



PASC SCPA 6th annual meeting 2020

E-conference

Held in conjunctions with CAPA/ACAP conference

At a glance:

Wednesday November 4th

9:00 – 12:00

Holocene bioarchaeology at Liang Bua (Flores, Indonesia):
When and how past modern human populations shifted
from foraging to farming in eastern Indonesia

12:00 – 13:00

Undergraduate Luncheon

13:00 – 17:00

Palaeoanthropology Society of Canada/ Société canadienne
de paléanthropologie (PASC/SCPA)

Wednesday, November 4th

9:00 – 12:00

Session 1

Invited Symposium: Holocene bioarchaeology at Liang Bua
(Flores, Indonesia): When and how past modern human
populations shifted from foraging to farming in eastern Indonesia

Organizer and Chair: Matthew W. Tocheri

Sponsored by SSHRC Insight Grant to M. Tocheri (NO. 435-2017-1234) and PASC/SCPA

Liang Bua is best known as the type site of *Homo floresiensis*, an extinct hominin species that vanished from the cave's archaeological record ~60 to 50 thousand years ago. However, Liang Bua also preserves a rich and relatively complete Holocene archaeological sequence that offers an unprecedented opportunity to examine modern human (*Homo sapiens*) cultural change through time, particularly the timing and nature of the complex transition of subsistence patterns from foraging to farming. The origins and spread of agriculture in Island Southeast Asia have been a source of longstanding inquiry and debate, but Liang Bua is relatively unique in that it preserves evidence before, during, and after this transition.

This session will bring together researchers whose work explores various aspects of this body of archaeological and bioarchaeological evidence at Liang Bua and its implications for understanding human dispersals and cultural diffusion throughout Island Southeast Asia during the Holocene.

Asynchronous 5-minute Presentations

1. Julianto IMA, Sutikna T, Jatmiko, Faith JT, Tocheri MW. The temporal distribution of pottery and aquatic shellfish in the Holocene deposits at Liang Bua indicates major shifts in modern human behaviour through time.
2. Oliveira S, Pugach I, Hubner A, Essel E, Hajdinjak M, Jatmiko, Sutikna T, Wahyu Saptomo E, Tocheri MW, Meyer M, Stoneking M. Human genetic variation across the Holocene at Liang Bua.
3. Tocheri MW, Sutikna T, Faith JT, Jatmiko, France C, Dupras TL. The onset of farming on Flores by at least ~2,700 years ago and the implications for Austronesian cultural history and dispersal.
4. Sutikna T, Faith JT, Jatmiko, Wahyu Saptomo E, Tocheri MW. Faunal change through the Holocene at Liang Bua: Endemic versus introduced mammals.
5. Evans BJ, Gansauge M-T, Tocheri MW, Schillaci MA, Sutikna T, Jatmiko, Wahyu Saptomo E, Klegarth A, Tosi AJ, Melnick DJ, Meyer M. Comparative mitogenomics of prehistoric longtail macaques (*Macaca fascicularis*) from Liang Bua (Flores, Indonesia): Implications for understanding of past modern human dispersals.
6. Alamsyah N, Munizzi JS, Tocheri MW, Metcalfe J, Dupras TL. Nitrogen stable isotope analysis of Holocene pigs and modern humans from Liang Bua.
7. Meijer HJM, Walker SJ, Jatmiko, Wahyu Saptomo E. Have fowl, will travel: Chickens and the transition to farming at Liang Bua, Flores.
8. *Eber A, Veatch EG, Tocheri MW. 2D geometric morphometrics analysis of Liang Bua rat taxa.
9. *Veatch EG, Jatmiko, Wahyu Saptomo E. Zooarchaeology at Liang Bua: Anthropogenic traces of human subsistence on small mammals.
10. Lin SC, Jatmiko, Julianto IMA, Ferdianto A, Sutikna T. Stone artefact assemblage composition as a proxy for changing Holocene land use practices at Liang Bua.

13:00 – 17:00

Session 2

Invited Symposium: Palaeoanthropology Society of Canada/
Société PaléoAnthropologique du Canada (PASC/SCPA)

Organizer and Chair: Mirjana Roksandic

Sponsored by NSERC Discovery Grant to M. Roksandic (RGPIN-2019-04113) and PASC/SCPA

Update on research projects by Canadian scholars, members of the Palaeoanthropology Society of Canada/ Société PaléoAnthropologique du Canada (PASC/SCPA) and their students. This forum is meant for the exchange of ideas by scholars and students of human evolution in its

most encompassing meaning: including the study of primates, environment, tools, morphology and ancient DNA. In addition to presentations and posters, the forum will feature short research updates.

Synchronous Presentations

- 13:00 – 13:15 Dewar G, Stewart BA, Zhao Y, Mitchell PJ, Gleason JD, Blum JD. Ostrich eggshell bead strontium isotopes reveal persistent macroscale social networking across late Quaternary southern Africa.
- 13:15 – 13:30 Mercader J, Akuku P, Boivin N, Bugumba R, Bushozi P, Camacho A, Carter T, Clarke S, Cueva-Temprana A, Durkin P, Favreau J, Fella K, Haberle S, Hubbard S, Inwood J, Itambu M, Koromo S, Lee P, Mohammed A, Mwambwiga A, Olesilau L, Patalano R, Roberts P, Rule S, Saladie P, Siljedal G, Soto M, Umbsaar J, Petraglia M. Hominin Ecology of the Early Oldowan 2 Ma.
- 13:30 – 13:45 Nowell A, French JC. Adolescence and innovation in the European Upper Paleolithic
- 13:45 – 14:00 Riel-Salvatore J, Lythe A. New data on Early Holocene funerary practices at Ganj Dareh (Iran).
- 14:00 – 14:30 Coffee Break (Gather)**
- 14:30 – 14:45 Schroeder L, Scott JE, Robinson CA, von Cramon-Taubadel N. The evolution of the human chin: A quantitative genetics perspective.
- 14:45 – 15:00 Komza K, Viola TB, Netten T, Schroeder L. Morphological integration in the hominoid midfoot.
- 15:00 – 15:15 Willoughby PR. The Stone Age archaeology of Iringa Region, southern Tanzania.
- 15:15 – 15:30 Boughner JC, Marchiori DF, Packota GV. Unexpected variation in molar size patterns in contemporary humans, including among wisdom teeth regardless of impaction.
- 15:30 – 16:00 **Coffee Break (Gather)**
- 16:00 – 16:15 Duke H, Feibel C, Harmand S. Bifacial strategies before the Early Acheulean: New evidence from Kokiselei 6, West Turkana, Kenya 1.8 Ma
- 16:15 – 16:30 Chazan M. If not base camps then what? Perspectives on *Homo erectus* mobility/territoriality and social organization from Wonderwerk Cave and the Kathu Complex
- 16:30 – 16:35 Roksandic M, Lindal J, Radović P, Dragosavac S, Plavšić S, Mihailović D. New hominin finds from Velika Balanica and Kozja Cave, Serbia.

Asynchronous 15-minute Presentations

1. *Appelt CM, Van Ankum EM, Marchiori DF, Boughner JC. Cell processes underpinning the evolution of primate dental form and formula.
2. Brun C, Riel-Salvatore J, Gravel-Miguel C. Les pratiques funéraires durant le Mésolithique ancien: l'exemple de la sépulture de l'enfant de l'Arma Veirana.
3. Vallerand A. L'organisation spatiale: Analyse quantitative et comparative des *Homo sapiens* et des Néandertaliens au site de Riparo Bombrini (Ligurie, Italie).

Asynchronous 5-minute Presentations

1. *Friesen SE, Knigge RP, Tocheri MW. Three-dimensional geometric morphometric analysis of talar and medial cuneiform shape variation in chimpanzees and bonobos.

Asynchronous Poster Presentations

- 1.*Ghalem Y (1), Ribot I (1). Re-examining human variation in Equatorial Africa from the Late Stone Age to modern times: a 3D analysis of the temporal bone.
2. Mackereth EM, Tocheri MW. 3D geometric morphometric analysis of the trapezoid in extant great apes and humans as well as fossil hominins.

ABSTRACTS

1. Nitrogen stable isotope analysis of Holocene pigs and modern humans from Liang Bua

Alamsyah N (1,2), Munizzi JS (3), Tocheri MW (1,4,5), Metcalfe J (1), Dupras TL (6)

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6. Department of Anthropology, University of Central Florida, Orlando, USA

At the archaeological site of Liang Bua, stable isotope analysis of carbon from Holocene pigs and modern humans reveal an abrupt shift to more C₄ plants in their diets beginning at ~2.7 thousand calibrated radiocarbon years before present (ka cal. BP). In the present study, we explore whether the nitrogen stable isotope values for these taxa show a corresponding shift in values that may also reflect dietary or environmental changes related to the transition to farming on Flores. In our pig sample (N = 59), 15 specimens are between ~4.3 and 3.1 thousand years (ka) old and occur in the stratigraphic sequence prior to the appearance of pottery at ~3 ka. Together, these oldest samples yielded a mean $\delta^{15}\text{N}$ value of 8.5, ranging from 7.5 to 9.4. In comparison, eleven specimens are between ~2.7 and 2.0 ka, have a statistically significant lower mean $\delta^{15}\text{N}$ value of 6.9 ($p < 0.01$), and range from 3.8 to 8.4. Interestingly, the mean $\delta^{15}\text{N}$ value of samples dated to between 1.7 and 1.2 ka is 8.1 (6.2–9.3), returning to pre-3 ka levels, whereas those dated to between 960 and 430 years ago significantly decrease to 6.8 (4.2–8.3) ($p < 0.01$). These observed changes in mean $\delta^{15}\text{N}$ values for pigs through time are due to the presence of multiple specimens from the past 1 ka and from 3–2 ka that are approximately one trophic level below the rest of the sample. A possible explanation for these changes is that after the transition to farming occurs ~3 ka ago, humans are controlling the diet of some of these pigs through domestication, resulting in a reduced amount of protein in the pig diet relative to that of other pigs that likely remain wild and/or more free-ranging. In contrast, $\delta^{15}\text{N}$ values for humans (N = 3) at Liang Bua before and after ~3 ka do not show any change (~10.0) but remain about one trophic level above the mean values for pigs.

2. Cell processes underpinning the evolution of primate dental form and formula

*Appelt CM (1), Van Ankum EM (1), Marchiori DF (1), Boughner JC (1)

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Primate dentitions develop and evolve under the regulation of cell processes to generate different dental formulae, asymmetry between upper and lower formulae, and specialized tooth forms. Here we explore and theorize about these underlying cellular and developmental processes. Our interdisciplinary meta-analysis integrated data and literature across physical anthropology, cellular biology, and evolutionary developmental biology, including our own research using a mouse mutant for the p63 gene. We found that prosimians show more variation across dental formulae compared to anthropoids. Also, across primates, lower teeth appear more labile in number and form, and morphology appears more varied in ante-molar teeth versus molars. We posit that primate dental formula evolves via changes in the odontogenic homeobox code that patterns the nascent lamina of the deciduous dentition. These changes implicate tooth signaling centres as well as differentiation, proliferation, migration and compaction of odontogenic cells. Referring back to the p63 mouse model of craniodental development, our results in primates generally support the hypothesis that stronger developmental and functional integration of the midface constrains dental macroevolution in the upper dentition compared to the lower dentition. We propose the Linchpin Hypothesis, that deciduous precursors are requisite for the formation of permanent successional (ante-molar) teeth but not additional (molar) teeth. Evolutionary losses in the dental formula likely occur via more than one type of change in the cellular dynamics of odontogenesis. More studies of diphyodont, heterodont animal models are needed to clarify the cell processes evolving under strong selection for diet and other para-functions in primates including humans and fossil relations.

3. Unexpected variation in molar size patterns in contemporary humans, including among wisdom teeth regardless of impaction

Boughner JC (1), Marchiori DF (1), Packota GV (2)

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The inhibitory cascade model (ICM) is a tenet of mammalian molar morphogenesis that predicts that the larger the first molar (M1) is relative to the size of adjacent molars (M2 and M3), the smaller the M3 and the later its initiation. Worldwide, contemporary modern humans frequently present with impacted M3s that, for unclear mechanisms, are at higher risk of impaction when they develop later. Unexpectedly, our radiographic sample of 323 oral quadrants from 99 dental patients presents 13 molar size ratio patterns at different frequencies (e.g., $M1 > M2 > M3$ in only 31.6% of cases) that reflect the maxilla versus the mandible. This pattern diversity includes non-linear size progressions (e.g., $M1 > M2 < M3$), and up to four patterns in the same person's mouth. Further, we report that M3 size is predicted not by M1 size but by M2/M1 ratio and absolute M2 size. We also report that M1 size does not predict early versus late M3 development, or proper M3 emergence versus impaction. Our findings that contemporary modern humans do not show one stereotypic molar size ratio pattern indicate that molar size is

genetically softwired in recent humans, and subject to oral quadrant-specific and jaw-specific effects. This divergence from the ICM implies relaxed selection pressures leading to weaker developmental integration, stability, and canalization of *Homo sapiens* molar sizes and molar proportions that nonetheless does not impact M3 eruption. Our work suggests that ICM predictions of molar sizes may only be conditionally applied, with caution, across humans including fossil anatomically modern *H. sapiens*. The lack of one stereotypical molar size pattern for contemporary humans may confound predictions of molar size in fragmented fossil human specimens.

4. Les pratiques funéraires durant le Mésolithique ancien : l'exemple de la sépulture de l'enfant de l'Arma Veirana

Brun C (1), Riel-Salvatore J (1), Gravel-Miguel C (2)

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2. School of Human Evolution and Social Change, Arizona State University, Tempe, USA

La découverte en 2017 de la tombe d'un nouveau-né daté du Mésolithique ancien (10000-9000 avant aujourd'hui [AA]) est très importante, tant par la rareté d'une telle sépulture que par la richesse et la diversité du mobilier funéraire qui l'accompagnait. Ces parures sont composées de différentes espèces de coquillages perforés et incorporés dans des ornements complexes. Au total, ce sont 84 coquillages perforés qui constituent l'assemblage du matériel funéraire, en plus de 4 pendentifs.

L'objet d'étude propose de décrire ces parures et d'étudier expérimentalement la manière dont elles ont été confectionnées et portées. Une phase de réplification en laboratoire de production des perles en utilisant des fragments de coquillages de la même espèce documentée à l'Arma Veirana est l'élément central de la recherche. Cela sera suivi par une analyse microscopique entre les répliques et les perles retrouvées à la sépulture.

Cette présentation sera donc sur le cadre de recherche dans lequel les expériences seront entreprises afin de mieux comprendre l'implication de l'archéologie expérimentale dans la démarche scientifique. À travers ces expériences, nous tenterons d'explorer les preuves possibles de l'émergence de comportements novateurs, en particulier les premières expressions de hiérarchie sociale manifestées par le développement ou la transmission du statut social héréditaire.

5. If not base camps then what? Perspectives on *Homo erectus* mobility/territoriality and social organization from Wonderwerk Cave and the Kathu Complex

Chazan M (1)

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Glynn Isaac's home base/food sharing model plays a central role in the archaeology of early hominins connecting the attributes of settlement structure visible in the archaeological record with aspects of social structure distinctive of human hunter gatherers. Yet decades of research have found little compelling evidence for such sites in Early Stone Age (ESA) contexts. This talk briefly presents a perspective on the structure of ESA archaeological

localities and possible implications for the social structure of ESA hominin society based on research at Wonderwerk Cave and the Kathu Complex, located in the Northern Cape Province, South Africa.

6. Ostrich eggshell bead strontium isotopes reveal persistent macroscale social networking across late Quaternary southern Africa

Dewar G (1,2), Stewart BA (3,1), Zhao Y (3), Mitchell PJ (4,5), Gleason JD (6), Blum JD (6)

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Hunter-gatherer exchange networks that dampen subsistence and reproductive risks by building relationships of mutual support outside local groups that are underwritten by symbolic gift exchange. Hxaro, the system of delayed reciprocity between Ju/'hoān individuals in southern Africa's Kalahari Desert, is the best known such example and the basis for most analogies and models of hunter-gatherer exchange in prehistory. However, its antiquity, drivers, and development remain unclear, as they do for long-distance exchanges among African foragers more broadly. Here we show through strontium isotope analyses of ostrich eggshell beads from highland Lesotho, and associated strontium isoscape development, that such practices stretch back into the late Middle Stone Age. We argue that these exchange items originated beyond the macroband from groups occupying the more water-stressed subcontinental interior. Tracking the emergence and persistence of macroscale, transbiome social networks helps illuminate the evolution of social strategies needed to thrive in stochastic environments, strategies that in our case study show persistence over more than 33,000 y.

7. Bifacial strategies before the Early Acheulean: New evidence from Kokiselei 6, West Turkana, Kenya 1.8 Ma

Duke H (1), Feibel C (2), Harmand S (3)

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We present new evidence for the emergence of biface shaping from the Kokiselei Site Complex (KS) in West Turkana, Kenya, at the Kokiselei 6 (KS6) site. This rich and well-preserved new site presents an opportunity to investigate processes of technological change

during the earliest development of biface shaping within a single site complex. The development of biface shaping in lithic technology is often used as evidence for increased and/or novel cognitive abilities that contrast prior hominins' flaking capacities. Yet, recent research reveals a story of gradual change over time in a variety of different flaking and shaping strategies. Here, we examine the emergence of biface shaping technology at KS6 with a focus on direct comparisons between flaking and shaping strategies at the site.

The Kokiselei Site Complex preserves the oldest known Acheulean lithic assemblage, KS4 (1.76 Ma), as well as several older sites. The chronostratigraphic research shows that KS6 stratigraphically underlies KS4 and is the oldest site in the complex at 1.8 Ma. The KS6 excavation yielded thousands of piece-plotted lithic artefacts and faunal remains. Technological analysis of the lithics (n=3856) indicates a prevalence of bifacial flaking strategies alongside minimal evidence for biface shaping. Bifacial flaking and biface shaping at KS6 draw on similar operations and abilities. The evidence from KS6 suggest that biface shaping emerged gradually out of variability in bifacial core reduction, ultimately leading to the systematic production of bifaces characteristic of the Acheulean. These conclusions question long held assumptions about hominin cognitive evolution that suggest Acheulean technology required new, and more complex, cognitive abilities and gestures. Instead, our results suggest that biface shaping required a reconfiguration of existing cognitive abilities that had deep roots in older flaking strategies.

8. 2D geometric morphometrics analysis of Liang Bua rat taxa

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Using 2D geometric morphometrics (2DGM) and high-resolution images of mandibular rat molars, this research aims to develop a robust, quantitative method to differentiate among the multiple species of rat present at the archaeological site of Liang Bua (Flores, Indonesia). Currently, there are eight endemic species of rats recorded in the Liang Bua stratigraphy (*Papagomys armandvillei*, *Papagomys theodorverhoeveni*, *Spelaeomys florensis*, *Hooijeromys nusatenggara*, *Komodomy's rintjanus*, *Paulamys naso*, *Rattus hainaldi*, and *Rattus exulans*) and these taxa vary in terms of their body size, habitat preferences, and adaptations. Using a set of 18 landmarks distributed throughout the molar row, results from this work successfully distinguish between species, particularly those of similar body size, and do not appear to be significantly affected by tooth wear. For example, Principal Components Analysis (PCA) of the Procrustes shape coordinates clearly separates two species of medium-sized rats (*Komodomy's rintjanus* from *Paulamys naso*), regardless of wear stage, based on differences from one another in terms

of subtle molar characteristics and relative dimensions. The PCA of the larger-bodied rats also results in clearly defined shape clusters for *Papagomys armandvillei*, *Papagomys theodorverhoeveni*, *Spelaeomys florensis*, and *Hooijeromys nusatenggara*. Overall, 2DGM appears to be an appropriate method for quantitatively assessing the taxonomy of the large number of rat jaws recovered at Liang Bua. The resulting 2D “warp grids” also provide visualizations of the key shape differences between various rat taxa. Because these different rat species are known to vary in terms of habitat preference, this 2DGM approach offers an important quantitative tool for studying paleoecological changes through time at Liang Bua and other archaeological sites on Flores.

9. Comparative mitogenomics of prehistoric longtail macaques (*Macaca fascicularis*) from Liang Bua (Flores, Indonesia): Implications for understanding of past modern human dispersals

Evans BJ (1), Gansauge M-T (2), Tocheri MW (3,4,5), Schillaci MA (6), Sutikna T (5,7,8), Jatmiko (8), Wahyu Saptomo E (8), Klegarth A (9), Tosi AJ (10), Melnick DJ (11), Meyer M (2)

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Wallace’s Line demarcates a biogeographical boundary between the Indomalaya and Australasian ecoregions. Most placental mammalian genera, for example, occur to the west of this line, whereas most marsupial genera occur to the east. However, macaque monkeys are unusual because they naturally occur on both western and eastern sides. To further explore this anomalous distribution, we analyzed 222 mitochondrial genomes from ~20 macaque species, including new genomes from 60 specimens. These include population sampling of *Macaca fascicularis* (long-tailed macaque) specimens that were recovered during archaeological excavations at Liang Bua, a cave on the Indonesian island of Flores, and also museum specimens from other parts of the Lesser Sunda Islands, including specimens that were collected by Alfred R. Wallace. Direct calibrated radiocarbon ages for four macaque specimens from Liang Bua

demonstrate that macaques were present on Flores by at least ~2,500 years ago, and analysis of ancient DNA from these specimens indicates that they were *M. fascicularis*. Mitochondrial genomes from these and other *M. fascicularis* specimens identifies three mitochondrial lineages that span the southernmost portion of Wallace's Line between Bali and Lombok, and divergences within these lineages are contemporaneous with, and possibly mediated by past dispersals of modern human populations. Taken together, these findings further characterize *M. fascicularis* evolution prior to and following modern human dispersal throughout Island Southeast Asia, and point to possible effects on biodiversity of ancient human cultural diasporas.

10. Three-dimensional geometric morphometric analysis of talar and medial cuneiform shape variation in chimpanzees and bonobos

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Interpretations of early hominin locomotor behaviour typically rely upon comparisons of fossil hominin anatomy with that of extant humans and great apes. Establishing form-function relationships between extant great ape anatomy and their locomotor behaviours, as well as understanding the breadth of variation that exists within these taxa, helps inform interpretations of early hominin behaviour. Previous studies have shown that the shapes of the talus and medial cuneiform among gorillas are strongly linked to how frequently particular populations or taxa climb. In this study, we explore the extent of shape variation in these foot bones among chimpanzees and bonobos. Early studies reported that bonobos practiced more arboreal locomotion than chimpanzees; however, more recent fieldwork indicates that bonobo and chimpanzee locomotor behaviours are more similar to one another than previously thought. This suggests that the tali and medial cuneiforms of bonobos and chimpanzees should show minimal shape differences. A large sample of chimpanzee and bonobo tali and medial cuneiforms ($N > 100$ for each) was quantitatively analyzed using 3D geometric morphometric methods. We found that talar and medial cuneiform shape for all chimpanzee subspecies differed significantly from that of bonobos, and that both western chimpanzee and bonobo tali exhibit characteristics previously linked to a higher frequency of climbing in gorillas and generally among catarrhines. The first metatarsal facet of bonobo and some eastern and central chimpanzee medial cuneiforms displayed morphology associated with greater abduction of the hallux. Significant differences in talar and medial cuneiform shape were also found between western, central, and eastern chimpanzees. Contrary to predictions, substantial variation in talar and medial cuneiform shape

was observed among chimpanzees and bonobos, including features that may represent some degree of functional adaptations for climbing in some taxa.

11. Re-examining human variation in Equatorial Africa from the Late Stone Age to modern times: a 3D analysis of the temporal bone

*Ghalem Y (1), Ribot I (1)

1. Département d'anthropologie, Université de Montréal, Montréal, Quebec

The human morphology of the cranium is a useful tool in exploring population history and adaptation. When establishing biological distances between groups, skull morphology, depending on the chosen anatomical region, reflects not only genetics but also environmental factors. For instance, studies have demonstrated that the face is associated with climatic adaptation, while part of the vault and the cranial base, especially the temporal bone, reflect human phylogeny. Thereby, the present study uses the temporal bone, a key anatomical region to investigate past and recent human diversity at several archaeological sites from Equatorial Africa. The best-preserved temporal bones from the Late Stone Age (Shum Laka 7,000 – 3,000 BP), the Iron Age (Upemba Depression, 600 – 1,900 AD), and the late modern period (19th – 20th centuries) were selected and were morphometrically analyzed using 3D geometric morphometrics to investigate human diversity through time.

Results show that: i) the 3D morphology of the temporal bone reflects phylogenetics; ii) there is morphological continuity from the Late Stone Age until the late modern period, and iii) there is morphological variation within the archaeological sample as well as within the recent sample. This study complements paleogenetics in highlighting the beneficial re-examination of archaeological human remains as they can provide novel information on humankind's diversity and adaptation in Equatorial Africa.

12. The temporal distribution of pottery and aquatic shellfish in the Holocene deposits at Liang Bua indicates major shifts in modern human behaviour through time

Julianto IMA (1), Sutikna T (2,3,4), Jatmiko (4), Faith JT (5), Tocheri MW (1,2,6)

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Liang Bua (Flores, Indonesia), is best known as the type site of *Homo floresiensis*. However, this extinct hominin species vanished from the cave's archaeological record ~60 to 50 thousand years (ka) ago. Although there is some evidence of modern humans at Liang Bua between ~47 and 12 ka, it is during the Holocene epoch that a reasonably continuous material record of modern human behaviour is recorded. To date, 80 radiocarbon ages have been acquired from charcoal samples excavated from this Holocene sequence. These ages span the entire duration of the Holocene and indicate that there are no major temporal gaps within this ~12-ka-long depositional sequence. Using the R Bacon package for age-depth modelling and the calibrated radiocarbon ages, age-depth models for multiple excavated 2 x 2 m sectors were constructed, enabling a reasonably detailed examination of modern human cultural change at Liang Bua through the Holocene.

Based on the age-depth models, we examine the temporal distribution of pottery and aquatic shellfish at the site in four adjacent sectors that together form a larger 4 x 4 m area. The age-depth models for this area derive from 35 calibrated radiocarbon ages that are relatively evenly dispersed between ~0.5 and 12.1 ka and span ~4 m depth of sediment. Our results suggest that locally sourced freshwater gastropods (Thiaridae and Neritidae) are absent or scarce through the first half of the Holocene but these shells become abundant after ~4 ka, with peak abundances occurring ~3.5 ka and a decline to moderate levels after ~3 ka. Pottery first appears at ~3 ka immediately above the shellfish midden and is consistently present in the sequence thereafter. Although the observed changes in pattern of freshwater shellfish exploitation clearly occurred over a longer period of time and were likely determined by factors other than the onset of an agricultural lifestyle, the appearance of pottery at ~3 ka signals a likely shift to increased sedentism and/or farming. Moreover, the specific timing of this shift to pottery suggests that it may represent an influx of Austronesian culture and/or people to Flores.

13. Morphological integration in the hominoid midfoot

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Patterns of morphological integration in living apes and humans can be used to make inferences about the evolvability of skeletal regions throughout hominin evolution, and can explain observed morphological patterns in the fossil record. Here, we consider the observation that medially-located elements of the foot appear more variable throughout the hominin lineage than laterally-located elements. Plio-Pleistocene hominins show adaptations for arboreal and terrestrial locomotion within the medial cuneiform, navicular, and metatarsals (Mts) 1 – 2. Laterally, there appears to be less variation, with most hominins showing adaptations for a stiff

foot. Based on these observations, we test the hypothesis that the medial elements of the great ape and human foot are less morphologically integrated compared to the lateral elements. This would imply that the medial elements are more evolvable, and would explain their high morphological variation throughout hominin evolution. The study sample is composed of midfoot elements (the cuneiforms, navicular, cuboid, and Mts 1 – 5) of *Homo sapiens* (n=83), *Pan troglodytes* (n=63), *Gorilla gorilla* (n=41), and *Pongo* sp. (n=42). Integration was quantified using interlandmark distances from these elements, organized into sets of *a priori* defined functional modules. Patterns of integration across these functional modules were then compared against sets of random traits from the whole midfoot. Results show that all non-human apes have less integrated medial elements, whereas modern humans have highly integrated medial elements. This may explain the morphological diversity we see in the medial elements of habitually and facultatively bipedal hominins. It also suggests that an abducted hallux is less integrated than an adducted one, and that the former may be more evolvable. For a large portion of the hominoid lineage, the medial midfoot may have been more evolvable, up until the evolution of obligate bipedalism. Afterwards, the medial midfoot became more integrated, and less likely to produce new morphological variation. Results also show that chimpanzees have relatively consistent magnitudes of integration throughout the midfoot, corresponding with their variable locomotor repertoire. In contrast, specialized taxa (i.e., orangutans and humans) have more distinct patterns of integration that correspond with plantar pressure distribution during locomotion.

14. 3D geometric morphometric analysis of the trapezoid in extant great apes and humans as well as fossil hominins

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Past studies have shown that quantitative assessments of carpal morphology capture important details about the functional morphology and evolutionary history of hominins and hominids. Here we use three-dimensional geometric morphometrics (3DGM) to explore trapezoid morphology in a relatively large comparative sample of extant hominids (N = 267) and fossil hominins (N = 6). Using the commercial software Stratovan Checkpoint, patches of landmarks with a density of 9 x 9 each were placed on the scaphoid, trapezium facet, second metacarpal, and capitate facets. A Generalized Procrustes Analysis was conducted on the landmarked data followed by a Principal Component Analysis (PCA) to visualize the resulting shape variation. A second analysis that did not include the patched landmarks for the capitate

facet was also conducted because this facet is absent in most of our gorilla sample. All statistical analyses were conducted in R.

The PCAs of both 3DGM analyses result in similar shape distributions along the first and second PC axes. Modern humans and Neandertals cluster positively along PC1 due to their more boot-shaped trapezoids whereas extant great apes and *Homo floresiensis* cluster negatively due to their more pyramidal wedge-shaped trapezoids. These findings are consistent with previous studies that examined trapezoid shape using a combination of articular surface angles and relative areas. However, previous work did not include bonobos and our results show that bonobos and orangutans cluster together positively along PC2 while chimpanzees and gorillas cluster together negatively. This suggests that the primitive trapezoid shape condition for hominids may have been more similar to that of orangutans and bonobos rather than chimpanzees and gorillas.

15. Have fowl, will travel: Chickens and the transition to farming at Liang Bua, Flores

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Chickens (*Gallus gallus* var. *domesticus*) are the most widespread domestic animals in the world and have become a dominant part of our diets. They became first domesticated in the Neolithic in Southeast Asia, and then spread both eastwards and westwards. Their eastward spread into Island Southeast Asia and the Pacific is believed to have been part of the Neolithic package and linked to the arrival of dogs, pigs and pottery. In the Pacific, Neolithic chicken remains appear closely linked to human migration. However, chickens are extremely rare in the archaeological record of Island Southeast Asia. The routes and timing of the dispersal of chickens from their native range in Mainland Southeast Asia into Island Southeast Asia, and from Island Southeast Asia into the Pacific, remain therefore unclear.

Here we present the first archaeological evidence for chickens on Flores, Indonesia from the site of Liang Bua. Liang Bua has yielded an extensive faunal sequence that spans the Late Pleistocene and Holocene. Despite junglefowl being native to Flores, they are absent from Liang Bua's Pleistocene sequence and appear for the first time in the Holocene deposits. Twelve chicken remains have been unearthed so far and the oldest remains, a premaxilla and a tibiotarsus fragment, are dated to ~2.2 and ~2.3 thousand years (ka) ago, respectively. The youngest chicken remains are dated to ~0.3 ka and include an immature radius. The absence of any junglefowl remains in older deposits, the cutmarks on some of the bones, and the presence of juveniles suggests that these remains likely represent domesticated chickens. If correct, this is the first evidence for domesticated chickens on Flores, and in Wallacea more broadly. Their first

recorded appearance in the Liang Bua sequence occurs a few centuries after pottery first appeared ~3 ka ago and the oldest directly-dated modern human burials at the site that have pottery as grave goods (~2.7–2.6 ka). Thus, chickens are found at Liang Bua within an archaeological context of farming but whether they were introduced nearer to the onset of agriculture on the island remains unclear.

16. Hominin Ecology of the Early Oldowan 2 Ma

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Environmental change is key for human evolution, especially at times of anatomical and behavioral change in life histories, such as the origin of meat consumption, economic diversification, and dispersal. However, for the earliest phase of human evolution featuring the technology-dependent hominins that shaped our lineage since 2.6 Ma, the Oldowan, there is a dearth of archaeological evidence directly associated with rich chronostratigraphic and environmental datasets amenable to tracking ecological change and adaptation to new physiographic conditions. One place where this type of information has been recently retrieved is the Western Plio-Pleistocene rift basin of Olduvai Gorge (now Oldupai), Tanzania. We explore habitat range by Oldowan-bearing hominins amidst extremely diverse ecosystems throughout a stratified sequence 235 ka-long, thus predating by >180 ka the earliest landmark fossil hominins and classic Oldowan from the Eastern side of the basin. Our study provides multi-proxy evidence of environmental adaptability, demonstrating colonisation of fresh volcanic landscapes and occupation of fast-changing biomes by 2 Ma.

17. Adolescence and innovation in the European Upper Paleolithic

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Childhood and adolescence are two stages of development that are unique to the human life course. While childhood in the Pleistocene has received considerable attention in recent years, adolescence during the same period remains an understudied area of research. Yet it is during adolescence that key social, physical and cognitive milestones are reached. Thus, through studying adolescents, there is enormous potential for improving our understanding of Upper Palaeolithic lifeways more broadly. The reason for the dearth of these types of studies may be the perceived methodological difficulty of identifying adolescents in the archaeological record. In many ways, it is easier to distinguish children (*sensu lato*) from adults based on size, developmental age and associated artefacts. Adolescents, however, are often seen as more ambiguous, more liminal. Working within an evolutionary framework and using a definition of adolescence rooted in biology, we draw on psychology, ethnography and palaeodemography to develop a model of what it might have meant to be a ‘teenager’ in the European Upper Palaeolithic. Citing the biological, social and cognitive changes that occur during this life stage, we propose an important role of teenagers in the origins and spread of new ideas and innovations throughout the Late Pleistocene.

18. Human genetic variation across the Holocene at Liang Bua

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The appearance of pottery (as a proxy signal for farming) in Island Southeast Asia has long been linked to ideas about the spread of Austronesian languages and culture through the region. Present-day Eastern Indonesians carry a mosaic of DNA segments that are related to Papuan and Austronesian groups. This dual genetic ancestry has been interpreted as a signature of admixture between indigenous foragers and Austronesian-speaking farmers who expanded out

of Taiwan beginning ~5 thousand years (ka) ago. However, it is not clear whether the Papuan-related ancestry identified in contemporary groups represents the ancestry of indigenous groups, or whether it was introduced more recently. Moreover, there is uncertainty as to when the contact between Austronesians and indigenous foragers took place in Eastern Indonesia, reflecting limitations in both the methods used to date admixture from genetic data, as well as the information contained in present-day genomes. To overcome some of these limitations, we generated genome-wide ancient DNA data from skeletal remains of eight modern human individuals recovered from Holocene sediments at Liang Bua. Bones from two of these individuals yielded direct calibrated radiocarbon ages before present (ka cal. BP) of 3.7 and 2.7 ka cal. BP, while another has a modelled U-series age of ~7.5 ka. The exact ages of the other four are less certain as they have not yet been directly dated, although one is from a similar burial context as the 2.7 ka-old individual.

Our preliminary analysis shows that two of the individuals (~2.7 ka old) share ancestry with both Papuan and Austronesian groups, while the others exhibit no Austronesian-related ancestry and are most closely related to present-day Australians and Papuans (Australopapuans) albeit highly differentiated from them. These data suggest that the cultural changes observed at Liang Bua after ~3 ka ago are associated with a component of Austronesian ancestry. Our analyses further indicate that the split between the pre-Austronesian Liang Bua individuals and Australopapuans occurred before the split of Australopapuans and Negrito groups from the Philippines, suggesting that the pre-Austronesians from Liang Bua harbor ancient ancestry related to an earlier modern human settlement of this region.

19. New data on Early Holocene funerary practices at Ganj Dareh (Iran)

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The Early Neolithic site of Ganj Dareh (Kermanshah, Iran) is arguably one of the most significant sites for enhancing our understanding of goat domestication and the onset of sedentism. Despite its central importance, it has proven difficult to obtain contextually reliable data from it and integrate the site in regional syntheses because it was never published in full after excavations ceased in 1974. Here, we present the Ganj Dareh archive at Université de Montréal (housed in the Laboratoire d'archéologie de l'Anthropocène) and show how the documentation and artifacts it comprises still offer a great deal of useful information about the site. In this presentation, we focus on three aspects. First, we present the complete first stratigraphic profile for the site, which reveals a more complex depositional history than Smith's five-level sequence. Second, we explore the spatial organization of different levels which highlights the presence of a single burial in Level B-02 and of a triple burial in an elaborate structure in Level C-01. Finally, we describe and analyze these mortuary data and situate them into the broader context of PPN mortuary practices in the Zagros, showing both similarities and differences from funerary practices at other coeval sites. These data help refine our understanding of Ganj Dareh's depositional and occupational history and recenter it as a key site

to improve our understanding of the social dimensions of the Neolithization process in the Middle East.

20. New hominin finds from Velika Balanica and Kozja Cave, Serbia

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The Central Balkans – the area south of the Danube River and north of Greece – is increasingly being recognized as an important area for the potential admixture of Neanderthal and modern human populations, as testified by new genetic evidence of the early presence of modern humans at the site of Bacho Kiro (Bulgaria). On the other side of the continent, new evidence from Portugal has pushed back the earliest appearance of the Aurignacian in the furthest corners of Western Europe to 38-40 kaBP, some 5 millennia older than the oldest previously established date. Further in the past, Apidima 1 and 2 testify that Neanderthals and modern humans either overlapped or succeeded one another as inhabitants of the Balkan Peninsula between 210-160 kaBP.

We present preliminary results on new specimens from Serbia uncovered this field season: two teeth from Velika Balanica in Southern Serbia, and a mandibular fragment from Kozja Cave in the Iron Gates hinterland. The Velika Balanica teeth come from two different layers: the older is dated radiometrically to 300 kaBP, while the younger has not been dated directly, but is no younger than 120 kaBP. The specimen from Kozja Cave has not been dated yet, but it was found in association with Mousterian artifacts. Another cave in the vicinity, Mala Cave, has a small Aurignacian tool assemblage dated to the period before the Campanian Ignimbrite (CI) eruption. The mandible shows a mixture of Neanderthal and modern human traits which makes it remarkably interesting.

21. The evolution of the human chin: A quantitative genetics perspective

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The evolution of the chin in humans is a longstanding area of inquiry in evolutionary studies. Previous research, ranging from biomechanical and ontogenetic approaches to studies of mandibular symphyseal form and rate of evolution, have provided a number of potential theories to explain the processes underlying chin prominence. Some have invoked the role of direct selection or interpreted the chin as a product of biomechanical, developmental, and architectural constraints on the skull, while others hold the view that the chin is a spandrel – a by-product of evolution. Here, we use a quantitative genetic approach to assess the latter. First, we estimated evolutionary rates, via Lande's generalized genetic distance, along each branch of a fully-resolved hominoid phylogeny to detect rate-shifts in masticatory and basicranial morphology. Second, where directional selection was identified, we reconstructed the pattern of selection acting on specific traits. Overall, results indicate that much of the diversity in extant hominoid mandibular form can be explained by strong stabilizing selection; however, a rapid evolutionary rate (suggestive of directional selection) was detected along the branch to humans. Reconstructed selection gradients indicate strong selection acting to decrease palatal, basicranial, and alveolar length (for both the mandible and maxilla), as well as anterior corpus width and height, and to increase posterior mandibular width, consistent with selection for a parabolic dental arcade. However, for the majority of the traits related to the chin, selection gradients and trait responses occurred either in opposite directions, indicating correlated responses to selection, or selection gradients were not significantly different from zero. The correlated responses were all negative, indicating that they were under the influence of strong negative selection coefficients acting elsewhere, likely related to facial retraction. Thus, our results provide evidence that the distinct human chin could be an evolutionary by-product of direct selection on other aspects of skull form.

22. Faunal change through the Holocene at Liang Bua: Endemic versus introduced mammals

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Flores is an oceanic island that has never been connected by land to either the Asian or Australian continents (during the Pleistocene these are referred to as Sundaland and Sahul, respectively). Because of this lack of past land connections, there is a paucity of terrestrial mammalian taxa that have successfully dispersed to Flores. At the archaeological site of Liang Bua, which preserves a relatively complete stratigraphic sequence that spans the past ~190 thousand years (ka), the first recorded appearance on Flores of a number of terrestrial mammals occurs during the Holocene. Here we examine the first appearance ages and subsequent distribution of several non-endemic taxa at Liang Bua in relation to the initial occurrence of pottery at ~3 ka ago and the oldest directly-dated modern human burials at the site that also include pottery as a grave good (2.7 ka and 2.6 ka). Pig is the only non-endemic mammal observed at Liang Bua prior to ~3 ka ago but it is relatively scarce through the earlier parts of the Holocene. Beginning ~3.6 ka ago pig becomes noticeably abundant relative to the total vertebrate assemblage. Macaques, porcupines, and civet cats appear together ~3 ka ago and are all consistently present in the sequence thereafter, albeit at lower relative abundances than pigs. In contrast, deer and dog are only observed within the past 1,000 years although a few putative fragments of deer are observed as far back as ~3 ka ago. In total, these results suggest major changes to the Flores mammalian fauna occurred between ~3.6 and 3 ka ago and these immediately preceded the onset of C₄-plant agriculture on the island. The observed pattern suggests that each of these non-endemic taxa was likely transported intentionally to Flores by modern humans (presumably Austronesians) although further evidence is needed to test this hypothesis.

23. The onset of farming on Flores by at least ~2,700 years ago and the implications for Austronesian cultural history and dispersal

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Agriculture is a key underlying factor of numerous modern human dispersals during the Holocene. The spread of Austronesian populations across the Pacific over the past five thousand years (ka) represents one of the last major prehistoric human dispersal events, but the role of

farming in this biological, cultural and linguistic expansion from Taiwan into Island Southeast Asia and beyond remains poorly understood. Here we show that modern humans, rats (murine rodents), and pigs from Liang Bua, an archaeological cave site on the eastern Indonesian island of Flores, abruptly shifted to eating C₄ plants ~2.7 thousand calibrated radiocarbon years before present (ka cal. BP), following a ~15-ka-period of C₃-dominated diets. This observed dietary shift, which occurs almost simultaneously with the first appearance of pottery (~3 ka) in the Liang Bua stratigraphic sequence, suggests significant anthropogenic landscape transformation for cultivation and a substantial change in the subsistence economy of prehistoric human populations living around Liang Bua. To date, multiple modern human burials with grave goods, including pottery and polished adzes, have been recovered from the Holocene sequence at Liang Bua. Although most of these were excavated between 1965 and 1989, we recovered three additional burials in 2019, one of which had associated pottery and one included a polished adze. Two of these burials yielded direct ages of ~2.7 and ~2.6 ka cal. BP and their carbon stable isotope values indicate a substantial C₄ component. In total, our results provide the first unequivocal demonstration that farming of an introduced C₄ plant(s), most likely millet, was adopted in eastern Indonesia by ~2.7 ka ago, corroborating linguistic, archaeological, and genetic evidence of Austronesian dispersal in Island Southeast Asia.

24. L'organisation spatiale: Analyse quantitative et comparative des *Homo sapiens* et des Néandertaliens au site de Riparo Bombrini (Ligurie, Italie)

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La disparition des Néandertaliens est l'un des plus grands débats en préhistoire. La période où l'on assiste à leur déclin correspond à l'arrivée des *Homo sapiens* en Europe, il y a environ 40 000 ans. On suppose ainsi que des différences fondamentales distinguent les deux espèces, ce qui aurait permis aux *Homo sapiens* de mieux s'adapter à l'Europe du Pléistocène supérieur. Un élément souvent mentionné afin de distinguer notre espèce des autres représentants du genre *Homo* est la capacité de structurer son espace au sein des sites qu'ils occupaient. Toutefois, des fouilles récentes de sites clairement attribués aux Néandertaliens ont livré des preuves de l'utilisation de l'espace de manière structurée notamment aux sites de Tor Faraj en Jordanie, La Folie en France, à l'Abric Romani en Espagne et tout récemment à Amalda I en Espagne. Afin d'établir si ces prétendues différences fondamentales entre les Néandertaliens et les *Homo sapiens* existent bel et bien, il est nécessaire de procéder à des analyses comportementales afin de comparer directement les deux espèces. Dans le cadre de ma thèse de maîtrise, je procède à une analyse spatiale comparative au site de Riparo Bombrini (Ligurie, Italie), un abri sous-roche effondré du Paléolithique supérieur et moyen contenant des artefacts aurignaciens et moustériens. Ce projet représente une opportunité unique et sans précédent de caractériser un comportement clé chez les Néandertaliens et les *Homo sapiens* dans un même site. Cette étude est intimement liée à l'utilisation et l'application des outils SIG en archéologie préhistoriques et à l'analyse quantitative des données. À travers cette présentation, je présenterai

les résultats préliminaires des analyses spatiales au site de Riparo Bombrini de deux couches protoaurignaciennes (A1, A2) et d'une couche moustérienne (MS) ainsi que les résultats des analyses précédentes sur les assemblages. Le but de cette analyse est donc d'utiliser des méthodes statistiques afin de mettre à jour les différences qualitatives des schémas d'utilisation de l'espace des deux espèces, d'observer la variabilité comportementale et de donner du sens à cette variabilité.

25. Zooarchaeology at Liang Bua: Anthropogenic traces of human subsistence on small mammals

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From the time modern humans first appear in the stratigraphic record (~46 ka) until the appearance of pottery (~3 ka) and the onset of C₄-plant farming (~2.7 ka) at Liang Bua, the primary mammalian prey available to these foraging populations would have included almost exclusively endemic murine rodents (i.e., rats). At ~3 ka and after on Flores, agriculture and several non-endemic mammals are introduced to the island that undoubtedly altered their diets and subsistence pathways from foraging endemics to consuming domesticates. The extent to which local populations hunted local murines prior to, during, and after the transition to sedentism at Liang Bua is unknown. Here, a taphonomic and zooarchaeological study was performed on a sample of 2,747 cranial and postcranial murine elements to identify human activity during this time. Skeletal elements derive from a single Sector (XI) retaining stratigraphic units of foraging activity (~18–5 ka), increased sedentism (~5–3 ka), and farming practices (~3 ka – present). Where possible, skeletal elements were identified to a body size category and analyzed for traces of human activity. Results from skeletal element abundances, bone surface modification analysis, and burning patterns indicate gradual yet fluctuating periods of human activity in the cave with a noticeable peak corresponding to the introduction of pottery (~3 ka) followed by a substantial decrease in fire-use. Cutmarks identified on large-bodied murines—indicating direct human consumption—before ~5 ka are scarce, but the greater relative abundance of large to giant-body sized murines (>600 g) coupled with an increasing amount of burnt bone may indicate a slow but increasing amount of human activity from ~18–5 ka. Between ~5 and 3 ka, small murines became incorporated into the human diet for the first time. This expansion of diet breadth—coupled with intensified shellfish harvesting—may indicate the presence of other biodegradable technologies (i.e., nets, snares, traps) used to collect these additional resources. Finally, the presence of cutmarks on large to giant-bodied size murines soon after ~3 ka suggest that humans continued to forage for endemic small mammals after the transition to farming.

26. The Stone Age archaeology of Iringa Region, southern Tanzania

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The Iringa Region, in the Southern Highlands of Tanzania, contains an archaeological and fossil hominin record ranging from the Acheulean through historic and modern times. Acheulean sites are located in open-air gullies, where Pleistocene sediments are exposed. A survey in 2018 located numerous new sites besides the famous Isimila Korongo. The region is also well known for its extensive rock outcrops with shelters. In them, a record from the Middle Stone Age (MSA) to present has been identified. Fossil modern human teeth have been recovered from one shelter (Magubike) and a partial Pleistocene human skeleton in another (Mlambalasi). The paper reviews recent work in Iringa and the role of this region in the emergence of modern *Homo sapiens*.