A REAPPRAISAL OF PREHISTORIC HUMAN SKELETAL REMAINS FROM THE BAHAMAS HOUSED AT THE YALE PEABODY MUSEUM OF NATURAL HISTORY

William C. Schaffer
Center for Bioarchaeological Research
School of Human Evolution and Social Change
Arizona State University, Tempe, AZ 85282
wschaffe@asu.edu

Numerous researchers have delved into the Yale Peabody Museum of Natural History's collection of prehistoric human skeletal material from the Bahamas with great interest. The present study is another reexamination of this assemblage in an attempt to provide a robust interpretation of the material that includes, but is not limited to, taphonomic processes, non-specific infectious agents, non-metric traits, trauma, and degenerative disease changes. This paper will also provide a brief review of the most current evidence for more specific diseases such as treponemal infection (various types of syphilis) and tuberculosis (e.g., M. tuberculosis*), or lack thereof, from prehistoric contexts throughout the Caribbean.*

Beaucoup de chercheurs ont examiné la collection d'ossements humains des Bahamas au Yale Peabody Museum of Natural History avec grand intérêt. Cette étude est un nouvel analyse de cet assemblage pour tenter d'offrir une interprétation fiable et solide des matériels, en se focalisant sur les processus taphonomiques, agents infectieux non-spécifiques, les traits non-métriques et des changements provoqués par les maladies dégénératives. Cet article fournira aussi une brève revue des preuves les plus actuelles sur les maladies spécifiques comme l'infection tréponémique (différents types des syphilis) et la tuberculose (par exemple M. tuberculosis), ou leur absence, dans les contextes préhistorique à travers les Caraïbes.

La colección de esqueletos prehistóricos Bahameses del Museo de Historia Natural Peabody de la Universidad Yale han sido la fuente de numerosos estudios científicos. El presente estudio reexamina la colección con el fin de proveer un análisis del material que incluye, pero no se limita a, procesos tafonómicos, agentes infecciosos no específicos, rasgos no métricos, trauma, y cambios en enfermedades degenerativas. El presente estudio, también incluirá un breve resumen de las mas recientes evidencias de enfermedades mas específicas como lo son: infecciones treponemicas (varios tipos de sífilis) y tuberculosis, o su ausencia de la escena prehistórica caribeña.

Introduction

The prehistoric human skeletons recovered by Froelich Rainey (1934), during his expedition in and around the Bahamas (Figure 1), have resided at the Yale Peabody Museum of Natural History (YPMNH) since that date. Though his field notes fail to provide the context that contemporary bioarchaeologists and archaeologists yearn for, and the remains are differentially preserved as well as commingled, the YPMNH collection is the largest on record of the Lucayans – the first Amerindian peoples to have encountered Columbus. This collection and Rainey's memoir serve as vital resources for studying the Lucayans. However, attempting to reconstruct the lifeways and deathways of the Lucayans via this collection is challenging.
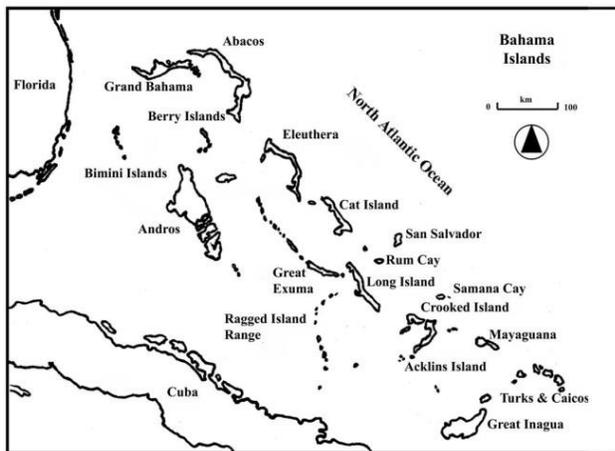
Figure 1. Map of the Bahamian Islands (after Curran and White 1995).

William Keegan (1982) was the first researcher to examine the YPMNH collection from the Bahamas including human skeletal material recovered from a burial cave located on Grand Bahama. Notably, the collection had lain unstudied for nearly 50 years prior to Keegan's landmark investigation. His descriptions include an inventory, biological profiles, and pathological data, accompanied by transcriptions of Rainey's notes. Later, Michael Pateman (2007) reanalyzed collection, adding human remains from Sanctuary and Stargate Blue Holes on South Andros Island (see Mack and Armelagos 1992; Palmer 1997) and one burial from Preacher's Cave on Eleuthera (Carr et al. 2006). The intent of both Keegan (1982) and Pateman (2007) was to use the biological information from their data sets to make inferences about Lucayan mortuary practice and social organization (*sensu* Binford 1971; Saxe 1970; Sears 1961). Both authors came to identical conclusions: that small sample sizes and other biases precluded such analyses. More recently, intact burials have been recovered from Preacher's Cave containing individuals that had been wrapped with basketry and cordage. One individual was interred with grave goods (Schaffer et al. 2012; Carr et al. 2013). The graves from Preacher's Cave are the most complete, archaeologically documented Lucayan remains, to date, and represent the most current understanding of Lucayan deathways. Snippets of Rainey's accounts and extrapolated biological data from the YPMNH collection (among others), in conjunction with newly excavated and analyzed remains, provide the best assemblage of data to illuminate and elaborate Lucayan mortuary practices. This, in turn, will allow researchers to make stronger inferences about the social roles that the deceased may have held during their lifetimes. Additionally, such finds allow us to propose details of the overarching social organization or kinship system of which the deceased was a member.

Collections such as these can be restudied, not only to entertain hypotheses about social and ritual organization, but to examine specific phenomena sensitive to diet, disease, skeletal biology and population biodistance. In fact, Keegan and DeNiro (1988) sampled stable isotopic signatures ($\delta^{13}C$ and $\delta^{15}N$) from the human bone collagen in this assemblage to help provide greater insight into Lucayan diet. Furthermore, Keegan (1982), Keegan and DeNiro (1988), and Pateman (2007) have made great strides in achieving greater understanding of additional components of bioarchaeological inquiry. Previous studies of the Bahamian collection at the YPMNH have supplied some data specific to pathology. Keegan (1982) described the presence of a degenerative condition known as osteophytosis in the lumbar vertebrae of three individuals. Additionally, Pateman (2007) recorded various pathological phenomena in his study, yet the scope of his work was more wide-ranging in that it encompassed material from the YPMNH, as well as more recently recovered skeletons (e.g., Carr et al. 2006). Since the span of the present study is relegated to the material from the YPMNH, and Pateman's (2007)

work does not partition the samples by collection, his specific observations of material at the YPMNH cannot be readily assessed here.

The most recent attempt to extract biological data from the amalgamation of human skeletal material from the Bahamas held at the YPMNH was performed by Rose Drew (2009). Her study sought to demonstrate anticipated variation between skeletal robusticity, limb bone shape, and overall health between Saladoid and Taíno population samples from different islands. In her manuscript, she asserts "[T]here is evidence of possible yaws in the Bahamian remains and also tuberculosis in several sets of Eluethra[*sic*] Island remains" (Drew 2009:180). From observing a lack of this same evidence among the human skeletal remains at the YPMNH from larger islands such as Hispaniola and Puerto Rico, she concludes that individuals on larger islands led healthier lives prior to European presence.

In contrast to the past investigations of the Yale assemblage (Keegan 1982; Pateman 2007), Drew's paper (2009) reports an appreciably higher occurrence of specific pathological responses of bone in the collection. She concludes that there is evidence to diagnose two specific infectious diseases within the collection: treponemal infection (various forms of syphilis) and tuberculosis. Drew (2009) does not identify any lesion in the collection as pathognomonic or indicative for treponemal infection (see Hackett 1976). Yet, her study lists treponemal infection as the potential causative agent for skeletal proliferation in at least four individuals. She does, however, mention a set of lumbar vertebrae with erosive lesions on the centra. If legitimate, these lesions would in fact be pathognomonic for tuberculosis (see Aufderheide and Rodríguez-Martín 1998:121–124). Additional evidence cited for the possible presence of tuberculosis is

three possible cases of septic arthritis. But, since her paper lacks detailed descriptions of each identified lesion, and without the inclusion of illustrations or figures of the remains, it is difficult to gauge the validity of her analysis.

The present study is a reexamination of this collection in an attempt to: (1) rectify discrepancies between conflicting published information concerning the islands of origin of the catalogued skeletal material; (2) demonstrate a number of taphonomic processes, non-specific infections, non-metric traits, archaeological recovery and conservation methods that can be mistaken for or inflated to infer more specific pathological condition(s); and, (3) argue that even possible skeletal diagnoses of treponemal infection (yaws, endemic syphilis, etc.) and tuberculosis (e.g., *Mycobacterium tuberculosis*) are unfounded and highly speculative, at best, particularly in lieu of macroscopic lesions that are pathognomonic or indicative for these microbial pathogens. This paper also provides a brief review of the most current evidence for these diseases from pre-European contexts in the Caribbean.

Materials and Methods

The primary objective of this study was to examine the known Lucayan skeletal samples with the intent of producing a comprehensive skeletal inventory. The next goal was to create a digital archive (i.e. spreadsheet, database) to provide the Yale museum with a readily accessible record that quantifies the human skeletal material and allows for queries to be made with greater ease. An archive of this nature has direct application to collections management facilitating use for curators and scholars. Detailed documentation of this quality, along with its dissemination to additional researchers will inform others of the nature and composition of the collection. The cursory analysis completed in the present

study should, in theory, act to reduce the amount of skeletal studies that are mostly descriptive in nature, and thus, promote the proliferation of problem-oriented studies by virtue of the identification of practical skeletal and dental data for use in future cross-cultural comparisons and hypothesis testing (Buikstra 1977).

Collection and inventory of macroscopic skeletal and dental data attributed to the indigenous Bahamians curated by the YPMNH were conducted by the author during early January 2011. Data were collected according to protocols set forth by Buikstra and Ubelaker (1994). This resource provides basic guidelines by which to capture data from human skeletal remains supported by a general consensus of diverse experts within the discipline of human skeletal biology. The remains are appended with catalogue numbers and assigned to specific Bahamian islands and sites, but their specific layout on the landscape or depositional nature is not entirely clear. Thus, without the vital contextual information, this collection presents itself in a similar way to remains that are commingled.

Age-at-death for juvenile skeletal remains was determined by observing skeletal elements that represent similar known rates of long and flat diaphyseal growth, as well as degrees of epiphsyeal union and dental development (Baker et al. 2005; Scheuer and Black 2000; Ubelaker 1999). Age ranges for juvenile remains have greater resolution because they are based on chronological growth and development with smaller quantifiable estimates of error.

Determining the age-at-death for adult skeletal material is not as straightforward since it is compiled from observed degenerative changes in the human skeleton. Due to time constraints and differential completeness of skeletonized individuals, not all available relative aging techniques for skeletally mature individuals

($\geq$ 20 years of age-at-death) were employed during this preliminary analysis (e.g., Lovejoy et al. 1985; Meindl and Lovejoy 1985). When applicable, observations of the pubic symphyses were recorded, and the subsequent assignment of an age range within a set of upper and lower confidence limits (Brooks and Suchey 1990). In this manner, an adult individual's age-at-death is generally placed within three broad categories: young adult (20–34 years), middle adult (35–49 years), or older adult (50+ years) (Buikstra and Ubelaker 1994:36). Predictably, a better feel for the skeletal elements present, including their preservation and completeness, will result from the production of a systematic and descriptive inventory. A skeletal analyst can then determine which elements may be the most robust for a relative comparison using the same age estimator across the sample, but potentially, identify one or more relative aging techniques applicable for aging the remains of each individual.

If the human skeletal remains encountered were aged as skeletally mature (otherwise adult) at or around the time of death, then sex was assessed by using a model of well-known patterns of sexual dimorphism prevalent in the cranial and pelvic bones (Ascádi and Nemeskéri 1970; Bass 1987; Buikstra and Mielke 1985; Krogman and İşcan 1986; Phenice 1969; Ubelaker 1999; White and Folkens 1991). Estimating the sex of subadult individuals via macroscopic means was not conducted. The sexing of subadult remains is considered unreliable as secondary sexual characteristics have not yet matured and are not visibly developed.

Proceeding identification of each skeletal element, side, segment, as well as age and sex (if applicable), the available contextual data associated with each skeletal element (i.e. catalogue number, island, site, chamber) was entered into a spreadsheet along with the string of skeletal attributes

associated with that element. The methodology for establishing the minimum number of individuals (MNI) for archaeological sites when the spatial arrangement of burials previously exhumed are relatively unknown (with the exception of a few hints from Rainey's log) is akin to an analysis of commingled remains. The presence of the most common element(s), for both adult and subadult remains independently, dictates the MNI. The most common element(s) for each site was tabulated, and this yielded site-specific MNIs, unless separate cave chambers were previously delineated (e.g., Gordon Hill Cave). These site-specific MNIs were later compiled to arrive at an overall MNI for the pre-European Bahamian skeletal collection curated at the YPMNH. From these data, sex ratios were established for each site.

A subsequent evaluation of all cranial and postcranial elements was undertaken to synthesize data pertaining to

inflammatory and lytic responses. This pathological analysis was aided by relevant literature (Aufderheide and Rodríguez-Martín 1998; Hillson 1996; Ortner 2003; Waldron 2008). The expression of bone response was categorized accordingly as caries sicca, periostitis, osteomyelitis, osteolysis and osteoperiostitis, if and when applicable (Aufderheide and Rodríguez-Martín 1998; Hackett 1976; Ortner 2003; Steinbock 1976). Endosteal bone and medullary cavities were also observed to investigate potential proliferative responses. A diagnosis of infectious disease would be determined by investigating lesions pathognomonic for a particular disorder. An assessment of corresponding lesions on several bones of discrete individuals was conducted when possible to signify a systemic response to infection. The presence and absence of skeletal lesions was then evaluated throughout the population sample.

Keegan (1982)				Drew (2009)				Schaffer (this study)				
Catalogue No.	Island	MNI	Sex[a]	Island	MNI	Sex[a]	Catalogue No(s).	Island	Site	MNI	Sex[a]	
4682	Rum Cay	1	1:0:0	No island specified	2	1:1:0	4682 & 4691	Rum Cay	Port Boyd Cave	3	1:1:1	
4683	Abacos	1	0:1?:0	Eleuthera	2	1:0:0	4683	Abacos	Imperial Lighthouse Caves	1	0:0:1	
4684	Eleuthera	1	1:0:0	Eleuthera	1	1:0:0	4684	Eleuthera	North Bannerman Town Cave	1	1:0:0	
4685	Eleuthera	1	1:0:0	Eleuthera	1	1:0:0	4685	Eleuthera	Wemyss Bight Cave	1	1:0:0	
4686	Eleuthera	1	1?:0:0	Long Island	3	2:0:1	4686	Eleuthera	South Bannerman Town Cave	1	0:0:1	
4687	Long Island	2	0:1:1	Eleuthera	1	1:0:0	4687	Long Island	Clarence Town Cave – Chamber One	2	0:0:2	
4688	Long Island	1	0:1:0	Long Island	2	0:1:1	4688	Long Island	Clarence Town Cave – Chamber Two	1	0:1:0	
4689	San Salvador	1	1:0:0	Eleuthera	1	1:0:0	11694	Long Island	Resident and Burial Cave	1	0:0:1	
4690	San Salvador	1	0:0:1	San Salvador	1	0:1:0	4689 & 4690	San Salvador	Victoria Hill Settlement	2	1:1:0	
4691	Rum Cay	2	0:1?:1	Rum Cay	2	1:1:0	28872 & 28919	San Salvador	Williams Cave #1	1	0:0:1	
4692	Crooked Island	1	1:0:0	Crooked Island	1	1:0:0	4692–6 & 4698	Crooked Island	Gordon Hill Cave – Chamber One	4	1:1:2	
4693	Crooked Island	1	0:1:0	Crooked Island	2	0:1:1	4697	Crooked Island	Gordon Hill Cave – Chamber Two	2	0:2:0	
4694	Crooked Island	4	1:1:2	Crooked Island	3	2:0:1?	–	–	–	–	–	
4695	Crooked Island	1	0:0:1	Crooked Island	3	1:1:1	–	–	–	–	–	
4696	Crooked Island	1	0:1:0	–	–	–	–	–	–	–	–	
4697	Crooked Island	1	0:1:0	Crooked Island	2	0:1:1	–	–	–	–	–	
4698	Crooked Island	1	0:1:0	Crooked Island	2	0:1:1	–	–	–	–	–	
		22	7:9:6		29	13:8:8				20	5:6:9	

[a] M:F:I; M=Male; F=Female; I=Indeterminate

Table 1. Site-specific MNIs and Sex Ratios Generated from the Present Study and Previous Results for Comparison.

Results

Inventory and Skeletal Biology
MNIs and sex ratios were calculated for each site independently as their own entity, with the exception of Gordon Hill Cave and Clarence Town Cave, as they contained two distinct chambers. The sum of the MNIs for

each site is equivalent to the overall MNI the author has estimated for the pre-European Bahamian skeletal collection curated at the YPMNH. Using Keegan (1982), courtesy of Rainey's notes, the catalogue numbers were aligned with their respective island and associated cave site (see Table 1). For added convenience, prior data from Drew (2009)

and Keegan (1982) are integrated into Table 1. The only remains not included in the previously published material are from Williams Cave #1 on San Salvador and a site labeled as "Resident and Burial Cave" on Long Island.

When comparing the observations from the three independent researchers, two clear patterns emerge. First, there is an obvious discrepancy between Drew (2009) and Keegan (1982) in terms of the catalogue numbers and the islands. As previously mentioned, I have chosen to incorporate the island designations from the catalogue numbers presented by Keegan (1982) in my tallies as they were transcribed and reconstructed from Rainey's diary, in addition to the original placards associated with each set of remains. These labels are also consistent with the records kept at the YPMNH. My results are in agreement with Keegan's (1982) original work, with an overall MNI for the Bahamian collection of approximately 20–22 individuals. It is reasonable to assume that Keegan (1982) assessed the overall MNI with comparable methodology as my own. Drew's (2009) methodology seems to arrive at an overall MNI closer to the maximum number of individuals (or maximum account of minimum number of individuals), using an approach similar to the maximum distinction method defined by Grayson (1973).

Bone	Left	Midline or Side Unknown	Right	Bone	Left	Midline or Side Unknown	Right
Long				*Metacarpals*		(6)[b]	
Humerus	7		8[c]	MC1	1		2
Radius	5		3	MC2	2		–
Ulna	4		6	MC3	1		2
Femur	8[c]	(4)[b]	7	MC4	1		1
Tibia	8[c]		4	MC5	1		–
Fibula	3	(1)[b]	3	*Hand phalanges*		(15)[b]	
Clavicle	5	(1)[b]	5	Proximal		(8)[b]	
Irregular				Intermediate		(5)[b]	
Scapula	3		6	Distal		(2)[b]	
Mandible		4		Segment Unknown		–	
Manubrium		2		*Tarsals*			
Sternum		3		Calcaneus	3		2
Pelvis	8[c]	(1)[b]	7	Talus	1		1
Patella	1		1	Cuboid	2		–
Rib	(21)[b]	(17)[b]	(19)[b]	Navicular	1		–
Vertebrae		(41)[b]		Cuneiform 1	1		–
Cervical		(8)[b]		Cuneiform 2	1		–
Thoracic		(10)[b]		Cuneiform 3	1		–
Lumbar		(10)[b]		*Metatarsals*			
Sacral		(13)[b]		MT1	2		2
Carpals				MT2	–		3
Scaphoid	–	1	–	MT3	–		2
Lunate	–		1	MT4	–		2
Triquetral	–		1	MT5	–		1
Pisiform	–		–	*Foot phalanges*		–	
Trapezium	–		1	Proximal		–	
Trapezoid	–		1	Intermediate		–	
Capitate	1		1	Distal		–	
Hamate	1		1	Segment Unknown		–	

[a] Modified from Ubelaker (1974:34).
[b] Numbers in parentheses indicate actual number of fragments, not individuals.
[c] Most common elements.

Table 2. Number of Individuals Represented by Each Type of Adult Bone.[a]

Table 2 provides a basic inventory of the number of individuals represented by each type of adult bone identified in the skeletal sample inclusive (modified from Ubelaker 1974:34). Table 2 only presents adult bones from the sample and does not include cranial elements, for which the sample contains at least four near complete and intact crania (with visible signs of cranial modification), as well as additional isolated cranial fragments. Noticeably, long bones such as the humerus, femur, and tibia are the most commonly observed elements, along with the bones of the pelvis. Examining the sample irrespective of its contextual information exemplifies how the most common elements underrepresent the estimation of the overall MNI. An abundance of subadult individuals could explain this disparity; however, the structure of the skeletal sample does not reflect this pattern. Instead, the samples from each cave site contain its own distinct most common element (stratified via adult and subadult remains) that was used to generate a site MNI. Therefore, the overall MNI reflects the number of individuals that must be present, and the most common elements reveal the types and quantities of skeletal elements available in the entire assemblage.

Table 2 also offers a general sense of the overall sample composition, degree of preservation, and may even reflect the preferential archaeological recovery of skeletal material by Froelich Rainey (1934). Furthermore, the inventory reveals the underrepresentation of various skeletal elements such as ribs, vertebrae, as well as bones of the hands and feet. This accurately details that there are few individuals in this assemblage represented by even a near complete skeleton. More commonly, individuals are represented by a single bone or a small aggregate of bones. Thus, data sets acquired from this sample via systematic extraction of more specialized skeletal and dental attributes, for example pathology and non-metric traits, will contain many missing values due to the inherent makeup of the sample itself. Ultimately, this complicates the fidelity and applicability of specific skeletal and dental data for use in comparative studies of variation. However, since long bones predominate, they might offer the richest data set to purge. Appendix 1 contains the adult postcranial measurements collected in the present study. The metrics gleaned from these remains will not only contribute to an already growing body of data specific to the skeletal biology of the Lucayans (Schaffer et al. 2012:69), but the overall variation within the Caribbean and surrounding regions, as well. These data have the potential to expand our knowledge of ecogeographic patterns and behavioral adaptations observed in human limb proportions, stature, body mass, skeletal robusticity, musculoskeletal stress markers, and relative bone strength (Ruff and Hayes 1983; Hawkey and Merbs 1995; Ruff et al. 1997; Ruff 2002; Ruff et al. 2005).

Pathological Analysis and Differential Diagnosis

A broad assessment of gross skeletal and oral-dental pathology within a skeletal sample is essential in order to gauge the prospective nutritional, physiological and environmental constraints encountered by people in the past. The information gleaned from a systematic evaluation of bone pathology will allow for comparisons within the Bahamian islands and between samples from the neighboring Antilles. As stated earlier, any systematic investigation of more detailed osteological data from the Bahamian material is fraught with difficulties. Regardless of these constraints, documentation and dissemination of skeletal elements that exhibit signs of a pathological condition(s) should still be conducted as

they will continue to contribute to our understanding of Lucayan diet, behavioral adaptations, and other conditions that may have had an impact on overall health and wellbeing.

Whenever conducting an interpretation of gross skeletal and oral-dental pathology, the foremost step in attempting to identify and describe antemortem or perimortem alterations to bone is to demonstrate that the observed modification is not a result of postemortem taphonomic processes (see Buikstra and Ubelaker 1994:95–106). This is a crucial component in any assessment of gross skeletal pathology, and in particular, even more critical when conducting an examination of skeletal remains where the observer has little to no knowledge of the initial appearance of the material as it was exhumed or the precise depositional environment from where it originated. More often than not, this is the circumstance of many researchers studying curated museum specimens, and the past and present studies of the Bahamian material at the YPMNH are no exception. After preliminary information for each skeletal element was recorded (i.e.

type of bone, side of body, bone segment), the overall preservation and condition of each element was assessed to identify the appearance of any potential bony change attributable to natural depositional processes, taphonomic alterations, or postmortem handling. A number of taphonomic changes were recorded in the collection. These include perforations and cracking due to weathering, staining, partial mineralization (likely from submersion below the water table), polishing (mostly from conservation, i.e. the application of polyvinyl acetate), and postmortem breakage.

Due to time constraints, not all pathological conditions were investigated (e.g., scoring of porotic hyperostosis and cribra orbitalia). A general summation of gross skeletal pathology observed in this study is presented in Table 3. The most frequent form of pathological condition recorded was the long, vertical striae indicative of healed periostitis or periosteal bone reaction on adult tibiae and femora. Additional common observations included osteoarthritic distal humeri and lumbar vertebrae.

	Periostitis (Healed)			Osteoarthritis		
Cat. No.	Element	Side	Cat. No.	Element	Side	Comments
4683	Femur[a]	L	4691	Humerus	L	Distal
4684/5	Femur	L	4698	Humerus	L	Distal
4692	Femur	L	4684/5	L1	–	Slight
4692	Femur	R	4684/5	L3/4	–	Slight
4682	Pelvis	R	4684/5	L3[b]	–	Slight
4682	Tibia	L	4684/5	L4[b,c]	–	Moderate-Severe
4682	Tibia	R	4684/5	L5[b]	–	Moderate-Severe
4684/5	Tibia	L	4688	L5	–	Slight-Moderate
4691	Tibia	L	4682	Pelvis	R	Severe
4691	Tibia	L	4694	Scapula	R	Slight
4692	Tibia	L	–	–	–	–
4692	Tibia	R	–	–	–	–

[a] Remains of a subadult; possible active bone involvement.
[b] Osteoarthritis of vertebral facets.
[c] Schmorl's node.

Table 3. Summation of Gross Skeletal Pathology Observed in the Present Study.

Though the results of this pathological analysis should be considered preliminary and incomplete, as they are not all-inclusive, sharp contrasts in the observation and interpretation of pathological conditions present within the sample are readily apparent when compared directly to the conclusions offered by Drew (2009). A subset of human remains posed disagreement among skeletal analysts. Table 4 lists the catalogue numbers, archaeological context, and biological profiles associated with this subset. Table 5 illustrates the disparity among interpretations of observed skeletal pathology. These tables crudely summarize the general conclusions drawn by both researchers. To help verify claims of the current study, a brief synopsis is provided for skeletal material observed in each catalogue number from Tables 4 and 5. Catalogue number PA 4686 was not included in this enumeration since the skeletal elements referenced by Drew (2009) were not recorded or observed by the author.

	Drew (2009)			Schaffer (this study)			
Catalogue No.	Island	Sex[a]	Age[a]	Island	Site	Sex	Age
4682	No island specified	M	OA	Rum Cay	Port Boyd Cave	M	OA
4683	Eleuthera	F	YA	Abacos	Imperial Lighthouse Caves	N/A	5–10 yrs
4684/5	Eleuthera	M	UA	Eleuthera	North Bannerman Town Cave/Wemyss Bite Cave	M	UA
4686	Long Island	N/A	6–8 yrs	Eleuthera	South Bannerman Town Cave	?	?
4689	Eleuthera	M	UA	San Salvador	Victoria Hill Settlement	M	UA
4690	San Salvador	F	UA	San Salvador	Victoria Hill Settlement	F	UA

[a]M=Male; F=Female; YA=Young Adult; UA=Unaged Adult; OA=Older Adult

Table 4. Associated Catalogue Numbers with Discrepant Results.

Cat. No.	Drew (2009)	Schaffer (this study)
4682	Treponemal Disease, Possible Septic Arthritis (Tuberculosis)	Traumatic Dislocation or Fracture of Femoral Head/Neck Traumatic Arthritis
4683	Possible Tuberculosis (Septic Arthrits) or Treponemal Infection	Taphonomic Alterations; Some Periostitis Observed, Possibly Active
4684/5	Tuberculosis (Potentially)	Degenerative Disease/Activity-based Skeletal Changes in Lower Back
4686	Possible Treponemal Disease	Unobserved
4689	Septic Arthritis; Healed Oval Defect (Parietal)	Taphonomic Alterations; Skeletal Variation (Parietal Foramen)
4690	Possible Treponematosis	Skeletal Variation/Activity-based Change on Femoral Head/Neck (Poirier's facet/plaque)

Table 5. Disparate Differential Diagnoses.

Port Boyd Cave, Rum Cay (PA 4682)

Eleven skeletal elements were observed and recorded in association with this catalogue number. These bones represent at least two individuals. An adult female is represented by a near complete right pelvis, and an adult male by intact cranial fragments and both pelves. Additional elements such as paired humeri, tibiae, ulnae, and a right fibula (that articulates with the right tibia) are also present. These long bones are robust and their maximum lengths are greater than most postcranial remains recorded in the collection (see Appendix 1). Presumably they are the limb bones that match with the male pelves and cranium observed.

The male cranium shows slight weathering of the outer table, and extreme cracking and discoloration from weathering is readily noticeable on the left ulna. Both ulnae present with slight osteophyte development in the trochlear (semiulnar) notch, which could be from the early onset of arthritis in the elbow joints. The paired tibiae exhibit the long, vertical striae indicative of periostitis in a stage of healing. In examining the right pelvis, extensive

bone production and remodeling has progressed at the base of the acetabulum (hip socket) as it articulates with the bones of the pelvis. Much of this new bone formation appears healed at or around the time of death. When compared to the antimere in posterior aspect, it is clear on the affected pelvis that new bone accumulation at the base of the acetabulum has caused it to distend and elongate laterally. In direct lateral view, the acetabulum has protracted from new bone formation and a clear line of eburnation (polished surface from bone-on-bone contact) presents on its posterior border (Figures 2 & 3).

Figure 2. Lateral view of male right pelvis (Division of Anthropology, YPM, ANTPA.004682. © Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA. All right reserved).

The pattern observed on the right male pelvis appears consistent with an etiology of traumatic origin that could range from hip fracture, femoral head and/or neck fracture, and even hip dislocation. The individual's right femur is not present in the collection.

Figure 3. Superior view of male right pelvis (Division of Anthropology, YPM, ANTPA.004682. © Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA. All right reserved).

Regardless of the circumstances of the fracture or dislocation, after the injury was sustained the joint continued to be utilized, and traumatic arthritis developed in the joint. It appears that some type of traumatic event with enough force to either: fracture the base of the acetabulum, fracture the proximal femur, or dislodge the femoral head from its normal articulation with the acetabulum and fovea capitis thus straining the ligamentum teres and engendering nuanced biomechanical demands. As the healing of the wound progressed, bone was produced medial of the acetabulum so it could extend laterally and compensate for the newly modified and abnormal articulation with the femoral head. As the joint was still being used the synovial fluid broke down since the joint space was invariably narrowed, and thus, the

production of osteoarthritis (eburnation) formed as a result of the newly modified and irregular range of motion. This would have given this individual atypical gait, made locomotion more challenging, and potentially increased the energetic cost as well as decreased efficiency of gait.

In comparison, Drew (2009) identifies two bones within this catalogue number with active periostitis, namely the matching left and right ulna. It is unclear if she meant to refer to the matching tibiae, which appear to have signs indicative of healed periostitis, or she interpreted what seemed to be extreme weathering as a skeletal lesion active at or around the time of death. In either case, her observation of "active periostitis" led to the diagnosis of treponemal disease. Also, her diagnosis of the bony changes in the pelvis previously detailed was possible tuberculosis from sepsis. I agree that infectious disease is possible in this case; however, no evidence of a cloaca is present (i.e., osteomyelitis), and the inductive leap to tuberculosis is highly problematic. Furthermore, without the right femur of this individual, most diagnoses remain tentative.

Imperial Lighthouse Caves, Abaco (PA 4683)

Fourteen skeletal elements were observed and recorded in association with this catalogue number. These bones appear to represent one subadult individual 5–10 years of age at or around the time of death. Intact articulated cranial elements with open sutures include the frontal, parietal, and occipital bones. Additional bones of the skull include a matching right temporal and a complete mandible with all tooth crypts present but only four teeth *in situ* (i.e. LM_1, LP_4, Ldm_1, and RM_1). Judging from the development of the teeth and the stage of their eruption, this individual can be aged 8 years +/- 24 months (Ubelaker 1999:64). Near complete long bones without epiphyses

fused include: the left femur, humeri, and left radius. The left radius was complete enough to measure the maximum length (175 mm). This is well within the range of an individual between 8–10 years of age-at-death (see Scheuer and Black 2000:298). Concurrently the epiphyses of the long bones aforementioned do not fuse until 12–20 years of age (Scheuer and Black 2000:295–296). It appears that the epiphyses were not collected during Rainey's archaeological recovery. In examining the long bones, extensive weathering was apparent that eroded the cortex and left the porous trabeculae exposed. Possible active periostitis was also observed on the humerus, yet not conclusive, as the product of weathering giving the appearance of active periostitis could not be convincingly ruled out.

Drew's (2009) interpretation of these remains included "osteoarthritic lipping" of the diaphyseal ends, abnormal growth or septic arthritis of the humerus and hypervascularization of the femur, and that this individual "possibly suffered from tuberculosis, which may have retarded growth and development, or from treponemal disease that affected her drastically" (Drew 2009:181). First, her interpretation of the age-at-death and sex of the remains was of a young adult female with subadult limb bones. This individual is predictably no more than 10 years of age. Second, in regards to pathology, the juvenile bones associated with them are likely coarse at the diaphyseal ends as they have yet fully fused to the corresponding epiphyses and not osteoarthritic. Her observation of hypervascularization could be due to the façade of multiple foramina from exposed inner trabecular bone due to extensive taphonomic alteration to the outer cortex. These bones also appear to be treated with a preservative (e.g. polyvinyl acetate), thus reducing the confidence of an accurate interpretation.

North Bannerman Town and Wemyss Bight Caves, Eleuthera (PA 4684/5)

Nearly 40 unique skeletal elements characterize the set of remains associated with these two catalogue numbers. At least two adult males are represented. A left femur and left tibia are present with long, vertical striae indicative of healed periostitis. At least five lumbar vertebrae are represented as well; though, they could not be attributed to a single individual since the author could not fully articulate them as L1–L5 (see Table 3). Bone mineral density of the lumbar vertebrae look to be affected by the depositional process and are highly fragmented post-mortem. Slight, moderate and severe osteophytosis of the centra was observed including osteoarthritis of the vertebral facets. Drew (2009:180) describes these lumbar vertebrae as containing "[R]agged perforations…considered consistent with potential evidence of tuberculosis." The disparity in observation seems to rise both from preservation issues as well as the exaggerated presence of pathology. Often, paleopathologists can only be confident in diagnosis of a particular disease when infection with the pathogen is quite advanced in presentation. In this case, Pott's disease is the most progressive form of tuberculosis in the vertebrae where destructive lesions have compromised the ability of the vertebrae to support the mechanical load of the upper body and collapse (Aufderheide and Rodríguez-Martín 1998:121–124). Baker (1999) has suggested that some perforations of the centra could be evidence of the early stages of tuberculosis. However, the advanced destructive vertebral lesions characteristic of tuberculosis were not observed by the author. Moreover, the perforations described by Drew (2009) are inconsistent with the phenomenon recorded by Baker (1999).

Victoria Hill Settlement, San Salvador (PA 4689 & 4690)

At least two adult individuals – one female and one male – are represented by this small array of remains that include diagnostic fragments of crania and femora. Drew's paper describes two pathological femora: (1) with septic arthritis from her observation of destructive lesions that dislodged the femoral head from the shaft *in vivo*; and, (2) with "[P]ossible treponematosis due to sclerotic healed reactive bone" (2009:178). Her first observation seems to be based on a misinterpretation of taphonomic changes. The femur in question shows no sign of healing and is highly fragmented post-mortem. The second observation of reactive bone appears to be a non-metric trait commonly known as a Poirier's facet or plaque formation at the site of the femoral head and neck (Kostick 1963; Finnegan and Faust 1974; Finnegan 1978:24). Kennedy (1989:149) and Capasso et al. (1998) indicate, however, that these types of bony ridges can arise from hyper-flexion of the hip from habitual activities such as squatting. Markers such as this that infer repetitive movement may supply us with clues as to the daily activities of the Lucayans.

Discussion

The principal objective of the current investigation was to produce an overall MNI, sex ratios, and a workable skeletal inventory of the Bahamian skeletal remains housed at the YPMNH in order to pinpoint fruitful skeletal and dental data that can be extracted and synthesized for use in comparative analysis and future hypotheses testing. It seems that the most prominent set of skeletal remains for future studies include the long and irregular bones (Appendix 1). A cursory pathological assessment of the collection was also presented in this paper (Table 3). Healed periostitis was the most common form of pathological response

recorded. Additional pathological conditions include osteoarthritis of the elbow, shoulder, hip joints, as well as the lumbar spine. The most severe expressions were limited to the lumbar vertebrae and the hip joint of one adult male. The hip joint pathology caused osteoarthritis, likely as the consequence of either traumatic injury or infection. This overall pathological assessment starkly contrasted with Drew (2009) as her diagnoses included specific diseases such as treponemal infection and tuberculosis. The discrepancy among researchers appears to be the result of both misinterpreting taphonomic alteration for pathology (i.e., pseudopathology) and the direct assignment of skeletal phenomena (i.e., periostitis) to specific infections.

One of the primary steps when assembling an inventory of skeletal remains is observing and recording postmortem changes or taphonomic alterations (Brickley 2004:6; McKinley 2004:15). Changes to bone as a result of taphonomy often can be difficult to differentiate from antemortem bone responses. Some examples of taphonomic changes include weathering, cracking, discoloration, polishing and post-mortem gnawing from rodents and carnivores. If the observer does not take into account the effects of taphonomic processes, he/she can be misled by falsely interpreting naturally occurring postmortem depositional alterations as antemortem or perimortem pathology (i.e. pseudopathology). This is precisely why in the volume *Standards for Data Collection from Human Skeletal Remains* the chapter on pseudopathology (1994:95–106) precedes the chapter on paleopathology (1994:107–158), and that "[S]tudies of ancient disease must therefore *begin* by eliminating postdepositional 'pseudopathologies' from the diagnostic process [emphasis added]" (1994:95). If taphonomic alterations cannot be ruled out, the observer has little choice but to describe it accordingly. Thus begins the daunting task of the paleopathologist to: (1) rule out taphonomic processes from diagnostic criteria; (2) accurately identify and describe a lesion(s) on bone; and, (3) like a modern medical professional, formulate a number of working hypotheses, or differential diagnoses, to explain what causative agent(s) may have led to the production of said lesion(s) and then, if possible, attempt to reject those causative agent(s) that seem least probable based on additional contextual evidence and sound reasoning. If this is not feasible, then an extensive differential diagnosis, or multiple working hypotheses, might be the most appropriate solution.

In this paper I have described a number of taphonomic changes observed in the YPMNH Bahamian collection. Drew (2009) identified a number of observations of bony responses that to the author were pseudopathology (PA 4683, PA 4689); others that do not appear infectious in origin but rather traumatic as it appears new bone has formed, and no evidence of cloacae inferring infection at the joint are present (i.e., osteomyelitis), and bony changes do not present as destructive which is observed in septic arthritis and tuberculosis (PA 4682); some as osteoarthritic changes or preservation issues (PA 4684/5); and, additional cases look to be degenerative in origin, within the realm of normal skeletal variation or activity-based (PA 4684/5, PA 4689, PA 4690).

In general, paleopathologists struggle with the assignment of specific infectious diseases from observations of periostitis. Periostitis is a proliferative response of the outer layer of bone, or periosteum. The inner layer of the periosteum maintains the ability to produce bone throughout one's life history (Ortner 2003:206). This inner layer remodels consistently through ontogeny, well into senescence, and up until death, simply to accommodate the functional and biomechanical demands involved with

controlled movement and consequential interaction with internal and external stimuli. Periostitis presents as a gradient of expressions from one or more layers of woven or compact bone to the more extreme expression that includes small, localized bony projections aligned perpendicular to the periosteum (Resnick 2002:4884). A tendency for many researchers is to attribute periostitis to either traumatic or infectious origin (see Senn 1886:5–6), or both. Putschar (1966:60) notes that it is often impossible to determine which of these two conditions gave rise to a given lesion in an archeological human skeleton. Whereas the periosteum will always be activated in fracture, periosteal reactive bone can also be stimulated by injury that does not produce fracture. The latter may resemble periosteal reactions stimulated by localized infectious foci (Ortner 2003:208). Additionally, Greenfield (1975:483–486) has summarized over 25 rather benevolent pathological conditions that can manifest as periostitis. Therefore, most bone altering phenomena documented as pathological on archaeological human skeletons are often attributed to non-specific causes, that is, the precise agent that caused a change in bone can rarely be confidently determined. This is due, in part, to the fact that identical skeletal lesions observed on bones, belonging to even the same individual, can arise as the result of disparate pathological circumstances. In this manner, making the causal connection from the skeletal presentation of a lesion to a specific disease process bears an elevated degree of uncertainty and should be executed with caution in mind.

There are, however, a very few lesions that present on bone that allow greater confidence in our ability to diagnose a specific infectious disease. These include infectious diseases such as treponemal infection (various form of syphilis), tuberculosis (e.g., *Mycobacterium tuberculosis*), and leprosy (*Mycobacterium leprae*). Since we have a rich history of documented changes in the skeleton of living people infected with these pathogens, and their respective bony presentations are quite distinguishable from many other skeletal manifestations, a firm macroscopic diagnosis for their presence in antiquity includes the positive identification of a bony response that is pathognomonic for that particular disease. In other words, the diagnosis of a specific infection holds very little weight, if any at all, without evidence for the presence of their clinically documented signatures on the skeleton. For example, with the treponemes, observation of the various stages of caries sicca, osteoperiostitis, and superficial cavitation of the periosteum are pathognomonic (Hackett 1976). Other lesions are indicative (e.g. saber shin, nodal lesion) and consistent with (e.g., anterior tibial expansion) treponemal infection (Hackett 1976; see also Smith et al. 2011). In congenital syphilis, Hutchinson's incisors and Moon's molars are the *conditio sine qua non* (Hillson et al. 1998:38). None of these skeletal or dental signatures was observed by the author or Drew (2009). An individual with treponemal disease may in fact present with periostitis (see Steinbock 1976 for many clinical studies), but in direct reference to Hackett's work (1976), the "naivety of the claim made in some paleopathological reports that, in effect, 'periostitis = treponematosis' (e.g., Rothschild and Rothschild 1995, and *contra* Weston 2008) is immediately apparent" (Cook and Powell 2012:483). This is similar to the caution posed by Waldron (2008:xvi), who suggests that we must in fact rely on clinical definitions in paleopathological diagnosis or else "[A] disease that exists only in the mind of a particular paleopathologist cannot really be said to exist anywhere else."

Skeletal lesions pathognomonic and indicative for treponematosis from

precolonial contexts have been reported in many parts of North America (see Powell and Cook 2005). Sufficient evidence from Puerto Rico (Crespo-Torres 2005), the U.S. Virgin Islands (Sandford et al. 2005), and Jamaica (Santos et al. 2013) reveal that the Caribbean region was no exception. At present, there appears to be no adequate macroscopic evidence for the presence of treponemal infection in human skeletal material from the Bahamas. Mack and Armelagos (1992) used the presence of periostitis to propose treponemal infection as the likely causative microbial agent in the skeletons from Sanctuary Blue Hole on South Andros. However, Rothschild (2000:142) questions the majority of periosteal reactions observed by Mack and Armelagos (1992) as misinterpreting the effects of diagenesis for antemortem bony response. Nonetheless, the problems associating periostitis directly with treponematosis have already been stressed. In the current study, no convincing evidence for treponemal infection in the Bahamian skeletal remains from the YPMNH was observed by the author. Drew (2009) also proposed that three additional individuals suffered from treponemal infection in the collections housed at the YPMNH, although these are from archaeological sites on other islands (i.e., Dominican Republic, Haiti, and Puerto Rico). But, given the criticisms of her analysis and interpretation of the Bahamian skeletal remains herein, those conclusions also remain suspect without corroboration.

Since pre-European remains in the Caribbean with pathognomonic signs indicative of treponemal infection have been reported (Crespo-Torres 2005; Sandford et al. 2005; Santos et al. 2013), one would predict that it might be found, too, among pre-European Lucayan human skeletal remains. The ethnohistoric account of Fray Ramón Pané (1978:25; 1999:10–11), documented the saga of a man named Guahayona among the Macorix people of

Hispaniola, who possessed the sores of *mal francés* or French disease – a reference to the lesions characteristic of syphilis (or *bubas*). The prediction that the disease was endemic to the Caribbean or present within the Bahamian populations based on this and the assignment of any potential sign of infection on the skeletons as such (e.g. periostitis), undermines the wealth of clinical literature available. Moreover, the attribution is based on circular logic (see Rothschild et al. 2000; Rothschild and Rothschild 1995; *contra* Cook and Powell 2012:485), and ignores the incorporation of alternate mechanisms of pathogenesis (see Weston 2008, 2012).

Predicting the prevalence of tuberculosis (TB) in the Bahamian islands and Caribbean periphery is more challenging. Entertaining ideas about the potential presence of TB in the region is provocative, yet no simple task. The *Mycobacterium tuberculosis* complex (MTBC) includes *M. tuberculosis* (humans), *M. africanum* (humans in Africa), *M. bovis* (feral and domesticated animals), *M. canetti* (humans), *M. caprae* (goats), *M. microti* (llama, hyrax, vole), and *M. pinnipedii* (seals and sea lions) (Roberts 2012; Stone et al. 2009). TB is usually contracted in humans from inhaling droplets containing the bacteria via an infected person (often *M. tuberculosis*) or contact (usually via consumption) with infected animals (often *M. bovis*). Humans have been documented as contracting *M. caprae* as secondary hosts (e.g. Rodríguez et al. 2009) as well as *M. microti* and *M. pinnipedii* on rarer occasions (Grange 2008; Panteix et al. 2010). A long held assumption was that *M. bovis*, the ancestral strain of the MTBC and *M. tuberculosis*, evolved around the time of human domestication of Old World cattle (Stead 1997; Steadd et al. 1995). However, recent biomolecular analysis has upended this notion suggesting that *M. tuberculosis* and *M. canetti* are ancestral to *M. africanum*,

M. bovis, and *M. microti* (Brosch et al. 2002).

Evidence of TB in human remains from the Americas occurs as north as Alaska (Dabbs 2009) and south to South America (see Stone et al. 2009:70–71 for a thorough review). Most of the TB cases in South America are located in northern Chile and southern Peru, but a few cases are known from Venezuela and Colombia. Population migration from Amazonia may have brought strain(s) of the MTBC into the Caribbean. In my own review of the paleopathological literature of the prehistoric Caribbean, no other literature besides Drew (2009) exists concerning the diagnosis of TB in human skeletal remains in the region. Though her diagnosis in the Bahamian remains is suspect, the possibility of the occurrence of TB in the Caribbean and North Atlantic is not far-fetched.

The current lack of skeletal TB in the Caribbean is due likely to sample bias and preservation issues, but also the parameters posed by the host(s) and the pathogen in the environment. First, conceivably less zoonotic hosts for the MTBC in the Caribbean than the mainland Americas were available, which included *alcos* or dogs (*Canis familiaris*), monk seal (*Monachus tropicalis*), and even potentially the hutia (*Geocapromys* spp). Second, human population size and density may have limited the pathogen's ability to become endemic. For appreciably small populations, the pathogen would not survive over a lengthy period of time, and for large populations, an epidemic would decimate host survival. A mathematical model designed by McGrath (1988) based on material from the Lower Illinois River Valley proposed that a social network size of between 180 and 440 people is necessary for endemicity of *M. tuberculosis* in humans. This range conceptually represents upper and lower confidence intervals essential for the host and pathogen to coexist. Models with a higher population size demonstrate a sudden and critical decline in host population.

Archaeological and historic evidence suggests that the Lucayans may have been organized as chieftain ("big men" or "great men") societies (Berman 2011) or simple chiefdoms that were less complex than their Antillean neighbors (Keegan 1992, 1997a, 1997b; Keegan et al. 1998). Columbus perceived the number of houses in Lucayan villages to range from 1 to 15 in number on Crooked Island, Long Island and San Salvador (Fox 1882; Keegan 1984). Using an estimate of 20 persons per house proposed by Guarch (1974) for pre-contact Cuba, any Lucayan village between 9 and 15 houses could support endemicity of *M. tuberculosis* when applying McGrath's (1988) population thresholds. In any smaller villages the pathogen would likely not survive. Therefore, it appears that the MTBC could have been supported in Lucayan populations, on occasion, but only if populations were maintained at modeled population levels.

Summary and Conclusion

As a result of completing a skeletal inventory for the YPMNH Bahamian collection, a cursory examination of the distribution of skeletal elements suggests that the postcrania may be the most valued data set with relevance to skeletal biology such as functional anatomy, variation in body size and stature and musculoskeletal stress markers and osteoarthritis. The integration of more skeletal samples will help to build inferences about past Lucayan behavioral adaptations. This paper emphasizes how the careful study and re-study of museum collections, principles of science and repeatability, and the application of sound methodological issues pertaining to bioarchaeological analysis contributes to the differential diagnosis in the field of paleopathology.

_____

References Cited

Ascádi, Gy., and J. Nemeskéri (1970). *History of Human Life Span and Mortality*. Akadémiai Kiadó, Budapest.

Aufderheide, Arthur C., and Conrado Rodríguez-Martín (1998). *The Cambridge Encyclopedia of Human Paleopathology*. University Press, Cambridge.

Baker, Brenda J. (1999). Early Manifestations of Tuberculosis in the Skeleton. In *Tuberculosis: Past and Present*, edited by edited by György Pálfi, Olivier Dutour, Judith Deák, and Imre Hutás, pp. 299–307. Golden Book and Tuberculosis Foundation, Szeged, Hungary.

Baker, Brenda J., Tosha L. Dupras, and Matthew W. Tocheri (2005). *The Osteology of Infants and Children*. Texas A&M University Press, College Station.

Bass, William M. (1987). Human *Osteology: A Laboratory and Field Manual*. 3rd ed. Missouri Archaeological Society, Columbus.

Berman, Mary Jane Berman (2011). Good as Gold: The Aesthetic Brilliance of the Lucayans. In *Islands at the Crossroads: Migration, Seafaring, and Interaction in the Caribbean*, edited by L. Antonio Curet and Mark W. Hauser, pp. 104-134. University of Alabama Press, Tuscaloosa.

Binford, Lewis R. (1971). Mortuary Practices: Their Study and their Potential. In *Approaches to the Social Dimensions of Mortuary Practices*, edited by James A. Brown, pp. 6–29. Memoirs of the Society for American Archaeology No. 25, Washington, DC.

Brinkley, Megan (2004). Compiling a Skeletal Inventory: Articulated Inhumed Bone. In *Guidelines to the Standards for Recording Human Remains*, edited by Megan Brinkley and Jacqueline I. McKinley, pp. 6–7. Institute of Field Archaeologists Paper No. 7, University of Reading, Reading.

Brosch, R., S. V. Gordon, M. Marmiesse, P. Brodin, C. Buchrieseer, K. Eiglmeier, T. Garnier, C. Gutierrez, G. Hewinson, K. Kreemer, L. M. Parsons, A. S. Pym, S. Samper, D. Van Soolingen, and S. T. Cole (2002). A New Evolutionary Sequence for the *Mycobacterium tuberculosis* Complex. *Proceedings of the National Academy of Sciences* 99:3684–3689.

Brooks, S., and Judy M. Suchey (1990). Skeletal Age Determination Based on the Os Pubis: A Comparison of the Ascádi-Nemeskéri and Suchey-Brooks Methods. *Journal of Human Evolution* 5(3):227–238.

Buikstra, Jane E. (1977). Biocultural Dimensions of Archaeological Study: A Regional Perspective. In *Biocultural Adaptation in Prehistoric America*, edited by Robert L. Blakely, pp. 67–84. Proceedings of the Southern Anthropological Society No. 11, University of Georgia Press, Athens.

Buikstra, Jane E., and Douglas H. Ubelaker, Editors (1994). Standards for Data Collection from Human Skeletal Remains. *Proceedings of a Seminar at the Field Museum of Natural History, Arkansas Archaeological Survey Research Series No. 44*, Arkansas Archaeological Survey, Fayetteville.

Buikstra, Jane E., and James L. Mielke (1985). Demography, Diet, and Health. In *Analysis of Prehistoric Diets*, edited by Robert I. Gilbert and James L. Mielke, pp. 359–422. Academic Press, New York.

Capasso, L., K. A. R. Kennedy, and C. A. Wilczak (1998). Atlas of Occupational Markers on Human Remains. *Journal of Paleontology* 11 Monographic Publication 3. Edigrafital S. P. A., Teramo, Italy.

Carr, Robert S., Jane S. Day, Jeff B. Ransom, and William C. Schaffer (2006). An Archaeological and Historical Assessment of Preacher's Cave, Eleuthera, Bahamas. Manuscript on file, Archaeological and Historical Conservancy, Davie, Florida.

Carr, Robert S., William C. Schaffer, Jeff B. Ransom, and Michael P. Pateman (2013). Ritual Cave Use in the Bahamas. In *Sacred Darkness: A Global Perspective on the Ritual Use of Caves*, edited by Holley Moyes, pp. 285–293. University of Colorado Press, Boulder.

Cook, Della Collins (2005). Syphilis? Not Quite: Paleoepidemiology in an Evolutionary Context in the Midwest. In *The Myth of Syphilis: The Natural History of Treponematosis in North America*, edited by Mary Lucas Powell and Della Collins Cook, pp. 177–199. The University Press of Florida, Gainesville.

Cook, Della Collins, and Mary Lucas Powell (2012). Treponematosis: Past, Present, and Future. In *A Companion to Paleopathology*, edited by Anne L. Grauer, pp. 472–491. Wiley-Blackwell, New York.

Crespo-Torres, Edwin F. (2005). Evidence of Pre-Columbian Treponematosis from Paso del Indio: An Archaeological Site on the Island of Puerto Rico. In *The Myth of Syphilis: The Natural History of Treponematosis in North America*, edited by Mary Lucas Powell and Della Collins Cook, pp. 386–401. The University Press of Florida, Gainesville.

Curren, H. A., and B. White (1995). Introduction: Bahamas Geology. In *Terrestrial and Shallow Marine Geology of the Bahamas and Bermuda*, edited by H. A. Curran, and B. White, pp. 1–3. Geological Society of America Special Paper 300, The Geological Society of America, Boulder.

Dabbs, Gretchen R. (2009). Resuscitating the Epidemiological Model of Differential Diagnosis: Tuberculosis at Prehistoric Point Hope, Alaska. *Paleopathology Association Newsletter* 148:11–24.

Finnegan, M. (1978). Non-metric Variation of the Infracranial Skeleton. *Journal of Anatomy* 125:23– 37.

Finnegan, M., and M. A. Faust (1974). *Bibliography of Human and Non-Human Non-Metric Variation*. Research Reports No. 14, Department of Anthropology, University of Massachusetts, Amherst.

Fox, G. V. (1882). Methods and Results: An Attempt to Solve the Problems of the First Landing Place of Columbus in the New World. *United States Coast and Geodetic Survey, Report for 1880*, Appendix no. 18. Washington, DC.

Drew, Rose (2009). From Saladoid to Taíno: Human Behavior from Human Remains in the Greater Antilles. *Bulletin of the Peabody Museum of Natural History* 50(1):167–185.

Grange, J. M. (2008). *Mycobacterium tuberculosis*: The Organism. In *Clinical Tuberculosis* edited by P. D. O. Davies, P. F. Barnes, and S. B. Gordon, pp. 65–78. 4th edition. Hodder Arnold, London.

Grayson, Donald K. (1973). On the Methodology of Faunal Analysis. *American Antiquity* 38:432–439.

Greenfield, George B. (1975). *Radiology of Bone Diseases*. 2nd edition. Lippencott, Philadelphia.

Guarch, José M. (1974). *Ensayo de Reconstrucción Etno-historica del Taíno de Cuba*. Serie Arqueológica no. 4, Havana, Cuba.

Hackett, Cecil J. (1976). *Diagnostic Criteria of Syphilis, Yaws, and Treponarid (Treponematoses) and of Some Other Diseases in Dry Bones*. Springer-Verlag, Berlin.

Hawkey, Diane E., and Charles F. Merbs (1995). Activity-induced Musculoskeletal Stress Markers (MSM) and Subsistence

Strategy Changes Among Ancient Hudson Bay Eskimos. *International Journal of Osteoarchaeology* 5:324–338.

Hillson, Simon (1996). *Dental Anthropology*. Cambridge University Press, Cambridge.

Hillson, Simon, Caroline Grigson, and Sandra Bond (1998). Dental Defects of Congenital Syphilis. *American Journal of Physical Anthropology* 107:25–40.

Keegan, William F. (1982). Lucayan Cave Burials from the Bahamas. *Journal of New World Archaeology* 5:57–65.

Keegan, William F. (1984). Columbus and the City of Gold. *Journal of the Bahamas Historical Society* 6:34–39.

Keegan, William F. (1992). *The People Who Discovered Columbus: The Prehistory of the Bahamas*. University Press of Florida, Gainesville.

Keegan, William F. (1997a). *Bahamian Archaeology: Life in the Bahamas and Turks and Caicos Before Columbus*. Media Publishing, Nassau.

Keegan, William F. (1997b). No Man [or Woman] is an Island: Element of Taíno Social Organization. In *Indigenous People of the Caribbean*, edited by Samuel M. Wilson, pp. 111–117. University Press of Florida, Gainesville.

Keegan, William F., and Michael J. DeNiro (1988). Stable Carbon- and Nitrogen-isotope Ratios of Bone Collagen Used to Study Coral-reef and Terrestrial Components of Prehistoric Bahamian Diet. *American Antiquity* 53:320–336.

Keegan, William F., Morgan D. Maclachlan, and B. Byrne (1998). Social Foundations of

Taíno *Caciques*. In *Chiefdoms and Chieftancies in the Americas*, edited by E. M. Redmond. The University Press of Florida, Gainesville.

Kennedy, K. A. R. (1989). Skeletal Markers of Occupational Stress. In *Reconstruction of Life from the Skeleton*, edited by M. Y. İşcan and K. A. R. Kennedy, pp. 129–160, Alan R. Liss, New York.

Kostick, E. L. (1963). Facets and Imprints on the Upper and Lower Extremities of Femora from a Western Nigerian Population. *Journal of Anatomy* 97(3): 393–402.

Krogman, Wilton M., and Mehmet Y. İşcan (1986). *The Human Skeleton in Forensic Medicine*. Charles C. Thomas, Springfield.

Lovejoy, C. Owen, Richard S. Meindl, Thomas R. Pryzbeck, and Robert P. Mensforth (1985). Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Adult Skeletal Age at Death. *American Journal of Physical Anthropology* 68:15–28.

Mack, M. E., and George A. Armelagos (1992). Skeletal Analysis of the Sanctuary Blue Hole Remains: The Lucayan Taino. Manuscript on file, Florida Museum of Natural History, University of Florida, Gainesville, Florida.

McGrath, Janet W. (1988). Social Networks of Disease Spread in the Lower Illinois Valley: A Simulation Approach *American Journal of Physical Anthropology* 77:483–496.

McKinley, Jacqueline I. (2004). Compiling a skeletal inventory: disarticulated and co-mingled remains. In *Guidelines to the Standards for Recording Human Remains*,

edited by Megan Brinkley and Jacqueline I. McKinley, pp. 14–17. Institute of Field Archaeologists Paper No. 7, University of Reading, Reading.

Meindl, Richard S., and C. Owen Lovejoy (1985). Ectocranial Suture Closure: A Revised Method of the Determination of Skeletal Age at Death Based on the Lateral-Anterior Sutures. *American Journal of Physical Anthropology* 68:57–66.

Mickleburgh, Hayley L. (2013). *Reading the Dental Record*. Ph.D. dissertation, Leiden University, The Netherlands.

Ortner, Donald J. (2003). *Identification of Pathological Conditions in Human Skeletal Remains*. Elsevier, San Diego.

Palmer, R. (1997). *Deep into Blue Holes*. Unwin Hyman, London.

Pané, Fray Ramón (1978). *Relación Acerca de Las Antigüedades de los Indios*. Edited by José J. Arrom. 3rd edition. Siglo Veintiuno Editores, Cerro del Agua, Mexico.

Pané, Fray Ramón (1999). *An Account of the Antiquities of the Indians*. Edited by José J. Arrom and translated by Susan C. Griswold. Duke University Press, Durham.

Panteix, G., M. C. Gutierrez, M. L. Boschiroli, M. Rouviere, A. Plaidy, D. Pressac, H. Porcheret, G. Chyderiotis, M. Ponsada, K. Van Oortegem, S. Salloum, S. Cabuzel, A. L. Bañuls, P. Van de Perre, and S. Godreuil (2010). Pulmonary Tuberculosis Due to *Mycobacterium microti*: A Study of Six Recent Cases in France. *Journal of Medical Microbiology* 59:984–989.

Pateman, Michael P. (2007). Reconstructing Lucayan Mortuary Practices Through

Skeletal Analysis. *Journal of the Bahamas Historical Society* 29:5–10.

Phenice, T. W. (1969). A Newly Developed Method of Sexing in the Os Pubis. *American Journal of Physical Anthropology* 30:297–301.

Putschar, Walter G. J. (1966). Problems in the Pathology and Paleopathology of Bone. In *Human Paleopathology*, edited by S. Jarcho, pp. 57–65. Yale University Press, New Haven.

Rainey, Froelich G. (1934). Diary Beginning January 22, 1934. Upon Arrival in Port-au-Prince. Manuscript on file, Yale Peabody Museum of Natural History, New Haven, Connecticut.

Resnick, Donald (2002). *Diagnosis of Bone and Joint Disorders*. 4th edition. WB Saudners, Philadelphia.

Roberts, Charlotte (2012). Re-Emerging Infections: Developments in Bioarchaeological Contributions to Understanding Tuberculosis Today. In *A Companion to Paleopathology*, edited by Anne L. Grauer, pp. 434–457. Wiley-Blackwell, New York.

Rodríguez, E., L. P. Sánchez, S. Pérez, L. Herrera, M. S. Jiménez, S. Samper, and M. J. Iglesias (2009). Human Tuberculosis Due to *Mycobacterium bovis* and *M. caprae* in Spain, 2004–2007. *International Journal of Tuberculosis and Lung Disease* 13:1536–1541.

Rothschild, Bruce M. (2000). Preconceived Notions and Hypothesis Testing: Holes in the Blue Hole. *Chungará: Revista de Antropología Chilena* 32(2):141–146.

Rothschild, Bruce M., Fernando Luna Calderon, Alfredo Coppa, and Christine Rothschild (2000). First European Exposure to Syphilis: The Dominican Republic at the Time of Columbian Contact *Clinical Infectious Disease* 31:936–941.

Rothschild, Bruce M., and Christine Rothschild (1995). Treponemal Disease Revisited: Skeletal Discriminators for Yaws, Bejel, and Venereal Syphilis. *Clinical Infectious Disease* 20:1402–1408.

Ruff, Christopher B. (2002). Variation in Human Body Size and Shape. *Annual Review of Anthropology* 31:211–232.

Ruff, Christopher B., and Wilson C. Hayes (1983). Cross-sectional geometry of Pecos Pueblo Femora and Tibiae–A Biomechanical Investigation: I. Method and General Patterns of Variation. *American Journal of Physical Anthropology* 60(3):359–381.

Ruff, Christopher B., Markku Niskanen, Juho-Antti Junno, and Paul Jamison (2005). Body Mass Prediction from Stature and Bi-iliac Breadth in Two High Latitude Populations, with Application to Earlier Higher Latitude Humans. *Journal of Human Evolution* 48:381–392.

Ruff, Christopher B., Erik Trinkaus, and Trenton W. Holliday (1997). Body Mass and Encephalization in Pleistocene *Homo*. *Nature* 387:173–176.

Sandford, Mary Kaye, Georgieann Bogdan, David S. Weaver, Grace E. Kissling, and Mary Lucas Powell (2005). Prehistoric Treponematosis at the Tutu Site: The U.S. Virgin Islands. In *The Myth of Syphilis: The Natural History of Treponematosis in North America*, edited by Mary Lucas Powell and Della Collins Cook, pp. 402–417. The University Press of Florida, Gainesville.

Santos, Ana Luísa, Michael T. Gardner, and Phillip Allsworth-Jones (2013). Treponematosis in Pre-Columbian Jamaica: a biocultural approach to the human cranium found at Bull Savannah. *Journal of Archaeological Science* 40:490–496.

Saxe, Arthur A. 1970 *Social Dimensions of Mortuary Practices*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Michigan, Ann Arbor.

Schaffer, William C., Robert S. Carr, Jane S. Day, and Michael P. Pateman (2012). Lucayan-Taíno Burials from Preacher's Cave, Eleuthera, Bahamas. *International Journal of Osteoarchaeology* 22:45–69.

Scheuer Louise, and Sue Black (2000). *Developmental Juvenile Osteology*. Academic Press, San Diego.

Sears, William H. (1961). The Study of Social and Religious Systems in North American Archaeology. *Current Anthropology* 2:223–246.

Senn, N. (1886). *Periostitis*. Philadelphia Medical Times, July 24a.

Smith, Maria Ostendorf, Tracy K. Betsinger, and Leslie Lea Williams (2011). Differential Visibility of Treponemal Disease in Pre-Columbian Stratified Societies: Does Rank Matter? *American Journal of Physical Anthropology* 144:185–195.

Stead, William W. (1997). The Origin and Erratic Global Spread of Tuberculosis: How the Past Explains the Present and is the Key to the Future *Clinics in Chest Medicine* 18(1):65–77.

Stead, William W., K. D. Eisenach, M. D. Cave, M. L. Beggs, G. L. Templeton, C. O. Thoen, and J. H. Bates (1995). When Did *Mycobacterium tuberculosis* Infection First Occur in the New World? *Critical Care Medicine* 151:1267–1268.

Steinbock, R Ted (1976). *Paleopathological Diagnosis and Interpretation: Bone Diseases in Ancient Human Populations*. Charles C. Thomas, Springfield.

Stone, Anne C., Alicia K. Wilbur, Jane E. Buikstra, and Charlotte A. Roberts (2009). Tuberculosis and Leprosy in Perspective. *Yearbook of Physical Anthropology* 52:66–94.

Ubelaker, Douglas H. (1974). *Reconstruction of Demographic Profiles from Ossuary Skeletal Samples: A Case Study from the Tidewater Potomac*. Smithsonian Contributions to Anthropology No. 18, Smithsonian Institution, Washington, DC.

Ubelaker, Douglas H. (1999). *Human Skeletal Remains: Excavation, Analysis, Interpretation*. 3rd ed., Smithsonian Press, Washington, DC.

Waldron, Tony (2008). *Palaeopathology*. Cambridge University Press, Cambridge.

Weston, Darlene A. (2008). Investigating the Specifity of Periosteal Lesions in Pathology Museum Specimens. *American Journal of Physical Anthropology* 1037:48–59.

Weston, Darlene A. (2012). Nonspecific Infection in Paleopathology: Interpreting Periosteal Reactions. In *A Companion to Paleopathology*, edited by Anne L. Grauer, pp. 492–512. Wiley-Blackwell, New York.

White, Timothy D., and Pieter Folkens (1991). *Human Osteology*. Academic Press, San Francisco.

APPENDIX I

Measurement Description													
Fibula	4697 L												
Maximum length	327												
Maximum diameter at midshaft	14.28												
Radius	4697 L	4694 R											
Maximum length	220	229											
Sagittal diameter at midshaft	10.82	9.9											
Transverse diameter at midshaft	13.03	15.64											
Clavicle	4697 L	4697 R	4694 R										
Maximum length	143	145	139										
Sagittal diameter at midshaft	8.57	7.89	10.81										
Vertical diameter at midshaft	10.15	10.14	8.09										
Ulna	4696 L	4697 R	4697 L	4694 R	4682 R	4682 L	4698 R						
Maximum length	237	243	240	248	281	–	–						
Dorso-volar diameter	11.66	14.33	14.94	14.14	13.48	–	–						
Transverse diameter	11.33	11.01	11	10.63	13.95	–	–						
Physiological length	208	211	209	220	247	246	–						
Minimum circumference	39	48	47	43	41	46	40						
Tibia	4691 L	4696 L	4692 L	4682 R	4692 R	4691 L	4682 L	4685 L					
Condylo-malleolar length	337.5	335	395	375	392	–	–	–					
Maximum proximal epiphyseal breath	69	62	78	–	–	–	–	–					
Maximum distal epiphyseal breadth	45	42	53	49	–	50	–	–					
Anterior-posterior diameter at nutrient foramen	30.24	27.62	34.93	37.68	32.69	37.38	30.14	–					
Medial-lateral diameter at nutrient foramen	19.84	18.04	21.54	23.88	22.18	24.43	20.96	22.78					
Circumference at nutrient foramen	81	74	92	94	87	98	82	–					
Humerus	4697 R	4691 L	4682 R	4698 L	4694 R	4694 L	4698 L	4685 R	4685 L				
Maximum length	283	273.5	318	270	–	–	–	–	–				
Epicondylar breadth	52.5	56	63.5	51	53	63	–	–	–				
Articular width	34.75	39.36	45.83	35.6	37.85	47.18	–	–	–				
Maximum vertical diameter of head	37.92	42.03	47.91	35.63	–	–	–	–	–				
Maximum transverse diameter of head	34.33	39.13	45.18	–	–	–	–	–	–				
Maximum diameter at midshaft	20.1	20.27	27.9	–	–	–	–	–	–				
Minimum diameter at midshaft	14.25	15.45	17.18	–	–	–	–	–	–				
Minimum circumference, distal to deltoid	68	59	74	–	–	–	69	70	68				
Femur	4691 L	4691 R	4692 L	4692 R	4694 L	4686 L	4696 R	4694 L	4696 L	4690 R	4689 L	4688 R	4685 L
Maximum length	399	396	455	–	–	–	–	–	–	–	–	–	–
Bicondylar length	394	392	453	–	–	–	–	–	–	–	–	–	–
Epicondylar breadth	75	–	–	–	–	–	–	–	–	–	–	–	–
Maximum vertical diameter of head	42.48	42.47	–	–	41.73	47.18	38.86	40.24	–	–	–	–	–
Maximum transverse diameter of head	–	–	–	49	41.1	47.68	38.84	40.54	–	–	–	–	–
Anterior-posterior subtrochanteric diameter	24.48	–	27.76	25.18	23.53	28.14	–	–	22.35	22.51	26.81	24.22	31.21
Medial-lateral subtrochanteric diameter	27.83	–	28.56	28.56	27.86	27.44	–	–	25.58	26.57	30.6	29.42	30.52
Anterior-posterior midshaft diameter	26.39	27.33	30.83	–	–	–	–	–	–	–	–	–	–
Medial-lateral midshaft diameter	25.18	28.35	26.94	–	–	–	–	–	–	–	–	–	–
Midshaft circumference	82.5	85	91	–	–	–	–	–	–	–	–	–	–