

## SESSION 11

### BIOARCHAEOLOGICAL APPROACHES

*Coordinated by Dušan Borić and Julien Riel Salvatore*

Over the past several decades, there have been major methodological advances in bioarchaeology, encompassing a wide range of scientific approaches to shed light on the diversity of human lives in the Mesolithic. Applied primarily to human and animal bone samples, these include biomolecular approaches and isotope analyses (notably nitrogen, carbon, sulfur, oxygen and strontium) to reconstruct diet, provenance/mobility, and/or seasonality. In addition, bone chemistry is an integral part of accelerated mass spectrometry (AMS) applied to short-lived organisms and are critical in establishing robust and precise chronologies. Likewise, the fast-growing field of past population genetics has also made remarkable progress over the past decade, as has proteomic research, including methods such as collagen finger-printing (e.g., Zooarchaeology by Mass Spectrometry, or ZooMS) which allow the identification of highly fragmented animal remains to the genus level. On the other hand, more traditional approaches such as morphometrics and histology have also developed substantially in analytical sophistication, contributing novel insights into Mesolithic human life histories. In this session, we invite contributors to present diverse studies within the wider field of bioarchaeology through both novel analytical approaches and state-of-the-art methodologies applied to Mesolithic assemblages.

## ANCIENT DNA FROM ARTEFACTS OFFERS A NEW PERSPECTIVE ON THE MESOLITHIC IN SOUTHERN SCANDINAVIA

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The population history of northern Europe remains a topic of intense research, particularly on the origins and spread of key technological innovations during the Mesolithic. Our study, which builds upon recent advancements in ancient DNA recovery, focuses on using birch tar mastics and hafted materials, such as slotted bone points, as sources of ancient human DNA. These tools, first appearing in Scandinavia around 9200 BP, are considered an innovation likely originating in northern Eurasia. However, the mechanisms by which this technology spread and reached Denmark—whether through incoming hunter-gatherer groups or local adoption by indigenous populations—remain unresolved. Through the extraction of ancient human DNA from birch tar mastics and slotted points, we have generated some of the oldest human genomes from Denmark and southern Scandinavia, significantly expanding the dataset of Mesolithic genomes beyond those published in 2024 by Allentoft et al. These genomes provide unprecedented insights into the population dynamics during the Maglemose (11,000–8,400 cal. BP) and Kongemose (8,400–7,400 cal. BP) cultures. Our findings address long-standing questions about the introduction of pressure-blade technologies in northern Europe, highlighting the potential for novel sampling strategies to transform our understanding of early human history.

## EXPLORING THE GENETIC LEGACY OF MESOLITHIC POPULATIONS IN THE EASTERN ALPS: ADNA EVIDENCE FROM THE VENETO AND TRENTINO-ALTO ADIGE REGIONS

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Recent studies conducted by our team have explored the biological makeup and the social and ecological context of Mesolithic hunter-gatherers in the Alpine region of northern Italy, focusing on the exceptionally rare human remains discovered in the Veneto and Trentino-Alto Adige regions. The genetic composition of these populations provides critical insights into the demographic and evolutionary processes that shaped early human groups in Europe. This study analyzes ancient DNA (aDNA) from three Mesolithic individuals recovered from archaeological sites across the eastern Alps: Mezzocorona-Borgonuovo and Vatte di Zambana in Trentino-Alto Adige, and Mondeval de Sora in Veneto. The analysis examines genetic diversity, population structure, and connections to broader European populations. Preliminary results reveal a genetic profile dominated by Villabruna ancestry, consistent with Epigravettian individuals from the Italian peninsula and comparable to other Mesolithic groups in Western Europe. Regional analyses, however, suggest localized differentiation and possible interactions with neighboring groups. Evidence from genetic data also explores the potential for early interactions between Mesolithic hunter-gatherers and incoming Neolithic farming populations, providing insights into the cultural and biological transitions in this region. These findings provide a deeper understanding of the genetic and cultural landscape of post-glacial Europe, highlighting Northern Italy's role as a potential corridor for human migration and interaction. Future research will further investigate the impact of environmental changes and the transition to the Neolithic on the genetic makeup of these populations.

## FROM BONES TO MUMMIFICATION: BREAKING GROUND IN MESOLITHIC MORTUARY STUDIES WITH BIOARCHAEOLOGY

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Mummification of the dead is a worldwide mortuary practice. It is the simplest and the most effective way to preserve a corpse offering the survivors a prolonged period of engaging with the body. Yet, in the absence of historical accounts, mummification in prehistory, while plausible, is largely unknown. In 2022, together with other colleagues, we discovered evidence of mummification in Mesolithic Portugal from 8000 years ago. This discovery prompts a radical reassessment of early mummification in Europe and opens a new debate about the cultural significance of the practice. In this presentation, we introduce our new research project, funded by the Swedish Research Council (2024-2027), which aims to develop a pioneering non-invasive bioarchaeological framework to investigate mummification at archaeological sites containing human bones but lacking tangible evidence of mummified soft tissues. Our innovative approach combines bioarchaeology and funerary archaeology to create methods for detecting mummification when only skeletal remains are preserved. By identifying prehistoric examples in Europe, we aim to evaluate the prevalence of the practice in Mesolithic Europe.

## **MANDIBULAR MORPHOLOGICAL CHANGES IN THE MESOLITHIC – NEOLITHIC TRANSITION ARE IMPACTED MORE BY POPULATION HISTORY THAN BY DIET**

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The transition from Mesolithic hunting-gathering to Neolithic agro-pastoralism involved meaningful social, cultural, economic and biological changes. These include, e.g., changes in population structure, diet and skull morphology. The latter have been shown to be impacted by the former two because bone morphology responds both to genotype and to biomechanical loading. Yet, it is still unclear which of these factors is driving the morphological changes arising in this transition. This study uses mandibular morphological, genetic and diet data to clarify this question. A sample of 259 mandibles from north Africa to western Eurasia and from the Upper Palaeolithic to the Chalcolithic was digitised and used in Geometrics Morphometrics (GM) based morphological analysis. Mitochondrial DNA (mtDNA) haplogroups were used as proxy for population history and dental wear magnitude as proxy for diet. These data were then used to generate distance matrices and Mantel tests to examine the relationship between these variables and to quantify the proportion of mandibular morphology that is explained by diet and by population history. Our results show that mandibular morphology is significantly correlated with population history and diet, but that the former explains a much larger proportion of mandible form. Thus, although our study is consistent with previous research in showing that the changes in diet introduced in this transition do impact skull morphology, it also shows that this impact is much smaller than that of the caused by changes in population structure arising due to migrations.

## MANDIBULAR SHAPE IN THE MESO-NEOLITHIC TRANSITION: THE ZVEJNIEKI CASE STUDY

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Subsistence strategy influences mandible morphology, such that agricultural groups have shorter and narrower mandibles than foraging groups. The same pattern is observed when comparing individuals across the Meso-Neolithic transition and its associated subsistence change. These morphological differences are often explained by a reduced masticatory stress resulting from a more processed agricultural diet, but recent research suggests population history may explain a higher proportion of this morphological variation than previously suspected. The Zvejnieki archaeological site in Latvia is one of the largest Stone Age cemeteries in Europe with over 300 burials dated from ~7500 cal BP to ~2600 cal BP. Here, the Meso-Neolithic transition was characterised by the appearance of pottery at 5400 cal BP without associated population replacement. Later, in the Bronze/Iron Age, the population adopted an agro-pastoralism subsistence. Hence, this population presents a compelling case study to study the influence of subsistence strategy on mandible morphology, while controlling for population history. In this study, we 3D scanned nearly 100 mandibles from Zvejnieki individuals, 36 from the Mesolithic, 57 from the Neolithic, and 5 from the Bronze/Iron Age, from which we collected coordinates for 21 anatomical landmarks, followed by geometric morphometric analyses, from which we will present preliminary analyses. This research stands to contribute to our understanding of this extraordinary population, as well as the Mesolithic and its transition to the Neolithic, more broadly. In addition, our results shed light on modern issues of tooth crowding and malocclusion, which have been associated with increased diet processing.



## **INTERACTIONS WITH THE DEAD: THE POTENTIAL FOR 3D DIGITAL MICROSCOPY TO REVEAL POST-MORTEM MANIPULATIONS OF THE BODY**

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This paper reports on the application of 3D digital microscopy to surface modifications on Mesolithic human bone, to elucidate the timing of post-mortem interactions with the body. A key piece of evidence for the deliberate manipulation of the body are bone surface modifications, such as cut-marks, scrape-marks and chop-marks. Macroscopic analysis of their location and morphology can provide information on the timing and motivation behind the action (e.g. cut-marks concentrated around skeletal joints suggest disarticulation of a fleshed body, those focused on the shaft of a bone may relate to defleshing or cleaning) but this is limited and not quantifiable. Recent work has however shown the potential for 3D digital imaging of the surface micromorphology of such marks to provide information which can distinguish between marks made at different stages of decay/decomposition (see Bello et al., 2016, Wallduck and Bello 2016a) and differentiate between marks resulting from the processing of bodies and those derived from engraving bone (e.g. Wallduck and Bello, 2016b). Confirming the timing of these interactions with the body is a key part of reconstructing the specific processes involved, which in turn is crucial evidence for reconstructing attitudes and beliefs towards the dead. Within the Mesolithic, however, application of this technique has so far been confined to sites within the Danube Gorges (Serbia). This paper will present the results of the application of this method to an assemblage of Mesolithic remains from northern Europe and discuss its implications for understanding mortuary treatment at this and other sites.

## THE BIOLOGICAL PROFILE OF MESOLITHIC INFANTS: A GEOMETRIC MORPHOMETRICS TECHNIQUE FOR SEX ESTIMATION USING THE AURICULAR SURFACE

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The Muge shellmiddens served as burial grounds for the last hunter-gatherers of the Iberian Peninsula. Approximately 300 individuals have been recovered, making it one of Europe's largest Mesolithic skeletal collections. These remains provide invaluable insights into the demographics and social structure of these communities. However, the lack of data on the biological sex of non-adults limits our understanding of these groups. This study uses three-dimensional Geometric Morphometrics (GM) and the auricular surface to estimate the biological sex of non-adults aged 0-6 years old. The ilia of 46 individuals (20 females, 26 males) from the Luís Lopes Identified Skeletal Collection were surface-scanned, and GM-based morphological analysis was conducted, including GPA, PCA, and non-parametric statistical tests to assess sex differences. Differences in the auricular surface morphology were identified in infants under one year, but no differences were observed in older individuals. The same methodology was applied to eight archaeological infants from two Muge shellmiddens, Cabeço da Arruda and Moita do Sebastião. Although the results were inconclusive, tentative sex estimation was possible for individuals under one year, suggesting that 2/5 of the archaeological infants may be female, and 3/5 are male. This study underscores the potential of 3D GM for sex estimation in archaeological non-adult skeletal remains. It also demonstrates that the auricular surface is a reliable sex indicator in infants under one year, but the biological signal reflecting sexual dimorphism fades after that age. Future research should include larger, more diverse samples to investigate inter-population variability and incorporate cross-validation and AI-based approaches.



## THE SHAMAN'S MESOLITHIC BURIAL OF BAD DÜRRENBURG (SAXONY-ANHALT, GERMANY): ENVIRONMENTAL AND DIETARY RECONSTRUCTION

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The Shaman's Mesolithic burial of Bad Dürrenberg, discovered in 1934, represents a remarkable archaeological find dated to approximately 7,000 cal. B.C. The burial contained the remains of a woman and an infant, accompanied by an elaborate assemblage of grave goods, including a roe deer headdress, pond turtle shell fragments, and other faunal remains, as well as stone artefacts. This study aims to reconstruct the environment and diet of the shaman, as well as other contemporary humans from Bottendorf, Hadmersleben, Kuckenburg, and Merseburg Ost, all located in central Germany. We analyzed 15 faunal remains mostly from Bad Dürrenberg and 11 human remains. Stable carbon, nitrogen, and sulfur isotope analyses were conducted on collagen to infer dietary and environmental conditions. Our findings indicate that the Mesolithic landscape around Bad Dürrenberg was predominantly open. Even species typically associated with forested environments, such as roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*), exhibited carbon isotope values ranging from -20.8‰ to -20.3‰ and -21.6‰ to -20.7‰, respectively, consistent with open-land habitats. Dietary reconstruction suggests that the primary food sources of the shaman and the other Mesolithic individuals have not yet been fully identified, as the burial offerings were not the main source of their daily diet. Furthermore, despite the proximity to the Saale River, sulfur stable isotopes suggest that aquatic resources were not a substantial component of their subsistence. An exception maybe the four individuals from Bottendorf, whose isotope values could be explained by aquatic resource consumption.

## INVESTIGATING MESOLITHIC FOODWAYS AT THE TRANSITION TO AGRICULTURE

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How prehistoric farming became established in Northern Europe, a region that supported relatively dense populations of hunter-gatherer-fishers, has troubled archaeologists for over a century. Empirical assessment of changes to food production, human diet and the ways that foods were prepared and eaten has been fundamental to exploring this problem. In one of the largest studies of its kind, here we present data from organic residue analysis of over a 1000 Mesolithic and Early Neolithic ceramic vessels to examine the role of pottery at the transition. We found unexpected consistency in the use of aquatic foods at odds with prevailing narrative of large-scale demographic and economic change. We argue that the ability of farming groups to adapt to their environment by learning hunter-gatherer-fisher practices, combined with dairying, was key to their northerly expansion. We also provide new, compelling, multi-proxy evidence of the use of dairy products by hunter-gatherer-fishers which we attribute to long-distance exchange with farmers, implying a much greater degree of interaction and cooperation than previously described. Focusing on Denmark, finally we offer a demographic explanation to reconcile the different lines of evidence for aquatic food exploitation at the transition to agriculture..

## WHAT WAS THE MESOLITHIC? REASSESSING COASTAL ADAPTATIONS BY HUNTER-GATHERERS IN ITALY

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Defining the Mesolithic is difficult, if one aims to understand it as a phenomenon, rather than simply identifying its inception with the Pleistocene-Holocene boundary or even with the first production of microlithic industries. Ever since its establishment as a period of human prehistory, the Mesolithic has been associated with the Ertebølle køkkenmøddinger of Denmark. As a result, Mesolithic hunter-gatherers have been depicted as reliant on marine resources to adapt to Postglacial environments. On this basis, Antonio Radmilli proposed the Mesolithic in Italy, following his 1958 excavations at Grotta La Porta and at other poorly published sites. This proposal was met with skepticism, but the inconsistencies in relevant chronologies, as well as poor typological reasoning and superficial analyses of subsistence data, were never addressed in detail. The present contribution does so, by reassessing what is known about coastal hunter-gatherer adaptations in Italy from the closing millennia of the Pleistocene to the arrival of Neolithic farmers. Recently acquired data on shellfish consumption by central Mediterranean Late- and Post-Glacial foragers, as well as zooarchaeological evidence for fishing and for the exploitation of marine mammals, along with isotopic data on human diets, will be presented to evaluate Mesolithic reliance on marine resources. This, in turn, forms the basis for a discussion on the unity of the Mediterranean Mesolithic, as well as its implications for understanding the transition to farming in Italy.

## FISHFUL THINKING: STABLE ISOTOPE ANALYSIS OF AMINO ACIDS IN EASTERN BALTIC FORAGERS AND EARLY FARMERS

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The transition from foraging to farming was a pivotal moment in ancient socio-economies, but its complexities and regional variation are still poorly understood. Recent research shows that in the Eastern Baltic during the 3rd millennium BCE, hunter-fisher-gatherers (HFG) and early farmers lived side by side. Farming was introduced by the Corded Ware cultural group (CWC), but dietary segregation existed, as stable isotope analysis of human bone collagen suggest that some individuals had greater access to domesticates while others relied more on wild resources. The local HFGs did not adopt domesticates. Instead of a transition, there was a complex system of parallel worlds: local HFGs continued their foraging lifestyles, while incoming farmers practiced mixed economies. These subsistence strategies persisted for at least a millennium after the introduction of domesticated animals. Here, we will investigate the dietary shift in more granular detail by deploying compound specific isotope analysis (CSIA) of amino acids from human bone collagen. Our goal is to better quantify the consumption of aquatic foodstuffs in the diets of 3rd millennium BCE HFGs and early farmers living on the Baltic Sea coast, which remains ambiguous using bulk stable isotopes alone. Through this case study, we will demonstrate the overall value of the CSIA methodology in providing a more nuanced and accurate assessment of ancient diets.

## LOOKING FOR DIACHRONIC PATTERNS IN DANISH MESOLITHIC DIETS

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After more than 40 years of stable isotope research, the stark contrast between Late Mesolithic Ertebølle and Early Neolithic Funnel Beaker culture diets observed by Tauber (1981, DOI 10.1038/292332a0) is still evident, and perhaps reinforced by archaeogenetic evidence of a major population turnover at this transition (Allentoft et al. 2024, DOI 10.1038/s41586-023-06862-3). Within the Ertebølle epoch, however, we (Meadows and Fischer 2024, DOI 10.1016/j.quascirev.2024.108745) found no diachronic dietary patterns: most of the 40 Ertebølle individuals with  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  data depended overwhelmingly on marine resources, particularly species associated with eelgrass (*Zostera marina*) meadows, but exceptions occurred throughout the 1500-year period (~5400-3900 cal BC).  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  data from only 20 earlier Mesolithic individuals are available, covering nearly twice the Ertebølle timespan. They appear to show a steadily increasing reliance on marine resources between 8400 and 5500 cal BC, although terrestrial resources always predominate. Here, we examine whether this trend is robust and corresponds to changes in technology and resource availability, or reflects natural developments in the isoscape, or whether the data are too sparse to say anything definitive. Additional Ertebølle cases provide further evidence of synchronic dietary variation, and provide a statistical framework for distinguishing diachronic from synchronic patterns in the earlier Mesolithic.

## 11 000 YEAR OLD HUMAN SKULLS FROM SOUTH-WESTERN LITHUANIAN PEAT BOG

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Re-discovery of unique human skull collection assembled by Jurgis Žilinskas in the 1st half of XX c. Lithuania provided a lot of new important anthropological data for Lithuanian archaeologists. Among the skulls was a unique group of 3 human skulls that were directly AMS dated to be around 11 000 years old. All 3 skulls were found in a peat bog making them the oldest known human remains from peat bogs in all of the north-eastern Eurasia. Results from C and N stable isotope analysis are expected to show the prevalent source of food for these societies living at the very early stages of Holocene. The main question here is where their food economy was focused on fishing or hunting migratory animals (e. g. reindeer)? 2 out of 3 skulls had their teeth preserved and this enabled us to do Sr isotope analysis to see their migratory patterns during their lifetime. The main question to be answered here is were they of local or migratory origin? Further research possibilities will be outlined as well.



## TRANSITIONS AND CHANGES IN EASTERN MIDDLE SWEDEN 5000 – 2200 BC

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According to cultural history research, migration was a natural part of transition and change. However, the migrations became unfashionable and were abandoned both in new archeology and postmodern research. DNA research represented a paradigm shift and reversal of migration models, albeit often simplistic and high-level ones. The transition must be broken down to the local level. My essay deals with a specific region, Östergötland, in eastern Central Sweden and its local story, its history. Transitions started approx. 5000 BC with a dissolution of the large Mesolithic settlements in favor of numerous, small, and scattered ones. The Neolithic farms were established on these Mesolithic sites and probably the local hunters and gatherers became farmers and incorporated into the funnel cup culture. However, according to DNA analysis, we know the migration from the south 3900 BC. Approx. 3200 BC another transition took place. The FBC disappeared and the hunters and gatherers returned, known here as the Pitted Ware Culture. According to DNA analyses, it was a new genetic population that settled along the coasts and waterways. The PWC had some genetic relatedness to the older, Mesolithic, population but was still a new and distinctly separate genetic population. To summarize: the transition from the Mesolithic to the Neolithic did not end with the rise of the FBC. If you like, in this area the early Neolithic was just a break in the Mesolithic.