39TH CONFERENCE OF THE ASSOCIATION FOR ENVIRONMENTAL ARCHAEOLOGY

Back where it all began! Archaeological science from the 'Kitchen Midden Commissions' to the present

29.11.2018 – 01.12.2018 | Moesgaard (Aarhus), Denmark

Moesgaard Museum (MOMU) and Department of Archaeology & Heritage Studies, Aarhus University

Moesgaard Allé 15 & 20, 8270 Højbjerg, Denmark

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CONFERENCE PROGRAMME

Thursday 29th November 2018 | Moesgaard Museum & Aarhus University Moesgaard Campus

12:00 registration at Moesgaard Museum

Keynote lectures | Moesgaard Museum Auditorium

13:00 Presentation by Marcello A. Mannino & Peter H. Mikkelsen

13:10 Catherine A. Jessen (National Museum, DK) | ***Reconstructing buried coastal landscapes: towards the mapping of human-environment interactions***

14:00 Bent Vad Odgaard (Aarhus University, DK) | ***Landscape openness and land-use in Danish prehistory: pollen and erosion evidence***

14:50 break

15:10 Søren M. Sindbæk (UrbNet, DK) | ***Putting context first: resource networks, urban evolutions, and high-definition data***

16:00 Peter A. Rowley-Conwy (Durham University, UK) | ***Where it all began: shell middens, archaeological science, and the setting of archaeological agendas***

17:30 *Welcome reception* | Department of Archaeology & Heritage Studies [building 4206], Aarhus University

Friday 30th November 2018 | Moesgaard Museum Auditorium

8:15 registration at Moesgaard Museum

9:00 introduction

9:10-10:30 **SESSION 1 | Humans & the Sea** | chaired by Søren H. Andersen (MOMU)

9:10-9:30

Sea-level changes in Mesolithic Southern Scandinavia: long- and short-term effects on society and the environment

Peter Moe Astrup | Moesgaard Museum (Denmark)

9:30-9:45

Facing the sea, relying on the land? - investigating the Tintagel middens

Gill Campbell et al. | Historic England (United Kingdom)

9:45-10:00

Reconstructing the internal architecture of giant medieval shell middens with the Ground Penetrating Radar (GPR)

Elsa Cariou et al. | Université de Nantes (France)

10:00-10:15

Woodlands under the waves: Orcadian landscape change from the Mesolithic to Bronze Age

Michelle Farrell et al. | Coventry University (United Kingdom)

10:15-10:30

Intra- and inter- tooth variation in strontium isotope ratios from prehistoric seals by laser ablation (LA)-MC-ICP-MS

Aikaterini Glykou et al. | Stockholm University (Sweden)

10:30-11:00 coffee break

11:00-12:30 **SESSION 2 | Diet & Health |** chaired by Jacob Kveiborg (MOMU)

11:00-11:15

Recreating past effects of seaweed-fertilisation on the isotopic and chemical composition of barley to further palaeodietary reconstructions

Magdalena Blanz et al. | University of the Highlands and Islands (United Kingdom)

11:15-11:30

Life and death in a* civitas *capital: deciphering the link between environmental constraints and health hazards at Aventicum, Roman Switzerland (1 st-3 rd c. AD)

Chryssa Bourbou | University of Fribourg (Switzerland)

11:30-11:45

Feeding Anglo-Saxon England: joining forces to break new ground

Mark McKerracher | University of Oxford (United Kingdom)

11:45-12:00

Diet, mobility and radiocarbon dating of Tollund Man – New investigations of a Danish Iron Age bog body

Nina Helt Nielsen et al. | Museum Silkeborg (Denmark)

12:00-12:15

Life in the Stone Age at Riņņukalns, Latvia: a Neolithic freshwater shellmidden in the eastern Baltic region

Kenneth Ritchie et al. | Centre for Baltic and Scandinavian Archaeology (Germany)

12:15-13:30 lunch

13:30-15:00 **SESSION 3 | Past Agriculture |** chaired by Welmoed Out (MOMU)

13:30-13:45

Small seeds – Big Data

Marianne Høyem Adreasen et al. | Moesgaard Museum (Denmark)

13:45-14:00

Resilience and breakpoints – exploring linkages between societal, agricultural and climatic changes in Iron Age Denmark

Mads Dengsø Jessen | The National Museum of Denmark (Denmark)

14:00-14.15

Arable farming in Viking Age Iceland: archaeobotanical evidence from Lækjargata 10-12, Reykjavík

Dawn Elise Mooney & Lísabet Guðmundsdóttir | University of Stavanger (Norway) & The Institute of Archaeology (Iceland)

14:15-14:30

North-south patterning of millet agriculture on the Loess Plateau: Late Neolithic adaptations to water stress, NW China

Pengfei Sheng et al. | Fudan University (China)

14:30-14:45

People, land-use & time: linking multi-proxy palaeoenvironmental & archaeological data

Daisy Spencer | National University of Ireland (Ireland)

14:45-15:00

Can geometric morphometrics reveal the origins of Scotland's island-adapted barley, bere?

Michael Wallace et al. | The University of Sheffield (United Kingdom)

15:00-15:30 coffee break

15:30-17:00 **SESSION 4 | People & Environments I: Individuals & Contexts** | chaired by Felix Riede (AU)

15:30-15:45

Reacquainting bog bodies with their landscape and environmental contexts

Henry Chapman et al. | University of Birmigham (United Kingdom)

15:45-16:00

How to identify cesspits as latrines? A study of macrofossils and non-pollen palynomorphs in Danish medieval cesspits

Renée Enevold et al. | Aarhus University (Denmark)

16:00-16:15

The archaeological potential of anthropogenic soils on Jæren, South-West Norway

Jutta Lechterbeck | University of Stavanger (Norway)

16:15-16:30

Plant use at Neolithic Frydenlund, Fyn, Denmark

Welmoed Out et al. | Moesgaard Museum (Denmark)

16:30-16:45

Fregerslev II at the microscale: Soil micromorphology and XRF analyses of a Viking grave

Federica Sulas et al. | Centre for Urban Network Evolution, Aarhus University (Denmark)

16:45-17:00

The Medieval geoarchaeology of lowland rivers: riverine place-names, environments and alluviation over the last Millennium in Central England

Ben Pears et al. | University of Southampton (United Kingdom)

17:30 **AEA ANNUAL GENERAL MEETING** | Aarhus University Moesgaard Campus [building 4206, room 117]

Saturday 1st December 2018 | Moesgaard Museum Auditorium & Aarhus University Moesgaard Campus

9:00-10:30 **SESSION 5 | People & Environments II: Landscapes** | chaired by Niels N. Johannsen (AU)

9:00-9:15

Twin Peaks in the Early Mesolithic. New results from ancient Lake Duvensee

Daniel Groß et al. | Centre for Baltic and Scandinavian Archaeology (Germany)

9:15-9:30

New advances in archaeological phytolith analysis: a peat deposit at Rue des Boîteux (Brussels)

Rosalie Hermans | Vrije Universiteit Brussel (Belgium)

9:30-9:45

Assessing vegetation change at the regional scale in western Sjælland: 7000 years of fluctuation in anthropogenic fire, deforestation, grazing and settlement

Anthony Ruter | Centre for GeoGenetics, Natural History Museum of Denmark (Denmark)

9:45-10:00

Project Wildscape: Reconstructing Hidden Landscapes through a Case Study in the Humberhead Levels

Nika Shilobod et al. | Plymouth University (United Kingdom)

10:00-10:15

European landuse at 6000BP: from on-site data to the large-scale view

Nicki Whitehouse et al. | Plymouth University (United Kingdom)

10:15-10:35 **SESSION 6 [part 1] | Five-minute-long presentations for each poster** | chaired by Federica Sulas (UrbNet, AU)

1. Nora M. Battermann | University of Leicester (United Kingdom)
2. Tony Brown et al. | Tromsø Museum, UiT (Norway)
3. Cannell et al. | University of Oslo (Norway)
4. Elsa Cariou et al. | Université de Nantes (France)

10:35-11:00 coffee break

11:00-12:40 **SESSION 6 [part 2] | Five-minute-long presentations for each poster** | chaired by Federica Sulas (UrbNet, AU)

5. Pam J. Crabtree & Douglas V. Campana | New York University & US National Park Service (USA)
6. Dragana Filipović et al. | University of Kiel (Germany)
7. Paul Flintoft | University of Reading (United Kingdom)
8. Thierry Fonville et al. | University of Southampton (United Kingdom)
9. Peter D. Heintzman et al. | The Arctic University of Norway (Norway)
10. Wiebke Kirleis et al. | University of Kiel (Germany)
11. Wilmer Koster | Utrecht University (The Netherlands)
12. Sascha Krüger & Martin Damrath | Centre for Baltic and Scandinavian Archaeology (Germany)
13. Johan S. Larsen | Centre for Urban Network Evolution, Aarhus University (Denmark)
14. Johan S. Larsen et al. | Centre for Urban Network Evolution, Aarhus University (Denmark)
15. Mike Lobb et al. | Trent and Peak Archaeology (United Kingdom)
16. Rikke Maring et al. | Aarhus University (Denmark)
17. Meriel McClatchie | University College Dublin (Ireland)
18. Julie-Anne Bouchard Perron | Historic England (United Kingdom)
19. Pengfei Sheng et al. | Fudan University (China)
20. David Stone | University College Dublin (Ireland)
21. F. Sulas et al. | Centre for Urban Network Evolution, Aarhus University (Denmark)
22. Pernille L.K. Trant & Barbora Wouters | Aarhus University & Centre for Urban Network Evolution, Aarhus University (Denmark)
23. Kathryn O. Weber | Cornell University (USA)

12:40-13:40 lunch

13:40-15:00 **SESSION 7 | Poster Session**

15:00-15:30 coffee break

15:30-17:00 **SESSION 8 | Advances in Archaeological Science** | chaired by Luise Ørsted Brandt (UrbNet, AU)

15:30-15:45

Ancient DNA reveal Holocene environmental change with and without human impact

Inger Greve Alsos et al. | The Arctic University of Norway (Norway)

15:45-16:00

Using sedaDNA and lipid biomarkers alongside palaeoenvironmental proxies for understanding wetland and lakeside archaeological site

Tony Brown et al. | Tromsø Museum, UiT (Norway)

16:00-16:15

Ancient DNA reveals vegetation history near the archeological site in Varanger, northern Norway

Dilli P. Rijal et al. | The Arctic University of Norway (Norway)

16:15-16:30

"Palaeoshellomics": biomolecular identification of prehistoric pearl shell ornaments

Jorune Sakalauskaite et al. | University of Turin (Italy)

16:30-16:45

Ancient Shell DNA: A New Proxy for Environmental Archaeology Research

Clio Der Sarkissian & Ludovic Orlando | Université de Toulouse (France)

16:45-17:00 closing remarks and greetings

17:20 *Visits of the* Department of Archaeological Science & Conservation *at Moesgaard Museum and of the* Moesgaard ArchaeoScience Laboratory *at the Aarhus University Moesgaard Campus*

19:00 **CONFERENCE DINNER** | Aarhus University Moesgaard Campus [building 4206]

[The catering for the dinner is by the ***Moesgaard Museum Café***]

Sunday 2nd December 2018 | Visit of Moesgaard Museum

Catherine A. Jessen

Department of Environmental Archaeology and Materials Science, National Museum of Denmark, Denmark

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Reconstructing buried coastal landscapes: towards the mapping of human-environment interactions

The postglacial relative sea level rise flooded much of the low-lying landscapes of southern Scandinavia submerging the coastal shelves along with any extant archaeology. These buried landscapes potentially hold well-preserved archaeological sites but are often not easily accessible and can rarely be excavated at a large scale. Coastal environments offer a variety of resources from marine, fresh water, woodlands and bogs to possibly cultivated areas. Placing cultural evidence within these diverse landscapes is therefore essential in the understanding of how people used and interacted with their environment. These drowned or buried landscapes and environments are naturally difficult to reconstruct but by combining sedimentological, stratigraphic and palaeoenvironmental data with archaeological evidence and landscape modelling it can be achieved. This contribution will cover some of the southern Scandinavian sites where it has been possible to apply this approach and shows what new knowledge can be gained when we have the rare opportunity to closely examine the relationship between coastal communities and their environment.

Bent Vad Odgaard

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Landscape openness and land-use in Danish prehistory: pollen and erosion evidence

Although evidence of natural or culturally induced openness in Mesolithic woodlands have been discussed the general interpretation of Danish pre-agricultural landscape is that of closed woodland communities. An exception is the nutrient poor soils of western Jutland. The introduction of early agriculture brought arable farming as well as animal husbandry to northwestern Europe and the resultant opening of woodland communities has been interpreted as being the effect of both of these economies. Since animal husbandry with freely roaming domestic animals requires more space per effective calorie produced than does arable farming domestic grazing is often believed to have had stronger effect on landscape openness. The extent of celtic field systems discovered by recent LIDAR techniques have questioned such interpretations at least for some prehistoric periods. I use classical pollen data and modelling based on pollen data to revisit the question of the balance between animal husbandry and arable farming during Danish (pre)history. Conclusions are tested using new erosion data based on sediment XRF-data. Finally, I comment on the future on archaeological palynology including the development of analysis of non-pollen-palynomorphs and its usefulness in relation to the potential of aDNA studies.

Søren M. Sindbæk

UrbNet and Department of Archaeology & Heritage Studies, School of Culture & Society, Aarhus University, Denmark

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Putting context first: resource networks, urban evolutions, and high-definition data

Urban sites are some of the richest archives available for the archaeology of complex societies across the world. The massive remains left by dense agglomerations of specialized and differentiated communities from ancient times to the present offer an alluring yet dauntingly complex record of anthropogenic processes in the past. Currently, the practice of urban archaeology is changing spectacularly. The application of increasingly sophisticated analytical methods and digital recording applications are transforming the means of archaeology to document and explore the big data of urban sites. The Centre for Urban Network Evolutions (UrbNet), based at Aarhus University, Denmark, was established in 2015 with a grant awarded by the Danish National Research Foundation. Its mission is to study urban societies in terms of their social networks in the broadest sense. In archaeological and historical research, this approach represents a new, explorative, even experimental perspective on a crucial topic. Approaching urbanism as network dynamics, we aim to develop a high-definition archaeology to determine how urban networks catalysed societal and environmental expansions and crises in the past. Traditional archaeological approaches to urban archaeology have been limited by a "feature first" approach, in which evidence is separated and analysed according to material classes and only re-integrated at a highly generalised level of interpretation. By introducing a "context first" approach in which a multi-dimensional interpretation of individual contexts forms the point of departure for integrated "biographies" of urban sites and groups, this will stimulate a new approach to urban archaeology.

Peter A. Rowley-Conwy

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Where it all began: shell middens, archaeological science, and the setting of archaeological agendas

In this contribution I explore scientific archaeology as applied to shell middens, from the earliest times. At several junctures shell midden research has produced unexpected and anomalous results that have conflicted with previous understandings. The first of these occurred in 1848, when human-made artefacts were found in shell deposits previously thought to be of natural origin. This led to the conclusion that shell middens were human settlement sites. On several subsequent occasions shell middens have produced other anomalies, which force changes in archaeological understandings. This can be tracked right up to the present day. I will argue that, contrary to many recent assertions, archaeological theory does *not* lead the way and set the disciplinary agenda: archaeological science does.

SESSION 1 | Humans & the Sea

chaired by Søren H. Andersen (Moesgaard Museum)

Sea-level Changes in Mesolithic Southern Scandinavia: Long- and Short-term Effects on Society and the Environment

Peter Moe Astrup[1]

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The seabed in southern Scandinavia contains numerous traces of a submerged landscape that is thought to be the remnant of a once important habitat for Mesolithic hunter-gatherers. Large parts of this landscape were gradually flooded by rising seas between 9500 and 4000 BC and perceptions of the Maglemose culture (9500-6400 BC) have, consequently, been based almost exclusively on former inland settlements. As a result, Early and Late Mesolithic societies have been understood as almost diametrically opposed with regards to their reliance upon marine resources and their degree of sedentism. The main objective of the lecture is to investigate a question that is directly related to our current understanding of the populations of the now submerged areas: Do we have a representative picture of the spread of Early Mesolithic sites in southern Scandinavia, or does the weighting towards inland sites reflect the fact that coastal sites have not been identified below present-day sea-level? The lecture presents a series of new coastline models made to determine the Mesolithic sea-level changes. On the basis of the new coastline models the lecture furthermore presents the preliminary results of 47 diver investigations conducted with the aim of identifying potential coastal settlements from the Maglemose culture. These are used to discuss the extent to which marine resources were utilised in the Maglemose culture.

Facing the sea, relying on the land? - investigating the Tintagel middens

Gill V. Campbell[1], Polydora Baker[1], Zoë Hazell[1], Jacky Nowakowski[2], James Gossip[2]

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Excavations on Tintagel Island, Cornwall in 2016-17 have uncovered 5th to 6th century A.D midden deposits underlying substantial buildings. These deposits probably represent deliberate levelling to provide foundations for the construction. In contrast to the assemblages recovered from earlier excavations at the site, the biological remains from the midden deposits are exceptional, in particular the vertebrate remains which rarely survive in the acidic soils prevalent in south west England. The assemblages include the remains of juvenile animals, a high proportion of pig, well preserved charcoal and cereal remains, the latter showing the use of barley, oat and both hulled and wheat. While the material culture demonstrates that the inhabitants were trading along the sea routes to the Mediterranean and beyond, the biological remains include very few marine resources suggesting that food, building material and fuel were primarily procured from the immediate hinterland. This paper employs a multidisciplinary approach to the study of formation processes, farming, diet and procurement, providing insight into life-ways at Tintagel in the early medieval period.

Reconstructing the internal architecture of giant medieval shell middens with the Ground Penetrating Radar (GPR)

Elsa Cariou[1], Agnès Baltzer Donatienne Leparoux[2], Catherine Dupont[3]

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The giant shell middens of Vendée (France) were made of billions of flat oyster shells, accumulated during the second half-part of the Medieval Warm Period (9th to 13th c.). Most of them are severely damaged or buried. They are now protected and excavations are prohibited. Thus, to go further in our understanding of these massive deposits, non-destructive techniques, such as geophysical surveys, are required (Cariou et al. 2018). Different techniques were tested in this study. Despite the heterogeneity and the high porosity of the medium, the Ground Penetrating Radar (GPR) survey revealed to be the most relevant method. In the Saint-Michel-en-l'Herm middens, the 3D-GPR survey showed the progressive infilling of an ancient tidal creek by successive sigmoid stratigraphic units of shells, separated by thin soils and trampled surfaces. This internal organization of the midden suggests periodic massive shell inputs (>100 m3), separated by periods of non-deposition and trampling. Within the units, different piles can also be distinguished, probably underlined by the stacking pattern of oysters. Similar surveys performed in other Vendée medieval shell middens demonstrate that the GPR is an excellent tool to reconstruct the geometry and internal organization of shell middens, leading to a better understanding of their edification.

Reference
Cariou E., Baltzer A., Leparoux D., Ledoyen J., Debaine F. 2018. Ground penetrating radar in the medieval oyster shell middens of Saint-Michel-en-l'Herm (Vendée, France). *Journal of Archaeological Science: Reports* 18: 186–196.

Woodlands under the waves: Orcadian landscape change from the Mesolithic to Bronze Age

Michelle Farrell[1], Scott Timpany[2], Martin Bates[3], Richard Bates[4], Jane Bunting[5], Alanis Buhat[2], Steve Davis[6], Sue Dawson[7], John Whittaker[8], Caroline Wickham-Jones[9]

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Coastal landscapes are vulnerable to both gradual and sudden, dramatic environmental change through the mechanisms of sea-level rise and extreme events such as storm surges and sand blow events. Coastal environments are also critical for resources, communication and living space, and arguably would have been even more important in prehistory. Here we present the results of a holistic investigation of coastal landscape change in Orkney over a period of approximately 7000 years, from Mesolithic to Bronze Age, achieved by analysing a section of landscape

which incorporates the dryland, intertidal and marine zones. Offshore geophysical survey has provided information on seafloor sediments and inundated land surfaces; pollen, diatom, ostracod, foraminifera and insect analyses of radiocarbon dated sediment cores recovered from intertidal peats and freshwater lakes have enabled reconstruction of rising sea-levels, climate, and terrestrial landscape change including woodland decline and the introduction of agriculture; and investigation of the remains of a submerged forest has provided further insights into the nature of Orkney's prehistoric woodland. The results provide valuable contextual information for the periods before, during and after the use of the monuments making up the Heart of Neolithic Orkney World Heritage site, including the ongoing excavations at the Ness of Brodgar.

Intra- and inter- tooth variation in strontium isotope ratios from prehistoric seals by laser ablation (LA)-MC-ICP-MS

A. Glykou[1], G. Eriksson[1], J. Storå[2], M. Schmitt[3], E. Kooijman[3], K. Lidén[1]

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[3]Department of Geosciences, Swedish Museum of Natural History, SE-10405 Stockholm, Sweden

Strontium isotope ratios ($^{87}Sr/^{86}Sr$) in marine environments are considered to be homogeneous averaging 0.7092. However, in the Baltic Sea there is major influx of freshwater, since more than 50 rivers discharging into the Baltic drain sedimentary rock-bearing areas of the Baltic Shield with different geological origin and thus different strontium isotope ratios. This results in mixing of sea water and continental drainage, leading to regional variations of strontium isotopic ratios. The aim of this pilot study was to explore if these regional variations of Sr can be detected in marine mammals from archaeological sites in the Baltic Sea. This was investigated by performing a sequential measurement of $^{87}Sr/^{86}Sr$ ratios in tooth enamel from three seal species by using laser ablation MC-ICP-MS. An inter-tooth $^{87}Sr/^{86}Sr$ variation can be detected in marine mammals that lived in the Baltic Sea, suggesting that different Sr ratios can be detected in different regions of the Baltic Sea. Furthermore, an intra-tooth variation suggests possible different geographic origin or seasonal movement of seals within different regions in the Baltic Sea through their life time. The data show clearly that we deal with a non-homogenous strontium isotope ratio in the Baltic Sea Basin. Archaeological implications are discussed.

SESSION 2 | Diet & Health

chaired by Jacob Kveiborg (Department of Archaeological Science & Conservation, Moesgaard Museum)

Recreating past effects of seaweed-fertilisation on the isotopic and chemical composition of barley to further palaeodietary reconstructions

Magdalena Blanz[1,2], Ingrid Mainland[1], Philippa Ascough[3], Mark A. Taggart[4], Jörg Feldmann[2]

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Historical and archaeological evidence indicates seaweed was a common fertiliser along European North Atlantic coastlines. The effect seaweed fertilisation has on crops in terms of $\delta^{13}C$, $\delta^{15}N$ and other dietary biomarkers that are transferred from plants up the food chain needs to be established, as this will influence interpretations of dietary and provenance reconstructions.
In this study, bere barley (*Hordeum vulgare*) was grown with seaweed-fertilisation in a field trial on the Orkney Islands (UK). Isotopic analysis showed $\delta^{15}N$ values of seaweed-fertilised plants to be elevated by 0.6 ± 0.5 ‰ (average ± 1σ for five replicate plots) in grain, and 1.1 ± 0.4 ‰ in straw compared to unfertilised plants. Notably, no significant differences were found for $\delta^{13}C$. Strontium concentrations were elevated in seaweed-fertilised crops compared to unfertilised crops (by factors of 1.2 to 1.4), indicating possible effects on $^{87}Sr/^{86}Sr$.
These results indicate that even short-term seaweed-fertilisation can significantly affect the isotopic and chemical composition of plants. Consumption of seaweed-fertilised plants can thus cause e.g. elevated $\delta^{15}N$ values in consumer skeletal material (particularly when plants are the main source of dietary protein), leading to an overestimation of the amount of animal protein in the diet if seaweed-fertilisation is unaccounted for.

Life and death in a *civitas* capital: Deciphering the link between environmental constraints and health hazards at Aventicum, Roman Switzerland (1st-3rd c. AD)

Chryssa Bourbou[1]

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The human-environment interaction is a millennia-long affair, but bioarchaeological studies investigating the relationship between environment and health declines in past populations are still relatively limited. This presentation discusses the possible effects of environmental constraints to the health of Roman populations (1st-3rd c. AD) at the *civitas* capital of Aventicum (Switzerland). The location of Aventicum near a marshy and subject to floods area, as well as paleoenvironmental data on climatic conditions, natural hazards and the human impact during the Roman era, all point to the significant role played by the environment to the health of the Aventicum populations. Natural changes, such as warm temperatures and heavy precipitation, are known to favor the growth and size of vectors responsible for infectious conditions, such as malaria, a hypothesis currently investigated for the site in question where high perinatal mortality is observed (71% or 66/93 of the total non-adult sample). Similarly, high flood activity during the Roman era could have resulted in resources scarcity, primarily affecting pregnant or lactating women as the possible cases of neonatal scurvy have demonstrated.

Feeding Anglo-Saxon England: joining forces to break new ground

Mark McKerracher[1]

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Radical changes in medieval farming practices fuelled demographic growth on an unprecedented scale: by the thirteenth century, cornfields in England – and more widely across Europe – were feeding more mouths than ever before. In large part, this achievement can be ascribed to the open field systems, which characterised much of the medieval landscape, based on collectively-organized crop rotation, heavy ploughing, and vast undivided fields. But the questions of when, where and how this distinctively cooperative farming system developed remain hotly contested, despite more than a century of historical research. A major ERC-funded research project at the Universities of Oxford and Leicester, entitled "Feeding Anglo-Saxon England", is applying modern bioarchaeological methods to these longstanding questions. Settlement studies, statistical archaeobotany, weed ecology, zooarchaeology, palaeopathology, palynology, and stable isotope analysis of cereal grains and animal bones are all being brought to bear on the crucial questions concerning this medieval agricultural revolution. One year into the project, this paper introduces our methodology, describes a case study combining several different strands of analysis at a single settlement, and presents preliminary patterns in crop and weed data gleaned from a new national dataset of archaeobotanical remains.

Diet, mobility and radiocarbon dating of Tollund Man – New investigations of a Danish Iron Age bog body

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Tollund Man is one of the world's most famous bog bodies due to his exceptionally well-preserved head. He was found in 1950 by peat cutters in the valley of Bjældskovdal, situated c. 10 km west of Silkeborg, Denmark. Over the years, several analyses have been performed on the body, but until recently these have primarily included forensic and medical examinations. However, strontium isotope analysis, stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) and a new radiocarbon analysis have now been carried out in order to shed light on the mobility, diet and dating of Tollund Man. The strontium isotope analysis was conducted on samples from his hair and femur, which made it possible to identify whether Tollund Man had been traveling or living somewhere during the last 10 years of his life other than where he spent the last four months of his life.
Stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) and radiocarbon dating of samples from a femur and a rib of Tollund Man provided insight into his long-term diet and produced an exceptionally narrow date range for his death. In this paper we present the new results as well as our plans for future investigations.

Life in the Stone Age at Riņņukalns, Latvia: a Neolithic freshwater shellmidden in the eastern Baltic region.

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The famous freshwater mussel shellmidden at Riņņukalns, Latvia continues to reveal life in the Stone Age of the eastern Baltic. Previous excavations at the site began already in 1874 and continued into the 20th century, focused on the shellmidden itself and the burials it contained. Recent investigations beginning in 2010 have sought to clarify the research history of the site and provide a more complete understanding of what actually occurred there using modern scientific archaeological methodology. Importantly, an occupation sequence predating the midden has been identified and excavated, allowing a discussion of subsistence practices before and during the accumulation of freshwater mussel shells that produced the midden. Good preservation conditions mean that both human skeletons and abundant evidence from food refuse are available for study. We will highlight findings from the burial of a middle-aged man that was found in 2017 and associated grave goods including remains of what appears to be a fish soup. ZooMS results on bones from this feature have helped to clarify identifications of bones from very small individuals of the perch family (Percidae). Equally important, zooarchaeological analyses contrast faunal exploitation strategies before and during the period of midden formation.

SESSION 3 | Past Agriculture

chaired by Welmoed Out (Department of Archaeological Science & Conservation, Moesgaard Museum)

Small seeds – Big Data

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Since the Department of Archaeological Science started at Moesgaard Museum in 2003 thousands of samples from Danish museums have been screened for their content of plant macrofossils. Many of the samples have been fully analyzed and have added to our knowledge about the prehistoric agriculture and plant economy in Denmark, but the major part of the samples contained no or only a few cereal grains and seeds and were therefore not analyzed. A few years ago, the question arose whether these screened but not analysed samples could contribute to the understanding of the prehistoric agriculture, land use and vegetation development. Together with the Museum at Sønderskov and Museum of Southwest Jutland we set out to create a database of the archaeobotanical material from Prehistory from five museums from the Southern part of Jutland stretching from the West to the East coast. The talk will demonstrate some of the challenges of incorporating data from three different laboratories working with plant macrofossils and the differences in data registration. Furthermore, some preliminary results of the project will be presented.

Resilience and breakpoints – exploring linkages between societal, agricultural and climatic changes in Iron Age Denmark

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The multi-disciplinary project Resilience and Breakpoints will explore potential linkages between changes in society, agriculture and climate in Iron Age Denmark by generating datasets of archaeological and palaeoecological variables with high temporal resolution. The Danish Iron Age (500BC to AD800) is a period characterised by large-scale changes in social structure and agricultural strategy, as well as relatively unstable climatic conditions. The project aims to map these human and natural systems and to understand the interaction between them. The overall aim of this project is to explore and interpret the linkages between the three datasets below within a cultural context, i.e. linking changes in settlement patterns and technology with changes in agricultural strategy and climate, in the theoretical framework of resilience thinking by:

• establishing an overview of changes in agricultural strategies, such as field conditions, levels of manuring and precipitation, based on isotope analysis of an updated and comprehensive dataset of charred plant remains covering Denmark;
• producing a new and robust high-resolution reconstruction of changes in summer cloud coverage and hydrological conditions based on isotope analysis of individual oak tree rings;
• identifying changes in the organization of Iron Age habitation and patterns of landscape settlement, in combination with household studies.

Arable farming in Viking Age Iceland: archaeobotanical evidence from Lækjargata 10-12, Reykjavík

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In 2015, excavations of a Viking Age settlement at Lækjargata 10-12, Reykjavík, produced the largest assemblage of charred cereal grain known in Iceland. Cereal cultivation has previously been investigated in Iceland mostly based on evidence from palynological studies, landscape surveys, and historical documentary sources, due to the generally low quantities of charred plant macrofossils recovered from archaeological sites. A general focus on the excavation of high-status sites has also led some researchers to conclude that cereal cultivation was practiced only by elites as a status signifier, while the general population relied on imported cereal grain from Scandinavia. Archaeobotanical and archaeological evidence from Lækjargata refutes this: the site is not of demonstrably high status, but it seems likely that the hulled barley from the site was grown and processed locally. Additionally, finds of barley and oats from small farm sites in northern Iceland suggest that barley cultivation was widespread in the settlement period (AD 870-930). However, it is still possible that the Lækjargata grain was imported, and a program of strontium isotope analysis of charred barley from the site aims to determine the exact origin of the grain. This presentation presents the current status of this ongoing project.

North-south patterning of millet agriculture on the Loess Plateau: Late Neolithic adaptations to water stress, NW China

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Water availability and climatic conditions profoundly control agricultural systems in different spatial-temporal conditions. Using new results of archaeobotanical research on the north Loess Plateau and extant macro-botanical data recovered from the east part of the north-south Loess Plateau, we investigated the ancient cropping patterns of different agrarian communities living in the marginal area of the East Asian monsoonal climatic zone. It indicated that the common millet (*Panicum miliaceum*)-based cropping pattern was dominant on the north Loess Plateau during around 3000~1800 cal BC. However, there is a preference of foxtail millet (*Setaria italica*)-based farming combined with a certain amount of rice (*Oryza sativa*) cultivation by the archaeological humans on the southern of the Loess Plateau during the same periods. We infer that the diverse ways of crop management selected by late Neolithic human beings adapting to various water stress that probably underpinned different developmental trajectories of ancient civilizations on the Loess Plateau during mid-late Holocene.

People, Land-Use & Time: Linking Multi-Proxy Palaeoenvironmental & Archaeological Data

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This study has used lake sediments as a means to investigate prehistoric human activity within the catchment of Lough Inchiquin, a large lake located in the Burren, Co. Clare, western Ireland – a landscape known for its rich prehistoric archaeological record. Through the combined use of pollen analysis, chironomid sub-fossil analysis, and organic ($\delta^{15}N$, $\delta^{13}C$ and C:N) and inorganic (Ti, S, Fe, Mn) geochemistry, the human-environment interactions that took place in this landscape have been examined. The results highlight the changing intensity of agricultural land-use through time and the impact that communities had on the landscape and lake system. Interestingly, agricultural practices were shown to be most intensive during the Late Bronze Age, contrary to the current archaeological narrative of the region which suggests a reduction in importance at this time. The palaeolimnology highlights increased lake productivity in the Late Bronze Age which indicates localised and intensive farming. Together, the data suggests a continuation of settlement and farming in the Burren throughout the Bronze Age. In addition, major soil erosion from the Burren uplands has been identified at an early stage in the long history of human-environment interactions in this area.

Can geometric morphometrics reveal the origins of Scotland's island-adapted barley, bere?

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Bere is a landrace (a locally adapted cultivar improved by traditional agricultural practices) of barley that is highly adapted to the environments of the northern and western islands of Scotland. Following a long association with these Scottish islands, bere is today of particular economic and cultural significance to the people of Orkney. Bere, like all cereal landraces, is 'invisible' in the archaeobotanical record, and so the nature of its origins are unknown. Whilst the suggestion has been made that bere is a Viking import to Scotland, its origins may yet lay on mainland Britain or as an indigenous adaption on the Scottish islands. To trace the origins of bere, Geometric Modern Morphometric (GMM) analysis of grains of present-day bere barley was compared to grains of other British and Scandinavian barley landraces. Having established a 'morphometric signature' for bere grains, we then seek out bere in the archaeobotanical assemblages of northern sites dating to Viking and prehistoric periods. This island-adapted landrace of barley, bere, thus serves as an ideal case study to explore the potential of GMM analysis in the macroscopic archaeobotanical record.

SESSION 4 | People & Environments I: Individuals & Contexts

chaired by Felix Riede (Department of Archaeology & Heritage Studies, Aarhus University)

Reacquainting bog bodies with their landscape and environmental contexts

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In Denmark and northern Europe more broadly, many of the well-known bog bodies were discovered and analyzed in the early and mid-20th century. One result of this is that often these archaeologically important bodies have become separated from their landscape and environmental contexts. This paper presents our attempts to place these bodies into their wider context. One story relates to recent research into the wider landscape of the Lindow bodies in the UK. The second story describes an attempt to do the same for the bodies at Bjældskovdal, which also brings to life the lost work of Troels Smith. The wider European contexts for these bodies will also be considered.

How to identify cesspits as latrines? A study of macrofossils and non-pollen palynomorphs in Danish medieval cesspits

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Field archaeologists rely on field observations of construction and fill characteristics to identify cesspits as latrines. When in doubt, the archaeologists turn to the natural sciences for further exploration of the feature fill. Archaeobotanical analysis is a classical method to describe cesspit fill elements, and the content of macrofossils might lead to the distinction between human waste and stable manure. More often the distinction between latrine and stable manure is less clear. So how do we determine cesspits as latrines? A meticulous analysis of non-pollen palynomorphs (NPPs) may hold the solution. A classification of fill composition can be made based on numerical analysis and the frequencies of indicator NPP types.

NPPs are microscopic remnants of a wide range of organisms, potentially indicative of the original feature function. They may be remnants of the original input to the fill (e.g. parasite eggs) or remnants of fill decomposers (e.g. fungal spores). This paper reports non-pollen palynomorph analysis of 18 samples from Danish medieval latrines or possible latrines. A meticulous sampling procedure was used to reassure representativety, and samples were prepared specifically for the highest recovery of non-pollen palynomorphs. This method has not been previously applied on Scandinavian archaeological contexts.

The archaeological potential of anthropogenic soils on Jæren, South-West Norway

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Results from soil profiles sampled during excavations on Jæren will be presented. The sites lie on the Tananger peninsula in the northern part of Jæren. The Tanangerpeninsula is a long settled landscape and as such rich in archaeological remains dating back as far as to the Neolithic. During the course of excavations, soil profiles were sampled for pollen analysis and macro remains. The aim of the botanical analysis of those soil layers was to give insights into the prehistoric and historic farming practice of the area. Up to now very little analytical work on anthropogenic soils in Jæren has been done. The profiles studied here differ considerably with respect to their stratigraphy, but some of the profiles are clearly anthropogenic. Their structure indicates that material to ameliorate the soil quality was brought in. Therefore, the pollen record as such does not allow environmental or ecological interpretations as the material comes from different sources and was mixed while working the soil.
However in connection with the obtained radiocarbon dates it could be shown that there were actually two phases of land use where those soils had been worked. Those two phases are connected with distinct pollen assemblages: whereas the older phase features mainly grass pollen, the younger phase is characterized by high amounts of *Calluna*-pollen. This might be the result of different land use techniques and the question arises whether the younger parts of the soil profiles were the result of some kind of plaggen cultivation.

Plant use at Neolithic Frydenlund, Fyn, Denmark

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Denmark is known amongst others for its high density of prehistoric grave monuments. On the island Fyn, some unique Neolithic grave monuments are found, including the Early Neolithic Funnel Beaker site of Frydenlund, 2 km east from the well-known Neolithic causewayed enclosure at Sarup. Excavations at Frydenlund in 2009-2012 revealed two houses covered by specific burial monuments, barkær structures. Directly to the west of these structures, deep ditches were present, revealing the original presence of tall wooden façades next to the burial monuments. This communication will present the results of the ^{14}C-dating, indicating that the site was in use during a very short period only, as well as the results of the charcoal and botanical macroremains analysis from a selection of contexts at Frydenlund. The aim of the botanical analyses was to get an understanding of the extra-local vegetation, plant use at the site, and site-function. What kind of wood was used for the façades, and can the macroremains analysis provide information about the type of activities that took place at the site? Methodologically, this analysis shows the continuous relevance of established methods.

Fregerslev II at the microscale: Soil micromorphology and XRF analyses of a Viking grave

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Researching grave contexts remain a challenging ground for archaeology due to the complex range of processes associated with the burial, preservation conditions and recovery of organic and inorganic remains. Recent investigations at Fregerslev has provided an excellent opportunity to investigate the microstratigraphy and ephemeral indicators of burial processes. One of the most spectacular status chamber grave of Viking Jutland, Fregerslev II is the grave of an elite horseman buried together with precious goods and likely his horse. Yet, the context of burial, the nature of the grave fill and the preservation conditions of archaeological materials remain unclear in this highly deteriorated grave. This paper presents the results of integrated soil micromorphology and handheld XRF analyses on the grave fill that shed light on the burial environment and postdepositional processes affecting the preservation conditions of the grave.

The Medieval geoarchaeology of lowland rivers: riverine place-names, environments and alluviation over the last Millennium in Central England.

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This paper presents the geoarchaeological results from the '*Flood and Flow'* Project which focussed on the environmental interpretation of riverine place-names in England and Wales. Environmental information contained in place-names has largely been overlooked by archaeologists. In England, nearly 2000 place-names—mostly coined during the early medieval period (c. 500-1100AD)—describe aspects of water behaviour or aspects of riverine landscape that were significant to the local population at the time of name-formation. Among these, a small number explicitly warn of flooding. High-precision scientific proxies and new dating techniques (OSL) now allow us to test this c. 1000-year-old toponymic record against the depositional histories of rivers reconstructed from sediment cores. In this paper, one recurring Old English place-name element '*wæsse*' is investigated, and the results of new sedimentary sequence analysis from three *wæsse* sites demonstrates that the rivers were behaving in a very particular way around the date of the foundation (and thus naming) of these settlements. The high-resolution analysis of the sedimentary record from each of the sample sites has identified very specific depositionary environments associated with climatic fluctuations and changing landuse. The *wæsse* flood chronologies offer new insights into medieval environmental perception and utilisation, which has lessons for today.

SESSION 5 | People & Environments II: Landscapes

chaired by Niels Nørkjær Johannsen (Department of Archaeology & Heritage Studies, Aarhus University)

Twin Peaks in the Early Mesolithic. New results from ancient Lake Duvensee

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The ancient lake Duvensee is one of the most famous archaeological micro-regions for the Mesolithic in Germany. Discovered almost 100 years ago, several excavation campaigns and surveys were conducted and revealed some of the most intriguing features known from the Preboreal and Boreal in Northern Germany.
In this paper we present new results for the site Duvensee WP 13 and its surroundings. Recent geophysical surveys included ERT (Electrical Resistivity Tomography) and GPR (Ground Penetrating Radar) were able to reveal the position and extent of prehistoric islands in the ancient Lake Duvensee. By taking into consideration new palaeoecological, chronological and palaeo-topographical findings we highlight Early Mesolithic economic behaviour and embed it into the former landscape. Finally, we want to provide an outlook on the relevance of vegetable resources in the Mesolithic and highlight chronological as well as functional differences between sites at ancient Lake Duvensee that are based on updated chronological models and re-evaluations of subsistence strategies. Our understanding of the Mesolithic at Duvensee provides a template for the regional sequence.

New advances in archaeological phytolith analysis: a peat deposit at Rue des Boîteux (Brussels)

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Phytolith studies have since long formed an established component of environmental archaeology. However, in recent years a number of methodological innovations have taken place, such as improved protocols for studying phytoliths in micromorphological thin sections, as well as an increase in experimental studies.
This presentation will focus on both, using the case study of a Holocene peat deposit at Rue des Boîteux, located in the centre of Brussels (Belgium). The peat deposit consists of two parts: the natural part of the peat sequence overlain by a thick "Dark Earth". First, an evaluation of phytolith content, preservation, and the phytolith assemblages present is made. A comparison between the natural peat accumulation and the Dark Earth makes it possible to evaluate the environmental impact of human activities on the landscape of the river Senne Valley.
Second, two methodological research questions are addressed. Two different phytolith extraction protocols on the same soil samples are tested and compared. Theoretically, both protocols should yield similar phytolith results, but this may not be the case in practice. Finally, my study intends to investigate the phytolith content of the Dark Earths using the integrated approach combining bulk samples and soil thin sections pioneered by Vrydaghs and Devos.

Assessing vegetation change at the regional scale in western Sjælland: 7000 years of fluctuation in anthropogenic fire, deforestation, grazing and settlement

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Integrating a regional scale reconstruction of palaeovegetation and fire-history based on a high-resolution pollen and charcoal record from lake Tissø, with the spatiotemporal distribution of archaeological sites in the lake's pollen catchment provides a perspective on the development of the cultural landscape.
Influx peaks in micro and macrocharcoal indicating an increase in the intensity of local and regional fire coincide with the spread of sites diagnostic of the Northern TRB in the Early Subboreal. The subsequent development of fire-dependent successional communities demonstrates that the expansion of Neolithic farmers into the interior forests was sustained by extensive shifting cultivation until Middle Neolithic B when regional fire-activity declined, yet the deforestation was gradual.
The spread of open grasslands during a less intense fire regime in Late Neolithic – Bronze Age is synchronous with a contraction of archaeological sites from the interior to more stable settlements closer to the coasts. Resettlement of the interior, associated with deforestation and expansion of arable land began by the Late Iron Age and accelerate thorough the historic period. However, the development of productive open habitats was punctuated by four episodes when forests re-advanced at the expense of grassland (and in two cases, arable land). The demographic and/or techno- economic forces driving deforestation were not monotonic.

Project Wildscape: Reconstructing Hidden Landscapes through a Case Study in the Humberhead Levels

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The Humberhead Levels, located in northeastern England, holds few parallels for its extent of palaeoecological and archaeological work. Today, the landscape appears as a featureless area of flat agricultural land crisscrossed by drainage ditches. Historical maps and the sediments underlying the fields provide a fragmented window into the past; detailing a rich wetland landscape mosaiced by marshes, moorlands, fen, rivers, wet woodlands and mire. The extensive wetland system which traversed this region was subject to diversion and canalisation during 'improvement' works in the 17th century. While there is great evidence for prehistoric human activity throughout the region, the archaeology remains still curiously unclear regarding the nature of anthropogenic activity in the wetlands prior to the area's drainage. This is confounded by a distinct lack of settlements during prehistory.
This paper investigates the relationships between wetland and dryland communities through an improved understanding of the spatial distribution of the archaeology and palaeoecology in the Humberhead Levels. The synthesis of a campaign of sediment coring, palaeoenvironmental reconstructions, and the collation of previous palaeoenvironmental and archaeological records provide an important environmental context in a highly dynamic landscape's ecological evolution. This allows for the study of the movements of the region's inhabitants through time.

European land use at 6000BP: from on-site data to the large-scale view

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The LandCover6K group is concerned with whether prehistoric human impacts on land cover were sufficiently large to have had a major impact on regional climates. Climate model simulations have shown that land use data sets can have large regional impacts on climate in the recent past and may have also done so during prehistory. However, there are major differences between the current available land use models and reconstructions based on pollen analysis. The only way to provide a useful assessment of the potential for land use changes to affect past climate is to input land use models with more realistic land cover and land use changes based on palaeo-vegetation (land cover) and archaeological evidence (land use). We present preliminary results from a recent initiative that is reconstructing land use for the European continent at 6000 BP, using a synthesis of land use data derived from the radiocarbon and environmental archaeological record. We discuss some of the methodological challenges of developing generalised land use categories within a European context, identify regions for which we have good datasets and major gaps in our understanding. We present a pilot study of first order, top-level land use maps for selected regions of Europe.

SESSION 6 & SESSION 7 | Mini-presentations of posters & Poster Session

chaired by Federica Sulas (UrbNet, School of Culture & Society, Aarhus University)

1.

Reynard at Randall – cementum annuli analysis of a red fox from Randall Manor, Kent

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Attitudes towards foxes are diverse; feelings towards the animals ranging from adoration to fear and from respect to hatred. This makes the red fox (*Vulpes vulpes*) a fascinating animal to study and it is the aim of my PhD to shed light on human-fox relationships over the past 10,000 years. Focussing on England, my interdisciplinary study combines zooarchaeological remains with historical sources and depictions to help understand changing attitudes towards the fox.

This poster focuses attention on a fox skull with highly worn teeth recovered from Randall Manor, Kent. Similar zooarchaeological finds from Scandinavia (Degerbøl 1933, Jonsson 1988) have been interpreted as representing individuals held in captivity: wild foxes barely reach an age of four years, while in captivity they can reach ages up to thirteen years. If this individual proves to be an older, captive animal, it would add diversity to the status of foxes in medieval England. Unfortunately, because foxes are omnivorous and have a highly diverse diet, tooth wear is not a reliable method for ageing. To overcome this problem, the specimen was subjected to cementum annuli analysis, a technique rarely used by zooarchaeologists. Here, the methodology is described and the results of the study are presented.

2.

Waves of colonization and the Sea of Moyle: Linking population history, resilience and landscape change of island communities. A new AHRC Project Starting October 2018

Tony Brown[1,2], Thierry Fonville[2], Ben Pears[2], Martin Van Hardenbroek[3], Helen Mackay[3], Andy Henderson[3], Inger Alsos[1], Patrick Gleeson[4], Gill Plunkett[4]

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Small islands present environmental archaeologists with the opportunity to study the sustainability and resilience of complex socioecological systems over time. This project is investigating the changing landscapes, environment and population of 6 small islands around the Sea of Moyle over the last three millennia. Today area is seen as a remote border zone between Scotland and Ireland. In the past this was not the case, and the Sea of Moyle, was at times a coherent and central geographic region crossed by sea voyagers and linked by culture and kinship. The islands (Rathlin, Tory, Arran, Islay, Gigha & Colonsay) all saw the establishment of early Christian communities, were within the Dalriada over-Kingdom in the 6th to early 7thC, were subject to early Viking Raids and then formed part of the Scandinavian Suðreyjar, or "Southern Isles". The later Medieval and post Medieval history of the islands is more complex and divergent but all six islands saw major, if not remarkable changes in population over the last 300 years. The project will be the first to explicitly compare archaeological proxies from islands in the same region with archaeological and historical data using new techniques (sedaDNA and biomarkers) in a controlled archaeological setting.

3.

Approaching Dynna: the burial mound as an assemblage

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Burial mounds are more than just a capping for the burial, or a store of palaeo-environmental data. They are also an integral part of the social process of death and burial, and the point of engagement for later actions involving the memory of the burial, and the pasts it represents. These approaches will be illustrated by a case study approach, focused on later Iron Age Norway. Sitting on a prominent ridge over a fertile valley in southern Norway, the Dynna burial mounds are little researched. A late Viking Age runic stone once stood on one of the two mounds, but which one, and why was it placed there? The mounds were approached from geoarchaeological and theoretical perspectives to better understand their temporal lives from the first phases of construction, to today. Preliminary results from coring and micromorphology allow us to relate the mound to the contemporary landscapes and assemblages the mounds have occupied.

4.

Oyster shell deposits: a good place to establish lead environmental backgrounds and monitor ancient anthropogenic contaminations

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Ostrea edulis is the endemic European oyster, present in most of archaeological shell deposits. The aim of this study was to test if the *O. edulis* shell composition reflects the lead (Pb) content of the surrounding surface sediments, and if it could be used to monitor modern and ancient lead contaminations. Pb/Ca ratios were measured with a LA-ICP-MS in shells of modern and archaeological samples. Modern samples were collected alive in three sites along the West coast of France (Brittany and Vendée), where the lead content of the surface sediments was measured (110, 45 and 20 ppm d.w. respectively). Those sites are legally considered as moderately and poorly contaminated (Cariou et al. 2017). Archeological samples were collected in two medieval shell middens near "modern sites".
Pb/Ca concentrations recorded by modern oysters are reproducible within a site (ranging from 0.08 to 0.44 µmol/mol), and differences between sites are significant. Mean shell Pb/Ca values and surface sediment Pb content show a strong positive linear relationship. Medieval oysters show lower Pb/Ca values (0.03-0.05 µmol/mol), probably reflecting the environmental background level of Pb in the surrounding surface sediments (estimated around 10 ppm d.w.). *O. edulis* shells seem to be a very sensitive tool to monitor and quantify modern and ancient lead contaminations.

Reference
Cariou E., Guivel C., La C., Lenta L., Elliot M. 2017. Lead accumulation in oyster shells, a potential tool for environmental monitoring. *Marine Pollution Bulletin* 125: 19-29.

5.

Using Zooarchaeology to Explore Early Medieval (8th- to 10th-century) Economy and Environment in Antwerp, Belgium: Evidence from the Burcht and Gorterstraat Sites

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The development of early medieval towns in northern Europe has interested both archaeologists and historians since the days of Henri Pirenne in the early 20th century. Recent excavations at the Burcht sites and the Gorterstraat site have shed new light on the economy and environments of early medieval Antwerp. Multiproxy environmental data have recently been published for the Burcht sites (Crabtree et al. 2017), dating to the 8th-10th-centuries and located inside the early medieval wall. This poster will compare these data to the animal bone information from the 10th-century and later Gorterstraat site that is located just outside the early medieval wall. Differences between the two sites, including differences in hunting and fish consumption, can shed light on changes in Antwerp's economy and environment between the 8th and the 10th centuries CE.

Reference
Crabtree P., Reilly E., Wouters B., Devos Y., Bellens T., Schryvers A. 2017. Environmental Evidence from Early Urban Antwerp: New Data from Archaeology, Micromorphology, Macrofauna and Insect Remains. *Quaternary International* 460, 107-123.

6.

Agricultural practices at Middle Neolithic Oldenburg LA77, northern Germany

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Tucked amongst numerous small settlements and megalithic tombs of the Oldenburger Graben region in northern Germany, the site of Oldenburg LA77 was occupied towards the end of fourth/beginning of the third mill BC by a community that practiced crop and animal husbandry, plant and shell gathering and hunting, and made tools and pottery. The settlement sat on a dune island, in a lagoon that was cut off from the Baltic Sea around 3000 BC and was subsequently fed by a nearby river and a number of smaller streams, thanks to which the saltwater environment turned brackish. Not much arable land would have been available in such a landscape, which nowadays is one of the most fertile areas in Schleswig-Holstein. Stable isotopic analysis for a number of Neolithic sites in Europe revealed that crop fields were manured. Functional ecological analysis of arable weeds accompanying crops suggest that other labour-intensive methods (tilling, weeding) were also employed, in an effort to increase and secure long-term yields. We measured the carbon and nitrogen isotopic content in emmer and barley grains from Oldenburg LA77. The nitrogen isotope values display high variance and can be understood as reflecting different levels, or absence of manuring. The poster presents these results and looks into the ecology of arable weeds.

7.

Archaeological Palaeoenvironmental Archiving - Thinking outside of the box

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As the theme of this years' conference asserts, we are indeed on the threshold of another 'scientific revolution' in archaeology. The affordable availability of biomolecular applications and uses of ancient DNA are providing insights into some of the definitive questions and arguments which have permeated archaeological research since its inception as an academic discipline. Consequently, archaeo-materials - which were once the preserve of 'traditional' forms of analyses such as taxonomic classification and morphometric analysis - are now frequently being sub-sampled for bioarchaeological analyses.
Future research is therefore likely to be shaped by archived materials in museum stores which can be re-analysed and re-interpreted. But what is the current state of our archives and our archiving practices? Have our forebears in the discipline collected and retained enough material in past investigations to allow us to commit to high quality research now and in the future? Have these materials being stored appropriately to prevent degradation?
The doctoral research I am conducting with the University of Reading (UK) and Historic England is asking challenging questions of England's archives and museums and examining how other countries, most notable Denmark, have historically dealt with archaeological palaeoenvironmental materials in archive.

8.

Palaeoenvironmental proxies from palaeochannel sediments adjacent to a long-lived Mesolithic sire in the environs of Stonehenge World Heritage site

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Blick Mead is located on the fringes of the Stonehenge World Heritage site at Amesbury, UK. It is a Mesolithic site with on-site activity over approximately 4000 years. Excavations have taken place since 2014 of a low river terrace preserved under a Medieval lynchet and into a palaeochannel adjacent to the site. The archaeological excavations have produced exotic artifacts, very high numbers of lithics and has demonstrated an extraordinary level of

preservation, including macrofaunal animal tracks alongside bones of wild animals and fish. A series of boreholes across the site at two spatial scales reveal intra-site stratigraphy. Palaeoenvironmental and geoarchaeological investigations are on-going and include pollen and spore analysis, which has revealed that the site existed in a large gap in the species rich broad-leafed forest alongside spore evidence indicating the presence and possible grazing of large herbivores. Sediment aDNA, loss on Ignition, magnetic susceptibility, particle size analysis, XRF and micrcomorphology is being undertaken from waterlogged but clastic rich organic sediments contemporaneous with site occupation. The use of multiproxy analysis on this site of national importance will reveal in greater detail the relationship between humans, animals and the landscape prior to its famous Neolithic and Bronze age inhabitation.

9.

Optimization of efficient ancient DNA extraction from lake sediment

Peter D. Heintzman[1], Dilli P. Rijal[1,2], Antony G. Brown[1,3], Iva Pitelkova[1], Francisco Javier Ancin-Murguzur[1,2], Charlotte L. Clarke[3], Mary E. Edwards[3], Inger Greve Alsos[1]

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Insights derived from ancient DNA are revolutionizing our knowledge of biotic dispersals and population histories. Ancient DNA from lake sediments (*sed*aDNA) has been shown to provide finer temporal resolution than the hard tissue record, and so has great potential to refine insights into the speed and dynamics of biotic changes, such as the appearance of a particular agricultural tradition or the immigration of key taxa to a region. However, unlike the mature methodologies for hard tissues, the extraction of *sed*aDNA can be problematic, due to the complex and variable geo- and biochemical composition of sediments, which currently constrain the type of sediments amenable to analysis. In this study, we compare *sed*aDNA extraction protocols across a variety of sediment types. Although protocol chemistry impacts metabarcoding-inferred plant taxonomic diversity, sediment types with high organic content often yielded near-unusable results regardless of the protocol used. However, slight modification of an existing protocol greatly improved the results for some of these problematic sediment types. We also explored a modification for DNA extraction from carbonate-rich sediments, which again yielded superior results. Together with other *sed*aDNA methodologies currently in development, this work brings us closer to unlocking the full potential of this underexploited ancient DNA source.

10.

Neolithic plant economy in the SW Baltic area – a long-term perspective

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Continuous collective effort in retrieving and analysing archaeobotanical material from the Neolithic sites in SW Baltic region has resulted in a large collection of the remains and the data on plant production and use during the Neolithic. Combined with the high-resolution absolute chronology, the qualitative and quantitative archaeobotanical data now offer a comprehensive picture of the introduction and establishment of crop production. Further, the results allow tracking of trends and changes in the choice of cultivated crops and gathered plants through time. The arable weed record gives insight into the conditions in which crops grew and helps identify specific agricultural strategies.

11.

Detecting agricultural changes in the Middle Ages using a pollen modelling approach

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Agricultural developments in the early Middle Ages changed the landscape significantly. The change from scattered farmsteads in Anglo-Saxon times to the open-field system and the introduction of the three-field rotation system

marked large socio-economic changes. This poster addresses the question whether these changes to the landscape are visible in pollen records, and at which pollen counts these changes become detectable in the pollen record. What do these differences in the landscape mean for the interpretation of pollen diagrams?
Several different landscapes are created (scattered fields, open-field system), and a pollen record is simulated for each landscape using the Prentice-Sugita dispersal and deposition model. The modelling is done in LandPolFlow, a software package part of the Multiple Scenario Approach (Bunting and Middleton 2009). The squared chord distance (SCD) between simulations is calculated to determine to which degree these landscapes are palynologically different. Data from the Domesday records (total area of arable land, meadows, and woodland) for the Humberhead Levels, Yorkshire, UK, is used as a starting point for modelling input.
Preliminary results show that, depending on the sampling location, these landscapes produce significantly different pollen signals. These results show that changes in agricultural practices can be detected in pollen records.

Reference
Bunting M.J., Middleton R. 2009. Equifinality and uncertainty in the interpretation of pollen data: the Multiple Scenario Approach to reconstruction of past vegetation mosaics. *The Holocene* 19: 799-803.

12.

In search for the Bølling-Oscillation – new palynological data on old questions at lake Bølling, Denmark

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In 1942 Johs. Iversen extended the common classification of Lateglacial biostratigraphy based on a pollen analysis from Lake Bølling, Denmark. His assumptions concerning the Bølling-Oscillation were based on sedimentological features and high birch pollen values in two pollen samples before the beginning of the Allerød. In order to further define the knowledge on Bølling-Oscillation Hartmut Usinger investigated the *locus classicus* in 1982. The method of pollen-size-frequency distribution was applied on birch pollen but never published and the results got lost over time. Therefore the method as described by Usinger (1975, 1978, 1981c) is performed on the dataset again. In order to process the inheritance of Hartmut Usinger it is one objective to make the data accessible and to discuss it against the background of the previous work by Iversen.
The Focus is set on the distinction of birch pollen in order to shed light on the question of the migration of tree birches especially before the Allerød. The results show that the dataset can immensely refine Iversens pollen zones. Furthermore, the record reveals that Iversens assumption concerning the existence of a climatic oscillation prior to the Allerød can be confirmed at the *locus classicus*.

13.

Environmental studies in urban archaeology

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The two fundamental questions of any archaeological investigation are *what is it* and *how old is it*. While it is usually possible to answer these questions through typologies, a better understanding can often be achieved through the inclusion of methods from the archaeological sciences. The most widely used methods are currently the ones related to dating, as they are both more well-known and directly related to the two fundamental questions.
The rapid development of new methods in the archaeological sciences has meant, that there are now a myriad of possibilities when conducting excavations. Given the limited funds for archaeological sciences in many excavations, most museums choose the known analyses for answering the fundamental questions, rather than attempt new methods. Therefore, the better-funded research excavations often become the beacons of innovation, as they can

test out new methods – both in the field and in the laboratory – without jeopardising the basic questions of the investigation.
This poster will attempt to elucidate the history, process, and consequences of including archaeological sciences in excavation practices. The talk is based on the research conducted as a part of my PhD-project *Interdisciplinary Methods in Town Archaeology*.

14.

Discarded shells on land? A zooarchaeological study of the Hjarnø Sund mollusc assemblage

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Archaeological underwater investigations from 2010 onwards have targeted the submerged remains of a Mesolithic shell midden on the small island of Hjarnø in Horsens fjord (eastern Jutland, Denmark). This work, made necessary by the marine erosion that is affecting the deposits, has resulted in the discovery of discarded shells dating back to as early as the ~5500-5300 cal. BC, around the transition from the Kongemose to the Ertebølle cultures (Larsen et al. 2018). The shell midden was sampled for detailed study in 2015 in 1m^2 grids, covering a total of 10m^2. The faunal assemblage was subsequently brought back to Moesgaard Museum, where this study was conducted. The assemblage consists of around 18000 identifiable shells (NISP), attributed to at least 3000 individual specimens (MNI). Excavations detected two discernible strata, which were most evident in the two farthest sampled squares (squares 1 and 9), consisting of around 10.000 identifiable shells (NISP). While artefacts were found among the shells, a zooarchaeological analysis was undertaken to determine whether the accumulation of marine molluscs was the result of human activity, or if the shell matrix was due to natural formation processes. Given the lack of epizootic encrustations, the presence of land snails, the assemblage composition, and average specimen size, our study attests that the shell assemblage from Hjarnø was deposited on land, following consumption by Mesolithic humans.

Reference
Larsen J.S., Philippsen B., Skriver C., Astrup P.M., Borup P., Mannino M.A. 2018. From oysters to cockles at Hjarnø Sund: Environmental and subsistence changes at a Danish Mesolithic site. *Radiocarbon* 60: 1507-1519.

15.

An estuarine tide-scape of production: terrestrial laser scanning (TLS) of fixed fishing structures and a tidal mill in the Léguer Estuary, Brittany, France

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Inter-tidal archaeology is under threat from sea level rise and natural erosion, much of it before it has been recorded. Terrestrial Laser Scanning (TLS) provides the means to combine rapid, highly accurate, surveys of excavations and structures within landscape scale context, which is particularly valuable in environments that are difficult to monitor, such as macro-tidal estuaries. In this paper we use TLS to record the excavation of multiple buried tidal fixed fishing structures and a feature postulated to be a tidal mill, within the Léguer Estuary around the monastic site at Le Yaudet. Our data shows that all the early Medieval (6th-8th century) structures lie within, and indeed exploit different parts of, the tidal frame and can be seen as part of a comprehensive resource exploitation system. Together they illustrate, contextualize, and in some aspects can quantify, an estuarine landscape of production associated with comprehensive monastic control of environmental resources. TLS can offer a step-change in the area of recording and understanding fixed fishing and allied structures by; in-situ recording during excavation, landscape analysis and functional modelling.

16.

A late Mesolithic and early Neolithic isotopic baseline for southern Scandinavia

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The investigation of the Mesolithic-Neolithic transition (c. 4000 BC) in southern Scandinavia has advanced considerably since 1851, when the Mejlgård shell midden was excavated by the so-called first Kitchen Midden Commission. The Danish area offers tremendous potential to further this line of research, given its impressive archaeological record for the transition from hunting and gathering to agro-pastoralism. While several human remains from the late Mesolithic Ertebølle (5.400-4.000 BC) and early Neolithic Funnel Beaker (4.000-2.800 BC) cultures have undergone isotope analyses to investigate the radical change in the diet identified by Henrik Tauber in the early 1980s, the number of analysed animal bones is comparably low. As a result, our understanding of the specific contribution of different animal foodstuffs to human diets during the Mesolithic-Neolithic transition remains low. This paper discusses how we may improve the isotopic baseline to enable a better interpretation of the Ertebølle and Funnel Beaker diets using carbon and nitrogen isotope analysis on bone collagen. The work is ongoing, but so far 121 animal bones have been analysed along with 17 human remains. The sampling has targeted preferentially animal taxa for which little data are available (e.g. birds and cetaceans), but also seeks to improve the distribution of isotope values across present-day Denmark to account for regional or topographical variability. The improved isotope baseline produced by our project, will enable us to apply Bayesian mixing models for a more detailed interpretation of the carbon and nitrogen isotope record of the Ertebølle and Funnel Beaker cultures. This approach is aimed at reaching a better understanding of the dietary change that occurred at the Mesolithic-Neolithic transition and, specifically, to investigate the reliance on aquatic resources by early Neolithic people in southern Scandinavia.

Funding
This work is part of the Ph.D. research by R.M., which has been funded by the Aarhus University Research Foundation through a grant awarded to M.A.M. for the project (n. 21276) titled *Danish and European Diets in Time*.

17.

Plant processing in Mesolithic Ireland

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Excavations in Ireland have revealed the well-preserved remains of a Late Mesolithic lakeside platform, with evidence for several phases of use and abandonment. Derragh Island is located at the edge of Lough Kinale in central Ireland. The site contained habitation deposits and features, knapping debris and peat sediments. Exceptionally good waterlogged preservation was encountered. A wide variety of environmental analyses was undertaken, several of which have just been published by the Irish Quaternary Association (IQUA). Analyses included plant macro-remains, animal bone, wood charcoal, pollen, insects, peat stratigraphy, geomorphology and sediments.
This poster will focus on plant macro-remains (non-wood) analysed by the author. A wide range of plant species was recorded, including hazelnut shell, yellow-water lily seeds and lesser celandine tubers. A very large deposit of water-lily seeds within a hollow may reflect processing of these seeds for consumption – perhaps the seeds were being fermented before being dried, dehusked, winnowed, parched, ground and consumed. This poster will explore the evidence from Derragh in the wider context of plant processing from Mesolithic Ireland and beyond.

18.

From onboard to the kitchen: 'the sea' and colonial foodways in Quebec City (Canada)

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The Atlantic Ocean had a pre-eminent role in the development of colonial North America. The sea mitigated the relationships between empires and their colonies but also marked a transition from the known and familiar to a wild land full of promises. Its influence reached inland communities through an intricate network of waterways which remained their main means of establishing and maintaining bonds between distant people and places until the end of the 19th century. Despite the central political, economic and social role of the sea little is known about how it might have contributed to forge inland communities' daily life. This paper explores how the experiences of the sea have impacted upon the perception of colonial landscapes and the dietary habits in Quebec City between the 16th and 19th centuries.

19.

Investigation of cereal remains at the defensive city site of Shichengzi (~40 BC-AD 75) on the Silk Road, Xinjiang, NW China

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The Shichengzi site is a remnant of an important defensive city of the Han Dynasties along the Silk Road in northern Xinjiang, China that dates to ~40 BC-AD 75. New archaeobotanical data recovered from the site was evaluated to gain a better understanding of the subsistence strategies and living conditions of that early fortress in the Western Regions of China. In the present study, by using charred crops, we investigated the ancient cropping patterns of human communities living in the Shichengzi site. In all, four types of cereals were identified: *Hordeum vulgare* var. *coeleste*, *Triticum aestivum*, *Panicum miliaceum*, and *Setaria italica*. It indicated that naked barley and bread wheat were dominant in the crop structure. All of the archaeobotanical remains leave us essential clues of the vegetable diet of the Han people who settled in the city on the northern slopes of the Tianshan Mountains 2,000 years before the present time.

20.

The Archaeobotany of Medieval Barda, Azerbaijan

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'The Landscape of Medieval Bərdə, Azerbaijan 6th - 13th Centuries AD' project is a pioneering environmental archaeological research initiative aiming to chart the history of the medieval Caucasian regional capital of Bərdə, Azerbaijan though the study of archaeobotanical material. In studies of medieval Azerbaijan, traditional approaches to archaeological recording are employed, focusing on artefacts and structures, with no environmental sampling occurring. This has resulted in a lack of archaeobotanical material for analysis, and consequently no research has been conducted in the field of archaeobotany. This represents a major knowledge gap in Transcaucasian medieval archaeology and its study is a new frontier for environmental archaeologists. This project will bring scientific approach, pioneering the use of modern environmental techniques, previously undeveloped in medieval archaeology in Azerbaijan, and apply them to Bərdə to understand the social, agricultural and economic practices of the region in this period. This project will generate new archaeobotanical data through analysis of plant remains from a current fieldwork project, The Archaeological Exploration of Bərdə (AEB), based at the Faculty of Oriental Studies, University of Oxford. This research will draw from and feed into the larger AEB project, revealing new insights into agriculture, society and urban rural interactions in the region.

21.

Multi-scalar geoarchaeology and Viking landscapes: A bottom-up approach to Borgring

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Remote sensing and aerial photography are now routinely applied for mapping cultural landscapes, and geophysical and micro-archaeological methods have proven useful to reconstruct landscape evolution and site stratigraphies. However, researching past human environments remain challenging due to modern disturbances, multi-period occupation and the difficulties of working simultaneously on a site and its landscapes. This is particularly the case of fortified settlements: physically separated yet highly interconnected with their surroundings. Drawing from ongoing research, this paper takes a bottom-up approach and explores the application of multi-scalar geoarchaeological methods to refine our understanding of Borgring Fortress. Here, the micromorphological study of buried soils provides us with new, important insights into the long-term history of the site. New evidence points to slow soil accumulation following the fire that destroyed the rampart, and the presence of animal grazing, and human settlement. These new records are important as they suggest that the area continued to be occupied after the fire, but under different land use strategies.

22.

Method Development in Urban Geoarchaeology: the High-definition Study of Viking-age Ribe, Denmark

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The early 8th to mid-9th century town of Ribe is the oldest of the four Scandinavian towns dating to the Late Iron and Viking Age, the others being Birka (Sweden), Hedeby (Germany), and Kaupang (Norway). New excavations were conducted in Ribe in 2017-2018 with the aim to study the settlement layers in greater detail than before. In this respect, Ribe offers an excellent opportunity for both the examination of this early town as well as for method development, since the stratigraphy is highly detailed and the preservation conditions are excellent taking into account the region's predominantly sandy soils.
This poster focuses on the methodology of analysing indoor spaces, more specifically the floor layers of houses. In addition to micromorphology blocks, geochemistry samples have been collected on 50 x 50 cm and 25 x 25 cm grids to evaluate how this difference in resolution affects the interpretative potential of the results. Other questions are how new, fast, and cheaper methods such as vis-NIR and handheld XRF can be applied to create larger amounts of data, and include statistical modelling of data. ICPMS is also included. At a later stage the geoarchaeological results will be combined with microrefuse, archaeobotanical (incl. phytolith), entomological, lipid, as well as DNA data.

23.

The Isotopic Analysis of Animal Individuals

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In this presentation, I discuss the analysis of oxygen and strontium isotope ratios from sites in the central South Caucasus (Georgia) dating to the Bronze Age (ca. 3500-1150). What makes this work innovative is its attention to the multiple scales of analysis demanded by these data. Treating animals as individuals, rather than as members of a population, expands the utility of this methodological technique and makes possible new questions about human-animal relationships. On the other hand, the temporal breadth of most archaeological faunal sampling strategies makes a diachronic approach productive. Approaching the subject of isotopic analysis at the individual level requires a prediction of variability, rather than identification of patterning or clustering. Recent developments in the chemical analysis of human remains suggest an alternative mode of interpretation of the quantitative results of faunal isotopic analysis. Most importantly, this perspective provides a solution to the perennial problem of sample size, which has been a particular challenge for zooarchaeology.

SESSION 8 | Advances in Archaeological Science

chaired by Luise Ørsted Brandt (UrbNet, School of Culture & Society, Aarhus University)

Ancient DNA reveal Holocene environmental change with and without human impact

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In the project ECOGEN, we develop high taxonomic resolution ancient environmental DNA methods in order to evaluate how drivers of change (human, climate, and biotic) affect species persistence and ecosystem tipping points in arctic-alpine biomes. I will start by summarizing three methodological studies that have implications for how to sample and interpret aDNA data. First, a study where we compared lake sediment DNA with historical vegetation map and pollen records which show that there is no confounding factors due to leaching of modern DNA into older layers or DNA originating from long-distant pollen. Second, a comparison of lake sediment DNA and contemporary vegetation surveys show that DNA mainly represents the vegetation growing within the lake or a few meters from the lakeshore. Third, a comparison of DNA from soil and arctic tundra vegetation shows that the DNA mainly represents plants growing within a meter of the DNA-sampling point. I will then give examples of how we use this knowledge to infer aDNA records from lake sediments and archeological sites in northernmost Norway.

Using sedaDNA and lipid biomarkers alongside palaeoenvironmental proxies for understanding wetland and lakeside archaeological site

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Wetland sites, including settlements on lake shores and artificial islands, often provide a wealth of well-preserved archaeological material, but are generally difficult and expensive to excavate. An alternative, or complimentary approach, can be the retrieval archaeological data from lake sediments, which can contain a continuous record of the archaeological site, the lake and its surrounding catchment. Here we present data from a study of crannogs (artificial island settlement) and an Iron Age lakeshore village where sedaDNA and faecal steroids were analysed from proximal sediment cores. Both sedaDNA and steroids provides direct and detailed information about the plants and mammals that lived, died, or were kept on the sites in different periods of site use. This information is compared with traditional proxies that allow us to differentiate between (i) changes that happened regionally in the lake catchment (ii) changes that happened in the lake ecosystem and (iii) changes that occurred very locally at the sites (based on pollen and spores, invertebrates, sterols, PAHs, and sedaDNA). Our sedaDNA and steroid results complement data from both archaeological excavation and traditional palaeenvironmental proxies to provide a more detailed and robust record of the site history, human activities and environmental impacts on lake ecosystems.

Ancient DNA reveals vegetation history near the archeological site in Varanger, northern Norway

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Mortensnes (Ceavccageađge) is one of the well represented areas in northern Norway in terms of archaeological explorations. It is also close to the eastern colonization corridor of Northern Norway, and is expected to provide a signal of early human interaction with vegetation in the past. Using sedimentary ancient DNA from Nordvivatnet at Mortensnes, we reconstructed temporal changes in the plant species composition of vegetation in this area for the first time. We also analyzed the sediments for loss on ignition (LOI), and other non-biological proxies. The sediment chronology covers the entire Holocene and part of the late Pleistocene. We identified nearly 40% and 45% of the taxa to species and genus level respectively. Our result captures the species poor Pleistocene-Holocene transition and the Younger Dryas, which is also marked by the appearance of *Dryas*. However, the total plant species richness increases rapidly during the Holocene, especially with increasing LOI, indicating a positive correlation between diversity and productivity. Presence of nitrogen demanding species such as *Anthriscus sylvestris*, *Chamerion angustifolium*, and *Filipendula ulmaria* indicate anthropogenic disturbances in the vicinity of the lake as early as the first quarter of the Holocene. Linkages in time between these compositional changes in vegetation and archeological events will be made in order to explore possible interactions between humans and vegetation development.

Note: This study is part of the ECOGEN project. ECOGEN aims to reconstruct environmental changes at sites with different levels of human impact in northern Norway and the Alps.

"Palaeoshellomics": biomolecular identification of prehistoric pearl shell ornaments

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Shell ornaments are one of the oldest and most widespread symbolic objects in prehistory. The selection of certain molluscan species as raw material reflects cultural and social aspects behind people's choices, for example perceived "prestige" (often linked to the "exotic" nature of the shells), but also the persistence of traditional crafts. However, thorough study of tiny shell ornaments (and their identification) is complicated - the samples are often very small and microdiagnostics features are usually obliterated due to the manufacture process and/or degradation. Here we exploit advances in archaeological biogeochemistry and develop a new application of paleoproteomics ("palaeoshellomics") in order to investigate archaeological shell ornaments at the molecular level. Our study on tiny pearl-like ornaments from European prehistoric sites, dating from the Late Mesolithic to the Early Bronze Age, that also includes a set of "double-buttons" from the Danish Ertebølle shell midden at Havnø, reveals the consistent exploitation of locally-sourced freshwater shells, widely used to manufacture ornaments and seen as prized materials that was locally available. Our findings suggest that local riverine environments held an important place in the minds of prehistoric people, also for those groups mainly focused on exploiting marine resources.

Ancient Shell DNA: A New Proxy for Environmental Archeology Research

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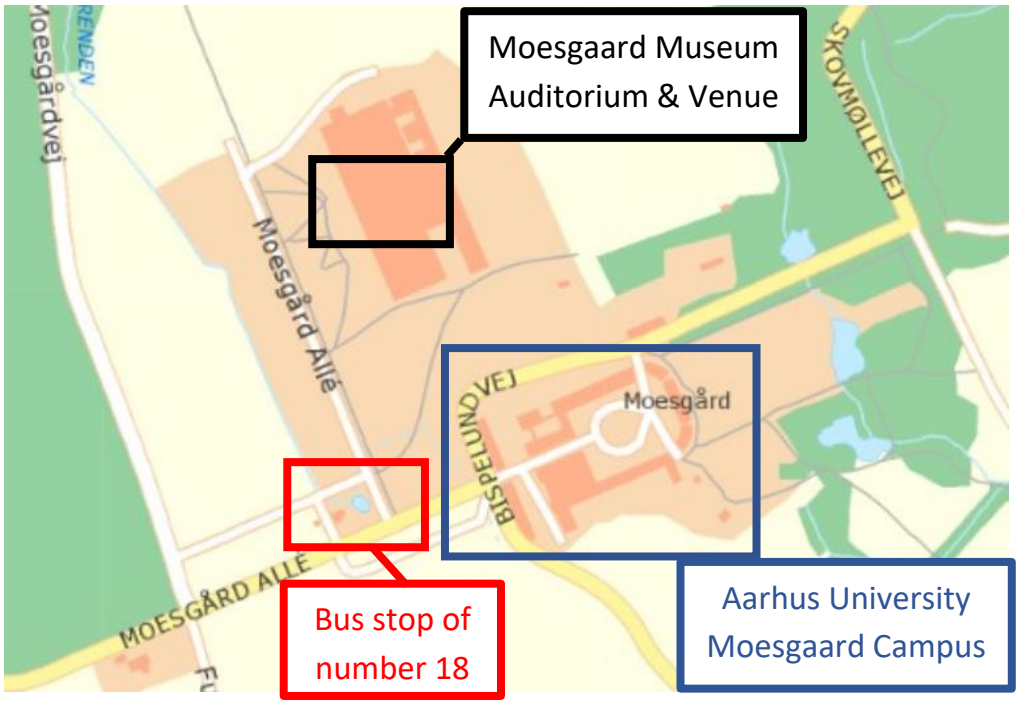
Mollusc shells are remarkable archives of past human-environment interactions. Cultural chronologies, diets, patterns of resource exploitation and mobility can be reconstructed from shells preserved in the archaeological record. Environmental conditions, mollusc evolution and life history traits can be investigated from the structure and biogeochemical composition of the shells. We have recently demonstrated that DNA also can be retrieved from ancient marine mollusc shells, revealing them as metagenomic archives of the past. Using biomolecular methods tailored to the degraded nature of ancient DNA in combination with shotgun high-throughput DNA sequencing, we showed that DNA recovery from marine mollusc shells depends on their microstructure, macroscopic preservation and disease state. We also reported the oldest mollusc DNA sequences to date, yielded by a 7,000-year-old blue mussel from Danish shell middens. We have now broadened the survey of DNA content and preservation in carbonate shells to freshwater, terrestrial, and other marine molluscs, including endangered and invasive species. This allowed us to better delineate conditions optimising the retrieval of authentic ancient DNA from mollusc shells, and the resolution of taxonomical reconstructions. Considering the large reservoir that carbonate shells represent, our work opens promising avenues for future multi-proxy and multi-disciplinary research in environmental and biomolecular archaeology.

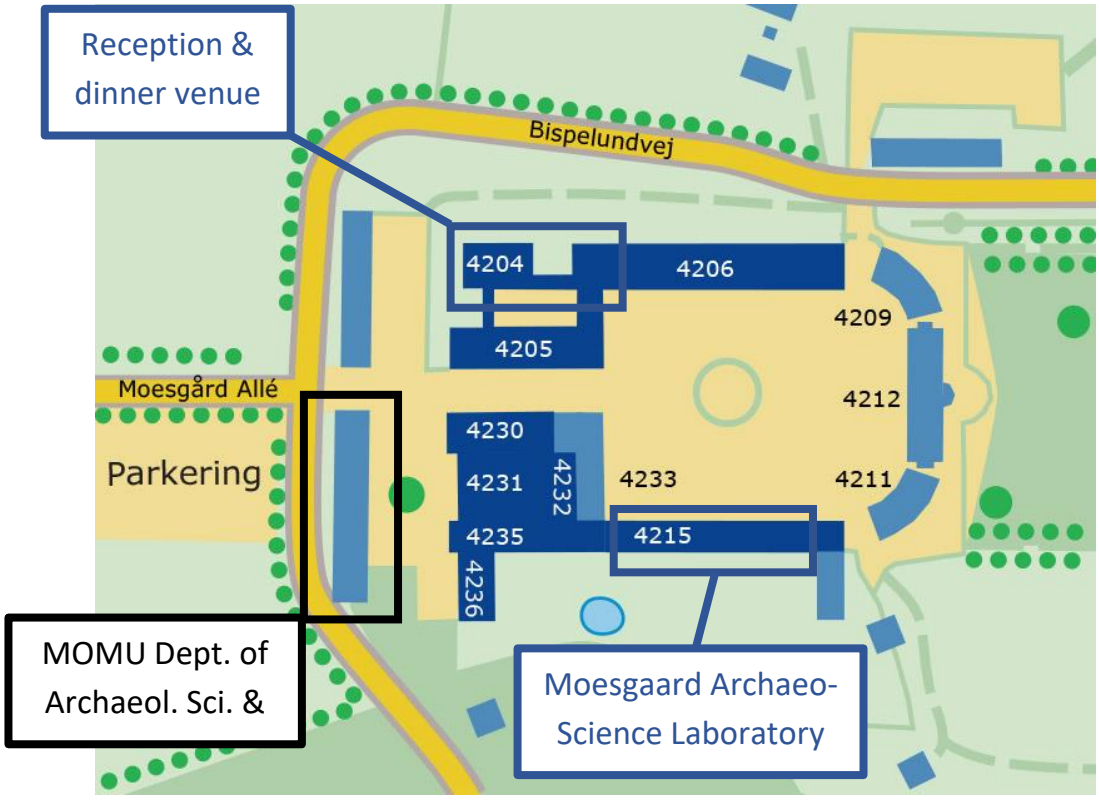
Conference Venues

[the conference venues can be reached by taking bus number 18 in the direction of Moesgaard Museum]

Moesgaard Museum (MOMU) & Surroundings



Aarhus University Moesgaard Campus



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