



SCIENTIFIC PROGRAM AND ABSTRACTS

(Edited after the meeting)

46th Annual North American Meeting

Hilton Downtown and Convention Center Cleveland (Ohio)

25-27 March, 2019

29 March, AAPA-PPA Joint Session

**46th Annual North American Meeting of Paleopathology Association
Cleveland (Ohio), 25-27 March, 2019
29 March, AAPA-PPA Joint Session**

Scientific Program

MONDAY, March 25

9:15 am-5:00 pm **Pre-meeting excursion** to Cleveland by [Lolly the Trolley](#) to [West Side Market](#), [Dittrick Museum of Medical History](#) and [Cleveland Museum of Natural History](#) which includes the visit to the Hamman-Todd collection
Meet at Hilton Lobby

TUESDAY, March 26

7:45 am-5:00 pm Registration *Hilton Hope Foyer*

8:30 am-5:00 pm Student Action Committee Raffle

8:30 am-11:30 am Workshop I *Cleveland Museum of Natural History*
Diagnosing treponemal infection in human skeletal remains
Hosted by Brenda J BAKER, Maciej HENNEBERG, Charlotte A ROBERTS, Ann LW STODDER

8:30 am-11:30 am Workshop II *Hilton Center Street A*
Assessing methods of recording cranial porotic lesions
Hosted by Amy ANDERSON, Dale HUTCHINSON, Marie DANFORTH

Lunch **11:30 am-1:30 pm**

1:30 pm-2:15 pm Keynote lecture **Chair Niels LYNNERUP** *Hilton Hope BC*
The dead teaching the living: Contribution of the Hamann-Todd Osteological collection to paleopathology
Yohannes HAILE-SELASSIE

2:15 pm-3:30 pm Podium Presentation – Part I **Chair Sharon DeWITTE** *Hilton Hope BC*

2:15 **Townscapes: Reflections on Middle Bronze Age life in Sidon (Lebanon)**
Chris STANTIS, Nina MAARANEN, Arwa KHARABI, Holger SCHUTKOWSKI

2:30 **Skeletal evidence of violent conflict in Judea during the 2nd-1st century BCE**
Piers D MITCHELL, Jenna M DITTMAR, Yossi NAGAR, K ARVIV, Tehilah LIEBERMAN

*** Entrant for the Cockburn Student Prize

++ Entrant for the Early Career Prize

- 2:45 [Break]
- 3:00 **Investigating the relationship between diet, mandibular morphology, malocclusion, and dental caries through time in Britain**
Cara S HIRST
- 3:15 **The antiquity of hydrocephalus: reassessment of existing knowledge and multidisciplinary analysis of the cases from the Museum of Anatomical Pathology of the University of Florence**
Francesco Maria GALASSI, Elena VAROTTO, Raffaella SANTI, Gabriella NESI

Coffee break **3:30pm-3:50pm**

Hilton Hope Foyer

- 3:50 pm-5:30 pm** Symposium **Chairs** Anne GRAUER, Anne KATZENBERG *Hilton Hope BC*
Honoring Jane Buikstra, Inaugural editor of *International Journal of Paleopathology*
- 3:50 **Jane Ellen Buikstra: Formative years**
Della Collins COOK
- 4:00 **The birth of Bioarchaeology in North America**
Mary Lucas POWELL
- 4:10 **“Out of the appendix and into the dirt”: The importance of mortuary analysis in Jane Buikstra’s Bioarchaeology**
Megan PERRY
- 4:20 **The “White Plague”: Jane’s contributions to understanding the origin, evolution and history of tuberculosis**
Charlotte A ROBERTS
- 4:30 **Bone chemistry and paleopathology**
M Anne KATZENBERG
- 4:40 **Clarity and nuance: The evolution of data collection in paleopathology**
Ann LW STODDER
- 4:50 **Scientific rigour in palaeopathological diagnosis and interpretation**
Simon MAYS
- 5:00 **Paleodemography and Paleopathology: Two fields with several common, yet still elusive, goals**
George R MILNER
- 5:10 **Burning, bootprints and decapitation: The contributions of Jane E. Buikstra to the maturation of the Forensic Anthropology discipline**
Dawnie STEADMAN
- 5:20 **Closing words**

- 5:30 pm-6:45 pm** Student Action Committee Events *Hilton Hope BC*
- 5:30 pm-6:15 pm** Student Group Discussion Panel **Chair** Ashley DAFOE
Ethics in Paleopathology
 Sharon DeWITTE, Carlina De La COVA, Molly ZUCKERMAN, Sue Guise-SHERIDAN
- 6:15 pm-6:45 pm** Student Group Meeting
- 5:30 pm-10:00 pm** Cash bar followed by *Association Business Meeting* and Dinner *Hilton Hope E*

WEDNESDAY, March 27

- 8:00 am-12:00 pm** Registration *Hilton Hope Foyer*
- 8:30 am- 5:00 pm** Student Action Committee Raffle
- 8:30 am-10:00 am** Podium Presentation – Part II **Chair** Simon MAYS *Hilton Hope BC*
- 8:30** **Exploring a new scoring scheme for the cribrous syndrome in relation to anaemia: A pilot study on an early Bronze Age cemetery in Northwestern China**
 Jennifer AUSTEN, Ruilin MAO, Hui WANG, Hui-Yuan YEH, Mary LEWIS ***
- 8:45** **Subadult scurvy in Peru: Potential cases in postcontact Mórrope**
 Mikayla K MATHEWS, Haagen KLAUS
- 9:00** **Can we identify cystic fibrosis from skeletal remains?: A proposed differential diagnosis**
 Melanie M BEASLEY, Clare REMY ++
- 9:15** **A new methodological approach to nasal trauma in Portuguese individuals from two documented osteological collections (19th-20th centuries)**
 Ana Luísa SANTOS, Simon MAYS, Bruno M MAGALHÃES
- 9:30** **Ancient DNA analysis: Results of a survey of users**
 Charlotte A ROBERTS, Eva FERNÁNDEZ-DOMINGUEZ
- 9:45** **Further incorporation of evidence-based diagnostic criteria for skeletal pathologies into standardized skeletal data recording systems**
 Molly K ZUCKERMAN
- Coffee break **10:00 am-11:00 am** *Convention Center Ballroom BC*

*** Entrant for the Cockburn Student Prize

++ Entrant for the Early Career Prize

10:00 am-11:30 am Poster Symposium

Convention Center Ballroom BC

Paleopathology and the rise of Industry

Hosted by Gillian CRANE-KRAMER, Jo BUCKBERRY

Influences of urbanization and industrial development on human health in premodern Japan

Tomohito NAGAOKA

Are the identified collections of immature skeletons dating from the Industrial Revolution good references for paleoanthropological studies? The example of France

Hélène COQUEUGNIOT, Antony COLOMBO, Olivier DUTOUR

Bioarcheological data and 18th to early 20th century's medical literature: Paleoevidence of rickets through the French industrial revolution

Antony COLOMBO, Hélène COQUEUGNIOT, Olivier DUTOUR

Secular trend in skeletal growth among urban Japanese during the Edo period (1603-1867)

Nana NAKAYAMA

Investigating the association between physiological stress and skeletal pathology in London: Incremental dentine analysis of 19th century dentine collagen

Ruth O'DONOGHUE, Julia BEAUMONT

The intersections of industrialization: Variation in physiological stress indicators by age, sex, and socioeconomic status

Samantha YAUSSY

The Proud Tower in the town: Cholera and tuberculosis among the working poor in early twentieth century Milwaukee

Norman SULLIVAN, Sydney RESLER, Noel HINCHA, Sean DOUGHERTY, Colleen MILLIGAN

Did the rise of industry was also those of tuberculosis? Epidemiological evolution of TB in France (18th-20th cent.) inferred from osteoarchaeological and historical archives

Olivier DUTOUR, Antony COLOMBO, Hélène COQUEUGNIOT

Industrialization and the prevalence of osteoarthritis in the United States

Ian WALLACE, Robert D JURMAIN, Daniel E LIEBERMAN

The cooper, the sailor, and the shoemaker's wife: Occupational hygiene amongst London's eighteenth-century working poor

Madeleine MANT

Dietary patterns and migration in pre-industrial Copenhagen

Marie Louise S JØRKOV, Janet MONTGOMERY, Darren R GRÖCKE

10:00 am-11:30 am Poster Session I *Convention Center Ballroom BC*
 Posters in place all day. Authors of ODD numbered posters will be present during this break. Poster titles and authors listed, alphabetically, at the end of the program.

Let's Do Lunch (optional) **11:30 am-1:45 pm**

1:45 pm-2:45 pm Podium Presentation – Part III **Chair** Sandra GARVIE-LOK *Hilton Hope BC*

1:45 **Prehistoric shark attack victim from Tsukumo, Okayama Prefecture, Japan: Skeletal mapping and patterning in 3D GIS**

J Alyssa WHITE, John POUNCETT, Rick SCHULTING, George BURGESS, Masato NAKATSUKASA, Soichiro KUSAKA, Yasuhiro YAMADA, Minoru YONEDA ***

2:00 **Sutural anomalies as a possible indicator of complex syndromes at Koster Mounds (Greene County, Illinois)**

Lita SACKS ***

2:15 **Reconstructing physical impairment in Medieval Cambridge society: A biomechanical approach**

Jenna M DITTMAR, Bram MULDER, Piers D MITCHELL, Sarah INSKIP, Benjamin NEIL, Craig CESSFORD, Jay STOCK, John ROBB

2:30 **Hard beginnings in Colonial Otago, New Zealand: Deciduous dental defects associated with in-utero vitamin D deficiency?**

Anne Marie E SNODDY, Hallie R BUCKLEY, Peter PETCHEY, Siân E HALCROW, Charlotte L KING, Rebecca L KINASTON, Lisa MATISOO-SMITH

2:45 pm-4:00 pm Poster Session II *Convention Center Ballroom BC*

Posters in place all day. Authors of EVEN numbered posters will be present during this break. Poster titles and authors listed, alphabetically, at the end of the program.

Coffee break **3:00 pm-4:15 pm** *Convention Center Ballroom BC*

4:15 pm-5:45 pm Podium Presentation – Part IV **Chair** Dong Hoon SHIN *Hilton Hope BC*

4:15 **Paleopathology of two Neolithic mass burials from Jagodnjak, Croatia**

Mario NOVAK, Dinko TRESIĆ PAVIČIĆ, Ivor JANKOVIĆ

4:30 **The effects of selective breeding on incidence of bone disease in domesticated dogs (*Canis familiaris*)**

Elizabeth W UHL

- 4:45 **Recent updates in phylogenetic analysis of ancient trematodes using the feces of Korean mummies of Joseon Dynasty**
Jong Ha HONG, Chang Seok OH, Min SEO, Dong Hoon SHIN
- 5:00 **Tycho Brahe, Danish Renaissance man: A rich table but short life**
Niels LYNNERUP, Sacha KACKI, Petr VELEMINSKÝ, Sylva KAUPOVÀ, Alizé L JEANSON, Ctibor POVYSIL, Martin HORÀK, Jan KUCERA, Kaare LUND RASMUSSEN, Jaroslav PODLIŠKA, Zdenek DRAGOUN, Jiri SMOLIK, Jens VELLE, Jaroslav BRUZEK
- 5:15 **On fevers and other foes of humankind: An inventory of diseases that raged the city of Almada (Portugal) during the late 18th century**
Francisco CURATE, Telmo ANTÓNIO
- 5:30 **Postcranial and cranial trauma comparative analysis of the Mississippi State Asylum skeletal assemblage (AD 1855-1935)**
M Cate McALPINE, Andrea M LOPEZ, Petra BANKS

5:45 pm Closing Remarks and Announcements, Award of Cockburn Student Prize and Early Career Prize, Announcements of Student Group Raffle and Silent Auction **Chair** Niels LYNNERUP

FRIDAY, March 29 AAPA-PPA joint session

Convention Center Ballroom A

The evolution of syphilis: A new approach

Hosted by Brenda BAKER

Details of the program on page 10

Posters (in alphabetical order of 1st author)

1. **The Fremont in the basement: A case study of perimortem processing, infectious disease, and *genu valgum* from Northern Utah, ca AD 975**
Meghan BANTON, Derinna KOPP
2. **No rest for the weary or young: Adolescent spinal health in the Milwaukee County Poor Farm Cemetery (1882-1925)**
Sarah A BONCAL
3. **A biological approach to evaluation of porotic lesions of the orbital roof and cranial vault**
Megan B BRICKLEY
4. **Mortality of twins in the archaeological record: new evidence from Papdomb, Valeni, Romania (17th century)**
Irene Hochgraf CAMERON, Allison MCCOSKEY, Jane GROSSMAN, Jonathan D. BETHARD, Katie ZEJDLIK, Zsolt NYÁRÁDI, Andre GONCIAR
5. **Pars basilaris porosity in non-adults from 17th century Transylvania**
Chaunese MJ CLEMMONS, Jonathan D BETHARD, Andre GONCIAR, Zsolt NYARADI
6. **Perceived offset between tooth types, formation rates and the timing of enamel defects in incremental dentine stable isotope profiles**
Kayla CROWDER, Janet MONTGOMERY, Darren R GRÖCKE, Mihai GLIGOR, Nyárádi ZSOLT ***
7. **Looking at individuals for once: what does the association between stress markers and isotopes tell us about individual lifestyle costs in Brazil (3,137-1,524 years BP)?**
Marina Di GIUSTO, Veronica WESOLOWSKI ***
8. **Childhood, parasites, and anemia: A case study analysis of a subadult burial from the 18th century Fortress of Louisbourg, Nova Scotia**
Mattia FONZO, Amy B SCOTT, Michael DUFFY ***
9. **Diary of a tooth: Harnessing the power of citizen science in bioarchaeology**
Julia GAMBLE, Rebecca FERRELL
10. **Improving observer error in orbital roof lesion analysis: A new classification system**
Brianna GARDNER, Tina JAKOB, Marie Louise JØRKOV
11. **Airborne environmental contamination: an ancient source of pinworm infections, Zape caves, Mexico**
Darwin HERTZEL, Elisa PUCU, Karl REINHARD, Jessica SMITH, Brandon STRAUSS
12. **New evidence of spinal tuberculosis from the Eastern Han Dynasty in China (AD 25-220)**
Mocen LI, Charlotte ROBERTS, Peter ROWLEY-CONWY, Liang CHEN, Dongyue ZHAO

*** Entrant for the Cockburn Student Prize

++ Entrant for the Early Career Prize

- 13. Difficulties in remote visualization and differential diagnosis of an isolated lesion in a child mummy from Kagamil Island, Alaska**
Kristin M MACAK, Janine HINTON, J Christopher DUDAR
- 14. A perimortem hip fracture in an adult woman from the Terry Collection**
Brianna MORGAN, Madeleine MANT, Carlina DE LA COVA, Megan BRICKLEY ***
- 15. Buried with wound: A case study of trauma from Farmana, India (c. 2400 BCE)**
Veena MUSHRIF-TRIPATHY, VS SHINDE
- 16. Tobacco smoking and tuberculosis in the Lower Illinois River Valley**
Savannah Leach NEWELL, Krystiana L KRUPA, Jonathan KARTY ***
- 17. A closer look at Morse's *Ancient Disease in the Midwest*: is 11:640-64 a case of polytrauma?**
Olof OLAFARDOTTIR, Krystiana KRUPA
- 18. Differences in rib fractures across temporal and spatial contexts: Comparing urban roman and historical rib fractures**
Taylor PEACOCK, Megan BRICKLEY ***
- 19. Patellar variants: frequency and etiology in pre-Hispanic Peru**
Sara S PHILLIPS, Anne R TITELBAUM
- 20. Growing up in Ancient Kerma (1750-1550 BC), Sudan: An investigation of childhood nutritional stress and age at death using vertebral neural canal size**
Kaitlyn SANDERS ***
- 21. Comparing demographic and pathological factors affecting osteocalcin concentrations in archaeological skeletal remains**
Amy B SCOTT, Mathew J COLLINS, Alberto TAUROZZI, Ioannis KONTOPOULOS, Dorthe DANGVARD PEDERSEN
- 22. Himera (Sicily): Estimating allostatic load and age-at-death using stress indices**
Safaa N SIDDIQUI, Britney KYLE, Stefano VASSALLO, Laurie J REITSEMA
- 23. Modernizing medical museums through the 3D digitization of pathological specimens**
Terrie SIMMONS-EHRHARDT, Brian F. SPATOLA, Bernard K. MEANS, Audrey D. SCHAEFER, Kristen E. PEARLSTEIN
- 24. A rare case of humeroradioulnar synostosis from late medieval Pawłów-Trzebnicki, Poland**
Victoria M SWENSON, Anna SPINEK ***
- 25. Three cases of brachydactyly from two tombs at the Late Intermediate Period site of Marcajirca, Department of Ancash, Peru**
Anne R TITELBAUM, Sam FRESH, Bronwyn MCNEIL, Bebel IBARRA ASENCIOS

*** Entrant for the Cockburn Student Prize

++ Entrant for the Early Career Prize

- 26. Patterns of degenerative joint disease in diabetics *versus* controls in two documented historical North American human skeletal collections**
Charity F UPSON-TABOAS ***
- 27. Pediatric paleo-nephropathology in the 16th century natural mummy of the illegitimate granddaughter of John II, King of Portugal**
Elena VAROTTO, Francesco Maria GALASSI, Nathalie ANTUNES-FERREIRA
- 28. Multiple skeletal pathologies in a Neolithic Sicilian adult male (5th millennium BC)**
Elena VAROTTO, Maria Teresa MAGRO, Francesco Maria GALASSI
- 29. Health on Medieval Isle of Man: A paleopathological analysis of Rushen Abbey (AD1134- 1540)**
Marie C WEALE ***
- 30. Pathological changes associated with resorption of a proximal femur from New Kingdom Tombos, injury or disease?**
Katie M WHITMORE, Michele R BUZON ***
- 31. Vertebral fractures and developmental anomalies in Carolingian Altenerding, Germany**
Leslie Lea WILLIAMS, Kendra S WEINRICH
- 32. A differential diagnosis of Fournier's molars in an individual from Santo Domingo Church (1541-1773), Guatemala**
Paige Wojcik WOOLFOLK, Rosalba Yasmin CIFUENTES ARGÜELLO
- 33. If you can't fix it, cut it off: Evidence of underlying congenital defects, accidental trauma, and perimortem amputation in a young adult from the 19th century Bethel Cemetery, Indianapolis (USA)**
Gretchen ZOELLER, Allie POWELL

FRIDAY, March 29 AAPA-PPA joint session (Abstracts are in AAPA Meeting Program Abstracts)

- The evolution of syphilis: A new approach** *Convention Center Ballroom A*
Invited Podium Symposium Hosted by Brenda BAKER
- 2:30 **Treponemal infections: One disease or many?**
SA LUKEHART, DC MABEY
- 2:45 **Disease ecology and the relationship of human- and nonhuman primate infecting *Treponema pallidum***
S KNAUF, C ROOS
- 3:00 **Phylogenetic investigations of *Treponema pallidum* and related spirochetes**
S WININGEAR, AC STONE
- 3:15 **Historic *Treponema pallidum* genomes: Towards a reconstruction of the evolution of treponemal diseases using ancient DNA**
VJ SCHUENEMANN
- 3:30 **Radiocarbon evidence pertaining to the origin and spread of treponemal disease**
M DEE
- 3:45 **A biogeochemical assessment of treponemal disease: Diagnosis, host mobility, & mercury treatment**
LA GREGORICKA
- 4:00 **A critical review of diagnostic criteria used to identify treponemal infection in human skeletal remains**
BJ BAKER
- 4:15 **Treponemal disease in Europe: A critical review of the skeletal evidence**
CA ROBERTS
- 4:30 **Silent evidence of Pre-Columbian treponemal infection in the Western half of the Old World**
M HENNEBERG, RJ HENNEBERG
- 4:45 **Evaluating the evidence of treponemal disease from India**
V MUSHRIFTRIPATHY
- 5:00 **The antiquity of Treponemal disease in the Asia-Pacific regions: Implications for settlement history**
HR BUCKLEY, M VLOK, K DOMETT, H HOANG TRINH, M OXENHAM
- 5:15 **Sociopolitical patterns in treponemal disease prevalence in the pre-Columbian eastern United States**
MO SMITH, TK BETSINGER
- 5:30 **Discussion:** Moderated by Brenda BAKER

Workshop I

Diagnosing treponemal infection in human

skeletal remains Hosted by Brenda J BAKER (Arizona State University, USA), Maciej HENNEBERG, Charlotte A ROBERTS (Department of Archaeology, Durham University, England), Ann LW STODDER (Musuem of New Mexico, USA)

The evolution and distribution of treponemal disease has been long debated. Persistent gaps in our knowledge are complicated by issues of data comparability and the proliferation of “possible” evidence, compromising our understanding of this infection.

This workshop promotes:

- awareness of the range of lesions caused by treponemal infection (yaws, bejel, and syphilis) in human skeletal remains
- use of standard diagnostic criteria and approach for recording skeletal pathology
- consideration of contextual information

At the Cleveland Museum of Natural History, participants will examine skeletons from the Hamann-Todd collection with known cause of death. Documentation and diagnosis of treponemal infection is emphasized rather than differentiation among variants that cannot be distinguished clinically. Criteria for diagnosing treponemal disease, including congenital infection and lesion specificity and sensitivity, are addressed, stressing the macroscopic and radiographic appearance of lesions in dry bone and their use in differential diagnosis.

The workshop prioritizes documentation of lesion distribution (single vs. multiple bones, or teeth, affected; unilateral or bilateral; symmetrical or asymmetrical), the degree of preservation and observability of each bone or tooth, characteristics of bone lesions (destructive, proliferative, or both), dental enamel reaction (including response to mercury treatment), and the state of bone reaction (active, healed, or mixed). Participants record pathology in one skeleton and survey others: some

with known treponemal infection, some with conditions relevant for differential diagnosis, and others with lesions consistent with, but not specific to, treponemal disease. Some examples will be provided with imaginative histories and questions designed to spark consideration of individuals within broader contexts.

Workshop II

Assessing methods of recording cranial porotic

lesions Hosted by Amy ANDERSON (University of California Santa Barbara, USA), Dale HUTCHINSON (University of North Carolina, USA), Marie DANFORTH (University of Southern Mississippi, USA)

Porotic cranial lesions are one of the most commonly observed pathological lesions in skeletal assemblages. Osteologists commonly record these lesions using one of several existing visual systems for classifying gross lesion morphology. However, neither the standardization of scores from one system to another nor the inter-observer reliability of the most commonly used systems has been formally tested (with the notable exception of Jacobi and Danforth, 2002). There have been several theoretical discussions of the etiology of porotic lesions since 2002, and it seems time to revisit their observation and interpretation. Inconsistent scoring likely prevents researchers from assessing subtle differences in lesion morphology and may mask important connections between aetiology, ecology, and behavior. This workshop is intended to focus on the pathophysiology of PH/CO and the morphological classification of macroscopic lesions. It will address the merits and challenges of current classification systems in order to move towards a consensus in the international osteological community on data collection protocol.

Symposium Honoring Jane Buikstra, Inaugural editor of *International Journal of Paleopathology*

Jane Ellen Buikstra: Formative years Della Collins
COOK (Indiana University, USA)

Jane's father was a physician in Evansville, Indiana, and her mother managed his office, setting Jane's scientific course. She attended De Pauw, earning her Anthropology B.A. in 1967, doing fieldwork with her mentor Edward Dolan and with James Kellar of IU. She entered graduate school at University of Chicago that fall, earning her M.A. in 1969 and her PhD in 1972.

Chicago's graduate program was amazing in those years. There were two physical anthropology doctoral programs, one in Anthropology and one in Anatomy. One could mix and match, and students were encouraged to explore the resources of the Committee on Evolutionary Biology and the Medical School. Charles Merbs, Albert Dahlberg and Russell Tuttle were important mentors, and projects begun in their seminars became her early publications.

In 1969 Merbs included her in his excavations on Southampton Island and arranged for her to work at Pete Klunk Mounds with Greg Perino. Though he had no degrees, Perino was a mentor to generations of archaeologists and physical anthropologists, as well as the excavator of large Midwestern skeletal collections that have been central to her research and teaching.

In 1970 she began as a lecturer at Northwestern, advancing to Professor, becoming integral to its archaeological research and transforming its field programs. While there she added Puerto Rico, Argentina, Brazil and Peru to her field experience and publication record. When she left NU for University of Chicago in 1986, the momentum of her remarkable career was already astonishing. It has never slowed.

The birth of Bioarchaeology in North America

Mary Lucas POWELL (Retired, USA)

Jane Buikstra is often credited with introducing the term 'bioarchaeology' into North American archaeology. How did this come about? In 1976, Buikstra participated in a symposium organized by Robert Blakely at the Annual Meeting of the Southern Anthropological Society. In her presentation, she announced "[a] new form of regionally based, interdisciplinary research in mortuary site archaeology and human osteology..." that featured "the active participation of both archaeologists and physical anthropologists in all phases of research design". This term had first appeared in European archaeological circles four years earlier by Cambridge archaeologist Grahame Clark as a synonym for 'zooarchaeology'. In 1991, Buikstra described early applications of this new comprehensive approach in her chapter in an edited volume that surveyed the current state of bioarchaeological research in the Southeastern United States. Since those early days, this "new" approach to the analysis of human remains has matured in both theory and methodology, to become the *sine qua non* for scientific analysis of human skeletons from archaeological contexts worldwide. Bioarchaeology students ideally receive intensive training in both archaeology and physical anthropology, emphasizing the necessity of understanding both cultural context and recovery methods as well as the biological dimensions of human remains.

Buikstra has also made singular contributions to one particular aspect of bioarchaeology: paleopathology, the study of health and disease in ancient populations, both human and non-human. Her decades-long interest in the origins and nature in the New World of one infectious disease, tuberculosis, prompted the identification of its earliest manifestations in coastal South America and its gradual appearance throughout prehistoric North America. She has indeed brought the scientific study of human remains from archaeological sites "Out of the Appendix and into

the Dirt”, to the benefit of our understanding of the co-evolution of humans and pathogens.

“Out of the appendix and into the dirt”: The importance of mortuary analysis in Jane Buikstra’s

Bioarchaeology Megan PERRY (East Carolina University, USA)

It has been over 40 years since Jane Buikstra first coined the term “bioarchaeology” to describe the integrated, population-level analysis of human remains recovered from archaeological contexts. The discipline today has expanded into realms barely imaginable in the 1970s to include aDNA analysis of humans and their pathogens and microbiota, isotopic and elemental investigations of diet and migration, μ CT scanning of pathological lesions, and methodologically- and statistically-sophisticated approaches to paleodemography. These scientific advances often overshadow the “archaeology” in bioarchaeology, which, as originally envisioned by Jane, broke the discipline from a purely descriptive science. The laboratory emphasizes the biological and material aspect of skeletal samples, but when placed into their archaeological context these skeletal remains embody a dynamic community – and the mortuary context becomes the scene in which this community expressed and commemorated their social identities, relationships, and conflicts as well as feelings surrounding death and the afterlife. Furthermore, illuminating the social aspects of skeletal sample creation provides an essential component to bioarchaeological analysis – identifying potential sources of bias in the sample. Thus, bioarchaeology’s true strength – one that moves it out of the appendix – is its careful study of the archaeological context from which the remains came. Jane Buikstra’s work along with that of other bioarchaeologists provide salient examples of how wedding the biological and social aspects of human remains creates a deeper understanding of ancient humans.

The “White Plague”: Jane’s contributions to understanding the origin, evolution and history of tuberculosis

Charlotte A ROBERTS (Department of Archaeology, Durham University, England)

TB is the leading cause of death from a single infectious agent, particularly affecting the poor. Approximately 10 million people developed TB disease in 2017; 1.3 million died. Twenty-three per cent of the world’s population are estimated to have latent TB (WHO 2018). While there have been advances in reducing the burden of TB since the early 1990s, there remain challenges (e.g. multi-drug resistance, non-diagnosis, and funding gaps. In 1993 the World Health Assembly declared a global emergency on TB, and in 2014 it passed a resolution approving the new post-2015 End TB Strategy with ambitious targets (WHO 2015). Most recently (September 2018), world leaders committed to bold targets and urgent action to end TB in our world. We know that TB has a long history, as seen in the bioarchaeological record, but it clearly remains a challenge today. This emphasizes how important it is for bioarchaeologists to consider focusing on present day diseases that also affected people in the past, thus providing a deep time perspective and hopefully contributing to understanding them better today. Jane has not shied away from doing this in her TB research. This presentation has three parts: 1. Jane’s contributions since the late 1970s, with a particular focus on her most recent work using ancient DNA analysis; 2. The impact of this work on my research, and the field of paleopathology overall; and 3. How the Int. J. Paleopathology has embraced research on TB since it was founded in 2011.

References

- World Health Organization 2015. *The end TB strategy*. Geneva, WHO
- World Health Organization 2018. *Global tuberculosis report*. Geneva, WHO

Bone chemistry and paleopathology M Anne KATZENBERG (University of Calgary, Canada)

Jane Buikstra has been at the forefront of developments in the field of bioarchaeology throughout her career. In her 1980 contribution to *Annual Reviews in Anthropology*, with co-author, Della Cook, she reviewed the then nascent research on “Paleonutrition” - trace elements and stable carbon isotopes and their potential for addressing important questions in paleopathology. Jane was a participant in the first Advanced Seminar on Paleodiet, held in Santa Fe in 1986 at the School of American Research. With colleague, George Milner, she explored diet shifts in prehistoric Illinois using stable isotopes, and later added to those studies with Stanley Ambrose and Hal Krueger working on Cahokia. Her goal was to refine estimates of the timing of diet change in order to better link diet and disease. As inaugural editor of *IJPP*, she has published many papers that incorporate stable isotope analyses of hair and/or bone in investigations of past health and disease.

Clarity and nuance: The evolution of data collection in paleopathology Ann LW STODDER (Office of Archaeological Studies, The Museum of New Mexico, USA)

Observations about pathologies in human remains have been recorded in composition books and journals, on index cards and legal pads, on punch cards and FORTRAN forms, on laptops and tablets, supplemented by reams of notes, sketches, photographs, radiographs, and scans. No matter the medium, methodological clarity and reproducibility determine the value of any data set. The development in the early 1990s of systematic paleopathology data collection protocols by the Paleopathology Association, and the broad distribution of the protocols in Buikstra and Ubelaker’s *Standards for Data Collection from Human Skeletal Remains* and the accompanying *Standardized Osteological Database* (Harris and Rose) represent a significant force in the professionalization of paleopathology. New research fuels ongoing refinements and expands

the scope of data collection, but methodological transparency is the framework that moves the work forward. The commitment to data quality provides the foundation for the current emphases on greater scientific rigor in differential diagnosis, for the focused training that the current generation of students enjoys, and for the publication of new and innovative research and interpretation. The multi-scalar approach embraced by the *International Journal of Paleopathology* – case studies, osteobiographies, and population studies – and the commitment to nuanced treatment of archaeological context stimulate the multidisciplinary energy that characterizes paleopathology today. We deal with detail, and we deal with uncertainty. Our ability to transform myriad small data points into information, and thence into knowledge of health in the past, owes much to Jane Buikstra’s foundational work, vision, and endurance.

Scientific rigour in palaeopathological diagnosis and interpretation Simon MAYS (Historic England, UK)

Over the last several decades, palaeopathology has developed from a status largely as a vassal to the clinical sciences and medical history, into a fully-fledged discipline with its own distinct research priorities, its own set of core research methods, and its own publishing venues. Diagnosis of disease from skeletal alterations is at once one of the most important, and the most problematic of our methodologies. The taking of major steps toward placing the diagnostic process within an explicit and increasingly rigorous scientific framework has been an important advance: it is a signifier of the maturity of our discipline, and it has helped to foster more productive relationships between palaeopathology and the clinical sciences. As regards publishing venues, the *IJPP* now provides a focus for the dissemination of the most cutting-edge research in palaeopathology. However, in keeping with its status as the journal of our Association, its editors have been effective at exerting leadership, using the journal to gently steer the field toward the most pressing research problems in diagnosis and elsewhere. It is from

these perspectives that Jane's contribution, both as researcher and journal editor, to promoting rigour in palaeopathological diagnosis and interpretation is assessed.

Paleodemography and Paleopathology: Two fields with several common, yet still elusive, goals

George R MILNER (Penn State University, USA)

Two related areas of skeletal research – paleodemography and paleopathology – share several goals that include characterizing past life, establishing how it varied in relation to varied socioeconomic settings, and understanding why it changed in the ways it did over time. Over 40 years ago, Jane Buikstra's pioneering work explored both the age-at-death structure and pathological bony lesions characteristic of the prehistoric peoples of the lower Illinois River valley. Since that time, paleodemography and paleopathology have been transformed by developments in analytical methods, the sheer volume of information available, and interpretive sophistication. Today we can look forward to a fusion of what has previously been two loosely linked fields into one: paleoepidemiology. This fusion promises to provide quantitative assessments of the disease experience of past communities, moving us from counts of bony lesions in mortality (skeletal) samples to an approximation of the life experiences of past people. Doing so requires new analytical procedures and accurate age estimates. Problems with obtaining the latter, notably for adults, have plagued paleodemographic work for decades. Fortunately, recent developments in analytical methods focused on a broader array of age-informative skeletal traits are poised to provide the level of accuracy necessary for paleoepidemiological assessments of past communities.

Burning, bootprints and decapitation: The contributions of Jane E. Buikstra to the maturation of the Forensic Anthropology discipline

Dawnie STEADMAN (University of Tennessee, USA)

Forensic anthropology is the application of skeletal biology to medicolegal questions. Forensic anthropologists tackle diverse tasks in casework, including locating and recovering human remains, identification of skeletonized, fragmentary, decomposed and burnt remains, assessing trauma, and estimating the postmortem interval. The purpose of this paper is to illustrate how Dr. Buikstra's research has directly and indirectly shaped the contemporary discipline of forensic anthropology. While she successfully led bioarchaeology "out of the appendix" and into a mainstream academic pursuit, her lasting contribution to forensic anthropology is perhaps under-appreciated. Various circumstances constrained her forensic case load, but it is her research that has most influenced the field. Intellectual curiosity about the intersection of culture and biology manifest in the human skeleton lies at the academic heart of all of her work, and this holistic perspective and problem-oriented approach defines her approach to forensic problems. For instance, a case of decapitation motivated her to produce an indepth study of individuation that is the basis of osteometric sorting methods in forensic anthropology today. She also tested a controversial practice of footprint analysis that ultimately helped to debunk the notion that shoeprints are accurate predictors of stature. Much of her work cross-fertilizes both paleopathology and forensic anthropology, including foundational work in paleopathology, taphonomy, aging and stable isotopes.

Poster Symposium

Paleopathology and the rise of industry Hosted by Gillian CRANE-KRAMER, Jo BUCKBERRY

The health of human populations, past and present, are influenced by external factors including population density, economy and subsistence. Major research has investigated the negative impacts the transition to agriculture and shift to complex societies have had on population health; the third major global transition is industrialization. The Industrial Revolution of the 18th Century represents one of the most significant social and biological transitions in human history. Like the adoption of agriculture, the rise of the Industrial Age transformed human society at all levels. It resulted in a large migration from rural to urban environments, and this transformation in human demographics had wide-reaching impact upon human health and quality of life. In addition, the resultant changes in the natural environment brought on by the process of industrialization provided new and lethal challenges to the human immune system. Popular perceptions of Victorian population health, exemplified by contemporary writers such as Dickens and Gaskell, include crowded slums, wide spread disease, hazardous working conditions, poor childhood health and low life expectancy; negative trends in health that we believe began in the 18th century. Skeletal evidence of disease appears to support these perceptions, with high rates of rickets, trauma, TB and neoplastic disease evident within excavated populations, but there has been limited synthesis of these data to date. This seminar focuses upon an evaluation of the skeletal and documentary evidence from diverse regions, in order to provide a holistic view of changes in health with the Rise of Industry. This session will provide scholars with an opportunity to discuss the complex issues that influence the length of life, alongside data on the quality of life for different segments of society during the creation of the modern world.

Influences of urbanization and industrial development on human health in premodern

Japan Tomohito NAGAOKA (St. Marianna University School of Medicine, Japan), Nana NAKAYAMA (Waseda University, Japan)

Industrial revolution involved the technological innovation of manufacturing systems and began during the Meiji Period (1868–1912) in Japan. The aims of this study are to examine the impact of urbanization and industrial development on health status in Japan, using the human remains from the Early Modern Edo (1603–1867) and Meiji Periods, and to elucidate the secular trends in their paleodemographic and paleopathological features. Here, the Edo Period corresponds to the era that the urbanization in Japan began and can be regarded as the prerequisite factor for industrial development.

The human skeletons belonging to the Edo Period were those from the urban (n=99) and rural (n=311) areas, as well as from the early (n=31) and late (n=93) half of the period. The human remains from the Meiji Period were those donated to the medical school for cadaver dissection or the deceased criminals (n=152). Although there are potential biases affecting the donated sample, it is safe to say that the Meiji sample represents the underclass of that period. This study examined their paleodemographic and paleopathological features and considered the impacts of industrial development on health.

The urbanization of the Edo Period had negatively impacted on the age-at-death distribution, as the higher rate of young deaths was detected in the urban area than in the rural areas both in the age-indicator stages and in the estimated ages. The rate of young deaths decreased within the Edo Period. In the Meiji Period, however, the rate of young death increased. Both the skeletal age composition and documented ages in the Meiji Period showed the consistent result that the rate of young deaths was higher than the Edo Period. These results strongly suggest that urbanization and industrial development led to the decline in lifespan and health.

Are the identified collections of immature skeletons dating from the Industrial Revolution good references for paleoanthropological studies? The example of France

Hélène COQUEUGNIOT (EPHE-PSL University at Paris, France; University of Bordeaux at Pessac, France; Max Planck Institute for Evolutionary Anthropology at Leipzig, Germany), Antony COLOMBO (EPHE-PSL University at Paris, France; University of Bordeaux at Pessac, France), Olivier DUTOIR (EPHE-PSL University at Paris, France; University of Bordeaux at Pessac, France; University of Western Ontario at London, Canada)

The possible impact on growth of main morbidity and mortality causes (TB, rickets, deficiencies ...) observed during the Industrial Revolution is tested on 2 French identified collections of immature skulls: Paris-Orfila, mid-19th century and Strasbourg, 1872-1918. The first one is composed of skulls (N=46) aged from 0 to 2.5 years at death, with very few information available. The Strasbourg collection includes 162 skulls ranging in age from 0 to 12 years, from both sexes. The sex and calendar ages are taken from dissection reports or inscriptions written directly on the crania. They are accurate to the month, the week, or sometimes the day, depending on the circumstances of the autopsies. Calendar ages of these individuals were compared both to dental and bone maturation ages (Coqueugniot and Weaver, 2007; Coqueugniot et al., 2010; Moorrees et al., 1963a,b). Any differences between these 3 ages, if they are statistically significant, could reflect a potential effect of diseases on growth before death. These results are analyzed in function of the main causes of morbidity and mortality during the Industrial Revolution (mentioned in hospital registers) in order to evaluate their possible impact on growth. This pattern of mortality causes is also compared with data available for periods predating the Industrialization (Christ Church, Spitalfields, identified collection, 1729-1852). This will help the anthropologists to decide whether or not these skeletal collections dating from the second part of the 19th century and early 20th century are

appropriate referential for studying growth patterns among archaeological populations.

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Bioarcheological data and 18th to early 20th century's medical literature: Paleoepidemiology of rickets through the French industrial revolution

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French industrialization began at the end of the 18th-century and accelerated significantly after the mid-19th. Even if no bioarcheological study about rickets exists for this period, a rough estimate of rickets prevalence in France before and after industrialization can be proposed. The bioarcheological study of Schattmann et al. (2016) showed that 50% of children under 5 years-old had rickets in North of France at the 17th-century end, and Mallet (2004) reported 15 to 30% of hospitalized children were with rickets until the 1960s.

To fill the gap in bioarcheological data in France and obtain rickets' paleoepidemiological data during industrialization, we analyzed the 18th-early 20th centuries' scientific literature.

This literature analysis shows rickets would have caused 20% of death in France at the 18th-century end, while at the 19th-century end, rickets affected 40% of the dead *children in care* in the Meuse; 17% of hospitalized children and 43% of autopsied children in Nancy; 34% of children from the working class in Paris. Then, the mid-19th-century

authors linked industrialization with an increase of both working children/poverty and rickets. Schattmann's study and Nancy autopsies show similar rickets prevalences that may suggest that there has been no real rickets increasing. Until late, rickets had no clear definition in France, it was synonymous with dwarfism at the 18th-century end and associated with syphilis and tuberculosis at the early 20th. After the mid-19th century, rickets was better known, understood and detected, explaining at least partially the rickets increase as a result of industrialization.

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Secular trend in skeletal growth among urban Japanese during the Edo period (1603-1867) Nana NAKAYAMA (Advanced Research Center for Human Sciences, Waseda University, Japan)

Human skeletal growth is greatly affected by children's general health status. At the beginning of the Edo period (1603-1867) in Japan, Edo (now Tokyo) saw various social changes that may have influenced the general health status of its urban population. These included a rapid population increase and the establishment of urban infrastructure. This study aims at investigating whether any secular trend in skeletal growth occurred during that time.

Subadult skeletal remains (0-9 years) of the early (the 17th century, n=42) and late Edo periods (the 18-19th century, n=35) excavated in Tokyo were examined to estimate age at death and to measure maximum diaphyseal femur length. Growth curves of diaphyseal length were obtained for each time period by fitting polynomial curves to the data. For damaged femurs, maximum diaphyseal length was estimated from an arbitrarily defined segmental length using a regression equation obtained from the measurements of complete femurs. Maximum

femoral lengths for adults from the early (n=24) and late Edo periods (n=102) were also measured. The growth curve of the diaphyseal femur length in each time period appeared to be similar to each other and a multiple regression analysis demonstrated no significant difference between the two curves. No significant difference among adult mean femoral lengths was found between the two periods. These results indicate no clear secular trend in skeletal growth, and this is not consistent with historical evidence suggesting an improved living environment during the late Edo period. Possible factors affecting the results are also discussed.

Investigating the association between physiological stress and skeletal pathology in London: Incremental dentine analysis of 19th century dentine collagen Ruth O'DONOGHUE, Julia BEAUMONT (Department of Archaeological and Forensic Sciences, University of Bradford, UK)

In clinical contexts, raised nitrogen isotope ratio ($\delta^{15}\text{N}$) values have been observed in sequentially sampled tissues such as blood, hair, and nail, during periods of physiological stress (malnutrition, disease, and trauma) (Neuberger et al. 2013). Recent research has found that physiological stress may be observed in archaeological dentine collagen (Beaumont et al. 2015). This project sought to investigate whether an association may be observed between isotopic stress indicators and skeletal evidence of pathological conditions.

To investigate this individuals were chosen for scientific analysis from two contemporaneous mid-19th century London burial grounds (City Bunhill, St.Mary and St.Michael's). Carbon and nitrogen IRMS incremental dentine analysis was performed on the incrementally sectioned dentine collagen of both deciduous and permanent teeth from these population groups (n=29).

Isotopic profiles were created for each individual spanning from tooth formation until death during tooth development. Individuals for whom skeletal evidence of chronic pathological conditions (e.g. rickets, tuberculosis) were recorded exhibited raised $\delta^{15}\text{N}$ values in the region of 0.5-1.74‰ in the

months prior to death. Raised $\delta^{15}\text{N}$ was not associated with stunted growth or non-specific skeletal stress indicators within this sample group. These findings are significant as they offer the opportunity to broaden the scope of archaeological investigations into disease and the disease process in past populations. This technique affords the potential to examine the link between specific pathological conditions and physiological stress, in order to more fully understand the onset, duration, and impact of specific diseases on childhood health and quality of life in the past.

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The intersections of industrialization: Variation in physiological stress indicators by age, sex, and socioeconomic status Samantha YAUSSY (University of South Carolina, USA)

Intersectionality theory argues that multiple levels of marginalization interact to produce observed patterns of frailty and mortality. Therefore, to better understand the origins of disparate health outcomes, bioarchaeologists should examine the intersections of biological and social factors, rather than only examining such factors separately. This study investigates the intersections of age at death, sex, socioeconomic status (SES), and the presence or value of three nonspecific skeletal indicators of stress (craniofacial fluctuating asymmetry (FA, n=168), cribra orbitalia (CO, n=457), periosteal lesions (PNB, n=436)) among adults (>18 years) using hierarchical log-linear analysis and 3-way ANOVA. The skeletal samples analyzed (St. Bride's Fleet Street, Coach Lane, St. Peter's Wolverhampton, New Bunhill Fields) date to the industrial period in England (18th–19th centuries) when status groups were rigidifying. Statistically significant interactions existed among the variables examined for each skeletal indicator: high SES females had lower frequencies of CO relative to

other groups, high SES males exhibited more pronounced FA relative to other groups, and males between ages 30-45 years exhibited a high frequency of PNB dissimilar to the pattern of consistent age-related accumulation seen in females. Additionally, FA was reduced in females and individuals of low SES, whereas CO was more common in males. These results suggest that patterns of stress indicators are complex and cannot be examined solely across unilateral axes of age, SES, or sex. For example, CO is less common in females when only sex is examined, but lesion absence is unequally distributed between high SES females and low SES females.

The Proud Tower in the town: Cholera and tuberculosis among the working poor in early twentieth century Milwaukee Norman SULLIVAN (Marquette University, USA), Sydney RESLER (Alaska Native Tribal Health Consortium, USA), Noel HINCHA (Marquette University, USA), Sean DOUGHERTY (Milwaukee Area Technical College, USA), Colleen MILLIGAN (California State University-Chico, USA)

By the end of the nineteenth and beginning of the twentieth centuries, industrial cities of North America were a focus for multi-ethnic migrations of labor. In turn-of-the-century Milwaukee, people of German and Polish descent comprised the largest of the immigrant groups. Milwaukee's German community generally had healthier living conditions than that experienced by Polish immigrants. The health experiences of these two ethnic groups are studied with a focus on cholera and tuberculosis which were among the leading causes of mortality in the city. The mortality impact of cholera was determined from surveys of 10,306 municipal death certificates dating between 1895 and 1905. The certificates include attribution of ethnicity and place of residence. Residence of cholera victims (N=1649; .16%) were mapped and were disproportionately in Polish parts of the city. This is explained by the lack of municipal water and sewage systems in Polish neighborhoods as well as the presence of abattoirs along canals adjacent to the area. Data on tuberculosis were compiled from the death certificates as well as making reference

to the burials from the Milwaukee County Almshouse Cemetery. Tuberculosis mortality (N=1134; .11%) was only marginally higher among Polish immigrants than Germans. This is likely due to the relative ease of spreading the tubercle bacillus both from an aerosolized route as well as contaminated food sources. The enteric disease data demonstrate ethnic inequality in mortality and ethnic differences in the timing of the epidemiological transition.

Did the rise of industry was also those of tuberculosis? Epidemiological evolution of TB in France (18th-20th cent.) inferred from

osteoarchoeological and historical archives Olivier DUTOUR (EPHE-PSL University at Paris, France; University of Bordeaux at Pessac, France; University of Western Ontario at London, Canada), Antony COLOMBO (EPHE-PSL University at Paris, France; University of Bordeaux at Pessac, France), H el ene COQUEUGNIOT (EPHE-PSL University at Paris, France; University of Bordeaux at Pessac, France; Max Planck Institute for Evolutionary Anthropology at Leipzig, Germany)

Tuberculosis is considered as the disease of the 19th century, contemporaneously with the rise of industrialization and development of urban areas. The goal of this study is to analyze both osteoarchoeological and historical data for France, from the early 18th to the early 20th centuries, using methods of paleoepidemiology (crude prevalence of TB cases) and historical epidemiology (morbidity and mortality rate by TB), to detect whether the rise of tuberculosis was contemporaneous to the one of Industrial revolution in France, around 1830. The osteoarchoeological data came from plague mass graves (South-Eastern France, about 200 individuals) and the historical data of tuberculosis morbidity and mortality rate from medical archives of four major French cities, ranging from 1750 to 1940 (several thousands of people). Once discussed various methodological biases (skeletal preservation state, errors of registration or wrong diagnoses in ancient medical records...), our results showed that (i) the prevalence of TB could have been already high during the early 18th century in

France, (ii) in big cities, the number of deaths due to TB increased at the rise of industrialization, with the increasing of urban population (over-crowding in poor neighborhoods); (iii) mortality rate by TB is clearly positively correlated to poor socio-economic conditions (iv) TB mortality rate started to decrease in French big cities from 1875, probably due to the massive urban renewal program headed by baron Haussman, (started in Paris from the late 1850s to the 1870s). This study demonstrates the interest of a multidisciplinary approach, including osteoarchoeological and historical data, to reconstruct the past of human infectious diseases.

Industrialization and the prevalence of osteoarthritis in the United States

Ian J WALLACE (Department of Human Evolutionary Biology, Harvard University, USA), Robert D JURMAIN (Department of Anthropology, San Jose State University, USA), Daniel E LIEBERMAN (Department of Human Evolutionary Biology, Harvard University, USA)

Although osteoarthritis is not a new disease and has been observed in skeletons of prehistoric humans, the current high prevalence of osteoarthritis in developed nations is typically considered a consequence of the epidemiological transition. During this shift, which occurred in the United States from the late 19th to mid-20th centuries, industrial-era improvements in sanitation and medicine lowered rates of infectious diseases and malnutrition and extended life expectancy, which led to a rise among older people in chronic, non-infectious diseases, presumably including osteoarthritis. To better understand the impact of industrialization on osteoarthritis levels, we traced the history of knee osteoarthritis prevalence in the United States using a large sample of cadaveric and archeological skeletons (n = 2576) of people aged 50 years and older, spanning from prehistoric times to the modern post-industrial era. Osteoarthritis was diagnosed based on the presence of eburnation (polish from bone-on-bone contact). After controlling statistically for age at death, sex, ethnicity, and other variables, we found that knee osteoarthritis

prevalence is 2.1-fold higher (95% confidence interval, 1.5–3.1) today than in the past, but the major spike in prevalence, rather than occurring during the industrial era, happened just within the last half-century during post-industrial times. Our analyses challenge the view that current high levels of osteoarthritis in developed countries are an inevitable consequence of people living longer since the industrial era, and instead point to additional potential risk factors that have become pervasive only very recently, including obesity, metabolic syndrome, dietary changes, and physical inactivity.

The cooper, the sailor, and the shoemaker's wife: Occupational hygiene amongst London's eighteenth-century working poor Madeleine MANT (Memorial University, Canada)

Eighteenth-century studies of occupational hygiene make little to no mention of broken bones, leaving fractured bodies on the margins of discussions of hazards associated with the industrial revolution. The skeletal remains of 721 individuals (402 males and 319 females) excavated from five working class cemeteries (St. Bride's lower churchyard, St. Thomas' Hospital, Cross Bones, Payne Road and Bow Baptist, and Royal London Hospital) who lived during the long eighteenth century in London, UK (curated by the Museum of London Centre for Human Bioarchaeology) were examined for evidence of antemortem and perimortem trauma. In addition, all extant 18th-century hospital admission and discharge records from the seven general hospitals operating in London (Westminster, Royal London, Middlesex, Guy's, St. Thomas', St. Bartholomew's, and St. George's) were examined, resulting in a sample of 9919 individuals (6647 males and 3272 females) with surviving details concerning admission date, reason for admission, and date of discharge. There was a positive linear correlation in the average number of femoral, tibial, and fibular fractures in both males (n = 502) and females (n = 275) admitted to the Middlesex Hospital over time (1760-1788), while fractures to the long bones of the arms decreased over the same period. The Royal London Hospital

admittance registers recorded individuals' occupations, revealing that male labourers were more likely to be admitted for a fracture than male tradesmen, members of the armed forces, or agricultural workers. Female workers, such as nurses, charwomen, and servants, also suffered a variety of simple and compound fractures. Contextualizing the skeletal results (188 males and 77 females displayed evidence of antemortem fracture; two males and one female displayed perimortem trauma) with these occupational data aids in considering occupational trauma alongside accidents and interpersonal violence as potential causes. This study emphasizes the importance of drawing upon disparate datasets to examine questions of occupational health and demonstrates the potential of palaeopathology to refine the image of fracture results found in the archival records.

Dietary patterns and migration in pre-industrial Copenhagen Marie Louise S JØRKOV (Laboratory of Biological Anthropology, Dept. of Forensic Medicine, University of Copenhagen, Denmark), Janet MONTGOMERY (Dept. of Archaeology, Durham University, UK), Darren R GRÖCKE (Dept. of Archaeology, Durham University, UK)

Recent excavations of 17th to 18th century cemetery at Holmens Church (a church of the Royal Danish Navy and Holmens Parish) in central Copenhagen have provided a unique opportunity to study diet and mobility in Pre-industrial Copenhagen. The Industrial revolution in Denmark started in mid-18th century, with Copenhagen as the main urban center. The aim of this study was to investigate the dietary record and provenance using multiple isotopic analysis ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $^{87}\text{Sr}/^{86}\text{Sr}$) of bone and teeth from 81 individuals (63 adults (>18 years) and 18 subadults (0-17 years)).

The stable isotope results from bone collagen indicated that brackish water fish and terrestrial animal protein constituted a large part of the diet and that males had enriched $\delta^{13}\text{C}$ values compared to females. Exclusive breastfeeding was practiced until the age of 1 year and weaning between 1 and 4 years. Incremental analysis from ten individuals,

with and without skeletal or dental evidence of stress or pathology (e.g. LEH, infections and osteomalacia), confirmed this weaning pattern. Only one adult had been weaned within the first few months of life. None of the incremental isotope results indicated any signs of physiological stress, nor did the bone collagen isotopes. It is not clear from these results if these early dietary patterns had a positive impact on early health and life expectancy. Strontium analysis (n=25) indicated that many of the people buried at Holmens Church came from outside of Denmark, most probably Norway, which was part of the Danish Kingdom at the time.

Keynote Lecture

The dead teaching the living: Contribution of the Hamann-Todd Osteological collection to paleopathology Yohannes HAILE-SELASSIE (Cleveland Museum of Natural History, USA)

Some human ailments leave their marks on the skeletal elements of the body. These ailments are manifested on human bones in different forms and at different locations. Using modern technology, these manifestations can be seen while a person is still alive. After death, they are retained as permanent marks on the skeletal elements. Therefore, pathological studies are not solely conducted on living forms. A lot more is learned from human skeletal remains after death. Researchers who study the cause and effect of modern diseases learn from skeletal remains as much as paleopathologists who try to understand ancient diseases. This is one of the reasons why the Hamann-Todd Human Osteological Collection, housed in the Cleveland Museum of Natural History, is one of the most attractive collections for paleopathologists. This collection has more than 3,100 human skeletons from pre-antibiotic era dating back to the 1920s. It has been one of the goldmines of research for the last century not only for paleoanthropologists and paleopathologists, but also for researchers in modern medicine and forensic anthropology. It continues to serve a large scientific community from all over the world and has a unique place especially in paleopathological and medical research.

Podium Presentations

Exploring a new scoring scheme for the cribrous syndrome in relation to anaemia: A pilot study on an early Bronze Age cemetery in Northwestern China Jennifer AUSTEN (University of Reading, UK), Ruilin MAO (Gansu Provincial Institute for Cultural Relics and Archaeology, China), Hui WANG (Gansu Provincial Institute for Cultural Relics and Archaeology, China), Hui-Yuan YEH (School of Humanities and Social Science, Nanyang Technological University, Singapore), Mary LEWIS (University of Reading, UK)

Cribrous lesions in the postcranial skeleton are becoming more widely used in current bioarchaeological studies to assess health. Defined as the 'cribrous syndrome', these lesions are believed to stem from the same condition as cribra orbitalia in response to marrow hyperplasia, whereby red bone marrow becomes overactive due to low levels of healthy red blood cells. While debate discussing the possible connection between the cribrous syndrome and anaemia is ongoing, a quantifiable scoring method for postcranial cribrous lesions has yet to be established. In an effort to quantifiably measure severity and expressions of cribrous lesions in the postcranial skeleton, this study proposes a new scoring methodology based on macroscopic analysis on a pilot sample from early Bronze Age China. The resulting numerical recording scheme provides cribra scores of 0-4, which were derived from varying expressions of cribra humeralis and femoralis observed in both adult and non-adult skeletons (n=83) from Mogou, a combined Qijia Culture (1750-1400BCE) and Siwa Culture (1400-1100BCE) cemetery in Gansu Province, China. Complimenting Stuart-Macadam's (1991) cranial cribra scoring scheme, these scores can be assigned to each sector within the affected areas of the proximal humerus and femur to produce a cribra score for the affected skeletal element, and further an overall cribra score for the individual examined. Not only does this scoring methodology allow more quantifiable analysis of cribrous lesions

to take place, it provides opportunity to assess the viability of postcranial cribrous lesions and further investigate the possible connection between anaemia and the cribrous syndrome.

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Can we identify cystic fibrosis from skeletal remains?: A proposed differential diagnosis

Melanie M BEASLEY, Clare REMY (Department of Anthropology, University of Tennessee, Knoxville, USA)

Cystic fibrosis (CF) is an inherited disorder that primarily affects the mucosal lining of the lungs and digestive system due to a defective gene that causes secretions to become sticky and thick resulting in blockages of tubes, ducts, and passageways. The type of gene mutation is associated with the severity of the condition, but with modern medicine individuals can live into their 50s.

Here we propose a differential diagnosis for identifying CF in the skeleton based on a list of bony pathologies that occur in higher frequency in CF patients. CF patients exhibit chronic sinusitis, clubbing of hands and feet, vertebral fractures/collapse and abnormal curvature, significantly shorter stature, lower bone density, rib fractures, and an increased chest diameter. While each pathology can occur related to other diseases, trauma, or variation, we argue that if observed collectively in a skeleton it would be sufficient evidence to suggest an individual had CF. Most significantly, a medial bulge in the nasal walls of CF patients is a unique etiology of chronic sinusitis distinguishing them from the non-CF population.

While prehistorically, the life expectancy would have been much shorter, it is important to note that living close to the salty air of the ocean would have mitigated CF symptoms. In a bioarchaeological coastal population, an individual with a less-severe gene mutation might have survived longer, hence why a differential diagnosis

for CF is important to be aware of for the paleopathology research community.

On fevers and other foes of humankind: an inventory of diseases that raged the city of Almada (Portugal) during the late 18th century

Francisco CURATE (CIAS, Department of Life Sciences, University of Coimbra, Portugal), Telmo ANTÓNIO (Almada City Hall, Archeology and Patrimony Unit, Portugal)

Gaspar Lopes Henriques de Chaves (1729–1795) was the municipal physician of the town of Almada (Portugal) between 1784 and 1793. During that period, he authored a ‘meticulous inventory of the diseases’ that affected the population of the municipality, providing case evidence for past disease experience that encompassed individual biographical details, and identification and description of diseases, symptoms, and therapies. The three surviving manuscripts preserved (from 1788, 1789 and 1792) at the Almada Municipal Archive, comprising the medical histories of 126 individuals (62 females, 59 males, and 5 of unknown sex), with recorded ages between 3 and 90 years, were studied according the ground rules proposed by Mitchell (2017). ‘Fevers’ were the most common documented disease (61.9%; 78/126), including «malarial fevers» (26.9%; 21/78) and the abstruse ‘synoch-putrid fevers’ (24.4%, 19/78). Malarial fevers were more prevalent in the spring and summer (71.4%; 15/21) while almost half of the synoch-putrid fevers occurred in autumn (47.1%; 8/19). Further reported diseases include measles, smallpox, renal colic or ‘phthisis’ (i.e., tuberculosis), among others. Almost 20% of the documented individuals died in consequence of the diseases reported (19.7%; 24/122). Individual cases are subjected to a retrospective diagnosis, while acknowledging that historical classification of disease is a social diagnosis (i.e., following the medical understanding of disease in late 18th century Portugal). Putrid fevers entailed an important disease category in western medicine to at least the end of the 18th century, being generally classified by 19th century nosographers as typhus or typhoid fever. The analysis of the

symptoms, therapeutics and environmental factors described by Gaspar de Chaves adds relevant information to knowledge of these fevers.

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Reconstructing physical impairment in medieval Cambridge Society: A biomechanical approach

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The aim of this research is to further understanding of physical impairment and disability in Medieval society through the biomechanical analysis and contemporary contextualization of skeletal trauma and musculoskeletal deformities.

Skeletal remains from individuals of all ages that were buried in medieval burial grounds associated with an urban parish (n=79), an Augustinian friary (n=38), and a hospital (n=209) in Cambridge, UK, were assessed for ante-mortem fractures and musculoskeletal deformities that affected the *osssa coxae* and the long bones of the lower limb. Ante-mortem complete fractures of the lower limb were found in six individuals and one individual presented with a musculoskeletal deformity (severe *genu valgum*). Plain X-rays were used to determine the degree of angulation, rotation and overlap of each fracture. The trabecular and cortical bone architecture of these individuals (n=7), and individuals without these conditions (n=10) were analyzed using micro-computed tomography (CT) to infer physical impairment. CT

proved to be a much more useful method to assess bone architecture than plain X-rays. The CT scans of the individuals with ante-mortem femoral or tibia fractures (n=6) showed bilateral differences in trabecular architecture consistent with altered loading. The bone architecture of the individual with *genu valgum*, who had an atypical gait, revealed unique adaptive changes in the cortical and trabecular bone.

The findings suggest that trabecular and cortical bone respond very differently to altered loading conditions. This research illustrates that the analysis of trabecular bone enhances the capacity to reconstruct physical impairment and lived experiences in past populations.

The antiquity of hydrocephalus: reassessment of existing knowledge and multidisciplinary analysis of the cases from the Museum of Anatomical Pathology of the University of Florence

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Hydrocephalus, a condition caused by the obstructions of the cerebrospinal fluid pathway, affects 1.1/ 1,000 births. While well understood in modern medicine, its antiquity is still fragmentarily reconstructed with only a limited number of cases reported in the palaeopathological and neurological literature.

This talk aims to *a.* recapitulate the history of hydrocephalus *b.* review the main studies on this disease *c.* build on existing knowledge by adding the description of the so far unstudied collection of hydrocephalic specimens (19th cent.) in the Museum of Pathology of the University of Florence. A full review of the history of hydrocephalus was made from its earliest descriptions (Ancient Egypt and the Classical World) and a systematic perusal of published articles on palaeopathological cases of this condition was implemented. Furthermore, six cases are being investigated primarily applying

classic anthropological methods. The cases can be subdivided as follows: four skeletonized subadults, aged between 2 and 18 months, one fetus/newborn mummified individual and one skull of an adult patient. The most striking case was analyzed in depth adding to the anthropological assessment the artistic study of a ceroplastic model representing the young patient, archival and clinical data on the patient deceased in 1831, palaeo-radiological and palaeo-molecular assessment. Among the obtained results, it was possible to determine that skeletal maturity did not coincide with chronological age, a discrepancy that can be explained by a perturbation of pituitary physiology.

This type of multiple-line-of-evidence studies allows palaeopathology to substantially increase its knowledge of the presentation of such highly incapacitating conditions in the past and add more to the differentiation of distinct degrees of severity of hydrocephalus.

Investigating the relationship between diet, mandibular morphology, malocclusion, and dental caries through time in Britain Cara S HIRST (Institute of Archaeology, University College London, UK)

Dietary consistency is known to have changed through time, with increasingly processed food requiring less forceful mastication. This softer, more refined diet is associated with an increasingly gracile mandible which is suggested to relate to an increased prevalence of malocclusion through time. Malocclusion due to dental crowding has also been associated with a higher prevalence of dental caries. However, previous studies analyzing mandibular morphology have typically focused on major dietary transitions associated with an increased prevalence of carious lesions. This poses problems when attempting to investigate the relationship between mandibular morphology, malocclusion, and dental caries.

This study investigates the relationship between mandible morphology, malocclusion, and dental caries without focusing solely on major dietary transitions. To further investigate this relationship a sample of c.1000 human mandibles from 52

British archaeological assemblages dating between the Neolithic and Post-Medieval periods were examined. Mandibular dental morphology, dental caries and intra-arch malocclusion were analyzed. Preliminary results support previous research with the prevalence of carious lesions and malocclusions increasing through time as the mandible becomes smaller and more gracile. For instance, the prevalence of rotation increased from 20.5% (n=146) among the Neolithic dentition to 36.1% (n=1,329) among the Post-Medieval. The prevalence of carious lesions showed a more prominent increase, for example among the molar dentition, carious lesions increased from to 3.5% (n=55) among the Neolithic to 26% (n=641) in the Post-Medieval. While specific morphological changes affecting the shape of the dental arcade were found to correlate with malocclusion, the relationship between malocclusion and dental caries was more complex.

Recent updates in phylogenetic analysis of ancient trematodes using the feces of Korean mummies of Joseon Dynasty Jong Ha HONG (Laboratory of Bioanthropology, Paleopathology and History of Diseases, Seoul National University College of Medicine, Seoul, South Korea), Chang Seok OH (Laboratory of Bioanthropology, Paleopathology and History of Diseases, Seoul National University College of Medicine, Seoul, South Korea), Min SEO (Department of Parasitology, Dankook University College of Medicine, Cheonan, South Korea), Dong Hoon SHIN (Laboratory of Bioanthropology, Paleopathology and History of Diseases, Seoul National University College of Medicine, Seoul, South Korea)

Archaeoparasitologists use various scientific techniques to improve our knowledge of parasite-infection patterns in ancient societies. Although attempts have been made to detect ancient parasite eggs in samples collected from excavation sites, few studies have been performed for getting genetic information of ancient parasite species. Fortunately, over the past several years, our archaeoparasitological studies have detected ancient trematode eggs in coprolite specimens (n=15; male=7, female=8) from 15th to 18th century Korean mummies.

In this study, we thus analyzed multiple DNA sequences obtained from ancient trematode eggs, especially of *Clonorchis sinensis* (*C. sinensis*), *Paragonimus westermani* (*P. westermani*) and *Metagonimus yokogawai* (*M. yokogawai*). These trematodes were transmitted to human by ingestion of infected intermediate hosts (raw and undercooked freshwater fish, crabs or crayfishes), causing various subclinical or clinical signs and complications. We were successfully amplified of ancient parasite aDNA, then determined consensus sequences by the alignment of the cloned sequences of PCR products. We also tried to do the phylogenetic and network analyses. In case of *C. sinensis*, our study re-confirmed previous report that *C. sinensis* could not be easily distinguishable by its geographic distribution. In case of *P. westermani* sequences, however, they were divided into two groups: one (including ours) for *P. westermani* reported from East Asia; another for *P. westermani* sequences in Southeast Asia and India. Finally, the current *M. yokogawai* sequences from Korean mummies were obviously distinguished from the other parasites. Although they were grouped with other *Metagonimus* species, they were not clustering according to regional differences of the *M. yokogawai* examined.

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Tycho Brahe, Danish Renaissance Man: A rich table but short life

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Museum, Denmark), Jaroslav BRUZEK (University of Bordeaux, France)

The exhumation of the Danish astronomer and nobleman Tycho Brahe (1546-1601) was performed in 2010 to verify speculative views on the cause of his death. A detailed paleopathological analysis of Tycho Brahe's skeletal remains was performed, and we found bone changes indicative of diffuse idiopathic skeletal hyperostosis (DISH). We also estimated his physical status (relative body fat) based on medullar and cortical dimensions of the femoral shaft, which classified him as obese. These calculations were based on a previous study on femoral dimensions and relative body fat deduced from whole-body post mortem forensic CT scans. We reviewed comorbidities of DISH and obesity and consider some conditions associated with metabolic syndrome as possible causes of Tycho Brahe's final symptoms (urinary retention, renal failure and coma), including diabetes, alcoholic ketoacidosis and benign prostatic hypertrophy. Although a definite and specific diagnosis cannot be established, our study points to today's civilization diseases often associated with DISH and metabolic syndrome as the possible cause of death of Tycho Brahe. Hence, so-called "modern" lifestyle diseases may already have made their mark among, e.g., the nobility of the 16th century, due to obesity and excess intake of alcohol. With this presentation we want to highlight this aspect, as well as how skeletal paleopathology may benefit from modern bone image databanks.

Subadult scurvy in Peru: Potential cases in

postcontact Mórrope Mikayla K MATHEWS, Haagen KLAUS (George Mason University, USA)

The study of scurvy in archaeological human remains has garnered increasing attention in recent decades. Although Donald J. Ortner and colleagues developed the current standards for differential diagnosis of scurvy utilizing remains from Peru, these bones were collected from the surface of looted cemeteries in the early 20th century and were culturally and temporally

decontextualized. Scurvy remains understudied in the Andes.

This work describes the differential diagnosis of scurvy from archaeologically recovered skeletons from postcontact Mórrope (16th–18th century A.D.), Lambayeque, Peru. Previous work demonstrated that multiple skeletal manifestations of biological stress among the native Muchik was systematically higher in Mórrope when compared to the Muchik people living in nearby contemporaneous Eten. Therefore, we hypothesized that signs of chronic vitamin C deficiency would also be more common in Mórrope. Skeletons of 138 subadults (0–15 years of age) from Mórrope were macroscopically examined for the presence or absence of abnormal new bone formation and porosity of the cranial vault, sphenoid bone, orbits, temporal bone, maxilla, mandible, zygomatic bones, palatine bones, scapulae, long bone metaphyses, and ribs. We documented 11 possible cases (8%) of scurvy in Mórrope *versus* three in Eten (2.1%). Yet, scorbutic lesions in Mórrope were far more subtle and not as severe or chronic as those observed previously in Eten. We consider various interpretations for this paradox but given the multiple lines of ethnohistoric and archaeological evidence reflecting severe socioeconomic marginalization and biological stress in Mórrope, these results may well reflect heightened frailty among Mórrope's indigenous children.

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Postcranial and cranial trauma comparative analysis of the Mississippi State Asylum skeletal assemblage (AD 1855-1935) M Cate McALPINE, Andrea M LOPEZ, Petra BANKS (Mississippi State University, USA)

This study examined possible correlations between cranial trauma (CT) and postcranial trauma (PCT) using the Mississippi State Asylum (MSA) collection. Written records of the MSA (AD 1855-1935) indicate widespread disease, overcrowding, underfunding, and poor living conditions. Over its use, it housed over 30,000 patients, including the

elderly and/or chronically ill. Only a total of 41 individuals of the 67 excavated in 2012-3 (20 females, 2 ambiguous, 17 males, 2 intermediate sex; 14 adults (18+), 5 young adults (18-35), 13 middle adults (35-50), 9 old adults (50+)) from the MSA excavations were included in this study due to preservation issues. As CT can be associated with long-term behavioral changes that may increase risk for PCT, it is hypothesized that individuals with one instance of CT will have a correlating increase in PCT. This correlation will increase with CT counts greater than 1 instances of PCT were scored for each individual. PCT data was then compared to previously collected CT data. A Fisher's Exact test ($\alpha=0.05$) was used to determine correlation between the variables. The results revealed that there was no correlation between CT and PCT for individuals with 1 instance of CT ($p=0.231$) or for individuals with >1 instances of CT ($p=0.233$). These results suggest that the presence of CT, often connected with long-term behavioral changes, did not make individuals from the MSA susceptible to additional PCT. This study demonstrates that in population analyses, CT and PCT data would benefit from separated analysis, as PCT can occur independent of CT.

Skeletal evidence of violent conflict in Judea during the 2nd-1st century BCE Piers D MITCHELL (University of Cambridge, UK), Jenna M DITTMAR (McDonald Institute for Archaeological Research, University of Cambridge, UK), Yossi NAGAR (Israel Antiquities Authority, Israel), K ARVIV (Israel Antiquities Authority, Israel), Tehilah LIEBERMAN (Israel Antiquities Authority, Israel)

This paper presents skeletal evidence of a massacre that occurred outside the city of Jerusalem around the end of the 2nd century or the beginning of the 1st century BCE. In 2017, the Israel Antiquities Authority conducted a salvage excavation at the Russian Compound in Jerusalem. During this excavation, human skeletal remains were found inside a disused water cistern that was located approximately 300 m west of the north-western corner of the present-day city wall.

The skeletal assemblage was co-mingled and fragmentary but at least 124 individuals, including fetuses, children and adults were found. Pottery sherds associated with the remains were dated to the end of the 2nd century—the beginning of the 1st century BCE. Sharp-force trauma was noted on many skeletal elements during the excavation, and a sample was retained for analysis prior to reburial in accordance to the Israeli Law. The retained sample consisted of partial crania (n=7), mandibles (n=10), vertebra (n=28) and one long bone fragment from a minimum of 23 adult individuals. Silicone impressions were made of the tool marks and analyzed using scanning electron microscopy. Peri-mortem sharp-force trauma, likely inflicted with a sword, was identified on one or more element from each individual. The placement and number of the weapon injuries identified on these individuals reveals the lethal intent of the encounter. When placed within the historical context, we suggest that this skeletal assemblage may be evidence of a massacre following an uprising that occurred during the reign of the Hashmonean king Alexander Jannaeus.

Paleopathology of two Neolithic mass burials from Jagodnjak, Croatia Mario NOVAK (Institute for Anthropological Research, Zagreb, Croatia), Dinko Tresić PAVIČIĆ (Kaduzej Ltd., Split, Croatia), Ivor JANKOVIĆ (Institute for Anthropological Research, Zagreb, Croatia)

The aim of this paper is to present the results of the paleopathological analysis of human skeletal remains found in two prehistoric mass burials from the multi-period archaeological site of Jagodnjak in eastern Croatia. Both features can be attributed to the Neolithic period based on the preserved pottery fragments (radiocarbon dating is pending). Although the human remains were mostly articulated, the individual skeletons became partially commingled due to the haphazard placement of the bodies and post-depositional processes.

The first mass burial contained the remains of ten adult males, while in the second the remains of three adult males and one adolescent were found. Most of the skeletons exhibit common pathological

changes, such as caries, AMTL, ectocranial porosity, *cribra orbitalia*, linear enamel hypoplasia, and ante-mortem injuries. However, two skeletons show evidence of intentional violence and possible surgical intervention. More precisely, a young male (26-35 years) from G 41 exhibits a series of cranial peri-mortem cuts and blunt force injuries, while the skeleton of a young male (26-35 years) from G 79 shows evidence of a possible amputation of the left hand with visible signs of healing (the distal thirds of the left ulna and radius were affected). A combination of non-standard burial practice with an unusual demographic distribution accompanied by peri-mortem injuries and a possible surgical intervention might suggest that the remains of the victims of a violent episode were interred in these archaeological features. However, a more comprehensive archaeological and bioarchaeological study is needed to confirm this assumption.

Ancient DNA analysis: Results of a survey of users

Charlotte A ROBERTS, Eva FERNÁNDEZ-DOMINGUEZ (Department of Archaeology, Durham University, UK)

Ancient DNA analysis has revolutionized our understanding of the past, and particularly through studies of archaeological human remains. Over the last 30 years analytical methods used in archaeology have developed alongside advances in modern DNA techniques, and have provided us with more nuanced data to explore aspects of our ancestors' lives such as their evolution, familial relationships, migration patterns, and especially their health and well-being (e.g. Schuenemann et al. 2013; Harbeck and Seifert et al. 2013; Bos et al. 2014). While not negating these revolutionary developments, there are increasing concerns in published literature about the ethics of aDNA analysis, not least its destructive nature and the impact that it has on preserving the integrity of human remains for future research.

This study presents the results of an anonymous online survey of students, academics and museum curators involved in of such analyses, with the aim of exploring good and poor practice by practitioners and users of this method. More than

160 people have completed the survey since June 2018. The results currently show that despite an overwhelming agreement on the usefulness of ancient DNA analysis (96%) in archaeology and an overall positive experience with some research groups (75%), the lack of engagement of geneticists with archaeology and the use of samples as commodities are the main concerns. Overall, the survey concluded that education of geneticists in the importance of the archaeological context, a more strict regulation of sample collection and disclosure of all the material tested should be priorities.

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Sutural anomalies as a possible indicator of complex syndromes at Koster Mounds (Greene County, Illinois) Lita SACKS (Eastern Washington University, USA)

Syndromes are rarely diagnosed in bioarchaeology due to the subtlety of skeletal defects and the medicodental focus on soft tissues and patient care. Clinically relevant skeletal features include craniosynostosis, metopism, and sutural bones. Craniosynostosis (particularly metopic, coronal, and sagittal) is a feature of dozens of syndromes, including Apert, Crouzon, and Tricho-Rhino-Phalangeal Syndromes. Wormian bones are found in Mohr Syndrome, Hallerman-Streiff Syndrome, Cleidocranial Dysostosis, Osteogenesis Imperfecta, Progeria, and Trisomy 18, among others. Metopism and delayed closure of fontanelles also occur occasionally in some complex syndromes. This study reviews paleopathological information that can be gathered from cranial suture anomalies and illustrates their utility in identifying potentially syndromic individuals.

Sutural anomalies were assessed for individuals of all ages and sexes at Koster Mounds, a skeletal

series of unknown age from prehistoric Illinois. Closure was assessed for the metopic, coronal, sagittal, lambdoidal, squamosal, petro-mastoid, and petro-squamous sutures in 175 individuals. The presence and number of sutural bones were assessed at bregma, lambda, parietal notch, and pterion, and in the coronal, sagittal, lambdoidal, and squamosal sutures for 165 individuals. Variation in the timing of metopic closure prevented confident diagnosis of trigonocephaly. The co-occurrence of craniosynostosis, metopism, abundant or unusually-placed sutural bones, and postcranial skeletal anomalies in any combination suggests the possibility of complex syndromes in seven individuals.

This study emphasizes the need for a paradigm shift in the perceived paleopathological importance of skeletal anomalies by illustrating the visibility of genetic syndromes in prehistory when such anomalies are carefully noted.

A new methodological approach to nasal trauma in Portuguese individuals from two documented osteological collections (19th-20th centuries) Ana Luísa SANTOS (CIAS and Department of Life Sciences, University of Coimbra, Portugal), Simon MAYS (Historic England, UK), Bruno M MAGALHÃES (CIAS and Department of Life Sciences, University of Coimbra, Portugal)

Reports of prevalence of nasal fracture in skeletal assemblages from Mediaeval and Postmediaeval periods are scarce, with variable prevalence and lack of specific methodological approaches. This work aims to study prevalence of nasal fracture in the 'Medical Schools' (Coimbra) and skeletal (Lisbon) identified collections from Portugal (19th-20th centuries). Overall, 907 individuals aged 1-95y.o. (\bar{x} =49.72; SD=20.44) were studied, 56.8% (515/907) males and 43.2% (392/907) females.

A new methodological classification analyzing 'side of deviation', 'side of trauma', 'pattern', 'other facial fractures', and 'remodelling' was proposed. Nasal trauma was recorded in 12.1% (95/784; 66 males, 29 females) of the individuals. Both higher frequency in males (14.3% vs 9%) and the increase

of age at death play a significant role. A lateral impact force trauma was recorded in 60% (57/95; 43 males, 14 females) individuals, whilst 12.6% (12/95; nine males, three females) show other fractures on the facial skeleton. Although the differential diagnosis is limited by the nonspecific location of nasal and facial fractures concerning blows and falls, lateral impact force is usually clinically associated with interpersonal and intimate partner violence in males and females, respectively. Unfortunately, (1) healed fractures without deformation, (2) the fact that nasal trauma is seldom fatal and usually not documented in nonadults, and (3) the fact that it is impossible to understand if other facial fractures are temporally concurrent with nasal bone trauma, are limitation to its study. Nevertheless, this standardization proposal, in both the definition and the methodological approach, permits a more accurate differential diagnosis in paleopathology.

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Hard Beginnings in Colonial Otago, New Zealand: Deciduous Dental Defects Associated with In-Utero Vitamin D Deficiency? Anne Marie E SNODDY (University of Otago, Department of Anatomy, New Zealand), Hallie R BUCKLEY (University of Otago, Department of Anatomy, New Zealand), Peter PETCHEY (University of Otago, Department of Archaeology, New Zealand), Siân E HALCROW (University of Otago, Department of Anatomy, New Zealand), Charlotte L KING (University of Otago, Department of Anatomy, New Zealand), Rebecca L KINASTON (University of Otago, Department of Anatomy, New Zealand), Lisa MATISOO-SMITH (University of Otago, Department of Anatomy, New Zealand)

The mid-19th century saw a wave of European immigration to the South Island of New Zealand with settlers attracted by the promise of cheap, productive land. One such settlers' community, comprised mostly of British immigrants, established itself in Milton, South Otago in 1860. In 2016 an excavation by the University of Otago at St. Johns Cemetery (1860-1926), Milton, was conducted as part of a larger investigation into the lives of colonial New Zealanders. Twenty-seven individuals interred in the 1870s, 11 adults and 16

non-adults, were recovered. Preservation was variable and the majority of non-adults were represented by teeth and hair only. One infant, B27 (approx. 1.5 years), exhibited unusual notched defects of the deciduous central mandibular incisors. MicroCT analysis was conducted to characterize these defects in greater detail and to assess hypomineralizations. While enamel hypomineralization is not a specific disease marker, the presence of central notching in deciduous incisors is unique and has a clinical association with maternally-transferred vitamin D deficiency (VDD) (Purvis et al., 1973; Reed et al., 2017), a condition which is endemic in Otago today (Wheeler et al., 2018). We discuss these findings within the framework of environmental and social stresses experienced by the first European Settlers and the developmental origins of disease, and argue that negative health outcomes in colonial Otago may represent the beginnings of the contemporary VDD crisis in this region.

This work also highlights the utility of microCT analysis in the investigation of dental defects in archaeological human remains.

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Townscapes: Reflections on Middle Bronze Age life in Sidon (Lebanon) Chris STANTIS, Nina MAARANEN, Arwa KHARABI, Holger SCHUTKOWSKI (Bournemouth University, UK)

Ongoing excavations at College Site, Sidon (Lebanon) have revealed dual identities: a coastal city with a heavy reliance on the extensive hinterlands, and a nexus of far-reaching trade with major ritual centers. An estimated 113 individuals from 82 burials (of those 20 females, 25 males, and

30 nonadults) are examined using a synthesis of bioarchaeological evidence- paleopathology, dental morphology, and stable isotopes- to investigate lived experiences in the Middle Bronze Age (c. 2000–1600 BCE).

The mortality profile reflects the typical demographic pattern of an attritional community cemetery. Pathological conditions were recorded following established assessment protocols. The most prevalent is degenerative joint disease, with 50% of the adult population affected. Dental pathology, in contrast, shows low prevalence (e.g. caries: 8%). There are moderate frequencies of trauma ($n=35$ or 30%). The highest number concerns hands and feet fractures ($n=14$), followed by vertebrae ($n=9$) and ribs ($n=8$). With few exceptions, mobility isotopes show homogeneous values suggesting coastal residence; dietary isotopes, however, indicate an almost total reliance on terrestrial resources despite the prevalence of fish bones in burial contexts and ritual offerings. The nonmetric dental traits (using ASUDAS) of Sidon individuals are highly uniform overall, following rates and degrees of expression observable across coastal Lebanese sites.

In general, favorable conditions seem to reflect the socio-politically stable climate of the time and suggest a thriving community with well-established trade links. The findings will be discussed in the context of a shift in burial customs from singular inhumations to group burials, coinciding with the development of the MBA temple in Sidon.

The effects of selective breeding on incidence of bone disease in domesticated dogs (*Canis familiaris*) Elizabeth W UHL (University of Georgia, USA)

Selective breeding has profoundly impacted disease susceptibility in animals, as it has resulted in extreme phenotypes not found in the wild. Thus while factors related to living in human manipulated environments can have similar impacts on human and animal health, susceptibility factors related to selective breeding are unique to animals, affect disease in species-specific ways, and need to be considered in paleopathological assessments of animal remains. Selected breeding

in domesticated dogs has produced the greatest phenotypic range of any mammal and has profoundly affected susceptibility to disease. Ventral spondylosis in the lumbar region predates the emergence of modern breeds: a 14% incidence being found in a collection of 126 Pre-Columbian (680-1430 CE) dog remains excavated at Weynaoke Old Town, Virginia USA. However, more extensive lesions and higher incidence rates (61-75%) have been found in modern dogs at necropsy. Review of orthopedic disease in modern dogs indicates susceptibility to certain bone diseases is determined by size and age. In particular, aseptic necrosis of the femoral head (Legg-Calvé-Perthes disease) has only been described in small, young dogs, while hypertrophic osteodystrophy, panostitis and osteochondrosis occur primarily in large young dogs. Osteosarcoma in the long bones is common in mature to old large dogs, but is extremely rare in small dogs. Susceptibility to hip dysplasia, while more common in medium to large dogs, is also associated with selection for confirmation. In addition to informing differential diagnoses on zooarchaeological specimens, consideration of the impacts of selective breeding can also lead to paleopathological contributions to the understanding when and where diseases arose in dogs as the traits influencing susceptibility often trace back to a mutation in a single individual; for example the over 20 different breeds with chondrodysplastic limbs all have the same distinct mutation.

Prehistoric shark attack victim from Tsukumo, Okayama Prefecture, Japan: Skeletal mapping and patterning in 3D GIS J Alyssa WHITE (School of Archaeology, University of Oxford, UK), John POUNCETT (School of Archaeology, University of Oxford, UK), Rick SCHULTING (School of Archaeology, University of Oxford, UK), George BURGESS (Florida Museum of Natural History, USA), Masato NAKATSUKASA (Graduate School of Science, Kyoto University, Japan), Soichiro KUSAKA (Museum of Natural and Environmental History), Yasuhiro YAMADA (National Museum of Japanese History, Japan), Minoru YONEDA (University Museum, The University of Tokyo, Japan)

Shark attacks on humans are uncommon today, and even rarer in the archaeological record. The oldest previously documented shark attack on a human dates to ca. AD 1000 from Puerto Rico (Keegan 2008). Here, we report a significantly earlier attack on an adult male excavated from a Late Jōmon fisher-hunter-gatherer (ca. 4550– 3240 BP) shell-mound cemetery near the Inland Sea, Japan.

The skeleton exhibits extensive serrated linear incisions and peri-mortem fractures that are consistent with an attack by a tiger shark. Analysis of the distribution of wounds suggests that the victim was alive at the time of the attack, but their severity is such that he certainly would have died from his injuries. As he was interred in a large contemporaneous cemetery, the body was clearly retrieved for burial, presumably by his companions. In order to illustrate and better understand the patterning of the extensive injuries, numbering at least 790, a freely available 3D model of the human body was used in GIS to ‘map’ their distribution. If one treats the skeleton as a spatial entity and maps injuries onto the body it then becomes possible to compile, attribute, query, and spatially analyse features of interest. Data for the overall completeness of the skeleton were combined with traumatic injuries in the model. The most likely impacted soft tissue was easily identified using associated models of the body’s soft tissue. The extent of the victim’s injuries is rare among shark attacks on humans and demonstrate the variable nature of linear marks that shark dentition can create.

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Further incorporation of evidence-based diagnostic criteria for skeletal pathologies into standardized skeletal data recording systems Molly K ZUCKERMAN (Department of Anthropology and Middle Eastern Cultures, Mississippi State University, USA)

Standardized systems for recording data from human remains, such as sex, age, stature, and pathological lesions and stress indicators caused by chronic and/or episodic conditions, have achieved

common usage within bioarchaeology and paleopathology since the mid-1990s. Examples of these recording systems include Buikstra and Ubelaker’s (1994) original standards; Powers ((2008) 2012), which was developed for the Welcome Osteological Research Database; and Steckel and colleagues (2011 (2005)), which was developed to enable the Global History of Health (GHP) project. These systems are based on evidence-based osteological methods, such as for the classification and diagnosis of stress indicators and skeletal pathologies.

This work identifies and explores potential routes for refining the existing diagnostic criteria and recording standards for pathological lesions within these standardized systems, such as Steckel and colleague’s codebook, through the incorporation of recently developed evidence-based diagnostic criteria for several common chronic conditions. These include tuberculosis, malaria, and the treponematoses, with a focus on the latter. Importantly though, these criteria have largely been developed through the study of 19th and 20th century medical anatomical and anatomical skeletal collections, which are primarily comprised of low socioeconomic status and socially marginalized individuals. Therefore, this work also discusses the considerations involved in applying these criteria to evidence of chronic conditions in skeletal material from diverse archaeological and historical contexts in light of increasing knowledge from social epidemiology and immunology on the embodied synergistic effects of poverty, social inequality, psychosocial and physical stressors over the life course on susceptibility to (and expression of) chronic disease.

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Student Group Discussion Panel

Ethics in Paleopathology. Sharon DeWITTE, Carlina De La COVA, Molly ZUCKERMAN, Sue Guise-SHERIDAN

Ethical considerations are ongoing and ever-changing within paleopathology. This panel will explore important considerations on the development and ongoing application of ethical obligations, new perspectives on our professional ethos to the remains we study and their descendants, and ethical issues faced regarding paleopathology in popular publications and on social media.

Poster Sessions

The Fremont in the basement: A case study of perimortem processing, infectious disease, and *genu valgum* from Northern Utah, ca AD 975

Meghan BANTON, Derinna KOPP (Utah Division of History - Antiquities Section, USA)

The remains of AS178B were discovered by a homeowner during basement excavation in Salt Lake City, Utah and transferred to the Antiquities Section of the Utah Division of State History for analysis. The well preserved skeletal remains belong to a Native American male between 15-25 years of age at death. Radiocarbon dating (Beta412135 Cal AD 890 to 1015) place the remains in the archaeological population known as the Fremont. Perimortem scrapes, cuts, hacks, percussion pits, and fractures were observed throughout the remains (largely in association with joints and muscle attachments). This perimortem processing (PP) is consistent with dismemberment and defleshing of remains; however, previous descriptions of the depth and patterning of PP marks and fractures motivated by violence and survival anthropophagy, including descriptions from the neighboring Southwest, are not an ideal fit for AS178B. It is proposed that this contrast may be explained by ritualistic motivations (excarnation). Of further interest, macroscopic observation of various lesions in AS178B suggest the presence of Tuberculosis. Destructive changes in the posterior maxillary sinuses are similar to lesions described in modern clinical cases of maxillary sinus tuberculosis. Slight spinal deformity (kyphoscoliosis) is likely association with destructive spinal lesions present in T9-L1 (probable lesions of Tuberculosis), but association with knock-knee posturing (*Genu valgum*), which resulted in anatomical irregularities in the tibiae, fibulae, tali, and calcanei, could not be excluded from differential diagnosis. AS178B contributes to ongoing discussions over the motivation and nature of PP, as well as the expression and

differential diagnosis of tuberculosis in skeletal remains.

No rest for the weary or young: Adolescent spinal health in the Milwaukee County Poor Farm Cemetery (1882-1925)

Sarah A BONCAL (University of Wisconsin Milwaukee, USA)

Vertebrae are an effective, though highly debated, data source for understanding physical activities of a populace due to the osteological reactivity of extensive weight and pressure. However, vertebrae also possess the potential to provide invaluable insight concerning the social consequences of spinal health and its impact on a person's quality of life. As part of an ongoing project, human remains are macroscopically examined and analyzed for a variety of spinal conditions and modifications in order to assess the spinal health of impoverished and/or marginalized people recovered from the Milwaukee County Poor Farm Cemetery 2 (MCPFC) (1882-1925). Included as an analytical subset is the adolescent age category (N=6). Historically, impoverished and/or marginalized adolescents in 19th and early 20th c. America attained a quasi-adult social status. In an attempt to make them useful members of society, many adolescents who attended the Poor Farm and were buried at the MCPFC were recorded as forced into indentured apprenticeships and/or servitude contracts as craftsmen, manual labors, or farm hands. This poster presents data recovered from the adolescents who show definitive pathological and morphological evidence (i.e. Schmorl's nodes, fractures, spondylolysis, etc) that these adolescents experienced the physical hardships characteristic of lower socioeconomic status adults.

A biological approach to evaluation of porotic lesions of the orbital roof and cranial vault

Megan B BRICKLEY (McMaster University, Canada)

Porotic lesions of the orbital roof and cranial vault, often referred to as *cribra orbitalia* and/or porotic hyperostosis, are commonly found in archaeological human remains, hominins and non-human primates. For many these lesions have

become synonymous with anemia, but debate on the causes and possible links between such lesions has continued for more than 30 years. The research reported here set out to investigate the potential of using the 'biological approach' to paleopathological diagnosis, used by Don Ortner and recently proposed more formally by Simon Mays, to investigate porous cranial lesions and evaluate links between lesion types. Published biomedical information on conditions that might result in the development of porous cranial lesions was evaluated. For all conditions the sequence and types of physiological changes were considered alongside potential co-occurrence; for anemia age-related changes in the normal distribution of marrow type and potential for conversion and re-conversion reported in the literature were reviewed. A wide range of conditions that have the potential to produce porous lesions of the cranial bones were identified, but combining careful evaluation of lesions found across the skeleton with biomedical information on marrow type and patterns of conversion with age were found to assist in suggesting a diagnosis. Results from this study show that in many cases if the 'biological approach' to paleopathological diagnosis is adopted it may be possible to suggest conditions involved in the development of porous cranial lesions.

Mortality of twins in the archaeological record: new evidence from Papdomb, Valeni, Romania (17th century) Irene Hochgraf CAMERON, Allison MCCOSKEY (Brown University, USA), Jane GROSSMAN, Jonathan D BETHARD (University of South Florida, USA), Katie ZEJDLIK (Western Carolina University, USA), Zsolt NYÁRÁDI (Haáz Rezső Museum, Romania), Andre GONCIAR (ArcheoTek, Canada LLC)

There is a significant increase in miscarriage, stillbirth, and infant death among multiple compared with single births. In 2009 the Office for National Statistics showed that twins were five times more likely to die within their first year than singletons, these deaths largely occurring as perinates. It is suspected that instances of twins in

the archaeological record typically died just prior to or during birth.

A broad temporal review of potential neonatal, perinatal, and infant twins in the archaeological record was conducted. Conclusive evidence of twin burials is extremely rare. Sites often lack the required stratigraphic details and burial placement information required, and can only confirm their presence through aDNA analysis or when fetuses were buried in utero. This past summer in Papdomb, Valeni, Romania, skeletal remains of two perinatal individuals interred within a single coffin from the 17th century were unearthed. While aDNA results are pending as part of a separate project, osteological analysis concluded that these two nearly complete individuals were the same age at their time of death.

The best documented skeletal records for infant double burials come from one site in South Dakota, 1600 to 1832 AD, four prehistoric burials in Thailand, and an Upper Paleolithic site in Austria. Two of these burials definitively occurred before birth; all but one were perinates aged between 36 and 39 weeks. Given the scarcity of twin burials and the challenges of establishing twin status, this site adds valuable data for understanding mortality among twins.

Pars basilaris porosity in non-adults from 17th century Transylvania Chaunesey MJ CLEMMONS (Texas State University, USA), Jonathan D BETHARD (University of South Florida, USA), Andre GONCIAR (ArcheoTek, Canada LLC, Canada), Zsolt NYARADI (Haáz Rezső Múzeum, Romania)

Paleopathologists have worked to develop diagnostic criteria for vitamin C deficiency. Beyond the "Ortner criteria" Moore and Koon (2017) argue that a lesion on the ectocranial surface of the pars basilaris, that has not previously been associated with scurvy in infants, could help to separate non-adult remains with scurvy from those indicative of differing metabolic diseases.

The *longus capitis* muscle is responsible for several actions of head and neck movement and inserts bilaterally on the ectocranial surface of the bone pars basilaris (e.g., basilar portion of the occipital in

adults). Deficiency in vitamin C can cause inflammation and pain in the neck causing difficulty in movement. Normal movement of the *longus capitis* in vitamin C deficient individuals can cause blood vessels to hemorrhage resulting in skeletal lesion presence.

A sample of perinatal and preterm individuals (n=41) from the Székely community of Telekfalva, located in present day Romania, exhibits skeletal evidence of periosteal reactions.

This study documents the presence of bilateral new bone growth with abnormal porosity on the ectocranial surface of the pars basilaris (n=41). Skeletal lesions in this location paired with the distribution of other periosteal/porotic lesions in the maxilla, mandible, frontal, parietal, temporal, scapulae, ilium, humerus, and femur as found in Osterholtz et al. (2014) are indicative of vitamin C deficiency (scurvy).

Understanding the presence of the lesion on the pars basilaris may aid in the reconstruction of infant mortality in the community of Telekfalva.

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Perceived offset between tooth types, formation rates and the timing of enamel defects in incremental dentine stable isotope profiles

Kayla CROWDER (Durham University, UK), Janet MONTGOMERY (Durham University, UK), Darren R GRÖCKE (Durham University, UK), Mihai GLIGOR (University Alba Iulia, Romania), Nyárádi ZSOLT (Haáz Rezső Múzeum, Romania)

If enamel hypoplasia (EH) occurs due to physiological stress, it would be expected to correspond to fluctuations in an isotope profile around the same age. However, mineralization rates of enamel and dentine vary across the length of teeth and between teeth, resulting discrepancies between the estimated age of the stress event. To further investigate these trends,

this study aims to examine the isotopic profiles of different types of teeth, and the approximate age EH occurred compared to fluctuations in isotopic profiles.

Macroscopic skeletal analyses (age at death, biological sex, palaeopathology) and stable isotope analyses were conducted on non-adult and adult individuals (n=44) from the Iclod, Bögöz and Fenyéd archaeological sites in Romania to assess the impacts of early life stress. Measurements were taken to estimate the approximate age of EH, and stable carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotope analyses were performed on incrementally sampled dentine to create early life-history profiles.

When incremental dentine stable isotope profiles were analyzed, a perceived offset appeared between profiles of different tooth types (i.e. deciduous/permanent, root apex complete/still forming), and between the approximate age of EH and changes in the profiles. Of the 44 individuals analyzed, 100% of defects (18/18) occurred *after* the changes in the isotope profile. Twenty-seven of 39 individuals (69%) showed an offset between different tooth types for the same period of life. This research will help to expand our understanding of varying mineralization rates and how it can affect interpretations of physiological stress in stable isotope life-history profiles.

Looking at individuals for once: what does the association between stress markers and isotopes tell us about individual lifestyle costs in Brazil (3,137-1,524 years BP)?

Marina Di GIUSTO, Veronica WESOLOWSKI (University of São Paulo, Brazil)

Traditionally, bioarchaeological research has used linear enamel hypoplasias (LEH) as an indicator of the occurrence of episodes of systemic stress in childhood, often associating the first peak occurrence with the weaning process. From the 1980s LEH analyses occurred concomitantly with studies of stable isotopes of δN and δC from bones and teeth.

In Brazilian archeology there are few skeletal series for which LEH and isotope studies have been combined in analysis, and for only one skeletal

series from Santa Catarina coast shell middens at Jabuticabeira II (occupation between 3,137-1,524 years BP) is there δN and δC isotope analysis to investigate the weaning process (Pezo-Lanfranco et al, 2018). Considering 34 individuals analyzed in this series for LEH with isotopic assays for δN and δC , the results indicate that age at weaning did not differ much and occurred between 2 and 3 years of age (Pezo-Lanfranco et al, 2018) with peak frequency of LEH between 3 and 4 years of age (Giusto, 2017). On the other hand, Pezo-Lanfranco et al. (2018) in their study suggest greater individual variation in weaning practices. From an osteobiographic perspective, this work presents an analysis of the stress profile of the individuals, as inferred from the occurrence of LEH, (in addition to porotic hyperostosis and *cribra orbitalia*, when possible), and isotopic signatures for individuals who were analyzed for these four elements in the Jabuticabeira II site.

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Childhood, parasites, and anemia: A case study analysis of a subadult burial from the 18th century Fortress of Louisbourg, Nova Scotia Mattia FONZO, Amy B SCOTT, Michael DUFFY (University of New Brunswick, Canada)

Daily life at the 18th century Fortress of Louisbourg was bleak, with poor sanitation practices, crowded living conditions, and a consistently cold and foggy climate. Although these conditions plagued all members of the community, young children were the most at risk of dying due to infectious diseases, nutritional deficiencies, or the severe cold. This research is a case study analysis of a 3.5-4.5-year-old subadult (Burial 58/2018) excavated from Rochefort Point at the Fortress of Louisbourg in Cape Breton, Canada. Soil samples collected during excavation allowed for the analysis of human intestinal parasite egg abundance. Using the micro-

sieve method (Williams et al. 2017), nematode parasite eggs were collected and examined with results showing that >1,800 *Enterobius vermicularis* (human pinworm) eggs per gram of soil were present in the intestinal tract of this individual at the time of death. Evidence of *Ascaris lumbricoides* (human roundworm) was also recovered, although substantially less (434 eggs/g). A macroscopic examination of the skeleton showed evidence of *cribra orbitalia* in both orbits, indicating non-specific stress that is likely linked with this parasitic infection. The crowded conditions, poor sanitation practices, and differential status of children at the Fortress would have contributed to the spread of pinworm and other parasites at Louisbourg affecting morbidity and mortality within this youngest group of individuals. This research is significant in that it demonstrates a link between parasitic infection and gross skeletal change and how this relationship affected the thousands of children that called Louisbourg home.

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Diary of a tooth: Harnessing the power of citizen science in bioarchaeology Julia GAMBLE (University of Manitoba, Canada), Rebecca FERRELL (National Museum of Natural History, Smithsonian Institution, USA)

Dental enamel developmental defects (DEDs) are used extensively in biological anthropology as indicators of nonspecific stress. Although DEDs are most often considered macroscopically on the surface, the analysis of internal microstructures permits identification of cuspal defects (accentuated striae of Retzius, or AS) and more comprehensive scoring of cervical defects (which are less apparent macroscopically). However, one challenge of micro-defect analysis is reliably distinguishing between AS and ‘normal’ striae of Retzius, which requires the imposition of an artificial boundary on features that exist along a continuum of visual accentuation. How, then, do we decide what to define as a DED on this level? To gain further insight into this question, this study

harnesses the power of citizen science to evaluate inter-observer error in AS identification using a large pool of observers with minimal prior training. Specifically, this project makes use of online citizen science to understand characteristics which are most consistently identified as DEDs in posted images of dental thin sections. Participants are provided with background information on dental structures and the research objectives, and with modules to help them distinguish between structures of interest (AS) and artifacts (i.e. slide defects and cracks). They then proceed through a series of 20 slide images of canine sections from medieval Danish samples. Data are evaluated for consistency in defect identification and for variation in identification across the crown. Results represent the first stage in a project to better define AS for bioarchaeological analyses, and also facilitate discussion of the advantages and challenges of citizen science collaborations.

Improving observer error in orbital roof lesion

analysis: A new classification system Brianna GARDNER (Durham University, UK), Tina JAKOB (Durham University, UK), Marie Louise JØRKOV (University of Copenhagen, Denmark)

Inconsistency in scoring orbital roof lesions results primarily from a discrepancy in perceived lesion severity. However, severity analysis introduces observer inconsistency and bias, which this new classification system seeks to remedy. In particular, there is a discrepancy in perceived lesion severity of Type 2 and 3 outlined in Stuart-Macadam 1991. Orbit size greatly affects the interpretation of Type 2 and 3 lesions, as identically sized lesions will appear larger in smaller orbits and vice versa. Differences in orbit sizes are most closely linked to age, as younger individuals will have smaller orbital roof surfaces. To remove severity bias and reduce the impact of age on lesion analysis, the authors combined lesion Types 2 and 3. This resulted in decreased interobserver error.

Interobserver error test results from Medieval (Late 10th – mid-16th c CE) Fishergate House, York, UK (N=60), Medieval (Early 10th – early 16th c CE) Tjærby, Denmark (N=30), and Medieval Aalborg,

Denmark (N=36) verified that distinguishing between lesion types 2 and 3 produced the highest discrepancy. By combining Types 2 and 3 into a single lesion type, interobserver error for the Danish populations improved from 65% to a 70% correlation between two bioarchaeologists with dissimilar research backgrounds. Combining lesion types for Fishergate House, York resulted in an improvement from 68.5% to 79.0% when using two researchers familiar with metabolic disease and orbital lesion analysis.

Due to the encouraging results, the authors propose a new lesion classification. The new classification chart modifies the lesion types outlined by Stuart-Macadam (1991), providing further clarity for lesion appearance and differential diagnoses.

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Airborne environmental contamination: an ancient source of pinworm infections, Zape caves, Mexico Darwin HERTZEL (University of Nebraska – Lincoln, USA), Elisa PUCU (Universidade Federal Fluminense, Brazil), Karl REINHARD, Jessica SMITH, Brandon STRAUSS (University of Nebraska – Lincoln, USA)

Pinworm (*Enterobius vermicularis*) prevalence was enigmatically high for agricultural people in northern Mexico and in the Four Corners region of the Colorado Plateau. For parasitologists, this prevalence poses a unique paleopathological conundrum. The prevalence exceeds that found in clinical settings or paleopathological records from other time periods or regions. Based on pinworm transmission adaptations, it was hypothesized that closed rockshelter and cave environments resulted in transmission by airborne eggs suspended in internal habitation atmosphere. These eggs floated down into food and drink or were inhaled to cause infection. Testing this hypothesis requires sampling sediment from cave environments for pinworm eggs. We examined six subsurface sediment samples from Cueva de los Muertos Chiquitos, Rio

Zape Valley, Durango, Mexico dating to 1,300 years ago. We recovered hundreds of eggs in the samples. This demonstrates that pinworm eggs were an airborne contaminant in this cave, both associated with trash and with burials. The finding supports the proposal that lifestyles, wholly or partly dependent on enclosed cave and rock shelter environments, put people at risk of pinworm infection.

New evidence of spinal tuberculosis from the Eastern Han Dynasty in China (AD 25-220) Mocen LI (Department of Archaeology, Durham University, UK), Charlotte ROBERTS (Department of Archaeology, Durham University, UK), Peter ROWLEY-CONWY (Department of Archaeology, Durham University, UK), Liang CHEN (School of Cultural Heritage, Northwest University, China), Dongyue ZHAO (School of Cultural Heritage, Northwest University, China)

Palaeopathological evidence for skeletal tuberculosis has been discovered from many parts of the Old and New Worlds. However, its presence in ancient China is limited. For example, one skeleton with tuberculosis (third/second century BC) has been reported, but no convincing spinal lesions were observed. This contribution describes possible spinal tuberculosis in an adult male dated to AD 25-220 from Xi'an, China. Aged around 30 years at death, this skeleton was found in an Eastern Han Dynasty (AD 25-220) cemetery in Liuwei. In total, 85 skeletons were excavated and analysed, with the spines of 17 individuals preserved for analysis of spinal diseases. The individual of interest was observed macroscopically to have vertebral destruction. Multiple lytic foci and draining sinuses were noted on the vertebral bodies of T11 to L2. The predominant abnormalities noted comprised partial destruction of the inferior portion of the first lumbar vertebral body and the superior portion of the second lumbar vertebral body. In addition, shell-like bony extensions were present on the left side of the inferior edge of the first lumbar vertebral body, and the superior edge of the second lumbar vertebral body, suggesting a paravertebral (psoas) abscess. The vertebral arches of the affected

vertebrae were normal. However, no spinal collapse was observed. This could be attributed to the death of this individual before collapse. Tuberculosis was considered a possible diagnosis for the spinal lesions observed, with differential diagnoses of osteomyelitis, typhoid, and sarcoidosis. This study contributes to knowledge about the presence of spinal tuberculosis in ancient China and may be the first evidence.

Difficulties in remote visualization and differential diagnosis of an isolated lesion in a child mummy from Kagamil Island, Alaska Kristin M MACAK, Janine HINTON, J Christopher DUDAR (National Museum of Natural History, Smithsonian Institution, USA)

Paleopathological analysis of bundled mummified remains is hindered by the inability to directly visualize skeletal elements. Non-destructive analysis is emerging as standard and requires remote visualization (i.e. x-rays, computed tomography, and endoscopic procedures). The mummified remains of a 2.5 to 4-year-old of probable Neo-Aleut origin were removed from the Warm Cave on Kagamil Island, Aleutian archipelago, part of a series of over 50 mummy bundles recovered by Ales Hrdlicka in 1936. The child presents an abnormal first lumbar vertebral body, with cavitating lesions and abnormal intervertebral disc spaces. Possible etiologies include: infection (tuberculosis or echinococcosis); trauma (vertebral ring apophysis injury); contact pressure erosion; or a rare syndrome such as Langerhans cell histiocytosis (LCH). Epidemiological study indicates infection by *Echinococcus granulosus* has not been reported in the Aleutian Islands, but infection by *Mycobacterium tuberculosis* is relatively common in pre- and post contact Alaska and presents as an isolated lytic lesion in the vertebral body of children \leq seven years. Injury to an unfused vertebral ring may lead to disc herniation that interferes with normal growth of the vertebral body, mimicking a lytic process. While LCH is rare, it is also viewed as underdiagnosed in clinical literature because isolated lesions (seen here) are often misdiagnosed as trauma. Trauma may be

common, but TB has been documented in remains from the Aleutian Islands, and a probable case of LCH was presented by London et al. (2013) from Hooper Bay, Alaska. This case highlights the difficulties in differential diagnosis using remote visualization on mummified remains.

This study was undertaken with the consent of the descendent peoples of the Aleutian Pribiloff Island Association

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A perimortem hip fracture in an adult woman

from the Terry Collection Brianne MORGAN (McMaster University, Canada), Madeleine MANT (Memorial University of Newfoundland, Canada), Carlina DE LA COVA (University of South Carolina, USA), Megan BRICKLEY (McMaster University, Canada)

To date, few perimortem hip fractures have been identified in the archaeological record, despite the significant mortality rates associated with hip fractures in clinical settings (RCP, 2017). This case study describes a 73-year-old female from the Terry Collection, who died 13 days after sustaining fractures of the left proximal femur as a result of a low impact fall. This report aims to explore the underlying circumstances and pathological changes associated with the fracture. Macroscopic examination was used to assess the femur, which had fractured into three fragments (femoral head, neck and trochanteric region, and diaphysis). Impaction of the femoral head occurred as a result of inferior displacement of the femoral head into the femoral neck. Eburnation and new bone formation were present on the fracture margins, and bending deformities were observed macroscopically in the sternum, indicating that an underlying pathological condition, likely osteomalacia, may also have been present. The age and sex of the individual put them at high risk for developing age-related osteoporosis. The circumstances of the fall support this diagnosis, and it is likely that osteomalacia also contributed to fracture risk. Additionally, the eburnation and new

bone formation demonstrate that bony changes associated with hip fractures can develop rapidly after the fracture has occurred. This report represents the first case study of an individual for whom a hip fracture is reported as the cause of death, in which the time of fracture and time of death are known, and in which an underlying pathology contributed to fracture risk.

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Buried with wound: A case study of trauma from Farmana, India (c. 2400 BCE). Veena MUSHRIF-TRIPATHY, VS SHINDE (Deccan College Post Graduate and Research Institute, India)

Interpretation of trauma is a complex process, particularly if it is a fatal cranial injury. Blunt-force trauma found at a cemetery excavated in 2007-2008 at Farmana, Haryana, India, is presented. The cemetery included 70 burial pits, of which 59 were excavated. Primary, secondary and symbolic burials (without human remains but usually with grave goods) were encountered with a total of 35 individuals (adults from both sexes and sub-adults) recovered. Burial 39, one of the largest pits, is the only grave with two individuals interred together in a secondary context. It contained two crania in bracket of 45 to 50 years, female on top of the male, and a few disarticulated long bone fragments along with 13 pots. The age and sex estimations are based on the standard methods described in Buikstra and Ubelaker (1994). The lower cranium shows blunt-force trauma and is the only instance of trauma found in this assemblage. This burial is dated to Matured Harappan phase II B (2400-2200 BCE) based on the ceramic assemblage. The male is represented by part of the cranium. Blunt-force trauma is located near the coronal suture on the left parietal bone. The unhealed fracture is characterized by a depressed lesion with concentric and radiating fracture margins. The bone is severely damaged but there is likelihood of marginal bone growth indicating few weeks of survival after the trauma. The other skull from the same burial pit belongs to a middle-aged female

and does not show any trauma. The burial is interesting from the perspective of the unusual treatment of these individuals.

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Tobacco smoking and tuberculosis in the Lower Illinois River Valley Savannah Leach NEWELL (Auburn University, USA), Krystiana L KRUPA (Indiana University, USA), Jonathan KARTY (Indiana University, USA)

Clinical literature demonstrates that tobacco smoking in modern people increases risk for tuberculosis (TB) infection. Individuals with respiratory damage from long-term smoking are at greater risk for these types of infections.

Paleopathological evidence suggests that TB was widespread in the Lower Illinois River Valley by the Mississippian period (1050-1400CE), and artifacts associated with tobacco smoking are common during the same time period. It is possible that tobacco was smoked therapeutically by those infected with the disease, which may increase lung damage and disease severity. This study determines nicotine presence using liquid-chromatography tandem mass spectrometry in prehistoric individuals from the Schild and Yokem sites who were previously identified as TB-infected using aDNA PCR methods.

Only adults (22 males, 27 females, 1 indeterminate) were included. Of these sampled, 14 (n=3, 11, and 1, respectively) tested positive for TB. Individual nicotine peaks, suggestive of smoking practices, are compared with PCR data to determine whether tobacco smoking in the past influenced risk of TB infection during the Late Woodland and Mississippian periods (500-1400 CE). The null hypothesis states that individuals with and without TB infection demonstrate comparable levels of nicotine consumption. The results indicate that those with TB consumed significantly less nicotine than those without TB ($p=.001$). Age ($p=0.86$) and sex ($p=0.89$) do not appear to impact this result. One possible explanation is the painful experience of smoking during any degree of respiratory distress or lung destruction. This

pattern was less clear when analyzing the Late Woodland component alone ($p=0.408$), which could be because of a difference in overall smoking practices between the two components.

A closer look at Morse's *Ancient Disease in the Midwest*: is 11:640-64 a case of polytrauma? Olof OLAFARDOTTIR, Krystiana KRUPA (Indiana University, USA)

In 1969 Dan Morse reported on a case of infectious arthritis of the right hip joint in a Middle Woodland (50 cal B.C. to cal A.D. 400) male from Pete Klunk Mounds (C40-64) in the Lower Illinois River Valley (Morse 1969:103). Here we re-visit the case of C40-64 and discuss a possible polytrauma. Traumatic lesions are commonly found in the archeological record and provide insight into the lives of past populations by reflecting the hazards of both their physical and social environments. A Middle Woodland male from Pete Klunk Mounds was reported by Morse (1969) to exhibit infectious arthritis of the right hip, evident by the acetabulum being shallow and enlarged in circumference and the femoral head grossly deformed and pointed. Upon further examination by the authors, he also had possible healed fractures on his left tibia, left fibula, and distal right humerus. This type of polytrauma would have caused disabling pain and very limited mobility. The amount of healing and new bone formation present suggest that the injury occurred years before the man's death, so this case can contribute to the bioarchaeological record relating to disability, adaptation to impaired mobility, and care.

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Differences in rib fractures across temporal and spatial contexts: Comparing urban roman and historical rib fractures. Taylor PEACOCK, Megan BRICKLEY, (McMaster University, Canada)

While rib fractures are commonly found in archaeological collections, few studies have examined ribs exclusively, likely due to issues of preservation. This study investigates rib fractures

across three Roman (1st-7th c. CE) *civitas*: Winchester, UK ($n=533$), Lisieux Michelet, France ($n=392$), and Barcelona, Spain ($n=92$). Further, this study compares Roman rib fractures to data from two historical samples to understand how fractures differed across time periods.

Roman rib fractures were analysed from records of 1017 adult skeletons (>17 years). Data was compared to published results from 19th c. Birmingham, UK (Brickley, 2006) and 19-20th c. Lisbon, Portugal (Matos, 2009), as both examined only ribs.

Comparisons between the three Roman sites found that Barcelona had a crude prevalence (CPR) of 17.4%, which was significantly higher ($\chi^2=20.459$, $p=.000006$) than Lisieux Michelet (4.8%), and Winchester (5.6%). In the historical samples, Lisbon's reported CPR was 23.9%, while Birmingham's CPR was 15.6%. When Barcelona was compared to the historical samples, the differences were not statistically significant, indicating the CPR fell within the expected values of the 19th-20th c. samples. In historical samples, rib fractures were associated with illness, violence, and lifeways of hard labour associated with industrialisation. The CPR at Barcelona suggests that Roman life in the port-city was comparable to that of 19th-20th c. urban individuals, while conditions at Lisieux Michelet and Winchester were distinctly different. While rib fractures are often overlooked, this study demonstrates that rib fractures remain an important means to assess differences and similarities in lifeways both within and across time periods.

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Patellar variants: frequency and etiology in pre-

Hispanic Peru Sara S PHILLIPS (State University of New York at Plattsburgh, USA), Anne R TITELBAUM (University of Arizona College of Medicine – Phoenix USA)

Variants of patellar formation affecting the superolateral corner have been observed clinically and paleopathologically, and are described as ranging from the presence of a vastus notch to bipartite patella. These variants are generally considered developmental in origin, affected by particulars of tendon insertion and differences in ossification. Notably, while clinical literature suggests that patellar variants are present in 2-3% of the population, some archaeology-derived samples have a much higher reported prevalence. The purpose of this investigation is to document the prevalence and appearance of patellar variants among two pre-Hispanic samples from Peru, and consider the possibility that activity impacts their frequency or expression. We compared samples from different cultural and environmental settings: 100 patellae (54 right, 46 left) from Early Intermediate Period Moche male sacrifices from the coastal site of Huacas de Moche (AD 500-600), and 123 patellae (57 right, 66 left) from commingled tombs at Marcajirca, a Late Intermediate Period highland site (AD 1075–1450). Superolateral variants were observed in 31% of Moche patellae (29% right, 33% left), and 34% of patellae at Marcajirca (43% right, 31% left). Vastus notch was more common than bipartite patella at both sites, and there is a wide range of expression within each population. Though the similar overall prevalence rates are consistent with developmental etiology for these variants, repetitive stress to the knee may have played a role. It is hoped that this study provides comparative data for future research examining these variants.

Growing up in Ancient Kerma (1750-1550 BC), Sudan: An investigation of childhood nutritional stress and age at death using vertebral neural canal size Kaitlyn SANDERS (Purdue University, USA)

Vertebral neural canal size is a non-specific indicator of physiological stress, as periods of nutritional stress or infection can lead to a smaller neural canal size. Small canal size relates specifically to periods of stress during childhood, as the canal reaches adult size before adolescence.

This study analyses canal size in a population from Kerma, Sudan (1750-1550 BC) to investigate how these periods of stress during growth may affect adult health and mortality.

Anterior-posterior and transverse measurements of lower thoracic and lumbar vertebrae were gathered from 58 females and 49 males from Kerma. Ages were estimated using Transition Analysis and the individuals were separated into 5 age categories: 15-24, 25-34, 35-49, 50-69, and 70+. Following methods used by Watts (2011), *t* tests were used to test for significant differences in the canal size between survivors and non-survivors of each age category (i.e. 15-24 and 25+). Additionally, *t* tests were performed between each age group. Males and females were analyzed separately and then combined to view overall population trends.

In general, canal size was smaller in non-survivors of each age group and larger in individuals living to advanced age, specifically in the transverse dimensions of the lumbar vertebrae. The 25-34 age cohort displayed the smallest canal sizes, even in comparison to younger individuals, suggesting that childhood stress had the largest effect on mortality in young to mid-adulthood. These trends were particularly present within the females. Overall, the patterns indicate that childhood stress may have had a significant impact on adult mortality.

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Comparing demographic and pathological factors affecting osteocalcin concentrations in archaeological skeletal remains.

Amy B SCOTT (University of New Brunswick, Canada), Mathew J COLLINS (University of Copenhagen, Natural History Museum, Denmark), Alberto TAUROZZI (University of Copenhagen, Natural History Museum, Denmark), Ioannis KONTOPOULOS (University of York, UK), Dorthe DANGVARD PEDERSEN (University of Southern Denmark, Denmark)

Osteocalcin is an abundant non-collagenous protein that is easily recovered from archaeological bone due to its affinity for hydroxyapatite.

Secreted by the osteoblasts during bone remodeling, osteocalcin informs our understanding of skeletal metabolism as these protein levels are influenced by biological factors such as age and sex. Osteocalcin fluctuations may also be associated with stress, as normal bone remodeling becomes compromised, diminishing the production of this protein. This study explores adult and subadult osteocalcin levels from the Skt. Albert's cemetery (1250-1536 AD) in Denmark. Following Scott et al. (2016), osteocalcin was extracted from 45 femoral bone samples and quantified using a human-quantikine ELISA kit. Results indicated that adult females (n=9) showed the least amount of osteocalcin variation between samples (25.8 ng/ml – 66.5 ng/ml), whereas adult males (n=20) showed the most (5.9 ng/ml – 87.9 ng/ml). While females are biologically predisposed to greater changes in osteocalcin concentrations due to factors such as menstruation and menopause, in this study males were far more variable. This variability is likely associated with the increased number of adult males showing evidence of active skeletal stress (e.g., unhealed fractures and infectious disease) and the impact of that stress on osteocalcin production. When looking at the subadult sample (n=16), osteocalcin levels peaked during early periods of rapid growth (birth to 3 years), as expected. This research is significant in that it allows us to explore demographic *versus* pathological factors influencing osteocalcin concentrations and how biochemical data may be used to better understand the stress mechanism

and how it is approached in archaeological research.

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Himera (Sicily): Estimating allostatic load and age-at-death using stress indices Safaa N SIDDIQUI (Mississippi State University, USA), Britney KYLE (University of Northern Colorado, USA), Stefano VASSALLO (Archaeological Superintendency of Palermo, Italy), Laurie J REITSEMA (University of Georgia, USA)

In humans, “stress” and “health” have a complex relationship. In living individuals, physiological strain is tracked using allostatic load, which is difficult to estimate within skeletal remains. The Skeletal Frailty Index (SFI), based on 13 skeletal biomarkers, measures allostatic load in skeletal remains. Applying a modified SFI, 9 skeletal biomarkers and age-at-death were used to estimate stress in individuals from the Greek colony Himera (n=428, 6th-5th c. BCE), located on Sicily, Italy. We expected a higher frequency and variety of early life pathological biomarkers correlating with earlier age-at-death, following the hypothesis that colonization causes stress during the life-course and that early life stress leads to earlier age-at-death. We created a pathological index by dividing pathological conditions present by pathological conditions observable per individual. Logistic regression analysis comparing age-at-death and pathological indices of three or more observable biomarkers revealed a significant relationship between stress and age-at-death ($p=5.792e-06$; $p<0.05$). There was a negative relationship between the childhood pathological index and age-at-death ($p=.10$), there was a positive relationship between a lifetime cumulative pathological index and age-at-death ($p=0.002281$). Skeletal pathologies that can develop at any age increased with age-at-death, while skeletal pathologies that only develop during childhood tended to decrease with age, possibly suggesting a relationship between childhood stress and early

mortality in Greek colonies. This project provides support for the use of biomarker-based indices for estimating stress in past populations and may facilitate understanding in similar modern situations of stress and demographic transition.

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Modernizing medical museums through the 3D digitization of pathological specimens Terrie SIMMONS-EHRHARDT (Virginia Commonwealth University, USA), Brian F SPATOLA (National Museum of Health and Medicine), Bernard K MEANS (Virginia Commonwealth University, USA), Audrey D SCHAEFER (Defense POW/MIA Accounting Agency Laboratory), Kristen E PEARLSTEIN (National Museum of Health and Medicine)

The skeletal collections at the National Museum of Health and Medicine contain specimens highlighting the history of military and civilian medicine dating from the American Civil War. The specimens exhibit various pathological conditions, including infectious and metabolic diseases, anomalies, neoplasms, osteomyelitis, and healed and unhealed battlefield injuries. A digital repository of these specimens would be an unprecedented resource for scholars. Sharing military medical assets improves historical knowledge and diagnostic capabilities in the fields of medicine and anthropology. We describe efforts to increase access to these unique and rare specimens through multi-modal three-dimensional (3D) capture. Digitization and dissemination of high-quality 3D models via an online portal enables scholars and educators to manipulate and analyze the 3D models from anywhere in the world. Sub-millimeter micro-computed tomography (CT) scans provide detailed images of internal and external structures for research. Models generated from micro-CT data, enhanced with photorealistic capture of external surfaces through laser scanning and photogrammetry/photo-texturing can provide specimen models for classroom interaction and 3D printing. Simpler representations, such as movie files or animated gifs, can also be generated from

the micro-CT slices, 3D volume renderings of the micro-CT data, and laser scans. By combining imaging capture techniques, the same specimens can be accessed on multiple web-based platforms by users with varying levels of experience or analytical needs. In developing protocols for digital representations of a specimen, our considerations include accuracy of internal and external structures and color/texture, computation of 3D models, and optimizing model sizes for different viewing/interaction platforms.

A rare case of humeroradioulnar synostosis from late medieval Pawłów-Trzebnicki, Poland Victoria M SWENSON (University of Nevada, USA), Anna SPINEK (Polish Academy of Sciences, Poland)

Congenital synostoses are defined as a rare abnormal formation of primary anatomical structures. There are three major classifications 1) skeletal anomalies, 2) soft tissue anomalies, and 3) anomalies involving both skeletal and soft tissues. A review of the clinical literature illustrates that radioulnar synostosis is the most common form of upper limb abnormalities (Vuillermin, 2018). Synostoses between the humerus and either the ulna, radius, or both have been documented and are far less common. Of these, the most common type is humeroradial synostosis followed by humeroradioulnar and humeroulnar synostosis. This study presents a case of a late medieval (15-16th c. A.D) adult female skeleton housed at the Institute of Immunology and Experimental Therapy of the Polish Academy of Sciences with bilateral upper limb synostosis. Macroscopic and radiographic analyses suggest a probable diagnosis of congenital humeroradioulnar and humeroulnar synostosis. Both radii were hypoplastic. The left radial head was significantly reduced, suggesting the radius was fused to the ulna. However, as a result of post mortem damage a definitive diagnosis of radioulnar fusion is uncertain. Although there is no evidence of bone remodeling of the humeri, radii, and ulnae, the acromial end of the right clavicle exhibits skeletal changes suggesting repetitive mechanical stress. A review of the clinical and bioarchaeological literature was

conducted to assess differential diagnoses for the conjoined humerus, radius, and ulna. To date, thirteen cases of radioulnar synostoses have been documented in the archaeological context, and to the best of the authors' knowledge, this is the first case of humeroradioulnar synostosis in the paleopathological literature.

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Three cases of brachydactyly from two tombs at the Late Intermediate Period Site of Marcajirca, Department of Ancash, Peru Anne R TITELBAUM (University of Arizona College of Medicine – Phoenix, USA), Sam FRESH (College of Charleston, USA), Bronwyn MCNEIL (Science World British Columbia, Canada), Bebel IBARRA ASENCIOS (Tulane University, USA)

Previously, two possible cases of mesomelic dwarfism (Léri-Weill dyschondrosteosis) recovered from one commingled tomb was reported from Marcajirca, a Late Intermediate Period (ca. AD 1250) highland site in Ancash, Peru (Titelbaum et al. 2015). Since that publication, 10 additional shortened skeletal elements representing a minimum number of three individuals from two additional commingled tombs have been discovered that may be related to a different heritable form of dwarfism, one that involves the distal segments of the extremities. The recovered shortened elements include two metacarpals (one right MC1, one left MC5) and eight metatarsals (three right and one left MT1, two right and one left MT4, one right MT5). No bones of the proximal or intermediate segments of the extremities from these tombs appeared to be shortened; rather, all shortening appeared to be limited to the distal segment. The affected metacarpals and metatarsals do not represent known patterns of shortened bones of the hands and feet and therefore may represent skeletal dysplasia, brachydactyly Type E, pseudohypoparathyroidism, or pseudopseudohypoparathyroidism. This presentation will describe the affected bones, present a differential diagnosis to better understand the condition, and discuss the cultural

implications of there being various forms of heritable shortened bones in multiple tombs at this site. In addition to providing evidence that tombs were utilized for familial interment, the occurrence of possible dwarfism over time and across tombs likely reflects the endogamous exchange of alleles and the continued use of the site over time by an extended kingroup.

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Patterns of degenerative joint disease in diabetics versus controls in two documented historical North American human skeletal collections Charity F UPSON-TABOAS (Indiana University, USA)

This research studied the patterns of degenerative joint disease in individuals with diabetes and in controls from two historical North American human skeletal collections. The skeletal materials examined are from the documented Hamann-Todd (assembled from 1912 to 1938) and the Robert J. Terry collections (1898 to 1967). Twenty-nine diabetic (11 and 18 respectively from Hamann-Todd and Terry) and 30 controls (12 from Hamann-Todd, 18 from Terry) individuals with age range 21-74 were macroscopically analyzed. Using a combination of methods, the severity of degenerative joint disease (DJD) was recorded in eight appendicular joints (DJ): shoulder, elbow, wrist, hand, hip, knee, ankle, foot; and in the zygapophyseal joints (DJV) and intervertebral body joints (DJB) of the vertebrae by region (cervical, thoracic, lumbar). Paired sample t-tests showed no differences between the collections in the average scores for any type of DJD (DJ $p=0.170$; DJV $p=0.918$; DJB $p=0.386$), nor were there any differences between scores for DJD in the diabetic group and controls, except for DJ of the wrist and ankle, where there was a significant difference in the scores for diabetic individuals (Mean=0.4, STDEV=0.2; Mean=0.6, STDEV=0.2, respectively) and controls (Mean=1.1, STDEV=0.2; M=1.2, STDEV=0.2, respectively) (wrist $p=0.02$; ankle $p=0.03$). Simple linear regressions showed that age

at death could statistically significantly predict DJ 28% of the time ($p<0.001$), DJV and DJB 37% of the time each ($p<0.001$ each). Spearman's correlations showed a relationship between shoulder, hip, and knee DJD and sex, where DJD was more common in females than in males ($r_s=0.296$, $p=0.023$; $r_s=0.257$, $p=0.049$; $r_s=0.472$, $p<0.001$, respectively). This research contradicts the expected trend of increased DJD in individuals with diabetes.

Pediatric paleo-nephropathology in the 16th century natural mummy of the illegitimate granddaughter of John II, King of Portugal Elena

VAROTTO (University of Catania, Italy), Francesco Maria GALASSI (Flinders University, Australia), Nathalie ANTUNES-FERREIRA (Instituto Universitário Egas Moniz, CRIA/FCSH, Universidade Nova de Lisboa Portugal)

This study explores the anthropological and paleopathological aspects of the mummy of the anonymous daughter of Jorge de Lencastre, Duke of Coimbra (1481-1550), the illegitimate son of King John II of Portugal (1455-1495), known as *o Príncipe Perfeito* ("The Perfect Prince") for his promotions of new explorations of Africa and the East. This attribution was possible thanks to historical data and inscriptions on the coffin. The mummy, housed in the Convent of Jesus in the city of Setúbal (50 Km from Lisbon), is in a fairly good state of preservation except for the lost neurocranium. After a preliminary morphological and archival assessment, the mummy was paleoradiologically investigated by CT scan, and a full paleopathological assessment, with a particular focus on renal findings, was performed. Sex was determined with an inspection of external genitalia and CT-scan analysis of the pelvis resulting in a female. Age at death was estimated with measurements of the length of the diaphyses of long bones and with the degree of tooth development and eruption yielding ca. 2 years. A dense rounded radiopaque mass (sagittal diameter = 1.18 cm; transverse diameter = 1.02 cm) located in the left hypochondriac region, occupied *intra vitam* by the upper half of the left kidney, was identified. Visual and radiological inspections revealed no disturbance of bodily

integrity meaning that the mass is endogenous - the likely outcome of a nephrological process. Based on the radiological features of density, compactness and lack of traces of vascularization compared with differential diagnoses including nephroblastoma and Wilms tumor, the most likely diagnosis is renal calculus, potentially caused by genetic factors.

Multiple skeletal pathologies in a Neolithic Sicilian adult male (5th millennium BC)

Elena VAROTTO (University of Catania, Italy), Maria Teresa MAGRO (Superintendency for Cultural and Environmental Heritage of Catania, Italy), Francesco Maria GALASSI (Flinders University, Australia)

This study aims to reconstruct the biological profile of a Neolithic individual focusing on the pathological conditions of the skeleton. It was found in the Neolithic site of Contrada Montagna (Caltagirone, Catania, Sicily) and was preliminarily C14-dated back to 4134-4057 BC (5th millennium BC), then anthropologically and palaeoradiologically assessed (X-Ray, CT Scan and 3D virtual reconstructions).

The skeleton, in fairly good preservation status, belongs to an adult male individual with a mean age of 40 years at death. Morphologically, it presents bilateral *cribra orbitalia*, dentoalveolar diseases, a well-healed trauma on the right parietal bone, localized periostitis on the right femur, osteoarthritis, osteophytes and three Schmorl's nodules. Interestingly, this skeleton shows three cavitations compatible with cysts in the upper left orbit, right superior articular facet of the axis and ventral part of the sacrum (S2-S3). Concerning the aetiology of this type of cysts, several theories have been proposed including trauma, genetic abnormalities, vascular anomalies or haemorrhagic outcomes and ossification failure. In this specific case, although no certainty exists, a vascular or haemorrhagic interpretation may be proposed as more consistent with the

clinical picture of anemia and the lack of other associated signs for the alternative causes. Palaeo-radiologically, the presence of the outcomes of otitis media and the thickening of the inner cranial vault were detected.

This most ancient man, likely affected by anemia, suffered from a combination of a series of pathologies which arguably had a major impact on his life and resulted in incapacitating outcomes, from chronic cranio-cervical pain and hearing loss.

Health on Medieval Isle of Man: A paleopathological analysis of Rushen Abbey

(AD1134- 1540) Marie C WEALE (University of Bradford, UK)

Rushen Abbey, a medieval site dating from the 10-14th century on the Isle of Man (an independent island in the Irish Sea) has undergone extensive archaeological work and produced one of the largest collections of human bone dating to this period from the Island. To date the MNI of the material is around 200 individuals, most of which are adults. However, a small number (n=12) of articulated non-adult remains are also present. The analysis has found evidence of multiple pathological conditions, many of which are common including osteoarthritis as well as infectious diseases such as osteomyelitis and dental diseases. However, the collection has also produced evidence of Paget's disease, and a benign neoplasm, currently the only known cases from Man. There is also evidence of interpersonal violence in the form of sharp force trauma to a spine of an articulated burial from a male, between the ages of 20-35.

Although a lot of work is still to be done on the collection, this is one of the first in depth analyses of osteological remains from the Island in recent years. The results so far offer a glimpse into the health of population of Man in the past and highlight the need for further work like this on the human remains from the Isle of Man, which overall have been understudied.

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Pathological changes associated with resorption of a proximal femur from New Kingdom Tombs, injury or disease? Katie M WHITMORE (Purdue University, USA), Michele R BUZON (Purdue University, USA)

The site of Tombos is located at the Third Cataract of the Nile River in modern-day northern Sudan. The Egyptian-Nubian cemetery at Tombos spans the New Kingdom Period (c. 1400-1050 BCE) through the Third Intermediate and into the Napatan Period (c. 750-660 BCE) and contains monumental pyramid complexes, underground chamber tombs, and tumuli. In one such Nubian-style tumulus from the late Third Intermediate/early Napatan Period, an older adult female was found extended and supine, with head to the west. She was buried in a coffin on top of a bed, with a large ceramic vessel. This individual has evidence of degenerative joint disease in the spine and osteoporosis. In addition, pathological changes were observed in the proximal portion of the right hip joint, where most of the femoral epiphysis was resorbed. This poster presents a differential diagnosis of the possible pathological condition(s) that resulted from the observed morphological changes to the right femur and associated acetabulum. The pathological changes observed in this individual are consistent with an injury resulting in a severe non-union fracture to the femoral neck with subsequent avascular necrosis. Other conditions considered include Legg-Calvé-Perthes disease, a slipped femoral capital epiphysis, and neoplasm. The significant resorption and remodeling observed at the femoral neck is indicative of long-term survival after the initial injury.

Vertebral fractures and developmental anomalies in Carolingian Altenerding, Germany Leslie Lea WILLIAMS (Beloit College, USA), Kendra S WEINRICH (The Ohio State University, USA)

This project examines vertebral morphological variation, both pathological and developmental, at

the early medieval site of Altenerding Petersberg in southeastern Germany. This cemetery was associated with a Merovingian/Carolingian settlement, and dates to the 9th century, a time of imperial expansion into the region. Excavations in 2008 unearthed over 120 graves in proximity to a church. The skeletal remains were examined in 2011 and 2018; 116 individuals were identified, 84 of which have observable vertebrae (59 with cervical vertebrae, 75 with thoracic vertebrae, and 80 with lumbar vertebrae). Subadults are 14.3% of the sample; of the 56 individuals for whom sex could be estimated, males and females are equally represented. These individuals were examined for evidence of vertebral joint degeneration, and vertebral anomalies were noted and described during analysis.

Within this sample, ten individuals (five males, three females, two unknown sex) exhibit vertebral developmental anomalies and fractures, including spondylolysis (n = 2), fractured neural arches (n = 3), fractured articular facets (n = 4), and agenesis/fusion of articular facets (n = 2). Three individuals have more than one bone affected, one of whom has both L5 spondylolysis and a healed fracture of the T10 spinous process. All the individuals with identifiable anomalies are adults and 70% are 35 years or older. These anomalies have diverse etiologies reflecting both activity patterns and developmental variation. When examined relative to the degenerative joint conditions that are common in this series, these vertebral variations highlight the intensive labor patterns of an early medieval community.

A differential diagnosis of Fournier's molars in an individual from Santo Domingo Church (1541-1773), Guatemala Paige Wojcik WOOLFOLK (Indiana University, USA), Rosalba Yasmin CIFUENTES ARGÜELLO (Universidad de San Carlos de Guatemala, Guatemala)

Despite their frequent association with congenital syphilis, Fournier's molars can result from a number of diseases in early childhood (Hillson et al., 1998). This case study presents a differential diagnosis of a subadult with Fournier's molars from the Museo Casa Santo Domingo skeletal collection,

excavated from a colonial church in Guatemala. Based on dental eruption, Individual 2079a was estimated to be approximately 6-11 years old at the time of death. Epiphyseal union and postcranial measurements suggest a minimum age of 5 years. The mandibular permanent first molars have a dome shape, and the left M₁ has a central depression with exposed dentin. The maxillary first molars are Fournier's molars, with enamel pitting and tubercles on the cusps. Further, the deciduous molars are carious with hypoplastic enamel. There are no postcranial lesions or anomalies suggestive of any specific disease. The differential diagnosis included leprosy, congenital syphilis, amelogenesis imperfecta, molar incisor hypomineralization, tuberculosis, and rickets, among other diseases. Amelogenesis imperfecta and molar incisor hypomineralization are unlikely diagnoses due to a lack of enamel defects on erupting permanent teeth. The defects on the permanent first molars most closely resemble those of probable mercurial teeth described by Ioannou et al. (2016), but due to the lack of pathognomonic signs in Individual 2079a, it is not possible to rule out all other possible diagnoses. The uncertainty surrounding the etiology of Fournier's molars and the confusion arising from their classification as mulberry molars mean differential diagnoses should include a wide variety of diseases and possible treatments.

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If you can't fix it, cut it off: Evidence of underlying congenital defects, accidental trauma, and perimortem amputation in a young adult from the 19th century Bethel Cemetery, Indianapolis (USA)

Gretchen ZOELLER, Allie POWELL (Indiana University-Purdue University, USA)

The Bethel Cemetery was excavated in the summer of 2018 as part of a basin development project at the Indianapolis International Airport, resulting in the exhumation of 540 individuals interred between 1827 and 1935. With fewer than 150 headstones and largely piecemeal or non-existent cemetery records, the identification of individuals has been rendered problematic with over 70% of individuals originating from unmarked graves. As a result, bioarchaeological and artefactual analyses are currently ongoing with one goal being the development of osteobiographies that document the lives and life experiences of individuals during a period of significant socio-economic transformation in central Indiana. Our case study presented here of Burial 219 examines a young adult male from the cemetery who exhibits pathological conditions documented among multiple individuals analyzed to date, including pronounced diploic expansion of the cranial vault. In addition, Burial 219 exhibits several congenital defects, including anterior bowing of several long bones, a bifurcated distal articular surface of the right humerus, hyperostosis of the femoral necks, and advanced arthritic change relative to his young age-at-death. Burial 219 also exhibits perimortem trauma, including spiral fractures of left tibia and fibula. This trauma, likely to be accidental in origin, led to amputation of the left femur at mid-shaft, presenting a unique opportunity to consider 19th century medical practices. Analysis of the collection is on-going; however, the individual discussed here presents a unique opportunity to dissect many of the phenomena recurring throughout the collection as the investigation continues.