8

TRABALHOS DO LARC 8

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FISHING THROUGH TIME

Archaeoichthyology, Biodiversity, Ecology and Human Impact on Aquatic Environments

28th September - 3rd October 2015
Lisbon

18th Fish Remains Working Group
International Council for Archaeozoology

LISBOA 2015

PATRIMÓNIO CULTURAL
Direção-Geral do Património Cultural

LARC Laboratório de Arqueociências

InBIO

CIBIO Centro de Investigação em Biodiversidade e Recursos Genéticos

LARC Laboratório de Arqueociências

PROGRAM AND ABSTRACTS OF THE 18TH INTERNATIONAL COUNCIL FOR ARCHAEOZOOLOGY

FISH REMAINS WORKING GROUP

ICAZ - FRWG

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ABSTRACT

In this volume of *Trabalhos do LARC* we present the Program and Abstracts of the 18th biennial meeting of the International Council for Archaeozoology - Fish Remains Working Group (ICAZ-FRWG), hosted by the Directorate-General for Cultural Heritage - Archaeosciences Laboratory (DGPC - LARC) and the Research Centre in Biodiversity and Genetic Resources – Environmental Archaeology Research Group (CIBIO - EnvArch).

The meeting is aimed primarily for archaeozoologists interested in the systematic study of fish bones retrieved from archaeological sites around the world, and also to archaeologists, ichthyologists, historians, ethnographers, and fishery biologists. To this end the conference is structured to encompass a multiplicity of approaches to the study of fish remains and their contribution to our understanding of how fishing, fish trade, fish consumption, biodiversity, ecology and human impact on aquatic environments have changed through time.

Trabalhos do LARC n.º 8
Lisboa, 2015

Cover: PENASCOSA 5 (Upper Paleolithic), Prehistoric Rock Art Sites of the Côa Valley (Portugal). Drawing used by kind permission of António Martinho Baptista (Fundação Côa Parque)

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11:10	Coffee break					
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11:30		Session 5. Morphometry and osteometry				
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12:10		Session 6. Fish as palaeoclimatic and palaeoenvironmental proxies – Isotopic data				
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DETAILED SCHEDULE FOR CONFERENCE DAYS 28, 29 AND 30 SEPTEMBER

18TH ICAZ - FRWG

FISHING THROUGH TIME

Archaeoichthyology, Biodiversity, Ecology and Human Impact on Aquatic Environments

MONDAY 28

8:45 – 9:30 – REGISTRATION
9:35 – 10:09 – OPENING REMARKS:

Sónia Gabriel Archaeosciences Laboratory (LARC)
Luís Aires-Barros President of the Lisbon Geographic Society (SGL)
Ana Cristina Martins Lisbon Geographic Society (SGL), President of the Archaeological division
Nuno Vassalo e Silva Director of General Directorate for Cultural Heritage (DGPC)
Ana Cristina Araújo Coordinator of the Archaeosciences Laboratory (LARC)
Nuno Ferrand de Almeida Director of CIBIO - InBIO

SESSION 1. Taxonomy and molecular analysis
Chair: LEMBI LÕUGAS

1. **10:10 – 10:29 -** JONES A.K.G.J., Widening the net. New approaches to the analysis of fish remains from archaeological sites: identifying the unidentifiable

2. **10:30 – 10:49 -** ZIVALJEVIĆ I., Revealing an extirpated species: identification of cyprinid pharyngeal teeth from the Mesolithic-Neolithic Danube Gorges

10:50 – 11:29 COFFEE BREAK

SESSION 2. COST- Oceans Past Platform (OPP)
Chair: ELIZABETH REITZ

11:30 – 11:39 - Paul HOLM, COSTOPP Project presentation

3. **12:00 – 12:19 -** BARRETT J.H., ORTON D.C., HAMILTON-DYER S., CULLING M., HÄNFLING B., HANDLEY L., O'CONNELL T.S., RICHARDS M.P. and HUTCHINSON W.F. The globalization of naval provisioning: stable isotope and aDNA analyses of stored cod from the wreck of the Mary Rose, AD 1545

4. **12:20 – 12:39 -** HARLAND J., From the fish middens to the herring: Archaeological and historical evidence for later medieval and early modern fishing in the Northern Isles, Scotland

12:40 – 13:49 LUNCH

5. **13:50 – 14:09 -** LÕUGAS L., Long and short distance fish trade during the Middle Ages in the eastern Baltic region

6. **14:10 – 14:29 -** MAKOWIEKI D., Fish fauna in Kołobrzeg and Gdańsk between 9th and 15th century: Reasons for diversity and changes

7. **14:30 – 14:49 -** RANNAMÄE E. and LÕUGAS L., Fish consumption and assertion of trade with coastal regions in medieval Karksi and Viljandi, Estonia

8. **14:50 – 15:09 -** MYLONA D., Fishing and fish eating in the southern Aegean through time. Fishing traditions and innovations

9. **15:10 – 15:29 -** ROSELLÓ-IZQUIERDO E., GONZÁLEZ-GÓMEZ E.A., FERNÁNDEZ-RODRÍGUEZ C., MORALES-MUÑIZ A. The Iberian medieval fisheries: a search for origins

15:30 – 16:19 COFFEE BREAK

SESSION 3. Roman fisheries, and fish products
Chair: WIM VAN NEER

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11. **16:40 – 16:59 -** GRAINGER S., Roman fish sauces: amphorae shape, fish sauce residues and the practicalities of supply

12. **17:00 – 17:19 -** NICHOLSON R., More sauce from the Thames: fish and fishing in and around the Thames estuary, England

13. **17:20 – 17:39** - THEODOROPOULOU T., SÁEZ-ROMERO A.M., WILLIAMS Ch. K., From beyond the Pillars of Herakles to the East: a fresh look at the remains of salted fish and transport amphorae from the Punic Amphora Building at Corinth

14. **17:40 – 17:59** - PIQUÈS G., TILLIER M., DJAOUI D., SANCHEZ C., Sauces and salted-fish for sailors: palaeocontent analysis of jars from the ports of *Gallia Narbonensis*

15. **18:00 – 18:19** - BERNAL-CASASOLA D., MARLASCA R., EXPÓSITO-ÁLVAREZ J.A., RODRIGUEZ J.J.D. Roman Tuna fish and Garum from *Baelo Claudia*. Recent archaeozoological evidence

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17. **9:50 – 10:09 -** JONES S. and LANDON W., Fishing, feasting and friendship; a cross cultural comparison of fish rituals in maritime contexts (c. 1500-1900)

18. **10:10 – 10:29 -** REITZ E., Charleston, South Carolina (USA): A case study of fish as evidence of social status and environmental impact

19. **10:30 – 10:49 -** LERNAU O. Fish consumption in the Beit Shean Valley as studied in two major excavations: Tel Beth Shean and Tel Rehov

10:50 – 11:29 COFFEE BREAK

SESSION 5. Morphometry and osteometry
Chair: REBECCA NICHOLSON

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21. **11:50 – 12:09 -** MARTÍNEZ-POLANCO M.F., JIMENÉZ M. and COOKE R., Estimating body length of two puffer-fish species (*Diodon*) to predict the size of archaeological individuals from two sites of different ages and palaeohabitats in the Pearl Island Archipelago, Panama

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Chair: JAMES BARRETT

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23. **12:30 – 12:49 -** HÄBERLE S., SCHIBLER J. and PLOGMANN H.H., Stable Isotope ratios of archaeological and modern fish bone collagen reflect interactions between men, fish and aquatic ecosystems

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SESSION 7. Fishing cultures of the World: environmental and human impact on fish resources
S.7 (1). South America and Caribbean
Chair: VIRGINIA BUTLER

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25. **14:20 – 14:39 -** BORGES C. and GROUARD S. Tracking fish and fishing practices over time in *sambaquis* of the Santos estuarine complex, southeastern Brazil (4900 – 1900 years BP)

SESSION 7. Fishing cultures of the World: environmental and human impact on fish resources
S.7 (2). North America, Alaska and Asia
Chair: RICHARD HOFFMANN

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27. **15:00 – 15:19 -** KRYLOVICH O. Decline of Rock greenlings from Adak Island (Aleutian Islands, Alaska)

28. **15:20 – 15:39 -** ZHANG Y., FULLER D., QIN L. and MARTIN L. The Rice-fish Economy: wetland fishing and rice cultivation in the Neolithic of the lower Yangtze River region, China

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S.7 (3). Europe
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30. **16:50 – 17:09 -** ROBSON H. and ANDERSEN S.H., Eel fishing in the Mariager Fjord during the Ertebølle and Funnel Beaker cultures: new archaeo-ichthyological data from the kitchen midden at Thygeslund

31. **17:10 – 17:29 -** RITCHIE K., The Chalcolithic fishery at Pietrele, Romania described from fish and fishing technology remains

32. **17:30 – 17:49 -** ROSELLÓ-IZQUIERDO E., ROS-SALA M.M., LÓPEZ-PADILLA J.A. and MORALES-MUÑIZ A., Fishing in the Iberian Bronze Age: The fishes from the Cabezo Pardo and Cerro De Los Gavilanes

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Chair: ARTURO MORALES

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35. **9:50 – 10:09 -** CARENTI G., Garbage into the well: exploitation of fish in two different historical phases of Sant'Antioco (SW Sardinia, Italy)

36. **10:10 – 10:29 -** YEOMANS L., A pit full of fish: fishing and fish storage at the Late Islamic settlement of Freiha, Qatar

37. **10:30 – 10:49 -** WOUTERS W., Fishing and eating plaice (*Pleuronectes platessa*) from Roman to modern times in Belgium

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Chair: HEIDE H. PLOGMANN

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39. **11:40 – 11:59 -** KÜCHELMANN C., Hanseatic trade in the North Atlantic: the archaeozoological evidence

40. **12:00 – 12:19 -** REYNOLDS R., The nature of Anglo-Saxon fishing and fish consumption: A Multi-disciplinary approach to the study of fish remains

41. **12:10 – 12:49 -** DeFRANCE S., Fishing and fish consumption in the colonial lower Mississippi valley: fish remains from European colonial and early American sites in the historic New Orleans French quarter

42. **12:30 – 12:49 -** FRADKIN A., Fish illustrations of colonial America by artist-naturalist Mark Catesby and the ichthyo-archaeological record

12:50 – 14:00 LUNCH

SESSION 10. Poster Session
S.10 (1) COST- Oceans Past Platform (OPP)
Chair: SÓNIA GABRIEL

COSTOPP

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P2. **14:30 – 14:39 -** MARTYN R., ORTON D., ROBERTS C., WOLFF G.A. and CRAIG O., In cod we trust: determining long-term changes to North Sea ecosystems through $\delta^{15}N$ analysis of single amino acids from historic fish bone

SESSION 10. Poster Session
S.10 (2) Taxonomy, molecular analysis, palaeoenvironmental data, osteometry and morphometry
Chair: KENNETH RITCHIE

P3. **14:40 – 14:49 -** THIEREN E., ERVYNCK A., BRINKHUIZEN D., LOCKER A. and VAN NEER W., The Holocene occurrence of sturgeon in the southern North Sea

P4. **14:50 – 14:59 -** BORGES C. and DUFOUR E., When this fish was fished? Otolith sclerochronology in a Brazilian *sambaqui*

P5. **15:00 – 15:09 -** ROYLE T., NICHOLAS G.P. and YANG D.Y., Ancient DNA analysis of Late Period (3500 to 200 cal. years BP) archaeological fish remains from the Interior Plateau region of British Columbia, Canada

P6. **15:10 – 15:19 -** GALIMOVA D., ASKEYEV I.V., ASKEYEV O.V., POPOVIĆ D.and PANAGIOTOPOULOU H., The study of fish bones from medieval town of Staraya Ladoga.

P7. **15:20 – 15:29 -** NEEDS-HOWARTH S. and HAWKINS A., "Diagnostic bones" for Great Lakes taxa revisited: Lessons from deposits with (mostly) whole fish

P8. **15:30 – 15:39 -** JIMÉNEZ-CANO N., Estimation of fish size from archaeological bones of marine catfishes (*Ariopsis felis*): assessing pre-Hispanic fisheries of two Mayan sites

P9. **15:40 – 15:49 -** MOHLENHOFF K., El Niño and trans-Holocene trends in Eastern Pacific fish: a pilot study from Abrigo de los Escorpiones, Baja California)

15:50 – 16:19 COFFEE BREAK

SESSION 10. Poster Session
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Chair: TATIANA THEODOROPOULOU

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P11. **16:30 – 16:39 -** ZIVALJEVIĆ I. and LOPIČIĆ M. Fishing the sensitive information: reconstructing fish processing practices from the Mesolithic-Neolithic Iron Gates (north-central Balkans)

P12. **16:40 – 16:49 -** RITCHIE K. A Tale of Two Shell Deposits: aquatic resource use at the Copper Age site of Pietrele, Romania

P13. **16:50 – 16:59 -** WILKENS B. Fish remains from the Middle Ages well in via Satta at Sassari (Sardinia, Italy)

P14. **17:00 – 17:09 -** BAKKER J. On an ichthyo-archaeological method to trace Jewish urban households. A study of fish remains from Post-Medieval Amsterdam and Medieval Cologne

P15. **17:10 – 17:19 -** ZABILSKA-KUNEK M. Fishing methods used in the past from archaeological, archaeo-ichthyological and ethnographic perspective

P16. **17:20 – 17:29 -** GRAÑA L. Tackling fishbones: an integrated approach to Roman fisheries

17:30 – 18:15 Closing remarks and general discussion: LÁSLÓ BARTOSIEWICZ

Proposals for the next FRWG

THURSDAY 1, FRIDAY 2 AND SATURDAY 3

FIELD TRIP

SESSION 1 - TAXONOMY AND MOLECULAR ANALYSIS

CHAIR: LEMBI LÕUGAS

Widening the net. New approaches to the analysis of fish remains from archaeological sites: identifying the unidentifiable

Andrew K. G. Jones

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Abstract

The last 40 years have seen many significant advances to the analysis of fish remains which have done much to increase the value of our studies to archaeologists, historians, fishery managers and the general public. Nevertheless, many challenges remain. The widespread use of sieving on excavations has done much, but we must acknowledge that many, dare I say most, of the fish remains recovered remain unidentified once post-excavation analysis and publication are complete.

Several reasons account for this woeful situation. The detailed osteological descriptions produced by 19th and early 20thC comparative anatomists are still lacking for many important food fishes. Accessible and well curated reference collections of fish bones, otoliths and scales are still widely scattered and often lack important species. Computer and internet based resources designed to assist identification can be frustrating to use, and like many reference collections, do not contain all distinctive elements and may lack important species.

Recent developments in mass spectroscopy, particularly the analysis of protein sequences in fish collagen has potential to meet some of the challenges outlined above. This paper is a call to assemble an international team of researchers who will collaborate to investigate the limits of this new technology and help transform archaeoichthyology from a subject based on 19thC comparative anatomy into one which uses all the tools of 21stC science.

Keywords: mass spectroscopy, identification, unidentifiable fragments

Revealing an extirpated species: identification of cyprinid pharyngeal teeth from the Mesolithic-Neolithic Danube Gorges

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Abstract

This paper presents and discusses the results of the first archaeozoological and DNA analysis of cyprinid pharyngeal teeth uncovered at Mesolithic-Neolithic sites in the Danube Gorges (North-Central Balkans) in the 1960s and the 1970s. Found primarily in burials, they caught the attention of early researchers and were recognized as grave goods specific to the region (Srejović and Letica, 1978; Boroneanţ, 1990). Recent technological, use-wear and residue analyses (Cristiani and Borić 2012; Cristiani et al. 2014) have shown that they were worn as appliqués attached to clothing by sinew threads and/or binding compounds. However, until recently, no precise species identification has been undertaken, and the teeth have been identified to the family level only. Continuing archaeozoological and DNA analysis has demonstrated that a single species was targeted for the production of teeth appliqués - *Rutilus frisii* (vyrezub, pearlfish), which has not so far been documented in the Middle-Lower Danube in the historical record. At present, this species inhabits the Azov, Caspian and Black Sea basins, but is absent in the Danube drainage apart from landlocked lake populations in Austria, where they are commonly referred to as *Rutilus meidingeri* (Kottelat and Freyhof, 2007). In terms of genetics, recent studies have shown that there are no significant differences between the populations in the Austrian lakes and the populations in the Black and Caspian sea basins (Kottlík et al. 2008). The occurrence of *Rutilus frisii* remains in the Mesolithic-Neolithic Danube Gorges of the Balkans further demonstrates that the past habitat of the species has been wider and included the whole stretch of the Danube at least up to the Middle Holocene. In addition to discussing new archaeozoological and genetic data on *Rutilus frisii*, my paper emphasizes the importance of precise cyprinid pharyngeal teeth identification in revealing the diversity of the prehistoric Danubian fish fauna and the geographical distribution of fish species which have long been extirpated.

Keywords: *Rutilus frisii*, cyprinid pharyngeal teeth, ornaments, Mesolithic, Neolithic

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SESSION 2 – COST-OCEANS PAST PLATFORM (OPP)

CHAIR: ELIZABETH REITZ

The globalization of naval provisioning: stable isotope and aDNA analyses of stored cod from the wreck of the Mary Rose, AD 1545

James H Barrett[1], David C Orton[2], Sheila Hamilton-Dyer[3], Mark Culling[4], Bernd Hänfling[4], Lori Lawson Handley[4], Tamsin C O'Connell[1], Michael P Richards[5] and William F Hutchinson[4]

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Abstract

The growth of long-range trade in high-bulk staple products in medieval and post-medieval Europe underpinned the development of urbanized market economies, colonialism, empires and concomitant environmental impacts. Concurrent with conquest and deforestation for increased cash-crop production, these periods saw the expansion of extensive sea fishing. Historical research, zooarchaeological evidence and stable isotope analysis of archaeological fish bones all indicate that preserved Arctic Norwegian and North Atlantic cod were increasingly transported to consumers around the North Sea – particularly expanding urban populations – between the 11th and 16th centuries. An open question is whether the requirements of naval provisioning may also have played a role in the development of extensive sea fisheries and, concurrently, whether the availability of preserved fish from distant seas helped sustain Europe's first navies. This question is especially pertinent for the 16th century, which saw both the birth of European trans-Atlantic colonialism and a growing importance of sea power in increasingly global conflicts. An unparalleled opportunity to investigate the role of fish in early naval provisioning is provided by cod bones recovered from the Mary Rose – a Tudor warship which sank in the Solent, southern England, in 1545 while sailing with crew and provisions to military action. New methods for investigating stable isotopes provide a promising way to detect non-local imports of cod and genetic markers have proven useful for studying population differentiation in marine fish. Single nucleotide polymorphisms (SNPs) are especially well suited for identifying source populations using DNA from archaeological samples because they combine the power to detect even weak structuring on a small geographical scale with their ability to genotype highly degraded ancient DNA samples. Because the stable isotope data employed ($\delta^{13}C$ and $\delta^{15}N$) reflect diet, whereas genetic markers reflect heredity and adaptation, the methods are independent. Thus together they can provide complementary information on the source of traded fish. We explore the potential and limitations of these approaches, while addressing the role of military provisioning in creating demand for preserved fish from distant waters, and of distant food sources in underpinning the provisioning of a navy.

Keywords: stable isotope analysis, ancient DNA, cod, fish trade, globalization

From the fish middens to the herring: Archaeological and historical evidence for later medieval and early modern fishing in the Northern Isles, Scotland

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Abstract

The heyday of Viking Age and medieval fishing in the Northern Isles of Scotland can be traced in the huge deposits of fish bones that appear circa AD 1000. This "fish event horizon", as it has come to be known, is a phenomenon now recognized throughout Europe. It can be explained by numerous factors, including Christian fasting, the rise of urbanism, and developing market economies. However, a few hundred years later, fishing in the Northern Isles had taken a dramatic downturn. Small-scale, subsistence fishing in relatively safe coastal waters became the norm. Early modern writers deplored the state of fishing in the islands in the late 18th century, while repeated attempts to develop commercial fisheries floundered due to lack of knowledge and investment. This paper examines archaeological evidence for the decline of fishing, looking at the fish bones from later medieval and early modern sites. Using estimates of fish sizes, species present and historical sources, it reconstructs fishing methods and likely fishing grounds, and asks why there was such a striking decline in fishing fortunes in the Northern Isles. The curious absence of herring bones from the archaeological record will also be discussed, a particularly relevant and perplexing question given that the herring industry became so important to the Northern Isles in recent centuries.

Keywords: Scotland, late medieval, early modern, herring

Long and short distance fish trade during the Middle Ages in the eastern Baltic region

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Abstract

Fish was an important food for people living in Medieval towns, especially during the fast. According to written sources the assortment of fish was very varied in Medieval markets both in the form of raw as well as processed fish. The knowledge obtained from the accounting books of Medieval towns concerns the fish species sold in markets as well as the sources and destinations of the trade in fish. However the archaeological evidence from these towns demonstrates local fisheries and it is not always possible to detect the distances involved in the trade of fish. The latter is based on our knowledge of fish distribution in local or distant water bodies. In the eastern Baltic region the long distance trade of fish basically means trade from the Atlantic side, whereas short distance means trade from neighbouring areas. However, there are no criteria for distinguishing between local fishing from the short distance trade and the archaeological fish bones, especially when the habitats of fish are similar in both areas.

In this paper the data from the Medieval accounting books of Tallinn (Reval) - one of the Hanseatic trade centres, and the archaeological material excavated from different Medieval towns are compared in order to ascertain similarities and/or differences in fish trade and consumption. This comparison of two different source materials (written and archaeological) will provide somewhat different information on fish and the role of fish in markets.

Keywords: fish trade, fish bones, Medieval, Tallinn, Baltic Sea

Fish fauna in Kołobrzeg and Gdańsk between 9th and 15th century. Reasons for diversity and changes

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Abstract

From the 9th–10th century onwards Kołobrzeg and Gdansk were among the most important centres in the southern coastal region of the Baltic Sea. This is very clearly confirmed both by archaeological discoveries and historical records, which provide an excellent opportunity to trace the main stages of cultural, social, political and economic development in both towns. As far as fish remains are concerned, thousands of these have been systematically collected during multiple seasons of excavation in different areas and representing each stage of historical development. They have formed the basis for a number of detailed studies into aspects of fish and the importance of fishing, which have already been discussed in several papers (Zbierski 1976, Leciejewicz 1991) and book chapters (Makowiecki 2003). In both centres it was possible to emphasize one feature of fishing, e.g. herring in Kołobrzeg and sturgeon in Gdansk. This paper presents a comparative review of fish fauna in both towns from the early medieval to the post-medieval period. The main goal is to present fish taxa and their diversity and significance in dietary, social and historical contexts. The similarities and differences between the compared centres are also considered.

Keywords: Middle Ages, fishing, south Baltic coast, settlements, towns

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Fish consumption and assertion of trade with coastal regions in medieval Karksi and Viljandi, Estonia

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Abstract

Historical evidence from towns and castles demonstrates that fish were an important resource during the Middle Ages in Estonia (13th to 16th centuries AD). The variability of species and the relative frequencies (NISP) of fish remains imply a certain amount of trade between the coast and the interior.

In this paper comparison is made between the fish bone assemblages recovered from the Medieval castles at Karksi and the contemporaneous castle and town at Viljandi. Since both sites are situated inland, discussion on coastal-hinterland trade will be presented. In addition social differences within the town's population will be outlined, and comparisons will be made with other sites in Estonia.

In brief, a large quantity of fish remains, including several freshwater and marine taxa, the latter from the Baltic Sea basin and the Atlantic, were recovered from Karksi. In addition numerous remains of juvenile domesticated livestock indicate that the castle's inhabitants were of a higher social status. Despite the smaller assemblage from Viljandi, located 20 km away, a similar pattern was observed. However differences in the consumption of certain taxa between the castle and the town were identified.

Keywords: Middle Ages, Livonia, coastal trade, fish consumption

Fishing and fish eating in the southern Aegean through time. Fishing traditions and innovations

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Abstract

Intensive archaeological research and a broadening of the research agenda to include an interest in bio-archaeological remains, have lead, in the last few decades, to the accumulation of a rich body of fishing related remains. These include both fish bones and fishing tools from archaeological sites on the southern Aegean coasts, both mainland and insular. These data indicate diachronic trends in the exploitation of marine resources in the area.

I shall present the available data and describe the main features of the exploited fish populations. These highlight the persistent and shifting choices made by fishermen and consumers from Neolithic to Roman times. Resource availability, technological possibilities and culinary preferences are all considered as equally important factors in the shaping of fishing and fish eating strategies in particular periods. I shall discuss the emergence of fishing and fish eating traditions that are still alive in the Aegean today.

Keywords: fishing traditions, fishing, fish eating, South Aegean, fish bones

The Iberian medieval fisheries: a search for origins

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Abstract

The origin and development of the Iberian medieval fisheries is a poorly documented phenomenon both from the standpoint of historical (documentary) and material (archaeological) evidence. Such dearth of knowledge can be explained in terms of proximal (i.e., a deficient retrieval of fish remains) and ultimate causes. Among the latter, the Muslim invasion, that lasted ca. 800 years of the "medieval millennium" in the Iberian Peninsula, needs to be taken into account as it probably delayed the development of fishing fleets within the Christian kingdoms for a substantial period of time. Be it as it may, the lack of knowledge does not allow one to explore a range of critical issues of Spanish and Portuguese history, such as the role played by the ever-expanding fishing fleets of Portugal and Castilla in the process of maritime discovery and colonization that these two kingdoms fostered by the end of the Middle Ages.

In this paper, the results from a comparative analysis of selected fish assemblages from primary (i.e. coastal) deposits of the northern Iberian shores are presented. The aim is to check whether changes can be documented both at the level of (1) the range of species occurring in sites from the late Iron Age (Castreña culture, IV-IBC) to the Early Middle Ages (VII AD), and (2) the skeletal spectra of certain species that could reveal a differential processing of taxa meant for local consumption and those that appear in inland sites.

Keywords: Fish, Fishing, Northern Iberia, Medieval age

SESSION 3 – ROMAN FISHERIES, AND FISH PRODUCTS

CHAIR: WIM VAN NEER

Fish and fishing in the northern part of the Roman Empire: evidence from the Netherlands

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Abstract

Preservation of fish remains from archaeological sites tends to be excellent in most parts of the Netherlands, due to wetland conditions. Furthermore, finds that provide information on fishing, such as wooden fish traps, metal hooks, and stone, ceramic and metal net-sinkers have been excavated. Until now however, there has been no comprehensive study of ancient fishing practices in the Netherlands. A first attempt is now being undertaken for the Roman period, in an area under Roman jurisdiction.

Roman period sites in the Netherlands have been the subject of continuous study over the last fifty years. As the River Rhine formed the northern border of the Roman Empire, finds in this region come from both military and civilian sites. These range from farmsteads and hamlets to watchtowers, forts, harbours, and urban centres.

All available excavated fish remains from these sites are being (re-)studied to understand which species were consumed by the inhabitants, both native and Roman(ized). Information on fishing equipment was gathered from site and specialist reports, and by studying finds from archaeological depots.

By bringing together this information with site type, occupation and period, we provide, for the first time, an integrated view of consumption, production and trade of fish and fish products in Roman Netherlands.

Keywords: fishing, Roman, *limes,* military*,* civilian, the Netherlands

Roman fish sauces: amphora shape, fish sauce residues and the practicalities of supply

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Abstract

The amphorae designed to transport preserved fish products in the Roman world come in a great variety of shapes and sizes and we are currently unable to recognise whether a fish sauce or a salted fish product was shipped in the various vessels. There are so many subtle differences between the shapes of fish sauce amphorae and it seems self evident that at least initially the differences were related to the various kinds and qualities of fish products rather than the simple need for the potter or manufacturer to identify themselves via elaborate amphorae shapes.

There is considerable doubt and inconsistency among experts how to distinguish between the fish bones found in and around amphorae that were originally a solid product and those that formed the residue of a sauce. Currently species' (clupeiforme, sparids), estimated size (under c. 10cm), and state of bone preservation (poor), as well as find site (land rather than shipwreck), are the criteria used to distinguish a sauce (Desse-Berset and Desse 2000). However, ocasionally larger fish such as mackerel could make a high quality sauce and it is now possible to suggest that fish sauces were shipped with their bone residue which is necessarily well preserved (Grainger 2013). The current consensus on the meaning of the various *tituli picti* that designate these products also indicates that salted fish and fish sauce were shipped indiscriminately in the various vessels: there is no discernable pattern in the use of the various amphora shapes. Vessels that ship *garum* or *liquamen,* clearly a sauce, could equally have been used to transport a product such as *cord(yla)* - understood to have been a form of salted tuna or a *saxitanus*: understood to be a form of mackerel from the epigraphic evidence. This necessarily means that we have simple 'presence' and 'absence' patterns of distribution of fish products within the Roman Empire and this will remain while we are unable to be more precise about what is being distributed when fish amphorae appear in large numbers without epigraphic or osteological evidence. I shall re-consider the nature of fish amphora in relation to the residues of the various products and offer a new interpretation of their use.

Keywords: Roman fish sauce, fish bone residues, amphora, *muria*, *liquamen, garum*

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More sauce from the Thames: fish and fishing in and around the Thames estuary, England

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Abstract

Excavations at Standford Wharf Nature Reserve, on the northern bank of the Thames estuary in Essex, south-eastern England, uncovered evidence for Iron Age and Roman salt production. A dense concentration of salt-encrusted remains of tiny fish and crustacea, probably shrimp, in a ditch fill dating to the Late Roman period suggests the local manufacture of a salted fish product, probably *allec*. The deposit contrasts with a concentration of bones from whole, juvenile clupeids previously discovered at Peninsula House, London, which were interpreted as evidence of local *garum* manufacture (Bateman and Locker 1982). The kinds of fish represented in the deposit from Stanford Wharf are very typical of fish found today in the nearby Thames estuary, which strongly suggests that fishing took place close by, using fine nets suspended in mid-water. The similarity between the fish fauna from Standford Wharf and those present in the tidal Thames today demonstrates the improvement in water quality that has taken place in the Thames as a result of human action over the last century. Although the origins and extent of fish sauce production are unknown, it is possible that it may have begun as a response to the disruption in trade from the rest of the Roman empire.

Keywords: fish sauce, Roman, Stanford Wharf, Thames estuary

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From beyond the Pillars of Herakles to the East: a fresh look at the remains of salted fish and transport amphorae from the Punic Amphora Building at Corinth

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Abstract

Although archaeo-ichthyological studies in the Aegean are increasing, the discovery of remains associated with processed fish from the Classical and Roman periods remains scarce. The earliest faunal material found in Greece so far comes from the so-called Punic Amphora Building at Corinth (mid-5th c. BC). The abundant remains of fish found together with Punic transport amphorae have been interpreted as evidence for an important trade of *tarichos* (the ancient term for preserved fish) between the West and the East as early as the 5th century BC (Zimmermann-Munn 2003). More western Punic amphorae found at Olympia and Athens, as well as quotes in the Greek literary sources of the 5th c. BC confirm the importance of these trading links.

The first publication of the archaeological assemblage from Corinth underlined the commercial role of the building (Williams, 1978, 1979, 1980; Williams and Fisher 1976). The amphorae and fish bones were found together in the courtyard of the building, mixed with other Greek imports (wine) and some Carthaginian amphorae. Archaeometric analysis of the western Punic vessels (Maniatis et al. 1984) indicated two different groups of fabrics, suitable for wet and dry contents. At the same time, only brief accounts of the fish bones have been included in the first publication of the archaeological assemblage. Fish remains, essentially consisting of packs of scales, scarce vertebrae and cranial bones, were primarily attributed to tunny and gilthead sea bream.

A new thorough study of the faunal material provides a detailed account of the fish bones and suggests how these fish were processed. The faunal analysis is part of a larger integrated project, including an updated study of the Punic imports found in the building (including both western and central Mediterranean amphorae). Increasing data in the last decades concerning the typology of amphorae and their fabrics, archaeo-ichthyological remains, and the excavation of several fish-salting plants and pottery workshops in the western Punic cities allows us to review the initial hypothesis published for the finds of the Punic Amphora Building, a major reference in the international commercialization of fish by-products from the Straits of Gibraltar region in the Classical period.

Keywords: Tuna, *Tarichos*, Salsamenta, Greece, Corinth, Punic amphorae

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Sauces and salted-fish for sailors: palaeocontent analysis of jars from the ports of *Gallia Narbonensis*

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Abstract

This paper focuses on the analysis of the palaeo-contents of a class of Roman jars found in southern Gaul. These jars produced in the *Latium* are known in Ostia under the designation « Ostia II-401 ». In Gaul, they are only attested in ports, especially Arles, Narbonne and Marseille (Djaoui et al., 2014). Their absence from terrestrial sites suggests they belonged to sailors. The discovery of two jars containing fish remains, one in Pompeii and the other in the ancient port of Narbonne (Port-La-Nautique) had led the pottery specialists to identify these ceramics as « *garum* jars ».

Reviewing thirty of these jars from different collections, allowed us to confirm that these pots contained fish-based products. In fact 34 of 38 studied jars still contained remains of fish caught in the pitch which had been smeared on the inside walls. The contents of six of these jars were sampled and sieved. They provided sufficient fish remains to be able to characterize the products they contained. The archaeozoological analysis has thus identified potted mackerels, sauces or rather "fish mash" made from young sardines or a preparation from a mixture of small fishes and topping waste. Archaeobotanical remains (seeds) were also found in one of these jars which could signify the presence of condiments.

These studies thus improve our knowledge of salted fish produced in *Latium*, and also the food consumed by sailors or passengers aboard ships during their trip from Ostia to the ports of Gaul.

Keywords: Roman period, *salsamenta*, palaeocontent, fish remains, Gallic ports

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Roman Tuna fish and Garum from *Baelo Claudia*: recent archaeozoological evidence

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Abstract

Recent archaeological research was undertaken in the maritime quarter of the Roman city of Baelo Claudia, located on the European side of the Straits of Gibraltar and funded by the HAR2013-43599-P project of the Spanish Government (2014-2016). Two new fish-salting plants were discovered. These were built in the I c. AD and abandoned in the V c. AD. Special attention was focused on the archaeozoological and other organic remains which were absent from other contexts of the Roman and Late Roman city. The archaeological trenches revealed at least 10 new salting vats. So far four have been completely excavated. In the inner layers of two of them we recovered fish remains in primary position related to the marine preserves that were being produced at the site in the V c. AD. These are of exceptional interest as it is the first time that these kinds of biological remains appear in Baelo Claudia and so well preserved. In one of the vats remains of small sparidae were identified - most belonged to Axillary Seabream (*Pagellus acarne*). After the abandonment of one of the fish-factories many fins and raquis of tuna fish remains were found in a sandy layer, where an organic dump was created after cutting and eviscerating recent catches, by the beach. It is the fourth deposit with similar characteristics found regionally (together with Gadir -"Teatro Andalucía" site, V c. BC; "Punta Camarinal" also at Bolonia, II c. BC; and Septem – modern Ceuta - I c. AD).

We shall present for the first time the preliminary results of the archaeozoological characterization of the species found and the cutting processes, as well as a discussion of the historical and archaeological contexts where the fish bones were found.

Keywords: Baelo Claudia, Roman & Late Roman layers, Garum, Allec, Tuna fish.

SESSION 4 – FISH, RITUAL, FEASTING, AND SOCIAL STATUS

CHAIR: PHILIPPE BÉAREZ

A Greco-Roman votive deposit of fish at Oxyrhynchus (Al Bahnasa, Egypt)

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Abstract

The site of Oxyrhynchus is at about 190 km south of Cairo and is located close to the Bahr Youssef which is a watercourse connecting the Nile with Lake Fayum. The site dates to the Greco- Roman period and is named after a fish that was venerated here, called oxyrhynchos in Greek (meaning sharp-nosed). This refers to fish of the family of the Mormyridae (elephant-snout fish) of which evidence for their worshipping was thus far limited to a few wall paintings and bronze figurines. Although excavations have been ongoing on the site since the end of the 19th century, it was only in 2012 that a deposit was found with thousands of complete fish that were piled up next and on top of each other, with in between layers of matting and wrapping. Although it was possible to lift some of the larger specimens (up to more than 1 meter total length) individually, they did not remain in articulation, and as a consequence enormous amounts of isolated fish bones need to be studied. The present paper will describe the deposit and will focus on the species represented (not only the expected *Mormyrus*), on their reconstructed sizes, and on the protocol that was developed to deal with hundreds of thousands of fish bones. Finally, the archaeological data will be confronted with information from the written sources to further clarify the cultic role this fish played.

Keywords: ritual, religion, Nile fish, Ptolemaic, Roman

Fishing, feasting and friendship; a cross cultural comparison of fish rituals in maritime contexts (c. 1500-1900 AD)

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Abstract

We explore the role of fish in ritual, cross-culturally drawing from regions as diverse as Italy (c. 1500), England (c. 1600), Hawaii and Fiji (c. 1800-1900). Specifically, we discuss how fish were acquired and consumed (in feasts, in mass quantities), and shared attributes of fishing across different cultures. While it has long been established that feasts characteristically reinforce alliances, celebrate life events, people and important religious dates, as well as reaffirming communities, and enhancing collaboration, we investigate more precisely how fish, the art of catching them and their presentation plays into these traditions. We have found, by bringing to bear archaeological, anthropological and historical methods, some surprising resonances in practices and fish-associations beyond mere subsistence. For example, the quantities of fish provided at such feasts, across the cultures being discussed, were indicators of wealth, prestige, and gender. Our discussions make clear that these phenomena cross-cut all social strata including, commoners, intellectuals, ambassadors, nobles, chiefs, and kings. The evidence that we draw is indebted to the French concept of material textuality, where text is used to reconstruct material culture and intellectual stratigraphy, or specifically in the case of our project - food rituals. We explore and reconstruct feasts and food practices by using ethnohistory and personal letters. In due course, our project will elaborate upon these themes using archaeology and zooarchaeology.

Keywords: fishing, feasting, Renaissance, Pacific Islands, material textuality

Charleston, South Carolina (USA): A case study of fish as evidence of social status and environmental impact

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Abstract

Charleston (South Carolina, USA) was founded as part of the English Carolina proprietorship in 1663 and moved to its present location on the south-eastern Atlantic coast of North America in 1680. We now have a record of the social and ecological aspects of fishing which extends into the early twentieth century. Charleston was the centre of a highly stratified social system, with wealthy plantation owners and an urban business community largely sustained by the labour of enslaved Africans. The record can be divided into four briefer periods: 1710-1750, 1750-1820, 1820-1850, and 1850-1900. Fish constitute ca. 20% of the vertebrate individuals in each period. All but three of the 55 collections from Charleston contain at least one of the 62 fish taxa found in the city's archaeological record. A core group of local fish were used throughout the city's history - animals that could be captured from local estuarine waters using relatively simple gear. These were primarily sea catfishes (Ariidae), sea basses (*Centropristis* spp.), sheepsheads (*Archosargus probatocephalus*), drums (Sciaenidae), mullets (*Mugil* spp.), and flounders (*Paralichthys* spp.). Over time, the percentage of fish in the faunal remains declined slightly, but dietary contribution (measured as biomass) and number of fish taxa (richness) increased. Fish were used by all social strata in Charleston. The townhouse assemblage is richer and more diverse than assemblages from sites occupied by people of lower socio-economic status. This higher diversity was achieved by using fish less frequently used by other social groups and probably more costly to acquire. The mean trophic level exploited in each period was 3.4. Most fish individuals were taken from trophic levels 3.4 and 3.5 regardless of period, occupant's status, or site function. Thus we find in Charleston's archaeological record evidence that fish were an important part of the local economy and cuisine, that social distinctions are reflected in fish remains, and that a fishery which by today's standards is considered a high-trophic level one was sustained for decades by Charleston's estuarine system.

Keywords: Southeastern Atlantic coast, post-Columbian North America, social status, trophic levels

Fish consumption in the Beit Shean Valley as studied in two major excavations: Tel Beth Shean and Tel Rehov

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Abstract

Two large tels were excavated in the Beit-Shean Valley south of Lake Galilee in Israel directed by Prof. Amihai Mazar. One is in Tel Beit Shean (1989-1996) and the other at Tel Rehov (1997-2012). Both excavations produced medium-sized assemblages of fish remains which are more or less contemporary and date from the Bronze Age to the Early Islamic period (second millennium BC to the 7th century AD).

Study of the fish remains, which were mostly imported from the Mediterranean (some 50 km to the west) and from the Nile (400 km to the south), has provided an insight into the nature of the organization of long-distance trade in fish in this area over time. Other issues were examined including questions about the relationship between the variety of consumed fish and the socio-economic status of the inhabitants of the sites. It was also interesting to learn from the new study of the finds at Tel Rehov, that previous suggestions made at Tell Beth Shean about the possible role of cultural preferences concerning the consumption of fish, could not be confirmed.

Keywords: commerce, cultural preferences, socio-economic status.

SESSION 5 – MORPHOMETRY AND OSTEOMETRY

CHAIR: REBECCA NICHOLSON

A geometric morphometric approach to shape variation in fish vertebrae for taxonomic and habitat identification

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Abstract

Zooarchaeological studies that have incorporated vertebrae in fish identifications have demonstrated a significant increase in sample size (NISP and MNI) and species diversity. Such studies provide more comprehensive information critical for the accurate reconstruction of the total fish diversity in any assemblage. Traditional methods for identifying fish vertebrae require detailed reference material, which needs to include every element from a neural spine for each taxon. These methods are labour intensive and require a great deal of training. Here we propose to improve these methods by applying a geometric morphometric approach for identifying the vertebrae of fish families in the Asia-Pacific region. We also relate shape variations within fish vertebrae to habitat. Our methods involve several steps. First, we digitized vertebrae of some reef (Balistidae and Serranidae) and pelagic/open water (Scombridae and Carangidae) families from the reference collection of the Department of Archaeology and Natural History (ANH), Australian National University. We scored each vertebra using 2D landmarks. Results were subjected to Procrustes fitting and analysed using standard shape analysis algorithms in order to assess whether shape differences can be used to separate the different families and habitats. These results were then applied to archaeological material from a recently excavated site in Alor (Nusa Tenggara Timur, Indonesia). Fish remains from Alor were first classified according to the morphological criteria based on the ANH reference collection. These results were compared to the quantitative shape variations observed, allowing us to compare archaeological fish identification methods, specifically inter- and intraspecific variations associated with family and habitat. This case study will provide insights into human exploitation of marine resources during the late Pleistocene and early Holocene on faunally depauperate islands in Southeast Asia.

Keywords: geometric morphometrics, vertebrae, taxonomy, habitat, shape analysis

Estimating body length of two puffer-fish species (*Diodon*) to predict the size of archaeological individuals from two sites of different ages and palaeohabitats in the Pearl Island Archipelago, Panama

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Abstract

This paper addresses the advantages and pitfalls of using allometry to estimate size ranges of two species of puffer-fish in pre-European archaeological samples from two ancient settlements in the Pearl Island Archipelago of Panama, 30-50 Km from the Pacific mainland. They are: 1) Playa Don Bernardo (PG-L-19/20), a Preceramic site (6.2-5.6 ka), and 2) Bayoneta Island (LP-8/10) a Ceramic site (~1 kya). Two puffer-fish species (*Diodon hystrix* and *D. holocanthus*) have a high rank at both sites although size range and relative species abundance differ between them. Four, not necessarily mutually exclusive, hypotheses may account for this situation: 1) a diachronic increase in small mangrove-estuary habitats due to changes in coastal geomorphology, 2) differential distribution of these habitats on the two islands despite their closeness, 3) temporal changes in captured diodont species owing to a shift in capture methods, and 4) diachronic decline in fish size due to human predation. We seek the best relationship between the dimensions of several body parts and fish length referring to allometric regression equations. A modern collection of both species was used. The most robust body part (maxilla/dentary) is the least reliable. This is a study-in-progress. By the time of the workshop we expect to have analyzed sufficient material to present a preliminary evaluation of our hypotheses and offer meaningful interpretations of resource use and fishing strategies vis-à-vis technological and ecological change. The paper will be presented by the first author.

Keywords: *Diodon*, pufferfish, Pearl Island Archipelago, Panama, osteometry

SESSION 6 – FISH AS PALAEOCLIMATIC AND PALAEOENVIRONMENTAL PROXIES – ISOTOPIC DATA

CHAIR: JAMES BARRETT

Isotopic sclerochronology provides insight into fishing seasonality in a palaeo-lake at Gobero (Niger) during the mid-Holocene

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Abstract

Isotopic sclerochronology is a discipline which combines the analysis of periodic growth marks and their stable isotopic composition. It provides an insight into the climate of the past, as well as the season of mollusk harvest or fish capture. It is usually used in marine contexts. Here we analyzed Tilapinii otoliths from the Gobero complex (Niger). The site is located on the edge of a palaeo-lake and provides an exceptional testimony of human occupation of the central Sahara (Tenere desert) during Holocene humid intervals. Otoliths were recovered from middens dating from the mid-Holocene (5200-2500 BC). They were used to document hydrologic conditions and seasonality of fishing and site occupation.

Sagittal sections were prepared for ten Tilapinii otoliths recovered from two middens. For each otolith, an oxygen isotopic profile was generated by micromilling and classical mass spectrometry. The quality of preservation of the aragonite was checked by SEM observation of the microstructure and analysis of the mineralogy form by localized optical FTIR analysis.

All isotopic profiles exhibit both large ontogenetic variation and regular cyclical changes. The cyclicity in $\delta^{18}O_{oto}$ values correspond to narrow periodic growth structures observed in sagittal sections. Adult fish inhabited water bodies with more or less regular seasonal hydrological variations. The reading of the outermost portion and its positioning within the annual cycle indicates that Tilapinii were captured at different times within the hydrological cycle. Fishing was practiced at different times of the year and the site occupied in different seasons. Very low $\delta^{18}O_{oto}$ values measured during early life suggest that young Tilapinii inhabited bodies of water fed by precipitation from high altitude such as the Air Massif. Much higher $\delta^{18}O_{oto}$ values during adulthood show that fishing was practiced in evaporative shallow water - lakeside or in marginal basins - where fish are more vulnerable to human predation. Good hydrological conditions, abundance and stability of palaeo-lake resources might have favoured the permanent or semi-permanent human occupation of Gobero during the mid-Holocene.

Keywords: otoliths, oxygen stable isotopes, seasonality, hydrology

Stable Isotope ratios of archaeological and modern fish bone collagen reflect interactions between men, fish and aquatic ecosystems

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Abstract

Freshwater fish remains are regularly recovered from archaeological contexts in Switzerland. This attests the importance to people of these aquatic food resources in the past. We measured carbon and nitrogen isotope ratios of freshwater fish bone samples from sites dating between the 11th and the 21st centuries AD in order to provide information about the human influence on fish stocks and aquatic ecosystems. The species considered include *Esox lucius, Perca fluviatilis, Barbus barbus, Rutilus rutilus and Cyprinus carpio.* The $\delta^{15}N$ results indicate a natural size and age-related trophic level effect. Heterogeneous carbon isotope signatures from samples from the same site could indicate spatial variation in isotope values within single ecosystems or alternatively represent the use of different fishing grounds. In comparison to the archaeological material, the modern fish samples show ^{15}N-enriched and ^{13}C-depleted isotope values. This is probably related to the beginning of the pervasive impact of industrialisation.

Keywords: Switzerland, historic time, aquatic ecosystems, fresh water fish isotope signatures

SESSION 7 – FISHING CULTURES OF THE WORLD: ENVIRONMENTAL AND HUMAN IMPACT ON FISH RESOURCES

1. S7: SOUTH AMERICA AND CARIBBEAN

CHAIR: VIRGINIA BUTLER

Bayovar 1: A pre-Hispanic fish-processing camp in the Sechura Desert, Northern Peru.

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Abstract

The Sechura Desert is the northernmost extension of the coastal Peruvian desert. However its littoral region is under the physical and ecological influences of the cold Humboldt Current that flows north from southern Chile to northern Peru. This area is strongly affected during El Niño events and appears to be a strategic place for studying this weather phenomenon through time. Our study of the subsistence strategies and resource management helps us understand how man has adapted to environmental constraints. We shall present the results of the excavation of a small site occupied by fishermen, dating to the Early Intermediate Period (ca. AD 547-766). The faunal assemblage contains an overwhelming amount of fish skeletal and otolith remains, and, in much smaller proportions, sea turtles, marine birds, and terrestrial mammals. The presence of such a quantity of fish remains and of the many recognized hearths lead us to propose the existence of a fish-processing site.

Species diversity seems at first sight relatively low, however the fish are represented by specimens of varied sizes whose weight ranged from 100 grams to several kilograms. The presence of shallow and warm water species such as the sciaenid *Micropogonias altipinnis* (Golden croaker), indicates that the environment was probably different from what it is today. The eventual presence of a lagoon environment, nowadays absent from the area, raises new questions about the environmental conditions at the time of the site's occupation.

Keywords: pre-Hispanic fishing, fish processing, palaeoenvironment, coastal desert, Peru

Tracking fish and fishing practices over time in sambaquis of the Santos estuarine complex, southeastern Brazil (4900 – 1900 years BP)

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Abstract

Sambaquis are shell mounds constructed along the southern and southeastern, Atlantic coast of Brazil by fisher-hunter-gatherer groups during the mid-Holocene.

Faunal remains from four archaeological sites located in various areas of the estuarine complex of Santos, São Paulo State, south-east of Brazil, were studied and compared with the archaeozoological results published for other *sambaquis* in the same region. These sites, Piaçaguera, Mar Casado, Maratuá and Buracão, have dates ranging between 4930 and 1950 years BP.

The aim was to determine the diet of their human inhabitants, and to identify the subsistence practices and the ecosystems that they exploited.

The results indicate that the marine resources, primarily fish (teleostei and chondrichthyes), were the most important food resource in all of the archaeological sites studied. The wide spectrum of fauna at these sites illustrates an opportunistic pattern of exploitation of a varied range of the estuarine and marine habitats by the inhabitants of the *sambaquis*.

The ichthyological profile identified is roughly equivalent between sites, with a dominant presence of the families Ariidae, Sciaenidae, Centropomidae, Eleotridae and Mugilidae, but the importance of each family and each species differs over time, indicating that human groups exploited their environment in different ways.

Size estimation of archaeological fish was made using osteometric models and the measurements taken on the archaeological bones and otoliths. This provides further insight into the type of fishing techniques that could have been potentially employed as well as the identification of associated fishing practices.

On the basis of these data, we discuss the changes and continuities of the fishing strategies and ecosystem exploitation in the Santos estuarine complex.

Keywords: *sambaquis*, fishing strategies, subsistence practices, archaeoichthyology, Brazil

SESSION 7 – FISHING CULTURES OF THE WORLD: ENVIRONMENTAL AND HUMAN IMPACT ON FISH RESOURCES

2. S7: NORTH AMERICA, ALASKA AND ASIA

CHAIR: RICHARD HOFFMANN

The effects of mega-earthquakes on northeast Pacific fish populations over the past 2000 years

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Abstract

The extent to which past human populations were vulnerable to abrupt environmental change such as volcanic eruptions, flooding, drought, and earthquakes, has interested anthropologists and archaeologists for many years. Research into the archaeology of disaster response suggests communities sometimes suffered significant stress, restructuring, or abandoning settlement after such events. Sometimes the effects of a "catastrophic" event were not all negative, and may have even enhanced environmental productivity. Research has also shown that catastrophes are not just natural events but are mediated by socio-cultural factors such as subsistence, settlement-mobility patterns, population size and infrastructure/technology. The northeast Pacific coastline adjacent to the Cascade Subduction Zone (CSZ) of Oregon, Washington, and British Columbia, is an ideal setting to study human response to catastrophes given the region's geological history of "mega-earthquakes" (magnitude 8.0 and greater on the Richter scale) and the record for large populations of sedentary "complex foragers" living there. Over the last 3,500 years, at least seven CSZ mega earthquakes at 400-600 year intervals have occurred; the latest in AD 1700. The recently excavated Tse-whit-zen village site on the coast of Washington State (United States), dating from ~2000 B.P. to the early 20th century, provides an excellent opportunity to explore ways past mega earthquakes affected indigenous populations of the north Pacific. In 2004, the site, a traditional village of the Lower Elwha Klallam, was extensively excavated (518 m^2, 261 m^3) with fine geo-stratigraphic control, resulting in one of the largest samples of houses, artifacts and fauna (including >500,000 fish remains) on the Northwest Coast. In 2012, a large-scale study began of a large sample of the invertebrate and vertebrate remains and associated geological matrix, to understand how the animals and in turn the humans, were affected by earthquakes and other environmental forces. This paper explores the results of this project and reviews patterns in the fish faunal record (~80,000 fish specimens) from one house area, represented by five periods defined by 40 radiocarbon dates.

Keywords: marine fish, environmental impacts, Northeast Pacific Ocean

Decline of Rock greenlings from Adak Island (Aleutian Islands, Alaska)

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Abstract

We studied remains of Rock Greenlings (*Hexagrammos lagocephalus*) from the ADK-009 archaeological site (Adak Island, Aleutian Islands). This shell midden, with a depth of 160 cm, was well stratified with several layers that had accumulated gradually. Radiocarbon dates of terrestrial bird bone collagen show that the cultural layer was formed from 800 to 300 years cal BP. About 16,000 remains of different taxonomic groups of fish were identified - Pacific Cod (*Gadus macrocephalus*) and Rock Greenling being the most numerous. The share of Rock Greenling bones gradually increases from 14% of NISP in the lower layers (800-700 years cal BP) to 78% in the upper layers (400-300 years cal BP). As a result, Rock Greenling replaced Pacific Cod in the catches made by local people. Reconstruction of population abundance shows the same tendency, abundance of Greenlings increased with time as well. The increase both in the abundance and the proportion of Greenlings in catches occurred during the period between 500 and 300 years cal BP. It is most noteworthy that these changes coincide with a period of comparative cooling in the Northern Hemisphere – also known as the Little Ice Age. Rock Greenling is a demersal solitary fish inhabiting shallow rocky areas. In the Aleutian Islands it is the most abundant and widely distributed species in inshore rock and algae community. Greenling body size was calculated from 617 bones. The average length of Greenling decreased by 2 cm (from 36 to 34 cm) over time. The average size of modern Greenling from Adak Island is about 35 cm. We suppose that this size decrease is a result of over-exploitation of the local Rock Greenling population.

Keywords: Aleutian Islands, *Hexagrammos lagocephalus*, Holocene, Rock Greenling

The Rice-fish Economy: wetland fishing and rice cultivation in the Neolithic of the lower Yangtze River region, China

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Abstract

China's Yangtze River region, especially the lower Yangtze basin with its abundant water bodies, has a long history of rice-fish economy. Historical records state that rice, fish, and wild aquatic plants here were the most important subsistence resources at least since the Bronze Age. Archaeologists suggested that fishing persisted as an important subsistence strategy in the Neolithic Yangtze region (Yuan et al, 2008). However, this assumption has not been proved archaeologically because the fish remains were usually overlooked during excavation and were rarely studied.

This research focuses on the fish and rice remains from Tianluoshan, a late Neolithic site in the lower Yangtze River region. Domesticated rice has been identified from Tianluoshan (Fuller et al, 2009); the fish remains were relatively well preserved and retrieved. A thorough analysis of the fish remains indicates that most fish were probably from the freshwater wetlands close to the settlement. Although the ocean was not so far from Tianluoshan, it was rarely exploited. Easy access made freshwater fish a reliable food resource which was exploited throughout the year. The connections between fish and rice in the subsistence can be summarized into three parts. First, fish and rice were from the same environment. Although rice domestication had begun, the rice field had not been separated from the natural wetlands, where most fish were captured. Second, the analysis of seasonality shows that the fishing seasons differ from the rice harvest season, indicating the management of labour. Third, the statistics indicate that the fish assemblage changed during the occupation of the site (about 1,000 years), along with the increase of domesticated rice.

The fish remains and the rice-fish economy in the Neolithic of the lower Yangtze River region is still under-studied, and so research at Tianluoshan is of a pioneering nature. The nature of the fish economy will be better investigated as more archaeological materials are retrieved and studied.

Keywords: the rice-fish economy, wetland fishery, lower Yangtze region, Neolithic

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SESSION 7 – FISHING CULTURES OF THE WORLD: ENVIRONMENTAL AND HUMAN IMPACT ON FISH RESOURCES

3. SESSION 7: EUROPE

CHAIR: DANIEL MAKOWIEKI

Burbot *(Lota lota)* and winter fishing in Finland during the Stone Age

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Abstract

Stone Age dwelling sites in Finland are typically located by lake shores. Finland was then – as it is now – a "land of a thousand lakes". Freshwater fishing has been an important source of livelihood throughout history. Pike *(Esox lucius),* perch *(Perca fluviatilis),* whitefish *(Coregonus lavaretus)* and Cyprinid fish are common in the Stone Age refuse faunas found in hearths and waste pits.

Winters in Finland are cold and snowy and the lakes and rivers freeze over. Winter fishing under the ice has been widely practiced during historic times. It requires different methods than open water fishing. For instance, pike and perch are easy to catch under the ice.

Recently I have found clear evidence of winter fishing during the Stone Age. Burned burbot *(Lota lota)* bones have been found at many Stone Age dwelling sites, almost throughout the country. Burbots spawn in the mid-winter in coastal waters. The rest of the year adult burbots stay in the deep waters of an open lake. The burbot bone finds derive from adult and spawning mature fish. It suggests that fishing occurred during the winter.

Keywords: winter, fishing, Stone Age, burbot, Finland

Eel fishing in the Mariager Fjord during the Ertebølle and Funnel Beaker cultures: new archaeo-ichthyological data from the kitchen midden at Thygeslund

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Abstract

Thygeslund is one of a number of Danish stratified 'køkkenmødding' (kitchen middens) spanning the late Mesolithic (Ertebølle) and the early Neolithic (Funnel Beaker) cultures, and has been dated from approximately 4400 to 3300 cal BC. A total 4 m^2 have been excavated at the kitchen midden during trial trenching undertaken in 2013 and 2014.

Here we present the results of a study conducted on the fish remains recovered by hand as well as on site dry screening of materials (4.0, 2.0 and 1.0 mm mesh) that were excavated through the midden sequence. The results are compared with contemporary kitchen middens in the fjord, including Havnø to the east-northeast and Visborg to north-northeast. All three kitchen middens are located < 5 km from one another, and the species spectra for the three sites comprised marine and to a lesser extent freshwater fish, the majority of which migrate between fresh and salt waters.

The material is quantified and estimates of total fish lengths are provided. Interpretation focuses on taphonomy, including element size distribution and percentage completeness, relative importance of the fish represented, especially the European eel (*Anguilla anguilla*), significance of the three-spined stickleback (*Gasterosteus aculeatus*) and the greater weever (*Trachinus draco*), presence of freshwater taxa, possible fishing methods employed, and season(s) of capture.

Keywords: Denmark, kitchen midden, Mesolithic, Neolithic, fish

The Chalcolithic fishery at Pietrele, Romania described from fish and fishing technology remains

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Abstract

The Chalcolithic period of the 5th millennium BC in the area of the Lower Danube River is of particular interest for archaeologists because it provides evidence for very early metallurgy, incipient social stratification, and, at many sites, a renaissance in the exploitation of wild animals in the subsistence economy – even though domesticated animals continue to be important. Since 2002, excavations at the tell near Pietrele, Romania on the floodplain of the Danube River, have produced abundant evidence of the exploitation of fish and other aquatic animals both in the form of faunal remains and some of the technologies used to procure them. Although examples of very large catfish and cyprinids are common in the assemblage, wet-sieving of soil samples has also revealed the presence of numerous bones from very small fish – indicating a very intensive exploitation of aquatic resources by the site's occupants. Although analysis is continuing, the data produced so far can begin to address questions of where, when and how aquatic resources were procured and how the settlement was provisioned.

Keywords: Chalcolithic, Romania, Danube, tell

Fishing in the Iberian Bronze Age: the fishes from the Cabezo Pardo and Cerro de los Gavilanes

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Abstract

The Bronze Age of the Iberian peninsula has been a period with little archaeoichthyological information. The traditional explanation to account for such dearth of data has been to consider that Iberian Bronze Age communities, focused their interest on mineral resources, agriculture and stockbreeding. But, at least in the case of the eastern Iberian shores, another equally important, often neglected, reason may have had to do with sea level fluctuations occurring over a tectonically active littoral that witnessed large changes throughout the second millennium BC.

In this presentation we will provide an overview of ichthyoarchaeological developments in the SW sector of the Iberian Peninsula, focusing on the assemblages from two sites. Cabezo Pardo (province of Alicante) is a rural settlement which presently lies ca. 5 km inland from the Mediterranean coast but that during the Bronze Age was stationed at the shoreline of a huge coastal lagoon. Cerro de los Gavilanes is a small rocky outcrop on the present day city of Mazarrón (province of Murcia) which for a prolonged period that spanned from the Early Bronze Age (*ca.* 1900 cal. BC) to republican times (*ca.* 200 cal. BC) served as a harbor and fishing village. The fish faunas from both sites exhibit differences and similarities that, along with fishes from other sites from SW Iberia allow one to grasp some features of the fishing strategies carried out during this interesting and enigmatic period of Iberian prehistory.

Keywords: Fish, Fishing, Bronze Age, Sw Iberia, Coastal morphology

Fish remains from the Neolithic site of *El Mirador* cave (Atapuerca, Spain): seasonality and resource management

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Abstract

Ichthyoarchaeological analyses were undertaken of the freshwater fish remains from levels 19 and 20 in El Mirador cave (Atapuerca, Spain). Fish were always present as a source of animal protein, although their importance in the human diet was not fully exploited by people during the Neolithic on the Iberian Peninsula. Two principal goals are treated here: a taxonomic study of the fish remains and a characterization of the exploitation of this resource. The results show that the human community of El Mirador cave practiced fishing, and that fish was part of their diet and social life.

Keywords: freshwater fish, resource, Neolithic, El Mirador cave, Atapuerca

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SESSION 8 – NATURAL DEPOSITS VS. FISHING, FISH PROCESSING AND CONSUMPTION EVIDENCE

CHAIR: ARTURO MORALES

Troubled Waters: Fish remains from Ménfőcsanak–Széles-földek, Hungary

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Abstract

The site of Ménfőcsanak–Széles-földek is located on a sand bank in the ancient floodplain, of the Holt-Marcal and Ős-Rába rivers. It is near the city of Győr on the right bank of the Danube in NW Hungary. The settlement falls within an area of 150 hectares covered by archaeological sites. The periods relevant to the fish remains discussed in our presentation include the Late Bronze and Iron Ages, and the Roman Empire.

Water-sieved samples show that fish have always been present. It is hard to tell, however, which remains originate from fish consumption and which are natural deposits resulting from inundations. The latter option needs to be considered in the light of environmental archaeological investigations that show dynamic fluviation and intensive sedimentation (Kreiter and Pető 2012). However, the remains of grasses and cultivated cereals indicate the exploitation of relatively dry habitats. According to observations made during the excavation and following extensive rainfall, deeper sections of the Ménfőcsanak archaeological site became inundated, despite water-regulation on the modern landscape: even temporary water cover in the area resulted in the occurrence of small fish, including small Cyprinids. Prehistoric hydrological properties of the region make natural deposition a likely interpretation, especially in the case of numerous bones of unusually small fish of negligible economic importance.

Meanwhile the remains of relatively large carp and pike came to light from Late Iron Age and Roman Period features in the eastern section of the site. These indicate their dietary roles in these periods. The remains of five large pike originate from what was considered a Late Bronze Age Tumulus – probably a sacrificial feature. They fall into the size category of individuals that can be caught by active fishing, as opposed to potting usually practiced in small, residual flood pools (Kovács et al. 2010: 248). This admittedly hypothetical argument concerning the pike sizes from Ménfőcsanak is confirmed by two bronze angle finds associated with the period between the Copper and Late Bronze Ages.

Keywords: natural deposition, angling, pike, carp, Danube

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Garbage into the well: exploitation of fish in two historical phases of Sant'Antioco (SW Sardinia, Italy)

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Abstract

Several excavations were undertaken in recent years in the ancient town of Sulky on the island of Sant'Antioco (SW Sardinia). These reveal evidence of the way of life of the inhabitants from the foundation of the city in the 8th century BC until Roman Imperial times. We studied fish remains found in the fill of certain architectural structures related to the use of water and food resources in the city centre. The first structure was a silo used during the Archaic phase for storing food. It fell out of use and was filled during the 8th c. BC. Other structures include two drainage pits related to the urban street closed and filled during the 1st c. AD. Findings allowed us to speculate on some important features concerning the exploitation of fish. Technological or cultural differences were identified between different contexts and historical phases.

Keywords: archaeozoology, taphonomy, fish remains, Sardinia, Phoenician, Roman

A pit full of fish: fishing and fish storage at the Late Islamic settlement of Freiha, Qatar

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Abstract

A large assemblage of fish bones was studied from the Late Islamic settlement of Freiha on the northwest coast of Qatar. One pit provided an exceptional collection of thousands of fish bones preserved below a capping deposit. This was interpreted as a fish storage pit and ethnographic parallels have been documented in Oman where dried and salted fish would be preserved for future consumption. A consideration of the species represented and calculations of fish size indicates that small fish were stored in this manner. Rabbitfish (*Siganus* sp.) were by far the most common species preserved. Intertidal stone fish traps would have yielded large catches of fish and the ability to store the surplus produce would have been hugely beneficial to settlement in such a harsh environment.

I shall present the results of my study of the fish bones from the fish storage pit and, in conjunction with the rest of the studied faunal assemblage, examine how the inhabitants were catching and processing fish at the settlement. Results are also compared to the assemblage from the slightly later settlement of Zubarah a few kilometers along the coast illustrating how the immediate marine environs of each settlement influenced fishing practices in the inshore waters. Both settlements also exploited the coral reefs reached by fishing boats and occasionally fished in open waters bringing home catches of pelagic fish.

Keywords: Qatar, fish storage, Freiha, Zubarah

Fishing and eating plaice (*Pleuronectes platessa*) from Roman to modern times in Belgium

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Abstract

The evidence for marine fish consumption from coastal and inland sites in Belgium shows a heavy reliance on herring, gadids (cod, haddock, whiting) and flatfish (plaice, flounder and dab). Within the last group, plaice is the most common. I shall provide an overview of the occurrence of this species from Roman to post-medieval times in sites along the Scheldt basin. The diachronic analysis focusses upon the contribution of this flatfish to the diet and on the way it was marketed. The intraskeletal distribution (head versus postcranial bones) and reconstructed fish lengths (based on new regression equations) are considered for the consumption sites. These data are compared to those seen at a major production site along the North Sea coast with the aim of establishing whether plaice was traded whole or as prepared fish, and whether particular size categories were chosen for export to the consumption sites. Finally, I shall consider to what extent the diachronic pattern seen in the size distributions can be considered as a possible marker of overfishing.

Keywords: plaice, fish curing, size reconstruction, overfishing

SESSION 9 – MULTI-DISCIPLINARY APPROACHES TO THE STUDY OF FISH REMAINS: ARCHAEOLOGY, WRITTEN AND ILLUSTRATED SOURCES

CHAIR: HEIDE H. PLOGMANN

What can be learned from the fisheries regulations of late medieval Europe?

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Abstract

From the early 1200s public regulation of fisheries became common across much, but not all, of western and central Europe. This was probably due to a simultaneous response to perceived depletion and the expanding purview of secular governments. Authorities with some claim to regional effectiveness such as Italian city states, regional princes and some national rulers, issued wide-ranging codes for economic and sustained use of inland and inshore (but rarely marine) biota. The scope of these ordinances grew over time and increasingly asserted their service of public rather than private interest. The protection and wise use of aquatic resources had considerable political importance. Certain characteristic measures reveal contemporary understanding of aquatic life and these help scholars interpret the varieties and sizes of archaeological fish remains. Other provisions, including some demonstrably enforced, identify specific capture techniques and socio-economic conflicts over their use. The contribution of public law to the sustainability of European fish populations should at least be considered. The paper draws upon laws and court cases from Britain, France, the Low Countries, German-speaking territories, northern Italy, and the Iberian kingdoms during the 13th through 16th centuries.

Keywords: Middle Ages, Europe, fisheries regulations, fish varieties, capture techniques

Hanseatic trade in the North Atlantic: the archaeozoological evidence

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Abstract

In May 2013 a conference concerned with the "Hanseatic trade in the North Atlantic" was held in Avaldsnes, Norway. The focus of the conference was the trade of Hanseatic merchants with Iceland, the Shetlands and the Faroes between the 13th and 17th century on which only a relatively small amount of research had been undertaken, compared to historic research on other Hanseatic destinations. The topic was tackled from historical, archaeological, etymological and archaeozoological aspects. Following the initial steps taken at the conference a research group was founded in 2014 which intends to make a more profound study of the topic. The application for the project entitled "Zwischen Nordsee und Nordmeer: Interdisziplinäre Studien zur Hanse" ("Between North Sea and North Atlantic: interdisciplinary studies towards the Hanse) has been granted by the Leibniz-Gemeinschaft and began its work in March 2015 at the Schiffahrtsmuseum (DSM) in Bremerhaven. The research group currently consists of four researchers: Natascha Mehler (archaeologist), Mike Belasus (marine archaeologist), Bart Holterman (historian) and myself (archaeozoologist).

As the most numerous and economically most important item in the Hanseatic North Atlantic trade was stockfish, the core of the archaeozoological study will mainly concern fish. My initial concern at the Avaldsnes conference was the evidence for the Hanseatic stockfish trade from the point of view of the consumer sites, the Hanse cities in Germany (Küchelmann in prep.). The counterpart of which was a study by Ramona Harrison and collaborators of the North Atlantic Biocultural Organisation (NABO) of fish remains from producer sites on the North Atlantic Islands (Harrison and Maher 2014). Within the new project I aim to study the Hanseatic stockfish (and other animal products) trade in the North Atlantic in general, integrating archaeozoological, archaeological and historical data. In cooperation with the Alfred-Wegener-Institut we will try to link the historical and archaeozoological data to relevant questions in ichthyology, ecology, population and fishery biology.

In my presentation I shall introduce this new research project, outline the evidence accumulated so far, show potentials and limitations of the data and present preliminary results.

Keywords: Gadidae, North Atlantic, Hanseatic trade

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The nature of Anglo-Saxon fishing and fish consumption: A Multi-disciplinary approach to the study of fish remains

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Abstract

The Anglo-Saxon period saw considerable change as well as continuation in England's society and economy. Numerous identities were formed while some were broken or changed. The importance of fish in the Anglo-Saxon diet and its place within the economy and society has long been debated, however the nature of fish remains has made their study fraught with problems. In addition, the rigidity of the framework in which many Anglo-Saxon contextual studies are conducted has meant that fishing as a whole has not often been seen to be of major significance in Anglo-Saxon England. Recent zooarchaeological studies of Anglo-Saxon faunal material have highlighted the major role that animals played in the formation of identities but also worldviews. However, these studies have merely touched upon the fish remains. This study sought to remedy this. In order to achieve this and to counter-act the limitations associated with fish bone analysis other evidence such as isotope data from human remains, fish-related place-names, weirs and material culture associated with fishing such as hooks and sinkers were studied and discussed alongside each other in order to achieve a full picture of the role of fishing and fish consumption throughout the Anglo-Saxon period. This has provided a more colourful view of fishing – one that is beyond purely economic factors and has highlighted the importance of socio-cultural factors. Unsurprisingly, many more questions remain to be answered and most of these relate to the multi-disciplinary approach adopted.

Keywords: fish, Anglo-Saxon, worldview, multi-disciplinary

Fishing and fish consumption in the colonial lower Mississippi valley: fish remains from European colonial and early American sites in the historic New Orleans French quarter

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Abstract

Located along the lower Mississippi River, the city of New Orleans, in addition to the river itself, is surrounded by rich waterways including the numerous bayous, bays, and lake systems. New Orleans, established in 1718, rapidly became an amalgam of Native American, European, and African American peoples. Fishing and fish consumption was a feature of life in this inland coastal city prior to European colonization, and fish and seafood consumption became signature elements of the city's unique cuisine. The zooarchaeological study of fish remains from three sites is used to examine changing habits of fish consumption, provisioning, and the roles of markets in providing fish to French Quarter residents and hotel guests. Diachronic analysis of the fish remains demonstrates how European and other occupants created distinct patterns of fish use. The site of St. Anthony's Garden located behind St. Louis Cathedral was extensively excavated. It is the locale of the city's first European settlement at the site of a Native American settlement. Fish remains from St. Anthony's Garden and the Rising Sun Hotel site provide a record of fish use from early French and Spanish colonial occupations of the eighteenth century until the American period of the late nineteenth century and the rise of the hospitality industry. Fish remains from the excavation of the Ursuline Convent, one of the oldest structures in the lower Mississippi Valley, provide information on how this all female religious order, the first such religious order to arrive in the city, was provisioned with fish products. Analysis of the patterns of fish use at these sites helps us to understand the enduring role that fish have played in the city's culture and cuisine.

Keywords: New Orleans, French Colonial, Spanish Colonial, historical fishing

Fish illustrations of colonial America by artist-naturalist Mark Catesby and the ichthyo-archaeological record

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Abstract

British artist-naturalist Mark Catesby was a key figure in American environmental history. He made two extended trips to the American colonies and the Bahamas in the early 18th century. Exploring the colonial wilderness, he collected plant and animal specimens and made drawings and paintings of the various species he encountered. His illustrations and notes were the basis for his monumental two-volume publication, *The Natural History of Carolina, Florida and the Bahama Islands*, one of the most comprehensive illustrated documentations of the flora and fauna of the New World. His depictions and accompanying descriptive accounts, in turn, can serve as a valuable resource for environmental archaeologists studying sites of that time. This presentation examines the various fish that Catesby visually documented and their representation in zooarchaeological assemblages from several colonial period sites in southeast North America and the Bahamas.

Keywords: fish, fish illustrations, colonial America, Bahamas

SESSION 10 – POSTER SESSION

1. S10: COST – OCEANS PAST PLATFORM (OPP)

CHAIR: SÓNIA GABRIEL

A reappraisal of eel fishing: new analysis on archaeological remains

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Abstract

The European eel (*Anguilla anguilla*) has traditionally been viewed as a catadromous species breeding in the Sargasso Sea and maturing in the river systems of Europe. It had been suggested that the juveniles swam upstream during the spring where they would spend variable periods in freshwater before a final migration during the autumn towards marine waters. However recent analyses demonstrate that our understanding of their life history and habitat use has been "grossly oversimplified" (Harrod et al. 2005, 681).

Throughout the course of the last 8,000 years eels were intensively exploited indicating that they were considered an important resource. In part this view is supported by the large numbers of eel remains routinely recovered during archaeological excavations (Kettle et al. 2008) as well as the presence of numerous stationary-fishing devices (for example fences or weirs) from coastal localities.

In this paper the complexities surrounding the habitat use and life history of the eel will be presented, based in part on the carbon and nitrogen stable isotope values (n = 96) of eel bone collagen recovered from 26 archaeological sites throughout northern Europe and the eastern Baltic region. These data will be compared with modern specimens (n = 16) caught from six Danish localities as well as the data reported by Harrod et al. (2005). Thus, a number of aquatic habitats are represented. A re-evaluation of eel procurement strategies will be considered that will be supported by ethnographic, historical and modern data. In addition the use of the eel as a seasonal indicator will be discussed taking into consideration eel size frequencies from archaeological sites.

Keywords: northern Europe, Baltic, eel, isotopes, seasonality

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In cod we trust: determining long-term changes to North Sea ecosystems through δ^{15}N analysis of single amino acids from historic fish bone

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Abstract

The zooarchaeological record is an often neglected but fundamentally important resource in environmental studies. When analysed using the appropriate methods, it provides physical confirmation of the presence of species, their exploitation, diversity, and abundance, and offers a perspective of past peoples, environments, and ecosystems which lie beyond the confines of contemporary research. However, despite this cache of potential data, the utilisation of archaeological fish remains in addressing the often rancorous issue of global fisheries decline is largely in its infancy. Large-scale changes in marine ecosystems are commonly attributed to the intensification of demand, and technological development (either progressive or reactionary); enabling fisheries to prosper even as stocks decline. A suite of methods has been used to quantify the efficiency with which humans have exploited these resources over the last century, but the nature of this process over a much longer period is yet to be evaluated. Here we offer a possible approach, through the application of compound specific isotope analysis of amino acids (CSIA-AA) to archaeological and modern cod (*Gadus morhua*) material, to establish the trophic level of this target opportunistic predatory fish. We hypothesise that following the Fish Event Horizon (c. 11th century AD), in which marine species replace freshwater species in the archaeological record of the intensified exploitation of marine resources in the North Sea caused a gradual narrowing of biodiversity. This manifested itself as a decline in the trophic position of this species as higher trophic prey were replaced by lower ones. It is anticipated that our analyses will allow us to broadly trace the long-term development of ecosystems along the east coast of England, and view the large-scale changes of 20th and 21st century fisheries as part of a much longer history of marine exploitation.

Keywords: CSIA-AA, fishing, North Sea, *Gadus morhua*

SESSION 10 – POSTER SESSION

2. S10: TAXONOMY, OSTEOMETRY, MOLECULAR ANALYSIS, AND PALAEOENVIRONMENTAL DATA

CHAIR: KENETH RITCHIE

The Holocene occurrence of sturgeon in the southern North Sea

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Abstract

Archaeological remains of sturgeon from the southern North Sea basin used to be automatically attributed to *Acipenser sturio*, since this was the only sturgeon species believed to occur in the region. However, these species identifications were in need of revision after a growing number of indications was found for the historical presence of *A. oxyrinchus* in western Europe. In our study, morphological and genetic data on sturgeon remains from archaeological sites along the southern North Sea have been revised. A large number of Dutch, Belgian, British and some French archaeological sturgeon remains, dating from the Mesolithic to Late Modern times, were morphologically examined and fish sizes were reconstructed. This study of more than 7000 sturgeon bones proves the sympatric occurrence of European sturgeon *Acipenser sturio* and Atlantic sturgeon *A. oxyrinchus* in the southern North Sea at least since the Neolithic (4th millennium BC onwards), with *A. oxyrinchus* remains always outnumbering those of *A. sturio*. Human impact is documented by the decrease in finds through time, but no clear evidence was found for a diachronic change in fish lengths that could possibly be related to fishing pressure.

Keywords: *Acipenser sturio*, *Acipenser oxyrinchus*, archaeozoology, zoogeography

When this fish was fished? Otolith sclerochronology in a Brazilian sambaqui

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Abstract

Sambaquis are unique testimonies of the long-term interactions between people and marine environments in South America. These shell mounds were constructed by fisher-hunter-gatherer groups during the middle Holocene and occur mainly along the south and south-east Brazilian Atlantic coast. Archaeozoological studies indicate that fishing was the main economic activity. However, questions still remain about the level of mobility, the fishing strategies and the patterns of site occupation of these people. Concerning these questions, otolith sclerochronology has the potential to document the seasonality of fishing at the *sambaquis.*

The present work focuses on abundant otoliths of *Micropogonias furnieri* (Sciaenidae, Demarest 1823) found in the site of Piaçaguera dated to 4930 ± 110 years ago and located inside the Santos estuarine complex (São Paulo region, SE Brazil). *M. furnieri* is a demersal marine fish and estuarine-dependent. It has an extensive distribution and is economically significantly important. Its biology and ecology are relatively well known. This species is one of the most important in the *sambaquis.* Thin sections from four well-preserved archaeological specimens and two modern specimens were studied using a sclerochronological and isotopic approach.

Otoliths of *M. furnieri* show regular growth marks composed of translucent and opaque zones. To estimate the timing and periodicity of deposition of the growth marks, intra-otolith isotopic profiles were made. A clear match was observed between the alternation of growth marks and the cyclical variations in $\delta^{18}O$ values that are related to cyclical variations in sea temperature. Results showed that growth marks are deposited annually, corroborating previous studies of the marginal increment, and enabling the determination of the season of formation of the translucent and opaque zones in the margin of archaeological individuals. In Piaçaguera, *M. furnieri* was captured during the warm season and the early dry season and, so far, there is no evidence for seasonal fishing.

This is the first study of archaeological otolith sclerochronology in Brazil. The preliminary results are very promising, but further analyses are needed to improve our data. Beyond that, this technique can provide more evidence concerning the way of life of these people who lived on the Brazilian coast.

Keywords: *sambaquis*, seasonality, sclerochronology, *Micropogonias furnieri*, otoliths

Ancient DNA analysis of Late Period (3500 to 200 cal. years BP) archaeological fish remains from the Interior Plateau region of British Columbia, Canada

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Abstract

EeRb-144 is a large Early (>7000 cal. years BP) to Late Period (3500 to 200 cal. years BP) campsite located on a river terrace in the Interior Plateau region of British Columbia, Canada. A multi-year excavation of the site conducted as part of the Secwepemc Cultural Education Society-Simon Fraser University Archaeological Field School has recovered a large number of fragmented fish remains associated with the Late Period occupations of the site. This fragmentation has generally precluded the identification of these remains through morphological analysis to a taxonomic level lower than class. Consequently, little is known about the taxonomic focus and breadth of the Late Period fishery at EeRb-144. This study sought to identify the focus of this fishery by employing ancient DNA (aDNA) analysis to assign species identifications to a sample of Late Period fish remains from the site. The results indicate EeRb-144's Late Period fishery probably focused on Largescale sucker (*Catostomus macrocheilus*), but also harvested a variety of other locally abundant fish species in smaller quantities. Ethnographic accounts of indigenous fishing activities in the region and the ecology of the identified species suggest fishing was undertaken in spring and summer. This study also highlights how aDNA analysis can be used to identify fish remains that are difficult to identify morphologically due to a lack of species specific morphological features.

Keywords: ancient DNA analysis, Interior Plateau, Late Period, Pacific Northwest, species identification

A study of the fish bones from the medieval town - Staraya Ladoga

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Abstract

We present results of a study of fish bones, obtained during excavations of the archaeological site of Staraya Ladoga (Leningrad region, Russian Federation) in 2009 and 2010. Most of the bone was removed from the layers of the object "Zemlyanoe gorodishe" which date from the 9th – 10th century AD (Kirpichnikov, 2011).

The first studies of fish bones from the site were conducted M.I. Tichiy (Tichiy, 1923) and V.D. Lebedev (Lebedev, 1960). In collections made in 2009 and 2010 (NISP > 10,000) we have identified 23 fish species. These are dominated in number of bones by *Sander lucioperca*, *Acipenser oxyrinchus*, *Abramis brama*, *Esox Lucius* and *Silurus glanis*. We also identified bones of *Acipenser sturio*, *Carassius carassius*, *Ballerus ballerus*, *Ballerus sapa*, *Blicca bjoerkna*, *Aspius aspius*, *Leuciscus idus*, *Leuciscus leuciscus*, *Rutilus rutilus*, *Scardinius erythrophthalmus*, *Vimba vimba*, *Pelecus cultratus*, *Tinca tinca*, *Coregonus albula ladogae*, *Coregonus baerii*, *Salmo salar*, *Salmo trutta*, *Lota lota*, and *Perca fluviatilis*. Bones of sturgeon species were identified using the morphological criteria of Desse-Berset (2011) and these indicated the predominance of *A. oxyrinchus* (> 90%) and *A. sturio*. Coregonidae and Salmonidae comprised less than 1% of all fish remains.

Another interesting find was bones of interspecific hybrids: *Rutilus rutilus* × *Abramis brama*, *Blicca bjoerkna* × *Abramis brama* and *Acipenser sturio* × *A. oxyrinchus*.

The estimated sizes (total length) and age determination are as follows:

Acipenser oxyrinchus - 52,8 - 370 cm, age 3 - 45 years;
Sander lucioperca - 33,8 - 108,2 cm, age 3 - 16 years;
Esox Lucius - 29,2 - 139 cm, age 2-15 years;
Abramis brama - 25,1 - 70 cm;
Silurus glanis - 45,3 - 169,4 cm.

In addition to the morphological determination of *Acipenser oxyrinchus* and *A. sturio*, we made genetic studies of these species (Galimova et al., 2013). The extraction of ancient DNA (mitochondrial and nuclear DNA) from 50 bones (mtDNA analysis) showed that 45 samples are A*. oxyrinchus*, and only 5 samples are *A. sturio*. Analysis of nDNA (Aox23; Ludwig et al., 2008) revealed 1 hybrid and 2 introgressed specimens.

This is the first study of ancient DNA of *Acipenser oxyrinchus* and *A. sturio* from the Russian Federation.

Keywords: Staraja Ladoga, fish bones, ancient DNA

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"Diagnostic bones" for Great Lakes taxa revisited: Lessons from deposits with (mostly) whole fish

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Abstract

The representation of the various cranial bones differs among fish taxa commonly recovered from archaeological sites. Various researchers have proposed basing quantification on subsets of bones in order to circumvent this variability (e.g., Leach 1986; Harland et al. 2003). In a continuing project, we have been following up from Needs-Howarth's (2001) initial work on establishing so-called diagnostic bones for Great Lakes fish families, with the incorporation of larger datasets, from different drainages, and with differing proportions of the various fish taxa (Needs-Howarth and Hawkins 2014). Coinciding with that, Needs-Howarth analyzed a large assemblage of Clupeidae bones that probably resulted from a die-off (Needs-Howarth et al. 2013). Surprisingly (or perhaps not), this assemblage, which one might anticipate to have similar MAU values for the various elements, still had quite an uneven representation of the different bones. A survey of previously published assemblages that we would also expect to have more "ideal" bone representation than we find in typical Great Lakes assemblages—such as dried flatfish production waste and preserved herring—shows that these assemblages, too, have uneven MAU representation of the readily identifiable cranial bones. We explore various taphonomic explanations relating to the Great Lakes assemblages and offer some suggestions as to how zooarchaeologists might deal with this bias, while acknowledging that there is no ideal solution.

Keywords: element representation, taphonomy, MAU

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Estimation of fish size from archaeological bones of marine catfishes (*Ariopsis felis*): assessing pre-Hispanic fisheries of two Mayan sites

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Abstract

The presence of marine catfishes (*Ariopsis felis*) in several pre-Hispanic Mayan sites indicates their importance in the economy of the region. The present study presents a method for predicting marine catfish body size, standard length, total length and weight, from bones usually recovered from archaeological sites. Osteometrical studies provide allometric formulae with high regression coefficients that were derived from 36 fresh catfish. Based on the regression coefficients, reliability of the measurements and survivorship of the bones in archaeological contexts, the following measurements were used: length of the parasupraoccipital, width and length of the otoliths, width of the dorsal spine, and width of the pectoral spines. The resulting equations were applied to archaeological fish bones from two Maya sites, Xcambó and Mayapán. The application of the osteometric results provides an assessment of the contribution of fish to the economy and permits the identification of fishing methods from two Mayan settlements. These range in date from the Classic (250-750 A.P) to Postclassic (900-1461 A.P) periods.

Keywords: osteometry, catfishes, pre-Hispanic fisheries, Maya

El Niño and trans-Holocene trends in Eastern Pacific fish: a pilot study from Abrigo de los Escorpiones, Baja California

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Abstract

Many questions surround trends in the dynamics of prehistoric fisheries and fish use along the Pacific Coast of North America. Marine fish are particularly sensitive to changes in their environment. These include changes in sea surface temperature (SST) that change cyclically with the El Niño/Southern Oscillation (ENSO). Trans-Holocene palaeontological or archaeological sites with large faunal assemblages, although relatively rare, are the ideal tool for use in reconstructing these palaeoenvironmental records. Here, I report a pilot study from Abrigo de los Escorpiones, a well-dated and stratified site from the Pacific Coast of Baja California. This initial study provides a record of the the last ~2000 years. A wide variety of fish taxa were identified, including a large proportion of surfperch (Embiotocidae). Rockfish (*Sebastes* sp.), sharks and rays (Elasmobranchii), and California sheephead (*Semicossyphus pulcher*), were also identified in this assemblage. Richness and evenness values were calculated for each level to track relative taxonomic abundance through time. Evenness values in particular have the potential to reflect El Niño frequency; higher values through time could indicate an expanding diet breadth due to decreased encounter rates in the highest-ranked fisheries. A significant increase in evenness values through time was revealed, which tracks with the increase in El Niño frequency in the late Holocene. This work has modern value as well as it reconstructs an extended record of marine environments that can inform on modern rehabilitation and conservation efforts.

Keywords: ENSO, palaeoenvironment, Baja California, marine fish

SESSION 10 – POSTER SESSION

3. S10: FISHING, FISH CONSUMPTION AND GENERAL ARCHAEOICHTHYOLOGICAL ANALYSIS

CHAIR: TATIANA THEODOROPOULOU

Fish remains from the Early Pleistocene hominid site of Barranco León (Guadix-Baza Basin, SE Spain)

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Abstract

The Guadix-Baza basin is located in the Betic Ranges (southern Iberian Peninsula) and overlies Mesozoic rocks. This basin was filled by marine rocks during part of the Miocene and continental infill was active until the middle Pleistocene. The Plio-Pleistocene basin infill is built up by the alluvial and fluvial Guadiz Formation (Viseras, 1991) while the lacustrine and palustrine formations are those of Baza, Gorafe-Huélago and Sola (Vera, 1970). The early Pleistocene archaeo-palaeontologial site of Barranco León (Guadix-Baza Basin, SE Spain) is located in the shallow lacustrine areas close to the basin margin and records the oldest hominin occurrence in Europe (Toro *et al.,* 2013) as well as a great number of stone tools and one human tooth with an abundant fauna of large and small vertebrates.

This paper describes the study of one taxon of small vertebrates, the ichthyofauna, which has hitherto been little studied at this site (Doadrio & Casado, 1989; De Marfà, 2007). The studied fish remains were recovered during the excavation and washing campaigns of 2010-11 and correspond to levels D1 and D2 (both belonging to the early Pleistocene, 1.4 My). All remains recovered belonged to the Cyprinidae family which are well conserved. This study improves our knowledge of the palaeogeography and palaeoclimatology during the early Pleistocene of the Guadix-Baza basin.

This study was financed by the national research project CGL2012-38358.

Keywords: Barranco León, Guadix-Baza Basin, Early Pleistocene, ictiofauna, Cyprinidae

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Fishing the sensitive information: reconstructing fish processing practices from the Mesolithic-Neolithic Iron Gates (north-central Balkans)

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Abstract

The Iron Gates area (Danube Gorges, north-central Balkans) have revealed fascinating evidence of human occupation over a long time, spanning the Late Pleistocene to Middle Holocene. It has been hypothesized that favourable fishing conditions lead to the prolonged stay of human communities at least from the regional Early Mesolithic (*c*. 9500-7400 cal. BC). Intensive exploitation of river resources enabled the establishment and development of the first (semi)sedentary settlements during the Late Mesolithic and Neolithic (*c.* 7400-5500 cal. BC). Numerous fish remains and isotopic signatures of individuals buried at the sites confirm the significant role of aquatic resources in peoples' subsistence. The occurrence of large quantities of stone and bone tools have led to conclusions that some of them must have been used in fish procurement and processing. However, to date, no clear connections between knapped stone artifacts and fish processing activities have been demonstrated. The poster presents preliminary results of the experimental work undertaken in order to reconstruct fish scaling and butchering practices. We have knapped chert and used non-retouched flakes to clean slime, scales, to filet and decapitate different fresh water fish whose presence in the Iron Gates has been documented via archaeozoological evidence. In addition, chert artifacts and fish bones with traces of butchery have also been documented in this particular context. The aim of this continuing research is to shed more light on the relationship between tools and fish processing activities, which were of vital importance in the Mesolithic-Neolithic Iron Gates.

Keywords: fish processing, knapped stone artifacts, experimental, cut-marks, use-wear

A Tale of Two Shell Deposits: aquatic resource use at the Copper Age site of Pietrele, Romania

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Abstract

Two shell deposits at a Copper Age tell site at Pietrele, Romania (one on the tell and one in the outer settlement) have faunal assemblages that point to significantly different utilization of aquatic resources, despite their being approximately contemporary. Most of the shells in the deposit on the tell are aquatic snails while those from the outer settlement are mostly freshwater mussels. Although the types of fishes present are substantially the same, the relative importance of the fishes varies significantly. The identified fish bones from the outer settlement are predominately cyprinid fishes, but on the tell there is a more even distribution of fish taxa. The sizes of the fishes also vary, with larger specimens represented in the remains on the tell. The causes and meanings of these differences are still uncertain, but continuing analyses of other materials from these contexts may help to resolve these questions.

Keywords: Chalcolithic, Romania, Danube, tell

Fish remains from the Middle Ages well in via Satta at Sassari (Sardinia, Italy)

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Abstract

Archaeological remains from a well in via Satta in Sassari have been dated to the beginning of the fourteenth century A.D. On the basis of the botanical finds, the filling of the well probably accumulated in a few months and represents the diet of a wealthy family of the period. There are numerous remains of fish, of which I have identified many species - both small and medium-sized. The town of Sassari is not on the seaside and so fish were imported from the coast. A contemporary code of laws regulated the sale of fish and other food in the town.

Keywords: fish, Middle Ages, Sardinia

On an ichthyo-archaeological method to trace Jewish urban households. A study of fish remains from Post-Medieval Amsterdam and Medieval Cologne

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Abstract

This study focuses on 18th century fish remains from an urban site located at the Valkenburgerstraat in Amsterdam. The location of the Valkenburgerstraat 130-146 site within Amsterdam's old Jewish quarter makes it probable that it was inhabited by Jews. Because of this presumed Jewish background it is to be expected that the Jewish dietary laws of kashrut may be reflected in its faunal assemblage. Besides a prohibition on the consumption of ruminants lacking cloven hooves and a number of other mammals and birds, according to kashrut the consumption of fish without fins and/or scales is also forbidden. These animals are considered to be 'unclean' - in Yiddish *treif (*meaning unclean food). The word is derived from the Hebrew *Tareif* meaning the same). Additionally, a number of supplementary criteria apply for the designation of *treif* fish. Most important may be the fact that the fish's scales need to be removable without damaging its skin. An example of a *treif* fish which meets the above mentioned criteria, and which is perhaps one of the most frequently consumed species of fish in the Low Countries, is the European eel. The exclusion of fish like European eel from the Valkenburgerstraat may indicate that it was indeed occupied by Jews. Unfortunately, similar research on fish consumption by Jews has only been done sporadically. Therefore, in order to compare the Valkenburgerstraat's fish record with other North-Western European sites, the contents of four cesspits located at the predominantly Jewish area of the Waterlooplein in Amsterdam together with four complexes located within the Medieval Jewish quarter of Cologne were added to this study. The result of this comparative study indicates that *treif* fish were consumed in very small quantities at most of these sites, including the Valkenburgerstraat. Because these amounts are considered to be very low and most probably the result of a sporadic unorthodox consumption or misunderstanding, together with the fact that European eel appears to have been consumed in far greater quantities at non-Jewish sites in Amsterdam, one can conclude that the Valkenburgerstraat was probably occupied by Jews.

Keywords: Amsterdam, Cologne, Judaism, Kashrut, eel

Fishing methods used in the past from archaeological, archaeo-ichthyological and ethnographic perspective

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Abstract

Fishing methods used in the past are of interest to archaeologists and archaeozoologists for several reasons. They can be the basis for a consideration of technological knowledge and skills of prehistoric societies. They can also be used to discuss such issues as the time and energy involved in fishing, that may indicate the relative importance of fish in the diet and economy.

Reconstructions of prehistoric fishing techniques are usually based on artefacts (hooks, fishing traps, sinkers etc.) and fish remains. The first type of finds, however, is rather rare in Poland. Many of them were probably lost during fishing and nowadays they are often found outside the archaeological sites. The chronological identification of such artefacts is possible only by comparison with similar, well dated finds from other regions of Europe. Fish remains are more numerous and their chronology is usually well known (see for example Makowiecki, 2003). Old fishing methods have been detailed as described in ethnographic references (Znamierowska-Prüfferowa, 1957, 1988). These three kinds of data, however, have not yet been brought together in one article.

This paper will present an overview of fishing techniques used in the Polish territory since the Stone Age to the Middle Ages. It will be based upon archaeological, archaeo-ichthyological and ethnographic data. Moreover, when possible, written sources and historical documents will also be used.

Keywords: fishing methods, Poland, archaeology, ichthyology, ethnography

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Tackling fishbones: an integrated approach to Roman fisheries

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Abstract

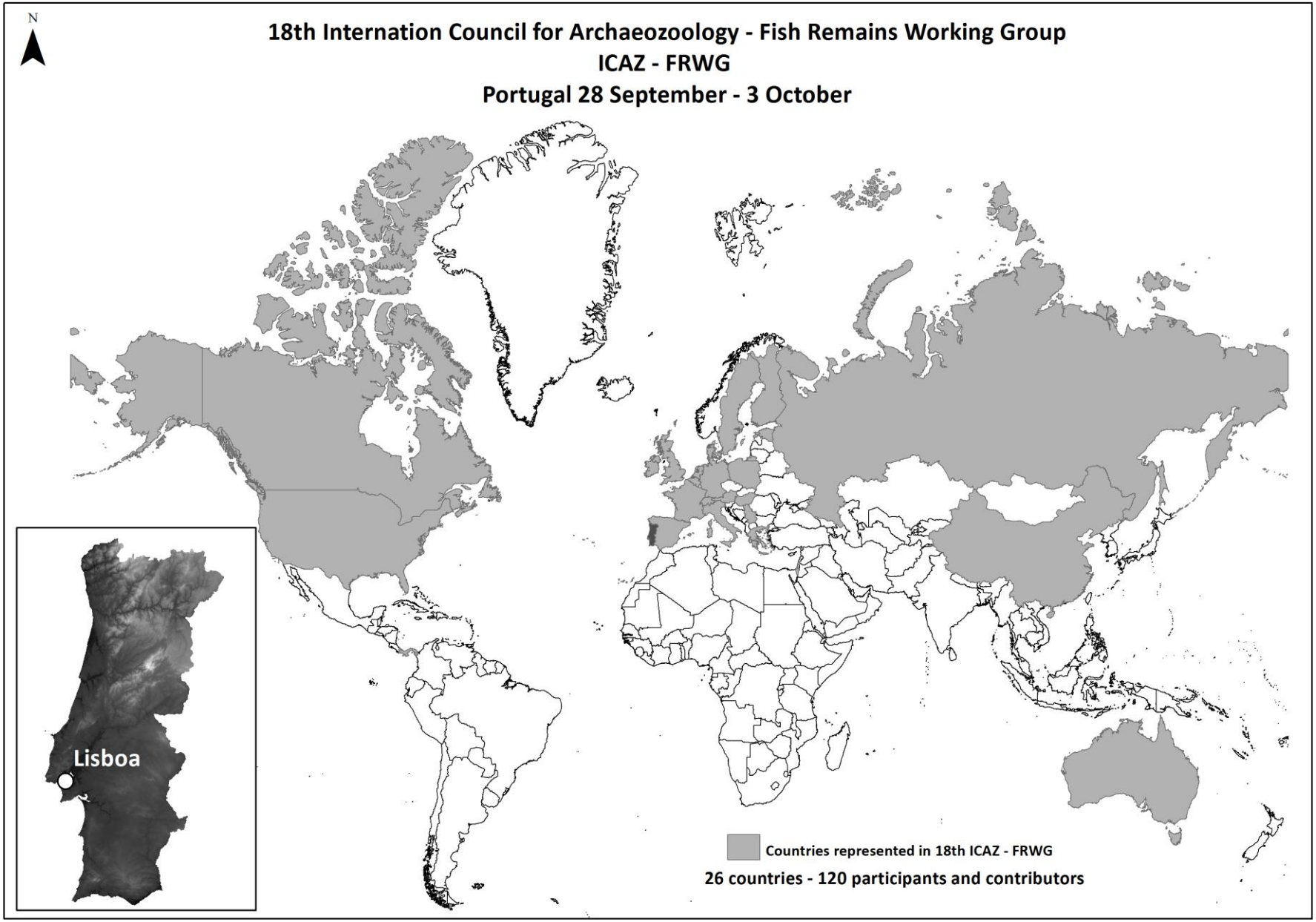
What can the study of fishbone remains from Roman sites tell us about ancient fisheries and fishermen? The growing number of fishbone remains recovered and studied from Roman contexts continues to feed the debate on the socio-economic importance of fishing in the ancient world. However, although the number of case studies is increasing, there continues to be a focus on fish processing sites. As a result, 'Roman fishing' is frequently associated with 'fish sauce'. Although the industrial scale salting of fish for sauce or dry salted products is of notable importance, to concentrate solely on this sector often clouds an underlying structure of equal or greater significance: the fisheries. Whether a permanent fixture to the processing sites, or independent organization within local settlements, Roman fishermen were able to exploit the local resources to an unprecedented scale. There have been few attempts to interpret how these fisheries functioned: the number of fishermen, the tools used, the seasons of fishing and the targeted species or marine habitats. These all require closer attention. The disparity between different research projects is often a result of the scarce archaeological evidence and the need for a complex interdisciplinary approach. This poster will outline preliminary results of a continuing project which seeks to demonstrate the significance of fishbone remains, in combination with other influential studies, in identifying the diversity and distribution of Roman fisheries. By focusing on the Iberian Peninsula and several case studies therein, hypotheses will be tested on how tools and species may be correlated. I will argue that fishbone analysis can ultimately successfully tell us about both small-scale and large-scale fisheries.

Keywords: fishbones, Roman, fisheries, Iberian Peninsula

Number of participants, papers and posters presented, in former FRWG Meetings[1]

Meeting	Participants (N)	Papers (N)	Posters (N)
Copenhagen 1981	16	7	
Sophia Antipolis 1983	30	19	
Groningen 1985	28	19	5
York 1987	38	35	3
Stora Kornö 1989	32	31	6
Schleswig 1991	33	37	5
Leuven 1993	48	36	6
Madrid 1995	57	50	12
Panama City 1997	38	32	3
New York City 1999	43	35	
Paihia 2001	56	39	
Guadalajara 2003	45	34	
Augusta Raurica, Basel 2005	45	31	6
Antibes 2007	87	38	17
Poznań - Toruń 2009	75	43	7
Jerusalem 2011	64	40	12
Tallinn 2013	35	32	3
TOTAL	**770**	**558**	**85**
Lisboa 2015	71	42	16

[1] after MAKOWIECKI D., HAMILTON-DYER S., RIDDLER I., TRZASKA-NARTOWSKI N. and MAKOHONIENKO M. (eds.) 2009. The 15th Meeting of the ICAZ Fish Remains Working Group (FRWG) "Fishes – Culture – Environment Through Archaeoichthyology, Ethnography & History", ŚRODOWISKO I KULTURA, Tom 7 (ENVIRONMENT AND CULTURE, Vol. 7): 10; ZOHAR I. and FRADKIN A. (eds.), 2013. "Fish and Fishing. Archaeological, Anthropological, Taphonomical and Ecological perspectives. *Archaeofauna*, 22; LÕUGAS L. (ed.), 2013. A fish Story or History? Evidence from the past. Program and Abstracts. 17th Meeting of the ICAZ Fish Remains Working Group, Tallinn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18th Internation Council for Archaeozoology - Fish Remains Working Group
ICAZ - FRWG
Portugal 28 September - 3 October
Lisboa
Countries represented in 18th ICAZ - FRWG
26 countries - 120 participants and contributors

List of Participants and Contributors

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