# Report on the Human Remains from the Sodo Tumuli and Circolo I and from Terontola Examined at the MAEC in May, 2010

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The Museo dell'Accademia Etrusca e della Città di Cortona is a remarkable museum with superb collections and educational displays; it was our privilege to conduct our research there.

All photographs were taken by Nancy Lovell and Erin Jessup except where indicated otherwise.

## EXECUTIVE SUMMARY

This report presents the results of the examination of Roman-period skeletal remains of 13 individuals from the Sodo Tumuli, plus one intrusive burial at Circolo I (now on display in the Museo dell'Accademia Etrusca e della Città di Cortona), and one individual from Terontola. Largely due to preservation problems, useful biological data could be obtained from only nine individuals.

The remains of the intrusive burial at Circolo I are those of a young adult female. We were able to examine only her skull and teeth, but noted one carious lesion in a molar tooth as well as evidence of episodic systemic stress during her childhood, as indicated by lines of *linear enamel hypoplasia*.

The remains recovered from the Sodo Tumuli included those of five young adults, two middle-aged adults, and one adult of indeterminate age and sex. Three of the young adults were female; two young adults and the two middle-aged adults were male. The most common pathological conditions were dental disease (caries, abscesses, calculus, and antemortem tooth loss), with minimal expressions of arthritis and trauma. One individual exhibited *porotic hyperostosis*, a condition usually associated with chronic anemia. The pattern of dental disease is consistent with a diet high in carbohydrates, such as processed cereals and perhaps dried fruits and honey. Unusual tooth wear in two individuals suggests that they may have used their teeth in craft or other habitual activities.

The individual from Terontola is an older adult male. He suffered a serious fracture of the right hip many years prior to his death, and exhibited pronounced bony attachments for the flexor muscles of the hand that suggest habitual grasping activity during his lifetime. Many of his teeth had been lost antemortem, and the few teeth that were still in occlusion were severely worn.

## RIASSUNTO

Questo rapporto presenta i risultati dell'esame del periodo romano-scheletrici resti di 13 persone dal Tumuli del Sodo, più una sepoltura intrusiva al Circolo I (ora in mostra nel Museo dell'Accademia Etrusca e della Città di Cortona), e una individuale da Terontola. In gran parte a causa di problemi di conservazione, i dati biologici utili potrebbero essere ottenuti a partire da soli nove individui.

I resti della sepoltura intrusiva al Circolo I sono quelli di una femmina giovane adulto. Siamo stati in grado di esaminare solo la sua testa e denti, ma ha rilevato una lesione cariose in un dente molare così come evidenza di episodi di tensione sistemica durante la sua infanzia, come indicato dalle *linear enamel hypoplasia*.

I resti recuperati dalla Tumuli Sodo compresi quelli di cinque giovani adulti, due adulti di mezza età, e un adulto di età indefinita e sesso. Tre dei giovani adulti erano donne, due giovani e due adulti di mezza età era di sesso maschile. Le condizioni patologiche più comuni sono le malattie dentali (carie, ascessi, calcolo, e la perdita dei denti ante mortem), con espressioni minime di artrite e traumi. Un individuo esposto *porotic hyperostosis*, una condizione solitamente associata ad anemia cronica. Il modello di malattia dentale è compatibile con una dieta ricca di carboidrati, come cereali trasformati e, forse, frutta secca e miele. Usura dei denti inusuale in due individui suggerisce che essi potrebbero avere utilizzato i loro denti in artigianale o altre attività abituale.

L'individuo da Terontola è un maschio adulto di età. Ha subito una grave frattura dell'anca destra molti anni prima della sua morte, ed espone pronunciato allegati osseo per i muscoli flessori della mano che suggeriscono abituale attività cogliere durante la sua vita. Molti dei suoi denti erano stati persi ante mortem, e pochi denti che erano ancora in occlusione sono stati gravemente usurati.

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# CHAPTER 1
# INTRODUCTION

This reports presents the results of the examination of Roman-period skeletal remains from the Sodo Tumuli and Circoli, and from Terontola (see Appendix A for details of the skeletal remains and their contexts). The total number of Roman-period inhumations from the Sodo tumuli is unclear. Containers holding the remains of 15 individuals were brought to the Museo dell'Accademia Etrusca e della Città di Cortona (MAEC) from the Centro Restauri (Sodo Restoration Workshop) were they are stored, although useful biological data could be obtained from only nine individuals, largely due to preservation problems. Additional material included nonhuman skeletal fragments as well as some terracotta and brick.

All of the remains from Sodo were discovered as a result of restoration work on the tumuli and circoli, rather than as a result of problem-oriented archaeological excavation. The remains from Terontola were discovered during construction of the Carabinieri Station. Thus, the remains can't be said to represent a meaningful sample of individuals from the Sodo or Terontola areas, but they still provide us with an opportunity to contribute to the knowledge of the ancient inhabitants of the Val di Chiana.

## The Sodo Tumuli and Circoli

The Sodo tumuli are located slightly over two km west of Cortona (Fig. 1.1, 1.2), just across the modern highway SS71/SR71, which corresponds to Roman Via Cassia and the earlier Etruscan road (Fracchia 2006:24; Vallone 1995:113). The two structures are approximately 300 m apart on either side of the Loreto stream, which may "correspond to an ancient *rivus* and thus represent a *limes* (boundary) between the different landed properties of which the tumuli were *monumentum*" (Vallone 1995:126).

### Sodo Tumulus I

Tumulus I, located on the south bank of the Loreto, was built in the first half of the 6$^{th}$ century BCE, although possibly as late as 550 BCE (Vallone 1995:131-4). The mound had been discovered by 1909, but there are no "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" (Vallone 1995:119). After falling into disuse, the tomb was used as a source of building materials and then sacked for valuable grave goods (*Ibid.*: 119-21).

The artificial mound is approximately 10 m high and over 50 m in diameter (Holder 1999:36). The tumulus contains a single five-chambered tomb with a southeast-northwest floor plan (Holder 1999:37). The covered *dromos* leads to three antechambers, before terminating in a larger, rear chamber. A total of four lateral rooms protrude off the second and third antechambers (Fig. 1.3). The pavement of the chamber-tomb is comprised of a local grey sandstone, while the wall structures are made of a yellowish sandstone of the Val di Chiana (Vallone 1995:121).

The first phase of Tumulus I dates to the early or mid 6$^{th}$ century BCE and indicates that the property owner was one of the local *principes* (Vallone 1995:123). Re-use of the tomb in the Hellenistic Age is documented by inscriptions and grave goods datable to the 4$^{th}$ century BCE (Vallone 1995:123). Specifically, an inscription cut into the main door of one of the lateral chambers indicates that the tomb was re-occupied by Arnt Mefanate, of Umbrian origin, and his local wife, Velia Hapisnei.

In the late Republic and early Imperial eras, Tumulus I was again reused for burials. Within the drum a number of burials were found and "the modesty of [associated artefacts], all from objects of common use and very wide diffusion, and the frequency of bricks indicate tombs *alla cappuccina* of poor peasants, or at least of persons of lower social level..." (Vallone 1995:123-4). 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. All three of the burials in question were found in the *dromos* of the tomb (Fig. 1.4).

**Sodo Tumulus II**

Tumulus II (Fig. 1.5) is located on the north bank of the Loreto and is datable to between 580 and 570 BCE. While the construction of Tumulus I at Sodo was more refined than that of Tumulus II, the second mound is considered the grander of the two, measuring 64m in diameter (Holder 1999:38).

Like the Tumulus of Camucia[1], Tumulus II contains two discrete tombs (Fig. 1.6): Tomb 1, which was excavated by Antonio Minto in 1928 and 1929, and Tomb 2, which remained undiscovered until 1992. 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 (Vallone 1995:125-6).

On the southwest side of the tumulus, a long *dromos* leads to Tomb 1, constructed in the third decade of the 6th century BCE, along with 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-occupied in the Hellenistic period is clear, despite the destruction caused by vandalism in antiquity.

Tomb 2 was constructed between 480 and 460 BCE and belongs to the second phase of the tumulus' use (Vallone 1995:130-1). Simpler than Tomb 1, it consists of a short *dromos* and two consecutive chambers separated by parapets. Upon discovery, only the lower 180 cm of the walls remained and the roof was missing entirely, yet Tomb 2 managed to preserve six sarcophagi in *pietra fetida*, from the 5th century BCE, and five cinerary urns of sandstone and terracotta indicating re-use of the tomb in the Hellenistic period (Vallone 1995:130). Tomb 2 also yielded more than one hundred pieces of Etruscan gold work, seemingly overlooked by the ancient grave robbers (Vallone 1995:130).

On the east side of Tumulus II, facing Mt. Sant'Egidio and the city of Cortona, a monumental stone terrace-altar was discovered in 1990 (Holder 1999:39). The altar 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, perhaps for religious ceremonies and processions honouring the deceased (Vallone 1995:126-133).

In the Roman period, the supporting stones of the altar collapsed, the tombs fell into disuse, and the tumulus became overgrown with vegetation. A number of inhumations dating from the 1st century BCE to the 1st century CE have been found at the

[1] The Melone in Camucia was discovered in 1842 by Alessandro François. The tumulus contains two tomb chambers. Francois excavated the south tomb; the north tomb wasn't excavated until 1964.

tumulus, however, with seventeen discovered in the vicinity of the terrace altar (Zamarchi Grassi, 2010) (Figs. 1.7, 1.8, 1.9). Of the burials around the altar, four were completed before the collapse. After the altar's collapse, some of the stone was re-used for the later burials, which consisted “mostly of simple inhumations in *cappuccina*-type tombs in wood or bricks.” The grave goods from the burials consist mainly of a few vessels for cooking and table-use.

Ten inhumations from the area of Tumulus II have been made available for study by the Museo dell’Accademia Etrusca e della Città di Cortona. Detailed information on the context of the burials is sparse but certain conclusions can be drawn. SII-1, SII-7a and SII-7b were found in association with Tomb 2: SII-1 was excavated from the *dromos* but the precise location in the tomb of SII-7a/7b, a burial containing the commingled remains of two individuals, is uncertain (Fracchia pers. comm.). SII-2 was most likely found in the vicinity of the terrace-altar, although its exact provenance is not known (Fracchia pers. comm.). SII-3, SII-4, SII-5, SII-6, SII-8, and SII-9 were excavated from the area immediately surrounding the terrace altar. SII-3, SII-4 and SII-8, from “tombs” D, G, and L respectively, appear to have lacked any sort of stone construction and could possibly be included in the “*cappuccina*-type tombs in wood” mentioned above. SII-5 and SII-9, from “tombs” M and E, appear to have had a substantial stone, brick or tile covering. All five burials date to after the period of the altar collapse. SII-6 was recovered from the vicinity of Tomba C. 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 (Fracchia pers. comm).

**The Circoli**

The Circoli necropolis was revealed in July of 2005, when archaeological testing was carried out during construction work designed to shift the course of the Loreto stream. The necropolis is composed of two circoli, or circular areas (Fig. 1.10), and is essentially an urn-field, much smaller but not unlike those of the Villanovan period (Torelli 1975:17). Approximately 40 m north of Sodo Tumulus II, the circles contain cremation burials dated to the early Orientalizing period, between the mid-7$^{th}$ and mid-6$^{th}$ centuries BCE. Circolo I, between 7.5 and 8 m in diameter, contains six tombs *a cassetta*. Circolo II, 8 m in diameter and outlined in roughly squared sandstone slabs, has thus far yielded fifteen burials. Several Hellenistic and Roman-period burials have been discovered in the necropolis, several of which disturbed the older deposits. At the time of this study, only one of these intrusive burials was available for examination: C-1, a Roman-period inhumation cut into Tomb 2 of Circolo I (Fig. 1.11). The ancient foundations of a large building were also discovered approximately 200 m west of the circoli, although investigations are incomplete and the structure's association with the necropolis or Sodo Tumuli is not known.

**Terontola**

Two graves were discovered in 2003 during construction of the Carabinieri station[2] on the Via Combattenti in Terontola (Figs. 1.12, 1.13), but the partial remains of only one individual (labelled Tomba 2) were available for analysis. Since the remains were recovered as a salvage excavation, nothing is known about the nature of the ancient burial site and whether additional inhumations are in the vicinity. The individual was found lying in an extended position on terracotta roof tiles (Fig. 1.14), tiles that are identical to those on display in the MAEC (Fig. 1.15).

## Works Cited

Fracchia H. 2006. The Villa at Ossaia and the Territory of Cortona in the Roman Period. Siracusa: Lombardi editori.

Holder PN. 1999. Cortona in Context: The History and Architecture of an Italian Hill Town to the 17th Century. Cortona: Arti Tipografiche Toscane.

Torelli M. 1975. Introduction. In: Boitani F, Cataldi M, Pasquinucci M. Etruscan Cities. Atthill C, Evans E, Pleasance S, Swinglehurst P (trans.) London: Cassell.

Vallone MT. 1995. Cortona of the principes. *Etruscan Studies* 2: 109-139.

Zamarchi Grassi P. (ed.) 2010. The II° Tumulus at Sodo. Ministero per I Beni Culturali e Ambientali. Soprintendenza ai Beni Archeologici Della Toscana. Sezione Didattica.

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[2] Reported in Gori Stefano, Guidelli Francesca, Salvi Ada. 2007. Località Terontola Stazione, Cortona-proprietà Farina. Notiziario della Soprintendenza per i Beni Archeologici della Toscana. Firenze: All'Insegna del Giglio s.a.s., pp. 186-187.

Figure 1.1. Satellite image (©2011 GeoEye; European Space Imaging) showing the location of the Sodo Tumuli and circoli, the Camucia tumulus, and the burial from Terontola.

Figure 1.2. Satellite map (©2011 Google) showing the location of the Sodo Tumuli relative to the Town of Cortona and the Camucia Tumulus.

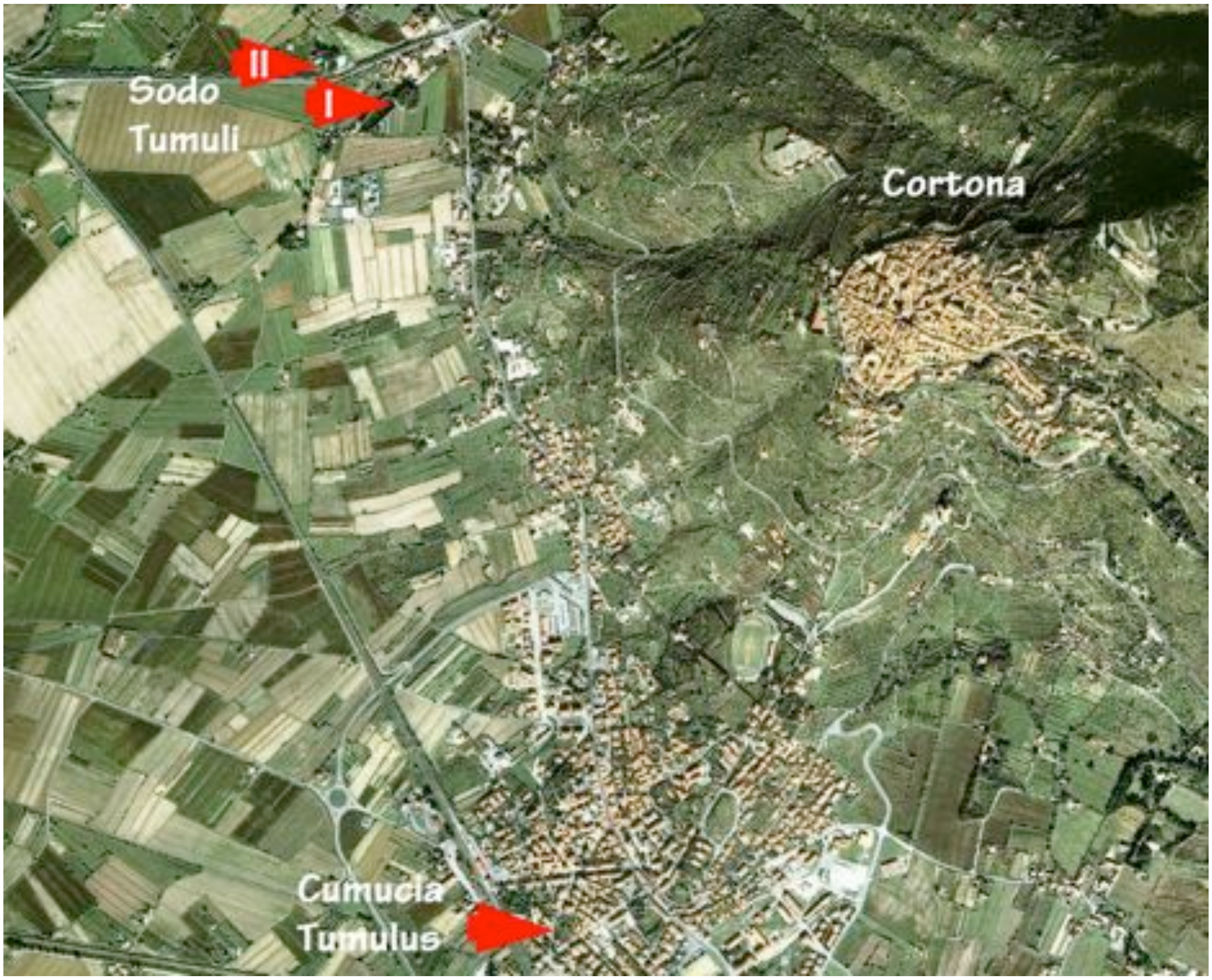

Figure 1.3. Plan of the Sodo I tumulus (adapted from Vallone 1995, Fig. 18). The covered *dromos* leads to three antechambers, before terminating in a larger, rear chamber. Two lateral rooms protrude off each of the second and third antechambers.

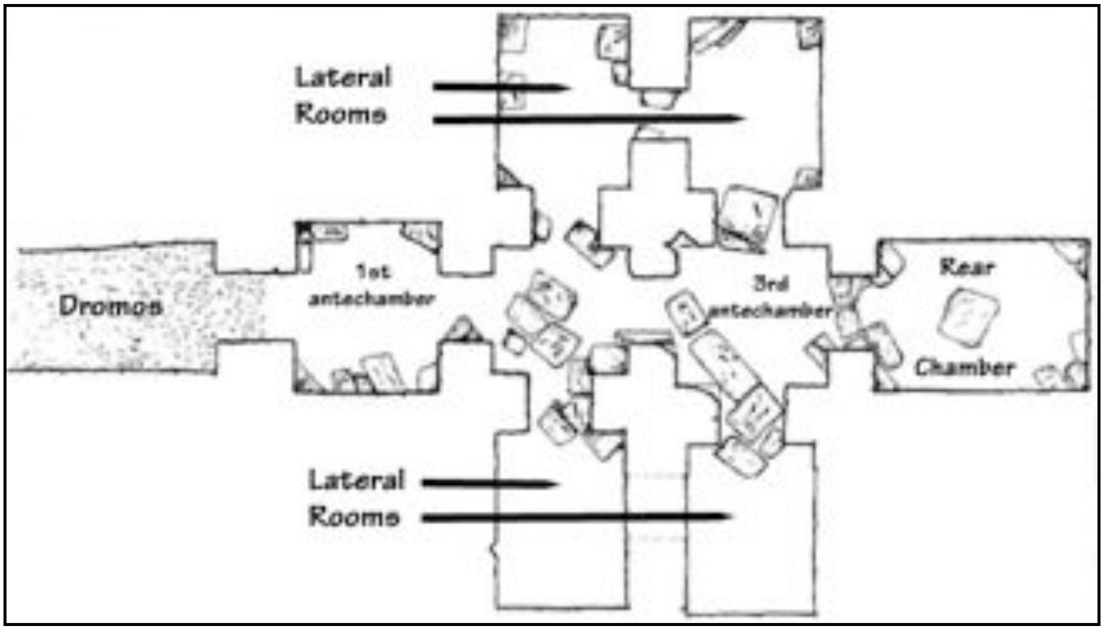


Figure 1.4. The *dromos* of the Sodo I tumulus, May 2010.

Figure 1.5. Sodo II tumulus in May 2010. The roof in the left of the photo covers the reconstructed terrace altar.

Figure 1.6. Plan of the Sodo II tumulus (adapted from MAEC display plaque).

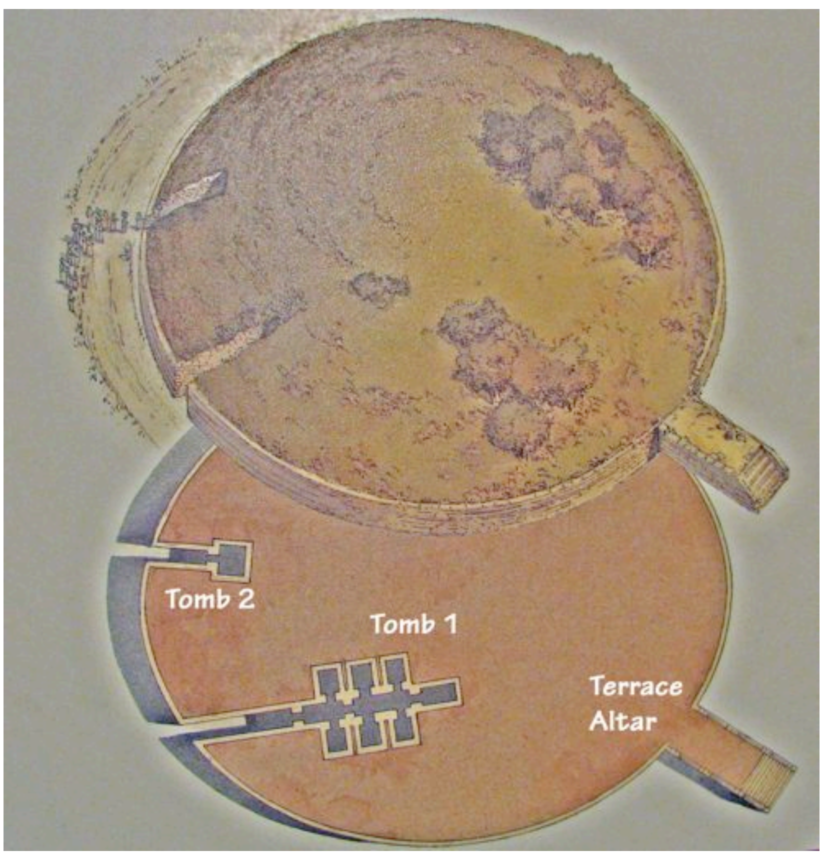

Figure 1.7. Plan of burials in the vicinity of the altar (adapted from MAEC display plaque).

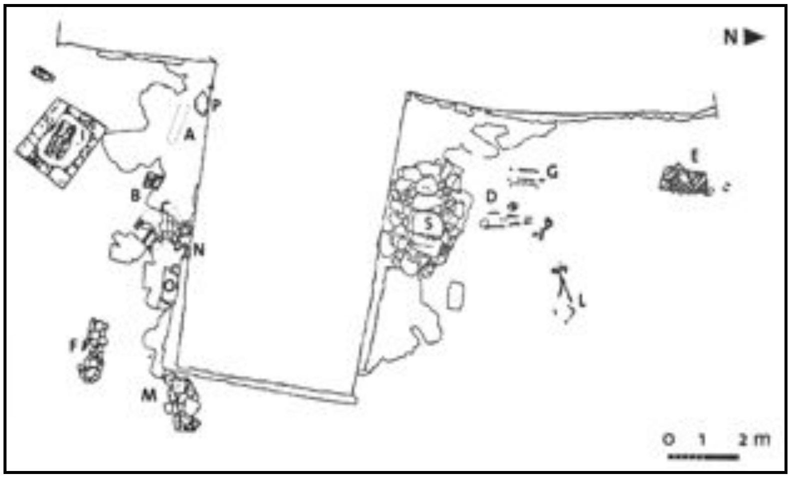


Figure 1.8. The terrace altar, as reconstructed. The remains of Grave S are visible to the right of the altar (arrow). The human remains from this grave were not available for study in May 2010.

Figure 1.9. Close-up of debris in Grave S (May 2010). The edges of roof tiles (arrows) on which the body would have lain are clearly visible.

Figure 1.10. Top: Plan of the Sodo Circoli; white arrow shows location of the burial of the skeleton (adapted from an interpretive plaque in the MAEC): bottom: the skeleton on display in the MAEC.

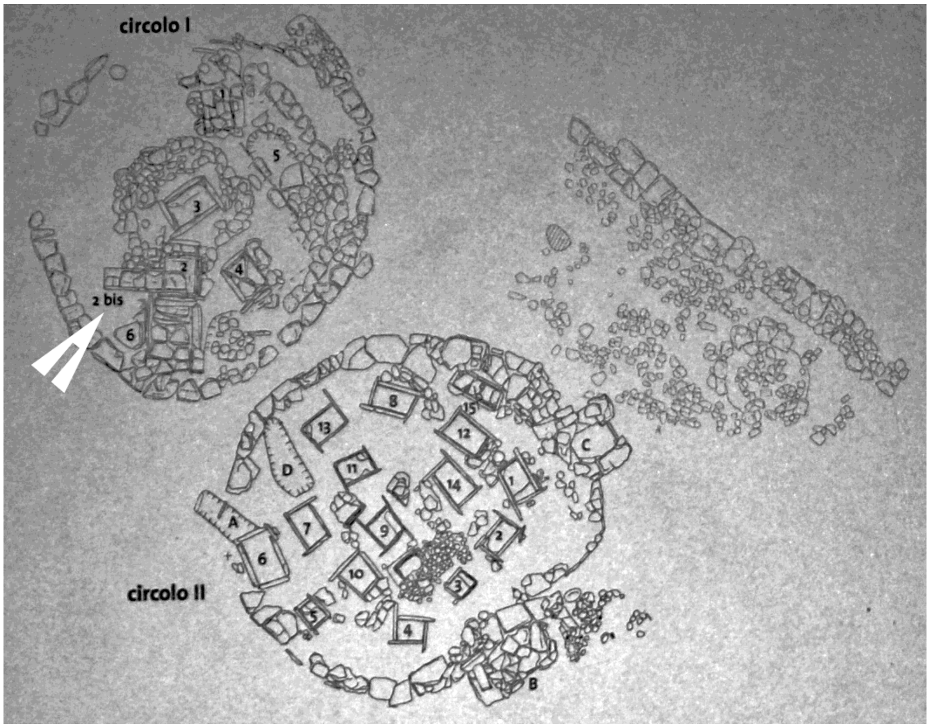


Figure 1.11. The skeleton from Burial 2bis at Circolo I during excavation (source unkown).

Figure 1.12. Satellite image (©2011 Google) showing the location of the Carabinieri Station in Terontola.


Figure 1.13. The Carabinieri Station in Terontola.

Figure 1.14. The partial skeleton from Terontola Tomba 2, in the museum storeroom, lying on the roof tiles upon which the individual was presumably interred. No remains from Terontola other than those pictured were presented for analysis.

Figure 1.15. Close-up of a roof tile from the Terontola burial (top), compared to a roof tile on display in the museum (bottom). Note the circular pattern (white arrows) on both tiles.

# CHAPTER 2

# PRESERVATION ISSUES

The skeletal remains recovered from the Sodo Tumuli were in extremely poor condition when examined at the Museo (Appendix A gives preservation summaries for each burial). The Val di Chiana's position as a floodplain means that much of the valley experiences a high water table and some locales can be marshy for several months of the year (Alexander 1984; Holder 1999). Indeed, excavations of the tumuli often have been disrupted by the infiltration of ground and surface water (Vallone 1995).

## First-order Taphonomy

Although the original burial conditions may have supported bone preservation, the graves had since been inundated with water for an unknown length of time (Fig. 2.1), leading to a number of problems associated with the accumulation of mud around and inside the skeletal remains themselves. Diagenesis of skeletal tissue involves the hydrolysis, dissolution, mineral replacement and recrystallization of its constituent parts.[3] 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). Chemical reactions during diagenesis are influenced by factors that are intrinsic to the bone tissue such as size, porosity and chemical structure; and by factors that are extrinsic, such as duration of interment, sediment pH, climate, and aeration (Henderson 1987, Nicholson 2001, Sandford and Weaver 2000, Sillen 1989, Von Endt and Ortner 1984).

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).

In hydrolysis, water breaks collagen down into polypeptides and amino acids, lowering the molecular weight of the bone protein and increasing its solubility (Hare

[3] 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).

1980, Hedges and Millard 1995, Henderson 1987, 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.

The effect of groundwater on bone is thus highly dependent on variations in flow rate (Chaplin 1971:16, Gill-King 1997, Hedges and Millard 1995, Henderson 1987, Nicholson 2001, Nielsen-Marsh et al. 2000, Sandford and Weaver 2000, 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 pass 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 and co-workers (2000) consider the three regimes put forward by Hedges and Millard (1995) 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 unchanging environments.

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, 2009). More detrimental than a cycling between wet and dry, however, is a burial environment in which the bones are constantly exposed to fresh water, such as when the water comes from a stream or other source of moving water. In such an environment, 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, Stodder 2008). Additionally, the constant supply of groundwater ensures the continuous presence of a diffusion matrix, for the diagenesis of both the inorganic and organic phases of bone.

Diagenetic processes affect bone significantly more than dental enamel, because bone is less dense, more soluble, and has a greater porosity (Carlson 1990, Clement 2009, Parker and Toots 1970, Parker and Toots 1980). 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). 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, Hare 1980, Lambert et al. 1982, Lambert et al. 1985a, Nawrocki 1995, Sandford and Weaver 2000). Due, in part, to the exposure of blood vessel channels and other internal structures to the burial environment, crushed or broken bones are also more susceptible than whole bone to these diagenetic changes (Bell 1990, Lambert et al. 1985b). Thus, bone that has been damaged during burial, such as may be caused by the collapse of a coffin or tiles in a cappucina-style covering, will be more greatly affected by the detrimental effects of groundwater.

Further problems are caused by fluctuations in temperature, as one might expect in a temperate climate such as central Italy. Seasonal episodes of freezing or low temperatures will alternate with heat during the summer months, and the burial environment will not necessarily protect remains from these fluctuations if the remains were placed in previously opened areas, such as a dromos, or in comparatively shallow graves in outside of the tumuli themselves. Although cold temperatures tend to retard diagenesis, a $10^{o}$ rise in temperature can double the rate of diagenetic processes (Henderson 1987).

**Second-order Taphonomy**

Second-order taphonomy refers to the loss of information during the processes of excavation and curation. Small skeletal elements (e.g., teeth, small bones of the hands and feet) often are not recovered during excavation, and choices pertaining to which aspects of the skeleton to retrieve also influence the type of elements that are preserved. The two plastics crates that held the skeleton from Terontola, for example, presented a reasonably articulated skeleton from the cranium to just above the knees: the bones of the lower legs and feet were not included, and may have been left behind unintentionally in the Restoration Workshop at Sodo I, or they may not have been excavated and remain in the ground under the land developed for the Carabinieri stazione in Terontola. In any event, they are likely still lying on a third roof tile.

Damage to the skeletal remains also can be attributed to the practice of leaving the bones *en bloc*, that is, in the mud. While removal *en bloc* can be ideal when the remains appear to be too fragile for excavation on site, or when time constraints require that the remains be removed quickly, unless the remains are immediately treated with proper conservation techniques the mud hardens and the fragile bone can never be adequately removed from the matrix (Fig. 2.2). The poor state of osteological preservation 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, Koob 1992, Rahtz and Hirst 1976, Stone et al. 1990). Bioarchaeologists and conservators continue to debate the proper treatment of remains in this state: washing the bones with water to remove the mud immediately after excavation can be useful, but only if the bones are sufficiently strong. A follow-up treatment with consolidant can then strengthen the remains. Occasionally, such washing and consolidation is found many years later to have contributed to deterioration of the bone, and much of the long-term conditions of the remains depends on the storage temperature and humidity, as well as the type of consolidant that was used. Some consolidants, for example, are designed expressly for use with wet materials, and others, intended for dry materials, can fail to penetrate the bone adequately and eventually lead to peeling of the consolidant from the bone surface, sometimes taking the outermost layer of the bone with it (Kres and Lovell 1995). Of course, the use of some consolidants can render biochemical analyses of bones (e.g., aDNA) ill-advised.

## Works Cited


Alexander D. 1984. The reclamation of Val-di-Chiana (Tuscany). *Annals of the Association of American Geographers* 74:527-550.

Bell LS. 1990. Palaeopathology and diagenesis: An SEM evaluation of structural changes using backscattered electron imaging. *Journal of Archaeological Science*. 17: 85-102.

Carlson SJ. 1990. Vertebral dental structures. In: Carter JG, editor. Skeletal Biomineralization: Patterns, Processes and Evolutionary Trends. New York (NY): Van Nostrand Reinhold, pp 531-556.

Chaplin RE. 1971. The Study of Animal Bones from Archaeological Sites. London (UK): Seminar Press.

Child AM. 1995. Microbial taphonomy of archaeological bone. *Studies in Conservation* 40(1): 19-30.

Clement JG. 2009. Forensic odontology. In: Blau S, Ubelaker DH, editors. Handbook of Forensic Anthropology and Archaeology. Walnut Creek CA: Left Coast Press, pp 335-347.

Gill-King H. 1997. Chemical and ultrastructural aspects of decomposition. In: Haglund WD, Sorg MH, editors. Forensic Taphonomy. Boca Raton FL:CRC Press, pp 93-108.

Gordon CC, Buikstra JE. 1981. Soil pH, bone preservation, and sampling bias at mortuary sites. *American Antiquity* 46(3): 566-571.

Hanson DB, Buikstra JE. 1987. Histomorphological alteration in buried human bone from the Lower Illinois Valley: Implications for palaeodietary research. *Journal of Archaeological Sciences* 14: 549563.

Hare PE. 1980. Organic geochemistry of bone and its relation to the survival of bone in the natural environment. In Behrensmeyer AK, Hill AP, editors. Fossils in the Making. Chicago (IL): University of Chicago Press, pp 208-219.

Hedges REM, Millard AR. 1995. Bones and groundwater: Towards the modeling of diagenetic processes. *Journal of Archaeological Science* 22: 155-164.

Henderson J. 1987. Factors determining the state of preservation of human remains. In: Boddington A, Garland AN, Janaway RC, editors. Death, Decay and Reconstruction: Approaches to Archaeology and Forensic Science. Manchester (UK): Manchester University Press, pp 43-54.

Holder PN. 1999. Cortona in Context: The history and architecture of an Italian hill town to the 17th century. Cortona: Arti Tipografiche Toscane.

Koob SP. 1992. Recovery and treatment of skeletal remains at Herculaneum. In: Payton R, editor. Retrieval of Objects from Archaeological Sites. Denbigh (Clwyd, Wales): Archetype Publications, pp 157-166.

Kres LA, Lovell NC. 1995. A comparison of consolidants for archaeological bone. *Journal of Field Archaeology* 22:508-515.

Lambert JB, Vlasak SM, Thometz AC, Buikstra JE. 1982. A comparative study of the chemical analysis of ribs and femurs in Woodland populations. *American Journal of Physical Anthropology* 59: 289-294.

Lambert JB, Simpson SV, Weiner SG, Buikstra JE. 1985b. Induced metal-ion exchange in excavated human bone. *Journal of Archaeological Science* 12:85-92.

Lambert JB, Simpson SV, Szpunar CB, Buikstra JE. 1985b. Bone diagenesis and dietary analysis. *Journal of Human Evolution* 14(5): 477-482.

Nawrocki SP. 1995. Taphonomic processes in historic cemeteries. In: Grauer AL, editor. Bodies of Evidence: Reconstructing History Through Skeletal Analysis. New York NY: Wiley-Liss Inc., pp 49-66.

Nawrocki SP. 2009. Forensic taphonomy. In: Blau S, Ubelaker DH, editors. Handbook of Forensic Anthropology and Archaeology. Walnut Creek (CA): Left Coast Press, pp 284-294.

Nicholson RA. 2001. Taphonomic investigations. In: Brothwell DR, Pollard AM, editors. Handbook of Archaeological Sciences. Chichester (UK): John Wiley & Sons, Ltd., pp 179-190.

Nielsen-Marsh C, Gernaey A, Turner-Walker G, Hedges R, Pike A, Collins M. 2000. The chemical degradation of bone. In: Cox M, Mays S, editors. Human Osteology in Archaeology and Forensic Science. London (UK): Greenwich Medical Media, pp 439-454.

Parker RB, Toots H. 1970. Minor elements in fossil bone. *Geological Society of America Bulletin* 81: 925-932.

Parker RB, Toots H. 1980. Trace elements in bones as paleobiological indicators In: Behrensmeyer AK, Hill AP, editors. Fossils in the Making. Chicago: University of Chicago Press, pp 197-207.

Pike AWG, Nielsen-Marsh C, Hedges REM. 2001. Modeling bone dissolution under different hydrological regimes. In: Millard AR, editor. Proceedings of Archaeological Sciences '97. British Archaeological Reports International Series 939. Oxford (UK): Archaeopress, pp 127-132.

Rahtz P, Hirst S. 1976. Bordesley Abbey, Redditch, Hereford-Worcestershire: First Report on Excavations 1969-1973. British Archaeological Reports, 23. Oxford (UK): British Archaeological Reports.

Sandford MK, Weaver DS. 2000. Trace element research in anthropology: New perspectives and challenges. In: Katzenberg MA, Saunders SR, editors. Biological Anthropology of the Human Skeleton. New York (NY): Wiley-Liss Inc., pp 329-350.

Sillen A. 1989. Diagenesis of the inorganic phase of cortical bone. In: Price TD, editor. The Chemistry of Prehistoric Human Bone. Cambridge (UK): Cambridge University Press, pp 211-229.

Stodder ALW. 2008. Taphonomy and the nature of archaeological assemblages. In: Katzenberg MA, Saunders SR, editors. Biological Anthropology of the Human Skeleton. 2nd Edition. Hoboken (NJ): John Wiley & Sons, Inc., pp 71-114.

Stone TT, Dickel DN, Doran GH. 1990. The preservation and conservation of waterlogged bone from the Windover Site, Florida: A comparison of methods. *Journal of Field Archaeology* 17(2): 177-186.

Von Endt DW, Ortner DJ. 1984. Experimental effects of bone size and temperature on bone diagenesis. *Journal of Archaeological Science* 11: 247-253.

Zamarchi Grassi P. 1999. Il tumulo secondo del Sodo. In: Bruschetti P, Zamarchi Grassi P (eds.) Cortona Etrusca. Cortona: Calosci-Cortona, pp 20-67.

Figure 2.1. Groundwater around the terrace altar during excavation (photo from Zamarchi Grassi 1999, Fig. 34)

Figure 2.2. This image of "ghost bone" in a block of dried mud indicates the condition of most of the postcranial skeletal remains from the Sodo. In this case, the bone appears to have been cut in half longitudinally during excavation, and the section shows how the bone was completely infiltrated by groundwater and mud. The protein component of the bone has disintegrated, leaving behind only a highly friable, chalky outline of the bone.

# CHAPTER 3
# THE HUMAN REMAINS FROM THE SODO: DEMOGRAPHY

As summarized in Table 3.1, demographic data were obtained from nine individuals: six males and three females. Of these, two of the individuals from the Sodo Tumulus I for which data could be collected were young adults and one was a middle aged-adult, whereas the remains from Tumulus II included three young adults and two middle-aged adults. The male recovered from Tertontola was an older adult. The burial numbers that appear here were not assigned by the excavators, but were assigned by the authors during analysis in order to facilitate the collation of data.

**Table 3.1**. Age, sex, and grave information for the human remains that were examined in the Museum (MAEC) and that are the subject of this report. SII-7a and 7b are the commingled remains of a minimum of two individuals; data could be collected from SII-7b only. C = Circolo I, SI = Sodo Tumulus I, SII = Sodo Tumulus II, T = Terontola; F = female, M = male, U = unknown. Grave information was taken from identification tags that accompanied the remains, or from labels on packaging that held the remains.

| Burial Number | Age | Sex | Grave Information |
|---|---|---|---|
| | | | |
| C-1 | young adult | F | Circolo I Tomba 1bis |
| | | | |
| SI-1 | young adult | F | Sodo I Tomba 1 US31 dromos |
| SI-2 | adult | U | Sodo I Tomba 2 US32 Saggio A Ampliato |
| SI-3 | young adult | M | Sodo I Tomba 4 US34 dromos |
| | | | |
| SII-1 | young adult | M | Sodo II Tomba 2 dromos |
| SII-2 | young adult | F | Sodo II Tomba 1 angolo altare |
| SII-3 | middle adult | M | Sodo II Tomba D (terrace altar) |
| SII-4 | U | U | Sodo II Tomba G (terrace altar) |
| SII-5 | U | U | Sodo II Tomba M (terrace altar) |
| SII-6 | young adult | M | Sodo II Tomba C (terrace altar) |
| SII-7a | U | U | Sodo II Tomba 2 |
| SII-7b | middle adult | M | Sodo II Tomba 2 |
| SII-8 | U | U | Sodo II Tomba L (terrace altar) |
| SII-9 | U | U | Sodo II Tomba E (terrace altar) |
| | | | |
| T-1 | older adult | M | Terontola Caserma Carabinieri Tomba 2 |

Sex was determined from features of the skeleton, such as degree of robusticity, morphology of the skull (Fig. 3.1) and pelvis, and size of teeth, following disciplinary standards as described by Buikstra and Ubelaker (1994). Age at death was estimated in broad terms since the precision of age estimates for adults is poor[4], and none of the more useful skeletal features for adult age estimation (e.g., pubic symphysis and auricular surface morphology) were adequately preserved. Thus, age estimates reflect categorization as young, middle, or older adult, and are based on other features of aging such as the relative degree of tooth wear (Fig. 3.2) (Brothwell, 1981; Smith 1984) and cranial suture closure (Meindl and Lovejoy 1985). Burial SI-2 was very incomplete but has been identified as a middle-aged adult because of the presence of arthritis.

Appendix B gives the full details of grave information, as recovered from the boxes, crates, or tags that accompanied the skeletal remains when they were examined at the MAEC.

## Works Cited


Brothwell D. 1981. Digging Up Bones. 3rd ed. Ithaca NY: Cornell.

Buikstra JE, Ubelaker DH (eds). 1994. Standards for Data Collection from Human Skeletal Remains. Arkansas Archaeological Survey Research Series No. 44. Fayetteville: Arkansas Archaeological Survey

Meindl RS, Lovejoy CO. 1985. Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateral anterior sutures. *American Journal of Physical Anthropology* 68:57-66.

Smith BH. 1984. Patterns of molar wear in hunter-gatherers and agriculturalists. *American Journal of Physical Anthropology* 63:39-56.


[4] No juvenile remains, which often can be aged quite precisely due to the timing of skeletal and dental growth and development, were found in the sample.

Figure 3.1. Partially reconstructed cranium shows clearly the pronounced nuchal crest and inion (arrows), indicative of male sex.

Figure 3.2. Relative degrees of premolar occlusal tooth wear indicate younger (left) and older (right) individuals, assuming that diets are similar.

# CHAPTER 4
# THE HUMAN REMAINS FROM THE SODO: SKELETAL PALAEOPATHOLOGY

Since most of the skeletal material was poorly preserved, palaeopathological observations could be made on only a few individuals. Furthermore, most of the individuals were young adults, and hence were not affected by the degenerative changes of arthritis. However arthritis was observed in middle-aged individuals, and another middle-aged adult displayed evidence of a chronic anemic condition, although whether the anemia was caused by a genetic disorder or an iron deficiency is unknown. One young adult exhibited healed trauma.

C-1: The skull from the museum display was examined but the cranium was highly fragmented and the ectocranial surface was badly damaged from the burial context. The endocranium was filled with dried mud. The mandible was held in place by matrix and the temporomandibular joint could not be observed. The skull was therefore considered not observable for pathological lesions (with the exception of the teeth).

SI-1: This burial consisted of only fragments of the cranium, cervical vertebrae, and hand, and hence could not be comprehensively studied for pathology. However, it was noted that arthritis did not appear in the hand or vertebral bones, which is consistent with the young age of the individual.

SI-2: Although the tibial and fibular shafts were exposed on top of a mud block, they were too badly damaged for observation. The patellae were better preserved, however, and both show evidence of arthritis, in the form of proliferative and erosive lesions on their medial articular aspects (Fig. 4.1).

SI-3: A number of cranial and postcranial fragments were preserved, but there were no indicators of arthritis, a finding not surprising given the young age of the individual. There was also no evidence of infectious disease. The lower jaw, however, showed evidence of healed trauma to the bottom of the chin on the right side (Fig. 4.2).

SII-1: Preserved pieces included some skull fragments and badly damaged portions of postcranial remains. None were observable for pathological lesions.

SII-2: Poorly preserved bones, unobservable for pathological lesions.

SII-3: The remains consisted of a skull encased in a block of dried clay; jaw fragments and teeth were extracted but the bone was not observable for pathological lesions.

SII-4: Unidentifiable bone fragments, badly exfoliated and unobservable for pathological lesions.

SII-5: Bone encased in dried mud and unobservable for pathological lesions.

SII-6: The cranium from this burial had been cleaned and partially reconstructed in the past. The endo- and ectocranial surfaces exhibited no evidence of pathological lesions although the condition of the bone surfaces did impair observation of conditions such as porotic hyperostosis. The maxilla exhibits a palatine torus (Fig. 4.3), which is a genetic variant that is not considered pathological in that it would not have impaired oral function and the living individual was likely unaware of the condition.

SII-7: The left mandibular condyle exhibits a small erosive lesion (Fig. 4.4) indicating slight arthritis at the temporomandibular joint, and a corresponding lesion appears on the left eminence on the cranial portion of the joint. A slight expression of arthritis is consistent with the degree of tooth wear in this individual, and if the individual had lived longer, and accumulated more extensive tooth wear, arthritis could have become severe.

The cranial fragments in these containers included portions of both right and left frontal bones, but of two different individuals (one individual is definitely male, based on the size of the glabellar region of the frontal bone, and one is older than the other, based on morphological changes to the endocranium). Small erosive lesions of *porotic hyperostosis,* a condition generally considered to indicate a chronic anemic condition, appear on both right and left orbits, hence both individuals, and on fragments of the cranial vault (Fig. 4.5).

One fragment of a finger bone exhibits arthritis (Fig. 4.6); no other bones of the hands were preserved and hence the extent of the condition could not be determined.

SII-8: Dried mud could not be removed from the long bones (labelled femora) that comprised this burial and hence the bones couldn't be examined for pathological lesions.

SII-9: No bones could be extracted from the dried mud and hence the burial was not observable for pathological conditions.

Figure 4.1. Erosive and proliferative lesions on the medial aspects of the patellae, where they articulate with the distal femur at the knee.

Figure 4.2. Healed trauma to the bottom edge of the mandible, facial side (arrow).

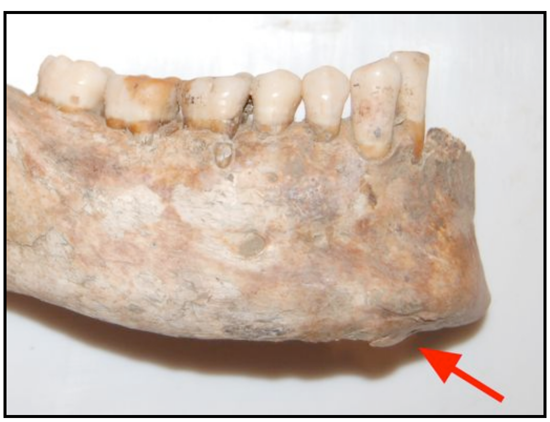

Figure 4.3. Smooth bone proliferation along the palatal suture of the maxilla, known as a palatine torus (arrows). This is a genetic trait that does not impair oral function.

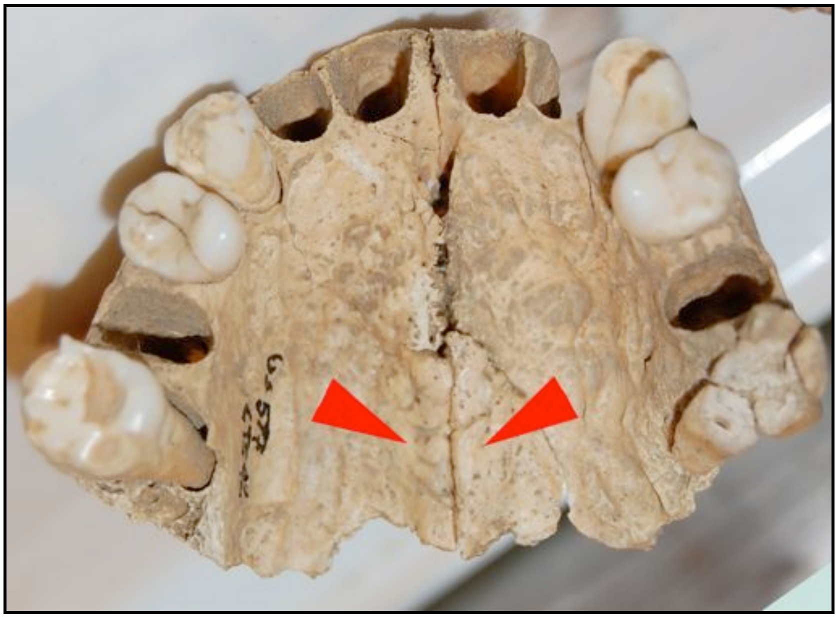

Figure 4.4. The mandibular condyle shows a small erosive lesion (arrow) consistent with a slight degree of arthritis at the temporomandibular joint.

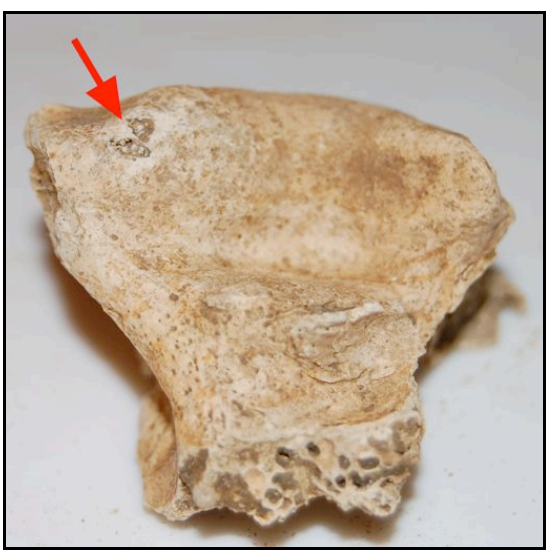

Figure 4.5. This small cranial fragment exhibits "pin-prick" lesions that are consistent with a pathological condition known as *porotic hyperostosis*. This condition is generally thought to be indicative of chronic anemia.

Figure 4.6. Destruction of the articular surface on the palmar aspect of the distal end of a fragment of a phalanx of the hand (arrow), consistent with arthritis.

# CHAPTER 5
# THE HUMAN REMAINS FROM THE SODO: DENTAL PALAEOPATHOLOGY

The study sample consists of eight crania yielding 127 permanent teeth: 79 *in situ* and 48 loose, and 159 observable alveoli (tooth sockets). Given that the normal adult human dentition has 32 teeth, for eight individuals we would expect a study sample of 256 teeth. Thus, slightly less than half of 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 (AMTL), reported below, must be considered a minimum estimate.

Data were accumulated and analysed according to the procedures established by Buikstra and Ubelaker (1994) and Hillson (1996). Assessment was completed according to the individual count (the number of affected individuals relative to the number of observable individuals) and tooth count (the number of affected teeth/alveoli relative to the number of observable teeth/alveoli) methods. Despite the small sample size, the individual count method will enable 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 a comparison of disease frequencies in different teeth.

## Individual Count

The prevalence of dental disease by individual count is presented in Table 5.1. Caries was the most common dental affliction, with carious lesions observable in all eight observable individuals. Antemortem tooth loss was observable only in a single middle adult male. Periapical abscesses were not observed in the Sodo sample, and this is likely due to the young age of most of the individuals as well as poor preservation of the skeletons. Due to the small sample size of the individual count method, statistical analysis was deemed unhelpful. However, there are no striking differences in the frequencies of any of these diseases between the sexes.

**Table 5.1.** Individual count comparison of dental disease frequencies. n = # of affected individuals; (%) = # affected individuals/# observable individuals x 100, rounded to nearest full percentage. AMTL = Antemortem tooth loss.

| | | 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 | 7 (100) | 0 | 4 (57) | 3 (43) |
| | Middle adult | 1 (100) | 1 (100) | 1 (100) | 0 |
| **Total** | | **8 (100)** | **1 (13)** | **5 (63)** | **3 (38)** |

## Tooth Count

The results of the tooth count evaluation of dental disease for the skeletal sample are presented in Tables 5.2-5.5. Due to poor 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.

### Caries

Caries occurs when the bacteria in the mouth break down the sugars and carbohydrates found in saliva and in the food that we eat. When they metabolize 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 the subsequent demineralisation of the tooth mineral. Such demineralisation is symptomatic of caries. Carious lesions, or cavities, are holes in the tooth (Fig 5.1) that develop when demineralised patches progress to the point of irreversible destruction of the enamel or cementum; these lesions are pathognomonic of the disease caries.

The sample exhibits a carious tooth frequency of 14% (Table 5.2). All eight individuals exhibited caries in at least one tooth, with an average of 2.25 affected teeth per individual. The largest number of affected teeth in a single individual was four, found in SI-3, a young adult male. The absence of caries in the anterior teeth (incisors and canines) and the high frequency of caries in the molars is 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 lesions was interproximal (Fig. 5.2), accounting for ten of the observed lesions. The close proximity of the premolars and molars, which produces spaces between the gum and the dental contact points that tend to accumulate food particles, 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. The difference in frequency of carious lesions between the maxilla and mandible is not significant.

Interestingly, there was a higher frequency of caries in young adults (15% of teeth were affected) than in middle adults (8% per cent of teeth were affected). Apart from the small sample size, this can be explained by two factors: postmortem and antemortem tooth loss. Only 12 (of a potential 32) teeth from the middle adult were present. Because many of these were lost postmortem, it is impossible to know whether they exhibited carious lesions. Additionally, 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 could have been lost antemortem, thus eliminating them from this count.

**Antemortem Tooth Loss**

Although it can have several aetiologies, AMTL (Fig. 5.3) is generally caused by carious infection of the pulp cavity (a process that can be accelerated by extreme wear of the tooth crown). 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.

**Table 5.2.** Tooth count prevalence of caries. $n_o$ = # observable teeth; $n_a$ = # affected teeth; (%) = # affected teeth/# observable teeth x 100, rounded to the nearest full percentage.

| | | $n_o$ | $n_a$ | % |
|---|---|---|---|---|
| Tooth class | Incisor | 17 | 0 | 0 |
| | Canine | 18 | 0 | 0 |
| | Premolar | 38 | 2 | 5 |
| | Molar | 52 | 16 | 31 |
| Sex | Male | 75 | 11 | 15 |
| | Female | 50 | 7 | 14 |
| Age | Young adult | 113 | 17 | 15 |
| | Middle adult | 12 | 1 | 8 |
| Jaw | Maxilla | 70 | 10 | 14 |
| | Mandible | 55 | 8 | 15 |
| **Total** | | **125** | **18** | **14** |

**Table 5.3**. Tooth count prevalence of antemortem tooth loss. $n_o$ = # observable tooth sockets; $n_a$ = # affected tooth sockets; (%) = # affected teeth/# observable teeth x 100, rounded to the nearest full percentage.

| | | $n_o$ | $n_a$ | % |
|---|---|---|---|---|
| Tooth class | Incisor | 35 | 0 | 0 |
| | Canine | 23 | 0 | 0 |
| | Premolar | 43 | 0 | 0 |
| | Molar | 58 | 3 | 5 |
| Sex | Male | 101 | 3 | 3 |
| | Female | 58 | 0 | 0 |
| Age | Young adult | 144 | 0 | 0 |
| | Middle adult | 15 | 3 | 20 |
| Jaw | Maxilla | 87 | 0 | 0 |
| | Mandible | 72 | 3 | 4 |
| **Total** | | **159** | **3** | **2** |

As expected, none of the young adults in the Sodo sample exhibited AMTL but the middle adult with an observable dentition had lost three teeth antemortem: both $M_2$s and the left $M_1$. The exclusive occurrence of AMTL in the lower molars (both $M_2$s and a left $M_1$) is consistent with the tooth morphology and could indicate that caries was the most important factor in the aetiology of AMTL, followed by infection and, ultimately, loss of the tooth. The $M_2$s were clearly lost due to abscessing, but the reason for the loss of the $M_1$ is unclear. 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**

Enamel hypoplasia describes an episodic deficiency in enamel thickness that occurs during tooth formation (i.e., childhood). Hypoplastic enamel defects can be related to localized disturbances during tooth formation (e.g., trauma or bone infection) 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, LEH), pit-type defects and plane-type defects (Hillson 1996: 166-7).

Of the eight individuals in the Sodo sample, five (63%) exhibited LEH in at least one tooth. 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 three or fewer affected teeth. The hypoplastic defects observed in the individual SI-3 most certainly had a systemic cause, due to the large number of teeth affected. 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 young and middle adults. Because enamel hypoplasia occurs during childhood and the lesions are not remodelled during later years, in a larger sample we would expect no change in the frequency of occurrence between young adult and middle or older adult.

Linear enamel hypoplasia was observed in 20% of the teeth, making it the most common dental affliction by tooth count (Table 5.4). It appears to have affected males more than females but it is difficult to know if this difference is meaningful with this small sample size.

**Table 5.4**. Prevalence of enamel hypoplasia (tooth count). $n_o$ = number of observable teeth; $n_a$ = # affected teeth; (%) = # affected teeth/# observable teeth x 100, rounded to nearest full percentage.

| | | $n_o$ | $n_a$ | % |
|---|---|---|---|---|
| Tooth class | Incisor | 17 | 3 | 18 |
| | Canine | 17 | 8 | 47 |
| | Premolar | 38 | 2 | 5 |
| | Molar | 51 | 11 | 23 |
| Sex | Male | 73 | 20 | 27 |
| | Female | 50 | 5 | 10 |
| Jaw | Maxilla | 68 | 11 | 16 |
| | Mandible | 55 | 14 | 26 |
| **Total** | | **123** | **25** | **20** |

**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, that live in the oral cavity. Tooth fissures, interproximal areas and gingival (gum) crevices are particularly susceptible to plaque build-up, protected as they are from the natural 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.

Calculus was observed on 15% of the teeth (Table 5.5). In all cases, the calculus depositions were slight (Fig. 5.4) and no associated resorption of the alveolar bone was observed. The mandibular teeth appear to be more affected than the maxillary teeth, with the lingual surface of the mandibular incisors most susceptible to calculus formation, although 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, cited in Hillson 1996).

Because the mineralization of calculus into plaque is a progressive process 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, a middle-aged adult. This anomaly is most likely explained by the loss of teeth both antemortem and postmortem in the individual. SII-3 is missing 20 of 32 teeth, however, 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.

**Table 5.5**. Prevalence of calculus (tooth count). $n_o$ = # observable teeth; $n_a$ = # affected teeth; (%) = # affected teeth/# observable teeth x 100, rounded to nearest full percentage.

| | | $n_o$ | $n_a$ | % |
|---|---|---|---|---|
| Tooth class | Incisor | 17 | 4 | 24 |
| | Canine | 17 | 3 | 18 |
| | Premolar | 38 | 6 | 16 |
| | Molar | 52 | 5 | 10 |
| Sex | Male | 74 | 12 | 16 |
| | Female | 50 | 6 | 12 |
| Age | Young adult | 112 | 18 | 16 |
| | Middle adult | 12 | 0 | 0 |
| Jaw | Maxilla | 69 | 4 | 6 |
| | Mandible | 55 | 14 | 26 |
| **Total** | | **124** | **18** | **15** |

## Tooth Wear

Tooth wear is caused by two processes: tooth-on-tooth contact (attrition) and the contact of food and other objects with the tooth (abrasion). All of the occlusal wear in the Sodo sample can be ascribed to a combination of attrition and abrasion, the latter likely comprised of dietary substances. One individual, however, exhibits an usual form of oblique wear (Fig. 5.5) that has been attributed in other studies to the habitual clenching of a pipe stem between the upper and lower teeth (e.g., Lovell and Lai 1994). The individual in question (SII-1) is a young adult female; whether pipe-smoking could be a habitual activity for young women in this culture is not known by the authors. Another individual exhibits a "stepped" form of wear on the lingual surface of a central incisor (Fig. 5.6), a type of wear that has been linked to the habitual use of the front teeth as a "third hand", particularly when processing plant or other materials. Unfortunately, the poor preservation of anterior teeth makes it impossible to determine how extensive this practice may have been, although at least three individuals exhibited heavier anterior wear than would be expected if due strictly to dietary chewing.

## Diet and Dental Disease

It is difficult to say much about the diet of the Sodo population due to the small sample size but one conclusion seems evident: the high frequency of caries (100% of individuals and 14% of teeth) appears to be a clear indicator of a diet high in carbohydrates, such as cereals, dried fruits, and honey. Given the important role of carbohydrates in the Etruscan and Roman diets, as well as the dominance of the Val di Chiana in cereal production, this finding is not surprising.

Conclusions regarding dental calculus or antemortem tooth loss are 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 LEH (63% of individuals and 20% of teeth) indicates that some sort of systemic stress (dietary or otherwise) was relatively prevalent in young children in this population, but without more contextual information further analysis is not possible at this time.

Tooth wear in the Sodo sample is generally slight; this can be attributed to the young age of most of the individuals as well as to a typically agriculturalist diet, i.e., a diet consisting largely of processed cereal foods and cooked meat is consistent with the degrees of wear. Unusually severe wear of the anterior teeth is more likely due to habitual activities rather than to a diet typical of hunter-gatherers.

## Works Cited


Beiswanger BB, Segreto VA, Mallatt ME, Pfeiffer HJ. 1989. The prevalence and incidence of dental calculus in adults. *Journal of Clinical Dentistry* 1:55-58.

Brothwell DR. 1981. Digging up Bones, 3rd ed. Ithaca NY: Cornell University Press.

Hillson S. 1996. Dental Anthroplogy. Cambridge: Cambridge University Press.

Lovell NC, Lai P. 1994. Lifestyle and health of voyageurs in the Canadian Fur Trade. In: Herring A, Chan L, editors. Strength in Diversity. Toronto: Canadian Scholars Press, pp 327-343.

Figure 5.1. A carious lesion (arrow) that originated in the pits/furrows of the occlusal surface of a molar tooth.

Figure 5.2. Carious lesions of interproximal origin affecting the maxillary left first and second molars (arrow).

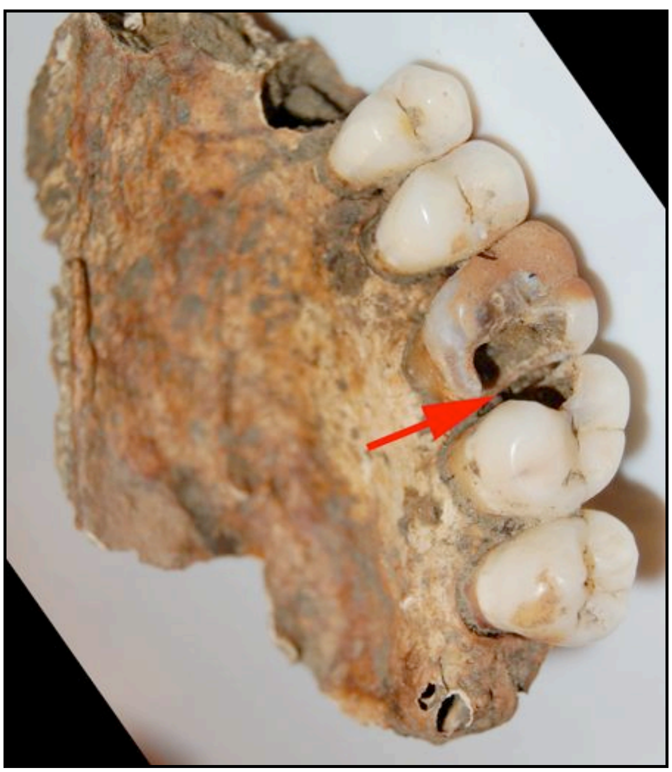

Figure 5.3. Antemortem tooth loss, the remodelled alveoli (arrows) indicating that the teeth were lost well before death.

Figure 5.4. Slight degrees of calculus indicated by arrows on the lower part of the tooth crown.

Figure 5.5. Oblique wear (arrow) that might be associated with the habitual clenching of an object between the upper and lower teeth. This individual also exhibits a single horizontal line of *linear enamel hypoplasia* at the approximate mid-point of the tooth crown.

Figure 5.6. The unusual pattern of "stepped" wear on the lingual side of the tooth (arrow) has been attributed to the use of the front teeth as a "third hand" in craft activities.

# CHAPTER 6
# THE HUMAN REMAINS FROM THE SODO:
# DENTAL ANTHROPOLOGY

The term "dental anthropology" originated in the early part of the twentieth century (Scott and Turner, 1988) and now encompasses a variety of research foci, including aspects of tooth size and shape, genetics, growth and development, health, diet, and the use of teeth as tools.[5] Teeth do not remodel or repair themselves in the manner that bones do, that is, in response to changing physiological factors and mechanical loadings. Thus, the features of a tooth that are unaltered by disease or abrasive wear are closely related to the gene-mediated control of development. Furthermore, although the dental tissues are laid down during childhood, their form is preserved throughout life, so that childhood development can be studied even in adults

Since some aspects of size and shape characteristics, such as the cusps, ridges, and furrows of tooth crowns, along with the number and form of tooth roots, vary within and between populations, they sometimes can be used to investigate the relationships between different archaeological groups (e.g., Manzi et al., 1997). Sufficiently large sample sizes are needed, however, for such statistical analyses.

Preservation of the skeletal remains from the Sodo tumuli and Circolo I is poor, although the dentition, when present, is in excellent condition. Antemortem tooth loss (described below) probably contributed to the incomplete nature of the dental sample, but the primary cause was likely problems encountered during excavation, since many of the skeletons were originally incomplete and damaged by the waterlogged sediments. In contrast, the teeth of the individual recovered through salvage excavations conducted during the construction of the Terontola carabinieri station were very well-preserved. Although the methods of data collection are the same for the Sodo and Terontola dentitions, the Terontola information is presented separately because it cannot be assumed that the individual comes from the same population as the remains from Sodo.

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[5] Since no juvenile remains, and hence no deciduous teeth, were found in the skeletal material that was available for study, tooth growth and development are not covered in this report.

## Dental Metrics

One or more tooth crown dimensions (e.g., mesiodistal and/or faciolingual crown diameter) could be measured in 77 of the collected permanent teeth. The remaining teeth could not be measured due to extreme occlusal wear or postmortem crown breakage.

Crown measurements were taken with a Helios needlepoint dial caliper, calibrated to 0.05 mm. Measurements were rounded to 0.1 mm. Two measurements, maximum faciolingual (FL) diameter, and maximum mesiodistal (MD) diameter were taken as described by Mayhall (2000). Intra-observer error was assessed by re-measurement of a randomly selected subset of 10 teeth, yielding a mean intraobserver error of 0.05 mm, which is well within acceptable ranges reported elsewhere (e.g., Lukacs 1985; Lukacs and Hemphill 1991). Due to the small sample size, asymmetry in size expression for left and right antimeres could not be examined statistically, but it is generally agreed that although one side is used for descriptive statistics, the other side can be substituted in cases of missing values.

Tables 6.1 and 6.2 present the mean crown diameters and mean crown areas of permanent left molars and premolars from the Sodo tumuli and Circolo I. The data show an obvious difference in tooth size between males and females, although the very small sample sizes prevent any statistical significance from being detected. This finding is consistent with the well established characteristic of sexual dimorphism in tooth size among most human populations.

## Dental Nonmetrics

Scoring of dental non-metric (or discontinuous) traits followed the Arizona State University system (Turner et al., 1991; and see also Coppa and Rubini 1996). Thirty-nine mandibular and 47 maxillary tooth-trait combinations were recorded.

While variation in morphology was scored along a continuum of expression, trait expression was dichotomized into presence-absence for comparative purposes; the degrees of trait expression required for a positive count are given in Tables 6.3 and 6.4. Ten tooth-traits were randomly selected and rescored to test for intraobserver error: inconsistencies did not affect the dichotomized expression of frequencies. The notable features of nonmetric variability are summarized here:

***Mandibular teeth***

- the anterior teeth (incisors and canines) tend to be simple in morphology
- the premolars are of typical anatomy, with two lingual cusps the norm
- The Y-groove pattern is most common on the first molar, which most commonly have five cusps (Fig. 6.1)
- The X-groove pattern also appears on the lower molars (Fig. 6.2)
- the hypoconulid, or cusp 5, tends to be small
- accessory cusps (i.e., cusps 6, 7, 8) were not observed
- accessory roots were not observed

***Maxillary Teeth***

- central incisors could not be scored for the shovel-shaped trait; where the lateral incisors and canines display shovelling, it is of a "trace" form
- the lateral incisors are somewhat complex in their morphology, since they exhibit interruption grooves and tuberculum dentale in addition to shovelling (Fig. 6.3)
- by contrast, the premolars are conservative in their crown morphology, with no accessory cusps or ridges
- large forms of the metacone (distobuccal cusp) are the norm (Fig. 6.4)
- the hypocone (distolingual cusp) is fully expressed in the first molars, but is less common in M2 and M3
- the metaconule, or cusp 5, does not appear on any molars
- none of the first molars or third molars exhibit the parastyle or trait of Carabelli, but these traits both appear on second molars (Fig. 6.5)
- the third premolars tend to have two roots, which is considered normal for maxillary premolars; no accessory roots were observed for any teeth
- unusual tooth forms, such as peg incisors and molars, and congenital absence of teeth, were not observed

It must be stressed that the very small sample sizes mean that these data should not be viewed as describing meaningful trends, but the tendency is to simple crown morphology, and a pattern of features that are consistent with a population that is of European ancestry.

## Works Cited


Coppa A and Rubini M. 1996. Per la conoscenza del patriomonio biological umano Scheletro & Denti; Atlante di caretteri discontinui. Roma: Soprintendenza Archaeologica per il Lazio.

Lukacs JR. 1985. Tooth size variation in prehistoric India. *American Anthropologist* 87:1-15.

Lukacs JR and Hemphill BE. 1991. The dental anthropology of prehistoric Baluchistan: A morphometric approach to the peopling of South Asia. In: Kelly MA and Larsen CS, eds. Advances in Dental Anthropology. New York: Academic Press, pp 77-119.

Manzi G, Santandrea E, Passarello P. 1997. Dental size and shape in the Roman Imperial Age: Two examples from the area of Rome. *American Journal of Physical Anthropology* 102:469-479.

Mayhall JT. 2000. Dental anthropology: techniques and strategies. In: Saunders SR and Katzenberg MA, eds. Biological Anthropology of the Human Skeleton. New York: Wiley and Sons, pp 103-134.

Scott GR. 1977. Classification, sex dimorphism, association, and population variation of the canine distal accessory ridge. *Human Biology* 49:453-469.

Scott GR. 1980. Population variation of Carabelli's trait. *Human Biology* 52:63-78.

Turner CG II, and Scott GR. 1973. Dentition of the Easter Islanders. In: Dahlberg AA and Grager TM, eds. Orofacial Growth and Development. The Hague: Mouton, pp 229-249.

Turner CG II, Nichol CR, and Scott GR. 1991. "Scoring procedures for key morphological traits of the permanent dentition: the Arizona State University Dental Anthropology System." In Kelly MA and Larsen CS, eds. Advances in Dental Anthropology. New York: Academic Press, pp 13-31.

**Table 6.1**. Males: Mean crown diameters (in mm) and mean crown areas (in mm$^2$) of permanent left molars and premolars from the Sodo Tumuli and Circolo. Since antimeteric differences are insignificant, values from the right side have been substituted for missing left side values; n = number of measureable teeth; sd = standard deviation.

| | Maxilla | | | | | | | | Mandible | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mesiodistal Diameter | | | Faciolingual Diameter | | | Crown Area | | Mesiodistal Diameter | | | Faciolingual Diameter | | | Crown Area | |
| Tooth | n | Mean | sd | n | Mean | sd | Mean | sd | n | Mean | sd | n | Mean | sd | Mean | sd |
| P3 | 3 | 6.8 | 1.0 | 3 | 9.2 | 1.0 | 62.8 | 12.2 | 1 | 6.8 | 0 | 1 | 7.1 | 0 | 48.3 | 0 |
| P4 | 2 | 6.8 | 0.1 | 2 | 9.5 | 0.1 | 68.8 | 1.3 | 1 | 7.7 | 0 | 1 | 8.0 | 0 | 61.6 | 0 |
| M1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10.8 | 0 | 1 | 9.5 | 0 | 102.6 | 0 |
| M2 | 4 | 10.0 | 0.2 | 4 | 12.0 | 0.7 | 119.5 | 7.0 | 1 | 11.1 | 0 | 1 | 10.0 | 0 | 111.0 | 0 |
| M3 | 2 | 9.3 | 1.1 | 2 | 11.0 | 2.0 | 102.8 | 30.0 | 1 | 11.7 | 0 | 1 | 9.5 | 0 | 111.2 | 0 |

**Table 6.2**. Females: Mean crown diameters (in mm) and mean crown areas (in mm$^2$) of permanent left molars and premolars from the Sodo Tumuli and Circolo. Since antimeteric differences are insignificant, values from the right side have been substituted for missing left side values; n = number of measureable teeth; sd = standard deviation.

| | Maxilla | | | | | | | | Mandible | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mesiodistal Diameter | | | Faciolingual Diameter | | | Crown Area | | Mesiodistal Diameter | | | Faciolingual Diameter | | | Crown Area | |
| Tooth | n | Mean | sd | n | Mean | sd | Mean | sd | n | Mean | sd | n | Mean | sd | Mean | sd |
| P3 | 3 | 6.7 | 0.3 | 3 | 8.9 | 0.2 | 59.9 | 3.7 | 3 | 7.5 | 0.8 | 3 | 7.8 | 0.9 | 59.0 | 13.0 |
| P4 | 3 | 7.6 | 1.5 | 3 | 9.2 | 0.1 | 70.5 | 16.3 | 3 | 6.9 | 0.2 | 3 | 7.9 | 0.2 | 55.0 | 1.2 |
| M1 | 3 | 10.1 | 0.6 | 3 | 11.1 | 0.6 | 112.7 | 12.8 | 2 | 11.0 | 0.1 | 2 | 10.0 | 0.6 | 109.0 | 7.7 |
| M2 | 3 | 9.2 | 0.4 | 3 | 10.6 | 0.7 | 98.6 | 8.3 | 2 | 10.8 | 0.2 | 2 | 9.7 | 0.2 | 103.8 | 0.2 |
| M3 | 1 | 7.8 | 0 | 1 | 9.5 | 0 | 74.1 | 0 | 1 | 11.5 | 0 | 1 | 10.5 | 0 | 120.8 | 0 |

**Table 6.3.** Frequencies of permanent mandibular dental traits in the Sodo dental sample. [n = number of teeth expressing trait; N = number of observable teeth; % = frequency of expression (n/N); dashes indicate that the trait was unobservable for that tooth]

| Trait | Tooth | n | N | % |
|---|---|---|---|---|
| Shoveling (+ = ASU 2-6) | I1 | 0 | 3 | 0 |
| Shoveling | I2 | 1 | 5 | 20 |
| Double shovel (+ = ASU 2-6) | I1 | 0 | 3 | 0 |
| Double shovel | I2 | 0 | 5 | 0 |
| Distal Accessory Ridge | C | 0 | 3 | 0 |
| Lingual Cusp # (+ = ASU 2-9) | P3 | 4 | 6 | 67 |
| Lingual Cusp # | P4 | 3 | 5 | 60 |
| Odontome | P3 | 0 | 4 | 0 |
| Odontome | P4 | 0 | 3 | 0 |
| Anterior Fovea (+ = ASU 2-4) | M1 | 0 | 3 | 0 |
| Y-Groove Pattern | M1 | 3 | 4 | 75 |
| +-Groove Pattern | M1 | 0 | 4 | 0 |
| X-Groove Pattern | M1 | 1 | 4 | 25 |
| Y-Groove Pattern | M2 | 3 | 5 | 60 |
| +-Groove Pattern | M2 | 0 | 5 | 0 |
| X-Groove Pattern | M2 | 2 | 5 | 40 |
| Molar Cusp # (+ = ASU 5-6) | M1 | 4 | 4 | 100 |
| Molar Cusp # | M2 | 0 | 5 | 0 |
| Molar Cusp # | M3 | 3 | 5 | 60 |
| Deflecting Wrinkle (+ = ASU 2-3) | M1 | 0 | 2 | 0 |
| Protostylid (+ = ASU 1-6) | M1 | 1 | 4 | 25 |
| Protostylid | M2 | 0 | 5 | 0 |
| Protostylid | M3 | 0 | 5 | 0 |
| Cusp 5 (+ = ASU 1-5) | M1 | 4 | 4 | 100 |
| Cusp 5 | M2 | 0 | 5 | 0 |
| Cusp 5 | M3 | 0 | 4 | 0 |
| Cusp 6 (+ = ASU 1-5) | M1 | 0 | 4 | 0 |
| Cusp 6 | M2 | 0 | 5 | 0 |
| Cusp 7 | M3 | 0 | 5 | 0 |
| Cusp 7 (+ = ASU 2-4) | M1 | 0 | 4 | 0 |
| Cusp 7 | M2 | 0 | 5 | 0 |
| Cusp 7 | M3 | 0 | 5 | 0 |
| Canine Root # (+ = ASU 2) | C | 0 | 2 | 0 |
| Tome's Root (+ = ASU 3-5) | P1 | - | - | - |
| Molar Root # (+ = ASU 3) | M1 | 0 | 1 | 0 |
| Molar Root # (+ = ASU 2-3) | M2 | 0 | 1 | 0 |
| Molar Root # (+ = ASU 2-3) | M3 | 0 | 1 | 0 |
| Congenital Absence | I1 | 0 | 4 | 0 |
| Congenital Absence | P4 | 1 | 7 | 14 |

**Table 6.4.** Frequencies of permanent maxillary dental traits in the Sodo dental sample. [n = number of teeth expressing trait; N = number of observable teeth; % = frequency of expression (n/N); dashes indicate that the tooth was not observable for the trait]

| Trait | Tooth | n | N | % |
|---|---|---|---|---|
| Winging (+ = ASU 1+) | I1 | 0 | 3 | 0 |
| Shoveling (+ = ASU 2-6) | I1 | - | - | - |
| Shoveling | I2 | 2 | 2 | 100 |
| Shoveling | C | 1 | 3 | 33 |
| Labial Convexity (+ = ASU 2-4) | I1 | 1 | 6 | 2 |
| Double Shoveling (+ = ASU 2-6) | I1 | 0 | 1 | 0 |
| Double Shoveling | I2 | 0 | 3 | 0 |
| Double Shoveling | C | 0 | 5 | 0 |
| Interruption Groove (+ = ASU M, D, MD, Med) | I2 | 2 | 3 | 67 |
| Tuberculum Dentale (+ = ASU 2-6) | I2 | 1 | 1 | 100 |
| Mesial Ridge (+ = ASU 1+) | C | - | - | - |
| Distal Accessory Ridge (+ = ASU 2-5) | C | 0 | 1 | 0 |
| Tricuspid ? | P3 | 0 | 10 | 0 |
| Tricuspid | P4 | 0 | 8 | 0 |
| Accessory cusps ? | P3 | 0 | 10 | 0 |
| Accessory cusps | P4 | 0 | 8 | 0 |
| Distosagittal ridge | P3 | 0 | 7 | 0 |
| Metacone (+ = ASU 3-5) | M1 | 6 | 6 | 100 |
| Metacone | M2 | 11 | 12 | 92 |
| Metacone | M3 | 5 | 5 | 100 |
| Hypocone (+ = ASU 3-5) | M1 | 6 | 6 | 100 |
| Hypocone | M2 | 3 | 11 | 3 |
| Hypocone | M3 | 2 | 5 | 40 |
| Cusp 5 (Metaconule) (+ = ASU 1-5) | M1 | 0 | 6 | 0 |
| Cusp 5 | M2 | 0 | 11 | 0 |
| Cusp 5 | M3 | 0 | 5 | 0 |
| Carabelli’s (+ = ASU 2-7) | M1 | 0 | 7 | 0 |
| Carabelli's | M2 | 1 | 11 | 1 |
| Carabelli's | M3 | 0 | 5 | 0 |
| Parastyle (+ = ASU 1-6) | M1 | 0 | 7 | 0 |
| Parastyle | M2 | 2 | 11 | 2 |
| Parastyle | M3 | 0 | 5 | 0 |
| Enamel Extensions (+ = ASU 1-3) | M1 | 0 | 2 | 0 |
| Enamel Extensions | M2 | 0 | 5 | 0 |
| Enamel Extensions | M3 | 0 | 1 | 0 |
| Premolar Root # (+ = ASU 2-3) | P3 | 1 | 2 | 50 |
| Premolar Root # | P4 | 0 | 5 | 0 |
| Upper Molar Root # (+ = ASU 3-4) | M1 | 4 | 5 | 80 |
| Upper Molar Root # | M2 | 1 | 6 | 2 |
| Upper Molar Root # | M3 | 0 | 2 | 0 |

| | | | | |
|---|---|---|---|---|
| Peg Incisor | I2 | 0 | 6 | 0 |
| Peg Molar | M3 | 0 | 5 | 0 |
| Odontome | P3 | 0 | 5 | 0 |
| Odontome | P4 | 0 | 4 | 0 |
| Congenital Absence | I2 | 0 | 8 | 0 |
| Congenital Absence | P4 | 0 | 10 | 0 |
| Congenital Absence | M3 | 0 | 6 | 0 |

Figure 6.1. The Y-groove cuspal pattern (dashed lines) on a 5-cusped lower molar. The arrow indicates the exposure of dentin under the enamel, which makes clear the 5 cusps of this molar.

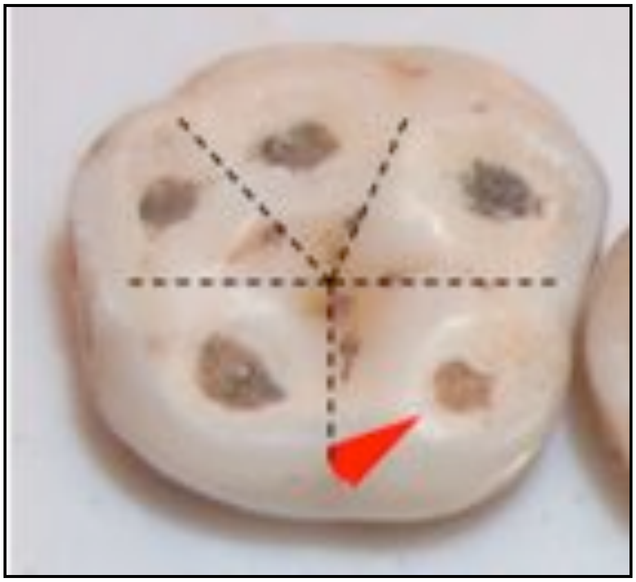

Figure 6.2. The X-groove pattern on two lower molars.

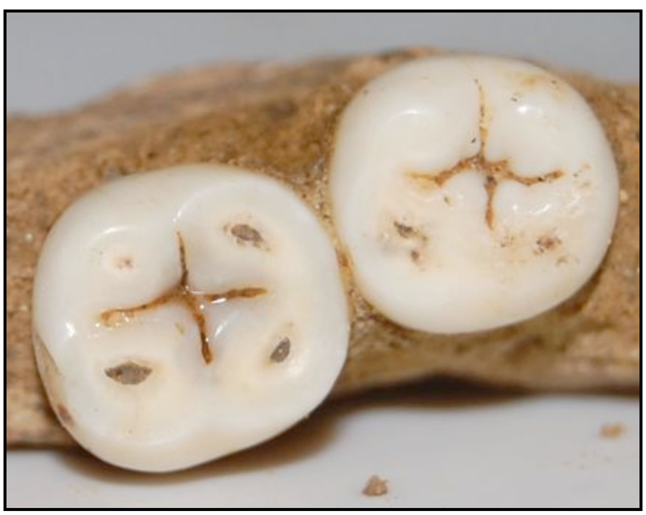

Figure 6.3. An interruption groove (arrow) on the lingual crown of a maxillary lateral incisor.

Figure 6.4. A large form of the distobuccal cusp (dashed line) on a maxillary molar.

Figure 6.5. An accessory cusp (arrow) on a maxillary molar.

# CHAPTER 7
# THE SKELETON FROM TERONTOLA

The origin of this skeleton and relevant preservation issues are described in Chapters 1 and 2 and Appendices A and B. Because this individual was not recovered from the same locale as the remains from the Sodo tumuli, we have not assumed that he comes from the same temporal or cultural population, and thus we present his biological data in this separate chapter.

## Age And Sex

Even while the skeleton was still partially encased in dried mud, aspects of the skeleton were visible that identified this individual as an older adult male, certainly much older than the remains found in the vicinity of the Sodo tumuli. Fusion of the ectocranial sutures (Fig. 7.1), the presence of arachnoid granulations on the endocranium (Fig. 7.2), arthritis, and severe tooth wear all point to an older individual. Unfortunately a precise age estimate is not possible because the best skeletal parts for age estimation of adults were not adequately preserved, but we have estimated that this individual was a minimum of 45 years of age at the time of death, at least a decade older than the oldest individual examined from the Sodo tumuli.

The skeleton is very robust and exhibits a narrow and deep sciatic notch in the ilium. The femora are especially large in diameter. Although AMTL renders the morphology of the mandible unhelpful for sex determination, the large glabella and supraorbital tori on the frontal bone and the large mastoid process on the temporal bone (Fig. 7.3) are consistent with an attribution of male sex.

## Skeletal Palaeopathology

Because bone preservation was poor, arthritic changes in the spine and other joints could not be observed. However, this individual did exhibit evidence of a serious injury to his right hip: the right femur has a well-healed fracture at the neck and inter-trochanteric region (Figs. 7.4, 7.5, 7.6). The degree of remodelling indicates that the injury occurred many years before death, but the fracture healed with displacement due to impaction and the leg would have been markedly shortened in length. Furthermore, the angle of the femoral neck was altered; it's likely that one or both knees were arthritic as a consequence of an abnormal gait, but the bones representing the knees, lower legs, and feet were not available for analysis. The misalignment would have been difficult to correct without surgical intervention.

Since this part of the bone is very well protected by the soft tissues of the thigh and buttocks it is not likely to have been caused by a blow. Indeed, a useful scenario that provides an explanation for this type of injury is that the leg was crushed between two unyielding masses, such as can be caused when a horse rears and then falls sideways on its rider: the weight of the animal puts a crushing weight on the medial aspect (inside) of the right thigh, while the leg itself is pinned between the fallen horse and the ground. Fractures of the femoral neck or inter-trochanteric region in clinical cases are most commonly due to osteoporosis, especially among post-menopausal women, and can be caused by minor biomechanical stress; however, the visible cross-section of the femoral shaft in this skeleton indicates good bone cortical health, arguing against osteoporosis as a cause of the hip fracture. Regrettably, the skeleton was not preserved in exact anatomical position, probably due to bone movement during the decomposition process, movement that was likely exacerbated by the collapse of tiles that had been positioned as a roof or lid for the grave. The corresponding innominate, for example, had flipped forward and was crushed postmortem and infiltrated with mud, so that the hip socket itself was unobservable and the related parts of the pelvic bone could not be assessed to see if they, too, showed evidence of healed fracture/s.

Other features of this skeleton suggest habitual activity stresses. The bones of the fingers show pronounced attachment areas for the flexor muscles of the hand (Fig. 7.7), muscles used in grasping. Although a particular behaviour can't be identified from the skeleton alone, these features have been linked to habitual grasping of a paddle in river canoeing among historic Canadian fur traders (Lai and Lovell 1992; Lovell and Dublenko 1999). It is therefore likely that this individual was engaged in some occupation that required habitual manual activity. While the lesions of the hip and finger bones are not necessarily related, it's possible that this individual was a cavalry man and habitually grasped reins and perhaps a sword, or spent his time on horseback herding animals, again grasping reins, but also using a crook or hooked stick (such as used historically by butteri in the Maremma) to drive the animals and to open and close gates.

## Dental Palaeopathology

This individual experienced AMTL of the posterior teeth of the mandible (Fig. 7.8) and the anterior teeth of the maxilla (Fig. 7.9). Overall, nine of 16 mandibular teeth were preserved; two teeth were lost postmortem, and five teeth, all posterior teeth, were lost antemortem. Three maxillary posterior teeth were preserved and were very severely worn; at least seven maxillary teeth were lost antemortem. Due to poor preservation, the fate of six maxillary teeth is uncertain. One tooth is represented by only a portion of the root and it cannot be determined conclusively whether it is a maxillary or mandibular tooth.

The mandibular anterior teeth show very light wear, no doubt because of early loss of corresponding maxillary teeth. When considered in the context of the severe wear of the posterior teeth, it would appear that the upper front teeth were lost several decades before the individual's death; at least some of them may have been lost due to carious destruction and abscessing of the teeth, but traumatic loss of the teeth is also a possibility.

The maxillary posterior teeth are severely worn, and are worn obliquely, so that the occlusal wear extends to the area of the root (Fig. 7.10). Wear occurred over a long period of time since secondary dentin was able to form and protect the pulp chamber from bacterial infiltration (Fig. 7.11), and the chewing stresses were sufficiently severe that the roots developed hypercementosis due to micro-movement of the tooth root within the socket (Fig. 7.12).

## Works Cited

Lai P, Lovell NC. 1992. Skeletal Markers of Occupational Stress in the Fur Trade: a case study from a Hudson's Bay Company fur trade post. *International Journal of Osteoarchaeology* 2:221-234.

Lovell NC, Dublenko AA. 1999. Further Aspects of Fur Trade Life Depicted in the skeleton. *International Journal of Osteoarchaeology* 9:248-256.

Figure 7.1. External surface of the cranial vault of T-1. The arrows indicate a fairly high degree of cranial suture closure, suggesting that the individual was older than 40 years of age at the time of death.

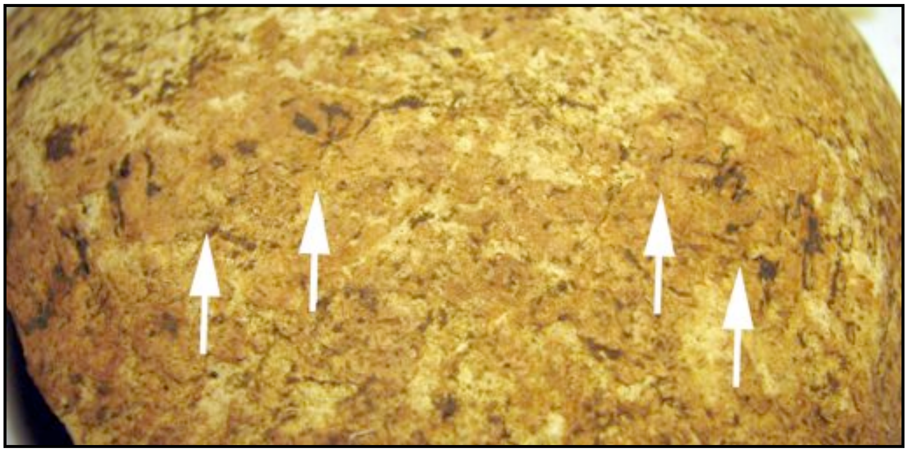

Figure 7.2. Internal surface of the cranial vault of T-1. Pacchionian, or Arachnoid, pits (arrows) and thickening in this bone (not illustrated) are found typically in older individuals; the pits are depressions in the bone caused by the development of fatty granules on the external covering of the brain.

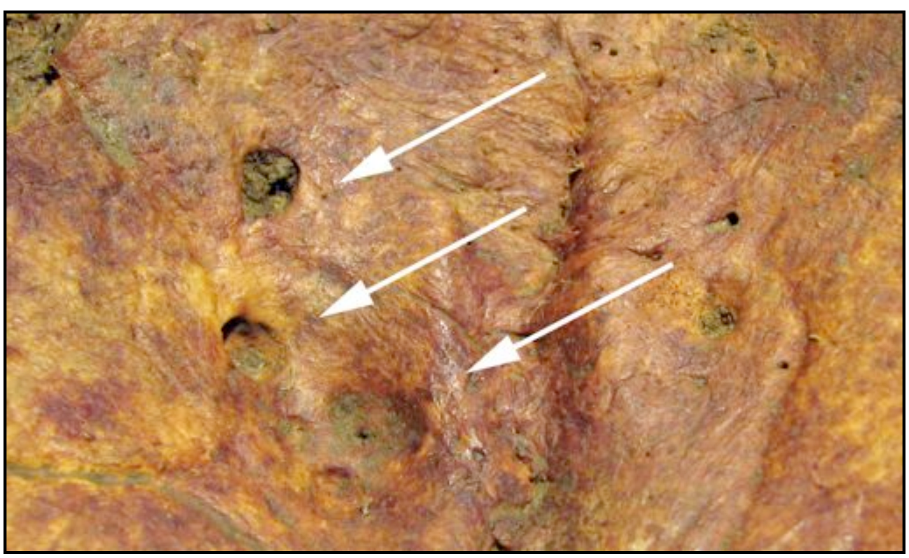

Figure 7.3. Although the cranium is badly damaged, the large brow ridge and mastoid process (arrows) are consistent with an attribution of male sex, an attribution confirmed by the robustness of the postcranial skeleton and features of the pelvis.

Figure 7.4. The fractured right femur *in situ*, before cleaning (arrow).

Figure 7.5. Impaction of the femoral neck at the inter-trochanteric region.

Figure 7.6. The pyramidal appearance of the cross-section (arrow) is consistent with the normal cross-section of the femoral neck just below the head of the femur, but does exhibit distortion and rotation due to trauma.

Figure 7.7. Arrows indicate enlarged attachment areas for flexor muscles on finger bones, indicating habitual grasping with the hand.

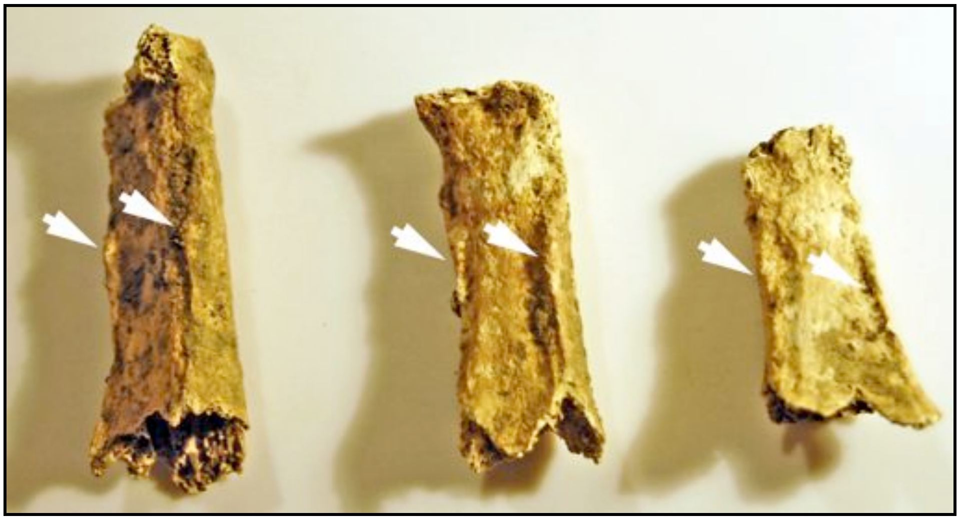

Figure 7.8. Antemortem loss of the posterior teeth on the mandible (arrows). Healing is not complete, but is well advanced and indicates that the tooth loss occurred at least a year before death. Note the very light wear of the right incisors, canine, and first premolar.

Figure 7.9. Antemortem loss of the anterior teeth on the maxilla. The white arrows point to the incisive foramen and medial palatine suture. Normally the central incisors would appear immediately in front of the incisive foramen, but these have been lost antemortem and the alveoli have remodelled completely. The red arrow indicates the portion of the maxillary bone from which teeth have been lost relatively recently; the bone has not completely healed. The yellow arrow shows greater healing in the area of lost posterior teeth.

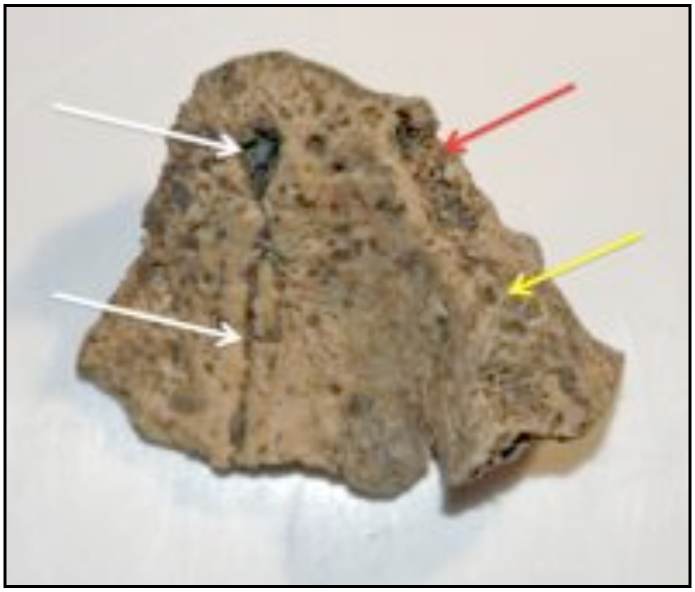

Figure 7.10. The wear on this upper molar was severe enough that most of the crown was worn away, causing the root to function in occlusion (arrow).

Figure 7.11. The darker, orange spots on the occlusal surface of this molar indicate the formation of secondary dentin, which means that tooth wear, while severe, occurred slowly enough that the tooth was able to repair itself to prevent exposure of the pulp chamber. The white rim of enamel is visible on part of the rim of the tooth, and the primary dentin, which has been exposed by wearing away of the occusal enamel, is yellow in colour. Postmortem cracking of the tooth and chipping of enamel is also evident.

Figure 7.12. Hypercementosis on a tooth root (yellow arrow), indicating that occlusal stresses were severe enough to cause the tooth to move in its socket, spurring the formation of extra cementum on the root. This tooth also exhibits an interproximal carious lesion (red arrow).

# APPENDIX A:
# PRESERVATION SUMMARIES

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## Sodo Circoli

**C-1: SGI Circolo I Tomba 2 bis (Museum display skeleton)**

- skeleton on display (see Fig. 1.10)
- Roman period - intrusive into the Orientalizing period remains in Circolo I (originally Tomba 2; this skeleton is 2 bis; the earlier tomb contained a cremation burial, probably datable to approx 580 BC)
- we were allowed to remove the skull for analysis
- cranium was lying on its left side; badly squashed (Fig. A.1a)
- mandible in place
- cranial vault bones are fragmentary
- mud is inside the cranial vault
- anterior teeth and maxilla are missing from the left canine through the right lateral incisor
- the rest of the skeletal material is in very bad shape (Fig. A.1b)
- note that the bones on display are anatomically misplaced in most cases
- teeth not measured because of risk of breakage
- Sex: female, based on size of teeth and very gracile nature of preserved postcranial elements (e.g., clavicle, ulna)
- Age at death: young adult, approx. 20-25 years, based on slight tooth wear and absence of arthritis and other degenerative changes in the skeleton

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## Sodo I

**SI-1: Sodo I Saggio A (Ampliato) US31 Tomba 1 (17/10/2003)**

- artifacts with the remains include a terracotta oil lamp (Fig. A.2) and some bits of iron
- small package includes some cranial vault fragments, cervical vertebrae fragments, fragments of 7 carpal bones, fragments of 5 metacarpal bones, and fragments of 4 phalanges (Fig. A.3)
- a lot of fragmentary mud that is wrapped in tin foil and unobservable
- 12 teeth (five maxillary and seven mandibular) (Fig. A.4)
- no arthritis in hand bones or vertebrae or other observable postcranial bones
- cranial sutures are open
- there may be parts of a second individual: the petrous portion of the right cranium is too large for most of the rest of the remains, and the long bones appear large (e.g., femur circumference, femoral head size) but sacrum has a broad (i.e., female) sciatic notch) -- these remains could be compared to SI-2 to see if the remains of more than one individual were commingled during excavation.
- growth of roots inside the medullary cavity of a long bone (Fig. A.5)
- Sex: female, based on size of vertebral bodies and size of teeth
- Age at death: given minimal tooth wear, approx 18-20 years

**SI-2: Sodo I T2 Saggio A Ampliato US32**

- plastic bags and foil-wrapped fragments (Fig. A.6) plus a large block wrapped in plastic and tape and labeled "Gambe" (Fig. A.7)
- after unwrapping, the badly damaged lower legs were found encased in a block of mud about 19 cm deep (Fig. A.7)
- fragmentary tibial and fibular shafts are exposed on top of the mud; no long bone ends are preserved so measurements are not possible
- both patellae are well preserved
- no data are obtainable except from the patellae
- no teeth
- Sex: undetermined (patellae and one partial calcaneus are neither very large nor very small)
- Age at death: adult

**SI-3: Cranio and Scapola SM Tomba 4 US34 Sodo I**

- wrapped package includes fragments of left scapula including glenoid fossa and part of spine, and acromial end of left clavicle
- no arthritis evident
- lots of cranial fragments including both petrous portions, occipital condyles, portions of both orbits, both zygomae, and teeth (Fig. A.8)
- almost all postcranial bones are preserved in relatively good condition. No time for thorough cleaning (e.g. vertebrae) but no evidence of trauma, arthritis, or infection
- Sex: Male, based on size of petrous, squared chin, angle of ascending ramus, etc.
- maxilla and mandible include most teeth, and long bone morphology
- Age at death: young adult, approx. 20-25 years

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**Sodo II**

**SII-1: Cortona Sodo II Tomba 2 15/10/2003**

- box contained "skull" encased in mud (Fig. A.9). We extracted the teeth first and then put the cranium in a bucket of water: the vault and facial bones were friable and splintery and disintegrated.
- the preserved pieces include some cranial bones, portion of mandible with two molars, portion of maxilla with 8 or 9 teeth and some isolated teeth (Fig. A.10).
- also in the box were two bags of pottery/terracotta fragments
- also large clumps of dried mud with whitish outlines of long bones. None of this "ghost" bone could be extracted manually, and since it as of little scientific value (i.e., no articular ends preserved; no intact shafts, etc.) we did not try to clean it (it likely would have disintegrated in water and the resulting bits would be non-diagnostic)
- Sex: probable female, based on tooth size
- Age at death: young adult, approx. 20-25 years of age, based on all three mandibular molars erupted and showing some wear.

**SII-2: Sodo Melone II Angolo Altare - lato sinistro (26/2/99)**

- cranial and postcranial bones in mud (Fig. A.11); preservation poor
- Sex: probable female; skull bones and mandibular condyle are gracile
- Age at death: 20-25 years, based on tooth wear.

**SII-3: CT92 Inumato Tomba D US512 (we referred to this as the "Iron Man")**

- cardboard box containing skull encased in really hard clay mud (Fig. A.12)
- extracted some teeth and jaw fragments
- large iron nail essentially point down into the individual's neck
- mandible was lying in what could have been proper anatomical position if it had dropped down during decomposition; cranium however was lying on right side
- possibility that nail comes from a wooden coffin and when the coffin disintegrated the head fell to the right and the nail fell into the temporary void
- no other remains
- transferred to plastic crate
- nail recovered, bent at tip (Fig. A.13); dimensions of the nail are: 8 cm long and 1 cm in diameter, with head 3 cm in diameter. Note, however, that rust "bloom" has enlarged the dimensions of the nail from its original size.
- Sex: Male
- Age at death: middle adult

**SII-4: CTS 92 Inumato Tomba G US523 (10/6/92)**

- tray contains several foil-wrapped blobs of mud encasing unidentifiable bone fragments (Fig. A.14)
- also several plastic bags with unidentifiable long bone shaft fragments, badly exfoliated
- couple of bags of small fragments
- couple of bags of dirt
- no biological data are obtainable

**SII-5: CTS92 US554 SGVI Tb M**

- cardboard box containing what is labeled as vertebral column and ribs, but which appear as one large mass of hardened clay mud that has broken into two pieces (Fig. A.15)
- some "ghost" bone in some places, and morphology of a rib and perhaps fragments of forearm bones discernable, but no recoverable elements.
- no biological data obtainable

**SII-6: CTS92 SgXVII US577 ("Ossa Vicino Tomba C")**

- cranium has been partially reconstructed but adhesive is separating from the bone (Fig. A.16.)
- in a box with animal mandible (right side of mandible, sheep/goat) (Fig. A.17) and large clods of mud encasing "ghost" bone (wrapped in foil)
- bone is badly warped; some insect damage.
- mandible not preserved
- 5 teeth *in situ*, most exhibit postmortem breakage of the tooth crown; 3 isolated teeth
- Sex: Male, based on size of petrous bones and teeth, pronounced inion and nuchal lines, extension of zygoma posteriorly, mastoid process, large foramen magnum, deep palate, etc.
- Age at death: young adult, roughly 21 years of age, based on unfused cranial sutures and minimal tooth wear

**SII-7: CTS 96 SG XVI TbII vario I US483 (on box) US843 (on tag) Repn 648**

- cranial fragments and globs of mud on the bottom of the plastic crate (Fig. A.18)
- remains of at least two individuals
- contents included a couple of long bone fragments (shaft and part of distal articular end: this was extremely large and indicates male)
- one unidentified non-human long bone
- cranial fragments include portions of left frontal and right frontal but these are not from the same individual. It is clear that some of the fragments are from a male, however, based on the size of glabella and other bony features.
- portion of the left maxilla is preserved with P1 in situ
- isolated right molar, probably 2nd due to root shape; moderate sized pit-fissure carious lesion, but no wear
- Sex: Male
- Age at death: young adult based on tooth wear, but cranial fragments could indicate middle adult. Thus the remains could represent one young adult and one middle-aged adult; at least one of which is male.

**SII-8: CTS 92 US 519 Tomba L**

- one bag with femur pieces largely encased in mud
- consolidant visible on fragments of the femoral shafts
- mud cannot be removed with plastic tools and brushes
- long bone pieces are encased in mud and are unidentifiable (labeled femora)
- plus one bag of dirt
- no data obtainable

**SII-9: US 85/B Tomba E SgVII**

- one bag of foil-wrapped unidentifiable blobs of mud, presumably encasing bone
- no bone identifiable
- tag reads "11/6/92 Area: Gradinete" (Eng: Terraces?)
- no data obtainable

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**Terontola**

**T-1: Terontola Caserma Carabineri Tomba 2 US5**

- Although this was the most complete skeleton we examined, it is missing the lower limbs and the skeletal elements preserved are highly fragmentary and encased in hardened mud (Fig A.19, and see Fig. 1.14).
- Sex: male, based on very robust skeleton and deep sciatic notch; femur is especially large in diameter.
- Age at death: older adult, based on arthritis and extreme tooth wear

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**Non-human remains:**

**Cortona 2003 Sodo II Ustrinum 2 Area N-E (5/11/2003)**

- terracotta brick and fragments
- scapola - nonhuman
- other bone fragments - nonhuman
- jaw and teeth are probably pig

Figure A.1a and b. Burial C-1. Note the highly fragmentary nature of the remains. The skull, on the left, shows good preservation of the teeth, but dried mud is clearly visible inside the cranial vault. The photo on the right shows fragments of the arm and hip.

Figure A.2. Oil lamp found with Burial SI-1.

Figure A.3. Burial SI-1. Left: the remains as received; middle: the remains unwrapped; right: the remains after being washed. The remains are very fragmentary and incomplete.


Figure A.4. Burial SI-1. Preserved teeth. The teeth exhibit very slight wear due to attrition or abrasion, consistent with a young adult aged approximately 18-20 years.

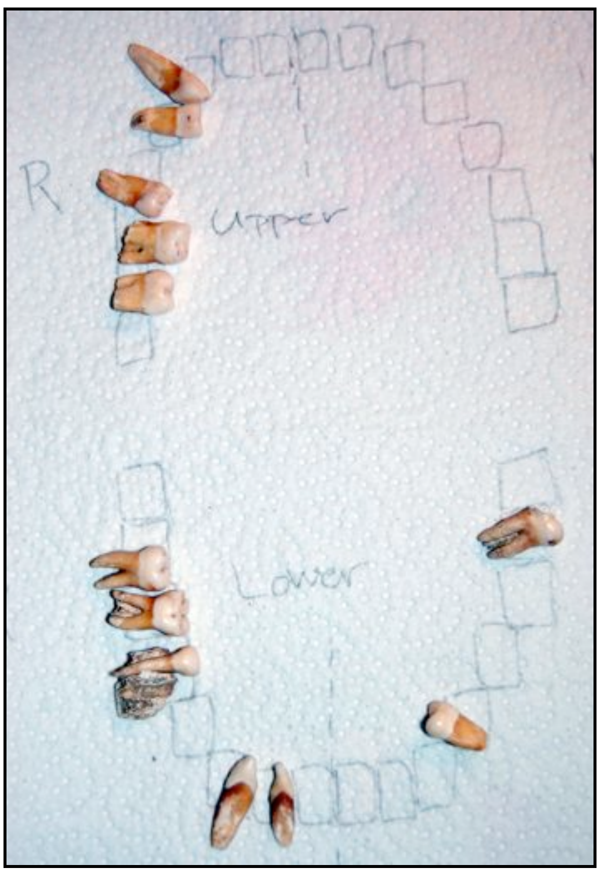

Figure A.5. Roots growing inside a bone (Burial SI-1).

Figure A.6. Burial SI-2, plastic bags and foil-wrapped fragments, as received (top) and after unwrapping (bottom).


Figure A.7. Burial SI-2, "gambe", as received (top) and after unwrapping (bottom).

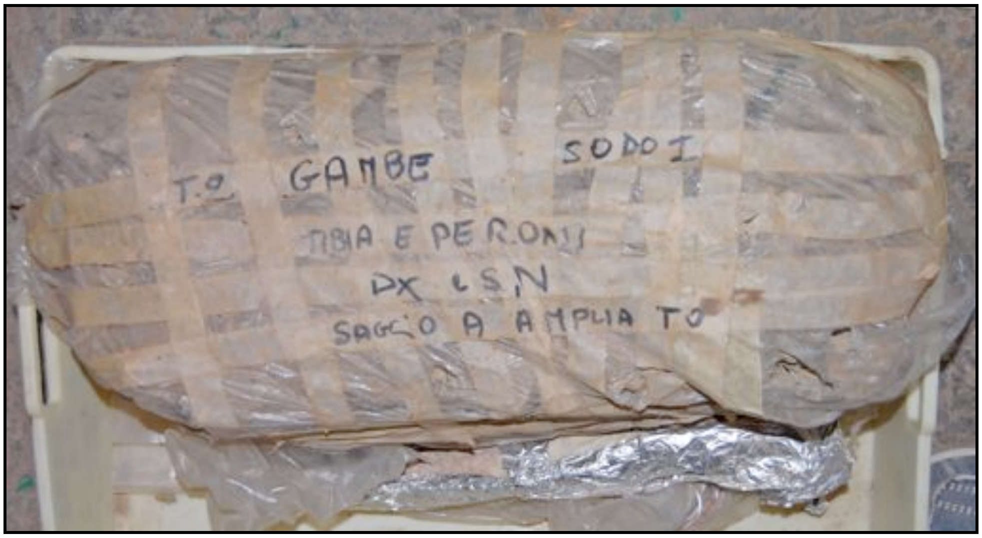


Figure A.8. Burial SI-3. Cranial fragments as received (top); dental remains after cleaning (bottom).

Figure A.9. Burial SII-1. Remains as received.

Figure A.10. Burial SII-1 dental remains. Mandibular teeth after cleaning (top); maxillary teeth during cleaning (bottom).

Figure A.11. Burial SII-2 cranial remains as received (top) and after cleaning (middle); femora as received (bottom).

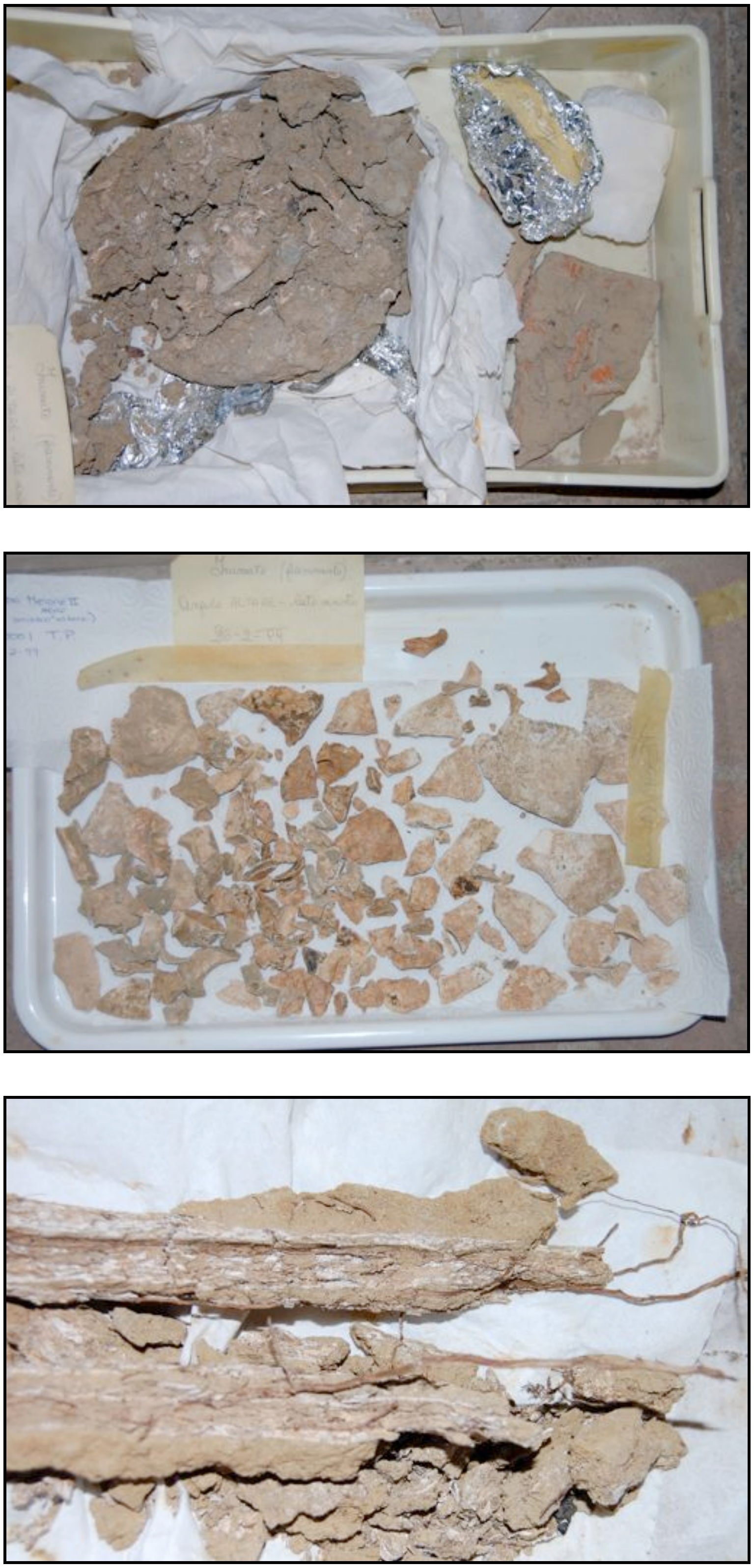

Figure A.12. Burial SII-3. Remains presented as skull in a large block of hardened mud, with an iron nail (arrow) positioned between the cranium and mandible.

Figure A.13. Burial SII-3. The iron nail removed from the matrix.

Figure A.14.  Burial SII-4.


Figure A.15. Burial SII-5, as received.

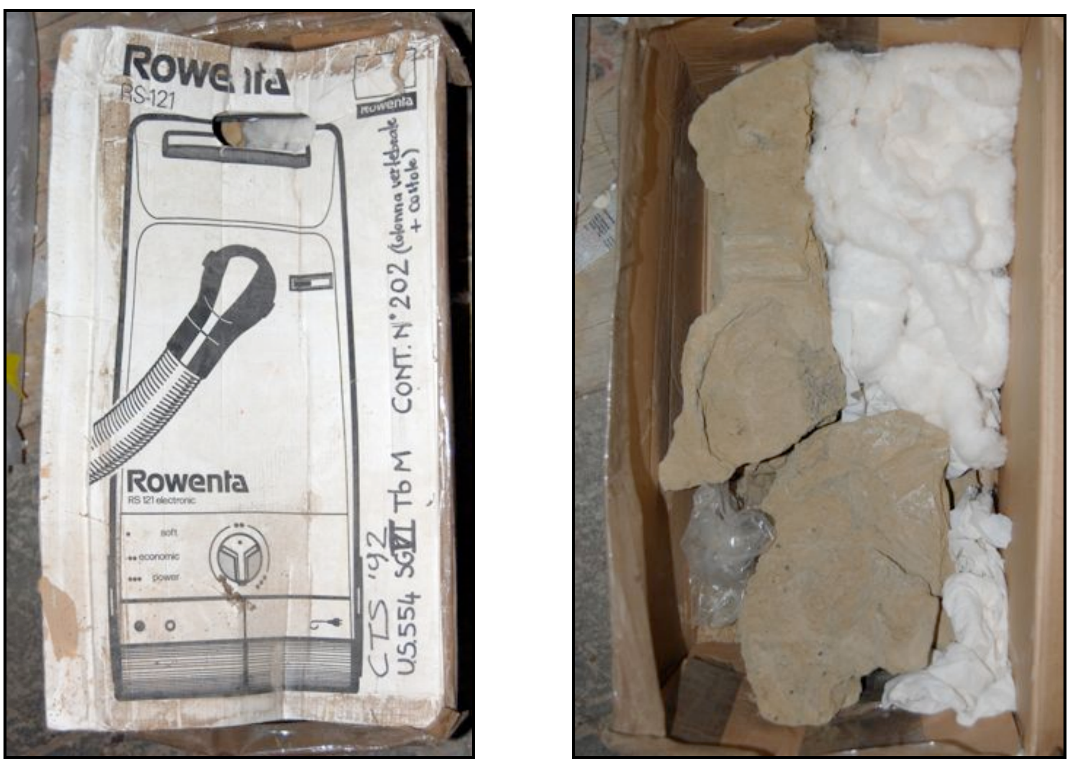

Figure A.16. Burial SII-6. Mended portion of the cranial vault (top). The adhesive used in the reconstruction is separating from the bone (bottom).

Figure A.17. Burial SII-6. The human upper jaw was accompanied by the lower jaw of an animal (arrow), probably sheep or goat. The lower jaw of the human individual was not found with the rest of the remains.

Figure A.18. Burial SII-7. Commingled remains of at least two individuals, as received (left), and after washing (right)

Figure A.19. Dried mud covers the broken end of the left femur from the Terontola skeleton, indicating that the bone was broken before or during the excavation process. Mud also has filled the medullary cavity of the bone, indicating that decomposition was complete before mud infiltrated the grave.

# APPENDIX B

## SUMMARIES OF BURIAL INFORMATION

| Burial Number | Age | Sex | Grave Information |
|---|---|---|---|
| C-1 | Young adult | Female | Circolo I Tomba 2bis |
| SI-1 | Young adult | Female | US 31 Sodo I Tomba 1 (10/17/2003) Saggio A Ampliato (expanded) ⑮ dromos/doorway of Sodo I |
| SI-2 | Adult | Unknown | US 32 Sodo I Tomba 2 Sodo I Saggio A Ampliato |
| SI-3 | Young adult | Male | US 34 Sodo I Tomba 4 (10/28/2003) dromos/doorway of Sodo I |
| SII-1 | Young adult | Male | Sodo II Tomba 2 (10/15/2003) dromos of tomba 2 |
| SII-2 | Young adult | Female | Sodo II Angolo Altare (lato sinistro) (2/26/1999) Somehow associated w/ the "angled altar" which Helena says is the one labeled Tomba I (lato sinistro = "left side"). Possibly Tomba I? If not, doesn't seem to be indicated on museum map. |
| SII-3 | Middle adult | Male | US 512 Tomba D (CTS 92) From terrace altar area |
| SII-4 | Unkown | Unknown | US 523 Tomba G From terrace altar area |
| SII-5 | Unknown | Unknown | US 554 Sg VI Tomba M From terrace altar area |
| SII-6 | Young adult | Male | US 577 Sg XVII (CTS 92)<br>In a box with bones labeled "vicino Tomba C"<br>Location unclear. Definitely from area of Sodo II. Helena suspects it was in the upper layers before they actually got down to the melon tomb. Lack of designation "tomba" probably indicates there was no actual tomb, but rather bones found in the stratigraphic units indicated. Because of Sodo mound, layers are not normal horizontal layers. Could be associated w/ little shrine on top of mound (i.e. not chronologically different).<br>Sg = Saggio which translates to "sample" or "test" |
| SII-7a<br>SII-7b | Unknown<br>Middle Adult | Unknown<br>Male | Card: CTS 96/XVI Tomba II/ vano I/quofe (?) -510/US 843 (7/11/1996)<br>Crate: CTS 96/Sg XVI/Tomba II/ vano I/ Repn. 648/④◎⊖ /US 483<br>**Card and crate were different. Not sure if 2 got mixed or if one of them is wrong.**<br>Vano translates to doorway or room. Also from the dromos of Tomba II? Or somehow associated with the actual room? Commingled remains: MNI=2. Data collected on SII-7b, a middle adult male |
| SII-8 | U | | CTS 92 US 519 Tomba L From terrace altar area |
| SII-9 | U | | US 85/B Tomba E Sg VII From terrace altar area |
| T-1 | Older adult | Male | Terontola (AR) CASERMA CARABINIERI Tomba 2 US 5 (2003) |
| n/a | Nonhuman | | Cortona 2003 Sodo II Ustrinum 2 Area NE (5/11/2003) |

Figure B.1. Location of examined burials on an overall map of the area of the Sodo Tumuli and Circoli (adapted from a display plaque at the MAEC). The location of Burial SII-2 is unknown and not indicated on this map.

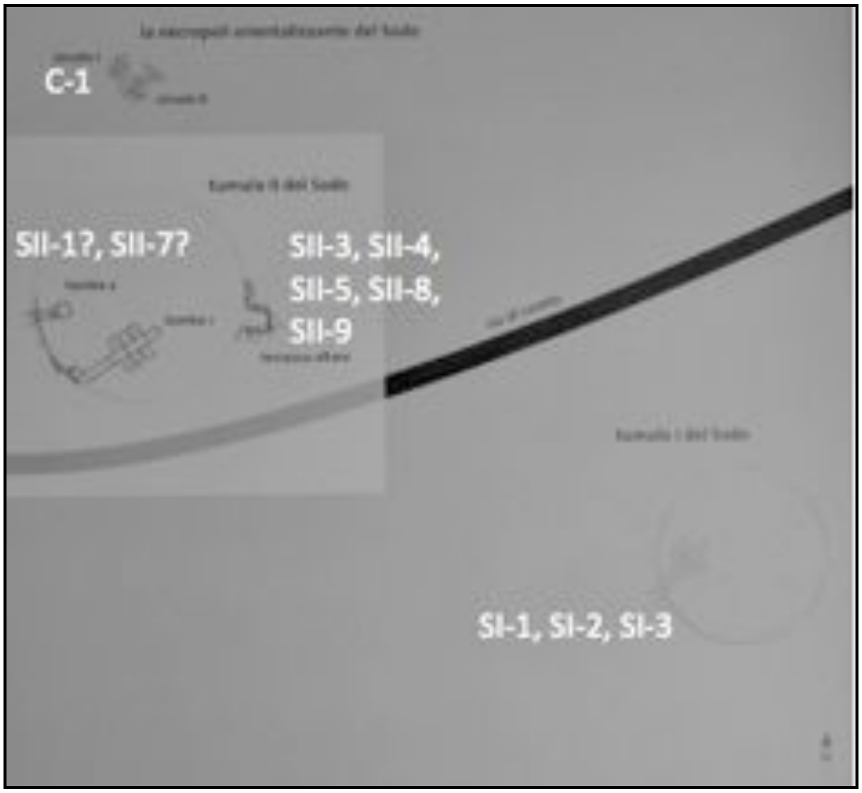


Figure B.2. Plan of Sodo Tumulus I showing the location of three burials in the dromos (adapted from Vallone 1995, Fig. 18).

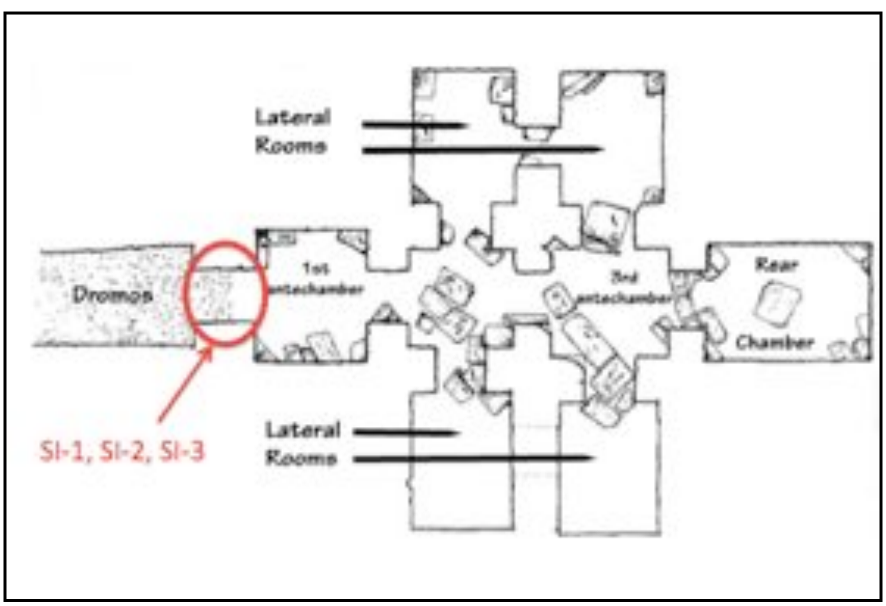

Figure B.3. Plan of Circolo I showing the location of the burial that we examined (adapted from a display plaque at the MAEC).

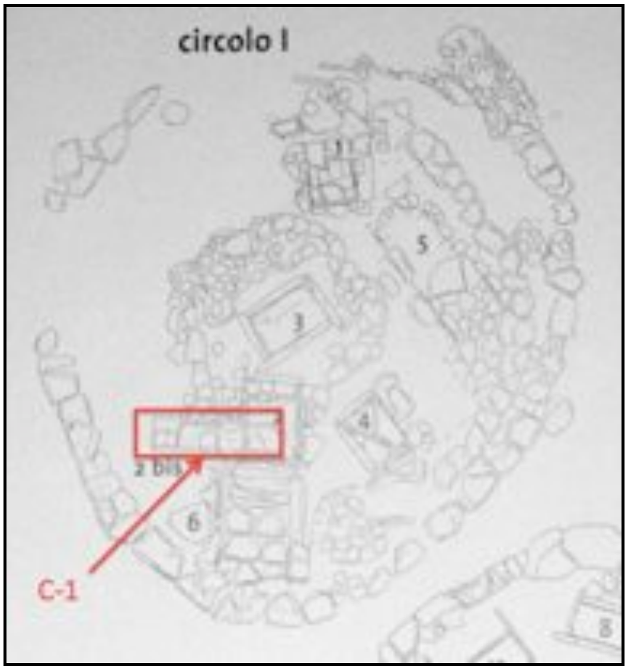


Figure B.4. Plan of Sodo Tumlus II showing the estimated locations of burials SII-1 and SII-7 in the dromos of Tomba 2 (adapted from a display plaque at the MAEC).

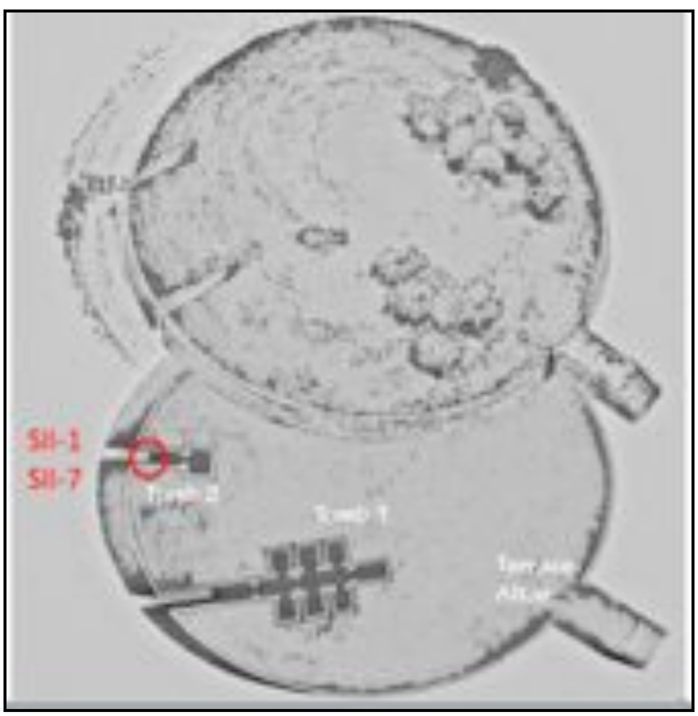

Figure B.5. Plan of the tombs of the terrace altar at Sodo Tumulus II showing the locations of burials SII-3, SII-4, SII-5, SII-6?, SII-8, and SII-9 (adapted from a display plaque at the MAEC). The location of burial SII-2 could not be determined from the available records.