine exposure from attritional pulp exposure. In practice, this difference would only have altered the calculations for the young female group (with the cranium labelled ?(7)b/x38), as the second affected individual (mn69) could not be placed into a specific age or sex group and was not involved in the calculations for caries prevalence.

Average occlusal surface wear was examined for intraobserver error, and was determined to be in agreement if the average amount of wear for the anterior and posterior sections of the dentition were judged to be in the same category of mild, moderate, heavy or severe. Six (6) of the 20 individuals chosen by the random sample generator did not contain permanent teeth that could be assessed for occlusal surface wear. Only 2 differences were found among the remaining 14 individuals, which resulted in an 85.7 percent agreement. While the differences in the average amounts of wear were quite small, in these two cases the teeth were elevated into the next wear category (refer to individuals x174/mn452 and mn414 in **Appendix I**). As mentioned in the discussion of *in situ* teeth, more teeth were observed during obs1.

Concurrence in age estimations was evaluated based upon final age group assigned for the adults and the age-at-death estimation by dental eruption sequence for the juveniles. Overall, there was agreement for 15 of the 20 individuals (75 percent), and a discrepancy for 3 adults and 2 children. Among the adults, the disagreements stemmed from some uncertainties regarding which category they belonged in, since the combinations of suture closures and dental wear indicated that they were around the transitions between age groups. In particular, x38 was deemed to be Young? at obs1 and Middle? at obs2, x191 was recorded as Middle? and then Older, and mn414 was judged as Young followed by Middle? at obs2. Of the three children involved in the intraobserver analysis, x179/mn448 was thought to be 9 years of age ± 24 months at obs1 and 8 years ± 24 months at obs2, there was agreement for x253 at 6 years of age, and mn325 was deemed to be 5 years ± 16 months and then 6 years ± 24 months. Given the ranges associated with each age in the dental formation and eruption sequence, the two disagreements remain within the same time overlap.

The analysis for reliability in sex estimations involved only 17 of the 20 individuals chosen by the random number generator, as sex estimation was not attempted for the three juveniles. Of the 17 adults, there was agreement with the two sets of observations for 11 individuals (64.7 percent). Five of the differences occurred as a result of a judgement for ambiguous sex at one event versus an assignment of male or female during the other observation event. Curiously, three of the females from obs1 were judged to be of ambiguous sex at obs2, while two of the ambiguous individuals from obs1 were assigned as probable males at obs2. Only one individual, mn66, was thought to be a probable female at obs1 and a probable male at obs2.

Limited interobserver comparisons are enabled, due to recent studies that were independently conducted on individuals from the Uxbridge Ossuary utilizing the same age and sex estimation techniques as were employed during the current study.

Forty-six (46) of the 51 adult crania examined for this study were also assessed by Deborah Merrett (1998, personal communication) for a Masters level analysis of maxillary sinusitis. These two independent assessments arrived at 95.7 percent agreement with age categories and 91.2 percent agreement regarding sex estimation. The two cases of disagreement for age estimations (individuals known as #2/x169 and #?(2)/x183) presented a wide range of age indicators regarding suture closures, and resulted in estimations of Middle-aged by one researcher and either Young or Older by the other researcher. In all four cases of disagreement for sex estimations, one researcher judged the individual as female while the other researcher evaluated the individual as ambiguous in sex.

Kleinburg Ossuary: There was 80 to 100 percent agreement among 6 of the 9 factors that were recorded during the second set of observations (obs2) when compared with the results from obs1 (**Appendix J**). These 6 factors involved teeth *in situ*, carious pulp exposures, antemortem tooth losses, carious teeth, and age and sex estimations. The remaining 3 critical factors, being pulp exposures caused by severe attrition, abscesses and occlusal surface wear, varied more considerably from obs1 to obs2. Details regarding the two sets of observations are discussed below.

Two observations that theoretically should be the most consistent during intraobserver error trials are the numbers of teeth present and those lost before death. During the second set of observations (obs2) for the 15 individuals chosen by the random sample generator, there was 100 percent agreement with the first set (obs1) regarding the numbers of teeth *in situ* for each individual. Concerning the numbers of antemortem tooth losses, there was 91.7 percent agreement between the two recording events. For two individuals, either one or two antemortem losses were not observed at obs2 that were recorded at obs1. In a third case, one additional antemortem loss was recorded at obs2. These inconsistencies tended to occur when either postmortem alveolar breakage or severe alveolar resorption obscured landmarks and masked the status of the socket at the time of death. Regardless, the agreement between the two sets of observations is good, and the slight differences would not have made a significant impact on calculations of caries prevalence.

The number of carious teeth observed among the two separate recording events was found to have 87.5 percent agreement. While 40 carious teeth were found among the intraobserver sample at obs1, 39 were recorded during obs2 with 5 differences in terms of presence or location. These cases likely reflect either positive observations or lack of perception of small 'pin-prick' lesions, turning a formerly sound tooth into one containing a carious lesion or vice versa. For the purposes of the caries formulae, the results from obs1 were used for the calculations, and it is probable that the few differences identified at obs2 would not have significantly altered the estimate of caries prevalence for these individuals.

While the number of abscesses found within each individual's mouth does not influence the caries formulae, it does reflect dental disease. Agreement between obs1 and obs2 reached 63.6 percent. There were 7 abscesses recorded for obs1 and 11 at obs2. The additional abscesses recorded at obs2 are ones that are difficult to perceive, as they are either small drainage channels that open into the maxillary sinus or the mandibular canal, or are abscesses with no apparent drainage channel.

Discrepancies regarding observations of pulp exposures, critical to Lukacs's Corrected Caries Rate, varied between the two recording events. Although there were 13 carious pulp exposures noted at both obs1 and at obs2, 2 differences in location existed, resulting in an 84.6 percent agreement. Pulp exposures caused by severe attrition were observed on 7 teeth at obs1 and 5 at obs2. In this case, both differences were seen in the mouth of the individual known as Burial 2, who was determined to be an older female who had experienced severe occlusal surface wear on the anterior maxillary and mandibular teeth. The variation between observation events lies in the difficulty to distinguish severe secondary dentine exposure from attritional pulp exposure.

Average occlusal surface wear was examined for intraobserver error, and was determined to be in agreement if the average amount of wear for the anterior and posterior sections of the dentition were judged to be in the same category of mild, moderate, heavy or severe. One of the 15 individuals chosen by the random sample generator did not contain permanent teeth that could be assessed for occlusal surface wear. Three differences were found among the remaining 14 individuals, which resulted in 78.6 percent agreement between obs1 and obs2. In one case, for the individual known as #70, the two teeth *in situ* were not scored for occlusal surface wear at obs1 due to the gross lesions that had destroyed most of the crowns. However, at obs2, the small surface area that remained was scored for wear, creating a difference between the two events. For the two other differences, among the individuals referred to as #73 and Burial 2, scoring differences were enough to shift the tooth or teeth involved into a different wear category.

Concurrence in age estimations was evaluated based upon the final assigned age group. Overall, there was agreement for 13 of the 15 individuals (86.7 percent). The disagreements stemmed from some uncertainties regarding which category these individuals belonged in, since the combinations of suture closures and dental wear indicated that they were around the transitions between age groups. In particular, #70 was deemed to be Older? at obs1 and Middle? at obs2, while #73 was judged as Young followed by Middle? at obs2. These differences would have served to shift #70 from the older male group to the middle male group. Individual #73 was not involved in caries calculations that compared the two sexes, as a determination for ambiguous sex was reached during both observation events.

The analysis for reliability in sex estimations found that there was 80 percent agreement between obs1 and obs2. Each of the three differences occurred as a result of an assignment of female during obs1 and a judgement for ambiguous sex at the second observation event. These differences would have had very little impact on the calculations for caries prevalence between the two sexes as they would have served to simply omit these three females from the sample. Of note, these three females were classified as being middle-aged and older. It is possible that changes in their dimorphic cranial features had begun to occur as they aged, making some of the features appear ambiguous in size and/or shape.

Limited interobserver comparisons are possible due to independent sex estimations conducted by F. Jerome (Jerry) Melbye (1997, personal communication from unpublished notes) on the individuals from the Kleinburg Ossuary. The precise sex estimation techniques employed by Melbye are not known. Of the 44 individuals examined for this study 38 assessments made by Melbye were available, and these two independent assessments arrived at 76.3 percent agreement. In one case, one researcher judged the individual as male while the other researcher concluded female. This young individual exhibits some ambiguous cranial features and others that lean towards the female expression, although the nuchal crest and supraorbital margins appear to be clearly male. Of the 9 individuals who were assessed to have ambiguous sex features during the current study, Melbye agreed with one, but found one to look male and another 7 to contain female expressions of the dimorphic cranial features. These latter 8 individuals may have potentially been included in the calculations for caries prevalence by age and sex group, but have been excluded at this time based upon the initial determinations as ambiguous.

Syers Ossuary: There was 80 to 100 percent agreement among 6 of the 9 factors that were recorded during the second set of observations (obs2) when compared with the results from obs1 (**Appendix K**). These 6 factors involved teeth *in situ*, carious pulp exposures, antemortem tooth losses, occlusal surface wear, and age and sex estimations. The remaining 3 critical factors, being carious teeth, abscesses and pulp exposures caused by severe wear, varied more considerably from obs1 to obs2. Details regarding the two sets of observations are discussed below.

Two observations that theoretically should be the most consistent during intraobserver error trials are the numbers of teeth present and those lost before death. During the second set of observations (obs2) for the 12 individuals chosen by the random sample generator, there was 100 percent agreement with the first set (obs1) regarding the numbers of teeth *in situ* for each individual. Concerning the numbers of antemortem tooth losses, there was 83.3 percent agreement between the two recording events. For two individuals, either one or two antemortem losses were not observed at obs1 that were recorded at obs2. These inconsistencies tended to occur when either postmortem alveolar breakage or severe alveolar resorption obscured landmarks and masked the status of the socket at the time of death. Regardless, the agreement between the two sets of observations is good, and the slight differences would not have made a significant impact on calculations of caries prevalence.

The number of carious teeth observed among the two separate recording events was found to have 73.1 percent agreement. While 19 carious teeth were found among the intraobserver sample at obs1, 26 were recorded during obs2. These cases likely reflect the lack of perception of small 'pin-prick' lesions, turning a formerly sound tooth into one containing a carious lesion. However, for the purposes of the caries formulae, the results from obs1 were used for the calculations, and so produced a conservative estimate of caries prevalence for these individuals.

While the number of abscesses found within each individual's mouth does not influence the caries formulae, it does reflect dental disease. Agreement between obs1 and obs2 only reached 37.5 percent, as there were 3 abscesses recorded for obs1 and 8 at obs2. The additional abscesses recorded at obs2 are ones that are difficult to perceive, as they are either small drainage channels that open into the mandibular canal or are abscesses with no apparent drainage channel. This was found to be a relatively consistent error among the three ossuary groups analyzed for this study, as it appears that, with more experience, the researcher was able to identify those cases with unusual drainage or atypical evidence of pathology.

Discrepancies regarding observations of pulp exposures, critical to Lukacs's Corrected Caries Rate, varied between the two recording events. While there were no differences noted for carious pulp exposures (4 at obs1 and the same 4 at obs2), there were 0 pulp exposures caused by severe attrition recorded for obs1 and 2 at obs2. In this case, both differences were seen in the mouth of the individual referred to as 895.6.3. During both observation events, the two teeth in question were scored with the same degree of occlusal wear, one with moderate wear and the other with heavy wear. The variation between observation events lies in the difficulty to distinguish a large amount of secondary dentine exposure from attritional pulp exposure.

Average occlusal surface wear was examined for intraobserver error, and was determined to be in agreement if the average amount of wear for the anterior and posterior sections of the dentition were judged to be in the same category of mild, moderate, heavy or severe. One of the 12 individuals chosen by the random sample generator, 2 did not contain permanent teeth that could be assessed for occlusal surface wear. One difference was found among the remaining 10 individuals, which resulted in 90.0 percent agreement between obs1 and obs2. While the differences in the average amounts of wear were quite small, in this case the posterior teeth were elevated into the next wear category, from mild to moderate.

Concurrence in age estimations was evaluated based upon the final assigned age group. Overall, there was agreement for 11 of the 12 individuals (91.7 percent). The one disagreement stemmed from some uncertainties regarding which category this individual belonged in, since the combinations of suture closures and dental wear indicated that the person died near the transition from the young to the middle age group. This difference would have served to shift this individual from the young male group to the middle male group.

The analysis for reliability in sex estimations found that there was 91.7 percent agreement between obs1 and obs2. The solitary difference occurred as a result of an assignment of female during obs1 and a judgement for ambiguous sex at the second observation event. This difference would have had very little impact on the calculations for caries prevalence between the two sexes as it would have served to simply omit this female from the sample.

Limited interobserver comparisons for the Syers Ossuary sample are possible due to independent sex estimations conducted by J. Eldon Molto (1983) during his Doctoral study of the cranial morphology of southern Ontario Woodland populations. Molto chose to employ the standard sexing methods of the day, which involved assessing the robusticity of the supraorbital ridge, the superior nuchal line, the mastoid process and the tubercles of the malar bone; features which he noted had "proved to be the most reliable in sexing Iroquois crania" based upon his experience (Molto 1983:144). The exact identities of the 25 individuals that comprised Molto's sample are not known. Molto (1983:148) concluded that his sample included 13 male crania, 9 female crania and 3 of unknown sex (some of whom were likely adolescents, to which Molto would not have assigned a sex estimation), resulting in a sex ratio of 1.44. In comparison, the sex ratio calculated for the 23 Syers individuals in the present study is 1.86 (13 males, 7 females and 3 of unknown sex). It is likely that these 23 individuals were among those examined by Molto in the late 1970s. Furthermore, it is possible that the sex assignments from the two independent studies were identical, and that the present study excluded 2 of Molto's females due to unacceptable conditions pertaining to postmortem dental preservation.

Additional Observations

Additional characteristics systematically observed for all individuals, but not discussed here, include calculus (amount and location when present), alveolar resorption, dental enamel hypoplasia (specified as pit or linear forms, and location relative to the cement-enamel junction), extra cusps (location on tooth), presence of hypercementosis, and mylohyoid bridge presence. Details are presented per individual in **Appendix L**.

Summary

The results presented here have targeted those characteristics that would assist in answering the primary hypothesis of this analysis, and have therefore been limited to observations regarding dental pathology and variables that are valuable age and sex indicators. All crania from the Uxbridge Ossuary collection, as well as many disarticulated mandibles, were examined for such characteristics. The juveniles and adults of ambiguous sex, due to the limitations of this analysis, were not included in the primary discussion of the results. Alternatively, much of the information obtained from the analysis of these latter segments of the burial population is available in appendices for future consultation. The same circumstance applies to those adults of ambiguous sex who were examined from the Kleinburg and Syers ossuary collections.

Molar size was determined not to be a reliable indicator of sex for these populations and, although it was described in some detail, did not factor into the final sex estimations in this study.

Occlusal surface wear was found to increase, on average, with the age of the individuals. The patterns of tooth wear were generally mild, indicating a relatively slow rate of wear; an observation that is consistent with other studies of maize-dependant Iroquoian populations from the fourteenth through to the seventeenth centuries from northeastern North America.

Regardless of age category, the females from the Uxbridge and Kleinburg Ossuaries demonstrated higher levels of caries than the males, as calculated by the Corrected Caries Rate (CCR) with the Proportional Correction Factor. A statistically significant difference (by Chi-Square analysis) was found only among the Uxbridge middle aged males and females with regard to the numbers of estimated carious teeth versus the numbers of estimated sound teeth (one component of the CCR) for this age group. No statistically significant differences were generated upon dividing the Kleinburg individuals into the various demographic groups.

The Syers demographic groups demonstrated a pattern that is unique when compared to the other two ossuary sample populations: Corrected Caries Rate (CCR) results were much lower than either Uxbridge or Kleinburg, and less consistent scores were found between the demographic groups. As an example, the young males scored higher than the young females for the CCR, but in the middle aged group, the opposite was true. Statisticallly significant differences (by the Chi-Square test) were found only among the middle aged males and females with regard to the numbers of estimated carious teeth versus the numbers of estimated sound teeth (one component of the CCR) for this age group.

Statistically significant differences were achieved, however, upon comparison of the same demographic groups among the three ossuary samples. The unfortunate consequence of this was that it was not possible to combine the data from the three groups for the purpose of expanding the numbers of people included in each demographic grouping. Statistical analyses indicated that these three ossuary populations do not exhibit similar enough pathological characteristics to enable a compilation of data and, therefore, a broader comparison between the sexes within each age group.

Testing for error is a critical component of any scientific analysis, to be conducted within the principal observer's data, as well as between independent observers. Within the current study, analytical conditions were maintained as consistently as possible. Intraobserver error was found to vary, depending upon the detail or relative ambiguity of each characteristic, but was not found to alter the final calculations for dental caries prevalence among the demographic groupings of individuals. Interobserver error testing was possible for the majority of the ossuary samples, and results were found to closely agree between the various independent observations.

Chapter 6: Interpreting the Results

Introduction

The primary aim of this study is to determine whether or not differences in the expressions of dental disease provides evidence to assist in the understanding of Late Ontario Iroquoian social roles and activities. The underlying objective of this research, however, is an attempt to identify personal conditions during life - to learn about the *people* who are represented by these masses of disarticulated skeletons.

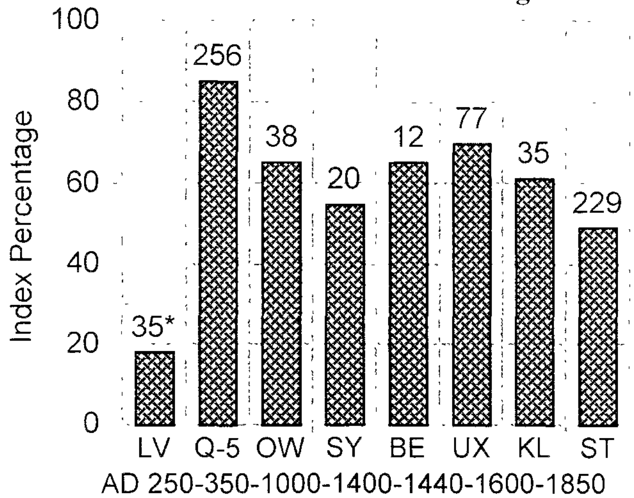
Attempts have been made to distinguish the individual archaeologically through analyses of material culture, such as lithic tools and ceramics, but none have the potential to provide as much personal data as skeletal analyses. The durable, yet vulnerable, and easily identifiable nature of teeth and their associated bony tissues allow for numerous macroscopic observations which directly chronicle an individual's dental health and dietary practices. As with all archaeological skeletal samples, several limitations must be considered; postmortem loss and damage being the most inhibiting factors. Reliable age and sex estimations are crucial to interpretations of dental conditions. Some of these limits may be overcome through standardized and replicable observations, and conservative conclusions. Despite these considerations, this analysis has uncovered several important indicators which aid in the understanding of life during the pre-contact period in southern Ontario.

The teeth analyzed from the Uxbridge, Kleinburg and Syers burial sites have revealed that these people experienced high levels of caries and antemortem tooth loss, and moderate amounts of apical abscessing and occlusal surface wear. These characteristics are consistent with pre-contact maize-eating agriculturalists (Leigh 1925; Patterson 1984), and were likely aggravated by a lack of dental hygiene practices. The principal hypothesis tested in this study was whether or not the various demographic groups present within one community experienced dental disease differently based upon their daily roles and dietary habits. Since high levels of caries and antemortem tooth loss were endured by these Late period populations in general, questions that are being asked include: Did each person in the community experience the same amount of dental disease? If not, how might this difference have affected an individual's overall health? This analysis has focussed on the number and severity of carious lesions, antemortem tooth losses, pulp exposures and apical abscesses experienced within each demographic group to resolve these issues.

Caries Throughout the New World

In order to place the state of dental health found among these three ossuary samples into perspective, the Diseased-Missing Index (DMI) from each sample may be compared to that from other populations in the New World (**Figure 6.1**). The individuals interred at the LeVesconte Mound site of southern Ontario were gatherers and hunters, with relatively healthy teeth (Patterson 1984:185). Compared with those from LeVesconte, the results from Quitor-5 in highland Chile are at the opposite extreme (Kelley *et al.* 1991). The people interred at Quitor-5 practised intensive maize agriculture during the 4th century AD and their carbohydrate-rich diet is clearly reflected by their quantities of teeth lost during life and diseased teeth.

Figure 6.1: Inter-sample Comparison of the Diseased-Missing Index



LeVesconte (LV), Quitor-5 (Q-5), Owasco (OW), Syers (SY), Bennett (BE), Uxbridge (UX), Kleinburg (KL), St. Thomas (ST)
*denotes number of individuals per site/culture

Gagnon (1999) examined 38 males and females from Owasco sites dating to AD 1000-1400. These people lived in what are now known as the states of New York and Pennsylvania, and are believed to be the ancestors of the Susquehannock and the Five Nations of the Iroquoian Confederacy. The Owasco peoples subsisted on a mixed economy of maize, beans, squash, plus wild animal and plant resources (Gagnon 1999). The Syers, Bennett (Patterson 1984:226), Kleinburg and Uxbridge burial populations all lived in southern Ontario and were also intensively cultivating maize. The Diseased Missing Index, a commonly reported measure of caries prevalence, shows that between one half and three-quarters of the teeth contained caries or were presumably lost due to caries among these five pre-contact populations.

Finally, the St. Thomas burial population is composed of 19th century individuals of European descent. These people were also agriculturalists who additionally had access to refined sugars. Dental hygiene was not regularly practised and, as a result, their dental health was comparable to the pre-contact Ontario agriculturalists (Saunders *et al.* 1997:80).

The females in the Quitor-5, Owasco and St. Thomas samples exhibited statistically higher DMI scores than the males. This difference between the sexes was not a primary focus for the Owasco and St. Thomas analyses. However, for the Chilean group, the sexual division of labour, with the females as the primary food gatherers, was suggested as the main contributing factor for this disproportionate pattern of dental disease (Kelley *et al.* 1991:209).

Since the likelihood of developing carious lesions increases with age, and the males are generally older than the females in the Uxbridge, Kleinburg and Syers samples, one would expect the males to score higher for the Corrected Caries Rate. The molar wear among virtually all individuals, both male and female, in the three samples is mild to moderate. Due to the slow rate of occlusal wear, it would be expected that individuals within the same age category would have experienced similar levels of caries.

Overall, there is no marked difference between the sexes for the Corrected Caries Rate during the young adult years within any of the three ossuary samples. The separation in caries experience takes hold once the individuals reached middle adulthood. Statistically significant differences (by Chi-Square analysis) were found among the Uxbridge and the Syers middle aged males and females with regard to the numbers of estimated carious teeth versus the numbers of estimated sound teeth (one component of the Corrected Caries Rate). The higher scores for the females indicates that they possessed more carious teeth, antemortem losses and pulp exposures caused by caries than their male counterparts. Of those people between the ages of 35 and 49 years, the males appear to have had superior dental health. Not many women in these samples lived 50 or more years. In the case of Syers, there were none. These older people did not have many teeth remaining to be studied, having lost the majority during life.

Alveolar abscessing is generally seen as a sign of prolonged and severe dental disease. In the cases of the individuals examined from the Uxbridge, Kleinburg and Syers Ossuaries, alveolar abscessing most often occurred in conjunction with carious pulp exposures. However, abscesses were also often observed in relation to sockets that were empty due to postmortem tooth loss. It may be advisable to include abscesses when calculating caries prevalence, particularly with the Corrected Caries Rate, which already takes into consideration antemortem tooth losses as well as pulp exposures. Estimations of dental disease that are attempted on archaeological populations that have undergone a great deal of postmortem tooth loss may be more accurate with the inclusion of alveolar abscessing.

Interpreting the Uxbridge, Kleinburg and Syers Dental Disease Experiences

The archaeological record provides evidence that the Late Ontario Iroquoian peoples subsisted on cultivated crops, gathered plant foods, and ate wild meat (Wright 1966:73; Trigger 1976:148). Archaeological, ethnohistoric and isotopic data indicate that maize constituted at least 51 percent of the general diet during the Late period (Heidenreich 1971:171-173; Schwarcz *et al.* 1985:201; Monckton 1992:86). Thus, the overall caries levels were expected to be high for the three populations involved in this study. Research initiated by Leigh in 1925 and subsequently carried out by many others has firmly identified the relationship that a subsistence economy dominated by maize and accompanying cultigens has with high levels of caries. The high carbohydrate content of the maize and the sticky, adhesive texture of the common maize dishes are thought to be the primary contributing agents. Tooth morphology, the species of oral bacteria, pH levels surrounding the teeth and other characteristics of the saliva, combined with the texture, chemical properties, frequency and combinations of food eaten, and the minerals entering the oral cavity all influence an individual's susceptibility for caries (Powell 1985:316).

The environmental factors, pathogenic agents and endogenous factors were likely equivalent for each member of an Iroquoian community. For instance, the trace mineral fluorine is known to be low in the soils and water in this region of North America (Shaw 1985 cited from Saunders *et al.* 1997:80). There would be little chance for remineralization of the damaged enamel to be facilitated by fluorine and, therefore, it is doubtful that this natural source of protection was working to improve the dental health of any particular demographic group. Additionally, the endogenous characteristics of tooth structure and salivary composition probably varied little from person to person.

Of the exogenous factors, it would seem that oral hygiene practices were not performed, as there has been no mention found in the ethnohistoric documents to suggest that this took place, and no evidence of mechanical cleansing has been witnessed on the skeletal remains from these populations. It is unlikely that the natural processes of cleansing, carried out by the saliva, tongue and cheeks, would be able to remove all of the food adhering to the occlusal surfaces and in the interproximal gaps. If the food particles do not pass through the oral cavity quickly, bacteria have their chance to metabolize the sugars, produce acid waste products, and lower the pH level in the saliva so that minerals may begin to leach out of the enamel. Although raw fruits and greens help to remove food particles from the tooth surfaces, it is most likely that these were only eaten in relatively small quantities when in-season, since much was dried and stored for the leaner winter months. Animal products are considerably better for the teeth due to the inherent absence of carbohydrates as well as the cariostatic properties of the meat, fat and oil. However, the small quantities eaten in conjunction with the maize dishes would have provided little overall protection.

Grit present in the diet has been observed to aid in the removal of food particles and also wear down the cusps fairly rapidly, effectively reducing the amount of bacterial metabolites (Powell 1985:309). Anvil stones and stone grinders are known to have been employed by the Iroquoians to make maize flour. It seems, however, that wooden mortars and pestles were used more frequently than their stone counterparts, so that grit may not have entered the oral cavity on a regular basis. It is the chemical composition and the texture of the foods, the methods of preparation and, in particular, the consumption patterns that are suspected to have created differences in dental health among those in a single community.

The seventeenth century chroniclers and the twentieth century ethnographers all identified *sagamité* as the most common Wendat (Huron) dish, which was made by pounding and then boiling the kernels of maize. A variety of foods, many of which are preserved in the archaeological record, were observed as ingredients in the main maize dish, including wild meat and fat, beans, squash, small fruits and berries, nut and seed oils, wild greens and fungi. The consistency of most daily meals was similar to soup or stew, and dense baked bread was also frequently eaten. The sticky texture and the high carbohydrate content of the daily maize meals would have left the teeth vulnerable to active oral bacterial colonization.

At the beginning of the last century, Waugh (1916:79) was aware that the typical liquid nature of the Iroquois diet may have caused dental decay:

> The causes of decay in teeth are not definitely known. The lack of foods requiring vigorous chewing, which keeps the teeth clean naturally, is probably a factor. It has also been suggested that starchy foods, of which the Iroquois used a large amount, ferment and attack the enamel, thus forming a nidus for the germs causing decay. A marked difference between Iroquois teeth and those of tribes using fewer starchy foods and more meat has been found by Mr. F.H.S. Knowles, physical anthropologist for the Geological Survey, the amount of decay being much less among the tribes last mentioned.

In his survey of pre-contact Ontario Iroquoians, Patterson (1984) also noticed a widespread trend towards rampant dental disease once a community became dependent upon cooked maize recipes as their staple food item. A subsequent study, undertaken by Schneider (1986) among pre-contact Native populations in Ohio, went one step further by finding a link between high levels of caries and weaker enamel composition in later agricultural groups. It was suggested that the dental enamel among the maize-dependent populations could be dissolved more readily by bacterial acids due to the lower levels of zinc, iron and copper, and the resulting increase in nickel and calcium-phosphorus ratios, present in their systems during enamel calcification (Schneider 1986:101).

The time interval between meals and consumption of snacks also factor into the cariogenicity of the diet, since short intervals do not allow for the saliva's pH level to increase, which allows the bacterial acids to act more powerfully on the enamel structure (Burt and Ismail 1986:1478). Some uncertainty remains regarding the average number of daily meals consumed by the Ontario Iroquoians. While Parker (Fenton 1968:61) and Waugh (1916:46) observed one daily meal among the twentieth century Iroquois communities they visited, Le Jeune (*JR* 8:113) and Champlain (Grant 1907:316) mentioned that two main meals per day were eaten among the seventeenth century Wendat. One common trait that linked all observations was that food was generally available so that smaller amounts could be consumed at other times during the day. If everyone did primarily eat only one or two times per day, it is possible that the salivary pH would have had the opportunity to rebound to a healthy level. In that case, the bacteria might not have had an excess of food to sustain huge colonies. It is almost certain, however, that this factor would have varied considerably from person to person, depending on their activity patterns throughout the day and their resulting proximity to food sources. Evidence exists in the ethnohistoric and ethnographic records to suggest that the roles fulfilled by different individuals in the community would have altered their access to amounts and certain types of food, which would have affected their susceptibility to dental disease.

The typical division of labour in Iroquoian communities was fairly well defined, as individuals began to carry out their expected roles and duties by late childhood. Trigger (1976:34) notes, "The most basic distinction in Huron society was that made between the sexes." The early written accounts relate that the men hunted, fished, traded, went to war, cleared the fields, and built houses and canoes, while the women did all work pertaining to agriculture, including the tilling, planting, harvesting and storing, plus the gathering of firewood, the sewing, tending their children, and the preparation and cooking of meals (Trigger 1976:37; Tooker 1991:58,59). Female children were taught household tasks from an early age and assisted their mothers in the fields, while boys practised hunting (Trigger 1976:47,48).

It is plausible that the women, who spent more time cooking meals and caring for children, may have had the opportunity to eat more frequently throughout the course of the day than the men. Waugh (1916:84) recorded that children breast-fed, but when they began to eat ordinary food, the mother chewed it first. Waugh also related an observation that Sagard had made: "When the mother died, the father sometimes took corn meal gruel in his mouth and let the baby suck it out." It is likely, though, that the mothers were the typical ones to provide this service for the infants. Due to the apparent lack of dental hygiene procedures, this practice would likely have resulted in more caries for the women. The men, however, were possibly eating a greater proportion of fish and animal meat while on their travels, of which the fat is healthier for the teeth than the carbohydrates contained in maize. It is also possible that by the time the permanent teeth began to erupt, the young boys were away from their mothers during the day, making it likely that the older children and subadults in the group may have also experienced differences in caries based upon their sex (gender). Small children and infirm adults may not have eaten the same meals as their family members. Another consideration is that if fish and meat were generally reserved for consumption during feasts, as suggested by Le Jeune, it would be important to know whether or not every member of the community had equal access to these cariostatic animal foods.

Future Endeavours

Anthropology, like other scientific and research-oriented disciplines, has in the past, and will continue in the future, to build upon its trials, errors and insights. As new methodologies are developed and tested, more information will be within reach. Analytical procedures for determining sex and pathological conditions utilizing DNA (for instance, Götherström *et al.* 1997), and examinations for microscopic age indicators are becoming more trustworthy and more widely available. This present study may have benefited from a new technique for judging sex by determining the amount of mandibular ramus flexure that is currently being tested for its reliability when used in conjunction with other morphological traits (Loth and Henneberg 1996; Haun 2000). Meanwhile, other accepted means for determining personal information continue to be put to the test, as attested by recent investigations of the supraorbital margin as a sex indicator (Graw *et al.* 1999) and the pubic symphysis as a criterion for gauging age-at-death estimates (Hoppa 2000).

In the future, anthropologists must continue, by whatever means available, to seek not only generalized knowledge, but also the specific histories of people from the past - if not from the skeletal remains of the people themselves, then through studies of written records, the archaeological material record, oral histories and cultural analogy from descendants of the ancient populations, and methods of study not yet imagined. Presumably, this would be best accomplished by considering the evidence provided by all of the above. However, it may not always be possible to analyze human skeletal remains in order to answer some of the questions that persist about past peoples. It must be recognized that modern populations may take offence to the disinterment and examination of their biological or cultural ancestors. Since the 1970s in Ontario, there has been published and openly discussed concern from the standpoint of the First Nations descendants of pre-contact Iroquoian peoples with regard to this issue (Cybulski *et al.* 1979). Future researchers of skeletal remains should bear this in mind, to keep the lines of communication open, respectful and honest.

Conclusions and Final Considerations

The results of this examination concur with previous studies of Late Ontario Iroquoian peoples who lived to middle adulthood, more than 35 years of age. The individuals observed from the Uxbridge, Kleinburg and Syers Ossuaries suffered from fairly severe dental caries and other related pathological conditions. The data suggests that the females in these burial groups experienced these conditions more severely than the males of the same age, although these particular sample sizes are not large enough to confirm this as a statistical certainty.

The causes of such poor dental health for the women, if this was truly the case, can only begin to be understood through a combined search for archaeological and ethnohistoric evidence. Post-contact European observers identified cultural roles for the adult sexes which seem conducive to differential susceptibility to dental caries. Males who spent some of their time away from the village were likely exposed to a greater variety of food resources, while the females were more likely to remain near the crops, with a more stable diet dominated by maize products. Other considerations for the adult females may factor into their susceptibility, such as premasticating food for infants or eating more frequent meals along with their young children.

The premature deaths of many of the women (as indicated by the relative abundance of females within the young adult age category) is not surprising, as pregnancy and childbirth are generally found to be dangerous among pre-industrial societies. It would be difficult to determine the contribution of severe dental disease to the deaths of these women. The primary consideration brought to light from this study is that the women in these Iroquoian communities, and presumably others, seem to have been at a higher risk of dental disease, which had the potential of causing widespread infection, a depleted immune system, and which may have resulted in terminal illness.

Only skeletal analyses can distinguish the consequences to an individual person's health as a result of differential dietary habits. However, interpretations cannot be considered complete without the information provided by archaeology, ethnohistory and ethnography to anticipate what the people would have eaten and how patterns of food consumption may have varied. In 1979, Kapches and Mayhall expressed their concern that the sub-disciplines of Anthropology were growing too distinct and disassociated from one another. This study exemplifies the belief that the strength of anthropological queries lies in the ability to draw from many distinct sources of evidence in order to reach a holistic, and it is hoped accurate, account of the lives of past peoples.

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APPENDICES

AND

PLATES

APPENDIX A: DATA COLLECTION FORMS

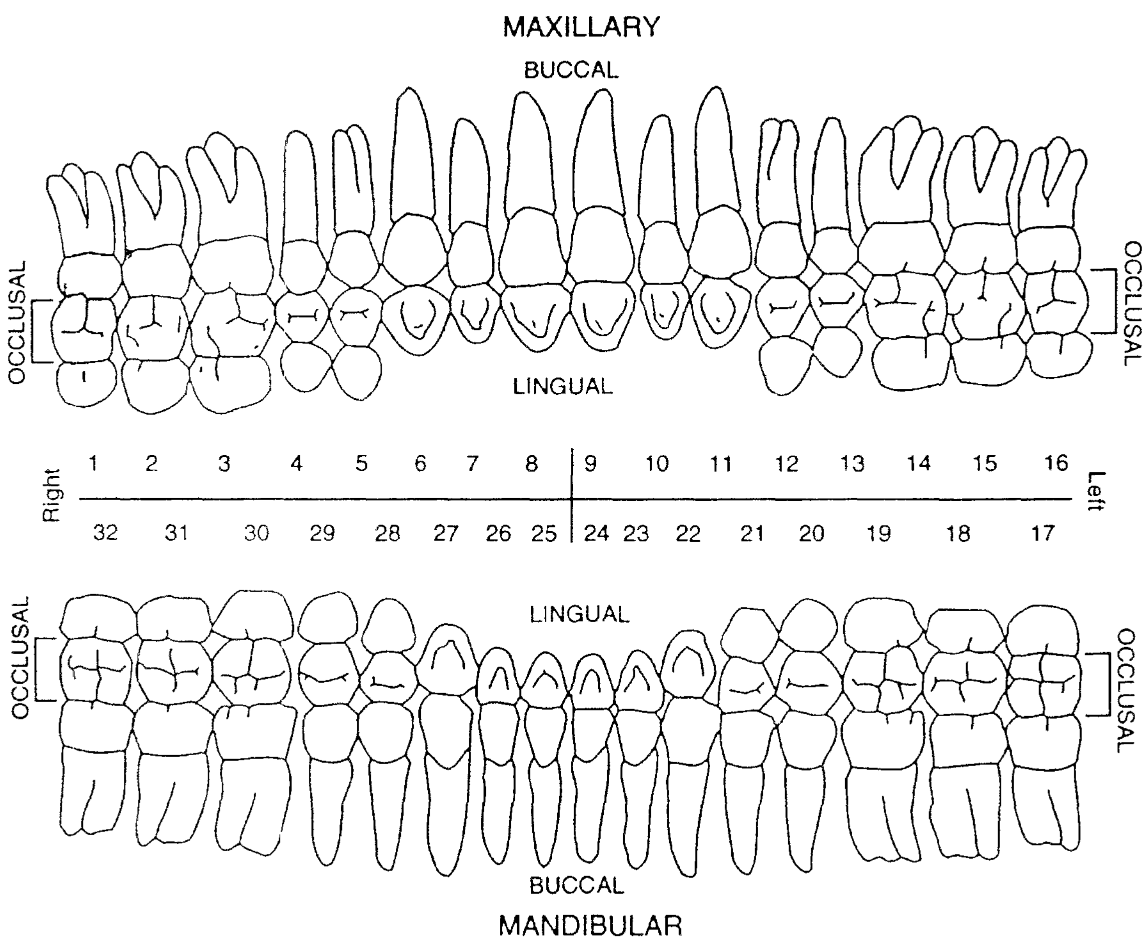
DENTAL INVENTORY
VISUAL RECORDING FORM: PERMANENT DENTITION

Site Name/Number ______ / ______ Observer ______

Feature/Burial Number ______ / ______ Date ______

Burial/Skeleton Number ______ / ______

Present Location of Collection ______



LEGEND

X = MISSING ANTEMORTEM

//// = MISSING POSTMORTEM

● = CARIES

------ = ENAMEL HYPOPLASIA

. . . = POROUS ALVEOLUS (INFECTION)

CHAPTER 5 · Attachment 14a

APPENDIX A: DATA COLLECTION FORMS

DENTAL INVENTORY RECORDING FORM

DEVELOPMENT, WEAR, AND PATHOLOGY: PERMANENT TEETH

Site Name/Number ______________ / ______________ Observer ______________

Feature/Burial Number ______________ / ______________ Date ______________

Burial/Skeleton Number ______________ / ______________

Present Location of Collection ______________

Tooth presence and development: code 1-8. For teeth entered as "1" (present, but not in occlusion), record stage of crown/root formation under "Development." **Occlusal surface wear:** use left teeth, following Smith (1984) for anterior teeth (code 1-8) and Scott (1979) for molars (code 0-10). If marked asymmetry is present, record both sides. Record each molar quadrant separate in the spaces provided (+) and the total for all four quadrants under "Total." **Caries:** code each carious lesion separately (1-7); **Abscesses:** code location (1-2). **Calculus:** code 0-3, 9. Note surface affected (buccal/labial or lingual).

		Tooth Presence	Development	Wear /Total		Caries			Abscess	Calculus/Affected	
Maxillary Right	1 M^3			+							
	2 M^2			+							
	3 M^1			+							
	4 P^2										
	5 P^1										
	6 C										
	7 I^2										
	8 I^1										
Maxillary Left	9 I^1										
	10 I^2										
	11 C										
	12 P^1										
	13 P^2										
	14 M^1			+							
	15 M^2			+							
	16 M^3			+							

APPENDIX A: DATA COLLECTION FORMS

Series/Burial/Skeleton________________

Observer/Date________________

		Tooth Presence	Development	Wear /Total	Caries	Abscess	Calculus/Affected
Mandibular Left	17 M_3	____	____	___ ___	___ ___ ___	____	___ _______
	18 M_2	____	____	___ ___	___ ___ ___	____	___ _______
	19 M_1	____	____	___ ___	___ ___ ___	____	___ _______
	20 P_2	____	____	___ ___	___ ___ ___	____	___ _______
	21 P_1	____	____	___ ___	___ ___ ___	____	___ _______
	22 C	____	____	___ ___	___ ___ ___	____	___ _______
	23 I_2	____	____	___ ___	___ ___ ___	____	___ _______
	24 I_1	____	____	___ ___	___ ___ ___	____	___ _______
Mandibular Right	25 I_1	____	____	___ ___	___ ___ ___	____	___ _______
	26 I_2	____	____	___ ___	___ ___ ___	____	___ _______
	27 C	____	____	___ ___	___ ___ ___	____	___ _______
	28 P_1	____	____	___ ___	___ ___ ___	____	___ _______
	29 P_2	____	____	___ ___	___ ___ ___	____	___ _______
	30 M_1	____	____	___ ___	___ ___ ___	____	___ _______
	31 M_2	____	____	___ ___	___ ___ ___	____	___ _______
	32 M_3	____	____	___ ___	___ ___ ___	____	___ _______

Estimated dental age (juveniles only)________________

Supernumerary Teeth:	Position between teeth	Location (1 - 4)	Position between teeth	Location (1 - 4)	Position between teeth	Location (1 - 4)
	____/____	______	____/____	______	____/____	______
	____/____	______	____/____	______	____/____	______

Comments:

____

____

____

____

____

____

Attachment 16: CHAPTER 5

APPENDIX A: DATA COLLECTION FORMS

ADULT SEX/AGE RECORDING FORM

Site Name/Number [illegible] / ________ Observer CC

Feature/Burial Number ________ / ________ Date [illegible]

Burial/Skeleton Number [illegible] / ________

Present Location of Collection R.O.M

SEX

Pelvis	L	R
Ventral Arc (1-3)		
Subpubic Concavity (1-3)		
Ischiopubic Ramus Ridge (1-3)		
Greater Sciatic Notch (1-5)		
Preauricular Sulcus (0-4)		

Skull	L	M	R
Nuchal Crest (1-5)		[illegible]	
Mastoid Process (1-5)			2
Supraorbital Margin (1-5)	[illegible]		[illegible]
Glabella (1-5)		1	
Mental Eminence (1-5)		[illegible]	

Estimated Sex, Pelvis (0-5) ________

Estimated Sex, Skull (0-5) [illegible]

Comments

APPENDIX A: DATA COLLECTION FORMS

Series/Burial/Skeleton ___
Observer/Date ___

AGE

Pubic Symphysis	L	R
Todd (1-10)	___	___
Suchey-Brooks (1-6)	___	___

	L	R
Auricular Surface (1-8)	___	___

Suture Closure (blank = unobservable; 0 = open; 1 = minimal; 2 = significant; 3 = complete)

External Cranial Vault	
1. Midlambdoid	___
2. Lambda	1
3. Obelion	___
4. Anterior Sagittal	___
5. Bregma	___
6. Midcoronal	___
7. Pterion	___
8. Sphenofrontal	___
9. Inferior Sphenotemporal	1
10. Superior Sphenotemporal	___

Palate	
11. Incisive	___
12. Anterior Median Palatine	___
13. Posterior Median Palatine	___
14. Transverse Palatine	___
Internal Cranial Vault	
15. Sagittal	___
16. Left Lambdoid	1
17. Left Coronal	___

Estimated Age		
	Young Adult (20-35 years)	___
	Middle Adult (35-50 years)	✓
	Old Adult (50+ years)	___

Comments

APPENDIX A: DATA COLLECTION FORMS

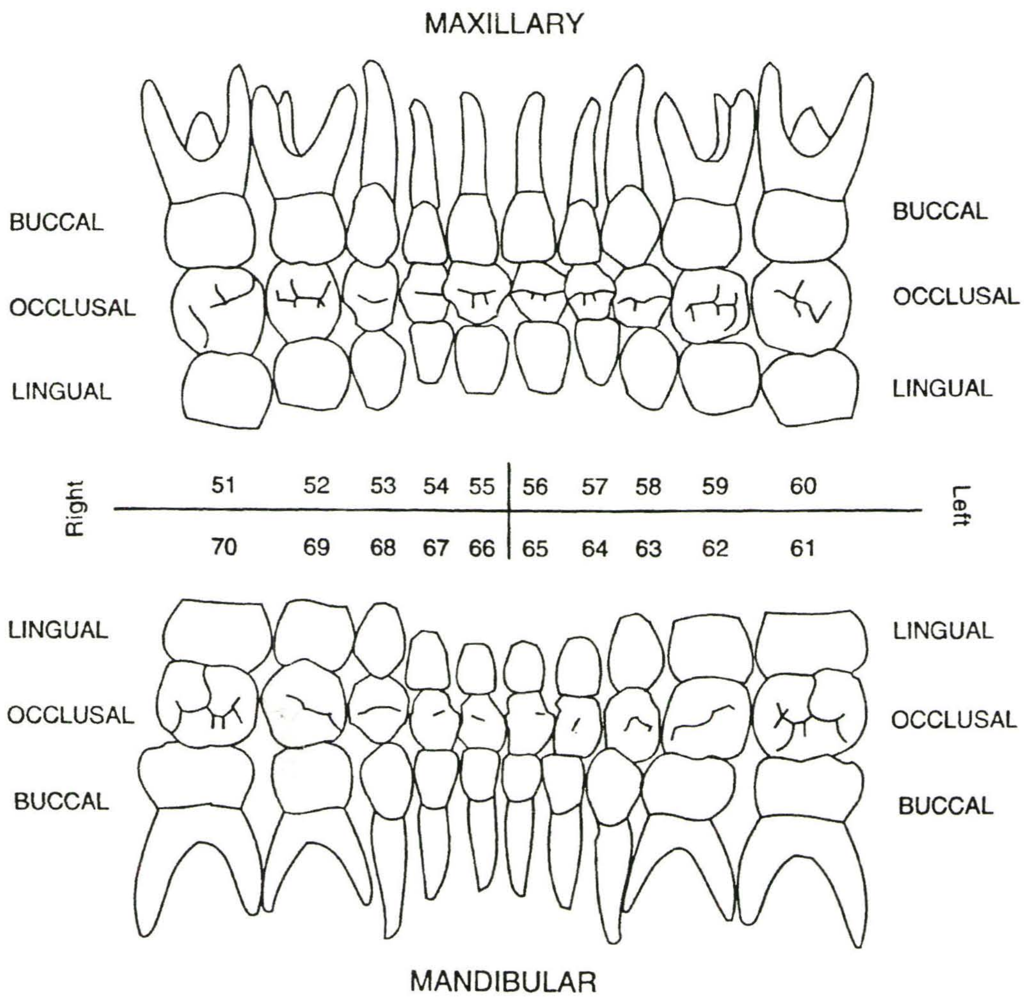
DENTAL INVENTORY
VISUAL RECORDING FORM: DECIDUOUS DENTITION

Site Name/Number UXBRIDGE OSSUARY/ BIGH 1 Observer CC

Feature/Burial Number ______ / UBC55B Date July 25/1997

Burial/Skeleton Number MN 313 / ______

Present Location of Collection U. of GUELPH



APPENDIX A: DATA COLLECTION FORMS

DENTAL INVENTORY RECORDING FORM

DEVELOPMENT AND PATHOLOGY: DECIDUOUS TEETH

Site Name/Number ____________ / ____________ Observer ____________

Feature/Burial Number ____________ / ____________ Date ____________

Burial/Skeleton Number ____________ / ____________

Present Location of Collection ________________________

Tooth presence and development: code 1-8. For teeth entered as "1" (present, but not in occlusion), record stage of crown/root formation under "Development." **Caries:** code each carious lesion separately (1-7); **Abscesses:** code location (1-2). **Calculus:** code 0-3, 9. Note surface affected (buccal/labial or lingual).

	Tooth	Presence	Development	Caries	Abscess	Calculus/Affected
Maxillary Right	51 m^2					
	52 m^1					
	53 c					
	54 i^2					
	55 i^1					
Maxillary Left	56 i^1					
	57 i^2					
	58 c					
	59 m^1					
	60 m^2					
Mandibular Left	61 m^2					
	62 m^1					
	63 c					
	64 i^2					
	65 i^1					
Mandibular Right	66 i^1					
	67 i^2					
	68 c					
	69 m^1					
	70 m^2					

APPENDIX B: UXBRIDGE OSSUARY DENTAL INVENTORY - ALL ADULTS[1]

	Tooth	Sockets (N)	Postmortem loss N	Postmortem loss %[2]	Antemortem loss N	Antemortem loss %[3]	Teeth *in situ* (N)	Carious teeth (N)	Observed Caries Rate (%)[4]	Abscesses (N)
rt M^1	1	40	29	60 4	16	33 3	3	2	66 7	0
	2	44	24	48 0	12	24 0	14	10	71 4	1
	3	46	16	32 0	11	22 0	23	17	73 9	3
	4	48	25	50 0	8	16 0	17	6	35 3	2
	5	46	21	42 0	7	14 0	22	7	31 8	0
	6	48	29	58 0	3	6 0	18	1	5 6	4
	7	48	36	76 0	5	10 0	7	1	14 3	2
	8	48	41	82 0	5	10 0	4	0	0 0	0
lt I^1	9	45	39	78 0	7	14 0	4	0	0 0	1
	10	47	35	70 0	8	16 0	7	3	42 9	0
	11	47	30	60 0	5	10 0	15	6	40 0	4
	12	47	28	56 0	9	18 0	13	6	46 2	0
	13	48	24	48 0	10	20 0	16	5	31 3	3
	14	45	14	28 0	14	28 0	22	14	63 6	6
	15	47	15	30 0	10	20 0	25	15	60 0	0
	16	43	26	55 3	12	25 5	9	6	66 7	0
supernumerary		1	1	100 0	0	0 0	0	n/a	n/a	0
lt M_1	17	43	5	11 6	30	69 8	8	5	62 5	1
	18	45	7	15 6	28	62 2	10	9	90 0	2
	19	46	2	4 3	32	69 6	12	9	75 0	3
	20	47	19	42 2	12	26 7	14	7	50 0	2
	21	46	23	50 0	8	17 4	15	3	20 0	3
	22	47	28	62 2	4	8 9	13	1	7 7	2
	23	46	26	56 5	7	15 2	13	2	15 4	1
	24	46	28	62 2	11	24 4	6	1	16 7	1
rt I_1	25	44	22	52 4	13	31 0	7	0	0 0	0
	26	45	28	65 1	5	11 6	10	0	0 0	0
	27	47	26	57 8	4	8 9	15	2	13 3	3
	28	48	25	52 1	9	18 8	14	2	14 3	4
	29	48	16	34 0	17	36 2	14	5	35 7	1
	30	48	5	10 4	31	64 6	12	9	75 0	1
	31	47	10	21 3	27	57 4	10	10	100 0	1
	32	46	6	13 0	33	71 7	7	5	71 4	0
Maxilla subtotal		743	435	54 6	142	17 8	219	99	45 2	26
Mandible subtotal		739	276	38 0	271	37 3	180	70	38 9	25
	Total	**1482**	**711**	**46.7**	**413**	**27 1**	**399**	**169**	**42 4**	**51**

[1] Includes crania (with maxillae and/or mandibles) regardless of age or sex plus all disarticulated mandibles

[2] Percent postmortem loss = (postmortem losses/(teeth *in situ* + antemortem losses + postmortem losses))x100
This is essentially equivalent to (postmortem losses/number of sockets present), but takes into account conditions such as the presence of supernumerary teeth, congenital absences and missing alveolar bone

[3] Percent antemortem loss = (antemortem losses/(teeth *in situ* + antemortem losses + postmortem losses))x100

[4] Observed Caries Rate = (number of carious teeth/number of teeth *in situ*)x100

APPENDIX C: UXBRIDGE OSSUARY DENTAL INVENTORY - JUVENILES[1]

	Tooth	Sockets (N)	Postmortem loss N	Postmortem loss %[2]	Buds in crypt (N)	Teeth *in situ* (N)	Carious teeth (N)	Observed Caries Rate (%)[3]	Location of lesion(s)
rt m^2	51	8	1	12.5	0	7	1	14.3	interproximal
	52	6	2	28.6	0	5	1	20.0	interprox.,cervical
	53	6	6	85.7	0	1	0	0.0	
	54	4	5	100.0	0	0	n/a	n/a	
	55	2	3	100.0	0	0	n/a	n/a	
lt i^1	56	3	3	100.0	0	0	n/a	n/a	
	57	4	4	100.0	0	0	n/a	n/a	
	58	7	7	100.0	0	0	n/a	n/a	
	59	7	2	28.6	0	5	1	20.0	interproximal
	60	9	1	11.1	0	8	2	25.0	occlusal,interprox
lt m_2	61	5	7	58.3	0	5	1	20.0	interproximal
	62	5	8	66.7	0	4	0	0.0	
	63	5	12	100.0	0	0	n/a	n/a	
	64	5	11	100.0	0	0	n/a	n/a	
	65	4	11	100.0	0	0	n/a	n/a	
rt i_1	66	4	11	100.0	0	0	n/a	n/a	
	67	4	10	90.9	0	1	0	0.0	
	68	5	9	75.0	0	3	0	0.0	
	69	5	7	58.3	0	5	2	40.0	occlusal,gross
	70	5	7	58.3	0	5	2	40.0	occlusal
rt M^1	1	3	1	100.0	2	0	n/a	n/a	
	2	9	2	100.0	7	0	n/a	n/a	
	3	9	2	22.2	0	7	0	0.0	
	4	1	1	100.0	0	0	n/a	n/a	
	5	3	2	100.0	1	0	n/a	n/a	
	6	3	2	100.0	1	0	n/a	n/a	
	7	7	4	100.0	3	0	n/a	n/a	
	8	7	6	100.0	1	0	n/a	n/a	
lt I^1	9	8	6	100.0	2	0	n/a	n/a	
	10	6	4	100.0	4	0	n/a	n/a	
	11	3	2	100.0	1	0	n/a	n/a	
	12	4	2	100.0	2	0	n/a	n/a	
	13	1	0	100.0	1	0	n/a	n/a	
	14	9	0	0.0	1	8	0	0.0	
	15	9	4	100.0	5	0	n/a	n/a	
	16	3	1	100.0	2	0	n/a	n/a	
lt M_1	17	1	0	100.0	1	0	n/a	n/a	
	18	5	2	100.0	3	0	n/a	n/a	
	19	5	1	33.3	2	2	0	0.0	
	20	0	0	100.0	0	0	n/a	n/a	
	21	0	0	100.0	0	0	n/a	n/a	
	22	1	0	100.0	1	0	n/a	n/a	
	23	3	2	100.0	1	0	n/a	n/a	
	24	4	3	100.0	1	0	n/a	n/a	
rt I_1	25	4	3	100.0	1	0	n/a	n/a	
	26	3	3	100.0	0	0	n/a	n/a	
	27	0	0	100.0	0	0	n/a	n/a	
	28	0	0	100.0	0	0	n/a	n/a	
	29	0	0	100.0	0	0	n/a	n/a	
	30	5	2	50.0	1	2	0	0.0	
	31	4	1	100.0	3	0	n/a	n/a	
	32	1	0	100.0	1	0	n/a	n/a	
Maxilla subtotal		143	73	64.0	33	41	5	12.2	
Mandible subtotal		83	110	80.3	15	27	5	18.5	
	Total	**226**	**183**	**72.9**	**48**	**68**	**10**	**14.7**	

[1] This group of individuals includes 9 crania, 2 with mandibles as well as maxillae, plus 3 disarticulated mandibles

[2] Percent postmortem loss = (postmortem losses/(teeth *in situ* + antemortem losses + postmortem losses))x100
This is essentially equivalent to (postmortem losses/number of sockets present), but takes into account conditions such as the postmortem loss of alveolar bone containing sockets

[3] Observed Caries Rate = (number of carious teeth/number of teeth *in situ*)x100

APPENDIX D: KLEINBURG OSSUARY DENTAL INVENTORY

	Tooth	Sockets (N)	Postmortem loss N	Postmortem loss %[1]	Antemortem loss N	Antemortem loss %[2]	Teeth *in situ* (N)	Carious Teeth (N)	Observed Caries Rate (%)[3]	Abscesses (N)
lt M^1	1	40	21	51 2	10	24 4	10	8	80 0	1
	2	43	11	25 0	9	20 5	24	12	50 0	2
	3	43	6	13 6	7	15 9	31	21	67 7	3
	4	44	21	47 7	4	9 1	19	6	31 6	2
	5	44	28	63 6	3	6 8	13	4	30 8	1
	6	44	25	56 8	4	9 1	15	2	13 3	3
	7	44	33	75 0	2	4 5	9	3	33 3	2
	8	44	35	79 5	4	9 1	5	0	0 0	1
lt I^1	9	41	38	86 4	5	11 4	1	0	0 0	1
	10	41	37	84 1	4	9 1	3	0	0 0	1
	11	42	31	70 5	3	6 8	10	1	10 0	3
	12	41	19	43 2	6	13 6	19	3	15 8	0
	13	40	20	45 5	4	9 1	20	4	20 0	3
	14	41	5	11 4	10	22 7	29	20	69 0	1
	15	40	12	27 3	11	25 0	21	16	76 2	1
	16	33	23	56 1	9	22 0	9	6	66 7	1
supernumerary		2	0	0 0	0	0 0	2	2	100 0	0
lt M_1	17	4	0	0 0	3	75 0	1	1	100 0	0
	18	5	1	20 0	3	60 0	1	1	100 0	0
	19	5	2	40 0	3	60 0	0	n/a	n/a	2
	20	5	3	60 0	1	20 0	1	0	0 0	0
	21	5	1	20 0	0	0 0	4	3	75 0	0
	22	5	2	40 0	0	0 0	3	2	66 7	1
	23	5	2	40 0	0	0 0	3	0	0 0	0
	24	5	2	40 0	0	0 0	3	0	0 0	0
rt I_1	25	5	3	60 0	0	0 0	2	1	50 0	0
	26	5	3	60 0	0	0 0	2	1	50 0	0
	27	5	2	40 0	0	0 0	3	1	33 3	0
	28	5	1	20 0	1	20 0	3	0	0 0	0
	29	5	2	40 0	1	20 0	2	0	0 0	0
	30	5	0	0 0	1	20 0	4	3	75 0	1
	31	5	0	0 0	3	60 0	2	2	100 0	0
	32	4	0	0 0	3	75 0	1	1	100 0	0
Maxilla subtotal		667	365	52 1	95	13 6	240	108	45 0	26
Mandible subtotal		78	24	30 8	19	24 4	35	16	45 7	4
	Total	**745**	**389**	**50.0**	**114**	**14.7**	**275**	**124**	**45.1**	**30**

[1] Percent postmortem loss = (postmortem losses/(teeth *in situ* + antemortem losses + postmortem losses))x100
This is essentially equivalent to (postmortem losses/number of sockets present), but takes into account conditions such as the presence of supernumerary teeth, congenital absences and missing alveolar bone

[2] Percent antemortem loss = (antemortem losses/(teeth *in situ* + antemortem losses + postmortem losses))x100

[3] Observed Caries Rate = (number of carious teeth/number of teeth *in situ*)x100

APPENDIX E: SYERS OSSUARY DENTAL INVENTORY

	Tooth	Sockets (N)	Postmortem loss N	Postmortem loss %[1]	Antemortem loss N	Antemortem loss %[2]	Intact Teeth (N)	Teeth *in situ* (N)	Observed Caries Rate (%)[3]	Abscesses (N)
rt M[1]	1	19	12	57 1	3	14 3	6	2	33 3	1
	2	19	5	23 8	3	14 3	13	6	46 2	0
	3	19	6	28 6	2	9 5	13	7	53 8	1
	4	19	17	81 0	1	4 8	3	2	66 7	1
	5	19	11	52 4	2	9 5	8	3	37 5	0
	6	19	18	85 7	0	0 0	3	0	0 0	0
	7	20	19	90 5	2	9 5	0	n/a	n/a	0
	8	20	20	95 2	1	4 8	0	n/a	n/a	1
lt I[1]	9	21	18	85 7	2	9 5	1	0	0 0	0
	10	21	20	95 2	1	4 8	0	n/a	n/a	0
	11	21	15	71 4	0	0 0	6	2	33 3	1
	12	21	8	38 1	2	9 5	11	4	36 4	1
	13	21	7	33 3	1	4 8	13	4	30 8	0
	14	21	2	9 5	5	23 8	14	3	21 4	0
	15	19	6	28 6	4	19 0	11	6	54 5	0
	16	18	12	57 1	6	28 6	3	1	33 3	0
lt M_1	17	2	1	50 0	0	0 0	1	0	0 0	0
	18	2	1	50 0	1	50 0	0	n/a	n/a	0
	19	2	0	0 0	0	0 0	2	2	100 0	1
	20	2	1	50 0	0	0 0	1	0	0 0	0
	21	2	2	100 0	0	0 0	0	n/a	n/a	0
	22	2	2	100 0	0	0 0	0	n/a	n/a	0
	23	2	2	100 0	0	0 0	0	n/a	n/a	0
	24	2	2	100 0	0	0 0	0	n/a	n/a	0
rt I_1	25	2	2	100 0	0	0 0	0	n/a	n/a	0
	26	2	2	100 0	0	0 0	0	n/a	n/a	0
	27	2	1	50 0	0	0 0	1	0	0 0	0
	28	2	2	100 0	0	0 0	0	n/a	n/a	0
	29	2	2	100 0	0	0 0	0	n/a	n/a	0
	30	2	1	50 0	1	50 0	0	n/a	n/a	0
	31	2	1	50 0	1	50 0	0	n/a	n/a	0
	32	2	2	100 0	0	0 0	0	n/a	n/a	1
Maxilla subtotal		317	196	58 3	35	10 4	105	40	38 1	6
Mandible subtotal		32	24	75 0	3	9 4	5	2	40 0	2
	Total	**349**	**220**	**59.8**	**38**	**10.3**	**110**	**42**	**38.2**	**8**

[1] Percent postmortem loss = (postmortem losses/(teeth *in situ* + antemortem losses + postmortem losses))x100
This is essentially equivalent to (postmortem losses/number of sockets present), but takes into account conditions such as the presence of supernumerary teeth congenital absences and missing alveolar bone

[2] Percent antemortem loss = (antemortem losses/(teeth *in situ* + antemortem losses + postmortem losses))x100

[3] Observed Caries Rate = (number of carious teeth/number of teeth *in situ*)x100

APPENDIX F: UXBRIDGE OSSUARY ADULTS[1] - DISTRIBUTION OF CARIOUS LESIONS

Number of Individuals	Age	Sex[2]	# Sockets Present	# Teeth *in situ*	# AMTL	# PMTL	# Caries	# Carious teeth	occlusal	Location of caries interproximal	smooth	cervical	root	gross	Pulp Exp from Caries	Pulp Exp from Attrition	# Abscesses
n=39	all	1	654	175	205	324	135	72	77	27	2	13	4	12	11	8	21
		avg	16.8	4.5	5.3	8.3	3.5	1.8	57.0%	20.0%	1.5%	9.6%	3.0%	8.9%	0.3	0.2	0.5
n=38	all	2	595	167	162	296	126	74	74	26	4	5	2	15	14	1	23
		avg	15.7	4.4	4.3	7.8	3.3	1.9	58.7%	20.6%	3.2%	4.0%	1.6%	11.9%	0.4	0.03	0.6
n=14	all	3	232	54	45	120	54	25	45	4	0	3	0	2	2	2	7
		avg	16.6	3.9	3.2	8.6	3.9	1.8	83.3%	7.4%	0.0%	5.6%	0.0%	3.7%	0.1	0.1	0.5
n=91	all	all	1481	396	412	740	315	171	196	57	6	21	6	29	27	11	51
		avg	16.3	4.4	4.5	8.1	3.5	1.9	62.2%	18.1%	1.9%	6.7%	1.9%	9.2%	0.3	0.1	0.6

APPENDIX G: KLEINBURG OSSUARY - DISTRIBUTION OF CARIOUS LESIONS

Number of Individuals	Age	Sex[2]	# Sockets Present	# Teeth *in situ*	# AMTL	# PMTL	# Caries	# Carious teeth	occlusal	Location of caries interproximal	smooth	cervical	root	gross	Pulp Exp from Caries	Pulp Exp from Attrition	# Abscesses
n=14	all	1	235	90	41	110	57	36	40	10	0	2	1	4	5	2	6
		avg	16.8	6.4	2.9	7.9	4.8	3.0	70.2%	17.5%	0.0%	3.5%	1.8%	7.0%	0.4	0.2	0.4
n=21	all	2	377	150	46	199	121	72	87	18	0	2	0	14	17	11	18
		avg	18.0	7.1	2.2	9.5	6.4	3.8	71.9%	14.9%	0.0%	1.7%	0.0%	11.6%	0.9	0.6	0.9
n=9	all	3	135	35	27	80	27	16	13	6	0	4	0	4	4	1	8
		avg	15.0	3.9	3.0	8.9	3.0	1.8	48.1%	22.2%	0.0%	14.8%	0.0%	14.8%	0.4	0.1	0.9
n=44	all	all	747	275	114	389	205	124	140	34	0	8	1	22	26	14	32
		avg	17.0	6.3	2.6	8.8	5.1	3.1	68.3%	16.6%	0.0%	3.9%	0.5%	10.7%	0.6	0.4	0.7

APPENDIX H: SYERS OSSUARY - DISTRIBUTION OF CARIOUS LESIONS

Number of Individuals	Age	Sex[2]	# Sockets Present	# Teeth *in situ*	# AMTL	# PMTL	# Caries	# Carious teeth	occlusal	Location of caries interproximal	smooth	cervical	root	gross	Pulp Exp from Caries	Pulp Exp from Attrition	# Abscesses
n=13	all	1	191	58	29	121	30	24	11	13	0	1	1	4	5	4	5
		avg	14.7	4.5	2.2	9.2	2.3	1.8	36.7%	43.3%	0.0%	3.3%	3.3%	13.3%	0.4	0.3	0.4
n=7	all	2	112	37	4	71	17	12	5	4	4	0	0	4	5	0	2
		avg	16	5.3	0.6	10.1	2.4	1.7	29.4%	23.5%	23.5%	0.0%	0.0%	23.5%	0.7	0	0.3
n=3	all	3	46	14	5	29	11	6	5	6	0	0	0	0	0	0	1
		avg	15.3	4.7	1.7	9.7	3.7	2	45.5%	54.5%	0.0%	0.0%	0.0%	0.0%	0	0	0.3
n=23	all	all	349	109	38	221	58	42	21	23	4	1	1	8	10	4	8
		avg	15.2	4.8	1.7	9.6	2.5	1.8	36.2%	39.7%	6.9%	1.7%	1.7%	13.8%	0.4	0.2	0.3

[1] Includes adult crania (with maxillae and/or mandibles) and all disarticulated mandibles

[2] 1 = male 2 = female 3 = ambiguous

APPENDIX I: UXBRIDGE OSSUARY INTRAOBSERVER ERROR ANALYSIS

Teeth *in situ*

Case	Obs1	Obs2	Difference
x38	4	4	0
x174/mn452	12	9	3
x181	11	11	0
x184	5	5	0
x185	11	11	0
x187	0	0	0
x191	3	3	0
x194	5	5	0
mn66	6	6	0
mn69	5	5	0
mn76	8	8	0
mn82	3	3	0
mn88	0	0	0
mn95	11	11	0
mn250	1	1	0
mn265	7	7	0
mn414	5	5	0
x179/mn448	11	1	0
x253	6	6	0
mn325	5	5	0
	119	**116**	**3**

116/119 = 97 5%

#AMTL

Case	Obs1	Obs2	Difference
x36	3	2	1
x174/mn452	0	0	0
x181	4	4	0
x184	0	0	0
x185	0	0	0
x187	6	5	1
x191	8	8	0
x194	1	1	0
mn66	4	4	0
mn69	4	4	0
mn76	0	0	0
mn82	6	6	0
mn88	9	8	1
mn95	0	0	0
mn250	11	10	1
mn265	5	5	0
mn414	1	1	0
x179/mn448	0	0	0
x253	0	0	0
mn325	0	0	0
	62	**58**	**4**

58/62 = 93 5%

#Carious Teeth

Case	Obs1	Obs2	Difference	
x38	3	3	0	
x174/mn452	6	9	3	<
x181	7	7	0	
x184	1	0	1	>
x185	5	10	5	<
x187	-	-	0	
x191	3	3	0	
x194	1	1	0	
mn66	2	1	1	>
mn69	1	1	0	
mn76	2	2	0	
mn82	0	1	1	<
mn88	-	-	-	
mn95	5	5	0	
mn250	1	1	0	
mn265	1	1	0	
mn414	5	4	1	>
x179/mn448	2	3	1	<
x253	1	2	1	<
mn325	1	4	3	<
	47	**68**	**17**	

(17/47) -1 = 63 8%

#Abscesses

Case	Obs1	Obs2	Difference	
x38	0	1	1	<
x174/mn452	0	0	0	
x181	0	1	1	<
x184	0	0	0	
x185	1	0	1	>
x187	2	1	1	>
x191	2	2	0	
x194	1	1	0	
mn66	2	1	1	>
mn69	0	0	0	
mn76	0	0	0	
mn82	0	0	0	
mn88	0	0	0	
mn95	1	1	0	
mn250	2	2	0	
mn265	0	0	0	
mn414	1	1	0	
x179/mn448	0	0	0	
x253	0	0	0	
mn325	0	0	0	
	12	**11**	**5**	

(4/12)-1= 66 7%

#Pulp Exp Caries

Case	Obs1	Obs2	Difference
x38	1	1	0
x174/mn452	1	1	0
x181	1	1	0
x184	0	0	0
x185	2	2	0
x187	-	-	-
x191	3	3	0
x194	0	0	0
mn66	0	0	0
mn69	0	0	0
mn76	0	0	0
mn82	0	0	0
mn88	-	-	-
mn95	0	0	0
mn250	1	1	0
mn265	0	0	0
mn414	1	1	0
x179/mn448	0	0	0
x253	0	0	0
mn325	0	0	0
	10	**10**	**0**

10/10 = 100 0%

#Pulp Exp Attrit'n

Case	Obs1	Obs2	Difference
x38	0	1	1
x174/mn452	0	0	0
x181	0	0	0
x184	0	0	0
x185	0	0	0
x187	-	-	-
x191	0	0	0
x194	0	0	0
mn66	0	0	0
mn69	2	3	1
mn76	0	0	0
mn82	0	0	0
mn88	-	-	-
mn95	0	0	0
mn250	0	0	0
mn265	0	0	0
mn414	0	0	0
x179/mn448	0	0	0
x253	0	0	0
mn325	0	0	0
	2	**4**	**2**

2/4 = 50 0%

Age Category

Case	Obs1	Obs2	Difference
x38	Y?	M?	1
x174/mn452	Y	Y?	0
x181	Y	Y	0
x184	Y	Y	0
x185	Y	Y	0
x187	O	O	0
x191	M?	O	1
x194	M	M	0
mn66	?	?	0
mn69	?	?	0
mn76	Y	Y	0
mn82	?	?	0
mn88	?	?	0
mn95	Y	Y	0
mn250	?	?	0
mn265	?	?	0
mn414	Y	M?	1
x179/mn448	9	8	1
x253	6	6	0
mn325	5	6	1
n=20			**5**

5/20 = 75 0%

Sex Estimation

Case	Obs1	Obs2	Difference
x38	2	2?	0
x174/mn452	3	3	0
x181	2	3	1
x184	1	1	0
x185	1	1	0
x187	1	1	0
x191	2	3	1
x194	2	3	1
mn66	2?	1?	1
mn69	3	3	0
mn76	3	1?	1
mn82	2	1?	1
mn88	2	2	0
mn95	1	1	0
mn250	1	1?	0
mn265	2?	2?	0
mn414	1?	1?	0
x179/mn448	-	-	-
x253	-	-	-
mn325	-	-	-
n=17			**6**

6/17 = 64 7%

Avg Wear

Case	Obs1	Obs2	Obs1 Category[1]	Obs2 Category	Difference
x38	13	13 7	-/mild	-/mild	[illegible]
x174/mn452	9 4	9 5	mod/mild	-/mild	1
x181	4 8	5 3	mod/mild	mod/mild	0
x184	9 2	9 3	-/mild	-/mild	0
x185	4 7	5 2	mild/mild	mild/mild	0
x187	-			-	0
x191	-	-	-	-	0
x194	12 8	11 6	-/mild	-/mild	0
mn66	2 8	3 2	mod/mild	mod/mild	0
mn69	6 2	5 6	heavy/mod	heavy/mod	[illegible]
mn76	4 2	5 7	-/mild	-/mild	[illegible]
mn82	4 7	4 7	heavy/mild	heavy/mild	[illegible]
mn88		-	-	-	0
mn95	5 6	6 9	-/mild	-/mild	0
mn250	-	-	-		0
mn265	3 3	3 6	mod/mild	mod/mild	0
mn414	19 5	21	-/mild	-/mod	1
x179/mn448	-	-	-/mild	-/mild	0
x253	-	-		-	0
mn325	-	-	-	-	0
n=14					**2**

2/14 = 85 7%

anterior \ posterior averages

[1]avg = (total / #cusps)

APPENDIX J: KLEINBURG OSSUARY INTRAOBSERVER ERROR ANALYSIS

Teeth *in situ*

Case	Obs1	Obs2	Difference
3	0	0	0
6	8	8	0
7	5	5	0
12	2	2	0
15	8	8	0
18	10	10	0
28	4	4	0
40	10	10	0
42	4	4	0
48	1	1	0
50	4	4	0
70	2	2	0
73	4	4	0
B2	18	18	0
B16	13	13	0
	93	**93**	**0**
		93/93 = 100 0%	

#AMTL

Case	Obs1	Obs2	Difference	
3	6	7	1	>
6	0	0	0	
7	0	0	0	
12	13	11	2	>
15	0	0	0	
18	0	0	0	
28	0	0	0	
40	0	0	0	
42	0	0	0	
48	7	[illegible]	0	
50	0	0	0	
70	7	8	1	
73	1	1	0	
B2	8	8	0	
B16	4	4	0	
	48	**46**	**4**	
		(4/48) -1 = 91 7%		

#Carious Teeth

Case	Obs1	Obs2	Difference	
3	-	-	-	
6	1	1	0	
7	2	2	0	
12	2	2	0	
15	6	6	0	
18	3	3	0	
28	1	1	0	
40	3	2	1	>
42	1	0	1	>
48	1	1	0	
50	0	1	1	<
70	2	2	0	
73	2	2	0	
B2	11	10	1	>
B16	5	6	1	<
	40	**39**	**5**	
		(5/40) -1 = 87 5%		

#Abscesses

Case	Obs1	Obs2	Difference
3	0	0	0
6	0	0	0
7	0	0	0
12	0	0	0
15	0	0	0
18	0	0	0
28	0	0	0
40	1	1	0
42	0	0	0
48	3	3	0
50	0	0	0
70	0	2	2
73	1	1	0
B2	1	2	1
B16	1	2	1
	7	**11**	**4**
		7/11 = 63.6%	

#Pulp Exp Caries

Case	Obs1	Obs2	Difference	
3	-			
6	0	0	0	
7	0	0	0	
12	1	1	0	
15	0	1	1	<
18	0	0	0	
28	0	0	0	
40	0	0	0	
42	0	0	0	
48	0	0	0	
50	0	0	0	
70	2	2	0	
73	2	2	0	
B2	6	5	1	>
B16	2	2	0	
	13	**13**	**2**	
		(2/13) -1 = 84 6%		

#Pulp Exp Attrit'n

Case	Obs1	Obs2	Difference
3	-	-	-
6	0	0	0
7	0	0	0
12	0	0	0
15	0	0	0
18	0	0	0
28	0	0	0
40	1	1	0
42	0	0	0
48	0	0	0
50	0	0	0
70	0	0	0
73	0	0	0
B2	6	4	2
B16	0	0	0
	7	**5**	**2**
		5/7 = 71 4%	

Age Category

Case	Obs1	Obs2	Difference
3	M	M?	0
6	M?	M?	0
7	M	M	0
12	M	M	0
15	Y	Y	0
18	Y	Y	0
28	Y	Y	0
40	Y?	Y?	0
42	Y	Y	0
48	O	O	0
50	Y	Y	0
70	O?	M?	1
73	[illegible]	M?	1
B2	O?	O?	0
B16	O?	O	0
n=15			**2**
		2/15 = 86 7%	

Sex Estimation

Case	Obs1	Obs2	Difference
3	2?	3?	1
6	3	3	0
7	2	3	1
12	3?	3	0
15	1	1	0
18	1	1?	0
28	2	2	0
40	1	1	0
42	[illegible]	3?	0
48	[illegible]	3	0
50	2	[illegible]	0
70	1	1	0
73	3?	3	0
B2	2	3	1
B16	1	1	0
n=15			**3**
		3/15 = 80.0%	

Avg Wear

Case	Obs1	Obs2	Obs1 Category[1]	Obs2 Category	Difference
3	-	-	-	-	0
6	10 8	9 5	mod/mild	mod/mild	0
7	7 2	9	-/mild	-/mild	0
12	6	5	heavy/-	heavy/-	0
15	9 1	9 9	-/mild	-/mild	0
18	7	6 8	mild/mild	mild/mild	0
28	6 8	6 8	mod/mild	mod/mild	0
40	11 1	11 6	heavy/mild	heavy/mild	0
42	8	9 5	-/mild	-/mild	0
48	22	22	-/mod	-/mod	0
50	10 6	13	-/mild	-/mild	0
70	-	7 5	-/-	severe heavy	1
73	4 5	4 5	mod/mild	mod/heavy	1
B2	9 1	5 6	severe mod	heavy/mod	1
B16	11 3	11 5	heavy/mild	heavy/mild	0
n=14					**3**
					3/14 = 78 6%

[1] anterior \ posterior averages
[2] avg = total / #cusps

APPENDIX K: SYERS OSSUARY INTRAOBSERVER ERROR ANALYSIS

Teeth *in situ*

Case	Obs1	Obs2	Difference
3	7	7	0
4	3	3	0
7	6	6	0
9	7	7	0
10	7	7	0
12	2	2	0
14	7	7	0
22	3	3	0
35	5	5	0
36	0	0	0
37	7	7	0
41	7	7	0
	61	**61**	**0**
		61/61 =	100 0%

#AMTL

Case	Obs1	Obs2	Difference
3	1	1	0
4	4	6	2
7	0	0	0
9	0	0	0
10	0	0	0
12	4	5	1
14	0	0	0
22	0	0	0
35	0	0	0
36	5	5	0
37	0	0	0
41	1	1	0
	15	**18**	**3**
		15/18 =	83.3%

#Carious Teeth

Case	Obs1	Obs2	Difference
3	1	1	0
4	3	3	0
7	0	0	0
9	4	7	3
10	0	1	1
12	2	2	0
14	4	5	1
22	1	1	0
35	1	1	0
36	-		0
37	1	1	0
41	2	4	2
	19	**26**	**7**
		19/26 =	73 1%

#Abscesses

Case	Obs1	Obs2	Difference
3	0	0	0
4	0	1	1
7	0	0	0
9	0	0	0
10	1	2	1
12	2	2	0
14	0	0	0
22	0	2	2
35	0	0	0
36	0	1	1
37	0	0	0
41	0	0	0
	3	**8**	**5**
		3/8 =	37 5%

#Pulp Exp Caries

Case	Obs1	Obs2	Difference
3	0	0	0
4	0	0	0
7	0	0	0
9	0	0	0
10	0	0	0
12	2	2	0
14	0	0	0
22	1	1	0
35	1	1	0
36	-	-	0
37	0	0	0
41	0	0	0
	4	**4**	**0**
	4/4 =		100 0%

#Pulp Exp Attrit'n

Case	Obs1	Obs2	Difference
3	0	2	2
4	0	0	0
7	0	0	0
9	0	0	0
10	0	0	0
12	0	0	0
14	0	0	0
22	0	0	0
35	0	0	0
36	-	-	0
37	0	0	0
41	0	0	0
	0	**2**	**2**
		0/2 =	0 0%

Age Category

Case	Obs1	Obs2	Difference
3	Y	Y	0
4	Y	Y	0
7	Y	Y	0
9	Y	M	1
10	O?	O	0
12	O?	O?	0
14	O?	O?	0
22	Y	Y	0
35	Y	Y?	0
36	O?	O?	0
37	Y	Y	0
41	O	O	0
n=12			**1**
		1/12 =	91 7%

Sex Estimation

Case	Obs1	Obs2	Difference
3	3?	3?	0
4	3	3	0
7	1	1	0
9	1	1	0
10	1	1	0
12	1	1	0
14	1	1	0
22	2	2	0
35	2	3	1
36	1	1	0
37	2	2	0
41	1	1	0
n=12			**1**
		1/12 =	91 7%

Avg Wear

Case	Obs1	Obs2	Obs1 Category[1]	Obs2 Category	Difference
3	10 1	11 1	heavy/mild	heavy/mild	0
4	5 7	6 7	-/mild	-/mild	0
7	10 7	13 2	-/mild	-/mild	0
9	9 4	10	-/mild	-/mild	0
10	11 1	11 6	heavy/mild	heavy/mod	1
12	-		-	-	0
14	6 1	7 6	-/mild	-/mild	0
22	2 5	2 5	mod/mild	mod/mild	0
35	13 5	16 5	-/mild	-/mild	0
36	-		-	-	0
37	6 1	7 7	mild/mild	mild/mild	0
41	8 3	8 9	-/mild	-/mild	0
n=10					**1**
				1/10 =	90 0%

[1] anterior \ posterior averages
*avg = (total / #cusps)

APPENDIX L: ADDITIONAL INDIVIDUAL OBSERVATIONS

Codes

Sex Estimation: 1 = Male; 2 = Female; 3 = Ambiguous
Age Estimation: Y = Young (18y-34y); M = Middle (35y-49y); O = Older (50+y); UA = Undetermined Adult; 9y = 9 years of age
Alveolar Resorption: 2.1@15 = alveolus measured 2.1 mm below cementoenamel junction at tooth 15; observation taken at molar region when possible; 1.0 mm is considered to be the normal pre-resorptive level

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
Uxbridge crania												
x28	2	Y				1.0@5						
x38	2	Y							✓	✓		
x100	2	M				severe						
x120	2	Y						✓				
x135	2	O				4.1@15						
x146	2	Y				2.2@15		✓		✓		
x147/mn	2	M				heavy						✓
x151	2	Y				0.9@14		✓				
x157	1	Y				2.2@15		✓		✓		
x159	2	Y				2.0@3	✓	✓	✓	✓		
x160	2	Y				2.4@15		✓				
x165	1	Y				2.6@14				✓		
x166	2	Y				1.7@15				✓		
x167	1	O										
x168	3	10y										
x169	1	M				5.0@15				✓		
x170	2	M				2.2@14			✓			

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
x171/mn[1]	1	M										
x172/mn451	3	7y					✓			✓		
x173	3	9y								✓		
x174/mn452	3	Y		✓		2.2@3		✓				
x175	2	Y				severe						
x176/mn445	1	M				severe			✓		✓	
x177[2]	1	Y	✓			1.5@15	✓	✓		✓		
x178/mn447	1	M				6.6@19		✓	✓		✓	
x179/mn448	3	9y										
x180	1	M				severe			✓			
x181	2	Y				4.0@15		✓	✓	✓		
x182	2	M	✓			2.4@3			✓	✓		
x183	2	M				2.9@14	✓			✓		
x184	1	Y		✓		2.0@14	✓	✓				
x185	1	Y				2.8@14				✓		
x186[3]	1	O				2.6@14	✓			✓		
x187	1	O										
x188	2	Y				1.8@14				✓		
x189/mn446	1	O				edentul.					✓	
x190	2	Y		✓		2.2@3		✓				
x191	2	M				severe						
x192	2	Y		✓		2.5@15			✓	✓		✓
x193	1	O				3.5@14	✓					
x194	2	M				2.4@15	✓					
x195	2	Y				2.6@15						

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
x196	2	M				3.4@4		✓		✓		
x197	1	O										✓
x198	2	M				2.1@15						
x199	2	Y				1.9@14	✓					
x200	1	Y				2.4@14	✓	✓				
x201	3	8y					✓					
x202	3	15y		✓						✓		
x203	3	18y										
x204	3	10y		✓						✓		
x205	3	M			✓							
x244	3	7y										
x253	3	6y										
x344	1	Y										
x345	3	5y										
x346	3	Y			✓	1.1@15				✓		
x347[4]	1	M				4.0@14	✓	✓		✓		
x348/mn444	1	Y		✓		4.5@3	✓					
mn453	1	M				present						
Uxbridge disarticulated mandibles												
mn66	2	UA					✓					
mn67[5]	1	UA				present	✓				✓	
mn69	3	UA				heavy		✓				
mn70	1	Y					✓				✓	
mn76	3	15y				0.9@19	✓	✓				
mn82	3	UA				heavy	✓					

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
mn88	2	UA				severe						
mn90	3	Y				present	✓					
mn93	1	M				6.6@30	✓					
mn95	1	Y				1.5@19		✓				
mn128	1	Y				present						
mn146	1	UA									✓	
mn165	2	Y				1.4@19		✓		✓		
mn169	2	UA				severe					✓	
mn183	1	Y				v. mild		✓				
mn223	1	UA				mod.	✓					
mn233	2	UA										
mn239	3	UA										
mn250	1	UA				present						
mn260	1	Y				0.3@18	✓	✓		✓		
mn265	2	UA				heavy		✓				
mn279	1	UA				heavy	✓					
mn313	3	4y										
mn325	3	5y										
mn335	1	Y				3.0@19		✓				
mn336	3	3y										
mn338	3	UA				heavy						
mn344	1	UA				present					✓	
mn351	2	UA				heavy					✓	
mn359	2	Y										
mn369	3	Y				1.8@14		✓				

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
mn379	2	UA										
mn382[a]	2	Y									✓	
mn385	1	UA									✓	
mn386	2	M									✓	
mn387	3	UA										
mn388	2	UA				heavy						
mn402	3	Y			✓	1.3@19	✓			✓		
mn410	1	UA				severe						
mn414	1	Y		✓		1.7@18	✓					
mn449	2	UA				present		✓				
mn455	1	UA				heavy					✓	
mn456	1	UA				present			✓		✓	
Uxbridge disarticulated maxillae												
x5	3	M				2.5@2	✓	✓				
x25	3	Y				1.7@14	✓	✓				
x60	3	O										
x64	3	Y				2.1@14	✓			✓		
x111	3	Y				2.4@14						
x113	3	M				heavy			✓			
x117	3	M				4.0@14	✓	✓				
x119	3	M				present						
x124	3	M										
x125	3	O				heavy						
x130	3	M										
x131	3	M				present						

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
x150	3	Y		✓		2.2@14	✓					
x153	3	Y				2.0@14						
x154	3	Y				1.9@14		✓				
x158	3	O				heavy						
x161	3	Y				3.2@3	✓		✓			
x162	3	Y				1.8@14	✓					
x163	3	Y				1.2@14						
x224	3	15y				none				✓		
x243	3	9y										
x251	3	6y								✓		
x260	3	6y								✓		
x272	3	3y								✓		
x298	3	3y										
x299	3	3y										
x319	3	3y										
x320	3	3y										
x321	3	4y										
x322	3	3y								✓		
B1	3	Y										
Kleinburg												
1	3	M				mod.						
2	1	O		✓		2.7@14	✓					
3	2	M				mod.						
4	2	Y				2.0@14	✓			✓		
5	3	Y				1.4@14	✓					
6[7]	3	M				2.5@14						

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
7	2	M				1.6@14	✓			✓		
8[8]	2	Y				1.7@2	✓					
11	2	Y				1.8@14				✓		
12	3	M				heavy	✓					
13	1	Y				1.9@14	✓					
14[9]	2	O				3.1@14	✓			✓		
15	1	Y				3.1@14	✓	✓	✓			
17[10]	2	M				2.6@14		✓				
18	1	Y	✓			1.9@14	✓					
19	1	O				present	✓					
20	2	Y				3.0@14	✓	✓		✓		
21	2	Y	✓			2.3@14	✓					
22	2	Y				3.0@6	✓	✓				
23[11]	1	O				3.6@14	✓					
25	1	Y				2.7@14						
27	1	O				severe						
28	2	Y				1.9@3		✓				
37	3	Y				1.6@14				✓		
40	1	Y				2.0@14	✓	✓	✓			
42	3	15y				none	✓			✓		
48	3	O				5.9@3	✓					
50	2	Y				1.8@3	✓					
51	1	O				3.2@3				✓		
57	2	O				mod.						
60[12]	2	M				3.7@5	✓		✓			

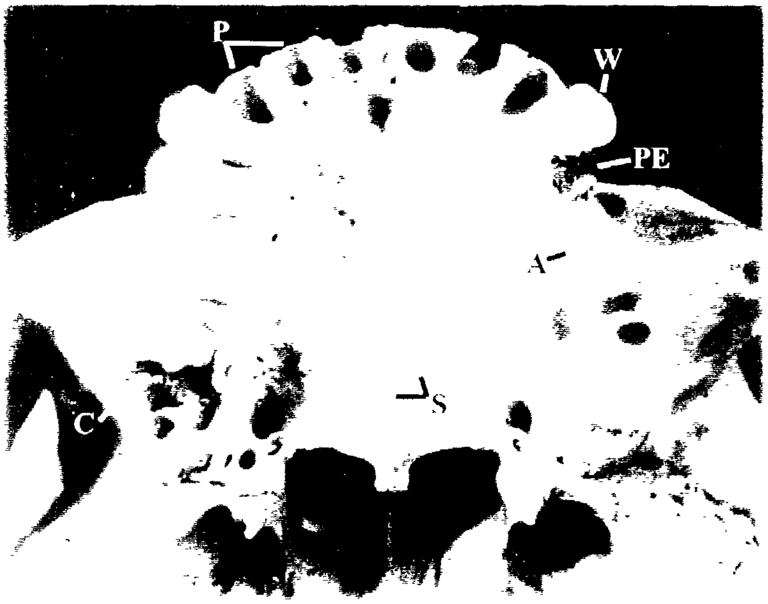
ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
61[13]	3	Y				2.3@3	✓	✓				
66[14]	1	M				3.3@14	✓					
70[15]	1	O				present						✓
72	2	Y			✓	2.3@14						
73	3	Y				1.9@6			✓			
74	1	O				heavy						
79	2	Y				2.5@14				✓		
B-2	2	O				3.3@30	✓	✓	✓			
B-3	2	M				4.9@16	✓		✓			
B-12	2	Y				1.7@14	✓	✓				
B-14	2	Y				1.7@14	✓				✓	
B-16	1	O				4.3@14	✓					
(?)-A-1	2	Y			✓	1.4@3	✓		✓			
Syers												
895.6.3	3	Y				2.4@14		✓	✓			
895.6.4	3	Y				heavy						
895.6.6	2	Y				1.8@14						
895.6.7	1	Y				1.8@14	✓					
895.6.9	1	Y				3.2@3	✓					
895.6.10	1	O				0.9@14						
895.6.11	2	M				3.5@2	✓					
895.6.12	1	O				heavy						
895.6.14[16]	1	O				3.7@15	✓	✓				
895.6.15	1	O				3.9@14	✓					
895.6.20	1	M				4.7@3	✓					

ID	Sex Estimation	Age Estimation	Supernumerary Tooth	Extra Cusp	Congenital Absence	Alveolar Resorption (mm)	Calculus	Enamel Hypoplasia	Hypercementosis	Tooth Staining	Mylohyoid Bridge(s)	Mandibular Dislocation
895.6.21	1	O				4.8@3	✓					
895.6.22	2	Y				min.		✓				
895.6.23	2	Y				1.7@14						
895.6.25	1	Y				present						
895.6.26	2	Y				2.0@3		✓				
895.6.30	3	Y				2.3@14				✓		
895.6.33	1	M				2.5@14	✓					
895.6.34	[illegible]	M				severe						
895.6.35	2	Y				1.7@14	✓			✓		
895.6.36	1	O										
895.6.37	2	Y				1.9@3	✓	✓		✓		
895.6.41	1	O				4.3@3	✓					

[1] Copper staining on the right sides of the maxilla and mandible.
[2] The supernumerary tooth appears deciduous. It is protruding from the alveolus and on an angle: the root is above tooth 3(M^1) and the crown is above tooth 4(P^4). Its presence has caused tooth 4 to rotate and to erupt closer to the palate than usual
[3] Tooth 5(P^3) is rotated 90°.
[4] Tooth 13(P^4) is rotated, causing crowding.
[5] Tooth 28(P_3) is peg-like and external to the tooth row on the lingual side.
[6] Both P_4s (tooth 20 and 29) are rotated.
[7] Possible cribra orbitalia. At least 6 cut marks were inflicted on the frontal bone while still green (perimortem trauma?).
[8] Possible cribra orbitalia, particularly porous in the right socket.
[9] Copper staining on left temporal bone and left zygomatic arch.
[10] Possible cribra orbitalia.
[11] Abscess present on the maxilla, under the orbit and near the infra-orbital foramen.
[12] Infection in the left temporomandibular joint.
[13] Possible cribra orbitalia.
[14] Left side premolars (tooth 12 and tooth 13) are both rotated 90° and are malaligned.
[15] Possible cleft palate, or very odd postmortem damage to anterior palate.
[16] Individual with an advanced case of infection (syphilis?) evident on the ectocranium - severe bone loss, particularly on the right parietal (some regions raised, some destroyed).

PLATE 1

SYERS OSSUARY: TYPICAL DENTAL OBSERVATIONS



INDIVIDUAL #895.6.20: OCCLUSAL WEAR (W), ANTEMORTEM TOOTH LOSS (A), CARIES (C), PULP EXPOSURE (PE), POSTMORTEM TOOTH LOSS (P), SUTURES (S)

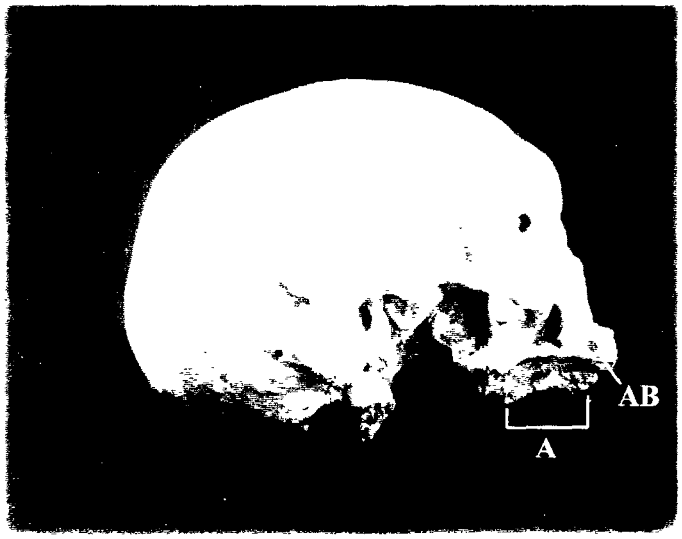
PLATE 2

SYERS OSSUARY MANDIBLE

INDIVIDUAL #895.6.22: CARIOUS LESION (C),
IMPACTED 3RD MOLAR (M), POSTMORTEM TOOTH LOSS (P)

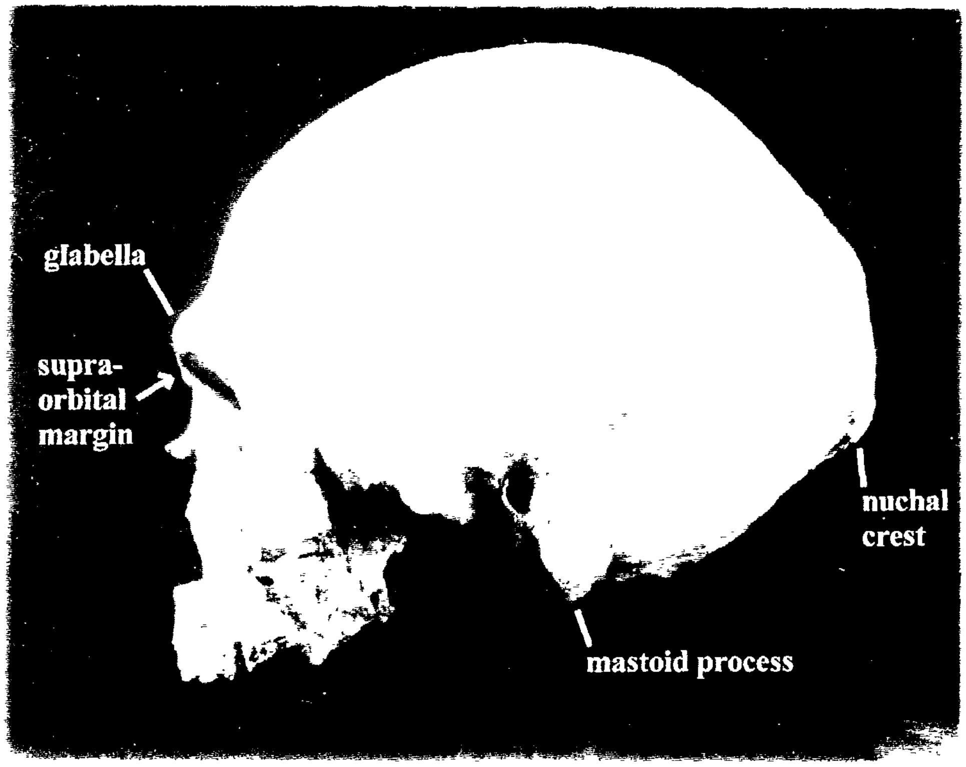
(photos courtesy of the Royal Ontario Museum)

PLATE 3
MULTIPLE ANTEMORTEM TOOTH LOSSES AND AN ALVEOLAR ABSCESS



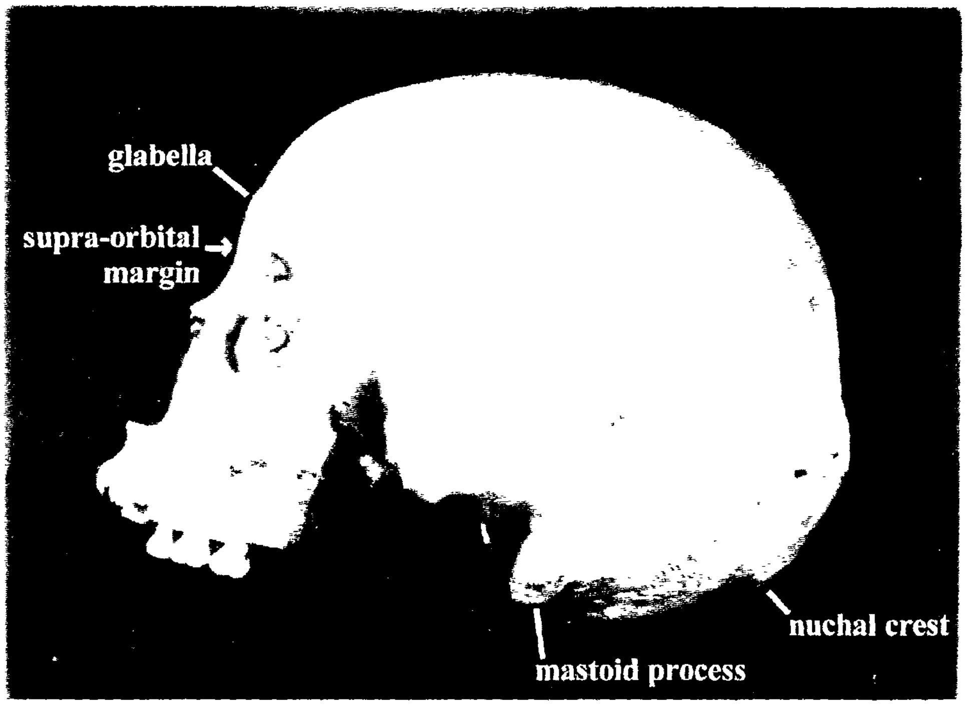
Syers Ossuary, individual #895.6.34:
antemortem tooth losses (A), abscess (AB)
(photo courtesy of the Royal Ontario Museum)

PLATE 4
MALE SEXUAL DIMORPHIC FEATURES OF THE CRANIUM



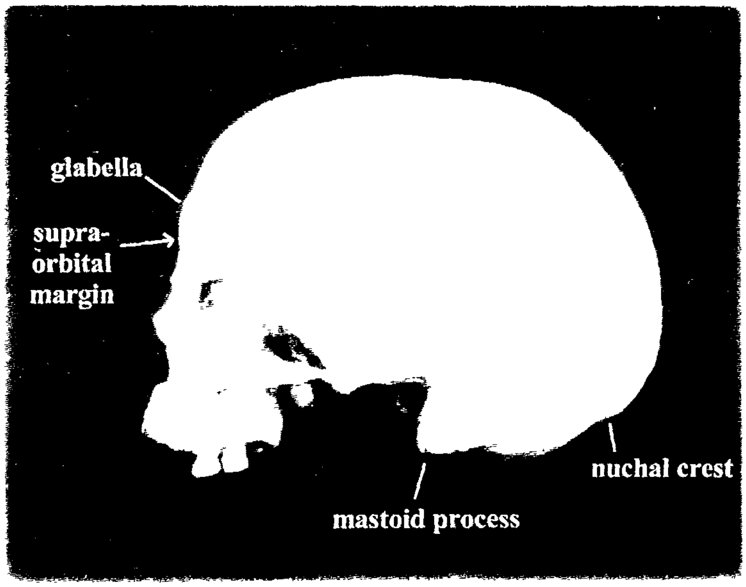
Syers Ossuary, individual #895.6.12: male sexual dimorphic features, left side (photo courtesy of the Royal Ontario Museum)

PLATE 5
FEMALE SEXUAL DIMORPHIC FEATURES OF THE CRANIUM



Syers Ossuary, individual #895.6.6: female sexual dimorphic features, left side (photo courtesy of the Royal Ontario Museum)

PLATE 6
AMBIGUOUS SEXUAL DIMORPHIC FEATURES OF THE CRANIUM



Syers Ossuary, individual #895.6.30: ambiguous sexual dimorphic features, left side (photo courtesy of the Royal Ontario Museum)