

SMIA 2016: Benchmarking Interdisciplinarity in Archaeological Research – Book of abstracts

ORAL PRESENTATIONS

Author: *Teija Alenius*
Title: *Neolithic land-use in the Northern Boreal Zone: High-resolution multiproxy analyses from Lake Huhdasjärvi, south-eastern Finland*
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The origins and spread of Neolithic agriculture in Europe remain a major focus in world archaeology.

In eastern Fennoscandia (Finland and the Republic of Karelia, Russia), the Neolithic period begins with the appearance of pottery ca. 5300–5200 BC. According to the traditional interpretation, in eastern Fennoscandia and in the Baltic States, the beginning of the Neolithic period was not associated with agriculture.

There is, however, increasing evidence that the initial stage of cereal cultivation in Northern Europe took place from the very beginning of Neolithic Stone Age, ca. 5300 – 4000 onwards. These results then turn the northern boreal zone from an apparent periphery to an important region in understanding Neolithisation on a Eurasian scale.

In this presentation, a case study from the province of Kymenlaakso, south-eastern Finland is presented. The combined application of high resolution multiproxy analyses from lake sediments and quantitative landscape reconstructions allows the accurate reconstruction of landscapes and land use during the Neolithic.

Authors: *Malou Blank¹, Emma Svensson²*
Presenting author: *Malou Blank*
Title: *Migration and mobility in western Sweden during the Late Neolithic*
Affiliations: *¹University of Gothenburg, ²Uppsala University.*

This paper addresses questions of migration and mobility in the Scandinavian Late Neolithic (2350-1700 BC) by combining knowledge from archaeology, isotope analyses and ancient genomes.

During the Neolithic period in south Scandinavia the Funnel Beaker complex gave way to the Battle Axe complex, which was later replaced by a more homogeneous Late Neolithic cultural complex.

Immigration from various regions has been proposed as an explanation for the increase of the population density in the Late Neolithic. Other explanations such as intensified cultivation and an ameliorated general health have also been suggested.

This regional study is based on analysis of bone material from several gallery graves in Falbygden. Falbygden is placed in the inland of western Sweden. Here one of Northern Europe's largest concentrations of Middle Neolithic passage graves and numerous Late Neolithic gallery graves are found

The large amount of well-preserved bone material enables various analyses on skeletal remains. The geology of Falbygden differs from surrounding areas, which implies good prospects for identifying mobility using strontium isotope analyses.

Here we show how taking a multidisciplinary approach helps address questions of mobility and migration during the complex period that is the late Neolithic in Scandinavia.

Author: *Thomas Birch*

Title: *A multifaceted approach to standardised artefacts: combining traditional archaeological, geometric morphometric (GMM) and material analyses of the Havor lance type*

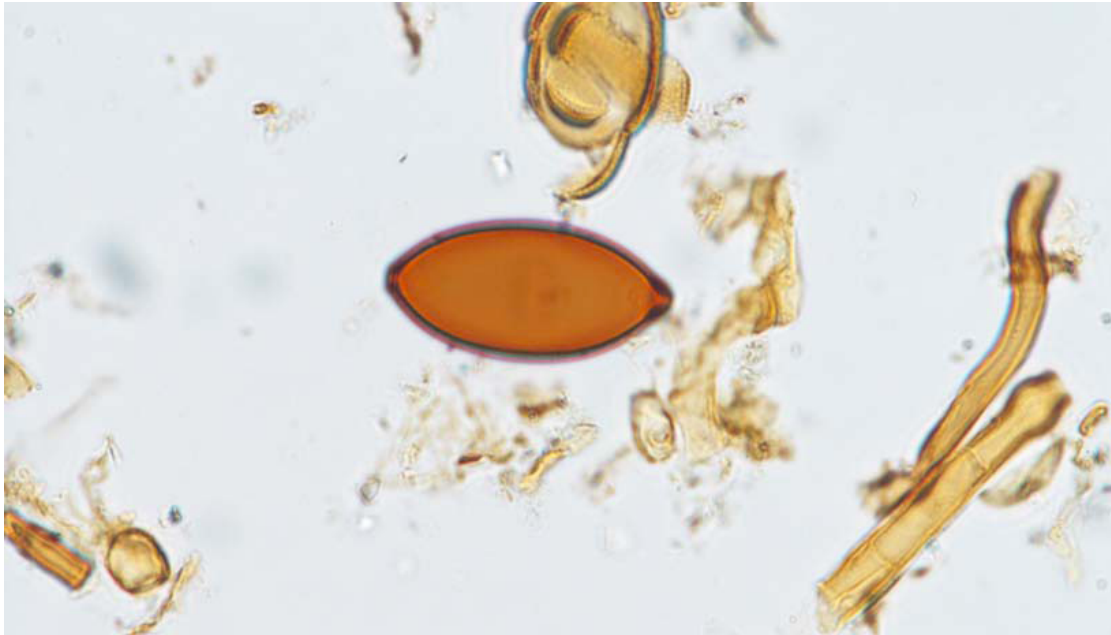
Affiliation: *Centre for Urban Network Evolutions (UrbNet), Aarhus University, School of Culture and Society. Moesgård Allé 20, 8270 Højbjerg, Denmark*

The famous war booty sacrifices from eastern Jutland contain some of the largest collections of war-gear and weaponry known from the Roman Iron Age in northern Europe. They have informed us a great deal about warfare, society and ritual in southern Scandinavia. Investigations of the weapons has shown many of them to be standardised types. One of those types is the Havor lance, narrowly dated to the Late Roman Iron Age (375-400 CE) and found in four of the six major weapon deposits, as well as numerous other weapon burials. Using a combination of different and complimentary methods, the case study of the Havor lance illustrates how a multifaceted approach can provide additional invaluable information concerning standardised artefact types. The project analysed over 120 published examples using traditional metric (dimensions) as well as geometric morphometric (GMM) analyses (shape). Thirteen lances were available for sampling, where metallography and slag inclusion (SI) analysis

focussed on their composition, manufacture and possible origin(s). The findings provide new insights into the movement of raw materials, technological decisions and manufacturing practices, as well as the significance of aesthetic qualities. Using both desktop- and materials-based methods, the case study of the Havor lance demonstrates the richness of results gained from employing an interdisciplinary approach.

Authors: *Renée Enevold^{1,2}, Bent Vad Odgaard²*
Presenting author: *Renée Enevold*
Title: *Promising method advancement in palynology: a supplement to pollen analysis*
Affiliations: *¹Department of Environmental Archaeology and Conservation, Moesgaard Museum, Denmark. re@moesgaardmuseum.dk, ²Department of Geoscience, Aarhus University, Hoegh-Guldbergs Gade 2, Denmark*

The analysis of Non Pollen Palynomorphs (NPPs) has evolved over the last few decades to be a fruitful supplement to palynological surveys and has especially proven to be a useful addition when interpreting anthropogenic disturbance of the natural environment. NPPs in anthropogenic soils and archaeological samples are often numerous in types as well as in abundance. The term encompasses a variety of organic remains from microscopic organisms including fungi, algae, insects and amoebae. Preparing these soil samples with standard methods based on acid digestion holds the potential of severe bias leaving the assemblages devoid of acid vulnerable NPPs. In many cases it might be worth the effort to prepare the samples with as mild a preparation method as possible for a representative NPP assemblage. We have mildly prepared samples from a small water hole, Tårup Lund, Denmark. The sediment from the water hole features environmental information from the last 6000 years, including a period of locally intense pastoral and/or agricultural activity during the Iron Age. We attempt identifying anthropogenic indicators from the recovered NPP assemblages by comparing to the environmental information derived from sediment-, pollen- and macrofossil analyses.



Fungal ascospore x1000. Photo: Renée Enevold

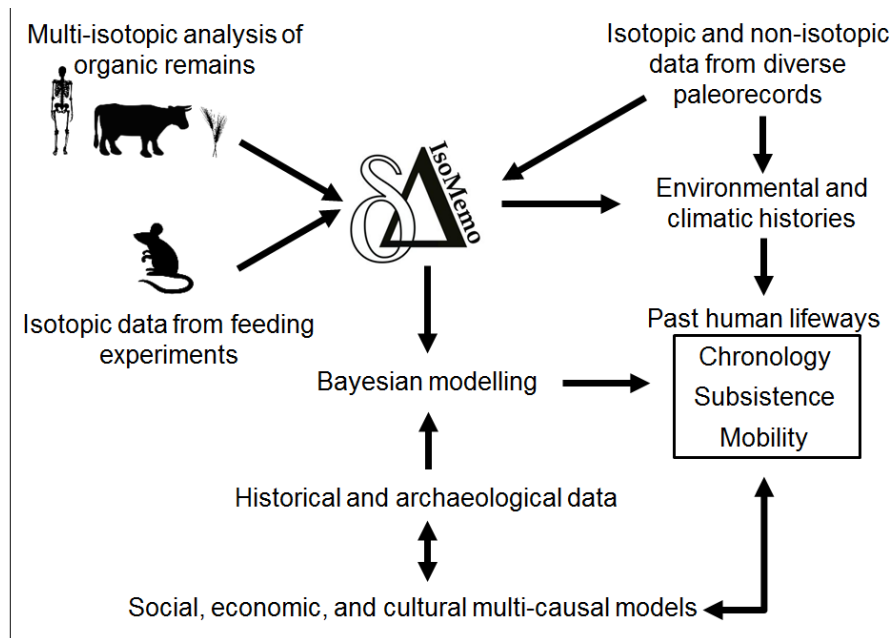
Author: *Ricardo Fernandes*
Title: *Proposal of an integrated approach to the reconstruction of past human lifeways*
Affiliations: *McDonald Institute for Archaeological Research (University of Cambridge) and Leibniz Laboratory for Radiometric Dating and Stable Isotope Research (University of Kiel)*
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The reconstruction of past human lifeways can be complex given the multiple causes that underline human behavior and some characteristic limitations of historical or archaeological evidence. Thus, it is proposed that the diachronic study of past human lifeways should be performed under an integrated approach (see figure below) bringing together a diversity of expertise and having the following key components:

- Employment of Bayesian modelling to quantitatively reconstruct past human lifeways. Aspects of specific interest are those of chronology, subsistence, and mobility.
- The starting point for the quantitative study of past human lifeways is a multi-isotopic analysis of organic remains.
- Isotopic data from controlled feeding experiments is employed to characterize the physiological mechanisms of signal transfer from the diet to consumers.
- Implementing open-access data repositories such as the isotopic database IsoMemo.
- Placing humans within the context of climatic and environmental histories reconstructed from isotopic and non-isotopic paleorecords.
- Incorporating diverse archaeological and historical information (e.g. written sources, archaeo- faunal or botanical analysis, etc) into Bayesian models.

- Under an iterative process social, economic, and cultural multi-causal models are put forward.

Relevant archaeological case studies that illustrate the application of the proposed approach will be presented.



Author: *Maiken Hemme Bro-Jørgensen*
Title: *Ancient DNA analysis of Scandinavian medieval drinking horns and the horn of the last aurochs bull*
Affiliation: *Centre for GeoGenetics. Present address: Institutet for arkæologi og antikkens kultur, Stockholms Universitet, Sweden.*

The now-extinct aurochs is the ancestor of modern domestic cattle, which were domesticated ca. 8500 BC. Genetic studies show that interbreeding between introduced domestic cattle and local aurochs probably occurred during their coexistence in Europe. The last known aurochs lived in Poland, and was killed in 1627. The timeline and extent of admixture that occurred between wild aurochs and cattle remain largely unexplored. To help investigate this, we extracted and shotgun sequenced DNA from six Scandinavian medieval drinking horns as well as the horn of the last aurochs bull. We successfully reconstructed the mitochondrial genome from five of the drinking horns, and the last aurochs bull. The mitochondrial phylogeny shows that two of the drinking horns and the horn of the last aurochs bull belong to the T3 haplotype characteristic of domestic taurine cattle, while the remaining three drinking horns exhibit European aurochs mitochondrial haplotype P. Since haplotype P is today found only in rare cases among domestic cattle, the drinking horns with this haplotype most likely represent some of the last aurochs in Europe. Our results demonstrate that

drinking horns are an excellent potential source for investigating the genetics of the last European aurochs, and further suggest that hunting of aurochs to make drinking horns contributed to their extermination. Lastly, the observation that the last aurochs bull carries a domestic cattle haplotype demonstrates how introgression from domestic cattle left a signal in the last population of aurochs.

Author: *Rowan Jackson*

Title: *Perspectives from the past: archaeology's contribution to contemporary climate change adaptation theory*

Affiliation: *University of Edinburgh and Aarhus Universitet*
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This paper focuses on the application of palaeo-societal research to contemporary climate change adaptation (Riede, 2014), with particular emphasis on social transformation frameworks that have grown in prominence over the past 5 years. It has been recognised that fundamental social and technical change will be required to build resilient societies now and in the near future. This necessitates fundamental social changes to reduce our exposure to negative outcomes of climate change (O'Brien, 2012). Social scientific studies have been particularly influential at identifying cultural and cognitive barriers to transformation and call for a greater intensity and duration of change. But for societies to avoid long-term vulnerabilities created by environmental change more clarity is required to identify what transformation implies. As I will argue, long-term social-ecological system dynamics identifiable in palaeo-societal and environmental records offer 'natural' and 'complete experiments' to explore the dynamics of transformation in more detail. Identifying how different cultures were (or were not) able to adapt or transform behaviour provides essential and much needed information on human adaptive challenges. Using examples from Norse Greenland I argue that for adaptive strategies to be transformational they must not only promote social equity and sustainability, as highlighted in contemporary literatures (O'Brien, 2012; Pelling, 2011), but also ensure new risks and vulnerabilities are not subsequently created by attempts to enhance adaptiveness.

Authors: *Jane Jansen¹, Karin Lund²*

Presenting author: *Jane Jansen¹, Karin Lund²*

Title:

Affiliations:

Most effective use of interdisciplinary data can only be achieved if the data itself is interdisciplinary and easy accessible and combinable. Intrasis, from National Historical Museums in Sweden, has that capability. Intrasis unique way of handling in-site relations makes it possible. You can store and register data for

any discipline related to archaeology. Each discipline can register their information as they wish, and at the same time have access to all other data from the site.

We will in this paper explore interdisciplinarity in archaeology with emphasis on GIS and databases. We will show how the workload of data analysis can be minimized by Intrasis combination of database and GIS. For each individual feature you are able to see all information related to the feature: e.g. images, drawings, samples, finds, and osteology. By the possibility to immediately take all information into account – better understanding and new ideas and interpretation of the individual site can arise. To demonstrate this we will use archaeological recordings and analysis of bones from one of our excavations. Showing your result contextual on a map or in a GIS environment can also make it more accessible for the reader. Interdisciplinarity is combination of data!

Authors: *Mathias Jensen¹, Tõnno Jonuks², Peter Bye-Jensen³, Mikael Manninen⁴, Kristiina Johanson⁵, Felix Riede¹*

Presenting author: *Mathias Jensen*

Title: *A Knife's Tale: A multi-methodological analysis of a Mesolithic slotted bone dagger*

Affiliations: *¹Aarhus Univeristy, Denmark, ²The Estonian Literary Museum, Estonia, ³University of Southampton, UK, ⁴University of Oslo, Norway, ⁵University of Tartu, Estonia
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All too often prehistoric objects are found as stray finds and therefore have little or no contextual information, which poses significant issues when attempting to study and understand these objects. As a consequence they often languish under-researched in museum collections. In this paper we present the results of a multi-methodological analysis of the pre- and post-depositional life history of the Ulbi dagger, an Early Mesolithic ornamented slotted bone dagger from southern Estonia. Before this analysis, very little was known about this dagger as it had been found during peat digging in the 1920's and it has lain virtually undisturbed in the museum storerooms since its discovery. However, by using a combination of different scientific methods the dagger went from an isolated, undated, and unique object to a tool with a complex life history extending more than 9000 years. Together, these analyses demonstrate the usefulness of close observation at macro- and microscopic scales and the need to develop adaptable scientific analytical procedures for archaeological stray finds.

Author: *Catherine Jessen*

Title: *The changing landscapes of a transgressive coastline: sea level rise and cultural activity east of Rødbyhavn, southern Denmark*

Affiliation: *National Museum of Denmark*

In 2012 a large borehole survey was undertaken to assess the archaeological potential lying beneath reclaimed coastal land east of Rødbyhavn, southern Denmark prior to the construction of the Femern Bælt tunnel. The primary aim of this survey was to locate archaeological remains but it also provided almost 400 stratigraphic sequences of sediment deposited by a rising sea level. Excavations have shown pronounced archaeological activity during each of the phases associated with sea level rise (dry land, boggy conditions and shallow water) and the combination of this evidence with the stratigraphic evidence gives not only a detailed image of the landscape and how it changed over time, but also how it was used by the local cultures. Further analysis of new boreholes will also document changes in water salinity and depth, local fauna and flora and more regional vegetation which together can inform us further on life in the landscape and any human responses to the changes in that landscape. The first stage of this study is presented here with a reconstruction of the now buried landscape and how the process of flooding relates to the archaeological evidence, and demonstrates the necessity of interdisciplinary research in such projects.

Authors: *Leif Jonsson¹ & Emma Maltin²*
Presenting author: *Leif Jonsson & Emma Maltin*
Title: *Traces of preserved fish in Nya Lödöse, Sweden (1473-1624).
An example of an interdisciplinary approach to
zooarchaeological research*
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During excavations of the town Nya Lödöse, today covered by Gothenburg, Sweden, an extensive fish bone assemblage was retrieved. This was largely due to zooarchaeologists being present on site, and therefore being able to prioritize and wet-sieve contexts rich in bone material. Interesting variations of the distribution of species and elements were noticed already early on, and we realized that we could identify several different preserved fish products; dried flatfish, dried spurdog, stockfish and dried heads from large cod and ling. While stockfish is a well-studied commodity, the other products have rarely been described in archaeological samples.

We explored these products further, by making use of contemporary early modern literature and custom accounts, as well as ethnographic data from a large geographic area. The combination of the zooarchaeological results with archaeological data, studies of taphonomy and historical and ethnographical data made it possible to draw conclusions about consumption, trade and connections. In the near future, isotope analysis will give an additional dimension to the question of where these products were imported from.

Author: *Arne Jouttijärvi*
Title: *More than numbers. Integrating analytical data in the archaeological interpretation*
Affiliation: *Heimdal-archaeometry. Skovledet 30, 2830 Virum, Denmark.*

Often scientific analysis is treated with a “what is this” approach, primarily aiming at the identification of single artifacts or pieces of debris. The interpretation does however become much more interesting if the data is seen in its archaeological context. Analytical data should be evaluated in close cooperation with the archaeologists, and should be seen as a tool to qualify the archaeological interpretation on equal terms with stratigraphy and other evidence. This does however call for a relatively large number of analyses, sufficient for statistical evaluation.

In this paper some examples of how such integration between analysis and archaeological data can be used to create an understanding of f. instance, the physical organization of iron smelting and forging areas are presented.

Linking analytical data better to archaeological context, for example of burial sites can also be used to gain an insight into the thoughts that lay behind the choices of specific materials and how they were perceived in a cultural and status context.

Authors: *Eberhard H. Lehmann, David Mannes*
Presenting author: *Eberhard H. Lehmann*
Title: *New approaches for the study of cultural heritage objects by means of neutron imaging methods*
Affiliations: *Neutron Imaging & Activation Group, Laboratory for Neutron Scattering & Imaging, Paul Scherrer Institut, CH-5232 Villigen PSI*

Neutron imaging is applied as tool for non-destructive investigations alternatively or complementarily to the more common X-ray methods. Since the interacting mechanism of neutrons with matter is completely different from that with X-rays, the obtained transmission contrasts are diverse. Metals can be transmitted in much thicker layers while organic materials provide a high contrast already for small amounts.

Our team has long-term experience in collaboration with museum experts for dedicated studies of cultural heritage objects, on the macro-scale of about 40 cm sample size up to the micro-scale with highest possible resolution on the order of about 10 micro-meters. Next to the simple radiography approach, neutron tomography has become now a routine method on the different length scales.

The new approaches are on the one hand the selection of narrow energy bands of the used neutrons. This enables to tune contrast and transmission of the investigated materials. More important is to characterize the metal structure with respect to texture and grain size distribution in relevant studies.

On the other hand, we installed and combined X-ray imaging options into our beam lines NEUTRA and ICON in order to have the pixel/voxel wise comparison for the same object. This enables a data fusion process for the enhancement of the inherent sample properties.

The presentation will give technical details of our state-of-the-art user facilities and demonstrates their performance by selected examples of previous studies. In particular, we will highlight the opportunities to study corrosion processes in metal artefacts best with neutrons (see figures).

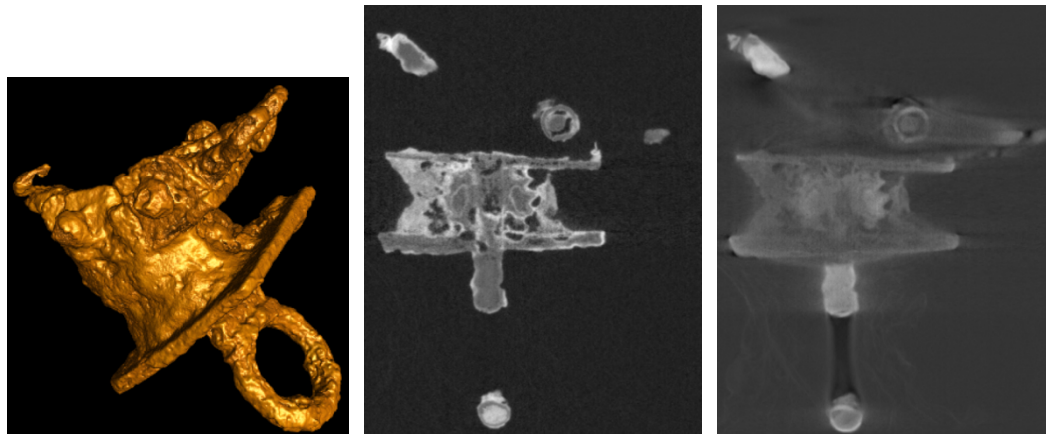


Figure: Neutron tomography view of a corroded Roman find piece of the Aventicum (Switzerland) site (left); the slice indicates in the bright areas the corrosion as found with neutrons (middle), but not with X-rays (right)

Authors: *P.E. Lindelof¹, A. Fedrigo^{2,3,4}, A.R. Williams⁵, L. Jørgensen^{6,§}, Peter Pentz⁶, D. Bausenwein⁷, B. Schillinger⁷, F. Grazzi³, and K. Lefmann²*

Presenting author: *Poul Erik Lindelof*

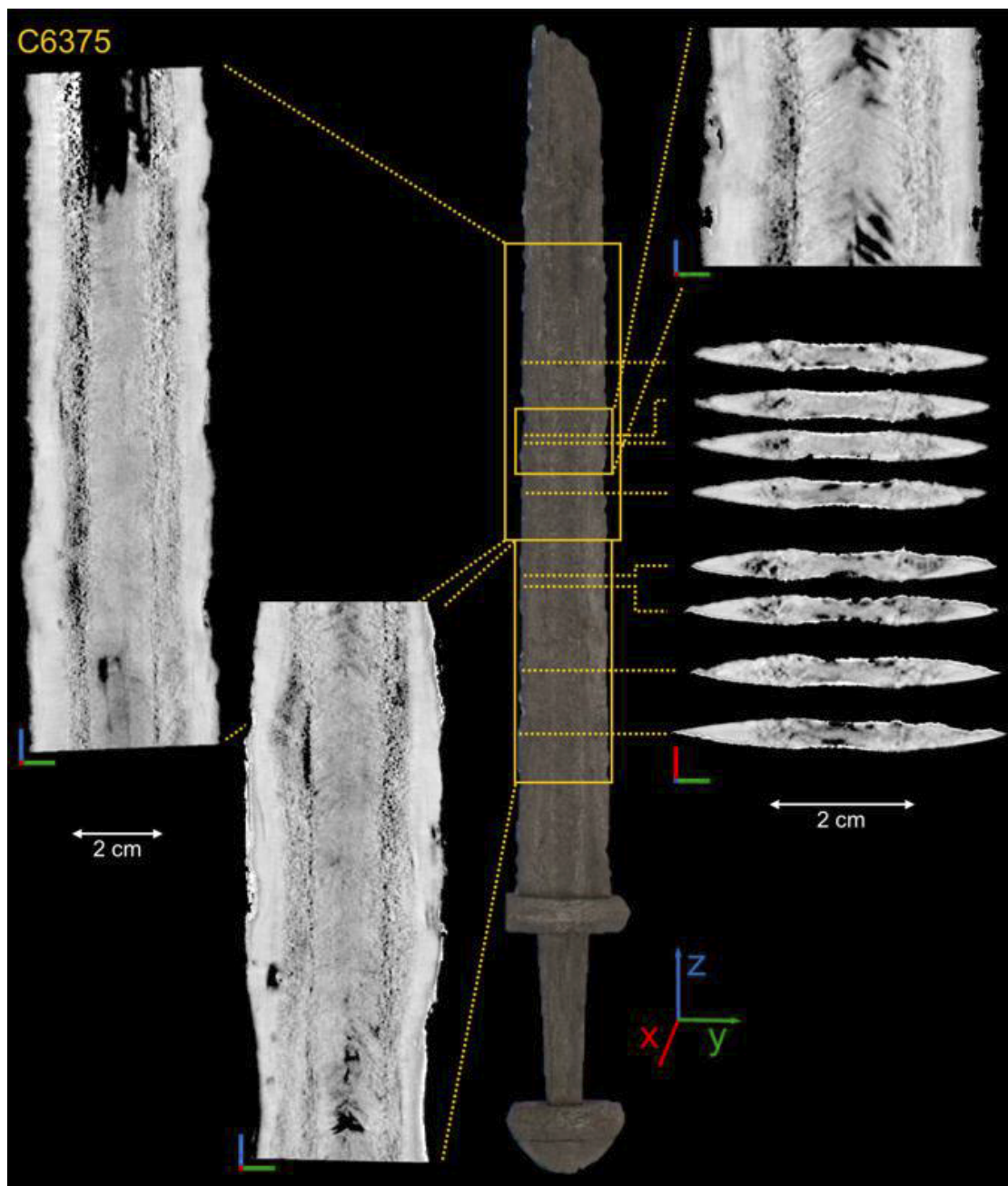
Title: *Viking Age swords studied with neutrons*

Affiliations: *¹ Neutron and X-Ray Group (CoNeXT project), Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark, ² Nanoscience Centre, Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark, ³ Istituto dei Sistemi Complessi, Consiglio Nazionale delle Ricerche, 50019 Sesto Fiorentino, Italy, ⁴ European Spallation Source ESS AB, SE-22100 Lund, Sweden, ⁵ The Wallace Collection, London, United Kingdom, ⁶ The National Museum of Denmark, 1471 Copenhagen K, Denmark, ⁷ Forschungs-Neutronenquelle Heinz Mayer-Leibnitz FRM II, Garching (DE), Germany [§] Deceased*

The populations of Scandinavia and the North Atlantic islands had great impact on most of Europe during the so-called Viking Age (800-1050 A.D.). Their trade and warfare were interfering with countries as far away as Russia, the Black Sea and the Mediterranean. They settled in England, Ireland and France. They were first and foremost farmers at their homeland and abroad, but they were also

tradesmen and warriors. Their great successes as warriors were based on their superior ships and, if we trust the many stories about their warlike successes, also their excellent weapons.

Interest has been devoted to the decorations of the their weapons, in particular the sword hilts [1]. The material compositions of the iron and steel in the Viking Age swords have only recently been explored [2, 3]. The metallurgy of viking swords was first thoroughly studied in 2009 [4]. Hesitation to cut small pieces from the precious viking swords for analysis has hampered this development. However recently it has been realized, that neutrons from nuclear reactors are an excellent tool for studying the tomography and the composition of iron and alloys inside the blades of swords [5].



Selected slices of Sword C6375 (National Museum of Denmark). Orientation and position of the slices are indicated next to each box. Bright areas represent ferrite, grey are as ferrite plus cementite, while corrosion is removed through processing of the images and appears black as the background. The edges show layers of soft iron, and the core is composed of twisted layered rods, where soft iron (ferrite) and steel (ferrite plus cementite) alternate.

Very recently we [6] have used neutron scattering to study the inner structure of the blades of viking swords. Neutrons are only weakly scattered in metallic samples. By using a parallel white beam of neutrons we obtain a shadow of the internal structure of an iron sword. By measuring the shadow while rotating the sword into 400 subsequent angles we are able to convolute the full 3-dimensional tomographic picture of the blade. We have studied neutron tomography of 3 viking swords from respectively the 9th, 10th and 11th century found in Jutland, Denmark and kept at the National Museum of Denmark in Copenhagen. The neutron experiments were performed at the Antares beamline at the FRM II research reactor facility at the Heinz Maier-Leibnitz Zentrum in Garching, Germany.

Another series of experiments use monochromatic neutrons obtained by a many blade turbine velocity selector. This beam gives rise to a Bragg reflection of the monoenergetic neutrons in the various polycrystalline phases of the blades of the viking swords. By performing measurements while rotating the swords in 400 steps just below and above the Bragg edge of a particular crystalline phase, we obtain by subtraction a 3-dimension picture of the extent of that phase. In this way we can separate the soft iron and the steel phases in the swords as shown in the figure above for the viking sword from the 11th century. Stresses and pattern weldings inside the swords have also been 3-dimensionally mapped.

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Authors: *Markku Oinonen, Teija Alenius, Laura Arppe, Heli Etu-Sihvola, Kristiina Mannermaa, Päivi Onkamo, Jukka Palo, Antti Sajantila, Tarja Sundell, Santeri Vanhanen and Anna Wessman*

Presenting author: *Markku Oinonen*

Title: *Levänluha water burial through radiocarbon and isotopic data*

Levänluha water burial in southern Ostrobothnia is one of the most famous archaeological sites in Finland. This Iron Age burial site contains bone remains from almost 100 human individuals deposited in a wetland together with animal bones and artefacts. Our multidisciplinary study combines archaeological, geological, genetic as well as dating methods and represents a national pilot to resolve the history of the area. 37 radiocarbon dates on the human bone collagen indicate that the burial was used from 4th to 8th centuries AD. Dietary isotopic data ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) indicates significant heterogeneity within the diets of the buried individuals clustering into four distinct groups. FRUITS modelling on the isotopic data allows us to estimate marine and freshwater contributions within individual diets and to perform reservoir effect corrections. Eventually, we discuss the temporal appearance of the marine signal within the individuals, its relation to 536AD climatic anomaly and contemporaneity with the emerging Merovingian period in eastern Fennoscandia.

Authors: *Ester Oras^{1,2,*}, Thomas F.G. Higham³, Lucy J.E. Cramp⁴ & Ian D. Bull⁵*

Presenting author: *Ester Oras*

Title: *Revealing object biography with archaeological sciences: a study of Roman bronze lamp from Kavastu (Estonia)*

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A unique Roman bronze lamp together with four bronze bars was discovered in a peatbog in Kavastu (Estonia) in 1902. The magnificent two nozzle lamp is the northernmost example of its kind with no parallels in local archaeological material. After the initial studies in the early 20th century the find was stored in archaeological collections with little further attention paid to its interpretation, origin and arrival at its final destination. Over a century later, with vast

improvements in scientific methods, the antiquarian find was “rediscovered” from the storage rooms and a thorough scientific analysis was conducted.

By applying AMS dating and lipid residue analysis combined with previous metallurgical studies we reconstructed the biography of this unique find. Differently from currently prevailing interpretations, the lamp appears to be concealed centuries after its production in the Mediterranean, and has not been used for its primary function in the north. Instead, the Kavastu deposit tells a story of Migration Period trade routes in Eastern Europe and evaluation of bronze in northern peripheral regions at the time. With this paper we wish to emphasise the importance of invoking a critical evaluation of artefact biography, chronology and interpretation of imported goods in peripheral regions.

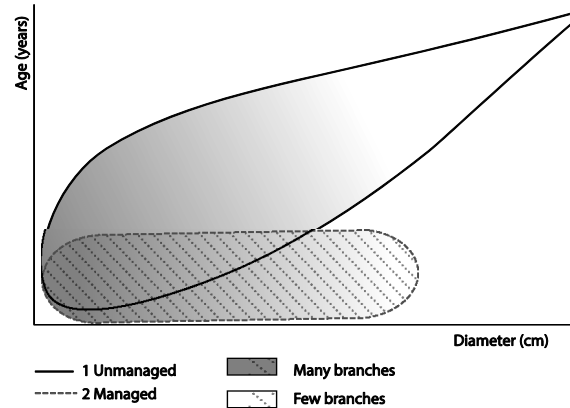
Authors: *Welmoed A. Out¹, Kirsti Hänninen², Jannie H. Larsen¹, Caroline Vermeeren²*

Title: *The potential of waterlogged wood to reconstruct woodland management*

Affiliations: *¹Moesgaard Museum, Denmark, ²BIAX Consult, the Netherlands*

In Northwest European archaeology, interpretations of pollen, seed and wood data often lead to suggestions that woodland management, such as pollarding and coppicing, was practised in prehistory. Direct evidence of woodland management during that period is scarce, however. Branch age and diameter data of waterlogged wood are often used as supposed evidence of management practices. Until recently however, the interpretation of age and diameter data was mostly based on untested assumptions.

To test whether it is indeed possible to identify past woodland management by branch age/diameter analysis, a model on branch age/ diameter of unmanaged and managed trees was developed (fig. 1). The model was tested by investigating modern-day unmanaged and managed trees of three taxa. The research outcomes clarify the potential of the method, and improve the possibilities to correctly identify woodland management. The results have already been proven to be of direct relevance for archaeology. The classical find category “wood” thus offers well-founded new perspectives for application in archaeology and, together with other methods, allows for obtaining a better understanding of how people interacted with their environment in the past.



Model age/diameter scatterplot models for branches of unmanaged and managed vegetation.

Author: *Bente Philippsen¹, Per Åke Persson²*
Presenting author: *Bente Philippsen*
Title: *The cuisine of the Pitted Ware Culture. Stable isotope analysis and radiocarbon dating in the context of a multidisciplinary project*
Affiliations: *¹ AU STAR, Science and Technology in Archaeological Research, Department of Archaeology, Aarhus University and Aarhus AMS Centre, Department of Physics and Astronomy, Aarhus University, Aarhus, Denmark*
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The Pitted Ware Culture is a Middle Neolithic culture in southwestern Scandinavia. It appears about thousand years after the introduction of agriculture to this area. In some regions, it is characterized by an almost fully “Mesolithic” economy with a heavy reliance on seal hunting. In Djursland, northeastern Denmark, however, the Pitted Ware Culture has always been regarded as having a mixed economy, utilizing both domesticated and wild resources.

The research presented here was prepared in the framework of the multi-disciplinary project “CONTACT. The Pitted Ware Phenomenon in Djursland and Maritime Relations across the Kattegat in the Middle Neolithic”. Stable isotope analysis of food residues on pottery show what the pottery was used for on different types of sites and which resources were exploited. In contrast to human bones, the food residues provide a snapshot of the food prepared at one point in time. Potentially, this will enable us to discern everyday and ritual meals.

Contacts between Sweden and Denmark, and more generally the spread of the Pitted Ware Phenomenon, can only be understood on the basis of accurate radiocarbon dates. Therefore, many sites are dated or re-dated using different sample types. At some of the West Swedish sites, food residues on pottery are the only datable material. Therefore, the reconstruction of ingredients by stable isotope analysis is vital to assess the risk of radiocarbon reservoir effects.

Authors: *Thomas Rose^{1*}, Sabine Klein^{1,2} & Heidi E. Höfer¹*
Presenting author: *Thomas Rose*
Title: *Lead isotope signatures of ores corrupted by gangue minerals: a plea for more geochemistry in archaeometallurgy*
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We present a previously unaccounted factor in the lead isotope signature of ores used for provenancing artefacts. In ores from Mocissos, lead rich inclusions could be identified in the gangue quartz, which severely corrupt the lead isotope signature of the ore minerals, leading to considerable deviations from the respective geological unit. This fuels the discussion in two ways: First, separation of ore and gangue prior to smelting cannot be reconstructed in archaeological contexts. Therefore the measured isotopic signature of the smelted metal can potentially lie between the lead isotope signature of the pure ore and the gangue. This leads to a decoupling of the metal and the pure minerals signature. In consequence, the isotope signature of the metal does no longer represent the geologic source mineral in full extent. Second, the purity of ore specimens in the reference data is rarely analytically evidenced or recorded. In combination, this could severely lead to blurred isotope fields for the deposits and misdiagnostic reconstructions of the local origin of objects. Therefore we claim detailed petrological understanding and geochemical assessment of deposits as well as a thorough re-evaluation of the available reference data in order to successfully continue the application of the lead isotope method.

Authors: *Federica Sulas¹, Innocent Pikirayi², and Elton M. Sagiya³*
Presenting author: *Federica Sulas*
Title: *Geoarchaeology of water management at Great Zimbabwe*
Affiliations: *¹ Centre for Urban Network Evolutions (UrbNet), Aarhus University, ² Department of Anthropology and Archaeology, University of Pretoria, ³ National Museums and Monuments of Zimbabwe, Masvingo*

In Africa, research on water management in urban contexts has often focussed rainfall, and the occurrence floods and droughts, whereas small-scale catchment systems and soil moisture regimes have received far less attention. This paper sets out to re-address the issue by examining the occurrence, distribution and use of multiple water resources at the ancient urban landscape of Great Zimbabwe. Here, the rise and demise of the urban site have been linked changing rainfall in the 1st mill. AD. Accordingly, rainfall shortages and consequent droughts eventually leading to the decline and abandonment of Great Zimbabwe at around 1550 AD. However, new research findings suggest a different scenario.

Combining geoarchaeological investigations, soil micromorphology and geochemistry with the study of historical sources and ethnographic records, new datasets indicate prolonged availability and diversified management of water resources over the last thousand years or so. These findings call for a rethinking of current models of urban evolutions in the region. More importantly, this study illustrates the need for integrating different datasets at multiple spatial and temporal scales to address people-water interactions.

Author: *Marc Vander Linden*

Title: *Beyond aDNA: multi-proxy approach to (Late) Neolithic demography*

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The extraction and sequencing of DNA from ancient bones is without doubt one of the most essential achievements of the last couple of decades for archaeological science, and archaeology in general. In several high-profile recent publications, the use of this technique has led to the identification of population shifts during the Later European Prehistory, especially associated with the spread of early farming and the 3rd mill. cal. BC. This, in turn, has led to a narrative dominated by past migrations, a view with which many archaeologists remain – rightly so – rather uncomfortable. By focusing on migrations, we however are at risk of missing the bigger picture of demography, i.e. the spatial and temporal changes in terms of size, structure and distribution of Neolithic populations.

As part of this presentation, I would thus like to review some of proxies available to archaeologists when approaching demography, including aDNA as well as, for instance, ¹⁴C summed probabilities, settlement pattern or anthropic pressure on the environment. In many instances, shortage of data is not an issue. What is rather missing is an explicit agenda and framework, offering ways to foster and articulate coherently interdisciplinarity.

Authors: *Susanne Østergaard¹, Marie Kanstrup², Eva Karina Enggaard Jørgensen³, Sahra Talamo⁴, Stig Bergmann Møller⁵, Bente Springborg⁵, Jesper Olsen², Marcello A. Mannino³*

Presenting authors: *Susanne Østergaard, Marcello A. Mannino*

Title: *Friend or foe? An isotopic investigation of a Late Medieval mass grave from Aalborg*

Affiliations: *¹ Department of Archaeological Science and Conservation, Moesgaard Museum, Højbjerg, Denmark, ² Aarhus AMS Centre, Department of Physics and Astronomy, Aarhus University, Aarhus, Denmark, ³ Department of Archaeology, School of Culture and Society, Aarhus University, Højbjerg,*

Denmark, ⁴ Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, ⁵ Nordjyllands Historiske Museum, Aalborg, Denmark

In 2015 the Aalborg Historical Museum excavated a small part of the churchyard of the former Church of Saint Peter in Aalborg. Along with human skeletons from 33 ordinary burials, remains of 18 individuals were found at Tiendeladen in a mass grave of Late Medieval age. To reconstruct their origin, we have undertaken an interdisciplinary archaeological, anthropological and isotopic investigation of the individuals from the mass grave. The osteological analysis revealed that the skeletons belonged almost exclusively to men, who had been subjected to unusually high levels of perimortem trauma by sharp weapons. As a result of this evidence and on archaeological grounds, it has been hypothesized that this common burial was dug to deal with the high death toll resulting from the incursion by the troops of king Christian III that took place in December 1534, as part of the conflict known as the Count's Feud. To determine if this was the case, human bone collagen has been submitted for AMS radiocarbon dating. Here we present the results of the carbon and nitrogen isotope analyses on individuals from the common burial and ordinary inhumations from the churchyard, to evaluate whether the victims were local civilians or foreign soldiers. The remains of the corpses from the common burial have isotopic ratios that completely overlap with those of the ordinarily inhumated people, suggesting that the diets of all those buried around Saint Peter's church were based mainly on terrestrial foods and included significant amounts of animal protein, around a fifth of which may have originated from fish such as herring. This dietary mix is different from that of other Late Medieval north European populations and compatible with the fact that Aalborg had the monopoly on Limfjord's herring fishery. Isotope analyses of sulphur and hydrogen on the bone collagen, along with those of oxygen and strontium on the dental enamel of selected individuals are planned to solve the question.

POSTER PRESENTATIONS

Author: Miki Bopp-Ito^{a,*}, Sabine Deschler-Erb^a, Werner Vach^b, Jörg Schibler^a
Presenting author: Miki Bopp-Ito
Title: Osteometric data reveal different size evolution of cattle between Central Plateau and Alpine regions in Bronze Age Switzerland
Affiliation: ^a Integrative Prehistory and Archaeological Science, University of Basel, Spalenring 145, CH-4055, Basel, Switzerland. ^b Clinical Epidemiology, Centre for Medical Biometry and Medical Informatics, Medical Centre. University of Freiburg, Germany
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Until now, osteometric data for Swiss Bronze Age cattle, particularly from Alpine sites, have been scarce. We used data recently obtained from a large Alpine settlement to augment the existing information and create a large database. Here, we evaluate the evolution of cattle size from the Late Neolithic to the Late Bronze Age and compare different cattle populations from the Central Plateau and the Alpine regions using *logarithmic size index* statistics. In addition, we analyse sex ratios using a *finite mixture model*. The results indicate that Bronze Age cattle were significantly smaller than those in the Late Neolithic. Furthermore, the size of Alpine cattle decreased markedly over the study period, while that of foreland cattle did not. Sex ratios did not affect size. We discuss inbreeding within the geographically and culturally restricted Alpine region as a possible factor in the size reduction in Alpine cattle. However, further interdisciplinary studies are needed to confirm this hypothesis.

Authors: Otto Brinkkemper¹, Bertil van Os¹, Annelies van Hoesel¹, Tony van Brussel², Ricardo Fernandes^{3,4*}
Presenting author: Ricardo Fernandes
Title: Are pre-treatments necessary to recover pre-burial isotopic values of charred plant samples?
Affiliations: ¹ Cultural Heritage Agency of the Netherlands, ² Institute of Biology Leiden (Leiden University), ³McDonald Institute for Archaeological Research (University of Cambridge), ⁴ Leibniz Laboratory for Radiometric Dating and Stable Isotope Research (University of Kiel)
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Isotopic analysis of archaeological charred plant remains offers useful archaeological information. However, adequate sample pre-treatment protocols are necessary to provide a contamination-free isotopic signal while limiting sample loss and achieving a high throughput. Under these constraints research

was undertaken to compare the performance of different pre-treatment protocols.

Charred archaeological plant material was selected for isotopic analysis from a variety of plant species, time periods, and soil conditions. Preservation conditions and effectiveness of cleaning protocols was assessed using FTIR and XRF measurements. An acid-base-acid protocol was used to define a contamination-free isotopic reference. Acid-base-acid isotopic measurements were compared with those obtained from untreated material and an acid-only protocol.

The isotopic signals of untreated material and an acid-only protocol typically did not differ more than 1‰ from the acid-base-acid reference. The isotopic offsets between acid-base-acid and untreated samples followed approximately symmetric distributions both for $\delta^{13}\text{C}$ (average = 0 ± 0.4 ‰) and $\delta^{15}\text{N}$ (average = 0 ± 0.2 ‰).

For the range of conditions described in this study untreated charred plant samples, efficiently cleaned of sediments, provide accurate isotopic values of carbon and nitrogen with assigned uncertainties of 0.3‰ and 0.5‰, respectively. Better measurement precisions may be reported following the application of pre-treatments and elemental pre-screening.

Authors: *B. Emmerova^{1,2}, D. Vanek^{1,3}*

Presenting author: *B. Emmerova, D. Vanek*

Title: *Mitochondrial DNA studies on European Neolithic and Mesolithic individuals – literature review*

Affiliations: *¹Forensic DNA Service, Prague, Czech Republic, ²Charles University in Prague, Faculty of Science, Prague, Czech Republic, ³Charles University in Prague, 2nd Faculty of Medicine, Prague, Czech Republic*
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The aim of the study we present was to review the scientific studies on Neolithic and Mesolithic skeletal material and collect and compare data of mitochondrial DNA typing. We managed to collect 166 mtDNA sequences and data about the age of the specimen, location of the excavation site (Denmark, Czech Republic, France, Germany, Hungary, Italy, Poland, Spain, and Sweden), D-loop mutations, haplogroups, sequencing primers and methods used. The frequency of the haplogroups (H=35%, U= 22%, K=13,5%, T=7,7%, J, N, X = 5%) differs from the current European population but is in a good shape with the previous findings that identified mtDNA haplogroups H and U being typical for early farmers and hunter-gatherers (1).

1. Fu Q, Rudan P, Pääbo S, Krause J. Complete mitochondrial genomes reveal Neolithic expansion into Europe. *PLoS One*. 2012;7(3):e32473.

Authors: *Heli Etu-Sihvola¹, Aleksis Karne², Kristiina Mannermaa³, Yuichi I. Naito⁴, Elina Sahlstedt⁵, Kati Salo⁶, Heikki Suhonen⁷, Jussi-Pekka Taavitsainen⁸, Laura Arppe⁹*

Presenting author: *Heli Etu-Sihvola*

Title: *What bones may tell? A multidisciplinary research on Late Iron Age Luistari cemetery in Finland*

Affiliations: *¹Laboratory of Chronology, LUOMUS, Finnish Museum of Natural History, University of Helsinki & Department of Archaeology, University of Turku, Finland & Hervé Bocherens, Department of Geosciences and Senckenberg Center from Human Evolution and Palaeoenvironment (HEP), University of Tübingen, Germany, ²Department of Geosciences and Geography, University of Helsinki, Finland, ³Department of Philosophy, History, Culture and Art Studies, University of Helsinki, Finland, ⁴Faculty of Symbiotic Systems Science, University of Fukushima, Japan, ⁵Laboratory of Chronology, LUOMUS, Finnish Museum of Natural History, University of Helsinki, Finland, ⁶Department of Philosophy, History, Culture and Art Studies, University of Helsinki, Finland, ⁷Department of Physics, University of Helsinki, Finland ⁸Department of Archaeology, University of Turku, Finland ⁹Laboratory of Chronology, LUOMUS, Finnish Museum of Natural History, University of Helsinki, Finland*

The project, entitled “Life Histories in Teeth” was launched in February 2015. We aim to develop isotope methods towards smaller sample sizes and sequential extractions, and to increase the amount of Finnish paleodietary baseline data by analyzing a selection of animal specimens relevant for Finnish prehistoric diets from museum collections. Our archaeological goal is to gain new multidisciplinary information on the people buried in the Late Iron Age (6th-13th century AD) Luistari cemetery in southwest Finland.

The selected human dental and bone remains will undergo bulk stable isotope analysis ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{18}\text{O}$ and $\delta^{34}\text{S}$) and the best preserved samples are further selected for compound specific isotope analysis. In addition to the isotope studies, μCT scanning, age at death -modeling and paleopathological analysis will allow us to have a better understanding of the life histories of this Late Iron Age population.

We will also have a possibility to utilize paleogenetic data, since aDNA studies and AMS datings of selected Luistari samples are performed in a related project “SUGRIGE” focused on the genome of Finno-Ugrians. Working with project members originating from different scientific backgrounds gives new ideas and advances the general knowledge and acceptance of scientific methods in archaeology in Finland.

Authors: *Ricardo Fernandes^{12*}, Alexander Dreves², Vera Klontza-Jaklova³, Gordon Cook⁴*
Presenting author: *Ricardo Fernandes*
Title: *Addressing the controversy of the chronology of the Thera eruption through radiocarbon measurements of modern plants*
Affiliations: *¹McDonald Institute for Archaeological Research (University of Cambridge), ² Leibniz Laboratory for Radiometric Dating and Stable Isotope Research (University of Kiel), ³ Archaeology and Museology Department (Masaryk University), ⁴ Scottish Universities Environmental Research Centre*
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Plant remains are commonly taken for radiocarbon dating. However, plant tissues may incorporate “old carbon” (e.g. through root uptake of soil carbonates, CO₂ from volcanic sources). Sources of “old carbon” have been proposed to justify the observed discrepancy between the radiocarbon-based and typology-based chronologies of the Thera eruption (17th or 16th centuries BCE).

Present-day potential for radiocarbon offsets in plant tissues was investigated by comparing radiocarbon measurements from plants tissues collected during the growing season of 2014 from varied geological locations in Aegean Islands (Nea Kameni, Santorini, Chrissi, and Crete) and in southern Germany. Plant radiocarbon measurements were performed at SUERC and additional atmospheric ¹⁴C data for 2014 was kindly provided by I. Levin. Obtained measurements showed non-significant radiocarbon differences between atmospheric and plant values for the different locations (uncertainty of 40 years for paired values). Major exceptions were plants located in the immediate vicinity of volcanic outlets at Nea Kameni that showed a large incorporation of “old carbon”.

Assuming similar past environmental conditions, the obtained radiocarbon results imply that the discrepancy (>100 yr) between the radiocarbon-based and typology-based chronologies for the Thera eruption cannot be justified on the basis of the incorporation of “old carbon” into plant tissues.

Authors: *Anna Fotakis^{1,2}, Beatrice Triozzi¹, Christian D. Kelstrup², Jesper V. Olsen², Rosa Boano³, M. Thomas P. Gilbert¹, Enrico Cappellini¹*
Presenting author: *Anna Fotakis*
Title: *Case Study: Proteomics on a Pre-Hispanic Mummy Head*
Affiliations: *¹ Centre for GeoGenetics, Natural History Museum of Denmark, University of Copenhagen, Øster Voldgade 5-7, 1350 Copenhagen, Denmark, ² Novo Nordisk Foundation Center for Protein Research, Faculty of Health Sciences, University of Copenhagen, Blegdamsvej 3b, 2200*

Copenhagen, Denmark,³ Legal Medicine Office, C.so Massimo D'Azeglio, 60/g, Turin, Italy

Ancient proteomics has recently gathered a lot of momentum in the field of ancient biomolecular research, and has been applied on, archaeological materials, bone, skin and mineralised plaque, amongst other things. In this paper we present the extremely rich amount of proteins that were isolated from the skin of an artificially mummified pre-Hispanic head, which originated from South America. We set out to isolate proteins of a non-collagenous nature. Using high-resolution mass spectrometry-based peptide sequencing, we were able to confidently identify a large number of proteins of interest. In particular, it was possible to identify proteins from bacteria that thrive in toxic environments. This provides firm evidence of previous suggestions (Bianucci 2008) indicating the exceptional preservation of the specimen was due to high amounts of heavy metals preventing biogenic degradation. In addition, it was possible to isolate proteins associated with certain pathological conditions, as well as mortuary practices.

Together our data paint a more accurate picture of the quality of life of this individual and the area, or type of area, of deposition. Although this study focuses on a single archaeological specimen, it represents an elegant example of the types of questions that can be answered using this innovative approach. The collaborative effort of interdisciplinary research will push this field further in examining both quantitative and qualitative proteins from the past to the service of archaeological investigation.

Reference

Bianucci R, Jeziorska M, Lallo R, Mattutino G, Massimelli M, et al (2008) A Pre-Hispanic Head. PLoS ONE 3(4): e2053. doi:10.1371/journal.pone.0002053

Author: *Chiara G. M. Girotto*
Title: *'Neolithisation' – Tracing Neolithic economy in Northern Europe*
Affiliation: *Goethe University Frankfurt (Germany)*
(research undertaken at Durham University, United Kingdom)

The 'neolithisation' of Northern Europe is still enigmatic and cannot be investigated by archaeological research alone. This poster examines the added layers of multistranded archaeo-scientific evidence in the light of the Craig et al. 2011 hypothesis: that diet and economy were potentially not entirely culturally related. Sites with most of the following indicators published were mapped: their archaeological culture, the hunter-gatherer Pitted Ware culture (GRK) as well as the first fully Neolithic culture of Northern Europe the funnel beaker culture (TBR), evidence for animal husbandry and agriculture as well as human isotope data, and lipid analysis.

Potential economic and cultural distinctions were evaluated. The data confirms a temporal North-South gradient, an early widespread appearance of domesticated animals and partially high reliance on marine proteins. Some TBR sites with transitional economy and some GRK sites with 'Neolithic' economy were observed. Although not many sites allow for this multi-stranded approach, it is highly likely that economy was adapted according to the present resources and was not entirely culturally constrained. Further research is needed to overcome draw-backs, like e.g. preservation bias. This study further highlights the importance of integrating scientific analyses in archaeological questions to analyse complex processes.

Reference

Craig OE, Steele VJ, Fischer A, Hartz S, Andersen SH, Donohoe P, Glykou A, Saul H, Jones DM, Koch E, Heron CP. 2011. Ancient lipids reveal continuity in culinary practices across the transition to agriculture in Northern Europe. *Proceedings of the National Academy of Sciences of the United States of America* **108**: 17910–17915. DOI: 10.1073/pnas.1107202108.

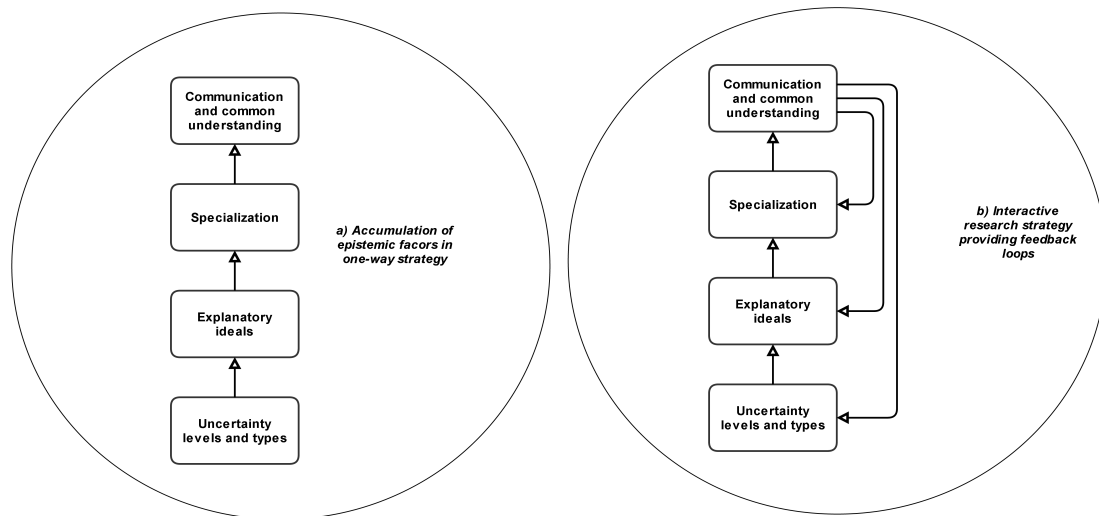
Author: Erlend Kirkeng Jørgensen

Title: *Interdisciplinary collaboration across the “two cultures” chasm: Managing epistemological challenges in archaeological science*

Affiliation: *University of Tromsø – The Arctic University of Norway.
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This paper reviews how the deep-rooted “two cultures” chasm in archaeology may create unfavorable conditions for the cooperation with the sciences. This is done by investigating a set of *epistemological* challenges pertaining to the integration of scientific methodologies with archaeology. The main objective is to a) evaluate what epistemological platform might integrate archaeology and archaeometry in interdisciplinary research projects, and b) how such a platform might provide productive interdisciplinary research strategies. Four epistemic factors at individual hierarchical levels are examined, consisting of 1) communication, 2) specialization, 3) explanatory ideals and 4) uncertainty levels and types. The discussion is based on a thorough review of the literature on interdisciplinary group work in science, and applies a formal-logical methodology in order to evaluate consistency in differentially based interdisciplinary research designs. The paper concludes by presenting a model of interdisciplinary research strategies able to cope with the cumulative and hierarchical epistemic challenges that affect the application of scientific methodologies in archaeology, and thus makes some suggestions for upping the performance of interdisciplinary archaeological science projects. In order to achieve integration proper, the results point to the importance of positive

feedback-loops and the establishment of a congruent mode of operation throughout every interdisciplinary module.



Author: *Kontopoulos¹, I., Penkman^{1, 2}, K., and Collins^{1, 3}, M. J.*
Presenting author: *Kontopoulos, I.*
Title: *Sample Preparation of Archaeological Bone for FTIR-ATR Analysis*
Affiliation: *Kontopoulos¹, I., Penkman^{1, 2}, K., and Collins^{1, 3}, M. J.
 BioArCh, Department of Archaeology, University of York,
 United Kingdom Department of Chemistry, University of York,
 United Kingdom Natural History Museum, University of
 Copenhagen, Denmark*

Fourier Transform Infrared (FTIR) spectroscopy in Attenuated Total Reflection (ATR) is commonly used for the investigation of diagenetic alterations in bone. However, the effects of sample preparation on the accuracy of the FTIR-ATR data is still unknown. This study reports the effects of bone powder particle size and within sample variation (i.e. periosteal, cortical, trabecular) on the Infrared Splitting Factor (IRSF), Carbonate/Phosphate (C/P) ratio, and Amide/Phosphate (Am/P) ratio.

Twenty-five cremated and non-cremated archaeological bone samples of different chronological age and burial environments were ground using either (1) a ball-mill grinder, (2) an agate pestle and mortar, or (3) both. Samples were sieved using Endecotts woven stainless steel mesh sieves (i.e. 500 μm , 250 μm , 125 μm , 63 μm , 20 μm) to produce bone powder of the same particle size. Sample measurements were performed using an Alpha FTIR-ATR spectrometer. The results demonstrate that bone powder particle size strongly but predictably affects the IRSF, C/P and Am/P values, likely to be because it has an impact on the contact between the sample and the prism. IRSF and Am/P values also

display variation between periosteal, cortical and trabecular areas of bone. Consequently, standard preparation methods for FTIR-ATR should be followed to improve accuracy, consistency, reliability, replicability and comparability of the data for the systematic evaluation of bone preservation.

Author: *Maria Lahtinen, Markku Oinonen, Miikka Tallavaara, James Walker, Peter Rowley-Conwy.*

Presenting author: *Maria Lahtinen*

Title: *'Advance of farming in Finland – evidence from summarising pollen evidence'*

Affiliation:

"Finland is situated in the part of northern most area in Europe where cultivation is still possible. In this northern periphery, the beginning and the spread of the cultivation remains still poorly understood. During recent years, it has been again in the centre of debate again. Old evidence has been combined with new techniques and methods.

In this area of thousands lakes and wetland, there are plenty of optimal sites for palynological analysis and undisturbed lake records of the past thousands of years is not a rarity. Therefore many pollen analysis has been carried out from many parts of the country. In this paper is presented a summery of these studies. With this summarized data we can understand more about the timing of the beginning or spread of cultivation in Finland. Results of this study suggest that the spread of cultivation was not a single event and is connected to increase of population."

Author: *Rikke Maring¹ & Felix Riede¹*

Presenting author: *Rikke Maring*

Title: *Possible wild boar husbandry preceding the introduction of the domesticated pig. A carbon and nitrogen isotope analysis of late Mesolithic wild boar from Denmark*

Affiliation: *Department of Archaeology, Aarhus University Moesgård, Moesgård Allé 20, 8270 Højbjerg, Denmark*
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This poster presents a stable isotope study of wild boar (n. 23) from four different Ertebølle sites in Jutland. Remarkably, four wild boars from the shell midden Fannerup F shows enriched carbon and nitrogen isotope values indicating a dietary intake of about 50 % marine food. It is tempting to propose that the people of the Ertebølle site Fannerup F, at least to some extent, managed wild boars in a similar way to how dogs were kept, considering that the carbon

and nitrogen values of the wild boars are comparable and almost identical to that of contemporary dogs. ¹⁴C dates of the four enriched wild boar range from 5290-4335 cal BC, suggesting that the management of wild boar was sustained over a longer time-scale and even began before the introduction of pottery.

Although the amount of analyses on wild boars are currently very limited, the existence of enriched values suggests that we must reconsider our understanding of early management of livestock and animal husbandry.

Author: *M. Oinonen^a, L. Arppe^a, H. Bocherens^b, J. Kantanen^c, M. Lavento^a, K. Majander^b, A. Mittnik^d, P. Onkamo^a, V. Palonen^a, J. Uusitalo^a, A. Vasks^e, G. Zarina^e, S. Översti^a*

Presenting author: *Markku Oinonen*

Title: *Kivutkalns bronze-working centre in light of natural sciences and archaeology*

Affiliation: ^a University of Helsinki, Finland, ^b University of Tübingen, Germany, ^c University of Eastern Finland, Finland, ^d Max Planck Institute for the Science of Human History, Jena, Germany, ^e University of Latvia, Latvia
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Kivutkalns complex of cemetery and hillfort has been considered as the largest Late Bronze Age bronze-working centre in Latvia. One third of the archaeological artefacts found at Kivutkalns hill-fort in the lower Daugava river are related to bronze working (Vasks 2010). According to archaeological excavations the hill-fort was built on top of a cemetery, from which burials of more than 230 individuals have been found. Recently, a set of radiocarbon dates on both the hillfort and cemetery provided new information on the relative dating of these and even challenged the old interpretation (Oinonen et al 2013).

In 2014 Finnish Cultural Foundation provided support for a new project to study chronology of the site, and cultural and genetical connections between Kivutkalns site and eastern Fennoscandia. In this contribution, we present the status of this project. First, we discuss the cultural connections based on archaeological investigations of the artefacts from Bronze Age cultures of north and south of Gulf of Finland. Second, we present new ¹⁴C-based chronologies of the site to shed light on both absolute and relative dating of hillfort and cemetery. Third, we present new data on dietary habits and discuss genetic affiliation of the people based on $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ isotopic data and ancient DNA measurements on human bones, respectively. Particularly, possible genetic connections between Kivutkalns and ancient and present populations of eastern Fennoscandia are discussed.

Reference

- Vasks A 2010. Latvia as part of a sphere of contacts in the Bronze Age. *Archaeologia Baltica* 13: 153-160.
- Oinonen M, Vasks, A., Zarina, G. & Lavento, M 2013. STONES, BONES AND HILLFORT – RADIOCARBON DATING OF KIVUTKALNS BRONZE-WORKING CENTRE. *Radiocarbon* 55: 1252-1264.

Author: *Charlotte Primeau, Preben Homøe, Niels Lynnerup*
Presenting author: *Niels Lynnerup*
Title: *Visualising evidence of infectious middle ear disease from CT scans of crania*

Affiliation:

Infectious middle ear disease (IMED) constitutes today a major health problem worldwide in both developed and developing countries and palaeopathological evidence has shown that humans have suffered globally from IMED for thousands of years. Evidence of IMED in archaeological populations has predominantly been macroscopically examined using the auditory ossicles, microscopically or using by X-ray imaging. Few studies have examined IMED using CT images. This study uses CT images to examine for evidence of IMED in archaeological skeletal material using two adult populations (n=91 and n= 59) from the Danish medieval period (1050 AD to 1536 AD). In total, fifty individuals (n= 24 and n=26) show osteological signs of IMED during childhood. The criteria for examining IMED is explained and illustrated in this poster together with a short discussion of issues with soil residues possibly mimicking sclerotisation from earth burials. It is concluded that more research is needed to develop a grading system of severity and for the borderline cases where IMED is expressed very slightly. The advantage of CT images is the 3D visualisation and being applicable to all adult skeletons with even fragmented crania, rather than using only individuals where the small and often missing auditory ossicles are found.

Author: *Zufar Shakirov*
Title: *ANTHROPOGENIC IMPACTS ON THE FOREST RESOURCES OF THE VOLGA AND KAMA RIVERS REGION IN THE MIDDLE AGES (HISTORICAL AND ARCHAEOLOGICAL ASPECTS)*
Affiliation: *Khalikov Institute of Archaeology, Tatarstan Academy of Sciences; Kazan Federal University, Kazan*
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Unsustainability of the forest resources of the Volga and Kama rivers region are conditioned by dynamic as well as periodical character of the historical development of the region, supposed to be covered by forest in case of the absence of anthropogenic impact according to previous studies. The research,

involving the studies of historical and archaeological aspects of this impact on the forest resources of the region, relates the issue to the occupation of the Volga and Kama rivers region by Volga Bulgaria and later by the Ulus of Juchi in the Middle Ages.

According to Arab written sources of the beginning of the 9th century, the region was fully covered by forests. The period of the reduction of the forest area is determined as the 11th – the beginning of the 13th centuries, conditioned by the preceding process of sedentarisation of semi-nomad Bolgars in the 8th-9th centuries, providing the increased demand of timber sources, as well as acreage. The research involves the following:

1. The ownership issues on forest resources;
2. The usage of homogeneous forests for supplying the demand on timber sources;
3. The presence of protected forest areas;
4. The composition issues according to written sources and sporo-pollen analysis;
5. The usage of timber sources;
6. The usage of other forest sources (animals, honey, plants);
7. The usage of forests as natural pasture areas for livestock.

The further application of ethnographic research methods would allow to improve the reconstructed image for Volga and Kama rivers regions, as well as to broaden the studies area.

Author: *Zufar G. Shakirov¹, Dilyara N. Shyamuratova²*
Presenting author: *Dilyara N. Shyamuratova*
Title: *THE USE OF FISH REMAINS AS A MARKER OF URBAN SOCIAL STATUS: ISSUES AND RESULTS (BASED ON MATERIAL FROM MEDIEVAL BILYAR)*
Affiliations: *¹Institute of Archaeology named after A.Kh. Khalikov, Tatarstan Academy of Sciences, Kazan, Russian Federation*
¹Kazan Federal University, Kazan, Russian Federation
²Institute for Problems in Ecology and Mineral Wealth, Tatarstan Academy of Sciences, Kazan, Russian Federation

Social status is closely connected with the range of foods consumed, both in ancient and in modern times. The main indicators of social status are diet and the quality of food products. In addition, the availability of products from remote regions can be used as an indicator of status. Basing on this issue, the article analyses the species composition of fish, consumed by inhabitants of the medieval Bilyar.

The archaeological site of Bilyar contains the remains of the medieval settlement known as the 'great city', described in Russian chronicles as the largest city of the

Eastern European Medieval state of Volga Bulgaria (according to the local chronicles attributed to the pre-Mongolian period). The settlement area was about 620 hectares, exceeding the size of the majority of the largest Medieval cities. Its fortification system, constituted by earth ramparts and moats, divided the city to its inner and outer parts. The research was based on the materials from the excavation unit 44 (dated by the 10th - the beginning of the 13th centuries AD) located in the 'inner city', the most high-status part of medieval Bilyar. Over 600 fragments of fish bone remains were found at the unit during excavation season of 2015. The analysis of the remains showed the presence of 17 species with the predominance of sturgeon species (constituting 57,3%).

The research was challenged by several methodological issues. The first was related to the quality and accuracy of the material selection process for the research conditioned by the size and the state of preservation of fish bone remains, distinctively from the remains of larger animals. The second one occurred during the analysis process and involved taxonomical identification of selected fish remains.

The studied samples allowed to establish the new concept of fish diet of the inhabitants of medieval Bilyar, as well as to develop the appropriate methodologies for fish remain samples selection, taxonomy and species domination identification, that can be applied in the studied region. The result of the research provides possibilities for reconstruction of fish delivery routes, its quality and the amount of its consumption, suggesting the high social status of the inhabitants of the inner part of Bilyar. The further research of fish bone remains may help to determine the features of medieval environment of the studied area.

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Title: *Blue textiles almost two millennia old from Northern Finland*

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A unique find from the Northern Finland contained six tiny textile fragments sized with ca 1 cm². These had been preserved in direct contact with a bronze bracelet, which has protected the wool material from decaying in cemetery of Kaakkuri in Välikangas in Oulu.

The finds are dated to AD 200–400, which makes them one of the oldest preserved woollen textile find of Finland.

The fragments are brownish in visual analysis. They have been woven using s- and z-spun yarns, possibly indicating spin pattern and/or the use of differently

coloured yarns. The bronze artefacts of the burial have parallels in Southern Scandinavia.

Optical microscopy (TLM and fluorescence) and electron microscopy (SEM) and element analysis (SEM-EDX) were applied to identify the blue colourant. In TLM, the fibres were blueish and that colour was fluorescent. In SEM, heavy degradation appeared of fibres, with copper (Cu), iron (Fe) and phosphor (P). In TLM, indigo-dyed modern references, indigo powder and other archaeological fibres with UHPLC-ensured woad were clearly fluorescent. Inorganic pigments azurite and vivianite are not fluorescent. These findings suggest that the blue colour was either indigotin (fluorescent) or azurite (that contains Cu) or vivianite (that contains Fe and P).

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Title: *DNA analysis of lineage markers from skeletons from a mass grave*

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During a rescue excavation in October 2011, archaeologists discovered a mass grave with 10 individuals. The skeletons should belong to victims of the battle of Reichenberg between the Austrian and Prussian armies on April 21, 1757. Several bones of the skeletons were covered with a blue colored encrustation. Initial DNA analysis failed due to strong inhibition. Chemical analysis of the bluish encrustation indicated the presence of the iron phosphate mineral *vivianite* (Fe₃(PO₄)₂·(H₂O)₈). DNA extraction and the inhibitor removal was performed according to the procedure described previously (1). Y-chromosome and mtDNA haplotypes obtained for DNA extracted from skeletal remains were compared to the contemporary population from the vicinity of the excavation site.

1.Votrubova-Dubska J, Vanek D, Zikmund J, Mestek O, Urbanova V, Brzobohata H, et al. Technical note: Efficient removal of a PCR inhibitory agent (vivianite) found on excavated bones. *Forensic science international*. 2016;261:8-13.

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Presenting author: *Federica Sulas*
Title: *Activity markers and household space in Swahili urban contexts: an integrated geoarchaeological approach*
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Investigating household space at urban sites presents a number of challenges from complex archaeological stratigraphies to different taphonomic processes and preservation conditions. Over the last decades, geoarchaeology has been furthering new methods and approaches to investigate the (micro-)context and processes associated with household space through the study of activity markers. Geoarchaeological methods are now routinely applied in urban sites, but these are seldom tightly integrated within the whole research process and, instead, are often performed as specialised studies. To bring research forward, this paper draws from recent work at a Swahili urban site to illustrate the potential and challenges of an integrated geoarchaeological approach to the study of household space. The site of Songo Mnara (14th – 16th c. AD) thrived as a Swahili stonetown off the coast of Tanzania. Here, our work has concentrated on the study of coral-built houses and wattle-and-daub structures via large-scale excavations, artefact distribution, context-specific soil micromorphology, and systematic soil chemical mapping (ICP-AES) to identify and interpret activity markers in different indoor contexts. In this paper, we discuss what this analysis can add to our knowledge of household at the site of Songo Mnara, and the implications for studies of urban sites elsewhere in the region.

Author: *Luise Ørsted Brandt*
Title: *Paleoproteomics and Polychromy: The identification of peptides from paint binders from the Palace of Apries, Egypt*
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Ancient art and architecture was very far from the pure white we usually see in museum exhibitions, but rather vibrant with colour. The study of the polychromy of ancient artefacts over the past decades has completely changed our perception of the ancient world and its aesthetics.

Most cultural heritage objects produced using biogenic materials are rich in protein residues. This is also the case for paint binders that were used as a medium for pigments applied to sculptures and architecture in Antiquity. So far, the research of ancient polychromy has, however, primarily focused on analyses and identification of pigments. The choice of the binding medium was, however, of crucial importance for the final polychrome appearance in terms of coverage,

nuance, intensity, and gloss. The nature of the binding medium is therefore of paramount importance for our understanding of the original appearance of painted objects.

In this pilot study we identify collagen alpha-1(I) and collagen alpha-2(I) from *Bos Taurus* in a sample from a polychrome layer from an architectural element from the Palace of Apries, Egypt, (around 589-568 BCE) using mass spectrometry-based peptide sequencing. Identifications of ancient paint binders will expand our knowledge on painting techniques of Antiquity considerably. Moreover the identifications will improve reconstructions of ancient polychrome artefacts in museum exhibitions.

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Title: *Species identification of Mesolithic bone revealed by ancient proteins*

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Preserved organic material from the Late Glacial and the Early Holocene in Southern Scandinavia is scarce. So scarce in fact, that faunal assemblages from this period cannot conclusively demonstrate species present at the time. Artifacts made of animal bone however, are preserved, often in the form of bone points lost during hunting in the newly formed lakes just prior to the last Ice Age. This presentation presents an overview of a new Ph.d project, which focuses on the application of Zooarchaeology by Mass Spectrometry (ZooMS) for species identification performed on Stone Age bone tools and fragments from Southern Scandinavia and Northern Germany.

