Primary and Secondary Burials with Commingled Remains from Archaeological Contexts in Cyprus, Greece, and Turkey

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Introduction

Commingling or mixing of human skeletal remains can take place at any stage from burial to excavation to storage of human skeletal remains and even beyond.[1] What will be presented herein are four examples of commingling or speculative commingling from sites in the Eastern Mediterranean ranging in date from the Hellenistic to the Late Byzantine periods (Fig. 1). The first site addressed, Late Roman/Early Christian Kalavasos-*Kopetra*, Cyprus, presents human remains initially interpreted as commingled following secondary burial practice. The second case discusses skeletal remains commingled from secondary burial rites at the Hellenistic and Roman sites of Paphos, Cyprus, and Corinth, Greece. The third example contains the commingled remnants of primary burials from two Late Byzantine graves at Thebes in Greece. The final study presents skeletal remains that were commingled during the excavation and exhumation of a Roman period mass grave primary burial at the site of Oymaağaç Höyük (ancient Nerik) in Turkey. Lastly, a developing methodology is proposed to maximize what can be gained from the study of commingled human skeletal remains.

This chapter ultimately focuses on a methodology conceived in Fox's dissertation research on commingled remains, *A comparative study of health based upon*

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Fig. 1 Map of Eastern Mediterranean and Black Sea with study locations highlighted: (**a**) Thebes; (**b**) Corinth; (**c**) Paphos; (**d**) Kalavasos-*Kopetra*; and (**e**) Oymaağaç Höyük

the human skeletal material from Hellenistic and Roman tombs from Paphos, Cyprus and Corinth, Greece (Fox, 2005; Fox Leonard, 1997), and greatly expanded by Marklein's efforts with recent work by the authors at Oymaağaç Höyük, Turkey.

The Commingled State of Eastern Mediterranean Bioarchaeology

Although populations are the preferred units of study in bioarchaeology, individuals characterize and define these populations. Aside from human actions, diagenesis can transform articulated individual burials into elemental components. Articulated whole skeletons can be analyzed by bioarchaeologists using relatively straightforward and time-tested methods. The state and context of these remains enable a complete, systematic analysis of the individual. In contrast, commingled remains may require considerably more time to study and yield more limited results than discrete burials from primary inhumation burials.

The unit of study among commingled human remains is not the individual per se but the skeletal element. This inevitability, however, should not preclude bioarchaeologists from devoting equivalent attention and time to commingled remains as to discrete individuals: much information can be gained from the study of commingled remains, such as demographic parameters of sex, age, and (reconstructed) statures, as well as skeletal indicators of disease and trauma. The following case studies first emphasize past and present anthropogenic factors affecting depositional and post-depositional commingling and secondly advocate paleoepidemiological studies of skeletal remains.

Because secondary burial and concomitant commingling are the norm rather than the exception in Cyprus and Greece, one would expect a wealth of information for commingling practices. The earliest case of commingling on Cyprus comes from a well dating to the Pre-pottery Neolithic B site of Kissonerga-Mylouthkia. Secondary burial and subsequent commingling also extend to the Chalcolithic period in the Paphos District of Cyprus from the site of Prastio-AgiosSavvas tis Karonis Monastery (Fox, 2005). Ubelaker and Rife (2008) present an excellent case for the preservation and study of commingled remains, notably cremated remains, at the Roman period cemetery of Kenchreai in Corinth. Unfortunately, their discussion mentions neither contemporaneous sites with commingling nor modern burial practices associated with commingled remains in the Corinthia of Greece. Overall, in Eastern Mediterranean bioarchaeology there appears to be an overarching lack of methodology, study, and publication on commingled remains.

Historical Contextualization of Commingled Burials

Modern and ancient history indicate that commingling is a conventional practice within the Eastern Mediterranean landscape, currently evidenced in the secondary burial practices within Greece and Cyprus that continue today as part of Greek Orthodox tradition (Danforth, 1982). Instances of commingled remains pervade the archaeological mortuary record geographically and diachronically from Iron Age Crete (Liston, 1993) to modern-day Arcadia (Danforth, 1982). Multiple interment tombs generally denote family affiliations, although small communities in Cyprus reportedly maintained village tombs into the modern era (A. Moustoukki, personal communication). Recent dental morphological and morphometric analyses of individuals within the Neolithic house burials at Çatalhöyük, for example, challenge speculations of a biologically associated kin group burial tradition (Pilloud & Larsen, 2011). In Roman times, burial clubs were known, somewhat akin to our modern military cemeteries (Fox Leonard, 1997). The Greek Orthodoxy tradition believes that the soul is released from the body when deposition leaves bones devoid of flesh. The remnant skeletal elements no longer represent the individual but represent the collective bones of ancestors (Danforth, 1982).

In present-day rural Greece, tombs are rented 4–7 years, allowing for decomposition to take place before the interment of another family member (Danforth, 1982). However, in actual practice (e.g., population-dense Athens), the demand for tombs is great, and the inter-burial interval may be only 3 years, with decomposition often incomplete upon exhumation (Liston 2012, personal communication). Subsequently, the body is redeposited into another grave outside the tomb later to be exhumed. Following decomposition, a secondary burial rite takes place prior to primary interment of the newly deceased. The bones of the previous individual are collected and repositioned to one side of the tomb or removed to an ossuary (Danforth, 1982).

Human skeletal remains oftentimes become commingled over time and with consistent tomb reuse. Such commingling has been documented up to 300 years, as is the case of Tomb 1 the site of Toumba tou Skourou (Vermeule, 1974).

Current debates in mortuary archaeology consider whether secondary burial practices follow similarly prescribed patterns over time. In the Neolithic burials at Ayios Charalambos, Crete, the depositional and postdecompositional recovery tradition presupposes the modern Greek ritual (Cholouveraki et al., 2008): long bones are "stacked" with crania positioned atop the long bones. This practice supposedly spanned time and sea, as evidenced in Chalcolithic burials at Souskiou-*Laona*, Cyprus (Crewe, Lorentz, Peltenburg, & Spanou, 2005). In early excavations around the Eastern Mediterranean, archaeologists initially espoused the hypothesis that secondary burial conveyed no intentionality and bones were simply haphazardly deposited within their final burial contexts. Archaeology in its present state employs an interdisciplinary approach, wherein bioarchaeologists play a crucial role in either the confirmation or denial of intentional secondary burial practices.

Kalavasos-Kopetra*, Cyprus*

The first presented example of commingling comes from the Early Christian (fifth to mid-seventh century) site of Kalavasos-Kopetra, a monastic complex comprising three basilicas, which was excavated by Murray McClellan formerly of Emory University and Marcus Rautman of the University of Missouri from 1988 to 1991 (Rautman, 2003). A preliminary study of the human remains from the site has been published since (Fox, 2005), and Kalavasos-*Kopetra* is included in a study of both Early Christian burial customs and comparative trauma (Fox, Moutafi, Prevedorou, & Pilides, 2012, 2014, respectively). Tomb 1 from *Sirmata* (Area One at Kalavasos-*Kopetra*) is one of two tombs within the basilica crypt. This tomb is oriented in a north–south direction and was excavated architecturally in 1988. The gypsum slab-built tomb was divided into quadrants upon excavation.

Preliminary analysis categorized the grave as an ossuary. As the bones were removed, they were placed in labeled boxes designated by their position in the tomb: northeast, northwest, southeast, and southwest. Study of the remains commenced the following year. Upon material inventory, it was observed that only upper body bones were represented within the northern two quadrants and only lower body bones from the southern two quadrants (Fox, 2005). A photograph of the tomb taken during excavation showed discrete, articulated remains, thereby disaffirming any previous observations that classified the grave as an ossuary.

Rather than an ossuary, the burial contained primary inhumations: four adult males extended in north–south orientation with their heads to the north. Postdepositional movement of skeletal elements undoubtedly took place from seasonal rainwater infiltration into the tomb. Spatial analysis, as elaborated by Tuller, Hofmeister, and Daley (2008), helped with the reinterpretation of this burial place. Had the tomb not been subdivided prior to excavation and removal of the human bones, this tomb would continually have been interpreted as an ossuary. Since the individuals were not exhumed intact, the remains, in essence, had become as commingled ex situ as would befit an in situ ossuary. Taphonomic conditions and

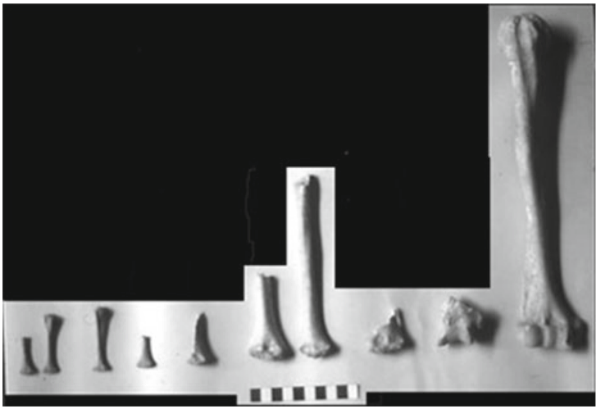

Fig. 2 Fragmentary and complete humeri from two perinatal individuals (*left*) compared with subadult and adult humeral remains

multiple reuse of the tomb may have contributed to the confusion. Unfortunately, the absence of a bioarchaeologist in the field at the time of excavation and removal has forever limited analyses of these human remains.

Alkaline soil conditions compounded by the alternating hot dry summers and cold wet winters contributed to the relatively poor state of human bone preservation at the site. Angel (1945)reported this situation for Attica in Greece, which has since been suggested elsewhere for Cyprus (cf. Harper & Fox, 2008). Certain microenvironments provide a more stable environment and ultimately better bone preservation. Such was the case within the cistern at the Sirmata locality of Kalavasos-Kopetra where originally the excavator characterized the bones as nonhuman, specifically ovicaprid. Fox (2005) was able to observe articulated human remains in situ prior to the completion of its excavation.

Although there were faunal remains recovered from this feature, the cistern was not determined to be a repository for secondary burial of human remains. Instead these remains represented a minimum of nine haphazardly deposited individuals of various ages at death who had likely been thrown into the cistern. Burial in a cistern does not constitute a normal practice for this period. Not only does this practice foul and contaminate the water supply for the monastery, but it suggests that some local catastrophe may have taken place.

However, the catastrophic circumstances leading to this mass burial deposition still remain unknown. Many of the individuals still can be partially segregated by age-at-death, for example, the two individuals of late gestational age depicted in Fig. 2. Further analysis of this material in a laboratory setting is necessary to elucidate what transpired, though plague and Arab incursions of the mid-seventh century present possible explanations for this unusual deposit. Currently known of this site is the change in settlement pattern occurring after the mid-seventh century CE, concurrent with people moving settlements from coastal Late Roman/Early Christian villages inland, with a few exceptions.

Nea Paphos, Cyprus, and Ancient Corinth, Greece

Two large cemeteries in Nea Paphos, Cyprus, date to the Hellenistic and Roman periods. The northern cemetery, known as "The Tombs of the Kings," is an elaborately constructed cemetery, with architecture strongly paralleling cemeteries from ancient Alexandria, Egypt. Although the human remains from this cemetery were not saved, it is speculated that "The Tombs of the Kings" was reserved for the social elites from the city. In contrast, the Eastern Necropolis of Nea Paphos, the largest ancient cemetery known on the island, contains hundreds of tombs which housed the dead from the nonelites. Demetrios Michaelides, former Paphos District Archaeological Officer, was able to establish a moratorium on construction for a year while this cemetery was excavated (Michaelides & Mlynarczyk, 1988). At this time, tourist hotels were being constructed over this cemetery. One of the larger tombs contained a minimum number of 82 individuals from a single tomb.

Study of the human skeletal remains from 31 rock-cut chamber tombs from the Eastern Necropolis led to a methodology for rather poorly preserved, commingled material. Pathological lesions among the minimal 275 individuals from the Eastern Necropolis were ascertained on an elemental, bone-by-bone basis. Data collection forms were developed for the long bones and crania.

The"surgeon's tomb" at Nea Paphos, one of the best-preserved Roman period tombs (Michaelides & Mlynarczyk, 1988), contained minimally 44 individuals. Although the "surgeon" may have been among one of the earliest to have been interred in the tomb, Michaelides reported that a number of individuals were interred during the mid-second century CE, and these remains had become commingled. For this reason, the identity of the speculative surgeon may never be known from the human remains.

The surgeon's tomb provides a microcosmic representation of the entire cemetery. Health profiles constructed from the commingled bones and fragments align with the discrete burials among the Nea Paphos cemeteries. Among these comparisons are the types and prevalence of pathological lesions, which display similarly between the tomb and site as a whole. For example, porotic hyperostosis has been found among individuals from the tomb and cemeteries at Paphos (Fox, 2005), but not among contemporaneous commingled remains from ancient mainland Greece, at Ancient Corinth.

Whatever the cause of the porotic hyperostosis at Paphos, differential diagnosis did not rule out vitamin B12 deficiency, folic acid deficiency, the congenital hemolytic anemias such as beta-thalassemia, or an acquired anemia, or even malaria, as contributing factors in their production (cf. Walker, Bathurst, Richman, Gjerdrum, & Andrushko, 2009). Additionally, a statistical correlation was found between two nonmetric traits, septal apertures of the humerus and tibial squatting facets, at Paphos, which were not found at ancient Corinth (Fox forthcoming). Fox speculates that women at Paphos were engaged in habitual or occupationally related postures that required constant squatting. Among many occupationally related activities, ethnoarchaeological information suggests weaving on ground looms as a potential explanation for these skeletal changes. These examples demonstrate the insight that can nevertheless be gained into the past ways of life from relatively poorly preserved, commingled remains.

Ancient Thebes, Greece

The third example provided is from two graves dating to the Late Byzantine period from the site of ancient Thebes in Greece. The site is currently under excavation by a joint project sponsored by Kevin Daly and Stephanie Larsen of Bucknell University and the Ministry of Culture of Greece.[2] There was evidence that at least one grave had been disturbed prior to excavation during the 2011 field season. Not a single intact long bone was recovered nor a single complete cranium from either tomb. The bones found within the tombs were commingled and comprised primarily of bones of the hands and feet. Preliminary field analysis of one tomb indicated minimally six individuals of various ages at death, based upon duplication of the calcaneus. These bones represent the remnants from primary burials after ritualized exhumation, removal, and transference of elements to an ossuary (cf. Ubelaker & Rife, 2008). During this secondary burial practice, the long bones and crania and larger bones were likely removed and the small bones left behind. Analysis of this material is ongoing in the Wiener Laboratory of the American School of Classical Studies at Athens.

Oymaağaç Höyük, Turkey

The final example of commingling involves a Roman mass grave (7384:009) from the Hittite site of Oymaağaç Höyük, Turkey. The site of Oymaağaç is located approximately 48 km south of the Black Sea and 75 km southwest of Samsun, within the western half of the Pontus expanse (Fig. 3). Under the aegis of the Turkish Ministry of Culture, initial surveys of the Samsun/Vezirkopru Province commenced on September 11, 2005. The project has been codirected by Jörg Klinger and Rainer Czichon of the Freie Universität in Berlin since 2007 and employs a cohesive, multidisciplinary methodological approach to excavation, analysis, and documentation. Oymaağaç, and specifically the nearby Höyük, has been proposed as the location of the ancient city of Nerik, the focal cult center for regional Hittite kings since the Middle Bronze Age (2000–1600 BCE). Archaeological investigations aim to illuminate the history of this putative city from its floruit in the Bronze Age to its gradual decline during the Roman period, when the regional focus shifted to the nearby city of Neapolis (Vezirkopru).

During the 2010 and 2011 field seasons, a reevaluation of the excavated humans remains from Quadrant 7384-Locus 009 was undertaken by Fox and Marklein. The skeletal material under consideration in this section was recovered during the 2008 season from a quadrangular (2.10 m length by 80 cm—southwest width and 90 cm—northeast width) stone-built, wall-plastered cist grave dated upon excavation to the Roman–Hellenistic period. Photographic documentation of the grave revealed a mass burial of primary inhumations wherein individuals were laid

[2]The 2011 field season was codirected by Vasilis Aravantinos, who is now codirecting the project.

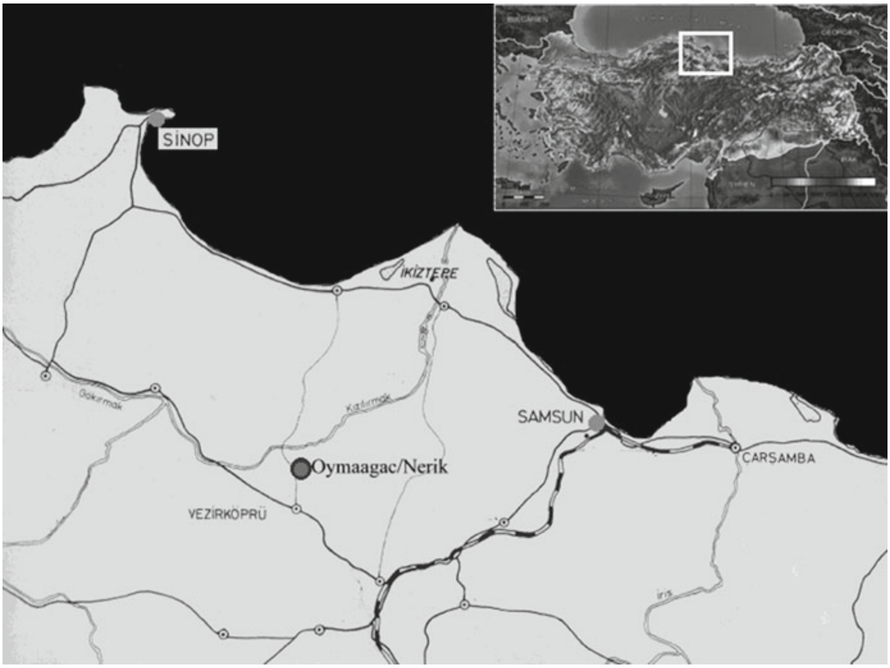

Fig. 3 Oymaağaç Höyük, Turkey

between two and four persons abreast in a consistently north-southwest orientation (Fig. 4). Exposure and recovery, furthermore, yielded a general scarcity of interred grave objects: an earring and ceramic plug (Czichon, 2007). The excavators initially assumed that over 40 individuals were represented within the mass grave, but the minimum number of individuals from the new database, based upon duplication of right calcanei (adults) and left humeri (subadults), count only 21. Individuals of all ages and both sexes were represented within the mass grave, including 14 adults and 7 subadults. Additionally, it appears that children were placed first within the mass grave, as they were removed last from the grave.

Pre- and Post-recovery Skeletal Assemblage

Despite the discrete postdepositional nature of these skeletons in situ, the bones were exhumed systematically according to anatomical region (e.g., leg, forearm), resulting in de-individualization of the remains and de-contexualization of the burial. Without the microscopic and biomolecular facilities to determine associative bone relations, Fox and Marklein endeavored “re-individualization” of remains by means of macroscopic and morphometric observations. Employing original field

Fig. 4 Roman period mass grave 7384.009 prior to exhumation of skeletal material (photo by H. Marquardt, with permission from Oymaağaç-Nerik Projekt)

reports and photographic records to identify complete skeletons, a referential minimum number of individuals were established: 12 adults. However, a preliminary assessment of the 30 bags of skeletal material indicated single-sided elemental counts beyond the expected 12 individuals. Additionally, unfused epiphyses and deciduous dentition signaled the presence of subadults within the grave which had been previously undocumented. After a consensus was reached that the discrete individuals could not be fully reconstructed, efforts were redirected toward the specific bones and diagnostic bone fragments and the subsequent information that could be gleaned from their exhaustive study.

Constructing a Commingled Methodology

When the analytical focus on individual persons was replaced by extensive and intensive evaluation of diagnostic skeletal elements, the research implications for population studies were soon realized. A contextualized and well-preserved skeletal assemblage remains the desired standard for bioarchaeological inquiry. However, direct and indirect effects of natural diagenesis and human interaction inevitably yield skeletal samples that are not wholly representative of the original interments or the entire population (Chamberlain, 2006; Waldron, 2007). By emphasizing discrete bones, this study does not equate the information obtained from one long bone with the related composite of bones from a single individual skeleton. The latter composite is always preferred as it definitively illustrates the integrative, systemic processes in action within the body.

Current standards for human skeletal remains (Bass, 1987; Buikstra & Ubelaker, 1994) concentrate on complete, or relatively complete, skeletons. The most efficacious methodology when approaching commingled remains has generally entailed the classification of elements according to side, sex, age, preservation, and MNI. Recent works in paleodemographic statistics, utilizing practices from zooarchaeological methodologies such as the Lincoln Index (Adams & Konigsberg, 2004; Winder, 1992), have sought to minimize the confounding factors that distort population profile reconstructions. While these fundamental data provide biological anthropologists with a precise paleodemographic profile of the sample (age and sex distributive patterns), demographic studies are oftentimes terminal, precluding further paleopathological and paleoepidemiological investigations (Adams & Byrd, 2008, p. v).

However, the disassociation of bones from complete skeletons should not prevent comparative studies of elements. The accuracy of population health and physiological profiles increases when equal representation of disassociated and articulated elements occurs in statistical analyses (Waldron, 2007). All of the nearly 3,000 commingled elements from Grave 7384:009 were thusly inventoried, analyzed, and labeled.

Each diagnosable bone or fragment received a unique collection number according to its specific quadrant, locus, and find number. For example, the left capitate of an adult of indeterminate sex was the 2974th bone analyzed from the grave (7384:009). As the capitate was also recorded within the find context 9, the full collection sequence for this element is 7384:009:009:2974. Similarly, the right tibial diaphysis of a juvenile, the 1739th bone from the 7384:009 grave, associated with find context 24 is recorded as 7384:009:024:1739. In total, 2986 elements were identified within the Roman grave in question and assigned collection number sequences in accordance with their burial context. These labels allow individual bones to be compared within and between quadrants, loci, finds, and elements. The first three context numbers facilitate spatial intra-grave (find and locus) and inter-grave (quadrant) distributive analyses. Additionally, these context numbers impart exact and relative chronologies upon associative skeletal remains, enabling diachronic and synchronic studies of the elemental collection.

The elemental number may exist independently from a discrete skeleton or interdependently within an individual skeleton, for example, a right lunate (7384:009:018:1602) exists outside of an individual skeleton while a right lunate (7384:009:018:1601) and scaphoid (7384:009:018:1599) articulate as components of one adult individual's hand. By allowing this dual applicability, interpreting skeletal elements apart from an individual skeleton or as part of an individual skeleton, this database is not exclusive to commingled material. In fact, since this methodology originates at the base level of the bone, this approach facilitates research between discrete and commingled burials.

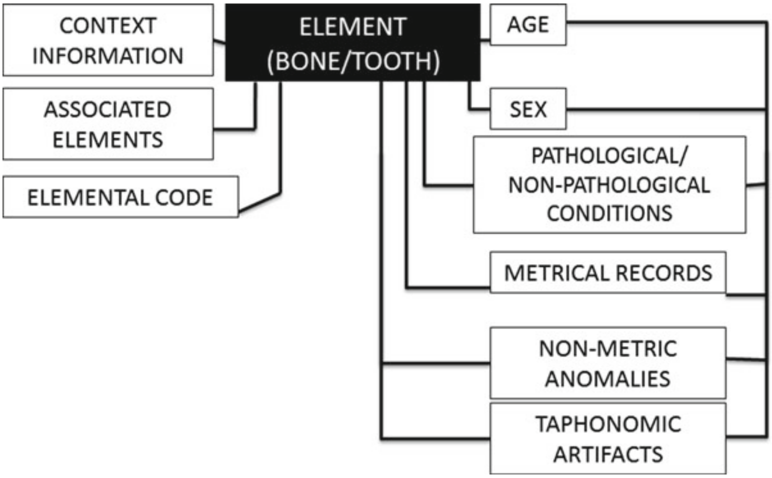

Fig. 5 Schematic representation of database coding system. Overall context and content of skeletal elements are linked with demographic, metrical/non-metrical, and pathological data

As a primary reference, the standards for documentation of commingled remains (Buikstra & Ubelaker, 1994) provided the foundational observations for each individual element: bone, side, completeness, age, and sex. To this base were added bone context and bone content observations (Fig. 5). The first component (context) addresses the burial environment, incorporating spatial, chronological, and artifactual details. Despite the disparate arrangement of the remains, there was some success correlating bones to distinct individuals. If the bone was linked to other bones (attributable to one minimum person), these connections were recorded. Unfortunately, the stratigraphic layers of skeletons were not readily visible from photographs, and these stratigraphic delineations were not maintained through the recovery practices.

The historically undisturbed nature of the mass grave places the time-of-death for these individuals within a relatively close time frame, but the exact succession of individuals into the grave was lost with excavation. Contextual finds dated this grave to the Roman period. This conclusion was then supplemented and supported by radiocarbon dating techniques; a 2.2-g sample from an adult right radius was prepared and tested at the University of Arizona AMS laboratory, positing the burial between 180 and 230 CE. The general dearth of artifacts within 7384:009 removed any issues assigning grave goods and bones.

In addition to the contextual data attributed to each bone, the bone itself provides a compelling narrative about the physical history of the individual. Although a bone or fragment may not be fully associated with an individual or multiple skeletal elements from a single individual, the information from this osseous remnant, nonetheless, exhibits a small fraction of the population profile. The current standards outline recording objectives for commingled, disparate remains/bones: elemental name, side, segment, completeness, MNI, count/weight, age, and sex (Buikstra & Ubelaker, 1994). Despite the demographic implications and interpretations generable from these observations, no means for quantifying pathological lesions and non-pathological bony responses have been standardized for biological anthropologists. For recording procedures utilized on the Oymaağaç assemblage, addenda to this initial standardized list included bony pathological manifestations, non-pathological osseous reactions, metric recordings (including stature estimates), nonmetric anomalies, and taphonomic artifacts.

Pathological diagnoses, though variable across time and geography, were categorized as joint diseases, infectious diseases, metabolic diseases, dental diseases, trauma, tumors, and atypical skeletal growth and development (Waldron, 2009). One of the issues surrounding paleopathological theory is the application of a standardized methodology to skeletal analyses (Ubelaker, 1998, p. 178). Multivariate environmental and sociobiological factors determine the occurrence and virulence of diseases throughout peoples and populations, thereby resulting in variable manifestations of conditions (Roberts & Buikstra, 2003). Unfortunately, paleopathological studies often resign to florid descriptions. While florid descriptions are preferable to binary "present"–"not present" records, intra- and interpopulation paleoepidemiological reviews expect and demand some standardization in disease manifestations over the course of the disease's [human-associated] history.

In line with the extensive work being conducted through The Ohio State University and "Global History of Health Project" (Steckel, Larsen, Sciulli, & Walker, 2005; Steckel, Rose, Larsen, & Walker, 2002), Fox and Marklein similarly established pathognomonic criteria for pathological conditions (Aufderheide & Rodriguez-Martin, 1998; Ortner, 2003; Steckel et al., 2005; Waldron, 2009). However, the observations that led to these diagnoses were descriptively documented in order to assess variability in bony manifestations. For example, osteoarthritis was determined by either the presence of eburnation or the combination of two skeletal phenomena: marginal osteophytes, alteration of the joint shape, new bone growth on the surface, and joint surface pitting (Waldron, 2009, p. 34). If the joint of a bone or fragment exhibited these characteristics, a diagnosis of osteoarthritis was made, yet these characteristics were maintained for the record for further investigations into the disease's etiologies and pathophysiology.

However, an inherent effect of commingled assemblages and the de-individualization of remains is the limitation of diagnostic accuracy. Without associative elements, a bone expressing reactive skeletal tissue cannot be indisputably correlated with a systemic condition. Until the other associative elements are recognized as concomitant to an individual, pathological lesions will remain generalized for a commingled collection. The ratio of non-pathological to pathological conditions within the de-individualized samples may be, as a presently irreconcilable reality, higher than the actual prevalence.

Inferences about past pathogenic and pathological events can also be determined through metric observations. Cueing from the *standards*, longitudinal and transverse measurements were taken for long bones, while the distances between osteometric points were determined for intact crania. Additional metrics (e.g., subadult metaphyseal breadths) were recorded in the database. As metric analyses, notably in forensic anthropological studies (e.g. Black & Ferguson, 2011), are producing results that continuously reformat understandings of genetic and epigenetic factors in development, the authors acknowledge the preliminary incompleteness of metric standards. With the expansion of the database, more metric data will gradually be incorporated. As with certain pathological lesions allowing for certain reassociation of skeletal elements, it is furthermore anticipated that metric data will reunite once individual-associated, now disparate, elements.

While nonmetric, discontinuous skeletal traits on discrete bones and fragments may link commingled elements to one individual, these traits frequently link multiple individuals to a biogeographical unit (Brothwell, 1981, p. 90). Cranial (e.g., metopic suture, extrasutural bones) and postcranial (e.g., os tibiale externum) skeletal variations that are asymptomatic or largely quiescent during life provide macroscopic starting points for research into genetic affiliations and family groups. The latter variation, os tibiale externum, will be evaluated in relation to the Oymaağaç population and database.

Finally, pre- and postdepositional structural alterations to the bone have been incorporated into the essential observations. Taphonomic patterns, foremost, may help with reassigning bones to discrete individuals. From death and past excavation, the body is subjected to myriad natural and human diagenetic influences (White & Folkens, 2005). These data also reveal the final stage of an individual's physiological life history (Stodder, 2008), the stage wherein self-agency is no longer a factor in skeletal changes. Therefore, in undisturbed or contextualized assemblages, mortuary practices can be extrapolated from the living population's treatment or disregard of their dead. From a perspective of preservation, information can provide precise results about the resilience of certain elements to burial conditions. The forms (Fig. 6) developed for the metric records of long bones provide additional visual representations of elemental preservation. This information not only adds to the growing taphonomic literature (Djuric, Djukic, Milovanovic, Janovic, & Milenkovic, 2011) but constructs an expected preservation distribution to which future recovered remains can be compared and contrasted. For example, if a high percentage (relative to the MNI count) of vertebrae survive within a cemetery, deviations from this distribution may indicate differences in vertebral preservation or reflect purposeful mortuary traditions.

The previous section dissects the methodological framework and justification of a developing database designed for accommodating data from individual and commingled human skeletal remains. Such preliminary procedures for observing and recording hope to maximize the interpretative potentialities from otherwise problematic commingled remains. The four-component coding system allows for associations between bones (on a comparative, elemental level), between bones and artifacts, within graves, and across quadrants. The data can then be viewed spatially and temporally according to age, sex, metric and nonmetric measures, pathological lesions, nonspecific bone anomalies, and taphonomic characteristics.

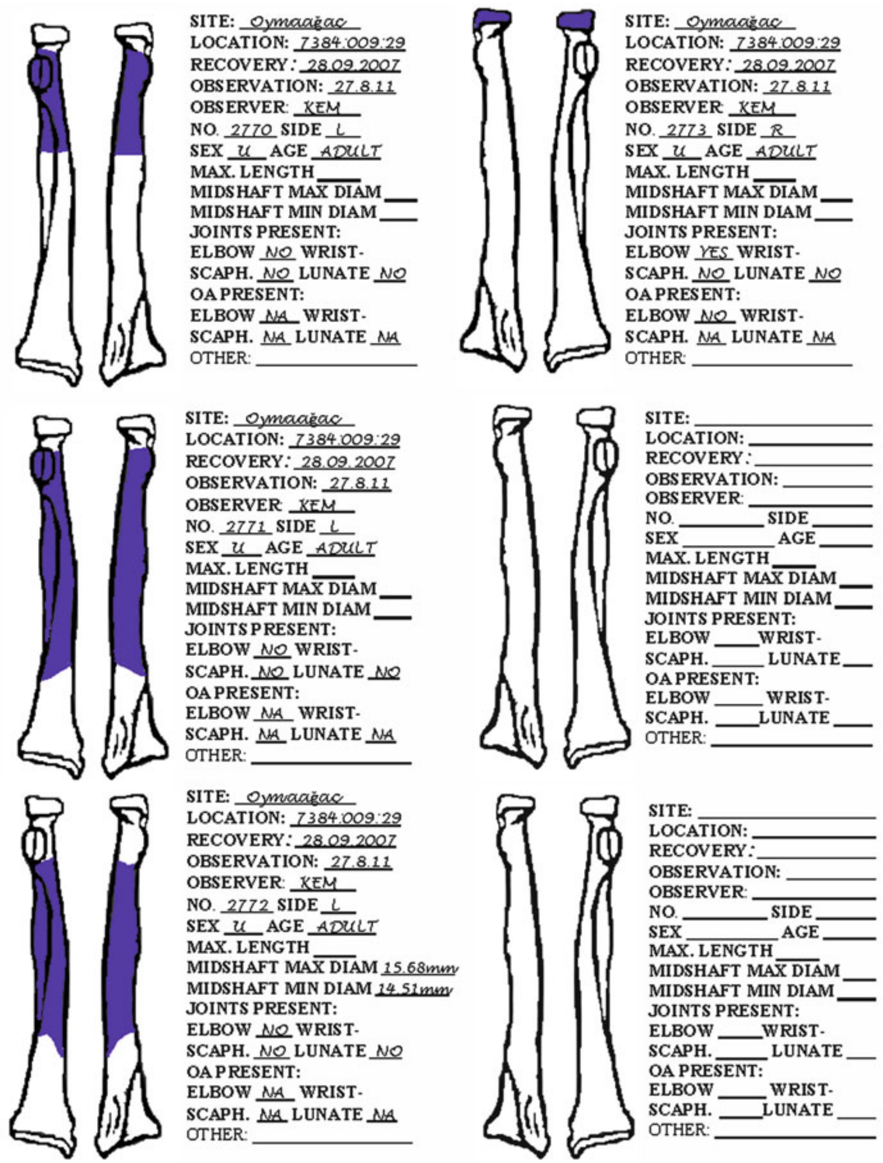

Fig. 6 Sample recording form for radial metrical and non-metrical observations

Application of the Proposed Commingled Database: Prevalence of *os tibiale externum* and Osteoarthritis

In order to evaluate the effectiveness of our database, a brief case study was conducted to calculate the prevalence of a congenital foot condition, *os tibiale externum* (OTE), discovered within grave 7384:009. Briefly, OTE, or os naviculare, presents an accessory bone medial to the navicular. Although three types have been identified in clinical literature, the occurrence of OTE within the Roman grave sample was exclusively Type II (Fig. 7), wherein the accessory bone is connected to the navicular through a cartilaginous bridge; this bridge often ossifies to become the Type III variant (Offenbecker & Case, 2012, p. 159), but no such occurrences were detected in the grave assemblage.

During the analysis of the skeletal remains, the Fox and Marklein observed five (3 left, 2 right) cases of OTE from a total of 17 (10 left, 7 right) adult naviculars and an MNI adult count of 13 individuals. These specimens were found disassociated from individuals, so the sexes were indeterminate and the age limited to an adult classification. However, the available data allowed the researchers to determine a minimum prevalence of individuals affected with the condition: 30 % (left affected naviculars/ total left naviculars) occurrence in the 7384.009 grave, in comparison to the 4–21 % incidence documented in clinical cases (Coskun, Arican, Utuk, Ozcanli, & Sindel, 2009, p. 675). Although these bones were not directly linked with individuals, this prevalence nonetheless supposes a genetic association (Kiter, Erduran, & Günal, 2000) between nearly one-third of the interred adults represented by naviculars.

Another application of the database addresses paleoepidemiological studies of commingled remains. However, since multiple bones are frequently involved in pathological conditions, disease profiles must be cleverly approached through statistics. Osteoarthritis (OA), for instance, may be identified at the intersection of the joints, between 2 and 3 bones. While the shoulder is a composite of humeral and scapular components, the elbow comprises humeral, radial, and ulnar elements. Therefore, when determining the prevalence of osteoarthritis at specific synovial

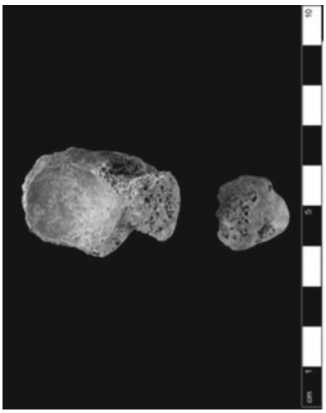

Fig. 7 Left navicular manifesting *os tibiale externum* (photo by H. Marquardt, with permission from Oymaağaç-Nerik Projekt)

Table 1 Prevalence of osteoarthritis in the left and right knee joints according to femoral, tibial, and fibular elements

	Right				Left			
Knee skeletal components	Number of present joint surfaces	Number of joints with OA	Prevalence of OA according to element	Maximum affected prevalence	Number of present joint surfaces	Number of joints with OA	Prevalence of OA according to element	Maximum affected prevalence
Femur	13	0	0.00	0.077	13	1	0.077	0.077
Tibia	5	0	0.00		13	0	0.00	
Patella	9	1	0.11		10	1	0.10	

joints, an inventory of all preserved joint elements is required. For the current chapter, Fox and Marklein will demonstrate a step-by-step analysis of OA at the knee joint.

The knee is a composite joint consisting of femoral, tibial, and patellar components, so these joint surfaces were recorded for their completeness as well as pathognomonic indicators of OA (Table 1). For the right knee the joint surfaces were present on 13 femora, 5 tibiae, and 11 patellae; complementarily, the left knee was expressed by 13 femora, 13 tibiae, and 10 patellae. Observations of OA were noted on the joint surfaces of one right patella, one left femur, and one left patella. Like the ratios calculated for the occurrence of *os tibiale externum*, these "commingled joints" were also analyzed for the maximum prevalence of affected individuals. This was attempted by creating a ratio between the highest number joint elements with OA and the highest number of elements present for the joint. For the right knee, 13 individual joints are represented by the 13 femora, but only one of the individuals exhibited evidence of OA, as shown on the articular surface of one right patella. Consequently, the maximum prevalence of OA in the right knee equates to 7.7 % (1/13). For the left knee, the prevalence also equals 7.7 % (1/13). Since the MNI_{adult} for this grave is 14, these prevalence results yield relatively accurate profiles of OA occurrence at the knee within the specific Roman sample. Where joint preservation is poor or joints are poorly represented in the grave (e.g., temporomandibular joint), it is difficult to extrapolate accurate prevalence.

In the last decades, paleoepidemiological research has sought to illuminate possible genetic and environmental factors engendering and impacting osteoarthritis (Waldron, 2009). Expression of OA changes across time and populations. These skeletal records, therefore, provide previous insight into the pathogenesis and potential etiology of OA. Studies across different populations have emphasized age as a significant variable impacting OA (Chung et al., 2010; Kramer, 2006). As individuals age, articular chondrogenesis decreases, and joints experience heightened susceptibility to normal biomechanical stress (Anderson & Loeser, 2010). Furthermore, the number of inflammation-inducing cytokines increases, coupled with poorly reactive, aged chondrocytes, upsets synovial homeostasis (Anderson & Loeser, 2010). Physical activity (chronic and repetitive) weighs on joints, especially during later years, contributing to the pathogenesis of OA (Anagnostopoulos et al., 2010; Larsen, 1997; O'Neill et al., 1999).

Despite the extensive, meticulous, and time-laden nature of this commingled data collection and documentation model, the authors have conveyed the invaluable research possibilities for de-contextualized remains. Forensic anthropology has assumed primary responsibility for developing methodologies that address commingled remains while bioarchaeologists have deterred from constructing methodological standards for commingled, de-individualized remains. Unfortunately, this negative bias toward commingled remains eliminates vast quantities of data from previously and poorly excavated archaeological sites. Since every individual, in life, impacted and factored into the overall sociocultural and sociobiological constructions of the population, would it not be remiss to overlook all the individuals who are incompletely and indiscreetly represented in death?

Conclusions

Commingling can take place at any stage from burial to the removal of human skeletal remains and beyond, and although time-consuming, much can be gained from studying commingled remains. This chapter has exhibited different contexts in which commingling has occurred, from depositional to excavation and recovery practices. These instances of commingling have inspired a developing methodology, which expands future analysis and research potential for commingled human skeletal remains. While commingling inevitably engenders research limitations, these limitations need not dissuade skeletal population comparisons. Implementing a cohesive methodology across sites will facilitate immediate dialogue between researchers in Turkey, Greece, and Cyprus. The Eastern Mediterranean region, as a notable byway between Europe and Asia, provides a remarkable palette on which human interactions have be continuously portrayed, and with standardized methods these interactions can be further realized and clarified in bioarchaeological studies.

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