University of Alberta

Dental Disease in Roman Period Individuals from the Sodo and Terontola, in the Territory of Cortona, Italy

by

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ABSTRACT

This study presents the results of a pathological examination of the dental remains of nine individuals from the territory of Cortona (Tuscany), dated to the Late Republican period (first century BC to first century AD). Eight of the individuals were excavated from the area of the Sodo tumuli, Etruscan funerary mounds dating to the sixth century BC, and a single individual from the nearby modern city of Terontola. The sample was examined for caries, abscesses, antemortem tooth loss, calculus, and enamel hypoplasia. Analysis reveals a high prevalence of caries, consistent with an agrarian diet, and enamel hypoplasia, indicative of poor health during childhood. Comparison of these data with those from other studies on Etruscan and Roman populations suggests that although the "typical" Mediterranean regimen of grains, legumes, and olives was consumed throughout the region, significant differences existed between populations in terms of the day-to-day diet.

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CHAPTER 1: INTRODUCTION

The last centuries BC and first centuries AD saw the expansion of Roman control across the Italian peninsula, and throughout Europe, the Near East and North Africa. This was a period of cultural change during which many aspects of Roman culture were adopted by local populations to serve specific ends. Other aspects were rejected or were somehow altered or combined with existing cultural strategies to create new, unique traditions (Wallace-Hadrill 2008: 10). Conventionally, these processes have been obscured by the blanket term 'Romanization', which has increasingly been criticized for implying a passive adoption of homogeneous traditions across a wide geographic area (Mattingly 2011, Terrenato 1998, Wallace-Hadrill 2008).

In an attempt to bypass these problems, Wallace-Hadrill (2008: 13) suggests thinking about Roman expansion in terms of the coexistence of "multiple identities" in the colonized regions. He suggests that a single individual could be bilingual, embody a unique combination of Roman and indigenous characteristics, and consider him- or herself to be both Roman and non-Roman. Additionally, a number of authors have emphasized the importance of a regional approach, where individual areas are examined for their own unique combination of Roman and non-Roman cultural characteristics (Mattingly 2011, Terrenato 1998, Witcher 2006). In this paradigm, overarching models and generalizations are abandoned, at least temporarily, for local explanations based on the archaeological and historical evidence from a given area.

The territory of Cortona, located in northern inland Etruria's Val di Chiana, is a prime candidate for a regional approach to Romanization. Throughout their histories, Etruscan and Roman cultures impacted and influenced one another through trade, warfare, and various other forms of contact (Barker and Rasmussen 1998, Johnson 1996, Toynbee 1971). Although the diffusion of cultural attributes between Etruria and Rome existed for centuries, this process intensified and became decidedly uneven in the fourth century BC as the Romans began to take control of the region. Between the fourth and second centuries BC the various city-states of Etruria succumbed to Roman rule and were subjected to varying amounts of castigation, dependent largely on the degree to which they resisted Roman invasion (Barker and Rasmussen 1998, Harris 1971, Scullard 1967, Torelli 1986).

Scholars agree that, relative to many of the other Etruscan city-states, the territory of Cortona had a nonviolent incorporation into the expanding Roman Empire. The new relationship was predominantly characterized by the signing of truces and the stability of the existing social hierarchy (Fracchia 2006, Harris 1971). Unfortunately, although great strides have been made in the last several decades, many of the details of this process remain unknown. The degree to which various aspects of the pre-existing Etruscan culture were kept, lost, or transformed in the Roman period is unclear. Additionally, the movement of people as well as ideas has complicated the issue, as scholars strive to interpret the cultural and biological make-up of the region throughout this time period (H.

Fracchia, pers. comm.). More information is needed to truly understand how the region shaped a place for itself after Roman conquest.

Nearly all of our knowledge of the Etruscans comes to us from the texts of Greek and Roman writers, who began documenting the Etruscans long before, and continued long after, their assimilation (Harris 1971, Spivey and Stoddart 1990). The Etruscans themselves are viewed as a 'proto-historic' society by historians: they developed writing some time before 700 BC but the surviving texts are few and restricted in content (Barker and Rasmussen 1998). Archaeological and other "on the ground" studies have been an invaluable source of information on the Etruscans, particularly in the sphere of Etruscan tombs and other monuments, material culture, and art (e.g. Dennis 1883, Izzet 2007, Oleson 1982, Spivey and Stoddart 1990, Zamarchi Grassi 1992). Etruscan skeletal studies have traditionally focused on cranial metrics (e.g. Claassen and Wree 2004, Sergi 1900-01) and establishing the Etruscan typology, with an increasing emphasis on variations within and between populations (e.g. Moggi-Cecchi *et al.* 1997, Rubini *et al.* 1997). Recently, ancient DNA studies have proliferated, often with the goal of determining the biological and geographic origin of the Etruscans (see Perkins 2009 for a review of recent Etruscan DNA studies).

The site at Sodo, in the territory of Cortona, consists of two Etruscan funerary mounds dated to the sixth century BC. Throughout the sixth, fifth and fourth centuries BC the tumuli were used and re-used for burial by the local elite before they fell into disuse in the third century BC (Vallone 1995). In the Roman period, the tumuli once again became a burial location when a number of individuals were interred in and around the earthen mounds. These individuals were identified as low status from the paucity of grave goods and the burial form, *a cappuccina*, which was common for low status individuals (Barker and Rasmussen 1998: 234, Toynbee 1971: 101). Fourteen individuals from the first century BC to the first century AD were recently made available for study by the Museo dell'Accademia Etrusca e della Città di Cortona (MAEC) and eight of these were examined for pathological conditions of the teeth. Additionally, the first century BC to first century AD grave of one individual from Terontola, located approximately 9 kilometres south-east of the Sodo tumuli, was made available. This individual was also evaluated for dental disease. Limited skeletal analysis was completed on the remains from both the Sodo and Terontola, although data collection was hampered by the poor preservation of the remains.

The value of the Sodo and Terontola samples in contributing to a better understanding of the Romanization of the territory of Cortona is clear. Not only do they provide skeletal data from a region and time period of which there is very little but they also represent a population that is both temporally and spatially defined. Being such an obviously small portion of the local population, the remains unfortunately do not provide an accurate sample for palaeodemography studies. They do, however, provide an interesting glimpse into the inhabitants of a specific territory in the Late Republican period and are valuable in attempts to understand how the Etruscan Val di Chiana was reconstructed culturally, biologically and physically in the Roman period.

The primary purpose of this thesis, then, is to contribute to the discussion of the Romanization of the Val di Chiana by providing information on the individuals inhabiting the territory of Cortona between the first century BC and the first century AD. To achieve this goal, the specific research objectives are: (1) to identify pathological lesions in the dentition of the skeletons from Sodo and Terontola; (2) to explore these data in the context of Romanization of the Val di Chiana, particularly with respect to diet and health.

This study will evaluate the dental data obtained from the Sodo and Terontola in light of existing information on the Romanization of the region. As such, Chapter 2 provides the cultural, historical and spatial background necessary to interpret the skeletal material. Chapter 3 discusses the site at Sodo, chronicling its use as a burial location and its excavation history, and provides a framework for interpreting the re-use of burial spaces, examining similar instances throughout the Roman world. Chapter 4 first outlines the preservation issues with the Sodo sample and the materials and methods used to collect and evaluate data from the skeletal remains. Chapter 4 then goes on to provide an examination of the pathological conditions identified in the teeth of the Sodo sample, including broad links to diet and behaviour. Chapter 5 examines the individual from Terontola independently and evaluates his relevance to the study of the Sodo material. Finally, Chapter 6 provides a summary and discusses conclusions.[1]

[1] Elements of this thesis have already been published in a report submitted to the Museo dell'Accademia Etrusca e della Città di Cortona, and the Soprintendenza per i Beni Archeologici della Toscana.

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CHAPTER 2: THE SPATIAL, CULTURAL, AND HISTORICAL CONTEXT OF THE VAL DI CHIANA

INTRODUCTION

This study examines available skeletal data from the Etruscan Sodo tumuli and Terontola in order to contribute to a fuller picture of the 'Romanization' of the Italian Val di Chiana. Such an examination cannot be completed outside a comprehensive, historical context. This chapter outlines the temporal, spatial and cultural framework within which the analysis should be considered.

ETRURIA

Etruria was located in central Italy and was comprised of portions of what are now Tuscany, Umbria and Latium. Etruria-proper was bordered by the Tyrrhenian Sea to the west, the Arno River to the north, the Tiber River to the south and east, and the Apennine Mountains to the north-east (Figure 2.1). Today, the climate of Etruria is typically Mediterranean with summer temperatures varying between 30 and 35°C and winter temperatures between 2 and 7°C. The average yearly rainfall in the region varies between 700 and 1,000mm, with most of the precipitation occurring in autumn and winter (Barker and Rasmussen 1998: 25).

Etruria's natural boundaries may have been the Arno and the Tiber, but Etruscan expansion took the culture well beyond these limits: north into the Po Valley and south into Campania (Nielsen 1984: 255, Torelli 1975). Moreover, the Etruscan "Tarquin" dynasty ruled Rome for roughly a century until they were expelled in 509 BC and the Etruscans have been credited with having a profound influence on the development of the early Roman Republic (Barker and Rasmussen 1998: 139-40).

The Etruscan culture first appeared in the seventh century BC, when the Iron Age Villanovan traditions of central Italy gave way to the Orientalizing period, heavily influenced by the Greek and Phoenician cultures (*Ibid.*: 1-6).[1] The term 'Etruscan' refers to people associated with what is perceived to be a different material culture than their Iron Age predecessors, although it is notable that the inland cities of northern Etruria were not as subject to Eastern influence and remained tied to their Villanovan traditions much more than the coastal and southern cities (Torelli 1986).

Etruria was divided into a series of autonomous settlements.[2] Initially these settlements were monarchies, each ruled by its own king (Holder 1999: 33). Later, these kings were superseded by aristocratic families, the *principes*, and Etruria became a collective of oligarchical city-states. Despite civil and diplomatic ties between the various sovereign territories, specifically the famous League of the Twelve (Etruscan) Peoples, the city-states remained independent

[1] There has been much debate in the literature as to whether this change involved the immigration of new people, or whether it was a progression of material culture within a continuous occupation. "Virtually all archaeologists now agree that the evidence is overwhelmingly in favour of the 'indigenous' theory of Etruscan origins: the development of Etruscan culture has to be understood within an evolutionary sequence of social elaboration in Etruria…" (Barker and Rasmussen 1998: 44).

[2] As with Etruria itself, Etruscan settlements and the individual properties within them were usually delineated and defined by natural boundaries such as rivers, valleys and mountains. Division of land was fundamental to the Etruscan world view and boundaries were viewed as immutable; handed down from the gods (Edlund-Berry 2006, Jannot 2005).

and there is little evidence that they presented a clear, unified political force (Harris 1971: 96).

Throughout Etruria social stratification intensified and a division is discernible between the aristocracy and what Terrenato (1998) refers to as the "dependent" class.[3] The power of the *principes* over this dependent class extended in part from their control of the prophets or haruspices. Religion permeated all aspects of Etruscan life and this close relationship with divinity appears to have reinforced the authority of the ruling class (Jannot 2005).

The Etruscans understood their civilization to be divided into a series of periods of varying lengths called *saecula*, the details of which were predetermined by the gods but unknown to the people. According to this system, the Etruscan civilization began in approximately 970 BC with the beginning of the first *saeculum* and would have a finite end with the close of the tenth *saeculum* (Harris 1971).

Historians mark the Etruscan Age as beginning slightly later and divide it into the following periods (after Barker and Rasmussen 1998: 5-6):

700 BC-570 BC – the Orientalizing period; Eastern influences brought about changes in material culture that coincided with the rise of city-states and an increase in ostentation

570 BC-470 BC – the Archaic period; the height of Etruscan power and influence

[3] While many labels, including "serfs" and "slaves" have been utilized in attempts to describe the dependent class, the actual nature of the relationship is unclear and likely varied between territories (Harris 1971, Terrenato 1998, Torelli 1986).

470 BC-300 BC – the Classical period, sometimes included within the Archaic period; saw the gradual retreat of Etruscan power

300 BC-31 BC – the Hellenistic period; characterized by the Roman conquest and acculturation of the Etruscan peoples

THE VAL DI CHIANA AND THE TERRITORY OF CORTONA IN THE ETRUSCAN PERIOD

The Val di Chiana[4] is a 1,367 square kilometre watershed between the Tiber Valley and the Ombrone Valley (Alexander 1984: 528). Sitting at the boundary between the 'anti-Apennine' and the 'pre-Apennine' hills and intersecting with a number of routes to the Tiber Valley, the Val di Chiana is an important transit corridor through northern inland Etruria (Figure 2.2). To the west, the sandstone, clay and limestone anti-Apennines reach several hundred metres above sea level (asl). Beginning in the Val di Chiana and continuing to the east, the predominantly limestone pre-Apennines rise irregularly from the valley floor (Barker and Rasmussen 1998: 16-19). Throughout the Val di Chiana these hills separate a western string of hot springs from the eastern cold springs (Fracchia 2006: 20).

Today, the valley floor descends from 260 metres asl at Chiusi to 243 metres asl at Arezzo and the mountainous boundary ranges from altitudes of 600 metres to 1,148 metres asl (Alexander 1984: 528). Once a shallow lake as far as Arezzo, the Val di Chiana was drained by the Etruscans in the late seventh or early sixth century BC so they could take advantage of the highly fertile alluvial

[4] Also called the Valdichiana and the Chiana, or Clanis, River Valley

deposits (Fracchia 2006: 20). Despite the slow moving waters of the Chiana River and the subsequent siltation issues, the Val di Chiana possessed "an agricultural potential unequalled in central Italy" (Vallone 1995: 109, for siltation see Alexander 1984: 531-2). Even by the fourth century BC, Chiana grain was exported as far away as Rome, where it was prized for its high gluten content and enormous yields (Fracchia, pers. comm.).

In the Etruscan period, the Val di Chiana would have likely supported deciduous forest, with a variety of trees including willow, alder, oak, ash, and elm extending up the slopes to about 1,000 metres asl (Barker and Rasmussen 1998: 38). Fracchia (1996) argues that the archaeological evidence suggests that the lower slopes of the south-eastern Val di Chiana were densely populated in this period, in the form of small settlements and isolated establishments. Due largely to farming and herding practices, the original tree cover gradually opened up so that, by the Roman period, the valley was a predominantly open landscape (Barker and Rasmussen 1998: 40).

The city of Cortona was one of twelve major Etruscan centres located between the Arno and the Tiber, and one of three (along with Arezzo and Chiusi) found within the Val di Chiana (*Ibid.*: 143).[5] The city sits in a saddle on Mt. Sant'Egidio, between 450 metres and 550 metres asl, while the sixteenth century fortress of Girifalco sits on the summit at 650 metres asl (Cataldi and Lavagnino 1990: 49, Holder 1999: 20). Continuous occupation of Cortona into modern times

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[5] While Cortona was certainly a *dodecapolis* (one of the twelve ruling city states of Etruria) by the third century BC, there is some disagreement as to whether it was a founding member of the original Etruscan league (*cf.* Fracchia 1996: 198, Holder 1999: 33, Torelli 1975)

has obliterated most traces of the Etruscan and Roman settlement, but it is generally agreed to have most likely run down the western slope of the hill, in a similar manner to the modern settlement (Scullard 1967: 156-7).

Below the city, the slopes of Mt. Sant'Egidio provided forage for grazing animals, workable sandstone and timber for building, and an ample supply of copper, iron and other minerals (Holder 1999: 21). In the Orientalizing and Archaic periods particularly, Cortona was a centre for decorative bronzework and other forms of metallurgy (Boitani *et al.* 1975: 50, Holder 1999: 30). The valleys around Cortona were also home to naturally occurring clay beds that provided the material for brick, tile and other ceramics (Fracchia 2006: 20; Holder 1999: 22). The wealth of the city, however, was primarily agricultural: the floor of the Val di Chiana provided extensive, fertile agricultural land and Etruscan crop husbandry involved the expanded cultivation of a wide range of cereals, legumes and tree crops (Barker and Rasmussen 1998: 182-184, Fracchia 2006: 12).

Animal husbandry in the Etruscan era included animals such as horses, donkeys, chickens, cattle, sheep, goats, pigs, and dogs, and the period saw an increased emphasis on producing secondary products from these domesticates, such as cheese, milk, and wool (Barker and Rasmussen 1998: 185). While hunting was not a vital subsistence practice, it may have been an important contributor to the elite diet, and the detection of wild foods such as fruit, nuts and large and small game at archaeological sites suggests local use of seasonal resources to compliment crops and domesticates (*Ibid.*: 200). Forniciari and Mallegni's (1987) study of strontium and zinc levels in two Etruscan populations indicate that generally, the diet came to rely increasingly on vegetable and plant-related foods and less on animal derived protein.

The wealth of goods and foodstuffs in the Val di Chiana stemmed not just from local resources but also from the valley's location in a trade network that extended across the Italian peninsula and beyond. Through the numerous routes that passed through the valley, the territory of Cortona was well-connected to the upper Tiber Valley to the east, the Ombrone River Valley to the west and, by extension, the Adriatic and Tyrrhenian coasts (Fracchia 2006: 21-2). Additionally, at the centre of a triangle formed by Arezzo, Perugia, and Chiusi, Cortona is less than a day's journey on horseback from all three (Holder 1999: 23, see also Cataldi and Lavagnino 1990: 49). This proximity was crucial, as economic exchange at the local and regional scale was integral to the Etruscan economy (Barker and Rasmussen 1998: 210-2).

ROMAN CONQUEST OF ETRURIA

Roman expansion across the lands of Etruria was lengthy process, marked by a series of major battles, small skirmishes and discrete treaties that bound Rome to the individual city-states one at a time. While the bulk of the fighting took place in the fourth and third centuries BC, total 'conquest' was not truly completed until several centuries later. But as the increasing pressure of Roman military and political forces became inescapable, the Etruscan cities ultimately succumbed and subsequently struggled to adapt to their new reality.

The Romans established a frontier in Southern Etruria by the early fourth century BC with the fall of Veii in 396. The town's territory was subsequently divided among Roman settlers and the Veientane survivors were likely enslaved. The defeat of Veii provided the Romans with a foothold in Etruria and left the land beyond exposed to Roman advancement. After this initial establishment of Roman settlers in the South and the subsequent establishment of Latin colonies nearby at Sutri and Nepi, the Roman conquest of Etruria progressed northward. The final series of Etruscan wars with Rome began in 311 BC and included most of the important towns of northern inland Etruria, including Arezzo, Chiusi, Cortona, Perugia, Volterra, and Volsinii (Harris 1971: 47, 96).

In 310 BC *indutiae*, or truces, of thirty years were signed between Rome and Perugia, Arezzo, and Cortona (Harris 1971: 54, Scullard 1967: 273). Cortona's initial status (i.e. *municipium, colonia* or *praefectum*) after the truce is unknown and, as a result, its level of self-governance and submission to Rome is unclear. Although, through the conditions of the truce, life in Cortona was to continue relatively uninterrupted, the city would have certainly been forced to pay taxes to the Roman government and supply soldiers to the Roman army (Holder 1999: 43-5). The resulting depleted labour force, in addition to the loss of capital, would have had serious repercussions on the local economy and, potentially, social structure. Like other city-states, however, Cortona would have received little by way of economic or political benefits in return (Harris 1977: 58).

The Social War of 91-88 BC was relatively uneventful for Cortona, as it remained allied with Rome against the other tribes of the Italian peninsula. While the general Sulla's passage through the Val di Chiana wreaked havoc on the territories of Chiusi and Arezzo, Cortona appears to have survived unscathed (Fracchia 2006: 34). By the end of 89 BC, the last of the Etruscan families received Roman citizenship (Harris 1971: 231). The Etruscans were also registered into Roman tribes for voting and bureaucratic purposes and Cortona was registered into the tribe *Stellatina*, along with Tarquinia, Tuscania, Nepi and others (Barker and Rasmussen 1998: 292, Harris 1971: 244, Torelli 1986).

With the Roman civil wars between Marius and Sulla, beginning in the second decade of the first century BC, the Etruscans' recent good fortune floundered. Almost unanimously, the city-states of Etruria sided with Marius and, subsequently, were punished by the victorious Sulla (Barker and Rasmussen 1998: 266, Harris 1971: 251, Torelli 1986). Centres of resistance to Sulla included Chiusi, Arezzo, Populonia and Volterra; fierce battles were fought at all of these places (Torelli 1986). After the defeat of Marius, Sulla severely limited the privileges enjoyed by the Etruscan people and seized huge tracts of land to penalize them for their disloyalty. Particularly in the territories of Fiesole, Arezzo, Volterra and Chiusi, land was confiscated and redistributed among Sulla's veterans as reward for active service. These veteran colonies had a devastating and demoralizing effect on the people of northern inland Etruria. Many, now landless, emigrated to Africa and Spain; those that stayed behind never fully recovered from the aggressive and devastating invasion (Barker and Rasmussen 1998: 266, Torelli 1986).

THE INHABITANTS OF ETRURIA BETWEEN THE FIRST CENTURY BC AND THE FIRST CENTURY AD

Although the separation of ‘Etruscan’ and ‘Roman’ becomes an increasingly problematic distinction to maintain into the second and first centuries BC (e.g. Fracchia 2006: 14, Holder 1999: 46), there remains a rationale for attempting to determine the ancestry, or ancestries, of the inhabitants of a given area. ‘Romanization’, the process of acculturation in which local language, religion, dress and other cultural aspects are replaced by Roman traits, has been criticized in recent years for the implication of Roman cultural dominance over conquered peoples and for conjuring images of uniformity between the Roman provinces (e.g. Wallace-Hadrill 2008: 9-14). For the purposes of this paper, ‘Romanization’ will be employed as defined by Harris (1971: 147): “the process by which the inhabitants came to be and to think of themselves as Romans.” It is important to bear in mind, however, that the population of Etruria was heterogeneous and the degree to which the different inhabitants self-identified as Roman would have varied across families, territories and social statuses. Determining the biological and cultural ancestries of the inhabitants of Etruria can help provide clues as to the true composition of ‘Roman Etruria’.

In the third and second centuries BC Roman colonization of Etruria was limited and despite several Latin colonies in the South, the majority of Etruria had yet to be occupied by Roman colonists (Harris 1971: 97). The Romans likely chose not to colonize extensively in Etruria because they were able to ensure the security of their interests through the preservation of the existing social structure and the local *principes* (Harris 1971: 202, Torelli 1986). With Etruscan society sharply divided between the aristocratic *principes* and the dependent class, Rome was able to enlist the help of the former against the latter: providing a method of maintaining security that made colonization largely unnecessary. As such, despite their numerous military victories the Romans founded no Latin colonies in northern Etruria before the first century BC (Barker and Rasmussen 1998: 266). Roman colonies in the South were more prolific although initially they were predominantly military bases, essential for further expansion, rather than civil colonies (Harris 1971).

Harris (1977: 56) argues that despite a lack of evidence, it is probable that Rome confiscated land from the territories of Perugia, Chiusi, Arezzo, Cortona, Roselle, and Volterra and converted it into *ager publicus* for settlement and agriculture by 270 BC. How much of this land actually accommodated Roman settlers as opposed to simply providing revenue for the Roman treasury is uncertain, however, as is whether such seizures of land affected all of these city-states. Furthermore, recent archaeological evidence from the territory of Cortona suggests that the distribution of Etruscan villages along the valley floor remained unchanged from the sixth century BC to the first century AD (H. Fracchia, pers. comm.).

Latin settlement of the territories of Arezzo and Tarquinia certainly occurred between 133 and 123 BC, with the land reform laws of the Gracchi (Torelli 1986).[6] Less than half a century later, the Sullan colonies at Fiesole,

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[6] Also associated with the establishment of Roman colonies is the relocation of the various Italic peoples. As part of their land reorganization strategies, the Romans habitually forced Etruscans,

Arezzo, Chiusi and Volterra significantly increased the number of Roman settlers in northern inland Etruria (Barker and Rasmussen 1998: 266, Harris 1971: 261-3). Cortona has been put forward as another potential Sullan colony site but there is no clear evidence to support this claim and Harris (1971: 264 n.9) suggests that this assertion is due to the confusion of Cortona with Croton, the Hellenistic settlement in modern Calabria.

In the last decades leading up to the turn of the millennium, Arezzo again saw the establishment of Roman colonies, along with Perugia, Siena and several other city-states (Harris 1971: 306-10, Torelli 1986). Unlike Sulla's veteran colonies, however, these new colonies contributed to the "economic and social stabilization and reconciliation" of these areas (Torelli 1986: 62). This "stabilization and reconciliation" was, in Perugia, undoubtedly hampered by the violent nature of the settlement: in addition to redistributing much of the land surrounding the city, Octavian's orders called for the slaughter of most of the wealthy Perugini (Harris 1971: 309, Torelli 1986). Regardless, the Augustan settlements are attributed with accomplishing a great deal in terms of the 'Romanization' of Etruria (Harris 1971: 313-4).

By the first century BC, then, there were a number of Roman colonies in northern inland Etruria, specifically in the territories adjacent to Cortona. Yet none of the evidence argues for a significant number of Roman immigrants within the territory of Cortona itself despite the specific mention of other city-states, including nearby Arezzo. One can hardly be expected to believe that despite all

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Umbrians, Lucanians and other Italic tribes to move around the peninsula (H. Fracchia, pers. comm.).

types of contact between Cortona and the surrounding areas, as well as Cortona's military defeat and subsequent submissiveness to Rome, there was a complete absence of Latin colonists in her territories. The evidence seems, however, to indicate that Cortona was not overrun with immigrants in the same way as many of the other Etruscan city-states.

THE ROMAN VAL DI CHIANA AND THE ROMANIZATION OF CORTONA

Throughout the Late Republican and Early Imperial periods, the cities of Southern Etruria began to fade in importance while the cities of the North, including Cortona, remained vital economic power centres (Bonfante 1986: 11). A major contributor to the survival of the Northern cities was the Roman road system, which came to consist of four principal roads in Etruria: the Via Aurelia which ran parallel to the Tyrrhenian coast, the Via Flaminia which ran across Southern Etruria and Umbria to the Adriatic coast, and the Vie Clodia and Cassia, both of which ran through central Etruria (Harris 1971: 161). The Via Cassia, dated to the first half of the second century BC, ran through the Val di Chiana past the base of Mt. Sant'Egidio, following the route of the earlier Etruscan road almost exactly as it linked Cortona to Arezzo, Chiusi and beyond (Harris 1971: 161-8). Such proximity to the principal overland route through Etruria surely facilitated the exportation of grain and other commodities from the lands around Cortona (Barker and Rasmussen 1998: 23, Harris 1971: 161-8, Harris 1977: 57).

Fracchia (2006: 30) describes the third and second centuries BC as belonging to a "general trend of architectural monumentalization and spatial definition" as Cortona vied for position in the new Roman reality. Although construction within the walls would have been limited by the existing city, Cortona certainly saw the erection of Roman baths. The presence of other typical hallmarks of a Roman town, such as a theatre and basilica, is also likely, though no traces remain (Fracchia 2006: 34-5, Holder 1999: 45, Torelli 1986). Through the adoption of such significant Roman social institutions, the *principes* of Cortona displayed a willingness to Romanize in the public sphere and this 'self-Romanization' guaranteed minimum social upheaval (Fracchia 2006: 35). Consequently, the traditional class system persisted in northern inland Etruria and, despite a severe crisis in the first half of the second century BC, endured into the first century BC (Harris 1971: 202-12, Torelli 1986)[7].

In the territory around Cortona, a number of small rural holdings, associated with a rapid population expansion, began to appear in close proximity throughout the valley in the early third century BC. After the Battle of Trasimeno and the associated devastation of 217 BC, the entire countryside around Cortona was deserted, although by the late third and early second centuries BC there was intense repopulation of specific areas, with concentrations detectable in the vicinity of the modern municipalities of Camucia and Terontola (Fracchia 2006: 11). While there is evidence for the concentration of land (and, resultantly, power) at the turn of the second century BC, in general the rural settlement pattern in the Val di Chiana appears to have remained largely unchanged (Fracchia 1996,

[7] The system was not without changes, however, and the dependent class was able to partially integrate into the Etruscan political system. Throughout the second century BC, a number of subordinate farmers came to own and work small tracts of land around Perugia, Chiusi, Volterra and Arezzo (Torelli 1986).

Fracchia 2006: 25-7). Terrenato (1998) has argued convincingly that in Volterra, the endurance of settlement pattern was related, at least in part, to the interwoven nature of social order, landholding practices, religion and ideology. Whatever the reason, evidence for a number of villas and rural hamlets has been discovered throughout the valley, indicating a continuation of Etruscan habitation sites (Fracchia 1996).[8]

The late second century and early first century also saw the function of locations that had been important to the Etruscan population "transformed" to have a different importance in the new Roman reality (Fracchia 2006: 14). Etruscan shrines and springs associated with healing waters became sites for Roman baths and, throughout the valley, a number of villas have been identified on the sites of Etruscan tombs, sanctuaries, or other "cult" places (Fracchia 2006). This was a period of true absorption: Latinization, followed subsequently by Romanization, occurred to the extent that by the third decade of the first century BC, "Etruria no longer existed as a separate entity" (Barker and Rasmussen 1998: 292, see also Bruun 1975: 496, Harris 1971: 318).

Throughout this period, however, there is evidence that many of the powerful Etruscan families continued to own their land and to fill politically important positions in the running of Cortona. At the villa at Ossaia, located approximately halfway between Camucia and Terontola on the Roman Via Cassia and dated to the late second or early first century BC, the earliest owners were of

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[8] Although Witcher (2006) notes that the lack of large-scale and systematic surface surveys limits our ability to draw conclusions about the settlement pattern in the Val di Chiana in the Early Imperial period.

Etruscan descent, though they displayed significant ‘Romanization’ in terms of language and fashions (Fracchia 2006). The famous first century BC *L’Arringatore*, or The Orator, statue found near the shores of Lake Trasimeno depicts Aulus Metellus: a member of a wealthy Etruscan family. This statue displays an interesting combination of Roman and Etruscan characteristics, as it portrays an individual from an Etruscan family in a Roman-appointed government position, in Roman dress with the Latinized version of his name inscribed on his toga in Etruscan (H. Fracchia, pers. comm.). This continuity of people and place, with the gradual adoption of Roman attributes, characterizes the Romanization of the Val di Chiana as a whole and the territory of Cortona in particular.

CONCLUSION

Analysis of the inhumations from the Sodo tumuli and Terontola is only valid within a thorough understanding of the cultural context presented above. With the necessary background information established, it is now possible to move forward into an examination of the archaeological context of the burials themselves.

Figure 2.1. Map of central Italy showing Pisa, Rome, and significant Etruscan settlements. (Adapted from Barker and Rasmussen 1998, Fig. 4).

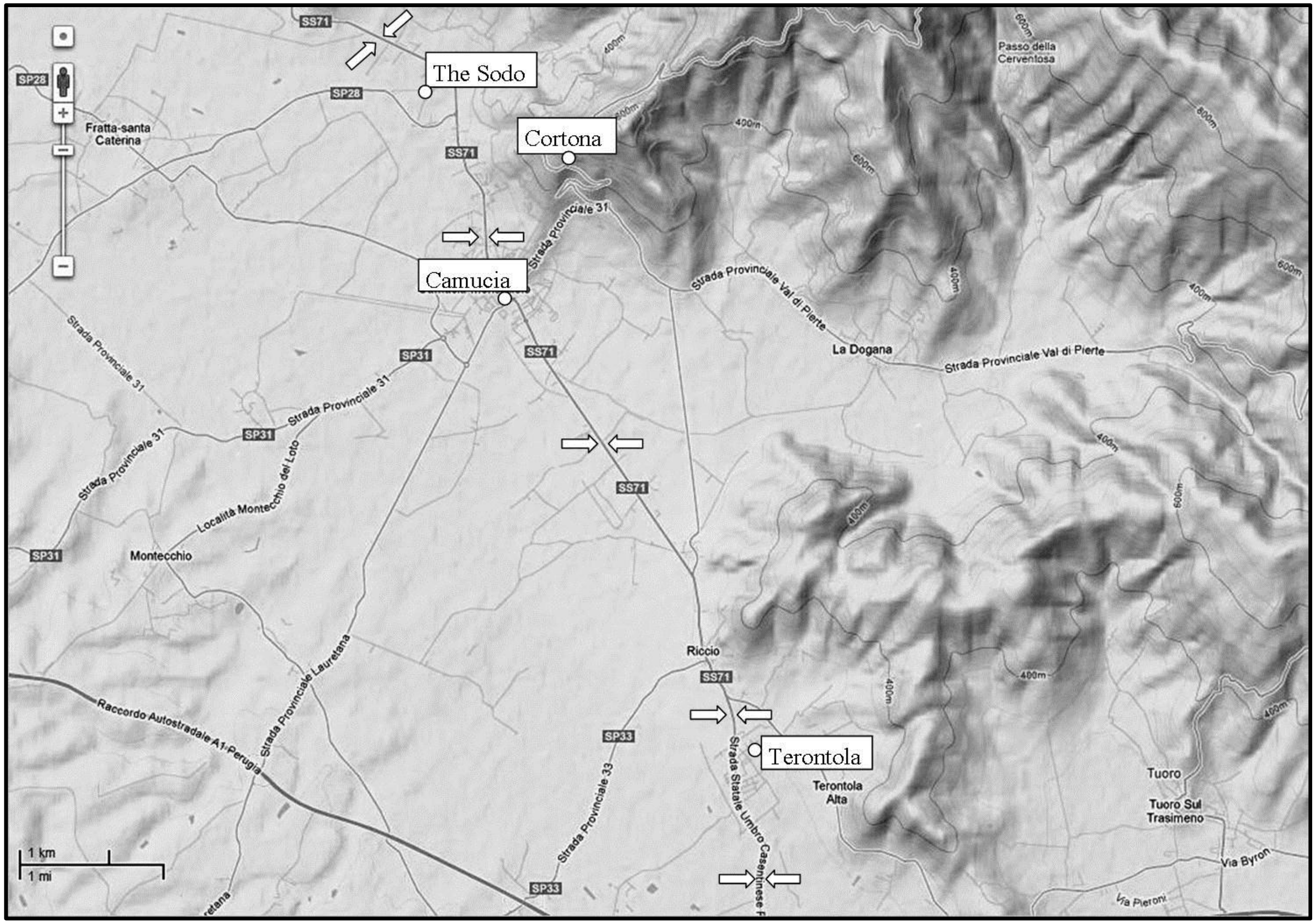

Figure 2.2. Val di Chiana in the territory of Cortona with important sites indicated. The modern SS71/SR71 highway is indicated (arrows). (©2012 Google).

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CHAPTER 3: THE SITE AT SODO AND ITS SETTING

INTRODUCTION

This chapter provides a description of: 1) Etrusco-Roman burial practices; 2) funerary structures in the territory of Cortona, including the Sodo tumuli; 3) the Roman period burials from the Sodo; and 4) the literature exploring the locations and rationalizations of Roman-period burials in association with prehistoric funerary structures.

ETRUSCO-ROMAN BURIAL PRACTICES AND FUNERARY STRUCTURES IN THE TERRITORY OF CORTONA

Both the Etruscans and the Romans varied between cremation and inhumation throughout their long histories, with different styles gaining and losing popularity at different times (Davies 1977). In Rome, both customs were practiced side by side until the beginning of the fourth century BC, when cremation became the standard and remained so until the second century AD (Davies 1977, Morris 1992: 41, Toynbee 1971: 39-40). Cremation was gradually adopted by the Etruscans throughout the Late Bronze Age and Iron Age, although it did not become prevalent until the fourth to second centuries BC. Even then, cremation was most common in central and northern Etruria while inhumation remained more frequent in the South and along the coast (Barker and Rasmussen 1998: 58, Bietti Sestieri 1984: 57, Toynbee 1971: 15). Barker and Rasmussen (1998: 122) suggest that in some cases, the Etruscans may have cremated the wealthy “as a mark of special status” but this practice was certainly not restricted to the upper class, as cremation burials of low-status individuals have been found throughout Etruria.

In the seventh and sixth centuries BC, the custom among the *principes* changed and increasingly elaborate chamber tombs began to appear throughout Etruria. The chamber-tombs varied according to terrain: some were rock-cut, others were built out of blocks and many were a combination of the two techniques (Barker and Rasmussen 1998: 120, Toynbee 1971: 18). Within these chamber-tombs the aristocratic dead were housed: either interred in sarcophagi or cremated and placed in urns. The Etruscan tumulus, with its circular retaining wall and earthen mound, is generally considered to be the source of inspiration behind the Roman mounds of similar design, including the Mausoleum of Augustus (Johnson 1996, Toynbee 1971, but *cf*. Holloway 1966). Around the tombs, it was common to bury the remains of poorer individuals. Cremations were often buried *a pozzo*, in cylindrical wells cut or dug into the earth, or *a casetta*, in stone-lined trenches. Inhumations were generally in simple *fossae*, trench graves, or free-standing stone sarcophagi (Barker and Rasmussen 1998: 234, Toynbee 1971: 18). All burials, whether cremations or inhumations, were generally accompanied by pottery, metalware and other grave goods (Barker and Rasmussen 1998: 239).

In the seventh century BC, the elaborate chamber-tombs that had become common elsewhere in Etruria spread to the North (Torelli 1975: 18). While in the southern territories a large number of elite families were burying their dead in the necropoles, in Cortona the political dominance of a few powerful families remained fixed, restricting the number of sixth century tumuli (Barker and Rasmussen 1998: 131, Spivey and Stoddart 1990: 143). Initially, the use of each tumulus was limited to the powerful family that ordered its construction (Holder 1999: 40). The tumuli were re-used over the centuries, however, and burials from the subsequent phases of use cannot be assumed to belong to the same lineage.

The earliest of these tumuli in the Val di Chiana, the Tumulus of Camucia, was built around 600 BC, followed by the two Sodo tumuli, built after 580 BC (Vallone 1995). These structures, referred to as *meloni* (melons) in the local idiom because of their domed appearance, are essentially burial chambers (tombs) surrounded by stone drums and covered in earthen mounds that closely resemble other Etruscan circular tumuli, such as those at Populonia and Cerveteri. A single tumulus can contain more than one tomb: the Tumulus of Camucia, for example, surrounds Tomb A and Tomb B, both of which contain funerary gifts datable to between the end of the seventh and the beginning of the fourth centuries BC (Vallone 1995).

Banti (1973: 172) has argued that the Sodo and Camucia tumuli are located too far from Cortona to belong to the city's elite and that they are more likely the tombs of rich valley landowners. Indeed there is a great deal of debate in the literature as to the date of Cortona's emergence as an Etruscan 'urban centre'. Some researchers (e.g. Bruschetti 1992: 183, Fracchia 1996: 194) argue that the locations of the tumuli suggest the presence of small habitation sites nearby. It is possible that the Val di Chiana was populated primarily by such sites scattered across the valley floor and the lower slopes of the surrounding hills rather than by a large settlement on Mt. Sant'Egidio. What is relevant for the purposes of this study, however, is that the ruling *principes* of the Val di Chiana, wherever they were settled, built the enormous tumuli "to bury their dead in the trappings of economic and social power" (Vallone 1995: 109).

In the third and second centuries BC, a number of new monumental tombs were constructed in the territory of Cortona. Several of these tombs, such as the Tanella Angori and the Tanella di Pitagora are closer to Cortona than the sixth century tumuli and Fracchia (2006: 27) suggests that their positions on the main roads to the city underscore the increasing importance of 'urban identity' in the Val di Chiana. The Tanella di Pitagora, now missing its protective mound, is the best preserved of these later tombs and contains ten niches designed to accommodate cinerary urns (Barker and Rasmussen 1998: 284, Oleson 1982: 87).

THE TUMULI DEL SODO AND THE ROMAN PERIOD BURIALS

The Sodo tumuli are located slightly over 2 kilometres west of Cortona, just across the modern highway SS71/SR71, which corresponds to the Roman Via Cassia and the earlier Etruscan road (Fracchia 2006: 24, Vallone 1995). The two structures sit approximately 300 metres apart on either side of the Loreto stream (Figures 3.1 and 3.2). In view of the Etruscan predilection for natural boundaries, researchers have suggested that the corresponding ancient stream could have served as a border between properties. If the tumuli were indeed located along such a boundary, their original purpose can be understood, in part, as *monumentum*: conspicuous symbols of the power and dominance of the landholding families, as well as tombs to shelter the dead (Vallone 1995).[1]

Sodo Tumulus I

Tumulus I, located on the south bank of the Loreto, was built in the first half of the sixth century BC, although possibly as late as 550 BC (Vallone 1995). After falling into disuse, the tomb was utilized as a source of building materials and sacked for valuable grave goods (*Ibid.*). The mound had been discovered by 1909, but "secure reports on the discovery, on the dates and on the methods of the discovery, on what the grave goods consisted of and what happened to them" are lacking (*Ibid.*: 119). The artificial mound is approximately 10 metres high and over 50 metres in diameter (Holder 1999: 36, Vallone 1995). The tumulus contains a single five-chambered tomb with a southeast-northwest floor plan (Figure 3.3). The covered *dromos* leads to three antechambers, before terminating in a larger, rear chamber. A total of four inter-connecting lateral rooms project off the second and third antechambers. The pavement of the chamber-tomb is comprised of local grey sandstone, while the wall structures are made of the yellowish sandstone of the Val di Chiana (Vallone 1995).

The date of the first phase of Tumulus I indicates that the property owner was one of the local *principes* (*Ibid.*). Re-use of the tomb in the Hellenistic Age is documented by inscriptions and grave goods datable to the fourth century BC (*Ibid.*). Specifically, an inscription cut into the main door of one of the lateral

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[1] The use of tumuli to indicate and reinforce control of a territory by family groups elsewhere in Etruria has been widely discussed (e.g. Riva 2010, Zifferero 1991).

chambers indicates that the tomb was re-occupied by Arnt Mefanate, of Umbrian origin, and his local wife Velia Hapisnei.

In the Late Republican and Early Imperial eras, Tumulus I was again reused for burials. A number of burials dating from the first century BC to the first century AD were excavated from within the drum of the tumulus, although none were found in the tomb chambers themselves. The Roman period burials were identified as low status individuals based on the paucity of grave goods, which consisted exclusively of simple artefacts: commonplace items of everyday use (*Ibid.*). The form of the burials, the *a cappuccina* tomb type, also indicates individuals of lower status. This unpretentious design, in which the deceased is laid out under a structure of gabled roof tiles, had become the norm for low-status individuals throughout Roman Etruria. The design owed its popularity to the inexpensive and uncomplicated nature of its construction (Barker and Rasmussen 1998: 234, Toynbee 1971: 101).

The precise number of Roman period burials at Tumulus I is unclear, as is the exact provenance of the interments, but three of the burials: SI-1, SI-2, and SI-3 were recently made available for study by the Museo dell'Accademia Etrusca e della Città di Cortona (MAEC)[2]. All three of the burials in question were found in the *dromos* of the tomb.

[2] Burial numbers were assigned by the author to facilitate data organization; they are not the original burial numbers used by the excavators. For detailed burial information see Appendix A.

Sodo Tumulus II

Tumulus II is located on the north bank of the Loreto and is datable to between 575 and 550 BC (Vallone 1995). While the construction of Tumulus I at Sodo was more refined than that of Tumulus II, the second mound is larger in size, measuring 64 metres in diameter. Like the Tumulus of Camucia, Tumulus II contains two discrete tombs: Tomb 1, which was excavated by Antonio Minto in 1928 and 1929, and Tomb 2, which remained undiscovered until 1992 (Figure 3.4). Research at the tumulus has been hampered by the sacking of both tombs in antiquity, as well as the infiltration of groundwater into the excavation area (*Ibid.*).

On the southwest side of the tumulus, a long *dromos* leads to Tomb 1, constructed at the same time as the tumulus itself. The seven-chambered tomb is generally oriented east-west, with the entrance facing west. Past the *dromos*, two antechambers, with a total of three cubicles per side, lead to a final room. That this tomb was re-used in the Hellenistic period is clear, despite the destruction caused by vandalism in antiquity (*Ibid.*).

Tomb 2 was constructed between 480 and 460 BC and belongs to the second phase of the tumulus' use (*Ibid.*). Simpler than Tomb 1, it consists of a short *dromos* and two consecutive chambers separated by parapets. Upon discovery, only the lower 180 centimetres of the walls remained and the roof was missing entirely, yet Tomb 2 managed to preserve six sarcophagi in *pietra fetida* from the fifth century BC and five cinerary urns of sandstone and terracotta indicating re-use of the tomb in the Hellenistic period (*Ibid.*). Tomb 2 also yielded more than one hundred pieces of Etruscan goldwork, seemingly overlooked by the ancient grave robbers (*Ibid.*).

On the east side of Tumulus II, facing Mt. Sant'Egidio and the city of Cortona, a monumental stone terrace-altar (Figure 3.5) was discovered in 1990 (Holder 1999: 39). Excavators suggest that the altar, which is 5 metres wide and 9 metres long, can be compared to the 'bridges' or access ramps of Southern Etruria and was likely used to obtain access to the top of the tumulus mound (Vallone 1995, Zamarchi Grassi 1992: 124-31). Further excavation has revealed signs of a temple or *sacellum* higher up the mound, that was likely associated with the terrace-altar (Zamarchi Grassi 2000, Zamarchi Grassi 2006). Zamarchi Grassi (1992: 124-31) argues it is also likely that the altar itself was a space for cultic activities, due in large part to the immense size of the terrace platform. Irrespective of whether mourners actually proceeded to the top of the tumulus mound, the placement of the terrace altar was likely connected with religious ceremonies and processions honouring the deceased (Barker and Rasmussen 1998: 238, Fracchia 1996, Vallone 1995).

In the Roman period, the stone altar collapsed and the tombs fell into disuse. A number of inhumations dating from the first century BC to the first century AD have been found at the tumulus, however, particularly around the terrace altar (Figure 3.6). According to Zamarchi Grassi (2010) seventeen tombs were discovered in the vicinity of the altar but the total number of Roman period inhumations for the tumulus in unclear. These burials consisted mostly of *a cappuccina* tombs in wood or bricks; many of the burials that were interred after the altar collapsed incorporated some of the remaining stone. The grave goods of these burials, too, were unexceptional: cooking vessels and tableware.

Ten inhumations from the area of Tumulus II were available for study although for most, information on the precise context is unavailable. Inhumation SII-1 was likely found in the *dromos* of Tomb 2 (H. Fracchia, pers. comm.). SII-2 was most likely found in the vicinity of the terrace-altar, although its exact provenience is unclear (H. Fracchia, pers. comm.). SII-3, SII-4, SII-5, SII-8, and SII-9 were excavated from the area immediately surrounding the terrace altar. Based on the MAEC display plaques, SII-3, SII-4, and SII-8, from "graves" D, G, and L respectively, appear to have lacked any sort of stone construction and could possibly be included in the *a cappuccina* type tombs in wood mentioned above, although this is uncertain. SII-5, from "grave" M, and SII-9, from "grave" E, appear to have had substantial stone, brick or tile coverings. All five burials date to the period after the altar collapse. While SII-6 certainly comes from the area of Tumulus II, more information is lacking. It is possible that the remains were found in layers above those of the altar burials or that they came from closer to the top of the tumulus but these speculations are unsubstantiated at this point (H. Fracchia, pers. comm.). The commingled remains of two other individuals, SII-7a and SII-7b, were found in association with Tomb 2: most likely in the entranceway to the first chamber (Pacciani and Mainardi 2006).

The Circoli

Approximately 40 metres north of Sodo Tumulus II, the Circoli necropolis was revealed in July of 2005, during a salvage excavation carried out in conjunction with work to shift the course of the Loreto stream. The necropolis is composed of two *circoli*, or circular areas, and is essentially an urn-field, much smaller but not unlike those of the Villanovan period (Torelli 1975). The circles contain cremation burials dated to the early Orientalizing period, between the mid-seventh and mid-sixth centuries BC. Circolo I, between 7.5 and 8 metres in diameter, contains six tombs *a cassetta*, in stone-lined trenches. Circolo II, 8 metres in diameter and outlined in roughly squared sandstone slabs, has thus far yielded fifteen burials. Numerous Hellenistic and Roman period burials have been discovered in the necropolis, several of which disturbed older deposits. To date, only one of these intrusive burials is available for study: C-1, a Roman period inhumation cut into Tomb 2 of Circolo I (Figures 3.7 and 3.8).

The foundations of a substantial building were also discovered approximately 200 metres west of the Circoli. Although the structure's association with the necropolis and Sodo tumuli is unknown, a preliminary assessment suggests it was likely a Roman farmhouse, dated to the first century BC. Given the location and date of the structure, as well as the conspicuous absence of individual farmhouses in the valley between the Sodo and Lake Trasimeno, it is probably that the farmhouse represents the southernmost of the Arezzo land allotments allocated by Sulla (H. Fracchia, pers. comm.).

RE-USE OF PREHISTORIC BURIAL SITES IN THE ROMAN WORLD AND POSSIBLE IMPLICATIONS FOR THE SITE AT SODO

The relationship between burial and cultural identity "dominates" research into burials in the Roman provinces (Pearce 2000: 2) but this line of questioning has been relatively overlooked in Etruria. Before we progress to an examination of the dental data, it is worth entering into a brief discussion of the issue of interpretation of the Sodo burials. According to available information, the Roman period individuals from the Sodo were all found in association with the drums of the tumuli but outside the actual tomb chambers. As stated above, poor individuals were frequently buried around tumuli throughout Etruria but the late date of the Roman period burials, as well as the extreme proximity to the tumuli, is unusual. This positioning raises interesting questions regarding the identity of the individuals and their motivation for choosing, if they did indeed choose, to be buried at the feet of these ancient funerary mounds. Vallone (1995) mentions that the beginning of the second century BC saw the occupation of all the cultivable space in the Val di Chiana and it could be argued that the choice in burial site was simply due to a lack of alternative locations. However despite the fact that the total number of Roman period burials at the Sodo is unclear, it is certainly not representative of the number of people living in the Val di Chiana at that time. Any theory on the re-use of the Sodo as a burial space must account for the fact that other inhabitants of the area were most certainly burying their dead elsewhere.

Torelli (1986: 62) says that at the turn of the millennium there developed among the Etruscans, “a thirst to rediscover the institutions and symbols of a past glory.” At this time the ‘League of the Twelve Peoples’ reappeared with fifteen members and memorials were erected to celebrate past achievements. This period also saw the beginning of a trend among Etruscan scholars to create a comprehensive documentation of Etruscan histories, genealogies, and religious texts. Zamarchi Grassi (1992) suggests that re-use of the Sodo tumulus II could have been an attempt on the part of the Roman period inhabitants to share in the prestige of the deceased *principes*. Fracchia (1996) adds that there were, at this time, hundreds of years of precedent for the sharing of myths, origin stories and other legends between the Etruscan *principes* and Rome. It is possible, she argues, that the re-use of the Sodo II tumulus is analogous to the way the aristocracy at this time was re-using Etruscan monuments and sacred places for their own purposes (Fracchia 2006: 33-4). There is a crucial difference, however, between the Roman period re-use of the Sodo and the re-use of other local Etruscan sites discussed in Chapter 2: at the Sodo it is not the aristocracy but low-status individuals that are burying their dead around the tumuli. This burial at the Sodo of poor individuals should be distinguished from the occupation of important Etruscan sites by the powerful inhabitants of the Val di Chiana.

Roman period re-use of prehistoric burial sites is not uncommon, particularly in the provinces (e.g. Galliou 1989, Jessup 1962, Vermeulen and Bourgeois 2000). Morris (1992: 51) argues that it is "tempting" to see this revival of the use of tumuli as "working at one level as a form of symbolic resistance to imperialism" by descendants of the indigenous population. Indeed, the argument that changes in funerary custom were often related to conflict between Roman forces and the local populations is a convincing one. Although dealing only minimally with the re-use of Etruscan tumuli, Thoden Van Velzen (1992) explores how funerary practices figured prominently in the struggle between

Etruscans and Romans in the second and first centuries BC at Chiusi. She observes that there, the indigenous Etruscans legitimized their inheritance claims and stressed a shared identity through the use of funerary inscriptions. Conversely, she notes multiple cases of Roman immigrants appropriating Etruscan tombs and deposing the original inhabitants: an act, she suggests, that was intended to establish and enforce their own territorial rights (*Ibid.*).

Other researchers have suggested that the re-use of traditional tumuli is less a political statement than a statement on the mystical nature of the tumuli themselves. When discussing the burial of Roman period individuals in and around prehistoric monuments in Brittany, Galliou (1989: 31) suggests that the size of these monuments as well as the darkness and mystery of their interiors led people to associate them with magical protection. He gives, as evidence, examples of monuments that have been found to contain Roman goods, such as coins and votive statues, apparently not associated with burials and suggests that these sites were understood to possess a power that extended past their purpose as funeral locales.

Vermeulen and Bourgeois (2000) explore the idea of how people in the past decided where to bury their dead and whether the presence of considerably older graves affected this decision. They discuss five potential explanations for why Roman graves, whether isolated or in cemeteries, are often found in association with prehistoric cemeteries:

First, there was a Roman law that stated that the presence of a grave transformed any land, public or private, into a *locus religiosus*. Lands with this status were respected and were considered legally protected against grave robbing and other forms of desecration. It is possible then, that Roman-period individuals in the Val di Chiana would choose to bury their dead at the Sodo if, as the authors suggest, indigenous burial grounds retained some level of protection from disturbance well into the Roman period.

Second, prominent funerary monuments are easy to identify in the landscape. Even if the burials themselves become overgrown, the prehistoric tombs can be used as a kind of grave marker, to help the living locate their dead. The effectiveness of prehistoric monuments as grave markers is heightened by close proximity to a road, such as at Sodo, which facilitates access to the site.

Third, burial monuments were frequently used as property markers in antiquity. The potential role of the Sodo tumuli, for example, as markers of two properties separated by the Loreto stream has already been discussed. Vermeulen and Bourgeois (2000) argue that in similar situations, the re-use of archaic burial spaces would grant them *de novo* the status of "structuring elements": reinforcing boundaries and ownership of the land. Riva (2010: 126) suggests that the conspicuous and extravagant nature of the funerary processions enhanced political authority and reaffirmed ownership of the land. In both scenarios, the Roman period use of prehistoric monuments serves a judicial function, endowing the tombs with a renewed relevance in the political as well as topographical and funerary landscapes.

Fourth, the spiritual or religious nature of prehistoric funerary monuments was still honoured in the Roman period. Similar to Galliou's conclusions in

Brittany, in this model a prehistoric site retains its importance in the landscape not because of pragmatic or logistical issues but due to its persistence as a sacred space. The relevance of this theory in interpreting the Romanization of the Val di Chiana has already been discussed in Chapter 2 with regards to the transformation of Etruscan springs, shrines and sanctuaries into important Roman sites. Although the purpose or ownership of the land may have changed, it continued to be regarded as an important, powerful or even sacred place. In the case of the Sodo tumuli, then, it is possible that the sacred or mystical aspects of the sites were considered to endure well into the Roman period.

Finally, the continued use of ancient cemeteries could have reinforced the belief that supernatural elements were "permanently present" which, in turn, stimulated further use of the cemeteries (Vermeulen and Bourgeois 2000: 145). The sites of prehistoric burials were then considered to be a kind of liminal zone: locations for ritual activities relating to the cult of the deceased. Izzet (2007: 88) argues that in the Orientalizing and Archaic periods, tumulus mounds throughout Etruria formed an "interface" between the living and the dead, and were important for "materialising social and cultural attitudes" towards the deceased. Riva (2010: 124) suggests that the construction of Tomb 2 at Sodo Tumulus II in the fifth century BC was a "physical alteration" of the tumulus' boundaries to suit the new reality. It is possible that similarly, the Roman period burials at the Sodo altered the boundaries of the tumulus and thus, the "interface" to which Izzet refers. The newly redefined burial zone could then, once again, have served as a locus for cultic activities focusing on the deceased. Vermeulen and Bourgeois (2000) apply this explanation to the continuous and prolonged use of prehistoric cemeteries, rather than individual funerary mounds. However, the authors credit such "indigenous traditions" (Vermeulen and Bourgeois 2000: 146) as responsible for the lasting importance of prehistoric tombs in the Roman landscape and the potential importance of ancestor worship at the Sodo should not be overlooked.

In creating their explanations, Vermeulen and Bourgeois borrow heavily from the phenomenological perspective outlined by Tilley (1994). Such an approach emphasizes how people in the past interacted with, interpreted and related to their environment. Parker Pearson (1993), too, emphasizes the importance of a "symbolic landscape" when attempting to understand the relationship between the living and the dead in archaeological contexts. At the Danish Iron-Age sites of southern Jutland, Parker Pearson identifies a number of general themes when interpreting the relationship between the living and the dead including: the use of the dead for political legitimation, the identification of the dead with a distant past, the naturalization of social order by reference to a supernatural or ancestral hierarchy and the emulation of restricted practices by inferior social groups.

Certainly, the strongest interpretations for the re-use of prehistoric funerary monuments involve a combination of explanations. Although these scenarios are helpful for interpreting the Roman period use of the Sodo tumuli, direct comparisons between sites are ill-advised. A regional approach is essential and only more information on the Sodo material can improve our understanding of who was buried at Sodo during the Roman period, and why.

CONCLUSION

This chapter outlines the archaeological context for the Roman period Sodo material, and briefly reviews the literature on Roman period burials in prehistoric funerary monuments. Although potential reasons for the Roman period re-use of the Sodo site is a thought-provoking topic, at this time there is insufficient information to draw any firm conclusions about motivation or intention. The remainder of this thesis will focus on the available dental data from the Sodo and Terontola.

Figure 3.1. A satellite image showing the location of the Sodo tumuli. The city of Cortona is visible in the bottom right while the modern highway SS71/SR71 is indicated by white arrows. (©2012 Google).

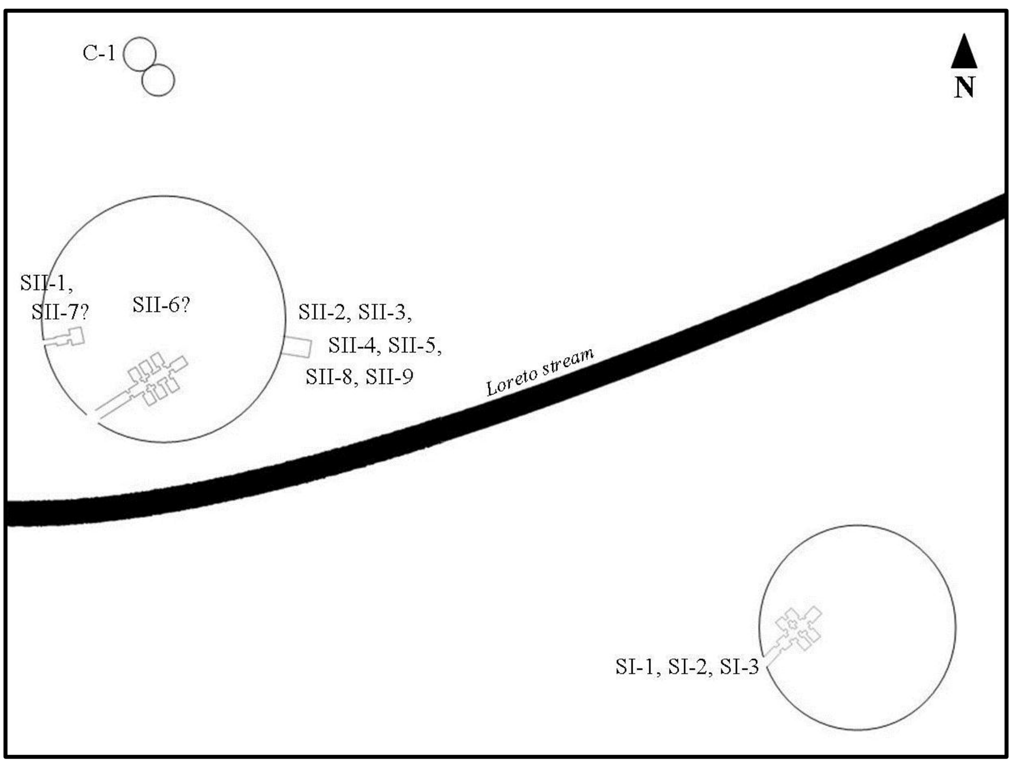

Figure 3.2. A plan of the Sodo tumuli and Circoli showing the locations of the Roman period burials. (Adapted from a display plaque at the MAEC).

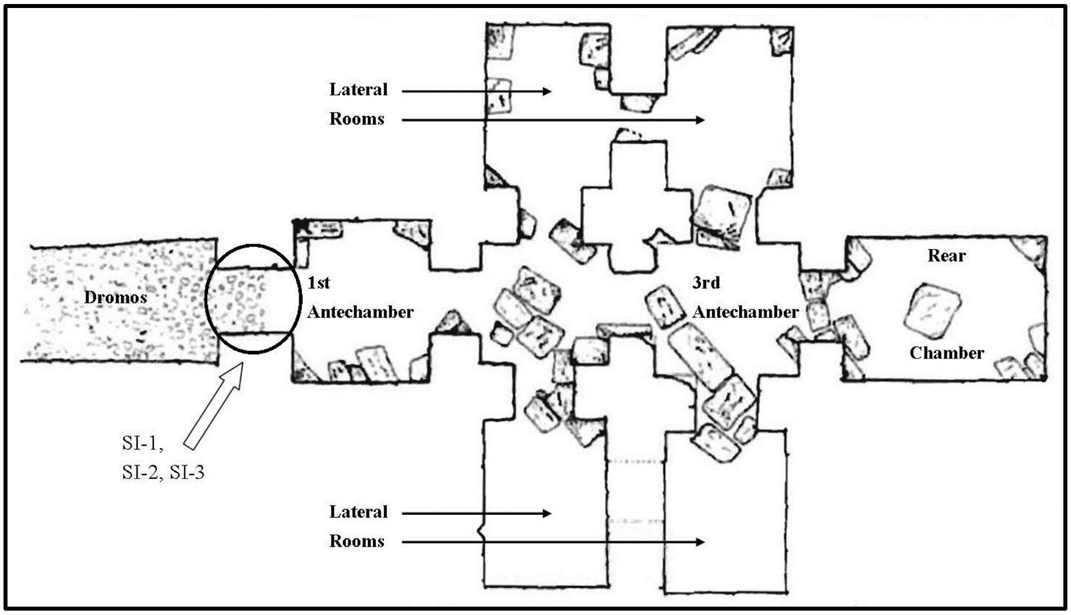

Figure 3.3. Plan of Sodo Tumulus I showing the location of SI-1, SI-2, and SI-3 in the dromos. (Adapted from Vallone 1995, Fig. 18).

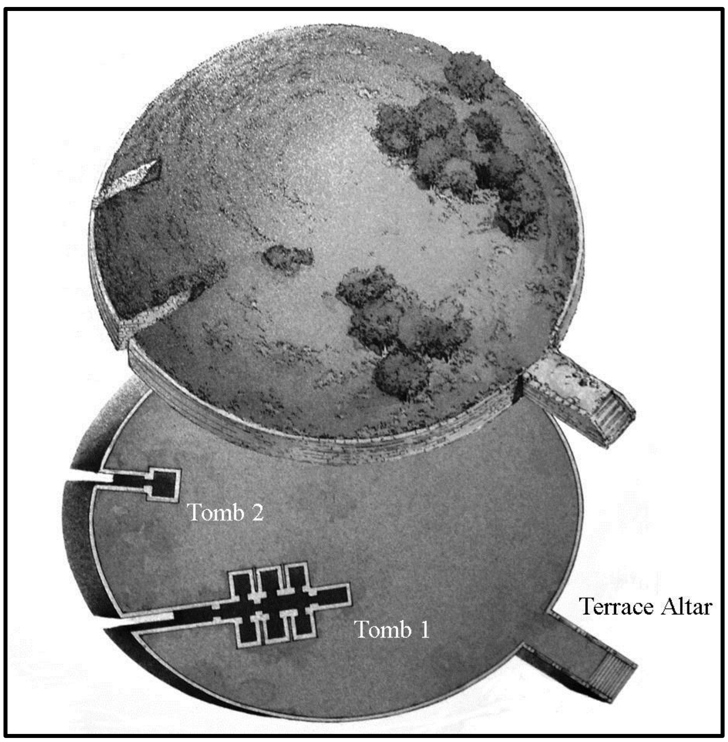

Figure 3.4. A drawing of Sodo tumulus II revealing the plans of Tomb 1, Tomb 2, and the terrace altar. (Adapted from a display plaque at the MAEC).

Figure 3.5. The reconstructed stone terrace altar at Sodo tumulus II.

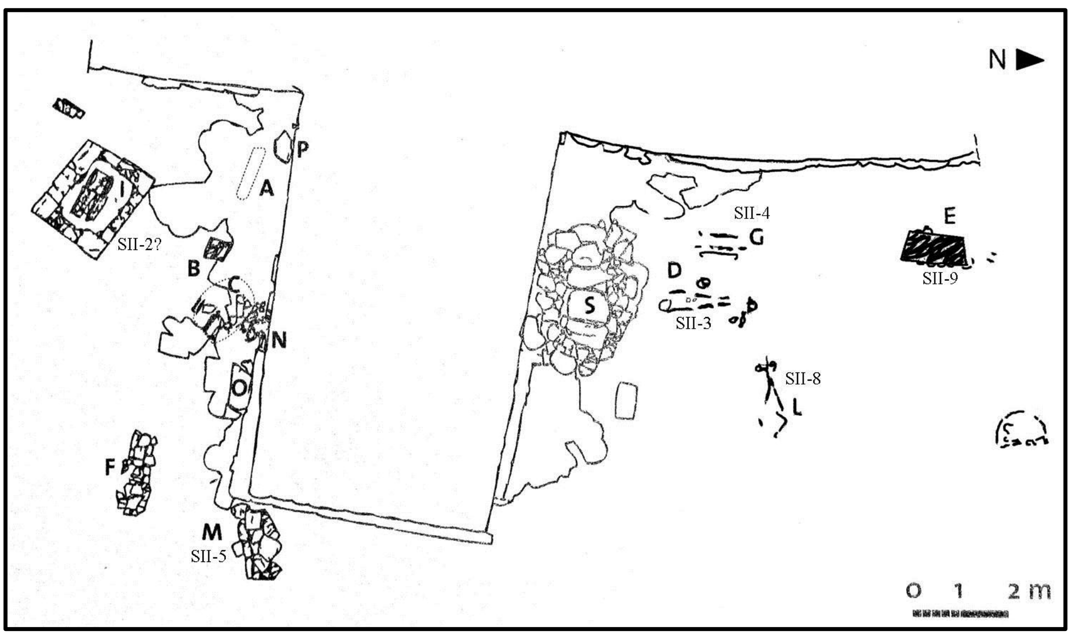

Figure 3.6. Plan of the tombs surrounding the terrace altar at Sodo II, showing the locations of burials SII-2, SII-3, SII-4, SII-5, SII-8, and SII-9. The precise location of SII-2 could not be determined from available records. (Adapted from a display plaque at the MAEC).

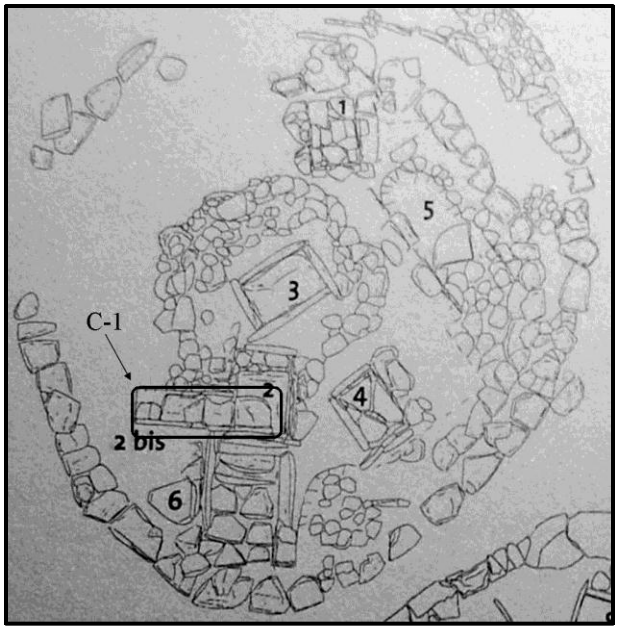

Figure 3.7. Plan of Circolo I showing the location of C-1, an intrusive inhumation disrupting an earlier cremation burial. (Adapted from a display plaque at the MAEC).

Figure 3.8. Photo of C-1 in situ, during excavation. (Credit: MAEC).

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CHAPTER 4: DENTAL DATA

INTRODUCTION

The Etruscans inhabited central Italy from the seventh century BC to the first century BC. Their land, known as Etruria, was comprised of portions of the modern regions of Tuscany, Umbria, and Latium. For most of its history, Etruria was divided into a series of oligarchical city-states ruled by families called *principes*. These powerful families expanded Etruscan control north into the Po Valley and south into Campania (Barker and Rasmussen 1998: 139-40, Nielsen 1984: 255, Torelli 1975: 11).

Over the course of the fourth and third centuries BC, Rome conquered Etruria through a series of military battles, truces, and treaties (Harris 1971). The ensuing centuries saw the forfeiture of goods, the reallocation of lands, and the movement of peoples throughout the region. By the first century BC, Etruria no longer existed as a separate entity from the Roman Empire and the Etruscans, as a distinct and recognizable cultural group, were gone (Barker and Rasmussen 1998: 292, Harris 1971).

The hilltop city of Cortona was one of twelve major Etruscan centres located between the Arno and the Tiber (Barker and Rasmussen 1998: 143). Following its absorption into the Roman Empire, Cortona remained an important economic hub for the exportation of grain and other commodities (Bonfante 1986: 11, Harris 1971: 161-8). Unfortunately, despite Cortona's role as a vital economic power centre in the Val di Chiana, relatively little is understood about the people who lived there during the various phases of Etruscan and Roman occupation, particularly at the turn of the millennium. As such, the details of Cortona's transition from an Etruscan city-state to a Roman economic centre are unclear.

This report presents the results of an examination of the dental remains of eight individuals from the territory of Cortona, dated to between the first century BC and the first century AD. It is intended as a contribution to the study of Cortona's population biology in the Late Republican period.

SKELETAL MATERIALS

The skeletal material was excavated from the vicinity of two large Etruscan funerary mounds, approximately 2 kilometres west of the city of Cortona. The mounds, or tumuli, are referred to as Sodo I and Sodo II and date to the sixth century BC; they sit on either side of the Rio Loreto, or Loreto stream, thought to have originally functioned as a boundary between lands (Vallone 1995). Originally used by wealthy Etruscan landowners, the tumuli were reused in the fifth and fourth centuries BC before falling into disuse and, ultimately, being partially dismantled and ransacked for grave goods. In addition to the funerary mounds, a small urn-field is located approximately 40 metres north of Sodo II, with burials dating from the mid-seventh to mid-sixth centuries BC.

The Roman-period burials, excavated in the 1990s and early 2000s, were found in and around the tumuli and urn-field. Despite their proximity to the Etruscan burial chambers, however, the Roman-period inhumations were not found within the tombs but rather in the *dromos* or entranceway, around the outside of the tumuli, and in the urn-field (Vallone 1995, Zamarchi Grassi 2010).

The burials were *a cappuccina,* that is, under a structure of gabled roof tiles or wood: the standard in Roman period Etruria for low status individuals (Barker and Rasmussen 1998: 234, Toynbee 1971: 102). The grave goods were a modest selection of common objects of everyday use such as cooking vessels and tableware, consistent with an interpretation of low status.

The total number of Roman-period inhumations from the Sodo tumuli is unclear. Although the discovery of seventeen tombs from the vicinity of the terrace altar at Sodo II is confirmed (Zamarchi Grassi 2010), at least eight other individuals were excavated from the territory of Sodo I, Sodo II and the urn-field. Containers holding the remains of fourteen individuals were brought to the Museo dell'Accademia Etrusca e della Città di Cortona (MAEC) from the Centro Restauri (Sodo Restoration Workshop) where they are curated. Additional material included nonhuman skeletal fragments as well as some terracotta and brick.

Preservation was a major issue with the Sodo material, due in large part to the location of the site on the valley floor and the resulting high water table. The obstructive and invasive nature of the surrounding groundwater during excavation is evident from the photographs and notes documenting the process (e.g. Bruschetti and Zamarchi Grassi 1999, Vallone 1995). Unfortunately, the negative effects of groundwater on the Sodo material started significantly before the twentieth century, as the two had been interacting for approximately 2,000 years by the time of excavation.[1]

Diagenetic changes to archaeological bone include changes in both the organic and inorganic components, and involve hydrolysis, dissolution, mineral replacement, and recrystallization (Hare 1980, Von Endt and Ortner 1984). These changes can be affected by a number of factors, including duration of interment, hydrology of the burial environment, and sediment pH and composition (Henderson 1987, Nicholson 2001, Sandford and Weaver 2000).

Generally, the longer the burial interval, the more advanced the diagenesis but the degree of diagenetic change does not necessarily bear a linear relationship to time (Sillen 1989). The movement of water in the burial environment is one of the most important factors affecting diagenesis, as water acts as the medium in which most forms of change take place (Millard 2001, Nielsen-Marsh et al. 2000). Water determines the movement of solutes into and out of the bone; it enables the leaching of peptides and amino acids and promotes recrystallization (Hare 1980, Nielsen-Marsh et al. 2000, Von Endt and Ortner 1984). The characteristics of the surrounding soil also play an important role in regulating the rate of diagenesis: grain size affects the flow of groundwater, with coarser soils allowing for more movement in the space between particles, and soil pH heavily influences the effect of water on archaeological bone, with acidic soils intensifying diagenetic processes (Gordon and Buikstra 1981, Henderson 1987, Nielsen-Marsh *et al.* 2000).

[1] What follows is a brief outline of bone diagenesis as it pertains to the Sodo material. For a more comprehensive review of the literature on bone diagenesis, see Appendix B.

Although the hydrology of the Sodo site has not remained unchanged over the last 2,000 years, due to the location of the site on a valley floor and the saturation and subsequent draining of the Val di Chiana, we can assume that groundwater infiltration has been a continual problem (for archaeological and historical evidence of flooding in the Val di Chiana, see Alexander 1984, Spivey and Stoddart 1990: 30). Soil samples from four different burials (SI-2, SII-1, SII-2, and SII-3) representing both tumuli were analyzed for acidity and particle size, in the hopes of better understanding the effects of the burial environment on the Sodo material. Tests indicate a range in pH values from 7.22 to 7.51, which should have retarded the degradation of the mineral phase, if only slightly. Samples were found to consist predominantly of silt and sand (2-50 micrometres and greater than 50 micrometres, respectively). Only a small percent of the soil samples were clay (under 2 micrometres): less than 20 per cent in all samples and as low as 13 per cent in SII-2.[2] Despite the slightly basic nature of the burial environment, the relatively large grain size of the soil surrounding the Sodo burials would have accelerated diagenesis by facilitating the movement of water around and through the skeletal material.

The Roman-period material from the Sodo displayed an extreme degree of degradation; exhibiting a fragility characteristic of diagenetically altered bone (Figures 4.1 and 4.2). Preliminary x-ray fluorescence analysis of long bone shaft fragments from two individuals, SI-3 and SII-2, has revealed abnormally high

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[2] The soil from burials SI-2 and SII-3 meets the criteria for a medium loam, according to the United States Department of Agriculture soil texture guidelines, while the soil from SII-1 and SII-2 is a sandy loam.

levels of silicates and iron, which are among those elements most frequently taken up by skeletal remains in archaeological contexts (see Parker and Toots 1980, Sandford and Weaver 2000). Additionally, collapse of the tomb walls and ceilings, as well as the *a cappuccina* tiles, has rendered the remains highly fragmentary: most likely exacerbated by the diagenetically weakened structure of the bone (e.g. see Pacciani and Mainardi 2006).

Light microscopy (LM) of thin sectioned long bone fragments from SI-3 and SII-2 revealed extensive microbial infiltration. Microbes such as bacteria and fungi are known to infiltrate bone by way of the lacunae and canaliculi, before spreading by way of the ‘path of least resistance’ until all areas are infiltrated (Pitre 2011, Turner-Walker and Jans 2008)[3]. Once microbial infiltration is complete, the organic material develops a mottled appearance and begins to break up and recede, leaving behind tunnels in the bone created through demineralisation and redeposition of the bone matter. The appearance under LM of the bone from SI-3 and SII-2 was consistent with that described by Pitre (2011), in that both the receding organic matter and some tunnels were visible (Figures 4.3 and 4.4). The Haversion canals were the only identifiable structures remaining in the histology of the Sodo bone: the remaining bone had been demineralised or hypermineralised by the microorganisms to such an extent that the structures were rendered unrecognizable.

[3] Pitre (2011) found that biodeterioration was guided by the preservation of the bone’s mineral and collagen components, with microorganisms showing a preference for less mineralised areas whenever available. In the Sodo sample, infiltration would have certainly been facilitated by the degree to which the mineral component had been compromised by diagenesis.

Due to the degree of taphonomic change in the Sodo material, postcranial analysis was largely impossible. Dental enamel's low solubility, low porosity and low organic content, however, means that teeth are more likely to survive burial conditions that destroy bone (Carlson 1990, Parker and Toots 1980). This study has therefore been necessarily restricted to dental pathology, for which the dentitions of only eight individuals were available.

The study sample consists of eight skulls yielding 127 permanent teeth: 79 in situ and 48 loose, and 159 observable alveoli. Given that the normal human dentition has 32 teeth, for eight individuals we would expect a study sample of 256 teeth. Thus, slightly less than half the expected number of teeth are present. While most of the missing teeth were likely lost postmortem, the 97 unobservable alveoli means that the frequency of antemortem tooth loss must be considered a minimum.

METHODS OF PALAEOPATHOLOGICAL IDENTIFICATION AND ANALYSIS

Data collection for this study was conducted by the author under the supervision of Dr. Nancy Lovell in June of 2010, at the Museo dell'Accademia Etrusca e della Città di Cortona in Cortona, Italy. Detailed written descriptions were recorded for each of the Sodo skulls and extensive photographs were taken[4]. Postcranial remains were examined and notes were taken on features that contributed to age and sex determinations for the skeletal remains.

[4] A sample data collection sheet is included in Appendix C.

In spite of the poor degree of preservation of the skeletal material, sex could be determined by a number of features of the skeleton, including degree of robusticity, size of teeth, and morphology of the skull and pelvis, where available (following the standards described by Bass 2005; Buikstra and Ubelaker 1994). Female skeletons were identified by a broad sciatic notch, small mastoid processes, sharp supra-orbital margins, a gracile mandible and smaller tooth crowns. Male skeletons were characterized by a narrow sciatic notch, large mastoid processes, dull supra-orbital margins, a robust mandible with a pronounced chin and larger tooth crowns. Sex was determinable for all eight individuals in this study: three females and five males. In the other five individuals from the Sodo, sex could not be determined due to poor preservation of the skeletal material or ambiguous characteristics: these individuals were labeled as “Unknown”.

There were no juveniles in the Sodo remains. Adult age at death was estimated in broad terms and individuals were grouped into four categories: Young Adults (20-34 years), Middle Adults (35-49 years), Old Adults (50+ years) and Unknown. Use of age categories such as these has been deemed helpful in bioarchaeology because they allow for the detection of age related trends. Techniques for specific age estimation in adults can be problematic even in ideal situations; in the Sodo sample, many of the features recommended for age estimation in adults, such as the pubic symphysis or the auricular surface of the pelvis, were not preserved. As a result, age estimation was based primarily on relative degree of tooth wear (Brothwell 1981, Smith 1984) and cranial suture closure (Meindl and Lovejoy 1985). One has to be careful when using tooth wear as an indicator of age because it can be affected by a number of other factors including diet and cultural practices. Within a given population where a similar diet can be assumed, however, tooth wear can be broadly understood to increase with age[5]. Cranial suture closure rates also see some variability but generally, cranial sutures fuse with age so that in juveniles, the cranium is composed of a number of completely separate bones that fuse over time and in Old Adults, the sutures are not only fused but largely obliterated. One burial, SI-2, was very incomplete and was identified as a Middle Adult from the presence of osteoarthritis on the patellae. Osteoarthritis is a degenerative condition and as such, typically more common in middle-aged and older adults (Ortner 2003). In all, data on age was obtainable from the eight individuals in the study: six Young Adults and two Middle Adults, and a ninth individual without a preserved dentition: a Middle Adult.

The identification and documentation of pathological features of the teeth followed the macroscopic standards outlined by Buikstra and Ubelaker (1994) and Hillson (1996). Although other forms of analysis, including x-rays and extensive microstructural analysis can provide valuable information, these were not applied to the Sodo material due to logistical constraints. That such forms of analysis are time consuming, require specialized equipment and are often destructive in nature placed them outside the scope of this study.

[5] The wear observed on the first molars of the Sodo sample averaged a high 3/low 4 on the Smith scoring scale, as compared to the much higher wear observed in the individual from Terontola (see Chapter 5).

Caries was documented in terms of the affected tooth type and surface. Only carious lesions that penetrated the surface enamel were documented. Abscesses were evaluated based on the presence of a channel in the alveolar bone for pus drainage. Dental calculus was recorded as absent, minimal, moderate, or severe and its position on the buccal/labial or lingual aspect of the tooth was noted. Enamel hypoplasia was recorded in terms of the affected teeth and the type of deformity. Forms of expression include linear horizontal grooves, linear vertical grooves and nonlinear arrays of pits. Where tooth loss was recorded for the Sodo skulls, attempts were made to differentiate between antemortem tooth loss (AMTL) and postmortem tooth loss (PMTL), based on the appearance of the alveolar bone. When a tooth is lost antemortem, the body fills the alveolus in with bone until it is obliterated completely and the surface is smooth and level with the surrounding bone. In postmortem tooth loss, the alveolus does not fill with bone and so the tooth socket is preserved. When teeth were missing but it was not possible to distinguish between antemortem and postmortem tooth loss, usually due to a lack of preservation of the alveolar bone, they were recorded as "unknown." Despite extensive efforts to prepare the Sodo material for observation, it was difficult in some cases to identify pathological conditions with certainty, due to the preservation issues discussed above. In these instances, the lesions were not recorded and thus, certain pathological conditions may be underrepresented in this study.

As a result of the small sample size in this study, statistical analysis was deemed largely unhelpful. Still, attempts were made to identify the most prevalent conditions and any strong differences in distribution between sex or age categories. Results are presented in both the individual count (number of affected individuals relative to the number of observable individuals) and tooth count (number of affected teeth/alveoli relative to the number of observable teeth/alveoli) formats. Despite the small sample size, the individual count method permits an understanding of the prevalence of a given disease across the sample. The tooth count method is useful in comparison with the individual count results and also allows for an evaluation of disease frequencies in different teeth.

RESULTS

Individual Count

The prevalence of dental disease by individual count is presented in Table 4.1. Caries was the most common dental affliction, with carious lesions observed in all eight of the individuals. Antemortem tooth loss was observed only in a single middle adult male. Enamel hypoplasia was also relatively common, with 63 per cent of the individuals exhibiting at least one affected tooth. The young age of the individuals is likely responsible for the low frequency of calculus (38 per cent of individuals) and the complete lack of peri-apical abscesses, although the poor preservation of the bone certainly would have contributed to these results. Due to the small sample size of the individual count method, statistical analysis was deemed unhelpful. However, there appears to be no marked differences in the frequencies of any of these diseases between the sexes.

Tooth Count

The results of the tooth count evaluation of dental disease for the skeletal sample are presented in Tables 4.2-4.5. Due to the poor state of preservation, the total number of teeth and alveoli were not observable for every condition: thus the number of observable teeth or alveoli varies between tables. [6]

Caries

The sample exhibits a carious tooth frequency of 14 per cent (Table 4.2). The largest number of affected teeth in a single individual was four: found in SI-3, a young adult male (Figure 4.5). The absence of caries in the anterior teeth (incisors and canines) and the high frequency of caries in the molars appear consistent with the common explanation that carious lesions frequently originate in the pits and fissures of the posterior teeth (Hillson 1996: 272). However, the most common type of carious lesion was interproximal, accounting for ten of the observed lesions. The close proximity of the premolars and molars likely accounts for the prevalence of interproximal caries in these teeth. Pit and fissure cavities were the second most common type, accounting for seven of the observed lesions.

Antemortem Tooth Loss

Antemortem tooth loss was not a common condition in this sample, affecting only three teeth in a single individual: SII-3, a middle adult male (Table 4.3). The exclusive occurrence of antemortem tooth loss in the molars (both M_2s and a left M_1) is again consistent with the tooth morphology and could indicate

[6] The presence of isolated teeth was taken as clear indication that they were lost postmortem and so, for the purposes of evaluating antemortem tooth loss, contributed to the number of observable tooth sockets. Thus, in this study, the number of observable tooth sockets referenced in Table 4 includes both observable alveoli and isolated teeth.

that caries was the most important factor in the aetiology of AMTL, with subsequent infection and, ultimately, loss of the tooth. The M_2s were clearly lost due to abscessing, but the reason for the loss of the M_1 is unclear (Figure 4.6). Caries is, of course, not the exclusive cause of AMTL; extreme wear and the loss of alveolar bone due to periodontal disease are other potential factors.

Enamel Hypoplasia

Linear enamel hypoplasia was observed in 25 teeth (20 per cent), making it the most common dental affliction by tooth count (Table 4.4), however a single individual (SI-3, a Young Adult male) accounted for 16 of those 25 affected teeth. The condition appears to affect males more than females but it is difficult to know if this trend would hold in a larger sample size. Enamel hypoplasia represents disruption of the enamel matrix secretion during the crown formation stage of tooth development (Figure 4.7). Hypoplastic lesions are nonspecific indicators of stress to the body and can result from malnutrition, disease or other factors (Hillson 1996: 165-167).

Calculus

Supra-gingival calculus was observed on 15 per cent of the teeth (Table 4.5). In all cases, the calculus depositions were slight (after Brothwell 1981) and no associated resorption of the alveolar bone was observed (Figure 4.8). The mandibular teeth appear to be more affected than the maxillary teeth and while it is difficult to pronounce with certainty, it is likely a larger sample size would support this trend. The lingual surface of the mandibular incisors tends to be the area most susceptible to calculus formation, and only 11 of a potential 32 lower incisors were observable. Males also appear to be more affected than females in this sample, a trend that has been observed in modern populations (Beiswanger *et al.* 1989).

DISCUSSION

Several factors make comparison of the Sodo dental data with those of other samples problematic. First and foremost is the small sample size. Only eight individuals are represented by the dental data above and none of these individuals possessed a complete dentition, unaffected by postmortem loss. Additionally, the average age of the study sample is relatively young, with six Young Adults and two Middle Adults. Many of the disease processes discussed in this paper are progressive, and the frequencies observed in a young sample cannot be generalized across a normal population age distribution.

Second, at the turn of the millennium, the various territories of what had been Etruria were inhabited by a mixture of local Etruscan descendants as well as immigrants: predominantly Roman war veterans and members of the other Italic tribes (H. Fracchia, pers. comm., Harris 1971). The composition of the population living in the territory of Cortona in this period is difficult to establish, let alone the cultural and biological identities of the individuals buried at the Sodo. Thus, with the population to which the Sodo individuals belonged unknown, available Etruscan and Roman reports can be compared and contrasted with the data from this study, but conclusive assertions cannot be made.

Third, there is a shortage of skeletal material from this area that can be used for comparative purposes. While this scarcity is due in part to the rite of cremation that waxed and waned in popularity throughout the Italian peninsula, it is also attributable to improper excavation and storage techniques that pervaded Etrusco-Roman archaeology for most of its history (e.g. see Pacciani *et al.* 1996). This dearth of skeletal material has led many researchers to group together remains from various sites and time periods for the purposes of examination (e.g. Brothwell and Carr 1962, Moggi-Cecchi *et al.* 1997). In addition to providing the sample size necessary for statistical significance, such grouping together of material from discrete sites enables the establishment of skeletal characteristics typical of the "Etruscan group" for the purposes of biological relatedness studies. Generalizations regarding "typically Etruscan" skeletal features can be useful for comparison with other populations but they do little to increase the understanding of population biology in a specific area and/or time period. In assuming that the Etruscan people, whose lands ranged from Rome to Pisa over hundreds of years, were a consistent and biologically homogeneous population, regional and temporal differences between populations are glossed over.

Despite these difficulties, an examination of the dental data from the Sodo sample is presented here, along with available data on comparable Etruscan and Roman populations. A brief discussion of Etruscan and Roman diet is also undertaken, with attempts to draw correlations between eating patterns and observed dental disease frequencies.

Caries

Caries occurs when the bacteria in the mouth break down the sugars and carbohydrates found in food and in the saliva. Upon metabolizing these sugars, the bacteria produce organic acids which are excreted into the plaque fluid and come into contact with the surfaces of the teeth. The metabolism of proteins, peptides, and amino acids produces alkaline waste products, which help to balance the plaque pH (Hillson 1996: 254-79). The frequent presence of dietary sugars in the oral cavity, i.e. in a diet high in carbohydrates and sugars but low in protein, results in a consistent decrease in plaque pH and subsequent demineralisation of the tooth mineral that is symptomatic of caries. Carious lesions, or cavities, are holes in the tooth that develop when demineralised patches, referred to as “incipient decay,” progress to the point of irreversible destruction of the enamel or cementum; these lesions are pathognomonic of the disease caries.

In the Sodo sample, all of the individuals displayed at least one carious lesion, with an average of two affected teeth per individual (14 per cent of all teeth were affected). There is no apparent difference in the frequency of carious lesions between the Young Adults (15 per cent of teeth were affected) and the Middle Adults (13 per cent of teeth were affected), though it is difficult to know if larger samples would provide a different outcome.

Other studies of Etruscan and Roman dental health have found lower rates of caries than exhibited in this sample. In Capasso’s (1987) study of 119 Etruscan crania from the territory of Chiusi, only 28 per cent of individuals and 7 per cent of teeth displayed signs of caries. In the population from the Monterozzi necropolis at Tarquinia, 25 per cent of individuals and only 3 per cent of teeth were affected (Bartoli *et al.* 1991). Brothwell and Carr (1962) found that 4 per cent of teeth were affected in their study of a number of skulls from all over Etruria. The Roman Imperial Age population from Isola Sacra was reported as exhibiting caries in 36 per cent of individuals and 4 per cent of teeth, while the population from Lucus Feroniae exhibited the disease in 52 per cent of individuals and 6 per cent of teeth (Manzi *et al.* 1999). Higher values were found in a sample of 67 adults of Roman Imperial Age from Quadrella, southeast of Rome: 72 per cent of individuals showed signs of the disease, and 15 per cent of teeth were affected (Bonfiglioli *et al.* 2003). While, at Quadrella, the tooth count frequency was slightly higher than that in the Sodo sample, the individual count frequency was still much lower.

The extremely high frequency of caries in the Sodo sample is likely at least partially attributable to the relatively young age of the sample. Caries is a progressive disease than can result in abscess and/or antemortem tooth loss when untreated. In young adults, caries has rarely had the time to progress to these stages but in middle and older adults, carious teeth are frequently lost antemortem, eliminating them from the count[7].

[7] Unless an attempt is made to compensate for the AMTL through the use of a caries correction factor (see Chapter 5, Footnote 4)

Antemortem Tooth Loss

Although it can have several aetiologies, antemortem tooth loss is generally caused by carious infection of the pulp cavity (a process that can be accelerated by extreme wear or dental trauma). It represents a gradual deterioration that begins with cavities or severe wear and progresses to infection, abscess and, ultimately, loss. As such, AMTL is uncommon in young adults and generally becomes more frequent with age.

As expected, none of the Young Adults in the Sodo sample exhibited AMTL but a single Middle Adult male, SII-3, lost three teeth antemortem: both M_2s and the left M_1. The fact that the Sodo sample is predominantly composed of young adults, combined with the progressive nature of AMTL, makes comparison with other samples particularly difficult but the findings of several studies are presented here for informative purposes.

Capasso (1987) observed AMTL in 50 per cent of individuals and 12 per cent of alveoli in his sample from Chiusi. In this sample, the primary identified causes were dental attrition and caries but 24 per cent of AMTL could not be definitively linked with either condition and the author suggested dental trauma as a potential cause. Bonfiglioli *et al.* (2003) had similar numbers with 60 per cent of individuals exhibiting at least one case of AMTL, and 13 per cent of teeth being lost antemortem. The populations at Isola Sacra and Lucus Feroniae, with 44 per cent and 48 per cent of individuals affected respectively, appear to have similar values (Manzi *et al.* 1999). However the tooth count reveals a disparity between the populations: almost twice the number of alveoli were affected at Lucus

Feroniae (12 per cent) than at Isola Sacra (7 per cent). In all of these cases, posterior teeth were more affected by AMTL than the anterior teeth and at Isola Sacra and Lucus Feroniae, the maxillary teeth were more commonly affected than the mandibular teeth.

Enamel Hypoplasia

Enamel hypoplasia (EH) describes an episodic deficiency in enamel thickness that occurs during tooth formation. Hypoplastic enamel defects can be related to localized disturbances during tooth formation (e.g. trauma, osteitis) or to a more generalized disturbance such as systemic disease or chronic malnutrition (Hillson 1996: 165-7). Localized disturbances tend to cause enamel hypoplasia on an isolated tooth or group of teeth, normally in a single area of the mouth. Defects on a number of teeth throughout the mouth are generally indicative of a systemic aetiology (Hillson 1996: 278-9). Hypoplastic defects can have a number of forms but are generally grouped into three categories: Furrow-type defects (also referred to as Linear Enamel Hypoplasia), pit-type defects, and plane-type defects (Hillson 1996: 166-7).

Of the eight individuals in the Sodo sample, five (63 per cent) exhibited Linear Enamel Hypoplasia (or LEH) in at least one tooth, with a total of 20 per cent of all teeth affected. The largest number of teeth affected in a single individual was 16 (found in SI-3, a Young Adult male), while all other individuals had no more than three affected teeth. Due to the large number of hypoplastic teeth, the defects observed in the individual SI-3 can most certainly be said to have a systemic cause. For the other individuals in the sample it is difficult to be certain due to the incomplete nature of the dentitions. LEH was observed in both the Young Adults and the Middle Adults. Because enamel hypoplasia occurs during tooth formation, in a larger sample we would expect no significant change in the frequency of occurrence between Young Adults and Middle or Older Adults.

The morbidity of EH varies highly between comparative populations, even within the Etruscan and Roman studies already discussed. Almost 42 per cent of the individuals from the Tarquinia had EH, and 18 per cent of teeth were affected. Brothwell and Carr (1962) recorded that approximately one third of the individuals in their sample displayed some degree of EH, although they acknowledged that accurate numbers were difficult due to postmortem loss. Bonfiglioli *et al.* (2003) found LEH in 95 per cent of the individuals in their sample, and 59 per cent of teeth. The authors conclude that such a high frequency of the condition suggests rampant metabolic stress during growth in the Quadrella population. Although not as high as the Quadrella sample, Manzi *et al.* (1999) list relatively high individual count values (81 per cent and 82 per cent of individuals) and tooth count values (36 per cent and 46 per cent of teeth) for LEH at Isola Sacra and Lucus Feroniae, respectively.

Calculus

Dental calculus is the mineralized form of plaque and therefore is linked to extensive plaque build-up which, in turn, is linked to poor oral hygiene and significant carbohydrate consumption (Hillson 1996: 254-60). Plaque is composed of a number of micro-organisms, including caries-causing bacteria, which live in the oral cavity. Tooth fissures, interproximal areas and gingival crevices are particularly susceptible to plaque build-up, protected as they are from the cleaning actions of the tongue (Hillson 1996: 254). While the progression from plaque to calculus is not well understood, it is known that the minerals involved in calculus formation derive originally from saliva and so tooth sites closest to salivary glands are particularly susceptible to mineralisation (Hillson 1996: 254-60). Major salivary glands are found under the tongue and inside the cheeks, making the lingual surface of the anterior teeth and the buccal surface of the molars prime locations for calculus development.

Slight calculus was observed in three (38 per cent) of the individuals in the Sodo sample with a total of 18 (15 per cent) of the teeth. The condition was considerably more prolific in the mandibular teeth (26 per cent) than in the maxillary teeth (6 per cent) and slightly more common in males than in females (16 per cent to 12 per cent respectively). The mineralization of calculus into plaque is a progressive process and we would generally expect to see a higher frequency of calculus in the older age groups. In this sample, no calculus was observed on SII-3, the Middle Adult. This anomaly is most likely explained by the high degree of antemortem and postmortem tooth loss in the individual. SII-3 lacks 20 of 32 teeth, including the lower incisors and six molars. With these key sites for calculus build-up missing, it is impossible to determine what the actual occurrence of calculus in this individual would have been.

As with AMTL, the young age of the individuals in the Sodo sample makes comparison with other samples problematic and it should not be surprising that the findings of other studies cite much higher frequencies of calculus. Bonfiglioli *et al.* (2003) observed calculus deposits in 84 per cent of the Quadrella individuals and 51 per cent of the teeth. In the sample from Lucus Feroniae, 67 per cent of individuals had calculus build-up on at least one tooth, but only 27 per cent of teeth were affected. In the population from Isola Sacra, only 59 per cent of individuals exhibited calculus but 34 per cent of teeth were affected. At Isola Sacra, as with the Sodo sample, calculus was more common in males than in females and at both Isola Sacra and Lucus Feroniae, the mineralised build-up was more common in the mandibular teeth (Manzi *et al.* 1999).

The Role of Dental Data in Understanding Diet

Much of the evidence for reconstructing ancient diets comes from written sources and tomb paintings (Barker and Rasmussen 1998: 180, Brothwell and Brothwell 1998: 13). Small pieces of information are seized upon by researchers and extrapolations are applied to “Etruscans” or “Romans” as a whole. Dental data, however, can help clarify the details regarding diet and nutrition in a specific sample. This information is valuable for highlighting similarities and differences between populations and between individuals within a population. Differences in diet, pertaining to age, sex, or class, for example, can be perceived only when the variances within a population are thoroughly examined.

The use of dental data to interpret diet is based on a simple principle: the chemical and physical composition of food affects the teeth that help to digest it. Thus, diets that are high in a certain substance have a different effect on the teeth than diets that are low in that substance but high in another. While general knowledge may indicate, then, that a population's diet consisted of cereals, meat, vegetables, and fruit, the dental data can help reveal the role filled by the various foods.

The function of sugars in the aetiology of caries has already been discussed: bacteria in the oral cavity digest the sugars, releasing acids that lower the oral pH and can result in cavities. A diet high in sugary foods, then, can give rise to a consistently acidic oral environment, and a relatively high frequency of caries. The extent of cariogenicity is dependent on the frequency, degree, and form of sugar consumption. Dried, sticky fruits such as figs carry an extremely high risk of caries, while the situation with starches is more complex: starchy foods tend to have a less immediate and less pronounced effect on the oral pH, but the consequences are longer lasting (Hillson 1996: 278, Rugg-Gunn 1993).

Other conditions, such as calculus and enamel hypoplasia, cannot be as simply interpreted as caries. Dental plaque appears to be related to the consumption of carbohydrates but the mineral precipitation that leads to calculus build up is linked to high-protein diets and an alkaline oral environment (Bonfiglioli *et al.* 2003, Hillson 1979, Hillson 1996: 254-60). Perhaps even more difficult to interpret, enamel hypoplasia is a nonspecific indicator of childhood health and while this can include diet, it is useful only as corroborative evidence. Ultimately, when using dental data to make interpretations about diet it is crucial to consider the varying forms of evidence in conjunction with each other.

Diet and Dental Health in the Population at Sodo

Most information on Etruscan and Roman diet is quite generalized: subtle differences between geographic regions and time periods are not well understood. Certain conclusions about wide-ranging nutrition and eating habits can be drawn, however, and these points should be kept in mind when interpreting the dental data.

Compared with the earlier Iron Age "Villanovan" period, the Etruscan period saw an increase in the number and variety of cereals and legumes cultivated and also involved the introduction of "tree crops" to the regional diet (Barker and Rasmussen 1998: 184). Generally, it can be said that Etruscan agriculture included the cultivation of barley, wheat, millet, and other cereals, as well as grapes, olives, and figs. The Val di Chiana, in particular, provided some of the most extensive, fertile, agricultural land in central Italy and the territory of Cortona derived much of its wealth from a strong agricultural industry (Barker and Rasmussen 1998: 182, Fracchia 2006: 12, Vallone 1995: 109). Wild foodstuffs such as fruit (e.g. cherries and pears) and nuts (including hazelnuts and acorns) were also consumed.

Animal husbandry in the Etruscan era included horses, donkeys, cattle, sheep, goats, pigs, dogs, and, possibly, chickens. The early (Archaic) Etruscan period saw an increased emphasis on producing secondary products from these domesticates, such as cheese, milk, and wool (Barker and Rasmussen 1998: 185). From the Archaic to the Hellenistic periods, however, the Etruscan diet came to rely increasingly on vegetable and plant foods and less on animal-derived protein (Forniciari and Mallegni 1987).

By the Roman period, the Val di Chiana was a predominantly open landscape, allowing for increased agricultural intensity (Barker and Rasmussen 1998: 40). Wheat had emerged as the favoured cereal and the Val di Chiana was a prime region of wheat production (Barker and Rasmussen 1998: 182, Brothwell 1988). Cereals and legumes were dietary staples for the poorer classes and the typical meal consisted of wine, root vegetables, legumes, lard, fruit, olives, and unrefined bread or *puls*, a porridge-like mixture of cereals, water, salt, and oil (Bonfiglioli *et al.* 2003, Brothwell 1988, Brothwell and Brothwell 1998, White 1988).

Due to the small sample size, it is difficult to say much about the diet of the Sodo population based on dental pathology. Nevertheless, one conclusion seems evident: the high frequency of caries (100 per cent of individuals and 14 per cent of teeth) appears to be a clear indicator of a diet high in sugars. This finding confirms the important role of carbohydrates in the Etruscan and Roman diets, and is consistent with the dominance of the Val di Chiana in cereal-production throughout this period. Conclusions regarding dental calculus or antemortem tooth loss are more difficult to interpret, due not only to the size of the sample but also the predominantly young age of the adults studied.

The relatively high frequency of Linear Enamel Hypoplasia (63 per cent of individuals and 20 per cent of teeth) indicates that some sort of systemic stress was relatively prevalent in young children in the Sodo population. This finding supports the commonly held attitude that childhood in antiquity was a hazardous time, with children at a higher risk for disease and malnutrition than their adult counterparts (e.g. FitzGerald *et al.* 2006, Garnsey 1991, Goodman and Armelagos 1989). Although actual numbers are difficult to establish with certainty, Garnsey (1991) estimates that of infants born alive, 28 per cent died in the first year and 50 per cent died before they reached ten years of age (see also Dupont 1994: 220-222).

The presence of LEH, however, indicates that the individual survived the period(s) of stress. We are interested, then, in ailments that could have caused periods of systemic stress in children but did not necessarily result in death. There are a number of such illnesses that could have affected children in the Roman period, including: infantile dysentery, chronic diarrhoea, various skin diseases, intense fevers (often with associated weight loss and dehydration), and lead poisoning, which can stunt growth, and lead to anaemia and kidney damage (Dupont 1994: 255-256, Soranus 2.27-8 in Temkin 1956, Summerton 2007: 29). One of the most serious diseases known to have been endemic to the region is malaria, in particular, the strains caused by the parasites *Plasmodium malariae* and *Plasmodium vivax* (Harris 1977: 61-2, Soren 2003). These forms of malaria are rarely fatal, but can still cause high fever, respiratory distress, diarrhoea, abdominal pain, cough, and anaemia, symptoms which are particularly severe in children (Webb 2009, Wilks *et al*. 2003). Additionally, malaria brought on by *P. malariae* can cause the kidneys to leach protein into the urine (nephrotic syndrome) and, although rare, congenital malaria of the *P. vivax* strain can occur, presenting as progressive haemolytic anaemia (Wilks *et al.* 2003). Many these illnesses could have been endemic to the Sodo population and could have functioned alone, or in consort with one another, to create the type of systemic stress that resulted in enamel hypoplasia.

When considering potential aetiologies for LEH it is also important to consider the role of malnutrition, particularly in relation to weaning practices. Weaning in the Roman period tended to be associated with problems in general health and development, as parents were unable to match the nutrition of breast milk with supplementary foods. Children typically suffered from a shortage of protein and numerous vitamins, both from the insubstantial nature of the new diet and from poor food preparation techniques that lead to numerous gastrointestinal issues (frequently grouped under "weanling diarrhoea") and subsequent nutrient malabsorption. Such issues were particularly common in the middle and lower classes, which would have relied on cereal as the primary weaning food (Garnsey 1991).[8] At Rome, babies were typically weaned around three years of age, but early weaning was often a problem in poor, rural communities where the women needed to return to work in the fields (Dupont 1994: 20, Garnsey 1991, Soranus 2.21 in Temkin 1956). In addition to causing malnutrition, early weaning or poor dietary practices[9] could impair the development of the child's immune system,

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[8] As demonstrated by the historical and dental evidence discussed above, the Val di Chiana was a prosperous agricultural region with a diet that relied heavily on grains. Goodman and Armelagos demonstrated that the decrease in overall health typically associated with a dietary shift to agriculture is particularly pronounced in children, who consistently exhibit signs of severe malnutrition in the archaeological record (1989, see also Cohen and Armelagos 1984).
[9] Soranus, the Greek physician, advised against allowing newborns to consume the colostrum (the form of milk produced in late pregnancy and just after childbirth), which is higher in protein and antibodies, and lower in fat, than regular breast milk (2.12 in Temkin 1956). Additionally,

making them more susceptible to disease and infection (Garnsey 1991, Goodman and Armelagos 1989). Clearly, although any one of these stressors could be behind the presence of LEH in the study sample, the reality is likely more complicated, with a combination of factors affecting the growth and overall health of the children at Sodo.

The limited dental data (and subsequent dietary information) from Sodo is more informative when viewed in light of other studies of comparable populations. Although information about diet and nutrition can be generalized across the Etruscan and Roman territories, specific populations (and groups within populations) differ in their habitual regimes. In the population from Chiusi, for example, researchers interpreted a low frequency of caries, high frequency of AMTL and severe dental wear as being indicative of a diet that was low in carbohydrates and high in fibre (Capasso 1987, Capasso and Di Tota 1993). The population from Tarquinia were deemed to have a cereal-dominated diet based on a high prevalence of caries, and the heavy wear observed in the sample was attributed to poorly ground flour (Bartoli *et al.* 1991). The Roman population from Quadrella was interpreted as having a rather limited diet, composed mainly of soft carbohydrates, due to a low frequency of wear and a high frequency of caries (Bonfiglioli *et al.* 2003).[10]

When Manzi *et al.* compared the population from Isola Sacra with that of Lucus Feroniae, they determined that the Lucus Feroniae diet appeared less

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numerous ancient scholars advised against allowing children to eat until full, either as a response to illness or to encourage proper growth (e.g. Dupont 1994: 223, Soranus 2.25 in Temkin 1956).

[10] In this case, however, the authors acknowledged that extensive cleaning and cooking of typically fibrous foods (e.g. vegetables) can reduce the abrasive effects and make these foods difficult to see in the skeletal record.

differentiated than that of Isola Sacra (1999). This finding was consistent with the different nature of the populations at the two sites: Isola Sacra was populated primarily by an urban middle class population that should have had access to a good supply of "primary foodstuffs", whereas Lucus Feroniae was a colony of relatively poor war veterans, slaves and freemen that would have fed mainly on cereals. In this study, the authors cited the importance of age at onset for antemortem tooth loss, which tends to be lower in agricultural populations, as central to their interpretation.

CONCLUSION

The archaeological and documentary evidence indicates that lower-class Etruscans and Romans had diets consisting of crude bread, *puls*, root vegetables and legumes, and fruit. The dental data from the Sodo sample suggests that this population in particular had a diet high in sugars, most likely derived from starchy carbohydrates and, potentially, dried fruit. The findings from the Sodo are most consistent with those of the population from Quadrella, a first to fourth century AD Roman settlement in the territory of Molise (Bonfiglioli *et al.* 2003). Interestingly, the sample of fourth to second century BC Etruscan crania from the nearby territory of Chiusi displayed an entirely different pattern of dental disease, indicating a low carbohydrate and high fibre diet (Capasso 1987).

Many of the interpretation issues with the Sodo sample can be resolved once more Roman burials become available for study. A larger sample size would allow more conclusions to be drawn regarding the specifics of diet and nutrition, as well as other areas of potential analysis such as dental trauma. Additionally, a broader skeletal sample, particularly in terms of age at death, would result in a better understanding of the distribution of the different dental diseases across the entire population. The turn of the millennium saw the movement of great numbers of people across the Italian peninsula. The lines between Etruscan and Roman, and between Roman and the other Italic tribes, became increasingly blurred. The territory of Cortona was no exception; for several hundred years the immigration and emigration of individuals left the populace in a state of flux. Further dental and skeletal analysis is necessary to the development of a comprehensive understanding of this complex, heterogeneous population.

Table 4.1. Individual count comparison of dental disease frequencies in the Sodo sample.

		Caries n (%)	AMTL n (%)	Hypoplasia n (%)	Calculus n (%)
Sex	Male	5 (100)	1 (20)	3 (60)	1 (20)
	Female	3 (100)	0	2 (67)	2 (67)
Age	Young Adult	6 (100)	0	4 (67)	3 (50)
	Middle Adult	2 (100)	1 (50)	1 (50.0)	0
Total		**8 (100)**	**1 (13)**	**5 (63)**	**3 (38)**

n = number of affected individuals; (%) = number of affected individuals/number of observable individuals x 100, rounded to the nearest full percentage; AMTL = Antemortem tooth loss.

Table 4.2. Tooth count prevalence of caries in the Sodo sample.

		n_a	n_o	%
Tooth class	Incisor	0	17	0
	Canine	0	18	0
	Premolar	2	38	5
	Molar	16	52	31
Sex	Male	11	75	15
	Female	7	50	14
Age	Young Adult	16	109	15
	Middle Adult	2	16	13
Jaw	Maxilla	10	70	14
	Mandible	8	55	15
Total		**18**	**125**	**14**

n_a = number of affected teeth; n_o = number of observable teeth; (%) = number of affected teeth/number of observable teeth x 100, rounded to the nearest full percentage.

Table 4.3. Tooth count prevalence of antemortem tooth loss in the Sodo sample.

		n_a	n_o	%
Tooth class	Incisor	0	35	0
	Canine	0	23	0
	Premolar	0	43	0
	Molar	3	58	5
Sex	Male	3	101	3
	Female	0	58	0
Age	Young Adult	0	131	0
	Middle Adult	3	28	11
Jaw	Maxilla	0	87	0
	Mandible	3	72	4
Total		**3**	**159**	**2**

n_a = number of affected tooth sockets; n_o = number of observable tooth sockets; (%) = number of affected tooth sockets/number of observable tooth sockets x 100, rounded to the nearest full percentage.

Table 4.4. Tooth count prevalence of enamel hypoplasia in the Sodo sample.

		n_a	n_o	%
Tooth class	Incisor	3	17	18
	Canine	8	17	47
	Premolar	2	38	5
	Molar	11	51	22
Sex	Male	20	73	27
	Female	5	50	10
Jaw	Maxilla	11	68	16
	Mandible	14	55	25
Total		**25**	**123**	**20**

n_a = number of affected teeth; n_o = number of observable teeth; (%) = number of affected teeth/number of observable teeth x 100, rounded to the nearest full percentage.

Table 4.5. Tooth count prevalence of calculus in the Sodo sample.

		n_a	n_o	%
Tooth class	Incisor	4	17	24
	Canine	3	17	18
	Premolar	6	38	16
	Molar	5	52	10
Sex	Male	12	74	16
	Female	6	50	12
Age	Young Adult	18	108	17
	Middle Adult	0	16	0
Jaw	Maxilla	4	69	6
	Mandible	14	55	25
Total		**18**	**124**	**15**

n_a = number of affected teeth; n_o = number of observable teeth; (%) = number of affected teeth/number of observable teeth x 100, rounded to the nearest full percentage.

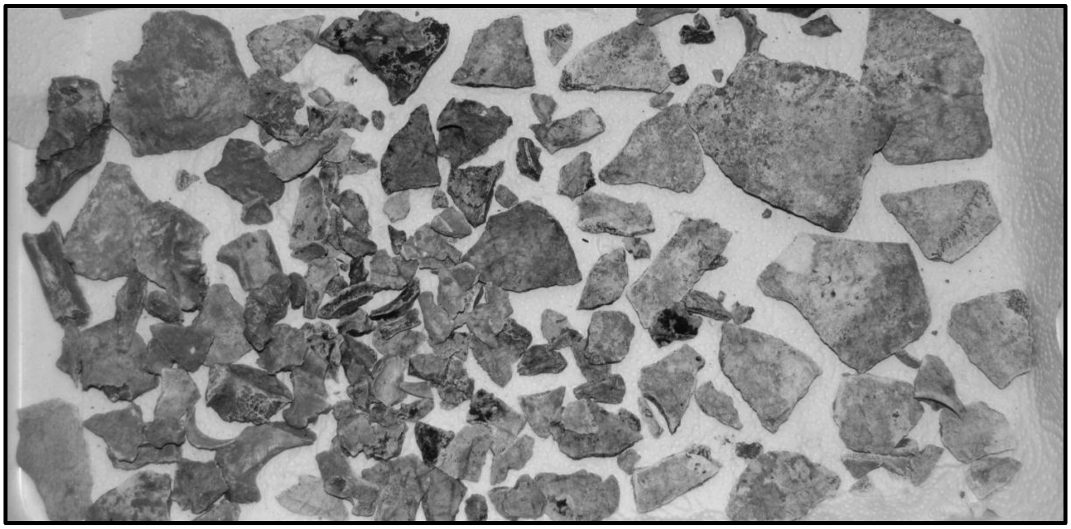

Figure 4.1. The cranial remains from SII-2 after cleaning. Remains were highly fragmentary.

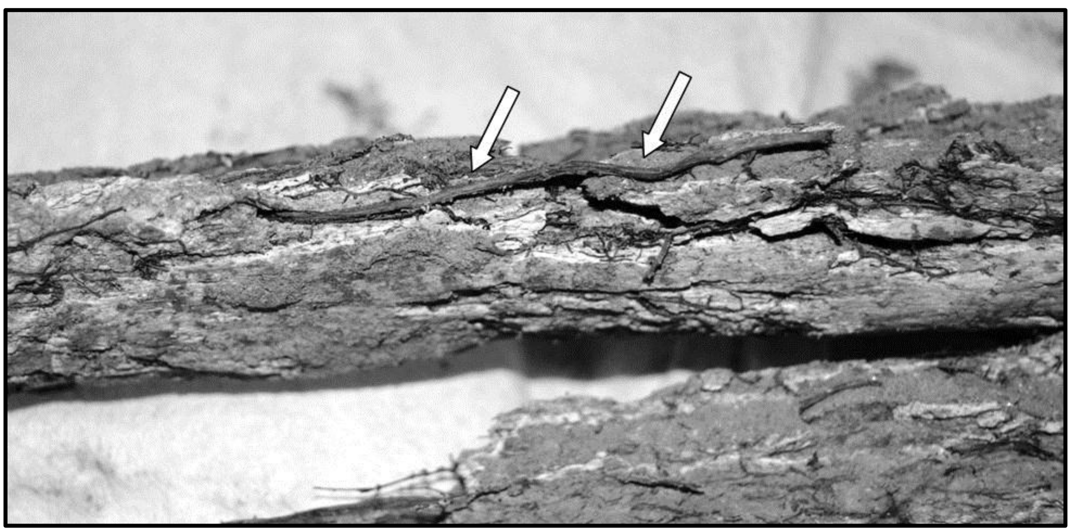

Figure 4.2. A long bone fragment from SII-1. The fragile nature of the bone is visible, as is the prolific infiltration by plant roots (arrows).

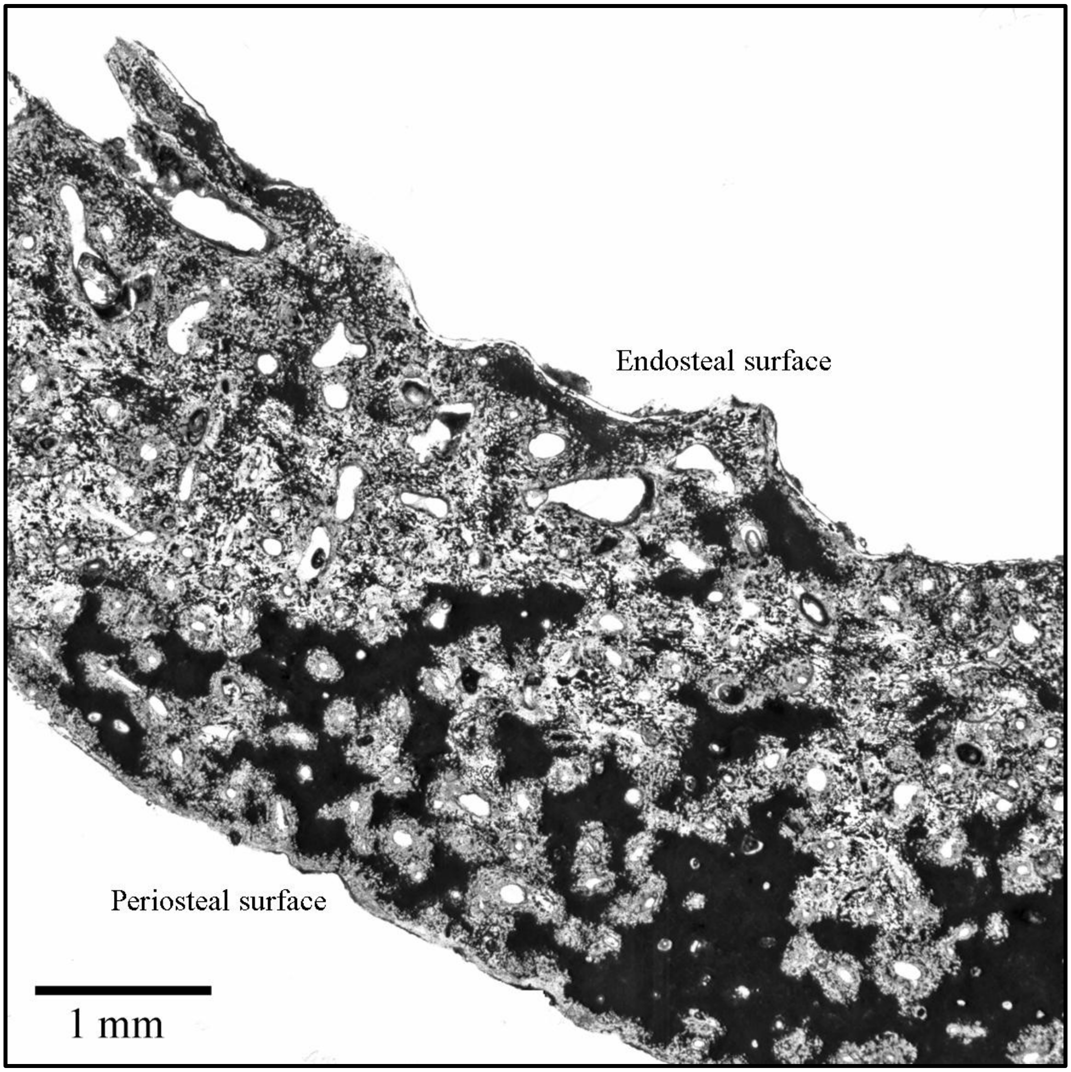

Figure 4.3. A long bone cross section from SI-3 under 2.5x magnification. The invasive organic matter appears black.

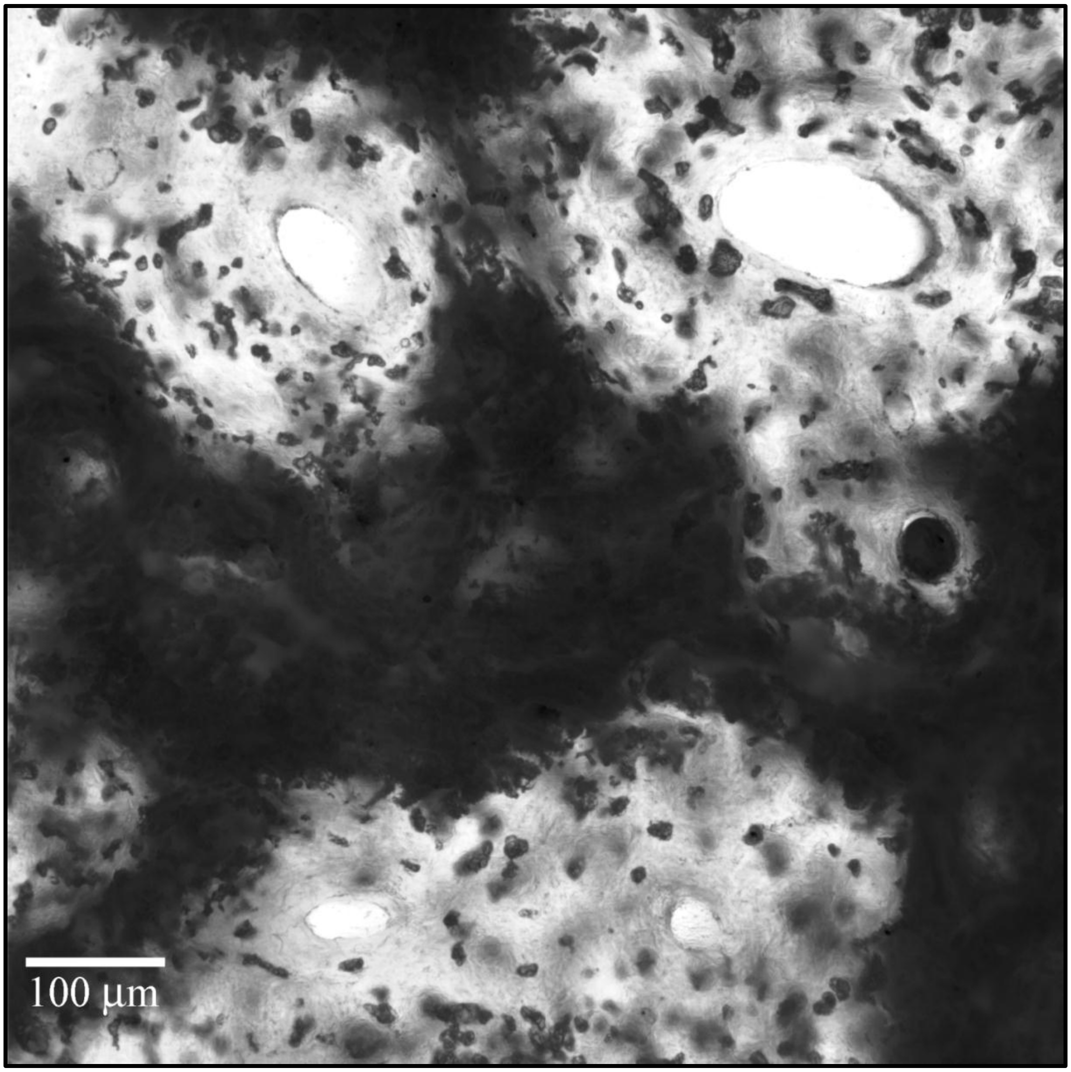

Figure 4.4. The same long bone cross section from SI-3 under 20x magnification. At this level, the globular appearance of the organic matter is visible, as is the extent of the infiltration.

Figure 4.5. A gross carious lesion in the right first molar of SI-3.

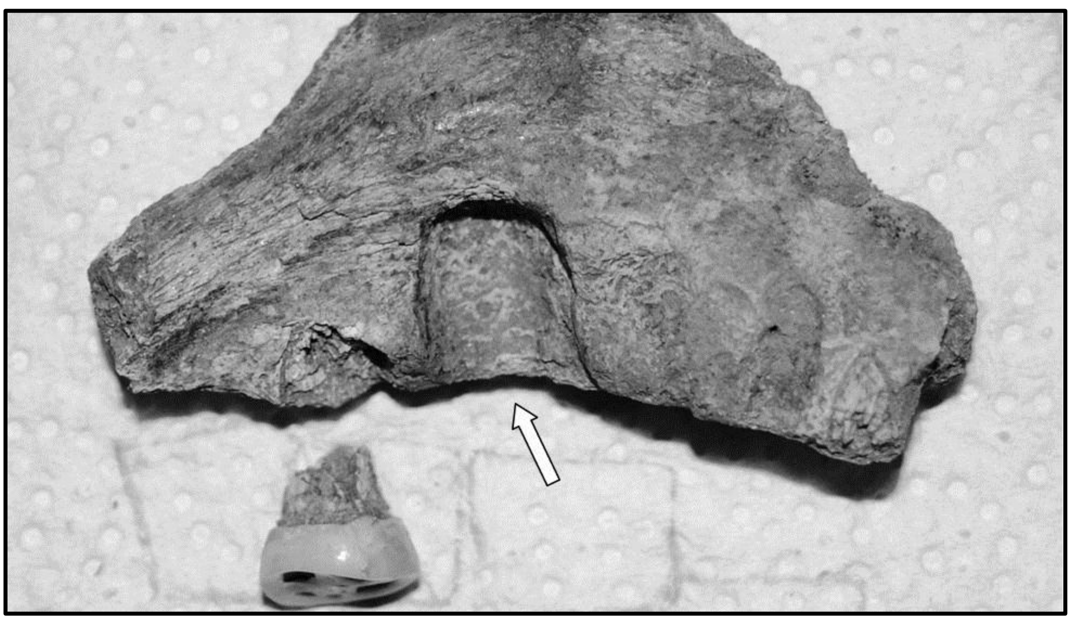

Figure 4.6. Antemortem loss of the lower left first and second molars in SII-3. The rounded cavity of the abscessed second molar is visible (arrow).

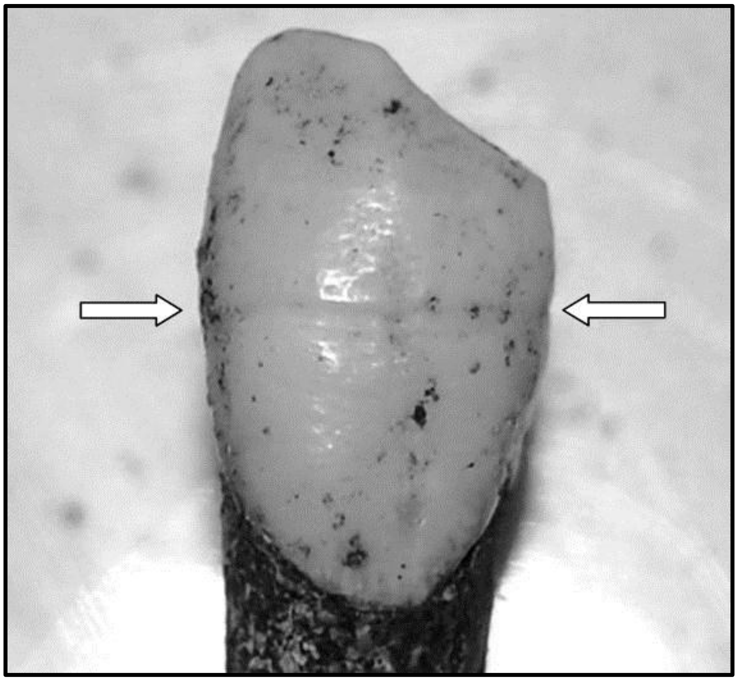

Figure 4.7. Linear enamel hypoplasia in the left mandibular canine of SII-1 (arrows).

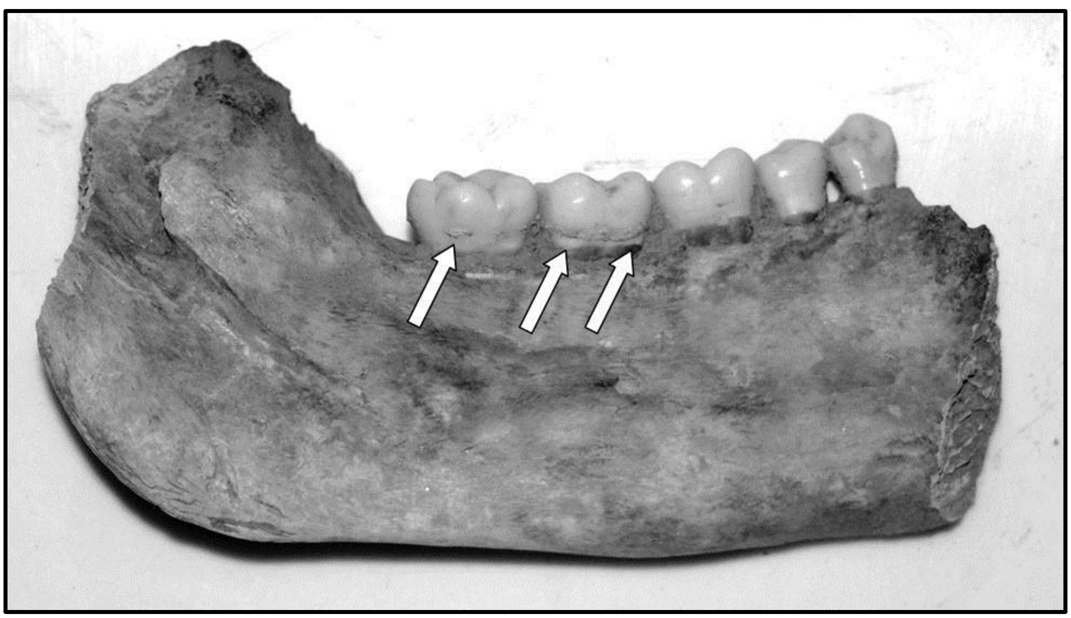

Figure 4.8. Slight calculus on the lingual surface of the left mandibular teeth in SI-3 (arrows).

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CHAPTER 5: TERONTOLA

INTRODUCTION

In 2003 the skeletal remains of two individuals were discovered during an archaeological survey prior to the construction of a *carabinieri* station on the Via Combattenti in Terontola. Only several hundred metres east of the SS71/SR71 that follows the course of the Roman Via Cassia, the remains were found in *a cappuccina* graves, near the probable foundations of a funerary monument dating to the Early Imperial Age[1] (Gori *et al.* 2007). Nearby, to the west of the Terontola train station and north of the local Landrucci road (and the Rio Cesa that runs parallel to it), archaeological excavation has revealed the presence of a *borgata rurale* (rural township), likely associated with a nearby villa (Figure 5.1). Preliminary excavation of the *borgata* has revealed additional *a cappuccina* tombs, also dating to the Early Imperial Age (H. Fracchia, pers. comm., Gori *et al.* 2007).

In June of 2010, one of the skeletons, an Older Adult male, from the site of the *carabinieri* station in Terontola was made available for study at the Museo dell'Accademia Etrusca e della Città di Cortona (MAEC).

BURIAL DETAILS

The individual, labeled T-1 by the author, was delivered to the MAEC in extended, supine position on terracotta roof tiles, consistent with the *a cappuccina* form of burial (Figure 5.2). The first roof tile held the skull, the upper axial

[1] The relation of the funerary monument to the burials is not well understood at this time.

skeleton and humeri. The second roof tile held the lower axial skeleton (including pelvis), the radii and ulnae, and upper portions of the femorae which had been severed mid-shaft postmortem. Presumably, a third roof tile held the lower leg and foot bones but whether this portion of the burial has been excavated is not known. As with the Sodo material, the preservation of T-1 was poor: skeletal elements were highly fragmentary and encased in hardened mud[2] (Figures 5.3 and 5.4).

The individual T-1 was identified as an Older Adult (50+ years) by the high degree of ectocranial suture closure (Meindl and Lovejoy 1985), the presence of arachnoid granulations on the endocranial surface (Basmajian 1952, Yew *et al.* 2011), and severe tooth wear (Brothwell 1981, Meindl and Lovejoy 1985)[3]. Although none of these features alone is a sure indicator of age, together they provide strong, independent evidence for categorization of T-1 as an Older Adult. T-1 was identified as male based on pronounced brow ridges, large mastoid processes, a narrow and deep sciatic notch, and the overall degree of skeletal robusticity (anatomical features were evaluated according to the standards proposed by Buikstra and Ubelaker 1994).

DENTAL PATHOLOGY

Eight teeth from the dentition of T-1 were unobservable: the left M_3 and P_2 were clearly lost postmortem, while five teeth could not be classified as neither

[2] The soil encasing T-1 had a pH of 7.04 and was a clay loam, according to the United States Department of Agriculture soil texture guidelines.
[3] Use of tooth-wear to estimate age at death will be elaborated on below.

the teeth nor the alveoli were present for examination[4]. A sixth tooth, reduced by postmortem damage to a minute root fragment, could not be identified and was omitted from the study. From the remaining 24 teeth, T-1 was determined to have suffered from caries, antemortem tooth loss and calculus. No enamel hypoplasia or abscessing was observed.

The prevalence of caries by tooth count is listed in Table 5.1. All six carious lesions were interproximal (Figure 5.5). The relatively low frequency of caries in the molars (a common site for carious lesions) is likely explained by the presence of only two of the twelve molars, the rest were lost either antemortem or postmortem.[5]

A total of seven teeth were lost antemortem (Table 5.2). The right P_2, M_1, M_2, and M_3 were lost significantly before death, allowing for substantial re-modeling of the mandibular bone (Figure 5.6). The left M_2 was lost more recently than the lower right teeth, although the alveolus had still filled with woven bone prior to death. The upper teeth: the right C and I^1, and the left I^1, I^2, C, P^1, and P^2 were, likewise, all lost significantly before death. Both upper canines were clearly lost due to abscessing, determinable from the expanded round alveoli at the points of infection. The cause of AMTL for the other teeth is unidentifiable but significant dental wear and the high frequency of carious lesions in the remaining teeth indicates that caries, exacerbated by severe wear, is a likely cause.

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[4] It is possible that the missing M^3s in this individual were congenitally absent, a trait that is not uncommon in Etruscan populations (e.g. see Becker *et al.* 2009).

[5] A number of attempts have been made to compensate for the effects of AMTL on caries frequencies, most notably the caries correction factor (CCF) put forward by Lukacs (1995). The CCF was not applied to T-1 for two reasons: 1) it was designed for application to a skeletal population, not a single individual, and 2) the accuracy of the CCF would be compromised by the high degree of postmortem tooth-loss and the poor preservation of T-1's dentition.

The high frequencies of caries and antemortem tooth loss in T-1 are consistent with an agrarian diet high in starches and sugars, similar to the Sodo sample. The considerably higher prevalence of AMTL in T-1 is likely attributable to his advanced age. As outlined in Chapter 4, AMTL is a gradual process, and we would expect it to be more common in Older Adults than in Middle or Younger Adults.

Slight calculus was observed on a single tooth, the right I_1, in this individual (Figure 5.7, Table 5.3). The lingual surface of the lower incisors and the buccal surface of the molars are the two regions typically most susceptible to calculus formation in humans (Hillson 1996: 254-60). It is curious, given the advanced age of the individual, that the I_1 was the only tooth on which calculus was observed, especially given the relatively good preservation of all the lower incisors in the mandibular bone.

TOOTH WEAR ANALYSIS

Dental wear is produced by a combination of two general processes: attrition, which is produced by tooth-on-tooth contact, and abrasion, which is produced when the tooth comes into contact with a foreign object (frequently food). The degree of tooth wear is progressive, and is affected by many conditions, including the age of the individual, the eruption sequence within the dentition, and any pathological conditions that might have affected use of the tooth.

Wear due to mastication is a complex process produced by a combination of attrition and abrasion. The nature of the food being consumed can have a profound influence on tooth wear as it both affects the degree and type of chewing that take place (attrition) and the food particles that come into contact with the teeth (abrasion). Dental wear patterns can therefore be useful for interpreting the abrasiveness of a particular diet. Detailed inferences are difficult however, as many different types of food can wear down the tooth surfaces and severe wear can be indicative of anything from rock granules in flour, to bone and animal tissue (Hillson 1979). Despite these difficulties, a thorough examination of the rate and pattern of wear can provide an understanding of diet beyond its general abrasiveness. Smith (1984), for example, showed that hunter-gatherers tend to display flatter molar wear due to the mastication of tough and fibrous foods, while agriculturalists display an oblique molar wear pattern due to preparation techniques that include grinding and cooking with water.

The use of teeth as tools and the intentional modification of teeth for aesthetic or other purposes can also complicate interpretations of dental wear. The anterior teeth in particular tend to be used for a variety of tasks related to food or craft processing and leisure (pipe smoking, etc.), and are often singled out for intentional modification (Hillson 1996). In Etruscan and Roman societies, intentional modification often involved the creation and application of elaborate dental appliances of gold or other materials, and false teeth (e.g. Becker 1994, Becker 1999, Crubézy *et al.* 1998).

Due to its progressive nature, many attempts have been made to use tooth wear as evidence in age estimation (e.g. Brothwell 1981, Brothwell 1989, Lovejoy 1985). Many of these attempts have been problematic, however, as tooth wear is degenerative, and is a direct indicator of usage, not age. A young individual with an exceptionally abrasive diet will display more severe wear than an older individual with an exceptionally soft diet. Nevertheless, when applied to a single population with a consistent diet, tooth wear can be effectively used as an indicator of general age (e.g. Lovejoy 1985, Mays 2002, Walker *et al.* 1991). Ultimately, if the varying forms of evidence are considered in conjunction with one another, dental wear analysis can yield important information about diet, habitual activity, and age in archaeological populations.

The mandibular anterior teeth of T-1 showed very light wear, scoring a 3-4 on the Smith scoring scale, suggesting early loss of the corresponding maxillary teeth (Figures 5.7 and 5.8, Table 5.4). The wear on both the upper and lower posterior teeth was more severe, with the premolars ranging between 5 and 7, and the molars between 7 and 8 (Figure 5.9). The presence of secondary dentine in all observable teeth indicates the wear occurred gradually, over a long period of time (Hillson 1996). Although the issues with using tooth wear to determine age are clear, the extensive wear observed in T-1 is consistent with his categorization as an Older Adult, particularly when compared to the minimal wear observed in the Sodo sample (see Chapter 4). Additionally, it was observed that T-1's maxillary premolars and molars were worn obliquely, to the point that portions of the roots functioned in occlusion (Figure 5.10). Such a wear pattern is consistent with Smith's observations on agricultural societies.

CONCLUSION

The Terontola excavation is only 9 kilometres southeast of the Sodo, and is connected to the tumuli by the modern, Roman, and Etruscan road that runs adjacent to both sites. Dating of the Terontola and Sodo burials based on grave goods places them all within the Early Imperial period (first century BC to first century AD). Moreover, T-1 was buried in the same manner as the individuals from the Sodo, *a cappuccina*, indicating that he, too, was likely an individual of low status.

The individual from Terontola is an Older Adult, an age category not represented in the Sodo collection, and thus serves as a useful compliment to the material discussed in Chapter 4. The high frequency of caries in the dentition of T-1 is consistent with a diet similar to that of the Sodo population: high in starches and other sugars. The substantial number of teeth lost antemortem by T-1 likely provides an indication of what could be expected in Older Adult individuals from the Sodo, although this hypothesis can only be tested if more individuals become available at a future date.

Table 5.1. Tooth count prevalence of caries in the individual from Terontola.

		n_a	n_o	%
Tooth class	Incisor	0	4	0
	Canine	2	2	100
	Premolar	3	4	75
	Molar	1	2	50
Jaw	Maxilla	3	3	100
	Mandible	3	9	33
Total		**6**	**12**	**50**

n_a = number of affected teeth; n_o = number of observable teeth; (%) = number of affected teeth/number of observable teeth x 100, rounded to the nearest full percentage.

Table 5.2. Tooth count prevalence of antemortem tooth loss in the individual from Terontola.

		n_a	n_o	%
Tooth class	Incisor	3	7	43
	Canine	2	4	50
	Premolar	3	8	38
	Molar	4	7	57
Jaw	Maxilla	7	10	70
	Mandible	5	16	31
Total		**12**	**26**	**46**

n_a = number of affected tooth sockets; n_o = number of observable tooth sockets; (%) = number of affected tooth sockets/number of observable tooth sockets x 100, rounded to the nearest full percentage.

Table 5.3. Tooth count prevalence of calculus in the individual from Terontola.

		n_a	n_o	%
Tooth class	Incisor	1	4	25
	Canine	0	2	0
	Premolar	0	4	0
	Molar	0	2	0
Jaw	Maxilla	0	3	0
	Mandible	1	9	11
Total		**1**	**12**	**8**

n_a = number of affected teeth; n_o = number of observable teeth; (%) = number of affected teeth/number of observable teeth x 100, rounded to the nearest full percentage.

Table 5.4. Tooth wear analysis in the individual from Terontola.

	Tooth Category	Wear Score
Maxilla	Incisors	Missing
	Canines	Missing
	Premolars	RP1 and RP2 = 7 left Ps missing
	Molars	RM1 = 7 other Ms missing
Mandible	Incisors	3-4
	Canines	4
	Premolars	LP1 =5 RP1 =6 P2s missing
	Molars	LM2=8 other Ms missing

Values assigned according to the system outlined by Smith (1984).

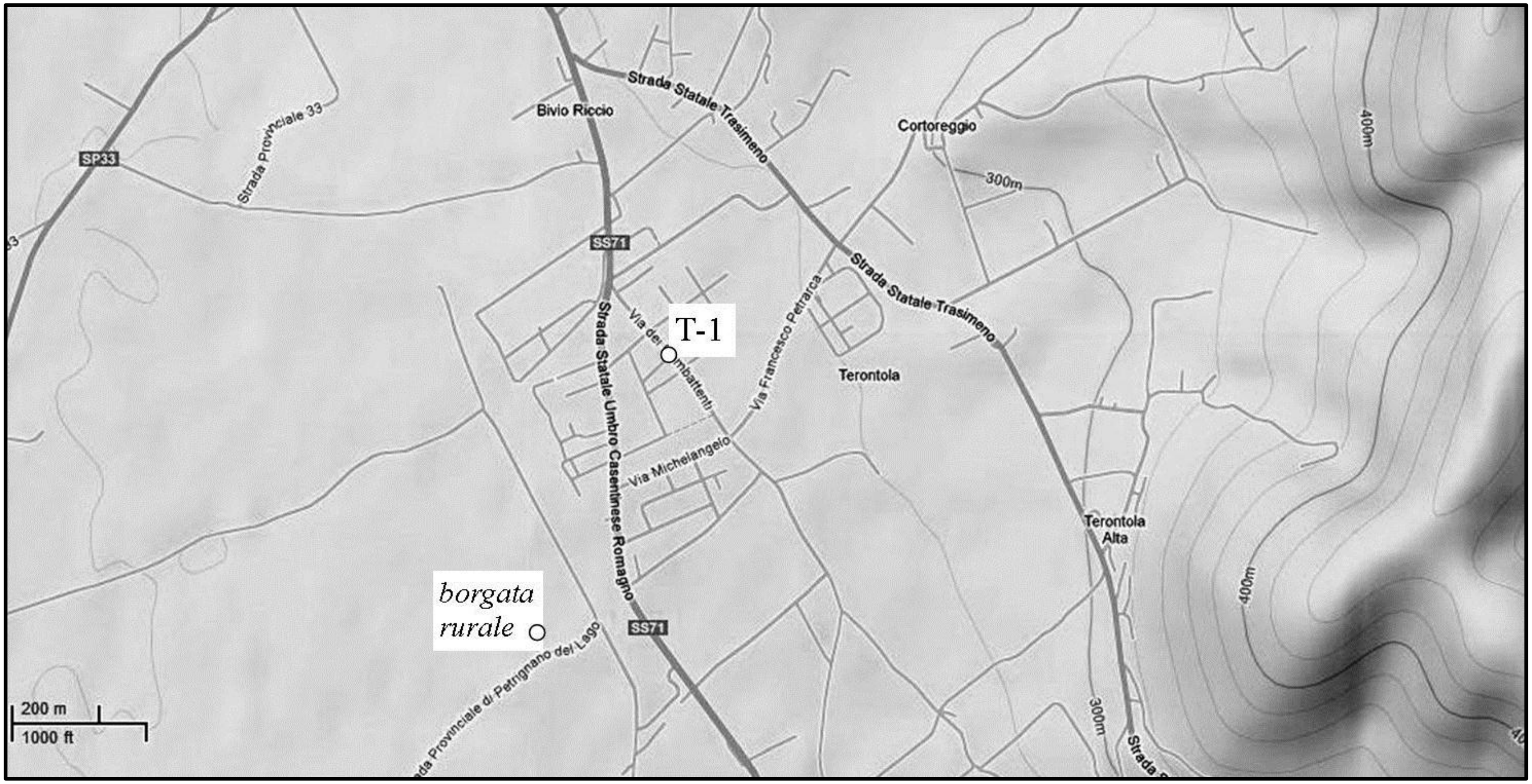

Figure 5.1. Map of Terontola showing the location of the burial under the current *carabinieri* station. Also pictured is the location of the *borgata rurale*, a source of several contemporaneous burials. (©2012 Google).

Figure 5.2. T-1 as received at the MAEC, in extended supine position on two terracotta roof tiles.

Figure 5.3. The cranium and mandible of T-1. The remains were highly fragmentary.

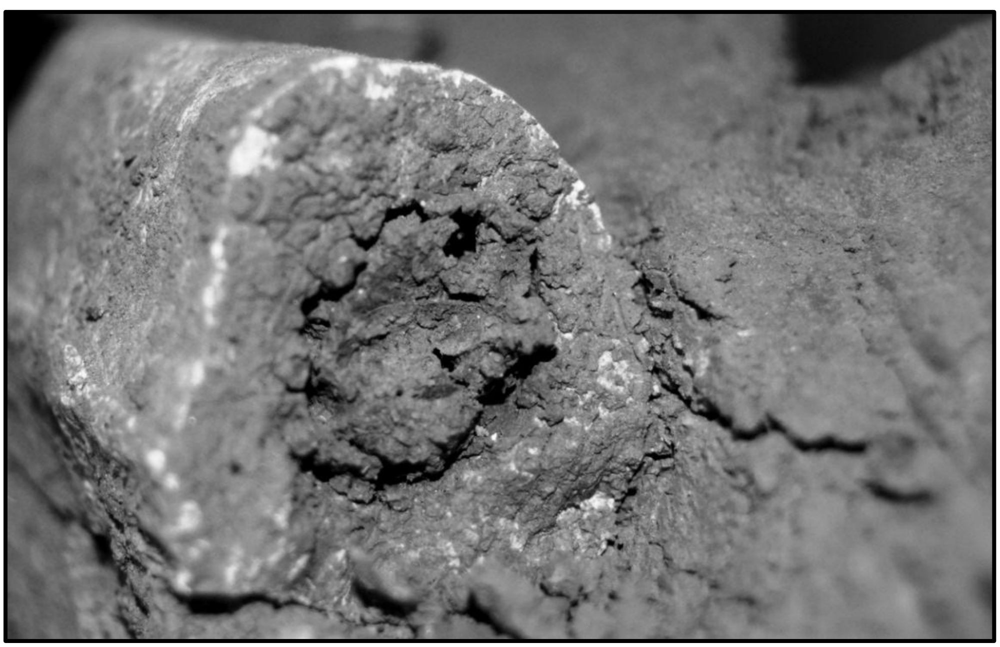

Figure 5.4. Left femur of T-1. The femoral shafts of T-1 were severed postmortem and the medullary cavities infiltrated by mud (pictured: left).

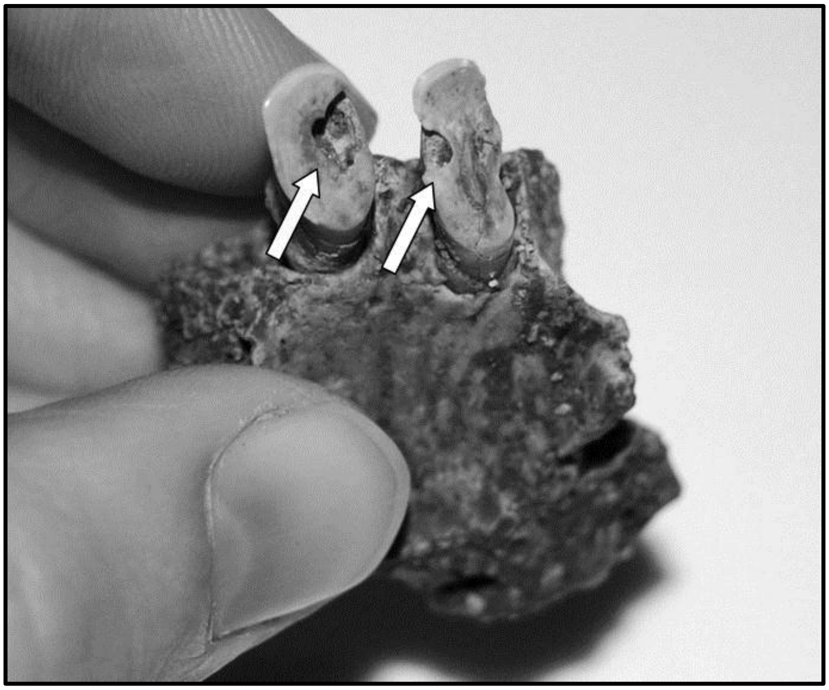

Figure 5.5. Interproximal carious lesions in the upper right second and third premolars (arrows).

Figure 5.6. Antemortem loss of the lower right second premolar and molars. Bone remodelling is incomplete but well advanced, indicating that tooth loss occurred significantly before death.

Figure 5.7. Slight calculus on the lingual surface of the lower right lateral incisor (arrow). Note also the minimal wear on the right incisors, canine, and first premolar.

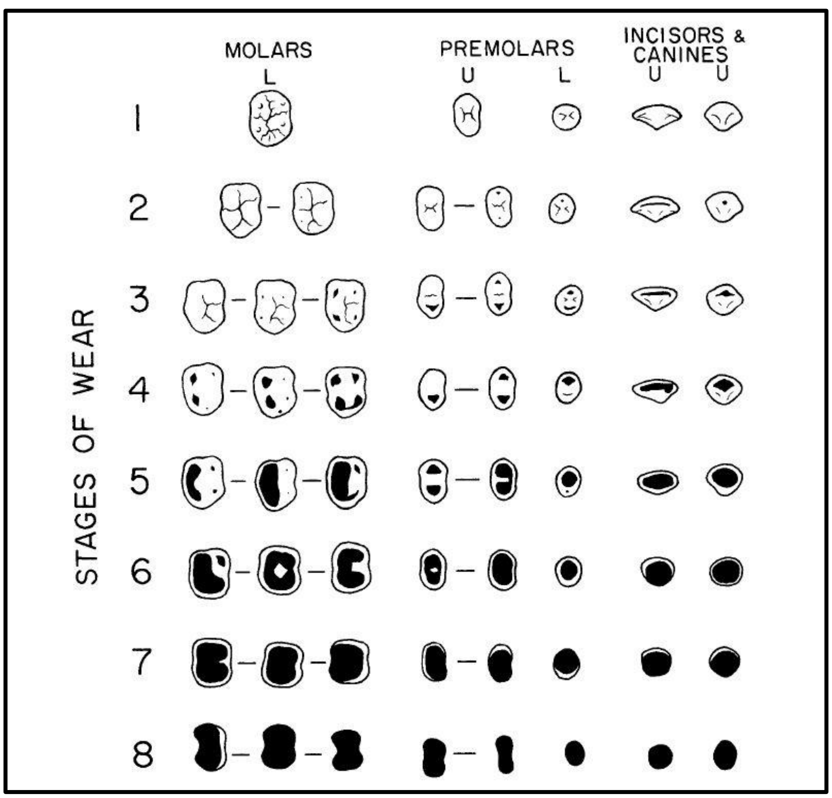

Figure 5.8. Smith's system for scoring stages of tooth wear. Reprinted from Smith (1984).

Figure 5.9. Severe wear on the lower left second molar.

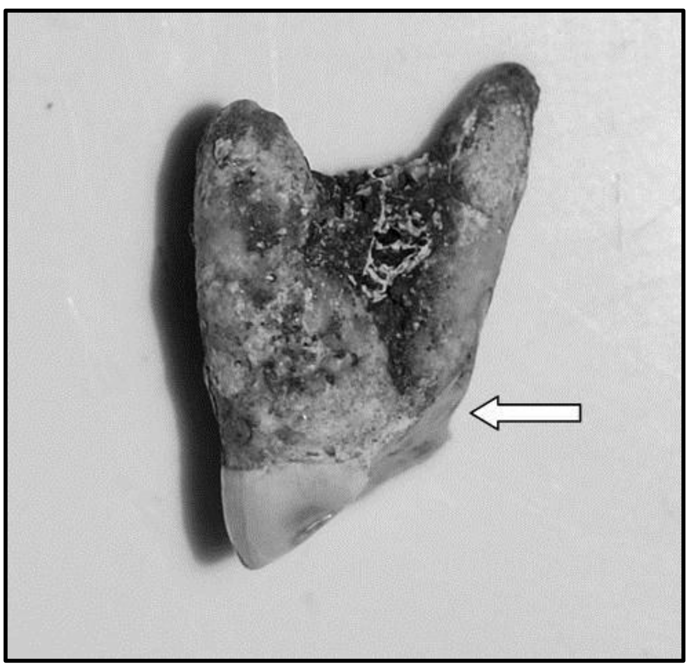

Figure 5.10. The wear on this upper right first molar is severe, scored as a 7 on Smith's scale. Additionally, the tooth was worn obliquely, so that the chewing surface extended past the cemento-enamel junction to include part of the root (arrow).

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CHAPTER 6: CONCLUSIONS

This study examines pathological conditions in the dentitions of Roman period individuals excavated from the Sodo tumuli and Terontola. The results help to shed light on the diet and overall health of the population of the territory of Cortona between the first century BC and the first century AD. Although the bulk of the data come from the Sodo sample, the individual from Terontola provides an example of an Older Adult, a demographic currently lacking in the Sodo collection.

The individuals buried at Sodo suffered from a high prevalence of caries. Comparison of these preliminary data with those of other, similar studies demonstrates that despite widespread trade and shared dietary staples, food consumption varied significantly from region to region throughout the peninsula. The Sodo sample consumed a diet that was particularly high in carbohydrates and other sugars, even relative to individuals from the nearby territory of Chiusi. That two populations with such varying frequencies of dental disease could be located in such close proximity to one another in the Val di Chiana outlines the importance of a regional approach to understanding the Roman world.

The high frequency of enamel hypoplasia indicates a widespread prevalence of disease and malnutrition in children from the population at Sodo, consistent with issues faced by children elsewhere in classical antiquity. Although enamel hypoplasia is a nonspecific indicator of systemic stress, we can hypothesize that poor weaning practices, as well as diseases such as infantile dysentery, chronic diarrhoea, and malaria may have been potential sources of poor health. While the presence of enamel hypoplasia indicates that the individuals at Sodo survived these periods of childhood stress, the proportion of children that did not survive to adulthood is currently unknown.

Analysis of the Sodo material was limited by the small sample size and poor preservation of the skeletal remains. If more of the Roman-period burials from Sodo become available, greater conclusions may be drawn about the frequency of dental disease, thus strengthening the interpretations of diet and health. Additionally, future analyses could elaborate on the findings of this study significantly by comparing them to earlier Etruscan and later Roman period data from the territory of Cortona. Such a comparison would allow us to track changes in diet and health in this region over the entire period of Romanization, thus providing invaluable data on changing lifeways in the territory of Cortona throughout this process. Finally, comparison of the Roman-period Sodo individuals with other individuals from the territory of Cortona may reveal information on why these particular individuals were buried at the feet of the grand tumuli of the Etruscan *principes*.

APPENDIX A - SUMMARY OF BURIAL INFORMATION

BURIAL NUMBER	AGE	SEX	DENTAL DATA
C-1	Young Adult	Female	Yes
SI-1	Young Adult	Female	Yes
SI-2	Middle Adult	Unknown	No
SI-3	Young Adult	Male	Yes
SII-1	Young Adult	Male	Yes
SII-2	Young Adult	Female	Yes
SII-3	Middle Adult	Male	Yes
SII-4	Unknown	Unknown	No
SII-5	Unknown	Unknown	No
SII-6	Young Adult	Male	Yes
SII-7a	Unknown	Unknown	No
SII-7b	Middle Adult	Male	Yes
SII-8	Unknown	Unknown	No
SII-9	Unknown	Unknown	No
T-1	Older Adult	Male	Yes

APPENDIX B - THE DIAGENESIS OF BONE IN GROUNDWATER

INTRODUCTION

The poor state of preservation of the Sodo material hampered data collection and limited the information that was obtainable from the remains. The myriad of issues typical of waterlogged sites is a familiar tale in the bioarchaeological literature: prolonged contact with groundwater has been found to compromise the integrity of skeletal remains and elaborate drying and consolidating strategies have been employed in an effort to minimize damage (e.g. Chaplin 1971: 18, Johnson 1994, Koob 1992, Rahtz and Hirst 1976, Stone *et al.* 1990). Most of the publications that discuss the taphonomic effects of water, however, focus on fluvial transport, diagenesis in marine environments, and the effects of freeze/thaw cycles, rather than the diagenetic effect of groundwater on bone chemistry and structure (but *cf.* Hedges and Millard 1995, Nielsen-Marsh *et al.* 2000, Pike *et al.* 2001). As such, most diagenetic changes are not well understood (Hedges and Millard 1995, Millard 2001: 642). This appendix will review the basics of hydrology and bone structure, as well as the known processes of bone diagenesis, to provide a better understanding of the factors behind the preservation issues with Sodo material.

In biological anthropology, diagenesis typically refers to the physical and chemical changes that affect skeletal material in a burial context. Along with mortuary practices, weathering, modification by biological organisms and other processes, it falls under the sphere of “taphonomy”: a term coined by the Russian palaeontologist J.A. Efremov in 1940 from the Greek *taphos* (burial) and *nomos* (laws). Taphonomy was originally defined as "…the study of the transition (in all its details) of animal remains from the biosphere into the lithosphere…" (Efremov 1940: 85) but has since come to encompass all attempts to deal with the biased, or incomplete, nature of any fossil, skeletal, or archaeological assemblage. With varying emphasis on diagenesis, taphonomy has become an essential subfield of many of disciplines, including palaeontology, forensic archaeology, zooarchaeology, and bioarchaeology (e.g. Behrensmeyer and Hill 1980, Haglund and Sorg 1997, Lyman 1994: 12-33, Stodder 2008). Diagenesis has received special attention in recent decades in the literature on palaeodietary reconstruction and palaeoecology, due to its effects on trace element and stable isotope analyses (e.g. see Lambert *et al.* 1985a, Lambert *et al.* 1985b, Sandford and Weaver 2000, Sillen 1989).

Diagenesis of skeletal tissue involves the hydrolysis, dissolution, mineral replacement and recrystallization of its constituent parts.[1] These processes are highly variable and can result in major or minor changes to both the organic and inorganic components of bone (Hare 1980, Von Endt and Ortner 1984). The chemical reactions are influenced by factors that are intrinsic to the bone tissue such as size, porosity, and chemical structure, and extrinsic, such as duration of interment, sediment pH, climate, and aeration (Henderson 1987, Nicholson 2001, Sandford and Weaver 2000: 335, Sillen 1989: 212, Von Endt and Ortner 1984).

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[1] In some publications, diagenesis also includes the microbial decomposition of collagen, in addition to the abiotic processes. For the purposes of this article, however, biotic factors are not included in diagenesis and will only be briefly considered (see Child 1995 and Sillen 1989 for a more detailed discussion of the degradation of bone by microbial agents).

Generally, the deeper the burial, the better the preservation of the skeletal remains: an increase in depth is accompanied by a reduction in insect activity, temperature fluctuations, and other harmful effects of the burial environment (Henderson 1987: 52). However, the advantages of a greater depth are complicated if the deeper soil is waterlogged.

Water, soil, temperature, and many other facets of the burial environment function together to accelerate (or limit) bone diagenesis. Focusing on a single aspect is simplistic and can provide an inaccurate understanding of the processes involved (Henderson 1987). Nevertheless, water is widely accepted to be one of the most important agents of deterioration (Goffer 1980: 239-46, Millard 2001, Nawrocki 1995, Nielsen-Marsh *et al.* 2000) and an analysis of diagenesis is woefully inadequate without proper consideration of the hydrology of the burial environment.

GROUNDWATER

Groundwater can be defined as "all the water contained in spaces within bedrock and regolith," where the regolith is the layer of loose rock and mineral fragments that have separated from the original bedrock due to weathering (Skinner and Porter 1987: 241). The total global volume of groundwater (measured to a depth of 4 kilometres) is 8,350,000 cubic kilometres, more than half of which can be found within 750 metres of the surface although this abundance certainly varies by geographical location (*Ibid*.: 240-2). Geologists recognize two distinct subterranean regions, defined by the incidence of groundwater: the unsaturated zone, or zone of aeration, and the saturated zone (Holmes 1962: 402, Skinner and Porter 1987: 240-2). The zone of aeration is that in which the open spaces of the regolith and bedrock contain predominantly air, although water (termed vadose water) is present occasionally, such as in the period following a rain. The depth of the zone of aeration can vary greatly: from less than a metre to hundreds of metres. Below the zone of aeration, in the saturated zone, all the open spaces are filled with water instead of air. The upper surface of the saturated zone is termed the "water table."

Almost all groundwater, regardless of the zone in which it is located, originates in rainfall and can be understood to be travelling, albeit very slowly, back to the ocean (Holmes 1962: 403, Leopold 1974: 18-9, Skinner and Porter 1987: 240-8). Underground, the water table rises until it is exposed in a low-lying "discharge area," such as a valley, creating a watercourse on the surface. Rivers and streams that continue to flow between rains are usually supplied with water from the saturated zone: an indication that they intersect the water table.

The infiltration of groundwater is affected by the characteristics of the soil: the larger the particles of dirt, the larger the spaces between the particles, and the more water enters the ground instead of running off into natural channels. The vegetation on the soil surface also plays a role by reducing surface run-off and increasing the amount of groundwater that can be stored below (Leopold 1974: 10-2). Once it has entered the zone of aeration, the movement of ground water is predominantly affected by topography and by the size of the pore spaces within the regolith. The movement of vadose water is achieved by two forces: capillarity and gravity. Capillary action plays a larger role in fine-grained soils, while in coarse soils the water travels down by gravity through the spaces between particles (Basile 1971: 18-29, Leopold 1974: 13-15).

Movement of water in the saturated zone is called percolation and is stimulated by gravity, as well as the pressure of the ground above. Groundwater in this zone will flow sideways until the water table becomes horizontal, at which point the flow ceases. The general level of the water table tends to be uniform, such that the saturated zone is located farther beneath the surface of a hill than it is in a valley. However, as water percolates quite slowly through the pores, cracks, and openings in the regolith,[2] the water table is always undulating: fluctuating most beneath hills and least beneath valleys (Holmes 1962: 402-3, Leopold 1974: 20, Skinner and Porter 1987: 243-4).

Now that the foundations of groundwater hydrology have been established, it is important to proceed to the basics of bone composition, before the diagenetic processes that act on human bone can be explored.

STRUCTURE AND COMPOSITION OF BONES AND TEETH

There are two basic types of bone: cancellous bone and cortical bone. Cancellous bone, also called trabecular or spongy bone, is found predominantly at the ends of long bones and in the bodies of vertebrae. It consists of tiny spicules of bone, called trabeculae, which are arranged in a lattice pattern and function like scaffolding. In living bone, the spaces between trabeculae are filled with marrow.

[2] The speed of groundwater is measured in centimetres per day or metres per year (Skinner and Porter 1987: 243).

Cancellous bone is quite light and, due to the arrangement of the trabeculae, remarkably strong.

Cortical bone, also called compact bone, is the dense bone found in the shafts of long bones, around the large marrow cavities, as well as in the outer layer of most bones. Much denser than cancellous bone, it is composed of cylindrical Haversian systems: concentric layers of ossified bone matrix around a central canal that run parallel to the length of the bone. Haversian canals, which contain nerves and vessels during life, are connected to each other by Volkmann's canals. In both cancellous and cortical bone, bone cells (called osteocytes) are contained in spaces throughout the ossified bone matrix, known as lacunae. Lacunae are linked by canaliculi, miniscule connecting channels that run through the bone matrix.

On a chemical level, bone tissue can be considered in terms of its organic and inorganic components. The organic fraction of bone is composed largely of collagen fibres (large protein molecules) and cell tissue. The inorganic, or mineral, fraction is essentially composed of minute apatite crystals, which are arranged around the bundles of collagen fibres (Chaplin 1971: 13, Schultz 1997: 188). In theory, most bone apatite is hydroxyapatite, a complex calcium phosphate with the formula $Ca_{10}(PO_4)_6(OH)_2$.[3] In actuality, during life much of a person's bone apatite is not true, stoichiometric hydroxyapatite but rather a transitory, more readily soluble phase of calcium phosphate (Pate and Brown

[3] The formula for hydroxyapatite is actually $Ca_5(PO_4)_3OH$ but is usually written as $Ca_{10}(PO_4)_6(OH)_2$ to indicate that a single crystal unit of hydroxyapatite contains two base units.

1985: 489, Sillen 1989: 213). The chemical makeup of the inorganic component of bone fluctuates as it stores minerals and releases them into the blood stream.

In living bone the intercellular matrix is approximately 25 per cent organic, 50 per cent inorganic, and 25 per cent water. In dry bone, almost one third of the weight of bone matrix is collagen, while the inorganic component provides approximately two thirds (Pritchard 1972, Schultz 1997: 189). The mineral component of bone is traditionally associated with rigidity and the collagen with tensile strength (e.g. Chaplin 1971: 12). Ascenzi and Bell (1972) demonstrate that both the organic and inorganic components of bone are essential for maintaining its physical properties. If either of the two components are partially removed or weakened, the strength and hardness of the bone will be compromised.

The general structure of teeth is similar to that of bone. Each of the three mineralized dental tissues (dentine, cementum, and enamel) includes the inorganic apatite and the organic proteins and lipids, but varies slightly in terms of composition and organization. Additionally, dentine, cementum, and enamel are avascular, unlike bone which relies heavily on a constant blood supply.

Dentine, which comprises the majority of a mature tooth, has a chemical composition similar to bone but harder (Carlson 1990, Pritchard 1972, Scott and Symons 1982: 227). The apatite crystallites in dentine are approximately the same size as those in bone but are found in a higher concentration. The organic component of dentine is proportionately less than in bone and the collagen fibres are more densely packed. The structure of dentine differs from that of bone, but like bone it is permeated throughout by cells called odontoblasts. The protoplasmic processes of the odontoblasts are contained in dentinal tubules: minute conduits that run between the outer surface of the dentine and the pulp cavity. The presence of these tubules gives dentine a comparable porosity to bone (Scott and Symons 1982: 227).

Cementum, found in a thin layer surrounding the dentine of tooth roots is less hard than dentine but otherwise similar in terms of chemical composition. There are two types of cementum: acellular, which is deposited first, and cellular, which is found in the root apices. Cellular cementum is more permeable than the acellular, although the permeability of both has been shown to decrease with age. Out of the three mineralized dental tissues, cementum most closely resembles bone (Carlson 1990, Scott and Symons 1982: 263-7).

Enamel covers the crown of the tooth, supported by the underlying dentine. Ectodermal in origin, it is completely acellular and devoid of canals. The minor organic portion is non-collagenous, composed of soluble and insoluble proteins, peptides, and citric acid. The enlarged inorganic portion (approximately 96 per cent of the enamel tissue) is primarily composed of calcium phosphate crystals that are considerably larger than those found in dentine, cementum, or bone (Carlson 1990, Pritchard 1972, Scott and Symons 1982: 194-9). Together, the low porosity, substantial inorganic component, and large, crystalline structure make enamel the hardest material in the skeleton, denser and less soluble than the other tissues (Carlson 1990, Clement 2009: 336, Pritchard 1972).

DIAGENESIS OF BONES AND TEETH IN GROUNDWATER

The diagenetic processes that affect bone vary greatly and, consequently, can produce highly variable results. The various chemical reactions in bone diagenesis impact one another: some slow one another down, others speed one another up, some can happen simultaneously while others are sequential (Von Endt and Ortner 1984). Diagenesis is complicated and even if a bone appears unaltered at the macroscopic level, it can prove to be significantly altered or damaged when examined under a microscope (Pfeiffer 2000: 291). Regardless of the nature of the change being examined, however, water is nearly always the medium in which diagenesis takes place.

As previously mentioned, much of living bone differs from true, stoichiometric hydroxyapatite: existing in forms that are less thermodynamically stable and more soluble. The diagenesis of the inorganic phase of bone "can be seen as a correction of this aberration" (Sillen 1989: 213). Two main processes constitute this stage of diagenesis: the loss, uptake, and exchange of minerals or trace elements, and internal changes in crystallinity.

The process of mineral loss, uptake, and exchange is the most important aspect of bone diagenesis, and is achieved through dissolution of minerals in the adjoining groundwater (Von Endt and Ortner 1984). So long as the groundwater is not already saturated with the minerals present in the skeletal apatite, ions are leached from the bone tissue and can be replaced with soluble ions from the surrounding soil matrix (Dodd and Stanton 1981: 128, Gill-King 1997: 105, Henderson 1987: 44, Nielsen-Marsh *et al.* 2000, Pfeiffer 2000: 291, Sandford and

Weaver 2000: 334). In acidic soils, for example, calcium ions from the skeletal apatite move into the groundwater and are replaced in the crystal structure by hydrogen ions (Gill-King 1997: 105). This type of exchange is highly dependent on the concentration of the groundwater solution, and the processes can slow, or even reverse, if conditions change. In the above example, should the groundwater becomes less acidic, calcium ions could move back into the bone from the soil, replacing protons and reconstituting the original mineral (White and Hannus 1983).

Dissolution in groundwater affects most of the elements contained in bones and teeth, with strontium being a notable exception (Parker and Toots 1980: 197). Among the trace elements typically lost in such a process are calcium, sodium, and chlorine, while fluorine, silicon, manganese, and iron are among those typically taken up by the skeleton (Hedges and Millard 1995, Lambert *et al.* 1985b, Nielsen-Marsh *et al.* 2000, Parker and Toots 1980, Sandford and Weaver 2000). The exchange of fluorine in groundwater for the hydroxyl in the apatite matrix has been particularly well-documented (e.g. Lambert *et al.* 1979: 119).

During diagenesis, the inorganic matrix can also see the recrystallization, growth, and "spontaneous rearrangement" of apatite crystals (Henderson 1987: 44, Sandford and Weaver 2000: 334, Sillen 1989: 221). Through this process, the inorganic phase moves from the unstable, microcrystalline form of apatite towards larger crystals and a more stable structure (Sillen 1989: 213, Von Endt and Ortner 1984). Two mechanisms are credited with the crystallinity increase (Nielsen-Marsh *et al.* 2000: 443-4). The first is the dissolution of the smallest crystallites, where preferential loss favours retention of the larger units. The second is dissolution and the subsequent recrystallization to larger, more thermodynamically stable crystals. Most likely, both mechanisms play a role in the internal changes observed during diagenesis but identification of instances of recrystallization is particularly significant to researchers in stable isotope analysis, as it could indicate the incorporation of exogenous ions deep into the mineral structure of the bone (*Ibid.*).

Diagenesis of the organic phase of archaeological bone deals primarily with collagen deterioration, as the cell tissue is subject to relatively rapid decay after death (Chaplin 1971: 13, Millard 2001: 640). Deterioration of bone collagen can be achieved by two processes: bacterial decomposition and hydrolysis of the collagen protein. In moist environments, the presence of fungi and other micro-organisms is prolific and the biological decomposition of bone collagen is substantial. In addition to decomposing the organic phase of bone, these micro-organisms excrete acids that expedite the dissolution of the apatite in the inorganic phase, further propagating the diagenetic processes (Sillen 1989: 220).

In hydrolysis, water breaks collagen down into polypeptides and amino acids, lowering the molecular weight of the bone protein and increasing its solubility (Hare 1980: 212-4, Hedges and Millard 1995, Henderson 1987: 44, Von Endt and Ortner 1984). This process does not require significant amounts of groundwater and can be achieved with only the naturally-occurring water in bone or atmospheric water vapour. These smaller peptides and amino acids can then be leached from the skeletal tissue by available groundwater. Like in the process of mineral exchange, the rate at and extent to which groundwater leaches the soluble protein from bone depends on the saturation of the groundwater (Hare 1980: 212-4). As a structural protein, collagen has a low solubility and for the leaching process a substantial supply of groundwater is necessary, to prevent the water from reaching the saturation point.

LIMITING FACTORS CONTROLLING BONE DIAGENESIS

While the processes of diagenesis all act within and through groundwater, other properties of the burial environment influence its progression: limiting or exacerbating the effects of groundwater on bone. Subsurface animal activity, for example, is known to create all sorts of issues for buried bone and one of the major consequences is the increased flow of groundwater into the burial and the subsequent increase in the rate of diagenesis (Nawrocki 1995: 51). The use of coffins (i.e. of stone, lead, or wood) can also affect decay: they have been shown to restrict the drainage of water from the burial environment, exacerbating diagenetic change (Pfeiffer 2000: 291). Rahtz and Hirst (1976) found a correlation between evidence for a coffin and poorer skeletal preservation at their site at Bordesley Abbey. Unfortunately, while the effect of coffins on soft tissue decomposition has been relatively well-considered (e.g. see Henderson 1987: 51 for a brief overview), the impact on skeletal tissue is not conclusive.

Temperature, too, is an important determining factor for the effects of groundwater on bone (Pate and Brown 1985, Sandford and Weaver 2000: 335, Von Endt and Ortner 1984). The relationship between temperature and diagenesis is complex but it can be generalised that cold temperatures tend to retard diagenetic change and that, typically, a 10°C rise in temperature can double the rate of diagenetic processes (Henderson 1987: 47).

While there are a number of limiting factors that determine the rate and progression of bone diagenesis, some of the most important include: the movement of water through the burial environment, the physical and chemical properties of the soil matrix, and the intrinsic properties of the archaeological bone. These elements will be discussed in more detail below.

Hydrology of the Burial Environment

The hydrology of the burial environment essentially determines the movement of solutes to, from, and within the bone. The effect of groundwater on bone is thus highly dependent on variations in flow rate (Chaplin 1971: 16, Gill-King 1997: 94, Hedges and Millard 1995, Henderson 1987: 46, Nicholson 2001: 186, Nielsen-Marsh *et al.* 2000, Sandford and Weaver 2000: 335, Stodder 2008). Average humidity, annual rainfall, and drainage all affect the degree of fluctuation in terms of contact between bone and groundwater.

Hedges and Millard (1995) identify three extreme hydraulic regimes (later expanded upon by Pike *et al.* 2001) as potential burial contexts, each primarily dependent on a different process for affecting bone diagenesis. The first of these is the Diffusive System, where there is no net flow of water but solutes may travel across a diffusion gradient (e.g. in permanently waterlogged soils). This model has the potential to allow for the most rapid progression of diagenesis, however diffusion becomes limited as surrounding groundwater becomes saturated with respect to bone apatite and collagen.

The second regime is the Hydraulic Flow System, where there is an episodic flow of water through soil and bone, under a hydraulic gradient. In this model, the supply of unsaturated groundwater can lead to a faster rate of dissolution. Nevertheless, the rate will still depend on the volume of water (mainly due to sporadic rainfall) and the relative conductivities of bone and the surrounding soil. In many cases, water can pass through the soil more easily than the buried bone and so it follows the path of least resistance. The more diagenetically altered a bone becomes, however, the greater the porosity and subsequent conductivity, so the effects of hydraulic flow become more significant as diagenesis progresses. In the third regime, the Recharge System, the dissolution rate of the Hydraulic Flow System is accelerated by a fluctuating hydraulic potential. Frequent cycles between wet and dry drive water in and out of the bone.

Nielsen-Marsh *et al.* (2000) consider the three regimes put forward by Hedges and Millard and reduce the hydrology of burial environments into two basic categories: saturated or dry environments (with little or no change in groundwater content) and fluctuating environments (where there is substantial oscillation in the groundwater content around buried bones). In such a system of hydrological classification, fluctuating conditions are more conducive to diagenetic change than static environments. Completely waterlogged and anaerobic environments (e.g. peat bogs and well deposits), with a negligible flow of ground water, can be as beneficial as dry sites in terms of bone preservation, due largely to the lower saturation point of standing water (Nicholson 2001: 181-2, Nielsen-Marsh *et al.* 2000). Water fluctuations, however, result in the poor preservation typically associated with infiltration by groundwater (Matheson and Brian 2003: 134-6).

Cycles of wet and dry encourage bone fracturing as the bone expands and contracts with each oscillation, accelerating the diagenetic processes (Chaplin 1971: 18, Nawrocki 1995, Nawrocki 2009). Conversely, cycles of wet and dry can also slow down diagenesis, as the lack of diffusion matrix during dry periods limits the amount of dissolution that takes place. Pike *et al.* (2001: 131), for example, showed that an average flow rate of at least 100 litres a day was necessary for a water fluctuation model to compete with a diffusion model in terms of bone dissolution.

More detrimental than cycling between wet and dry is a burial environment in which the bones are constantly exposed to fresh water. In such an environment, the constant presence of water provides a continuous diffusion matrix, while the regular replenishment of the surrounding water prevents it from reaching the saturation point, the major limiting factor in the Diffusive System. Once the point of saturation is reached, diagenesis slows considerably. If the water is being replenished frequently, it is less likely to reach its saturation point in terms of collagen and minerals, and the dissolution through diffusion will be a continuous process (Hare 1980, Nielsen-Marsh *et al.* 2000: 446-7, Stodder 2008).

Soil Composition and pH

The physical and chemical characteristics of the surrounding soil matrix also play a role in determining the effects of groundwater on archaeological bone. One of the most important characteristics is pore-size distribution, which affects the movement of water through the soil. Dissolution of bone's mineral and protein content usually requires permeable sediment: mediums like gravel tend to exacerbate diagenesis because they increase percolation, while soils of a finer texture retard diagenesis, especially in a waterlogged environment (Chaplin 1971: 16, Dodd and Stanton 1981: 128).

The chemical composition of the soil matrix is also a key limiting factor in diagenesis. The rate of bone dissolution is determined, in large part, by the chemistry of the groundwater relative to bone (Hare 1980, Stodder 2008). The chemistry of the groundwater, while refreshed by a high flow rate, is essentially determined by the chemistry of the soil in which it is found (Basile 1971: 9, Holmes 1962: 409, Skinner and Porter 1987: 253-4). As groundwater passes through the bedrock and regolith, minerals are dissolved and pass into the water solution. The quantity of iron, sulfates, and bicarbonates of calcium, magnesium, and other ions in groundwater are all determined by the surrounding soil. Groundwater that is already high in calcium ions due to the composition of the bedrock will reach its saturation point more quickly and dissolve less calcium from the bone apatite. Accordingly, the greater the difference between the mineral composition of the soil and that of the bone apatite, the greater the degree of diagenetic change (Dodd and Stanton 1981: 128).

Through the identical process, the pH level (an expression of the concentration of hydrogen ions) of the groundwater is determined by the pH of the soil (Gill-King 1997: 94). A significant correlation exists between soil pH and bone preservation, so that as the soil becomes more acidic, the dissolution of the bone's mineral content is accelerated (Chaplin 1971: 16-7, Gordon and Buikstra 1981: 569, Henderson 1987: 46, Lambert *et al.* 1979, Lambert *et al.* 1985b, Nielsen-Marsh *et al.* 2000, Pate and Brown 1985, Sandford and Weaver 2000: 335, Stone *et al.* 1990). As stated above, acidic soils and groundwater work in concert so that through groundwater, the acids in the soil dissolve the inorganic matrix, leaving behind a "model" of organic matrix that's then more susceptible to leaching by water. Base-rich soils lack the surplus of hydrogen ions present in acidic soils, and so are much kinder to bone. Using a laboratory environment, Pike *et al.* (2001) modeled that a 500g long bone fragment would take 0.08 years to dissolve in calcium-free groundwater with a pH of 5, 0.64 years in groundwater with a pH of 6, and 4.83 years at a pH of 7.

Because the composition of groundwater depends on the kind of rock in which it occurs, it is specific to each burial environment and cannot be determined without direct testing or analysis of the underlying geological foundations. Nevertheless, Baas Becking *et al.* (1960) provide data that establish the limits of different burial environments in terms of pH. Globally, the pH of groundwater can vary between 2.8 and 10. Wet soils (described as soils that are dry for part of the year but can have seasonal waterlogging) can have a pH anywhere between 3.7

and 8.5, while permanently waterlogged soils are restricted to a pH between 5 and 8 (Baas Becking *et al.* 1960: 252-6).

Surface Area and Porosity of Bone

Surface area is a crucial determining factor in the destruction of both the organic and inorganic phases of bone because it determines the extent of the "interface" between the bone matter and the surrounding matrix (Gill-King 1997: 105, Von Endt and Ortner 1984). An increase in surface area means an increase in the speed at which water chemically breaks down the collagen and mineral matrix, as water can only interact with bone at the exposed surfaces (e.g. Hedges and Millard 1995: 156). Other than size and degree of fragmentation, the primary determinant of surface area in bone is porosity. Pore spaces also define the capillarity of bone. Capillary action is responsible for pulling groundwater into bone, accelerating diagenesis.

Martill (1991: 285-7) identifies two pore-space environments within the bone: the marrow cavities and spaces located in long bone shafts and within the trabecular bone, and the lacunae and linking canaliculi of the bone itself. The marrow spaces are connected to the exterior environment by foramina, holes for blood vessels that pass through the cortical bone. The lacunae and other structural spaces are not naturally well-connected to the exterior, although ante- or post-mortem damage can result in their exposure (*Ibid.*).

Although it has been demonstrated that chemical weathering of bone is not directly related to pore size (White and Hannus 1983), the varying porosity of different skeletal tissues affects the progress of diagenetic change (Bell 1990: 99, Hedges and Millard 1995, Lyman 1994: 418, Sandford and Weaver 2000: 335, Von Endt and Ortner 1984). Diagenetic processes affect enamel significantly less than dentine or bone, for example, because it is denser, less soluble, and has a lower porosity (Carlson 1990: 545, Clement 2009, Parker and Toots 1970, Parker and Toots 1980: 199-200). At a more minor level, dentine is also slightly less susceptible to diagenetic change than bone, although the difference is much less significant than that between bone or dentine and enamel. Likewise, juvenile bone is more predisposed to diagenetic change than adult bone because of its lower mineral content and high porosity (Gordon and Buikstra 1981, Sandford and Weaver 2000: 335). Similar results can even be seen between differing skeletal elements, so that small, porous bones like ribs have been shown to be more susceptible to protein loss and mineral exchange than larger, denser, predominantly cortical bones like femora (Hanson and Buikstra 1987: 552-3, Hare 1980: 214, Lambert *et al.* 1982, Lambert *et al.* 1985a: 478, Nawrocki 1995, Sandford and Weaver 2000: 335). Due, in part, to the exposure of lacunae and canaliculi to the burial environment, crushed or broken bones and bones with pathological lesions are also more susceptible than whole bone to these diagenetic changes (Bell 1990, Lambert *et al.* 1985b).

An increase in porosity is the most common change resulting from the mineral dissolution of bone (Nielsen-Marsh *et al.* 2000). Indeed, when Hedges *et al.* (1995) and Nielsen-Marsh *et al.* (2000: 443-4) identified a series of diagenetic parameters intended to measure the state of bone diagenesis, increased porosity was identified as a vital indicator.[4] Initially this increased porosity means an increased rate of diagenesis, which in turn means an increase in porosity, etc. Eventually, however, the overall surface area begins to decline as the pores join together, resulting in a reduced boundary for interaction with the burial environment (Hedges *et al.* 1995: 207, Hedges and Millard 1995). Still, an increase in macroporosity at the expense of microporosity allows for increased water movement in and out of the bone itself. Clearly, a complicated relationship exists between diagenesis and porosity that would benefit from further study.

The result of a limiting factor is shaped by each of the other aspects of the burial environment, and despite the generalisations discussed above, "it is not possible to be too sweeping about the effects of a given soil/water regime because the factors involved are numerous and complex and may have changed with time" (Chaplin 1971: 17). For example, dissolution rates will certainly differ between a warm, waterlogged burial environment with a low concentration of calcium ions in the groundwater, and a cool, fluctuating burial environment with a high concentration of calcium ions. How they differ, however, may be in complex and perhaps unanticipated ways. Additionally, while the various chemical reactions in bone diagenesis impact each other, the processes occur independently and a certain degree of mineral exchange does not imply the same degree of protein hydrolysis. Hedges *et al.* (1995) noted a low correlation between the different diagenetic parameters, further suggesting that diagenesis is a complex, multifaceted collection of processes. Any attempt to predict the precise impact of

[4] Other diagenetic parameters included histological preservation, protein content, crystallinity increase, and incorporation of exogenous ions (Hedges *et al.* 1995, Nielsen-Marsh *et al.* 2000: 443-4).

a specific burial environment in bone diagenesis must consider all the relevant components.

CONCLUSION

The diagenesis of archaeological bone refers to the processes of ion exchange, recrystallization, hydrolysis and dissolution. Together, these processes function to weaken the protein-mineral bond which, in turn, makes the bone more susceptible to future change. As the medium in which said processes occur, water (particularly groundwater) is critical to diagenetic change and features such as the water's pH and flow rate can largely determine the degree of deterioration found. Even so, the multitude of factors that can affect diagenesis make the particulars difficult to foresee, and the outcome can vary widely between contexts. This summary has attempted to provide a framework of known information regarding the diagenesis of bone in groundwater, to create a better understanding of the forces that acted on the Sodo material *in situ*. Clearly, much research is still required for archaeologists to understand and predict the changes that can occur to human remains in the burial environment.

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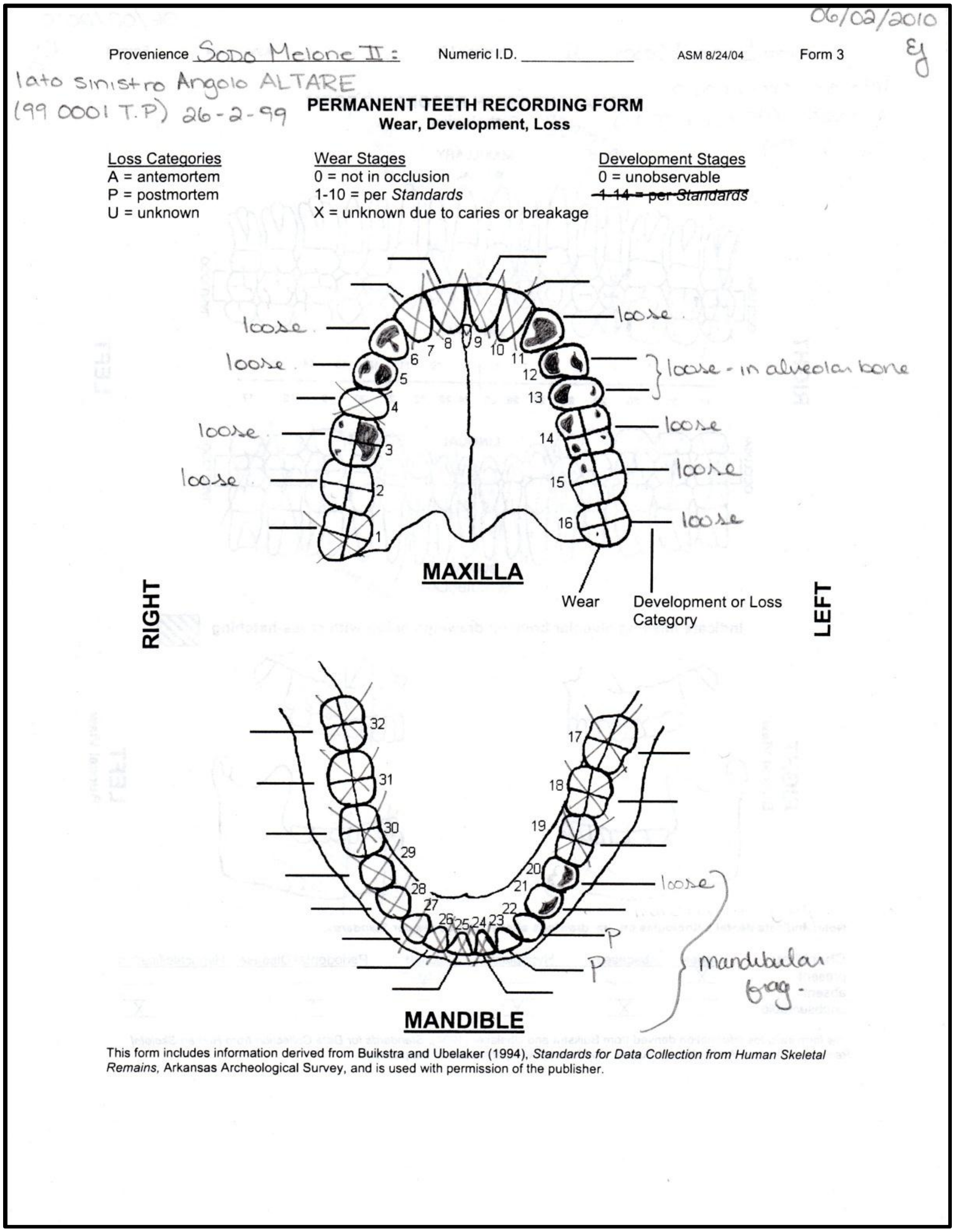
APPENDIX C – SAMPLE DENTAL DATA COLLECTION FORM



06/02/2010

Provenience Sodo Melone II: Numeric I.D. ____________ ASM 8/24/04 Form 3

lato sinistro Angolo ALTARE

(99 0001 T.P) 26-2-99

PERMANENT TEETH RECORDING FORM
Wear, Development, Loss

Loss Categories	Wear Stages	Development Stages
A = antemortem	0 = not in occlusion	0 = unobservable
P = postmortem	1-10 = per *Standards*	~~1-14 = per *Standards*~~
U = unknown	X = unknown due to caries or breakage	

This form includes information derived from Buikstra and Ubelaker (1994), *Standards for Data Collection from Human Skeletal Remains*, Arkansas Archeological Survey, and is used with permission of the publisher.

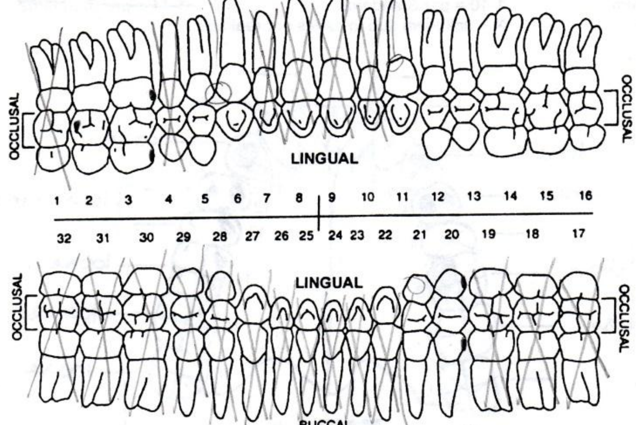
06/02/2010

Provenience Sodo Melone II Numeric I.D. ______ ASM 8/24/04 Form 4

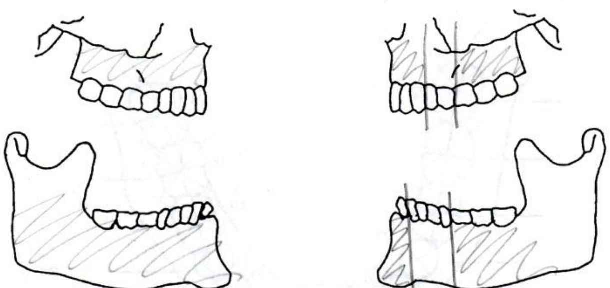
lato sinistro Angolo
ALTARE (99 0001 T.P)
26-2-99

PERMANENT TEETH RECORDING FORM

Pathologies



Indicate missing alveolar bone on drawings below with cross-hatching



Note: Indicate dental pathologies on the drawings above. Use codes per *Standards*.

Checklist:	Caries	Abscesses	Hypoplasia	Calculus	Periodontal Disease	Hypocalcification
present	X	___	___	slight	___	___
absent	___			___		
unobservable	___	X	X	___	X	X

This form includes information derived from Buikstra and Ubelaker (1994), *Standards for Data Collection from Human Skeletal Remains*, Arkansas Archeological Survey, and is used with permission of the publisher.