



Fondazione di Sardegna



Comune di Alghero



Fish and Fishing Communities
Understanding Ancient and Modern Fisheries
through Archaeological Fish Remains

ITALY | ALGHERO - STINTINO

1st - 7th OCTOBER 2017



ICAZ | 19th FRWG Meeting | Sardinia, 2017

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ABSTRACT BOOK

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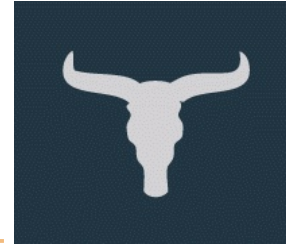
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ICAZ | 19th FRWG Meeting | Sardinia, 2017

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INDEX

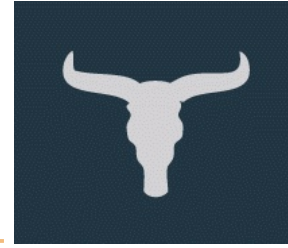
Index	3
Detailed schedule	5
Session 1. Commercial fishing including storage and trade of fish	5
Session 2. Freshwater fishes: fishing and aquaculture	6
Session 3. Dawn of fisheries: Stone Age fishing techniques	7
Session 4. Life in ancient and modern fishing communities	8
Poster Session	9
Session 5. Fish food supply: historical and archaeological data	10
Session 6. Advance in Methodology, Microbiology and Applied Chemistry	11
Schedule	13
List of lecture abstracts in alphabetical order	15
Number of participants, papers and posters presented in former FRWG Meetings	60
Sponsors and contributors	63



ICAZ | 19th FRWG Meeting | Sardinia, 2017

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19th FISH REMAINS WORKING GROUP MEETING

DETAILED SCHEDULE

SUNDAY, OCTOBER 1st

conference hall of the Fondazione META, Largo S. Francesco, Alghero

10:00 - Registration

16:30 - Opening Remarks:

Barbara Wilkens and Gabriele Carenti (Organizers of the 19th ICAZ FRWG);
Mario Bruno (Mayor of Alghero); Raffaele Sari (President of the META foundation);
Piero Bartoloni (Professor of Phoenician and Punic Archaeology); Arturo Morales
Muñiz (founder member of the ICAZ FRWG).

18:00 - Reception

MONDAY, OCTOBER 2nd

conference hall of the Fondazione META, Largo S. Francesco, Alghero

09:00 - Opening Session 1

Session 1. Commercial fishing including storage and trade of fish

chair: Philippe Béarez

Luis Roberto Miranda Muñoz, The fish from the Paloma village, Lima, Peru.

Lee Graña, The Romano-British fisheries: An integrated approach.

Nayeli Jiménez Cano, Eufrasia Roselló Izquierdo and Arturo Morales Muñiz,
Ichthyoarchaeology from the Mayan World: Transforming palaeocultural and
palaeoecological paradigms in the Northern Lowlands from the Classic (500-900
d.C) to the Post-Classic (900-1400 d.C) periods.

Sandrine Grouard, Chronology of West Indian palaeofishery.

Frank Salvadori, The ichthyofauna findings from Late Antiquity and Middle Ages Italian contexts.

Leif Jonsson, Stockfish and dried pike in Medieval Uppsala, a case study of the recognition of dried fish products in urban zooarchaeology.

10:30 - Discussion

11:00 - Coffee Break

11:30 - Session 1, continued

Lembi Lõugas, Eve Rannamäe, Andres Tvauri and Freydis Ehrlich, Duty on fish: Analyses of animal remains found from the Uue-Kastre castle and customs station site between Russia and Estonia.

Hanna Kivikero, Fish products in the Åland islands during the Early Modern period.

Ambra Zambenardi, The non-fish or the hyper-fish of the Mediterranean: Bluefin tuna (*Thunnus thynnus*) and its fishing communities through the Tonnara culture.

12:15 - Opening Session 2

Session 2. Freshwater fishes: fishing and aquaculture

chair: Heide Hüster Plogmann

Ying Zhang, Freshwater fishing strategies in the Neolithic Yangtze River region: Environment and culture.

Alfred Galik and Elisabeth Stephan, Fishing at the Early Neolithic Hornstaad-Hörnle site at Lake Constance, Germany.

Miroslawa Zabilska-Kunek, Neolithic fish remains from Rakushechny Yar, South Russia.

13:00 - Discussion

13:30 - Lunch

15:00 - Session 2, continued

Chong Yu, The exploitation of fish in the Pearl River Delta, South China during the Neolithic and Early Bronze Age.

Angela Maccarinelli, Food for the wealthy? An overview of the role of freshwater fish in Medieval England.

Simone Häberle and Heide Hüster Plogmann, Archaeological and Historical evidence of fish food supply, fish farming, and fish trading in Medieval and Early Modern Switzerland.

15:45 - Opening Session 3

Session 3. Dawn of fisheries: Stone Age fishing techniques

chair: Harry Robson

Emilie Guillaud, Philippe Bearez, Marie-Hélène Moncel, Arturo Morales and Wim Van Neer, Exploitation of aquatic environments during the Middle Palaeolithic in Western Europe.

Kenneth Ritchie, Harry Robson, Fishing in Stone Age Southern Scandinavia.

16:15 - Discussion

16:45 - Coffee Break

17:15 - Session 3, continued

Veerle Linseele, Donatella Usai and Sandro Salvatori, Fishing at Mesolithic Al Khiday (Central Sudan, 7th millennium cal BC): Multidisciplinary data and their anthropological implications.

Eufrasia Roselló Izquierdo, Leif Jonsson, José Luis Arribas Pastor, Laura Llorente Rodriguez and Arturo Morales Muñiz, The European Hake (*Merluccius merluccius* L.): A deep-water fishery during the Neolithic?

Ivana Živaljević and Sofija Stefanović, Neolithic fishing landscapes: Case studies from Serbian sites in the gorges and in the plains.

Kevin Lidour, Philippe Béarez, Sophie Méry, Akab Island, new results on fishing at a Late Neolithic stratified site in the Persian Gulf.

Anaïs Marrast and Philippe Béarez, Ancient fishing at the Neolithic settlement of Ra's al Hamra 6 (Sultanate of Oman).

18:30 - Discussion

19:00 - Close

TUESDAY, OCTOBER 3rd

conference hall of the Fondazione META, Largo S. Francesco, Alghero

09:00 - Opening Session 4

Session 4. Life in ancient and modern fishing communities: Ethnicity

chair: Kenneth Ritchie

Tarek Oueslati, A French Fish Event at the turn of the 10th century? Environment, economy and ethnicity in maritime Flanders.

Sónia Gabriel and André Teixeira, Fishing in the Straits of Gibraltar in Late Medieval times: Food in Islamic contexts from the archaeological site of Qsar es-Seghir, Morocco.

Ivana Živaljević, Nemanja Marković and Milomir Maksimović, Food worthy of kings and saints: Fish consumption in the Medieval monastery Studenica (Serbia).

Emma Maltin, Ethnicity expressed in fish consumption?

Jan K. Bakker, Fish consumption amongst the Ashkenazi and Sephardi Jews in Post-Medieval Amsterdam.

Omri Lernau, Remains of kosher and non-kosher fish in excavated settlements in Israel.

10:30 - Discussion

11:00 - Coffee Break

11:30 - Session 4, continued

Session 4. Life in ancient and modern fishing communities

chair: Sónia Gabriel

Tatiana Theodoropoulou, Bringing the sea into the cave: Fish and other marine animal remains from the Neolithic cave of Alepotrypa, Diros (Greece).

Stephanie Emra and Alfred Galik, Fishing strategies at the coastal site of Çukuriçi Höyük in Western Anatolia at the dawn of the Bronze Age.

Mari Yamasaki, Fishing and connectivity in the Eastern Mediterranean Bronze Age.

Wim Wouters, 1,000 years of fishing and fish consumption in the town of Mechelen (Belgium).

Philippe Béarez and Laurie Bouffandeau, Fishing for survival: The forgotten slaves of Tromelin Island (Indian Ocean).

Matthew Campbell, A highly fragrant comestible: The cartilaginous fish (Chondrichthyes) in Pre-European Maori New Zealand.

13:00 - Discussion

13:30 - Lunch

15:00 - Poster Session

chair: Arlene Fradkin, Gabriele Carenti

Session 1: Commercial fishing including storage and trade of fish

Alfredo Carannante, Garum production in Pompeii and Campania in the last two millennia: A multidisciplinary approach

Session 2: Freshwater fishes: fishing and aquaculture

Frank Salvadori, **Barbara Wilkens** and Enrico Cavada, Project SMaLL: The fish remains from San Martino Site (Lomaso, TN).

Yevheniia Yanish, Results of the analysis of the fish bones from the archaeological excavations of the Scythian hill fort, Severynivka.

Eric J. Guiry, Suzanne Needs-Howarth, Alicia L. Hawkins, Trevor Orchard, Isotopic analyses of archaeological fish track significant human impacts on Lake Ontario nutrient cycle.

Session 3: Dawn of fisheries: Palaeolithic fishing techniques

Clara Boulanger and Alfred Pawlik, Coastal subsistence strategies at Bubog I (Ilin Island, Mindoro, Philippines) from the Terminal Pleistocene to the Middle Holocene.

Lucie Coudert, François Bon, Laurent Bruxelles, Jessie Cauliez, Asamerew Dessie, Elise Dufour, Denis Fiorillo, Marc Gosselin, Lamy Khalidi, Michel Lemoine, Joséphine Lesur, Clément Ménard, and Romain Mensan, Change in fish lacustrine communities in the northern part of the East African Rift Valley (Ethiopia, Djibouti) between 11500 and 2000 cal BC.

Natalie Roski, Wim Van Neer, Wim Wouters and Jörg Linstädter, Marine fish exploitation during the Epi-Palaeolithic and Early Neolithic of Abri Ifri Oudadane, North East Morocco.

Session 4: Life in ancient and modern fishing communities

Olga Krylovich, Fish remains from an ancient midden on Chuginadak Island, Islands of Four Mountains, Aleutian Islands, Alaska.

Gabriele Carenti and Kirsi Lorentz, Fishing in Ancient Cyprus: Ichthyology and human bioarchaeology.

Nayeli G. Jiménez Cano, Jeff Bryant and Marilyn Masson, Ichthyoarchaeological analysis at Mayapán: Post-Classical fish use and environmental implications.

Session 5: Fish food supply: historical and archaeological data

José Barbieux, Etienne Louis and **Tarek Oueslati**, A hundred rotten fish in a pit. Historical and archaeological evidence of seizure and burial of fish improper for sale in the 18th century city of Tourcoing, France.

Session 7: Advance in Methodology, Microbiology and Applied Chemistry

Elise Dufour, Benoît Clavel, Gabriela Borges, Sophie Cersoy, Matthieu Lebon, Olivier Tombret, Denis Fiorillo and Laurent Simon, Fish, where are you from? Bone collagen analysis of remains from the 8th to the 17th centuries in Northern France.

Elise Dufour, Lucie Coudert, Joséphine Lesur, Marc Gosselin, Michel Lemoine, Denis Fiorillo. Kelig Mahé, Romain Elleboode, Xavier Gutherz and Jessie Cauliez, Timing of fishing of Tilapinii... but which one?

Alicia L. Hawkins and **Suzanne Needs-Howarth**, Are all identifications created equal? An experiment in inter-analyst variation.

Anaïs Chalant and Benoît Clavel, Sampling methods applied to the Medieval archaeological site of Boves castle (Somme, France).

Emilie Guillaud, Arturo Morales, Eufrosia Roselló, Philippe Bearez and Marie-Hélène Moncel, Taphonomic analysis of fish bone accumulations produced by Yellow-legged Gull (*Larus michahellis*, Laridae) in Chafarines Island, Spain.

17:15 - Coffee Break

17:45 - Opening Session 5

Session 5. Fish food supply: historical and archaeological data

chair: Alfred Galik

Alessandra Tarter, Marco Bertolini and Ursula Thun Hohenstein, Exploitation of fish resources during the Recent Bronze Age in the Polesine area: The cases of Campestrin, Larda and Amolara sites (Rovigo-Northeastern Italy).

Aurélia Borvon, New data on the consumption of fish from the Alsace Region, Eastern France, from the Bronze Age to the First World War.

Arlene Fradkin, Colonial and Modern fisheries in the Indian River Lagoon, Florida, USA.

18:30 - Discussion

19:00 - Close

WEDNESDAY, OCTOBER 4th

09:00 - Transfert from Alghero (start point: via Sassari, 3, Porta Terra) to Stintino - Museo della Tonnara, via Lepanto, Stintino.

10:00 - Visit to the museum conducted by Salvatore Rubino (Scientific Director of the Tonnara Museum - Stintino) and welcome ceremony: Esmeralda Ughi (curator of the Tonnara Museum - Stintino); Antonio Diana (Mayor of Stintino); Francesca Demontis (Cultural heritage council member of the Stintino community).

11:00 - Coffee Break

11:30 - Opening Session 7

Session 6. Advance in Methodology, Microbiology and Applied Chemistry

chair: Salvatore Rubino, Tatiana Theodoropoulou

David Orton, Using fish bone data to construct long-term economic time-series: Potential and limitations of a new approach.

Ryan Desrosiers and **David Orton**, Understanding variation in fish bone isotopes: A *bigmedium* data approach

Laura Llorente Rodríguez, Oliver E. Craig, Rachelle Martyn, Arturo Morales Muñiz, Eufrosina Roselló Izquierdo, Eduardo González Gómez de Agüero and Carlos Fernández Rodríguez, Unrevealing hake fishing with isotopes through time.

Richard C. Hoffmann, Who dined extensively on fish in Medieval Europe? A critical consumer reads stable isotope analyses.

Thomas C. A. Royle, Eric J. Guiry and Dongya Y. Yang, Ancient DNA and stable isotope analysis of fish remains from Charlie Lake Cave (HbRf-39), British Columbia, Canada.

Gregory Neils Puncher, Alessia Cariani, **Elisabetta Cilli**, Francesco Massari, Castrense Savojardo, Sara De Fanti, Agostino Leone, Pier Luigi Martelli, Andrea Luchetti, Barbara Mantovani, Rita Casadio, Arturo Morales, Vedat Onar, Nezir Yaşar Toker, Tom Moens and Fausto Tinti, The impact of fisheries on bluefin tuna (*Thunnus thynnus*) over two millennia (2nd century BC – 20th century AD): Genetic and genomic analyses of ancient tuna remains from the Mediterranean, Atlantic, and Black Seas.

13:00 - Discussion

13:30 - Lunch



15:00 - Session 6, continued

chair: Elise Dufour

Simon Hickenbotham, **Matthew Collins**, Kristine Korzow Richter, Krista McGrath, Jessica Hendy and Nicole Bovin, ZooMS for everyone.

Kristine Korzow Richter, Jennifer Harland, Andrew A. K. G. Jones, Krista McGrath, Camilla Speller and Matthew J. Collins, Widening the net: ZooMS identification for fish.

Susan D. deFrance and Michelle J. LeFebvre, Problems and issues in Ancient Caribbean fisheries research.

Jen Harland and Wim Van Neer, Weird fish: Pathological fish bones and what we can do with them.

16:00 - Discussion

16:30 - Coffee Break

17:00 - Closing Remarks and proposals for the 20th Fish Remains Working Group

18:30 - Transfer to Capo Falcone

20:00 - Reception and Social Dinner

23:00 - Transfer to Alghero

OCTOBER 5th-7th

10:00 - October 5th: Start Field Trip

17:00 - October 7th: End Field Trip

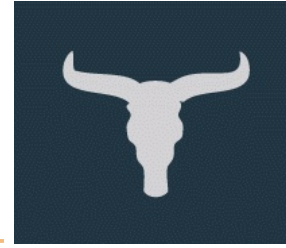




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LIST OF LECTURE ABSTRACTS IN ALPHABETICAL ORDER

Jan K. Bakker*

* Amsterdam Centre for Ancient Studies and Archaeology, University of Amsterdam (Turfdragsterspad 9, 1012 XT Amsterdam, The Netherlands); j.k.bakker@uva.nl; +31205253784

Fish consumption amongst the Ashkenazi and Sephardi Jews in Post-Medieval Amsterdam

Keywords: Amsterdam; Waterlooplein; Judaism; Ichthyoarchaeology

This preliminary study explores the potential differences in fish consumption between the 17th and 18th century AD members of Amsterdam's two major Jewish communities, the Ashkenazim and Sephardim, by examining the fish remains found in several cesspits at the former predominantly Jewish Vlooienburg neighborhood. Differences in customs and rites between these two communities, which is thought to have led to many serious disputes between them throughout Early Modern times, may potentially be reflected by the fish remains found within these archaeological complexes. This is based on the hypothesis that the Sephardi Jews originating from the Iberian Peninsula (mainly Portugal) who came to settle in Amsterdam, as well as their later descendants, were more accustomed to consuming marine fish. In contrast, the Ashkenazi may have been more familiar with consuming freshwater fish as a result of the more landlocked regions (e.g. present day Germany, Czech Republic and Poland) from where they originated. Because trends, market supplies, and financial wealth may have very well influenced what kinds of fish these people ate or had access to, a comparison is made with several non-Jewish Amsterdam complexes.

José Barbieux, Etienne Louis and **Tarek Oueslati***

* CNRS University of Lille (Domaine Universitaire du Pont de Bois B.P. 60149, 59653 Villeneuve d'Ascq, France); tarek.oueslati@univ-lille3.fr; +33 6 89 14 93 16.

A hundred rotten fish in a pit. Historical and archaeological evidence of seizure and burial of fish improper for sale in the 18th century city of Tourcoing, France

Keywords: Fish market; Quality control; History; Archaeology

The Main Square in the city of Tourcoing (France) was excavated in 1982. An unusual discovery within a shallow pit motivated the excavator to preserve the entire fill of this structure for future research. In 2016 this material was sieved and studied in our zooarchaeology laboratory. We identified over 100 whole haddock skeletons buried with their skin, which measured between 50 and 60 cm in total length. The ichthyoarchaeological analysis alongside a historical study of the preserved archives in the area demonstrated the seizure of a stock of fish improper for sale. In this paper we will describe how fish markets operated and the type controls imposed upon fishmongers. We will provide examples of violations to the rules, seizures and trials recorded in the local archives.

Philippe Béarez* and Laurie Bouffandeau

* UMR 7209 CNRS/MNHN, Muséum national d'histoire naturelle, (55 Rue Buffon, 75005 Paris, France); bearez@mnhn.fr; +33140793736

Fishing for survival: The forgotten slaves of Tromelin Island (Indian Ocean)

Keywords: Island; Hostile environment; Subsistence fishery; Indian Ocean

In July 1761, a ship coming from Madagascar was on its way to Mauritius to clandestinely deliver its cargo of slaves. Unfortunately, the ship was grounded on the island of Tromelin, and a few survivors took refuge there. The remains of the wreck were used to construct a small boat so that the French crew could return to Madagascar. They left behind 60 slaves, promising to return and rescue them. Since 2006, under the archaeological program "Forgotten Slaves", a multidisciplinary team has explored the settlement of the Malagasy slaves abandoned on the island. Thousands of animal bone remains have been found at the tip of the island where the slaves stayed after the departure of the French crew. These food remains, accumulated during the 15 years of their forced stay on Tromelin, testify to how these people survived. While most of this food waste consists of seabirds, fish and sea turtle remains are also present. The fish remains

are surprisingly scant, which is surprising on a small island where the ocean is omnipresent. However, the swell reaches the island without any obstacles and continually breaks, making the approach to the shore dangerous. Moreover, the origin of the slaves is unknown. They may have come from the plateaus of Madagascar and thus were not fishermen. The identification of the fish remains indicates relatively high species diversity, with at least 11 families represented. The fish consumed are also of various sizes, and most of them may have been caught from the shoreline, though larger fish probably required angling from a boat. Although it had a limited accessible coastline, Tromelin appears to have been rich in resources. The diversity of the species found in the excavations testifies to the skill and opportunism of the inhabitants of the island. This study addresses the conditions and problems of survival in a pristine but confined and hostile coastal environment.

Aurélia Borvon*

* Independant researcher - UMR 7041 ArScAn Equipe Archéologies Environnementales, Nanterre & Laboratoire d'Anatomie Comparée, Oniris (École Nationale Vétérinaire, Agroalimentaire et de l'Alimentation, Nantes-Atlantique); 16 rue Gabriel Goudy 44200 Nantes FRANCE; aureliageronimo@aol.com; aurelia.borvon@mae.u-paris10.fr; +33603470747

New data on the consumption of fish from the Alsace Region, Eastern France, from the Bronze Age to the First World War

Keywords: Fish consumption; Diachrony; Alsace; France

Until recently, very few fish studies were available on the historical periods for the Alsace region in Eastern France. The recent study of several archaeological sites, however, brings new knowledge about the consumption of fish for this region. The data come from different types of sites (abbey, urban, etc.) and structures (latrines, habitat, etc.) dating to the Roman, Medieval, and Modern periods. The assemblages vary at each site, ranging from ca. 150 to 3500 bones, of which 40 to over 800 were identified. Two sites, one from the Bronze Age and one from the First World War, had only a few bones, one and nine respectively. Various species were identified, consisting mostly of freshwater species, such as cyprinids, pike, and stickleback. The one bone from the Bronze Age is a Wels catfish vertebra, which provides new evidence for the presence of this species in Western Europe. Migratory fish are also present, consisting mostly of European eel. Also, there were several marine species, such as herring, which is surprising especially for the earlier contexts because of the distance of these sites from the sea. Herring is found in contexts from the Roman period to the First World War.

Clara Boulanger¹ and Alfred Pawlik²

¹ UMR 7194, Muséum national d'Histoire naturelle (Musée de l'Homme - 7, place du Trocadéro 75016 Paris; School of Culture, History & Language, ANU College of Asia and the Pacific (Acton ACT 2601); clara.boulanger@gmail.com, +33640647030

² Archaeological Studies Program, University of the Philippines Diliman (Albert Hall, Lakandula Street, Quezon City, 101 Metro Manila); afpawlik@up.edu.ph

Coastal subsistence strategies at Bubog I (Ilin Island, Mindoro, Philippines) from the Terminal Pleistocene to the Middle Holocene

Keywords: Australo-Melanesian; Ichthyofauna; Mangrove swamps; Coral reefs

The Bubog I rockshelter (Ilin Island, Southwestern Mindoro, Philippines) has revealed a human-induced shell-midden spanning from the Terminal Pleistocene to the Middle Holocene. Several vertebrate remains have been recovered here mostly from marine environments. This unique study for an island in Southeast Asia highlights the subsistence behaviour of an Australo-Melanesian group of people who were mainly based on fishing and crabbing as well as the exploitation of terrestrial micro-vertebrates. The inhabitants of Bubog I developed skills to live on the coasts of the small island of Ilin, exploiting the surrounding coral reefs and mangrove swamps. Reefal taxa such as Scaridae, Labridae, Acanthuridae and Balistidae have been identified at the highest possible taxonomic level, as well as predators such as Carcharhinidae, Muraenidae, Serranidae, Lutjanidae, Lethrinidae and the anecdotal presence of Scombridae. Mangrove swamps are also nurseries for some species of these families. From this diversity, both in taxa and environments, the inhabitants of Bubog I most likely developed a wide set of fishing and catching techniques. They further developed some specific knowledge as shown by the presence in high quantity of poisonous Tetraodontiformes fish remains (Ostraciidae, Tetraodontidae and Diodontidae). At the light of proportions of crustacean and fish remains versus mammal remains, mangrove foraging in Bubog I was interestingly replaced by ca. 6000 BP by tropical rainforests foraging when the development of the swamps was at its maximum in the Philippines.

Matthew Campbell*

* CFG Heritage Ltd (132 Symonds Street, Eden Terrace, Auckland 1010, New Zealand); mat.c@cfgheritage.com; +6421437555

A highly fragrant comestible: The cartilaginous fish (Chondrichthyes) in Pre-European Maori New Zealand

Keywords: Sharks and rays; Vertebrae; New Zealand

While the importance of sharks and rays (Chondrichthyes) in Pre-European Maori

economies in New Zealand is clear from ethnographic sources, archaeological evidence of shark and ray fisheries is extremely limited. This paper examines the ethnographic literature on shark and ray fisheries and the rather limited evidence of sharks and rays in the archaeological record. The analysis of approximately 6500 Chondrichthyes vertebrae from the NRD site (R11/859) near Auckland is presented.

Alfredo Carannante*

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Garum production in Pompeii and Campania in the last two millennia: A multidisciplinary approach

Keywords: Garum; Fish sauces; Pompeii; Roman period; Campania

Pompeii was one of the most important garum production centres in the Roman Empire. Recent ichthyoarchaeological analyses on fish remains from Pompeii and other archaeological sites reveal details on garum and fish sauce production processes in ancient Campania. A multidisciplinary approach allows for the reconstruction of the fishing techniques and seasonality patterns involved in this industry. A comparison of the Imperial Age data with Campanian Medieval sources and modern ethnographical research shows the continuity in fish sauce production in Campania over the last two millennia.

Gabriele Carenti¹ and Kirsi Lorentz²

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Fishing in Ancient Cyprus: Ichthyology and human bioarchaeology

Keywords: Mediterranean; Cyprus; External Auditory Exostoses; Fish remains; Bibliographic data

Activities related to the exploitation of maritime natural resources have been, and continue to be, a fundamental aspect of human history on the Mediterranean island of Cyprus. This paper focuses on the ichthyological evidence for marine resource procurement in relation to evidence for repetitive aquatic activity by humans (external auditory exostoses, hereafter EAEs), from the earliest attested human occupation of the island (Pre-Pottery Neolithic B) to the Middle Ages. EAEs are clinically proven proxies for repetitive aquatic activity

and, in the absence of substantial freshwater bodies in Cyprus, can be related to maritime activity. Examination of fish bones from archaeological sites in Cyprus allows us to study topics related to the evolution of fishing and of human engagement with the sea. These remains also help us address key questions on the archaeology of the region, such as the Broad Spectrum Revolution. Quantitative and qualitative data on fish species uncovered from a large number of archaeological sites (published reports and grey literature) and contextual data on archaeological fishing gear, together with ethnographic research, form the core focus of this paper. The results include describing patterns regarding the type of fishing activity/exploitation at specific sites and time periods (including settlements likely specialising in fishing) and providing recommendations for improving recovery strategies. This is the first time an effort is made to arrive at a synthesis of the state of research in this domain. As such, the paper will also outline avenues for further research.

Anaïs Chalant* and Benoît Clavel

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Sampling methods applied to the Medieval archaeological site of Boves castle (Somme, France)

Keywords: Sampling; Fish; Archaeozoology; Medieval Period

In a similar manner to vertebrates, fish remains are strongly underestimated in archaeological contexts. This can be explained by at least two reasons: differential preservation and/or recovery techniques (i.e. sieving); the latter is a recurrent problem even though this practice has become more frequent during archaeological investigations over the last five decades.

In order to recover small bone remains, it is important to realise a more selective sorting. Yet, it requires collecting a substantial volume of sediments, dictated by a well-reasoned sampling protocol elaborated with the operation manager.

As part of the GDR 3644 BioarcheodaT (directed by J-D Vigne), the “ichthyoarchaeology sampling” group, supervised by M. Sternberg and B. Clavel, was formed in 2014. The purpose of this group is to create indicators in order to guide sampling implementation in the field. Considering bone remains coming from an entirely sieved context, the aim is to develop one or several statistical

sampling models to reduce the collected volume without losing information. This contribution will focus on applying developed statistical tools to the castle of Boves (Somme, France).

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Change in fish lacustrine communities in the northern part of the East African Rift Valley (Ethiopia, Djibouti) between 11500 and 2000 cal BC

Keywords: Rift Valley; Palaeoenvironment; Pleistocene; Holocene; Fishing

The East African Rift Valley is characterised by the presence of a series of rather small and isolated watersheds. Present hydrological conditions are recent and changing. Due to the Pleistocene and Holocene climatic fluctuations, the lakes have undergone several transgressions and regressions. These have resulted in salinity variation and isolation of lakes that were previously connected, forming an extensive hydrographical system. These hydrological fluctuations have caused fundamental changes in fish populations and it is difficult to determine which species inhabited successively the different lakes. This pattern greatly limits the specific identification of fish remains present at the archaeological sites and reconstruction of fishing practices. An attempt to estimate the community composition was therefore initiated. A series of samples from archaeological sites and natural lake deposits dated between 11500 and 2000 cal BC were taken in the northern part of the East African Rift. To reconstruct palaeoenvironmental conditions, a geological and geomorphological study as well as stable isotopic analyses on *Tilapia* otoliths were carried out. The results of these different approaches will be compared to interpret as precisely as possible the faunal assemblages. It will also lead to a better understanding of the human subsistence strategies in accordance with the major environmental constraints in play, i.e. the regression and the transgression phases of the lakes.

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Problems and issues in Ancient Caribbean fisheries research

Keywords: Caribbean; Taxonomy; Hybrids

Fish assemblages from most Pre-Columbian Caribbean sites are characterised by high taxonomic diversity because of abundant remains of varied reef fishes and their predators. When analysts make taxonomic identifications of these remains, we are often unable to make species level identifications with confidence because of the morphological similarity among species of common fish genera; for example, parrotfishes, genus *Sparisoma*. Although many species of the same genus may share similar habitats and probable methods of capture, our inability to identify exact species as opposed to genus level identifications hampers our ability to understand human preference or selection of fishes with particular traits, such as fish color. This in turn impacts the use of archaeological fish assemblages in rendering both cultural and biological understandings of fishing through time. In this paper, we explore some of the identification challenges that Caribbean assemblages pose using fish remains from the large, Late Pre-Hispanic Taino village of En Bas Saline, Haiti, and the Ceramic period village of Tibes on Puerto Rico. We consider which elements are most amenable to species level identifications and those that are best identified to higher-level taxonomic categories. We also discuss how recent applications of interdisciplinary methods of bone identification may be applicable to Caribbean fish assemblages for elucidating taxonomic diversity.

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Understanding variation in fish bone isotopes: A bigmedium data approach

Keywords: Stable isotopes; Ecology; Methodology; Salinity; Climate

Stable isotope analyses are increasingly used within ichthyoarchaeology in order to explore past fish migration patterns, detect long-range trade, or assess trophic cascades and other ecological shifts. While the broad factors affecting the carbon and nitrogen isotopic values in fish (e.g. temperature, salinity, trophic level, terrestrial nutrient input) are fairly well understood, the relative importance of and

interaction between these factors are less clear. A better understanding of how these factors play out in isotope values across past aquatic ecosystems would greatly enhance the potential of isotope studies in ichthyoarchaeology. We take an empirical approach to this issue, presenting results from an ongoing effort to construct a comprehensive database of published fish bone isotope data that can be examined to assess the relative impacts of different ecological and methodological variables. In addition to the still fairly limited number of isotopic studies of ancient fish per se, this database utilises the large and growing body of fish isotopic data generated by studies focusing on human diet. We present initial findings regarding: (a) the consistency of freshwater versus marine values over time and space; (b) the relative importance of salinity and climate in determining isotope values; and perhaps most importantly, (c) apparent impacts of methodological and taphonomic factors on isotope results.

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Fish, where are you from? Bone collagen analysis of remains from the 8th to the 17th centuries in Northern France

Keywords: Bone collagen; Stable isotopes; Provenance

Archaeozoological studies show a drastic change in the exploitation of aquatic resources in Northern France since AD 1000. However, it is not possible to determine the precise location of the fishing areas because most fish species were ubiquitous during the Early Middle Ages and could have lived either in estuaries or in the open sea. Isotopic biogeochemistry is now an integral part of the tools available in archaeology to reconstruct past food patterns and residential mobility of humans and animals. Previous studies have demonstrated the importance of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of fish bone collagen to describe the ecology and ethological evolution of marine, freshwater, and anadromous species and to identify the provenance of fisheries. However the collagen of archaeological fish is likely to be altered due to the small size and fineness of the majority of bone remains. The aim of this study is to identify the fishing areas and, by extension, the distribution networks of fishery products in Northern France and thus to

document the adaptation of fishermen to changes in their immediate environment. To this end, bone collagen of species of different ethology from sites dating from the 8th to the 17th centuries was analysed using Isotope Ratio Mass Spectrometry (IRMS). An adapted analytical protocol was used which includes the prior Fourier Transform Infrared (FTIR) analysis—Attenuated Total Reflection (ATR mode) of total bone to estimate the quantitative and qualitative preservation of collagen.

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Timing of fishing of Tilapinii... but which one?

Keywords: Africa; Otoliths; Stable isotopes; Form analysis

Fishing has played a very important role in the diet as well as the mobility of human groups in North Africa during the Holocene. The Tilapinii are well represented in continental African sites and often almost all of the otoliths recovered in sites can be attributed to this taxon. The classic analysis of bone remains hardly provides information on the role of fish in the annual food round. Isotopic sclerochronology is the combined analysis of growth marks with a seasonal rhythmicity and oxygen isotopic values ($\delta^{18}\text{O}$). Isotope sclerochronology of Tilapinii otoliths was used to document the hydroclimatic conditions and reconstruct the period of the hydrological cycle when the fish died – and then when fishing took place at Asa Koma (1500-2500 cal BC; Djibouti). Adaptations were made necessary for the sampling of Tilapinii otoliths. Estimating the fishing season will allow us to obtain an insight into the seasonality of occupation of the site. For such analyses, it is useful to determine the otoliths at the species level. The diversity in otolith morphology at Asa Koma suggests the presence of different species. However, species attribution is difficult because of low morphological differences between genus and species of Tilapinii and a lack of data on the former geographical repartition of the species. In order to distinguish species a Linear modelling of general descriptors of shape (external contour of otolith) was developed at the genus level. The method appears promising but necessitates a large and good quality dataset of modern otoliths.

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Fishing strategies at the coastal site of Çukuriçi Höyük in Western Anatolia at the dawn of the Bronze Age

Keywords: Early Bronze Age; Anatolia; Metallurgy; Coastal

Çukuriçi Höyük is a tell settlement in Western Anatolia and one of the oldest sites on the Western Mediterranean coast. It was settled at the beginning of the Pottery Neolithic and continued into the Early Chalcolithic Period. After a hiatus, the settlement phases document human activities from the Late Chalcolithic into the Early Bronze Age I (hereafter EBA I), 2900–2750 cal BC. The excavations in the EBA I settlement revealed very early metal production activities and an abundance of obsidian coming from the island Melos. The archaeological remains were recorded with detailed contextual information. The majority of the fish remains come from sieved sediment samples with only a few larger remains deriving from hand collection. Besides evidence of catadromous European eel, the ichthyofauna consists only of marine species, indicating exploitation of nearby marine environments. The most important fish resource used at the site were sea breams and grey mullets. The presence of parrotfish, scorpionfish, goatfish, lippfish, sea bass, drums, whiting, grouper, and a clupeid fish probably indicate a concentration of fishing close to the shore rather than offshore fishing, although some larger individuals found may indicate that some fishing was done at a greater distance from the shore. A rather large number of cartilaginous fish remains were also found, including two stingray spines. This paper will explore the fishing and marine exploitation strategies employed by the Early Bronze Age dwellers of Çukuriçi Höyük.

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Colonial and Modern fisheries in the Indian River Lagoon, Florida, USA

Keywords: Fish; Estuaries; British Colonial Florida; Modern fisheries

The Indian River Lagoon (IRL) is a narrow estuary extending 251 km (156 miles) along the Atlantic coast of Florida. One of the most biodiverse waterways in North America, this aquatic ecosystem is home to more than 4000 plant and animal species, including approximately 700 fish species. Nevertheless, over the past

several decades, the Lagoon has become an “estuary in peril”, its waters threatened by degradation from pollution, habitat loss, stormwater runoff, and other human-induced activities. Local fish populations have been greatly affected as toxic algae blooms periodically trigger massive fish kills. According to archaeological faunal evidence from a mid-18th-century Colonial site in the Northern Indian River Lagoon region, however, this estuary provided an abundance of wild animal resources in the past. The colonists relied heavily upon the Lagoon as indicated by the predominance of ray-finned fishes in the examined faunal samples. A comparison between the size and quantity of particular fish species represented in the archaeological colonial record versus those currently present in the Lagoon today demonstrate that these fish were more numerous and attained a much greater size in the past.

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Fishing in the Straits of Gibraltar in Late Medieval times: Food in Islamic contexts from the archaeological site of Qsar es-Seghir, Morocco

Keywords: Fish remains; Northern Africa; 13th to 15th centuries; Islamic period

According to written sources, Qsar es-Seghir was first settled between the 10th and 11th centuries and subsequently became an important port and shipyard by the 12th/13th centuries. Later, it underwent substantial urban construction. In 1458, it was captured by the Portuguese who remained there for almost a century. Situated on the mouth of the river Qsar Seghir, on the south bank of the Straits of Gibraltar, Qsar es-Seguir played an important role connecting North Africa and the Iberian Peninsula and benefited from both Mediterranean and Atlantic seafaring. The coexistence of different cultures, as well as economic and political changes in the Maghreb, may have resulted in the modification of diverse aspects of human-animal interaction in the region. The importance of maritime life seems to have always been considerable, as descriptions from Late Medieval times indicate the existence of a thriving fishing industry. Fish were salted and sold locally. Nevertheless, according to the archaeological fish bone remains at Qsar es-Seguir, fish did not play a major role in the economy but rather formed a

supplementary contribution to the diet throughout the different phases of occupation. We present a revision of previous studies of fish remains in North African Late Medieval Islamic archaeological sites. We add new data, based on studies of fish remains recovered from Qsar es-Seghir. Our aim is to understand the role that fish played in the subsistence and economy of its inhabitants.

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Fishing at the Early Neolithic Hornstaad-Hörnle site at Lake Constance, Germany

Keywords: Fish; Pike; Lake-dwelling settlement; Neolithic; Germany

The Hornstaad-Hörnle IA site is one of the earliest Neolithic pile-dwelling settlements on the shore of Lake Constance in Southwestern Germany. It was inhabited from 3917 cal BC until 3910/3909 cal BC, when a disastrous fire destroyed most of the village. The settlement was subsequently rebuilt, as documented by four different construction phases. Exploitation of domesticates, mainly cattle and pig, as well as hunting provided a certain amount of the animal protein supply for the Neolithic settlers. However, another important protein source was supplied by fishing as indicated by the recovery of more than 10000 fish remains. Although most of the remains only can be determined as fish bones due to a high percentage of burnt bones and poor preservation, the ichthyofaunal distribution reveals exploitation of diverse fish species. The ichthyoloarchaeological assemblages are clearly dominated by pike, representing obviously the most important fish. The size of pike ranges from small up to very large individuals, with mostly medium to larger individuals. Other fish groups, which are much less frequently represented but certainly of some importance, are cyprinids, coregonids, trout and perch. Pikeperch and European catfish in contrast are minimally represented.

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The Romano-British fisheries: An integrated approach

Keywords: Fish processing; Roman period; Britain

The subject of Roman fishing, indeed ancient fishing, is primarily fuelled by

Mediterranean-led research. Although recent case studies suggest the potential for large-scale fish processing in Britain, it remains largely unexplored and is typically interpreted as playing a minor role within the Roman fishing industry. The increasing wealth of evidence for fishing in Roman Britain consists of fishing tools, traps, net-weights and over 100 fish bone assemblages. However, to date, there has been no attempt to conduct a comprehensive study of the evidence. This presentation will provide an overview of my PhD research by looking at several case study sites. I will also highlight the suggested methodology for tackling this subject, developed from Mediterranean approaches, which continue to demonstrate the significance of an integrated approach to the study of ancient fishing. One question yet to be answered is how the small- and large-scale fisheries of Britannia fit into the wider context of the Roman Empire.

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Chronology of West Indian palaeofishery

Keywords: West Indies; Pre-Columbian; Fish size; Palaeofishery

The West Indies archipelago is an exceptional example of continental populations adapting to an insular environment, with many inter-island exchanges due to highly effective naval technology. Pre-Columbian archaeological sites in the Caribbean contain a significant amount of well-preserved vertebrate remains (fish, turtles, snakes/lizards, birds, mammals), and, at a majority of sites, ichthyological remains predominate. However, the importance of different marine ecosystems varied in each Pre-Columbian culture. The selection of captured marine species (sea turtles, manatees, monk seals, cetaceans, fish) indicate that fishing grounds and techniques also changed according to archaeological periods. Based upon 890,000 fish remains recovered and identified from 90 Pre-Columbian archaeological sites in the Lesser Antilles (including St Martin, Barbuda, Antigua, the archipelago of Guadeloupe and Martinique) since 1994, a palaeofishery chronology can be determined using the composition of the faunal spectrum and size of the animals. The earliest Archaic populations exploited seagrass meadows and lagoons near coral reefs. Later, the earliest Ceramists exploited equally all the ecosystems (deep water channels, rocky bottoms, coral reefs, sandy bottoms,

seagrass, mangroves, foreshore). The Late Ceramists moved their villages near lagoons, mangroves, and corals. Satellite islands were colonised, and some villages were highly specialised on certain species (e.g. surgeonfish, parrotfish). Indeed, coral reef fish became increasingly important in subsistence through time. Finally, fish sizes decreased over time but fishing technology did not change.

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Exploitation of aquatic environments during the Middle Palaeolithic in Western Europe

Keywords: Middle Palaeolithic; Western Europe; Fish; Neanderthals

Whether or not Neanderthals practised fishing remains an enigma at present. It has been shown that the range of exploited animals was far wider than previously postulated and that Neanderthals could hunt and collect small prey. For that reason, it is worth considering if fishing, in particular freshwater fishing was a potential activity because most Neanderthal sites were located along rivers. More specifically, it should be investigated whether fishing was an occasional and opportunistic activity or rather a routine practice among the Neanderthals. The aim of this presentation is to discuss the state-of-the-art data concerning this question by reviewing the ichthyoarchaeological data available in several West European countries. In the studied assemblages, fish remains are, in most cases, insufficient to provide clear-cut answers due to three major drawbacks: (1) fishes were apparently not exploited in large quantities; (2) taphonomic loss might be an important source of bias suggested by the fact that fish remains gradually become more numerous in younger sites (i.e. Holocene); (3) excavation methods implemented to recover fish remains might possibly remain inappropriate. Europe with its large number of sites with faunal remains available for analysis is a privileged region for the study of Middle Palaeolithic subsistence. Thus far, limited research has been carried out on the role of small prey. The emerging picture, however, is that, much earlier than previously thought, small animals, including fish, were not just a secondary food item but an integral part of a more complex subsistence system that included a great variety of resources.

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Taphonomic analysis of fish bone accumulations produced by Yellow-legged Gull (*Larus michahellis*, Laridae) in Chafarines Island, Spain

Keywords: Taphonomy; Fish accumulations; Yellow-legged Gull; Digestion; Pellets

Fish remains can be abundant in European Upper Pleistocene and Holocene sites. The origin of such assemblages is generally unknown and often considered to be the result of human activities. To determine the origin, taphonomic analyses have proven to be a relevant instrumental tool. Many kinds of predators might have produced fish bone accumulations in prehistoric sites including birds, carnivores and humans, separately or combined. In Iberia and other parts of the Mediterranean region, one well-documented agent is the Yellow-legged Gull (*Larus michahellis* Naumann, 1840) that has been rarely studied from the standpoint of prehistoric fish collections. The major aim of this study is to determine the taphonomic features of fish prey remains ingested by the Yellow-legged Gull, in order to evaluate the role played by this species in the formation of some subfossil assemblages. The collection of the meal leftovers from this gull was conducted between 1978 and 1979 at the Islas del Congreso and Rey (Chafarinas Islands, Alborán Sea, Spain). Based on surface modification features, breakage and digestion traces, as well as on element representation, we have recorded a set of criteria that may be of interest in determining the nature and origin of archaeozoological and palaeontological fish assemblages. The taphonomic features that were evaluated suggest that *L. michahellis* produces moderate digestion (i.e. categories 2-3 Andrews, 1990) on fishes that have passed through its digestive track. This study provides a reference for understanding fish archaeological accumulations and expands our taphonomic criteria from previous works in the field.

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Isotopic analyses of archaeological fish track significant human impacts on Lake Ontario nutrient cycle

Keywords: isotope, historical ecology, Great Lakes

To understand how natural and anthropogenic forces are reshaping aquatic environments, biologists have created isotopic baselines using archived fish tissues (e.g., scales and flesh) to detect changes in environmental conditions in the recent past. Most baseline datasets begin in the twentieth century, long after major developments such as the industrial revolution began to have serious environmental consequences and are therefore unable to provide information on longer-term processes in aquatic ecosystems. In this context, isotopic analyses of archaeological fish remains offer significant potential for helping to contextualize conservation research aimed at assessing how and where human activities have impacted aquatic ecosystems. This study presents stable nitrogen isotope compositions of archaeological bone collagen from over 500 fish as a proxy measure for long-term (A.D. 1000-1900) environmental changes in Lake Ontario, the most easterly of the Great Lakes, with the longest history of intensive exploitation. Results show a significant shift in the $\delta^{15}\text{N}$ values of multiple fish taxa, consistent with a change in the state of the freshwater nitrogen cycle of Lake Ontario during the nineteenth century. This shift is likely linked to human-induced changes in the lake's nutrient and trophic structures. These findings provide fresh insights into the broader environmental context of the impact of European settlement in the region.

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Archaeological and Historical evidence of fish food supply, fish farming, and fish trading in Medieval and Early Modern Switzerland

Keywords: Switzerland; Medieval; Early Modern period; Fish exploration

It was not until the 1970s that increasingly meticulous excavation methods in Europe provided evidence that fish as a food resource was much more important throughout prehistory than previously believed. In Switzerland, fish also played an important role in the diet during the Medieval and Early Modern periods. Beyond their dietary role, fish remains, together with archaeological and historical data, can provide information about human utilisation of aquatic ecosystems and fish

stocks in former times. In this presentation, we provide examples of the results gained by ichthyoarchaeological research that indicate different modes of exploitation of this important aquatic resource.

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Weird fish: Pathological fish bones and what we can do with them

Keywords: Pathologies; Gadidae; Joint disease

The study of animal palaeopathology is a maturing subset of zooarchaeology, but fish bone pathologies have not been studied in any great detail. Using several large assemblages from the North Atlantic region (primarily comprising Gadidae species), as well as selected examples from elsewhere, the authors aim to explore and categorise fish pathologies. Several categories have been identified, including injuries, tooth 'abscesses', congenital abnormalities, illness and stress, and neoplasms. Joint disease has been identified across a range of very large and very old fish, indicating that these changes are likely age-related. Using modern reference collections and fisheries biology literature, we attempt to link these categories to causative agents. We conclude by asking how useful these pathologies are, both to zooarchaeologists and to fisheries biologists.

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Are all identifications created equal? An experiment in inter-analyst variation

Keywords: Identification; Inter-analyst variation; Fish; Diagnostic elements

When re-examining bones that have been previously analysed, it is not uncommon for researchers to discover a number of differences in the taxonomic data produced. When reviewing others' work, we generally make the assumption that identifications are correct. But are we right to make this assumption? Others have investigated this question by having multiple analysts examine the same set of bones of unknown identity. In this case, we asked a number of zooarchaeologists to analyse a set of fish bones of known identity using their

normal procedures. We consider the results of this in terms of the effort (time) invested in identification and the level of experience of the analyst.

This research contributes to the formulation of best practices for zooarchaeologists, including those working within the standards and guidelines for consulting archaeologists in the jurisdiction of Ontario, Canada. This research also contributes to our understanding of what skeletal elements are considered “diagnostic” across analysts.

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ZooMS for everyone

Keywords: ZooMS; Identification; Mass spectrometry

The ability to identify fish remains by peptide mass fingerprinting (ZooMS) has potential to aid in the study of ancient fish remains. However, few laboratories have sufficient access to the expensive instrumentation required to run these analyses. An initiative funded largely by the Max Planck Institute for the Science of Human History in Jena and supported by the Universities of York and Copenhagen is seeking to equalise access to ZooMS analysis. This will be achieved by making available integrated datasets and software that together simplify the process of interpreting MALDI-TOF data and increase the classification accuracy. We present our vision for ZooMS analyses of fish remains, detail our progress to date, and seek advice and support from the community as the optimal direction for developing the software tools and running workshops. The intent is that it will be possible for most laboratories with very basic equipment (pipettes, a bench, fridge, and heating block) to prepare their own samples with plates being sent to Jena for MALDI-TOF analysis.

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Who dined extensively on fish in Medieval Europe? A critical consumer reads stable isotope analyses

Keywords: Medieval Europe; Fish consumption; Stable isotopes

Stable isotopes of carbon and nitrogen in bone collagen extracted from human

remains provides direct physical evidence that specific past individuals consumed significant quantities of aquatic resources. On the whole carbon isotope ($\delta^{13}\text{C}$) values differentiate between proteins of different biosynthetic origin (marine versus terrestrial), while nitrogen ($\delta^{15}\text{N}$) places the individual on the trophic level hierarchy. Stable isotope studies therefore promise significant new insights into fish consumption by communities across large areas of Medieval Europe. But convincing interpretations demand careful handling of these results. This paper examines more than 30 published studies of stable carbon and nitrogen isotopes extracted from human remains at Medieval sites distributed from Sweden and Scotland to Spain and Southern Italy and dating from the 5th and 6th through the 15th and 16th centuries. It identifies certain important findings and strong cautions regarding chronological, social, economic, and geographical patterns in Europeans' consumption of large amounts of aquatic protein. Interpreters are urged to observe individual skeletons as closely as they do collective averages, to remember that Medieval Western Christendom was surrounded by and exploited marine ecosystems on three sides, and to remain aware that some European regions long relied on local fisheries in both salt and freshwaters.

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Ichthyoarchaeological analysis at Mayapán: Post-Classical fish use and environmental implications

Keywords: Maya; Post-Classical; Fish use; Paleoecology

This paper presents the ichthyoarchaeological results of the fish assemblage from Mayapán, the capital of the Postclassical period (1100-1400 AD) in the Mayan Northern lowlands. The assemblage represents the most abundant and diverse fish sample for an inland Mayan site and offers new data to deepen our understanding of fish procurement and use in Mayan subsistence activities. Catfishes, drums, snooks and sharks, which indicate two ecological areas of provenance, cenotes and aguadas, as well as estuaries, were identified in the

assemblage. Regarding trade and transportation, the skeletal frequencies indicates that fishes, with sizes similar to modern modal sizes, were transported complete to the site. From a palaeoecological perspective, seasonality studies aid our understanding of the ecological role of the fishes transported to the site. In addition, the fish fauna from Mayapán is key to reconstructing the past conditions of the Gulf of Mexico estuaries since the majority of the fishes identified are locally available. The change in the biogeography of these species might indicate a possible change in ecological conditions that may have taken place since Post-Classical times.

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Ichthyoarchaeology from the Mayan World: Transforming paleocultural and paleoecological paradigms in the Northern Lowlands from the Classic (500-900 d.C) to the Post-Classic (900-1400 d.C) periods

Keywords: Maya; Fisheries; Palaeoecology; Fish processing

The results of the analyses of fish remains from Mayan settlements of the Classic (500-900 AD) and Post-Classical (900-1400 AD) periods are presented. According to the ichthyoarchaeological evidence of Mayan fish remains, we propose a series of hypotheses to aid in our interpretation and deepen the cultural knowledge of ancient fishing practices and the paleocoastal ecosystem of the Mayan world. Such approaches range from the fish processing methods to their ritual use that entails a change in the traditional paradigms of such practices in the Mayan world. Also, we assess the effects of the droughts recorded at the time of the Mayan collapse (800-1000 AD) on the estuarine ecosystems. These effects may have led to increasing muddy areas on the coast as a result of a reduced freshwater flow into the estuaries. As a consequence of this situation, changes in the values of global trophic levels are recorded as well as the absence of fishes present in the ichthyoarchaeological record but absent in the current ichthyological record. The results presented here serve as a preliminary baseline, both to understand the implications of Pre-Hispanic Mayan fishing from an archaeological perspective and to provide a chronologically broad record that may contribute to the knowledge of fisheries along the Mayan coastlines.

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Stockfish and dried pike in Medieval Uppsala, a case study of the recognition of dried fish products in urban zooarchaeology

Keywords: Stockfish; Dried cod and pike; Diagnosis of preserved fish; Sweden; Medieval Uppsala

The importance of fish in urban archaeological sites is often underestimated due to inadequate recovery and lack of understanding by archaeologists. Here a case study is presented where a zooarchaeozoologist was part of an excavation team on a large-scale excavation in the city of Uppsala in Eastern Sweden. A total of more than three tonnes of animal remains were recovered. All bones were related to contexts and dated. Wet sieving of layers was performed to check quality of bone recovery. All bones of pike and cod were studied in detail with respect to skeletal element, size and butchery marks. This resulted in a consistent pattern in skeletal representation and size distributions of pike, medium size cod and big cod respectively. The provenance of the three groups of fish is discussed as well as their state of preparation as commodities. Finally their importance in relation to the main meat-producing mammals is discussed.

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Fish products in the Åland islands during the Early Modern period

Keywords: Fish products; Baltic Sea; Economy

The castle Kastelholm was a centre of economy in the Åland islands. The castle with its estates produced meat products, butter and cheese from domestic animals for their own need but also for the need of the castle in Stockholm; the centre of economy in Sweden. Based on the castle accounts from the 16th to 17th centuries, relatively large amounts of fish and seal products were also exported from the Åland islands.

In the osteological material, various fresh- and saltwater fish were identified. Most of them can be locally caught in the brackish waters of the Baltic Sea. From the taxation list of the castle accounts it can be seen that some areas of the island group selectively targeted certain species, such as herring and cod. The account

books are also interesting when tracing the fish products traded and consumed in the castle. The anatomical distribution of the fish species identified in the osteological material is useful in understanding the food products recorded in the accounts.

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Widening the net: ZooMS identification for fish

Keywords: ZooMS; Species identification; Cyprinids; Tuna; Flatfish

One of the largest problems that limits detailed interpretation of archaeological fish remains is the identification of bones and scales to species of certain genera and families. Often only some elements are diagnostic between closely related species, leading to many archaeological bones and scales remaining unidentified. Zooarchaeology through Mass Spectrometry (hereafter ZooMS) has the potential to identify even small scales through peptide mass fingerprinting of collagen. Fish groups that pose problems for morphological identification include tuna, flatfish, and cyprinids. Here, we present preliminary results on the potential of ZooMS to distinguish between species in the Cyprinidae and Scombridae families and the order Pleuronectiformes. Case studies include bones from Medieval fish ponds in Yorkshire and tuna scales from multiple Roman period sites in Italy.

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Fish remains from an ancient midden on Chuginadak Island, Islands of Four Mountains, Aleutian Islands, Alaska

Keywords: Islands of Four Mountains; Holocene; Gadus macrocephalus; Hemilepidotus sp.

Zooarchaeological material was collected from an ancient shell midden on Chuginadak Island during the multidisciplinary project titled “Geological Hazards, Climate Change, and Human/Ecosystems Resilience in the Islands of the Four Mountains” in 2014. The midden accumulated between 2800 and 2200 cal BP and contains numerous remains of invertebrates, birds, and fishes. All material

was water screened using 3 mm mesh screens. The fish remains were identified to the most specific taxon possible, including identifications to order, family, genus, and species. We used skull bones for identification only. For quantification of the fish remains we used the number of identified specimens (NISP).

To date, 2550 fish remains were identified to family level or higher. At least nine taxa of teleosts were identified in the assemblage. Of the identifiable fish bones, the majority belonged to Pacific Cod (*Gadus macrocephalus*) and Irish Lords (*Hemilepidotus* sp.). The sample produced 1075 Pacific Cod bones, representing approximately half of all identified fish remains (47.8%). Only one bone of Alaskan Pollock (*Gadus chalcogrammus*) was identified. Cods were followed by Sculpins (Cottidae) with 38.2% of the identified NISP (NISP=974). This material mostly consists of remains of Irish Lords (NISP=971). Greenlings (*Hexagrammos* sp.) comprise 16.6% of the identified remains (NISP=424). Remains of other taxa are comparatively scarce; Halibut (*Hippoglossus stenolepis*, NISP=34), Atka Mackerel (*Pleurogrammus monopterygius*, NISP=17), rockfish (Sebastidae, NISP=11) and flatfishes (Pleuronectidae, NISP=4). Notably, all of species or groups of species that were identified in the material from the investigated midden are commonly found in the waters off the Aleutian Islands.

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Remains of kosher and non-kosher fish in excavated settlements in Israel

Keywords: Fish remains; Israel; Kosher; Biblical laws.

Jewish dietary taboos consist of several types of animals including fish. There are two kinds of Non-Kosher fish that are frequently identified in assemblages of excavated fish bones: catfish and cartilaginous fish. The presentation will describe the Biblical laws concerning fish and the findings in excavated sites across Israel in different periods. It will address a series of questions including: When did the inhabitants of the kingdoms of Israel and Judea begin to abstain from eating non-kosher fish? Was the avoidance of non-kosher fish in ancient times as strong as the avoidance of pigs? Does the archaeological record of fish bones provide clues to the ethical identity of the inhabitants of ancient settlements?

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Akab Island, new results on fishing at a Late Neolithic stratified site in the Persian Gulf

Keywords: Neolithic; Eastern Arabia; Persian Gulf; Arabian Gulf; United Arab Emirates

The Neolithic period in Eastern Arabia is beginning to be better understood due to new excavations of well-stratified sites in Kuwait and the United Arab Emirates. Despite the aridity, shell middens provide the best preservational conditions dating from ca. 6500-4500 cal BC.

Here, violence has been documented which may be partly explained by Neolithic coastal groups competing for access to specific locations. However, we also note a coherent regional cultural entity according to the lithic technology and personal ornament production. Since oasis agriculture developed from the Bronze Age onwards, herding (goat and cattle), shellfish gathering and fishing were the primary modes of subsistence. Moreover, marine resources had become symbolically very important, and were intrinsically linked to cultural identity and social representation. Recently, the link between fishing and the symbolic use of animals has been attested by ritual deposition of fishing gear in the dugong bone mound of Akab, which may be as a propitiatory rite. While the dugong structure is later than the settlement levels, the marine mammal were caught and consumed during all the occupations at the site.

Akab Island is situated in the bottom of the Umm al-Quwain lagoon, in Northern Emirates. Excavations were conducted by V. Charpentier (INRAP) and S. Méry (CNRS, head of the French Archaeological Mission in United Arab Emirates) between 2002 and 2007. The earliest occupation at the site is dated to the Late Neolithic I (ca. 4500-4000 cal BC) and has been identified at other nearby sites around the lagoon. The settlement area of Akab has provided more than 38000 fish remains, which derived from over 40 fish species. Analysis of the

ichthyofauna identifications underlines predominance of coastal pelagics, *Euthynnus affinis* (Scombridae), *Carangoides chrysophrys* and *Gnathanodon speciosus* (Carangidae) in all levels of the site. The associated fishing gear, typical of the Neolithic period, is composed of stone net sinkers and shellfish hooks, both of which are well attested in the Sultanate of Oman for catching pelagic fishes. The great quantity of crab remains discovered at the site also questions the common use of basket traps. Other teleost taxa reveal that Akab inhabitants fished in a large aquatic territory, including mangrove, chenals inside the lagoon and the nearby open sea. They probably focussed on particular events as sparoid spawnings and coastal pelagic migrations. These results directly question the seasonal organisation of activities and mobility. During the same period (Late Neolithic I), the Umm al-Quwain sites 2 and 36, situated near the mouth of lagoon, were strictly involved in a lagoonal exploitation. Thus, inter-group relations concerning territory will also be discussed.

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Fishing at Mesolithic Al Khiday (Central Sudan, 7th millennium cal BC): Multidisciplinary data and their anthropological implications

Keywords: Sudan; Mesolithic; Hunter-gatherer-fishers; Fish conservation

Specific fishing strategies and fish conservation techniques seem to characterise the economy of the population living during much of the 7th millennium cal BC at Al Khiday, a site located on the west bank of the White Nile, nearly 25 km south of Omdurman in Central Sudan. Observations on these practices result from multidisciplinary work that included archaeological, archaeozoological, geochemical and palaeoenvironmental studies. At the site, multiple Mesolithic habitation structures have been found and recorded, including over 150 pits. These pits are usually full of animal bones, mainly fish, which represent food refuse that accumulated over a brief period of time. In the last field season at Al Khiday, a Mesolithic shell midden has also been identified. Emphasis on fishing was larger at Al Khiday than recorded elsewhere in the Mesolithic of Central

Sudan, focusing primarily on catching clariid catfish in a local swamp. The organisation of space at the site seems to have been increasingly structured, reflecting a specialised model of hunter-gatherer-fishers lifeways. In this context, fish salting developed and storing food permitted an increase in sedentism. Increased sedentism fits in the general framework of an intensified use of wild resources preceding the appearance of food production in Central Sudan. An attempt will finally be made to compare fishing in different contexts, at different latitudes and, whenever possible at a diachronic and synchronic level.

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Unrevealing hake fishing with isotopes through time

Keywords: Hake; Iberia; Fishing; Isotopes; Trophic level

The European hake (*Merluccius merluccius*, L. 1758) is one of the most important commercial fish species today but is facing a dramatic depletion linked mostly to anthropogenic exploitation. This fishing pressure, especially in Iberia, could have led to a decrease in the mean size of the fish and its level trophic position as has been identified for other species. In the region, the intensive exploitation of hake has been identified as early as the 18th century (AD). However, the archaeological data in the Iberian Peninsula demonstrates that fishing for hake took place during the Neolithic.

Bulk and single amino acid stable isotopes of carbon and nitrogen have been used to examine the trophic structure of modern and archaeological hake populations from Iberia and, in the case of imports, to identify their geographical origin. The differences in the carbon and especially nitrogen values demonstrate change in the mean trophic level of hake through time, potentially as the result of overexploitation. Additionally, we were also able to differentiate the catchments areas of these fish (i.e. Atlantic or Mediterranean) using stable isotopes, which is important for our understanding of hake trade throughout antiquity.

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Duty on fish: Analyses of animal remains found from the Uue-Kastre castle and customs station site between Russia and Estonia

Keywords: Uue-Kastre castle; Fish duty; Medieval; Early Modern; Trade

The majority of Medieval and Early Modern fish remains originate from urban contexts, but a very promising site for archaeological fish remains outside of towns is Uue-Kastre (Varbek) in Eastern Central Estonia. The site was a castle and customs station that belonged to the Tartu Bishop and was first founded at the end of the 14th century on the bank of the River Emajõgi between Lake Peipsi and Tartu town.

The river traffic was controlled there; inter alia the trade between the Hanseatic towns of Novgorod in Western Russia and Tartu. Based on historical sources, duty was collected on fish during the 15th and 16th centuries. During the excavations at the site in 2001 a considerable number of fish and mammal remains were recovered, which will be the subject of this presentation. The faunal material analysed within the current study demonstrates the consumption of animal products by the castle's staff, while any direct connection with the customs tax has not been proven.

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Food for the wealthy? An overview of the role of freshwater fish in Medieval England

Keywords: Freshwater fish; Migratory fish; Consumption; Luxury food; Status; Medieval England

In the earlier part of the Middle Ages, rivers and estuaries were the main sources of fish exploitation in England. This situation persisted until around the 1000 AD, when a substantial increase in the frequency of marine fish occurred. At the same time, freshwater and migratory fish, such as eel, bream, perch, pike and tench, become less represented in archaeological sites and mainly associated with

moated sites and castles. Historical evidence documents the high price and value attached to freshwater fish; fishing rights on rivers, estuaries and natural and artificial ponds were exclusive, thus representing symbols of social privilege. As a consequence of these processes, freshwater fish became a luxury item and maintained such status until at least the 15th century. Towards the end of this period, there were cases where some freshwater and migratory species, such as roach, dace and small eels, were consumed also by the lower classes, as they could be purchased from the market.

The zooarchaeological evidence from a number of English sites, selected on the basis of chronological breath and social status, will be reviewed and discussed. The aim of this study was to investigate the nature and level of diachronic changes in freshwater fish production and consumption, in view of the evolving ecological, cultural, religious and socio-political contexts. Potential factors, such as selection of species, size, capture methods and sources of fishing will be briefly explored.

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Ethnicity expressed in fish consumption?

Keywords: Ethnicity; Urban archaeology; Fish; Early Modern

Is it possible to trace consumers' origin with the aid of fish remains? This was the question asked in a subproject of the research project URBAN DIASPORA – Diaspora Communities and Materiality in Early Modern Urban Centers. The task was to trace immigrant households in the multiethnic trading town of Nya Lödöse (1473-1624 AD), located in Western Sweden.

It turned out to be possible to identify a probable non-local household. The deviating consumption was not characterised by exotic species, but by certain preserved fish products not eaten by the other residents. Particularly the extensive consumption of dried flatfish was investigated further. In this paper I propose that some preserved fish products are connected to regional cuisines, and therefore might be used as indicators of consumers' origin.

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Ancient fishing at the Neolithic settlement of Ra's al Hamra 6 (Sultanate of Oman)

Keywords: Sultanate of Oman; Fishing; Neolithic; Scombrids; Carangids

Traditional fishing is still practiced in the Sultanate of Oman, which is part of the well-known 'land of the ichthyophagi'. Until recently, fisher-bedouins travelled all along the Omani coast, however, the history of the region is still poorly understood and very few studies on fishing have been carried out.

Ra's al-Hamra 6, a Neolithic shell midden situated near to the capital, Muscat, benefited from a two-year excavation campaign in 2012 and 2013. The site covers a Holocene sequence of ca. 1000 years of occupation (ca. 5500–4500 BC) divided into six periods. Here, we present the results of the analyses of the fish remains from all layers that were identified in one trench at the site.

The study of more than 57,000 fish remains provided a faunal spectrum comprising 33 families, 54 genera and 68 species. In all layers, Carangids and Scombrids predominated. The high diversity of the spectra revealed that different environments surrounding the site were exploited, including mangroves, beaches and rocky reefs. Net sinkers and hooks recovered at Ra's al-Hamra 6 led us to suggest that passive fishing techniques (traps and nets) had been employed at the site. The seasonal behaviours of the species indicate that an all-year occupation at the site could have taken place, contrary to the general idea of winter occupation of Arabian coastal sites.

This research shows that fish remains can be a source of information to better understand fishing practices, the choice settlements and the yearly cycle activity.

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The fish from the Paloma village, Lima, Peru

Keywords: Lima; Peru; Anchovies; ENSO

The site of Paloma is located to the south of Lima, Peru. It is currently situated between 200 and 250 m above sea level and 4 km from the sea. It is one of the oldest fishing villages on the central coast of Peru dating to ca. 6000 BC. Ichthyoarchaeological analyses has demonstrated that the assemblage was largely comprised of anchovies, which alongside other species, had probably been dried.

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The impact of fisheries on bluefin tuna (*Thunnus thynnus*) over two millennia (2nd century BC – 20th century AD): Genetic and genomic analyses of ancient tuna remains from the Mediterranean, Atlantic, and Black Seas

Keywords: Bluefin tuna; Ancient DNA; Genotype; Mediterranean Sea; Atlantic Sea; Black Sea

Archaeological fish remains provide an invaluable opportunity to understand subsistence economy, ancient culture, and the diet of past peoples. They can also provide information about past genetic variability of halieutic resources from different geographical areas and temporal periods, allowing for insights into the impact of human activities and changing environmental factors. Among the many fish species commercially exploited since prehistoric times, tuna is one of the most economically significant.

Using advanced molecular techniques, ancient DNA was extracted from Atlantic bluefin tuna vertebrae excavated from Late Iron Age and Roman settlements in coastal Iberia (Portugal and Spain, 4th-2nd century BC; n=23) and Byzantine Constantinople (4th-15th century AD; n=6), as well as vertebrae from the Massimo Sella archive located at the University of Bologna (Ionian, Tyrrhenian

and Adriatic Seas, Early 20th century; n=150). A high performance genotyping panel was designed for the purpose of genotyping all archaeological samples along with modern samples collected from the same geographic areas. Included in the panel are 76 single nucleotide polymorphisms (hereafter SNPs) with high similarity to a wide variety of genes associated with the musculoskeletal system, development, metabolism, cellular function, osmoregulation, and immune response. An additional 20 SNPs that provide significant discrimination among modern populations were included in the panel. Finally, four modern and one ancient sample were subjected to shotgun sequencing of the entire genome, with the aim of screening the temporal variation of transposable element insertion profiles, whose mobilisation increases when organisms are under stress.

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Using fish bone data to construct long-term economic time-series: Potential and limitations of a new approach

Keywords: Time-series; Data synthesis; Chronological uncertainty; London; Urban

This paper demonstrates and evaluates a new approach to the construction of long-term time-series from fish bone data, aimed primarily at urban settlements with multiple small-to-medium-scale faunal assemblages. Individually these assemblages may be hard to interpret; collectively they can represent the economic history of a settlement.

In this approach, Monte Carlo simulation is used to combine data from numerous sites and contexts at the maximum possible chronological resolution, avoiding the need to lump data into broad phases and resulting in relative frequency distributions that explicitly incorporate chronological uncertainty. In ideal circumstances, where detailed sample-volume information is also available, biases in the intensity of research on different chronological periods can also be factored in, permitting inferences about changes in absolute rates of deposition over time. These analyses can be carried out readily using a purpose-built, freely available R package, archSeries.

The approach is illustrated via two examples from Medieval England, respectively

addressing the Fish Event Horizon phenomenon as seen from London and the development of Atlantic cod fisheries and import trade along the east coast. Finally, the paper considers the potential for extending this approach to chronological synthesis of non-frequency data such as measurements and isotope values.

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A French Fish Event at the turn of the 10th century? Environment, economy and ethnicity in maritime Flanders

Keywords: Carolingian; Gadids; Marine mammals; Maritime Flanders

Recently, sites dating between the 7th and the 11th centuries have been discovered in Northern France; which have shed light on an evolution of fishing techniques and grounds at the turn of the 9th-10th centuries thus hinting at a trend similar to the one characteristic of the British Isles.

In this respect, at the turn of the 10th century the French shores of the Channel provide heterogeneous fish assemblages within which some contain very large cod and haddock and sometimes modified or butchered whalebones. This previously unseen trend of the exploitation of marine resources and its distinctiveness from local anterior and contemporaneous patterns may be linked to the presence of non-native individuals. The mastering of gadid fishing and the exploitation of marine mammals points towards Scandinavian traits, even though no other arguments sustain this hypothesis. Instead, archaeological evidence brings forward the consistency, across maritime Flanders, of the nature of the buildings associated with the intensification of exploitation of marine resources: chronology, orientation and architecture (division into three naves).

For a better understanding of these local changes, one must take into account environmental and political dynamics. Indeed, geomorphology and historical texts provide us with ample evidence of a recapture of this newly emerged land by the earldom of Flanders for the purpose of grazing, as the land was still unsuitable for cultivation because of salt marsh-dominated environment and the occurrence of marine transgressions.

This paper will bring forward an integrated approach for the characterisation of the evolution of fishing in maritime Flanders through the confrontation of fish catches with archaeological and historical sources.

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Fishing in Stone Age Southern Scandinavia

Keywords: Mesolithic; Denmark; Southern Scandinavia

Fish played a vital role in the development of the Stone Age in Southern Scandinavia. From their inferred role in the colonisation of the region at the end of the last Ice Age to the ongoing discussions about the role of aquatic resources in the lives of the first farmers of the region, they are central to many of the great archaeological questions of this era. Of great interest is the recovered evidence of hundreds of thousands of fish remains from the Final Mesolithic, when fish (and other aquatic resources) were a fundamental aspect of society. Using new zooarchaeological evidence from two Late Mesolithic sites in Denmark (Hjarnø and Skellerup Enge) as well as previously published assemblages, these data are explored to provide information about the dynamic nature of subsistence practices and other aspects of the archaeological cultures of this period.

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The European Hake (*Merluccius merluccius* L.): A deep-water fishery during the Neolithic?

Keywords: European Hake; Deep-Water Fishing; Mesolithic; Neolithic Sweden; Spain

The European hake is presently one of the most important species of the NE Atlantic fisheries, its catches exceeding 100,000 tonnes. With a recorded bathymetric range of 15-600 fathoms (27.5–1,100 m) this nekto-benthonic species is characterised as a typical deep-water fish given that ca. 70% of the catch is carried out at depths of more than 55 fathoms (100 m) and just a minimal fraction (6%) at depths of less than 20 fathoms (36.5 m). Such a distribution must have restricted its accessibility to fishermen operating near the shore at all times and it

is for that reason that its scarcity in the European ichthyoarchaeological record came as no surprise. Set within the former scenario, it is remarkable that the earliest evidences of hake in archaeological deposits that we report in this paper, despite being located on opposite corners of the continent (Sweden and Spain), derive from a time of the Holocene (Scandinavian Mesolithic-Iberian Bronze Age) when one assumes that deep-water fishing was not practiced by the coastal populations. In this paper we explore the implications of these findings, their coincidence with the Holocene's Climatic Optimum and the possibility that hake habits in the past may have differed notably from those that are recorded today.

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Marine fish exploitation during the Epi-Palaeolithic and Early Neolithic of Abri Ifri Oudadane, North East Morocco

Keywords: Epi-Palaeolithic; Neolithic; Fish remains; Marine resources; Morocco

The preliminary study of the fish remains from Abri Ifri Oudadane (Eastern Rif, Morocco) aimed to illustrate the relationship between humans and the Mediterranean marine environment during the transition between the Epi-Paleolithic and the Early Neolithic. The present research deals with dry sieved fish remains from the first two excavation campaigns. The material consists of hundreds of cranial and vertebral elements, mainly from coastal fish species. They are provisionally assigned to six families (Serranidae, Sparidae, Mugilidae, Labridae, Carangidae, Muraenidae), two genera (*Diplodus* sp. And *Decapterus* sp.), and more specifically to the species, *Decapterus punctatus* and *Gymnothorax unicolor*. After the study has been completed, the fish data will be compared to the terrestrial and other marine fauna in order to reconstruct prehistoric diet based on the animal resources. Data recorded so far show that the inhabitants of the Abri caught fishes in the Epi-Palaeolithic (EPI) as well as in all Early Neolithic phases (ENA, ENB, ENC). Larger fish (40-50 cm SL) of the family Serranidae were identified in all phases. With the beginning of the Early Neolithic a significant increase in numbers is noted but most of the fish remains as well as terrestrial fauna appear in the main occupation phase of Early Neolithic B. Moreover, floated and additional material from the 2010 and 2011 excavation

campaigns is currently under investigation, which may shed new light on the diversity, size ratio and exploitation of marine fish during all of the excavated phases.

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Ancient DNA and stable isotope analysis of fish remains from Charlie Lake Cave (HbRf-39), British Columbia, Canada

Keywords: Ancient DNA; Stable Isotopes; Canada; Historical Ecology

Excavations of Charlie Lake Cave (HbRf-39) in Northeastern British Columbia, Canada, have recovered fish remains from stratified deposits that span the Late Pleistocene and Holocene. A previous morphology-based analysis of the fish remains from the site (n=1235) identified the majority of the remains as sucker (*Catostomus* sp.) (n=669). Due to fragmentation and a lack of interspecific morphological variation, only a small number (n=20) of the remains were identified to the species level, while a large number were simply identified as fish (n=465). Consequently, little is currently known about the species composition of the ichthyofaunal assemblage from Charlie Lake Cave, and how it changed over time. To address this question, we used ancient DNA analysis to assign species-level identifications to fish remains from Charlie Lake Cave, and investigate changes in these species' population structure. Moreover, we sought to explore temporal shifts in the ecology of the identified species and their environment by conducting stable isotope analysis on a subset of the remains. By documenting these kinds of temporal changes through ancient DNA and stable isotope analysis, this research can potentially shed light on the dynamics of the complex relationships between fish, people, and the environment over the longue durée.

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The ichthyofauna findings from Late Antiquity and Middle Ages Italian contexts

Keywords: Zooarchaeology; Medieval archaeology; Fishing; Trade; Consumption

The widespread use of the natural sciences such as zooarchaeology in Historical

archaeology survey, in particular in Italian Medieval archaeology, has produced a remarkable quantity of bioarchaeological data. This is important for many zooarchaeological datasets including aquatic fauna, despite the taphonomic factors that cause their disappearance in many cases. Since the 1970s there has been an increasing number of zoological reports concerning aquatic animal remains. This is apparent from a census of Italian zooarchaeological literature from Late Antiquity to the Middle Ages. In fact, it shows an impressive assemblage made up of 16,841 pieces classified and published, relevant to 10 zoological classes subdivided into 203 lower taxonomical classifications. All of these fragments came from 83 archaeological sites spanning 156 chronological contexts.

With an abundant zooarchaeological heritage like this it is possible to try to explore topics regarding usages and customs of past human groups developed during history and associated with the exploitation of fish resources.

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Project SMaLL: The fish remains from San Martino Site (Lomaso, TN)

Keywords: Late Antiquity; Early Medieval; Alps

Monte San Martino is located about 20 km to the north of Lake Garda, in the west ramification of the mountain that divides the Giudicarie valleys from the final tract of the Sarca Valley.

The site was subjected to 11 archaeological investigations (2005-2015), which were carried out together by the Superintendence of Cultural Heritage of Trento, the Municipality of Comano Terme and the Bayerische Akademie der Wissenschaften (project SMaLL).

The archaeological survey has revealed the traces of a fortified settlement covering an area of over 17,000 m² wide, built from the mid 5th century and occupied until the mid 7th century. It was protected by defensive walls constructed around the perimeter, with watchtowers, gates and internal buildings, a road system and a cemetery church. The size and the complexity of the investigations,

and the level of conservation of the surviving evidence, make it one of the most significant Early Medieval settlements in the Central Alps.

More than 18,000 animal remains were recovered and analysed from the layers of the site, among these 11 fragments are of osteichthyes. Their presence in a place characterised by the complete absence of water resources, unfold important questions about the supply system of a Late Antiquity and Early Medieval fortified settlement.

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Exploitation of fish resources during the Recent Bronze Age in the Polesine area: The cases of Campestrin, Larda and Amolara sites (Rovigo-Northeastern Italy)

Keywords: Fish remains; Zooarchaeology; Recent Bronze Age; Polesine; NE Italy

Polesine is located between the lower courses of the Adige and the Po rivers (Veneto region, Italy), archaeologically known for the village of Frattesina, an important centre of production and trade of allochthonous raw materials since the Recent/Final Bronze Age-Early Iron Age.

Archaeological research documented settlements from the Early Bronze Age with the discovery of Canàr site and from the Middle-Recent Bronze Age with the Larda I and II di Gavello (Rovigo), Campestrin (Grignano Polesine, Rovigo) and Amolara (Adria, Rovigo) sites, permitting further comparison.

These settlements have yielded an abundance of mammal, bird and fish remains, with fish being the primary supplement to the economy of villages. Fishing activity was already attested in the Canàr and Frattesina sites, where the exploitation was focused on Cyprinidae and Esocidae.

In this research, the preliminary results of archaeozoological and taphonomic analyses of fish remains coming from Campestrin, Larda and Amolara sites are presented, with the aim of understanding the exploitation of fish resources in Polesine during the Late Bronze Age.

The ichthyofauna consists of 4589 remains, of which 96.2% come from Campestrin, 2.61% from Larda and 1.08% from Amolara. As much as ca. 80% of the faunal assemblages was identified at species level and is attributable to Cyprinidae (*Tinca tinca*, *Scardinius erythrophthalmus*, *Leuciscus cephalus*),

Esocidae (*Esox lucius*), Salmonidae (*Thymallus thymallus*, *Salmo* sp.), Percidae (*Perca fluviatilis*) and Acipenseridae (*Acipenser* sp.).

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Bringing the sea into the cave: Fish and other marine animal remains from the Neolithic cave of Alepotrypa, Diros (Greece) and their mediterranean context

Keywords: Greece; Neolithic; Cave; Coastal vs. open-sea; Marine resources

The study of marine resources from Neolithic cave contexts in the Mediterranean sheds light on a specific aspect of cave use and sea-related subsistence activities during the Neolithic. The cave of Alepotrypa-Diros in the Peloponese offers an exemplary case of a coastal Neolithic community oriented towards the sea for the needs of subsistence and beyond. Several lines of evidence, of which an abundant marine faunal record including fish bones and shells is the most prominent, reveal the particular connection of the cave with the sea. This paper will focus on the fish remains from the cave, but will also offer a more holistic appreciation of the connection of Neolithic users of the cave with the marine element. Specific exploitation practices and diachronic trends will be discussed in the overall context of marine animal exploitation within caves in the Mediterranean during the Neolithic.

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1,000 years of fishing and fish consumption in the town of Mechelen (Belgium)

Keywords: Mechelen; Late Medieval; Post-Medieval; Fish consumption; Pollution; Overfishing

Mechelen is a town on the river Dyle, a tributary of the Scheldt basin. Fish bones from 10 different sites covering the 10th to 20th centuries AD from the town have been studied. Through the analysis of material from different sites covering a large timespan, a better understanding of fish and fish consumption in the past is provided. The diachronic overview partly focuses on the rise of marine fish in the food supply as a whole and also verifies the order in which the different marine species gain in importance at the various sites. Does this increase coincide with a

depletion of freshwater fish stocks? Attention is paid to possible indications of overfishing and the effects of pollution on the freshwater fish.

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Fishing and connectivity in the Eastern Mediterranean Bronze Age

Keywords: Eastern Mediterranean; Bronze Age; Seascapes; Coastscapes; Islandscapes

Liminal in their position, nested between land and sea, Bronze Age coastal communities played a crucial role in the development of the Eastern Mediterranean network, becoming nodes of exchange between the foreign and the local, but also as mediators between the hinterland and the sea, in virtue of their quasi-amphibian experience of both worlds.

The importance of these nodes for the understanding of the inter regional as well as the local connectivity is well acknowledged within landscape studies, and so is the necessity of moving the scope of research towards a more sea-centred perspective. In the past decades, this resulted in the coinage of the concepts of seascapes, coastscapes and islandscapes, employed with varying degrees of success and sometimes-ambiguous definitions.

What this work proposes is to provide an in-depth analysis of these concepts taking the study of the marine environment and exploitation of its resources as its starting point. Through the examination of material culture dispersion patterns and ichthyofaunal and malacological remains, this work will attempt to build an interpretative framework for the concepts of seascapes that takes in consideration both cultural and geographical criteria. Particular attention will be given to the impact that fishing and coastal foraging activities might have had in developing a propensity for connectivity.

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Results of the analysis of the fish bones from the archaeological excavations of the Scythian hill fort, Severynivka

Keywords: Scythian; Severynivka; Cyprinids; Fish length; Fish weight

Ichthyological material, including 175 fish remains from the excavations of the

Scythian hill fort at Severynivka are presented. In total, eight species of fish were identified in the assemblage: common carp (*Cyprinus carpio*), roach (*Rutilus rutilus*), white bream (*Blicca bjoerkna*), common bream (*Abramis brama*), common nase (*Chondrostoma nasus*), European perch (*Perca fluviatilis*) and northern pike (*Esox lucius*). In this poster the anatomic and age composition is defined. In addition, a reconstruction of fish length and weight is attempted. In the osteological material roach dominated. Young fish (small size, age 1+ 2+ years) amounted to 50.0% of all fish remains. We assume that a significant percentage of small and immature fish is associated with cases of insufficient availability of food on the settlement, which were caused by some external factors - hunger as a result of crop failure, cattle pestilence or invasion of enemies. In this case, as a rule, all available sources of food were utilised.

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The exploitation of fish in the Pearl River Delta, South China during the Neolithic and Early Bronze Age

Keywords: Fish resource; Pearl River Delta; Neolithic; Early Bronze Age

Zooarchaeological studies in China have previously focused on mammal remains, just as in many other places around the world. However, mammal species are only a part of the resource spectrum that people used in throughout prehistory, especially in areas near water. The Pearl River is the second largest river in China, which runs through most of the area of South Mainland China. Zooarchaeological study in this area is relatively rare due to the lack of current research interest and acidic soil conditions, which together have led to poor preservation and collection. Therefore, neither the ancient environment nor subsistence has been investigated systematically.

This research aims to establish the pattern of fish resource exploitation in the Pearl River Delta area using faunal remains from four shell midden sites dating from 6000 to 3000 BP, namely Guye, Cuntou, Yuanzhou and Lujingcun. This is the first time that both qualitative and quantitative analyses were applied to fish remains in the studied region and also will be one of the very few in the whole country. The results of this study reveal details of past environment and ancient subsistence in the Pearl River Delta during the Neolithic to Early Bronze Ages, which gives information about the social complexity of the Neolithic to Bronze Age transition.

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Neolithic fish remains from Rakushechny Yar, South Russia

Keywords: Neolithic; Fish remains; South Russia

The site of Rakushechny Yar is located on the shore of the Don River, South Russia. It is one of the earliest Neolithic sites of this region, which is particularly important regarding the diffusion of the Near Eastern 'Neolithic package' and the 'Neolithisation' of Eastern Europe.

In the lower layers of the site, shells and fish remains alongside charcoal and artefacts were recovered. To get an impression of the fish species in the region as well as the specimens caught by the Neolithic settlers and the fishing techniques employed, all fish remains were analysed. To date, the results obtained demonstrate that fishing for freshwater and migratory species took place.

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The non-fish or the hyper-fish of the Mediterranean: Bluefin tuna (*Thunnus thynnus*) and its fishing communities through the tonnara culture

Keywords: Bluefin tuna; Tuna trap fishery; Interspecies ethnography; Local knowledge; Mediterranean Sea; Sardinia

The *tonnara* system (En. tuna trap fishery, Fr. *madrague*, Sp. *almadraba*, Ar. *al-madraba*, Pt. *almadrava* or *armação*, Greek and Turkish *dalian*) is a traditional fishing technique to hunt the Eastern Atlantic Bluefin Tuna (*Thunnus thynnus*). Once very common throughout the Mediterranean, this art has almost disappeared, swept away by aggressive, disrespectful, voracious and unsustainable fishing practices. Indeed, in the last decades, tuna fishing and production systems across the Mediterranean have undergone profound changes: recent innovations have been introduced to maximise captures, optimise processing and enhance worldwide distribution. In particular we are witnessing a gradual transition from a hunting-fishing technique pursuing a wild prey to an aquaculture system, even if capture-based; this obviously affects the fishermen's daily job and might end up in a loss of traditional knowledge and expertise, through the obsolescence of their key technical

skills. Nonetheless, through a qualitative field research conducted in the past two years among the last *tonnarotti*, I had the opportunity to observe and analyse this veritable cosmology (thus far quite disregarded by academic anthropologists). This paper is based on the outcomes of this ongoing research and it focuses on the relationship between these Mediterranean fishing communities and their prey, the red tuna as human partner and counterpart, merging history and anthropology. We could cautiously call this an inter-species ethnography, stemming from the local unwritten knowledge, both from the material (body techniques, gestures and sensoriality experienced through the full physical contact with the fish among the slaughter and butchering, the salting and culinary preparations) and immaterial standpoint (symbols, imaginary, vernacular forms).

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Freshwater fishing strategies in the Neolithic Yangtze River region: Environment and culture

Keywords: Freshwater fishing strategies; Environment; Yangtze River; Integration

The Yangtze River originates in the Tibetan Plateau and runs eastward across China, passing through a large area of diverse physiographic and environmental settings. Ecologically, the Yangtze River region provides habitat for a great diversity of plants and animals. Culturally, it is considered as the cradleland of agriculture and civilisation in South China. There is a long history of fish consumption in the Yangtze River region. Historical records and archaeological findings imply that freshwater fish may have played an important part in the subsistence economy, possibly more important than any other cultural centre in China.

This paper examines archaeological evidence for freshwater fishing strategies in the Yangtze River region, looking at the fish remains from Neolithic sites dating between ca. 8000–4000 BP. It aims to reconstruct the fishing methods, fishing grounds, and likely fishing seasons using both fish remains and other archaeological artefacts. By comparing the fish assemblages from sites of different ages and environmental settings, this paper aims to investigate the differences in the environmental and cultural aspects, and to generate a broader view of the subsistence economy.

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Food worthy of kings and saints: Fish consumption in the Medieval monastery Studenica (Serbia)

Keywords: Medieval fish trade; Sturgeons; Feasts; Religious celebrations; Studenica monastery

The paper focuses on fish consumption and long-distance fish trade in the Medieval monastery Studenica in Serbia, from the perspective of archaeozoology, historical sources and pictorial evidence. Medieval written sources on the subject suggest that fish was available primarily to particular social classes – the royalty, nobles and monasteries. Preserved muniments indicate that the majority of distinguished monasteries during the 13th-15th centuries had their own fishing ponds, fishing grounds and their own fishermen. Fish consumption occupied an important role in monastic contexts, both in Christian religious practices (e.g. Lent) as well as in celebrations commemorating the Virgin Mary and the monastery founder, during which high-quality fish was obtained from greater distances. Ichthyoarchaeological remains discussed in this paper originate from waste deposition areas within and outside of the ramparts of the Studenica monastery, accumulated during the 14th and first half of the 15th centuries. Apart from remains of locally available species (catfish, carp, pike), the faunal assemblage contained the remains of migratory sturgeons (beluga, Russian sturgeon, stellate sturgeon) most likely transported from the Danube area, about 200 km away as the crow flies. Skeletal element distribution, butchering traces and size estimations (of beluga in particular) indicate that large specimens (over 2 m in total length) were brought whole to the monastery, possibly dried or salted. Their occurrence is an additional indicator of long-distance fish trade recorded in muniments, and it offers new insights into economic, social and religious practices in Medieval Eastern Orthodox monasteries.

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Neolithic fishing landscapes: Case studies from Serbian sites in the gorges and in the plains

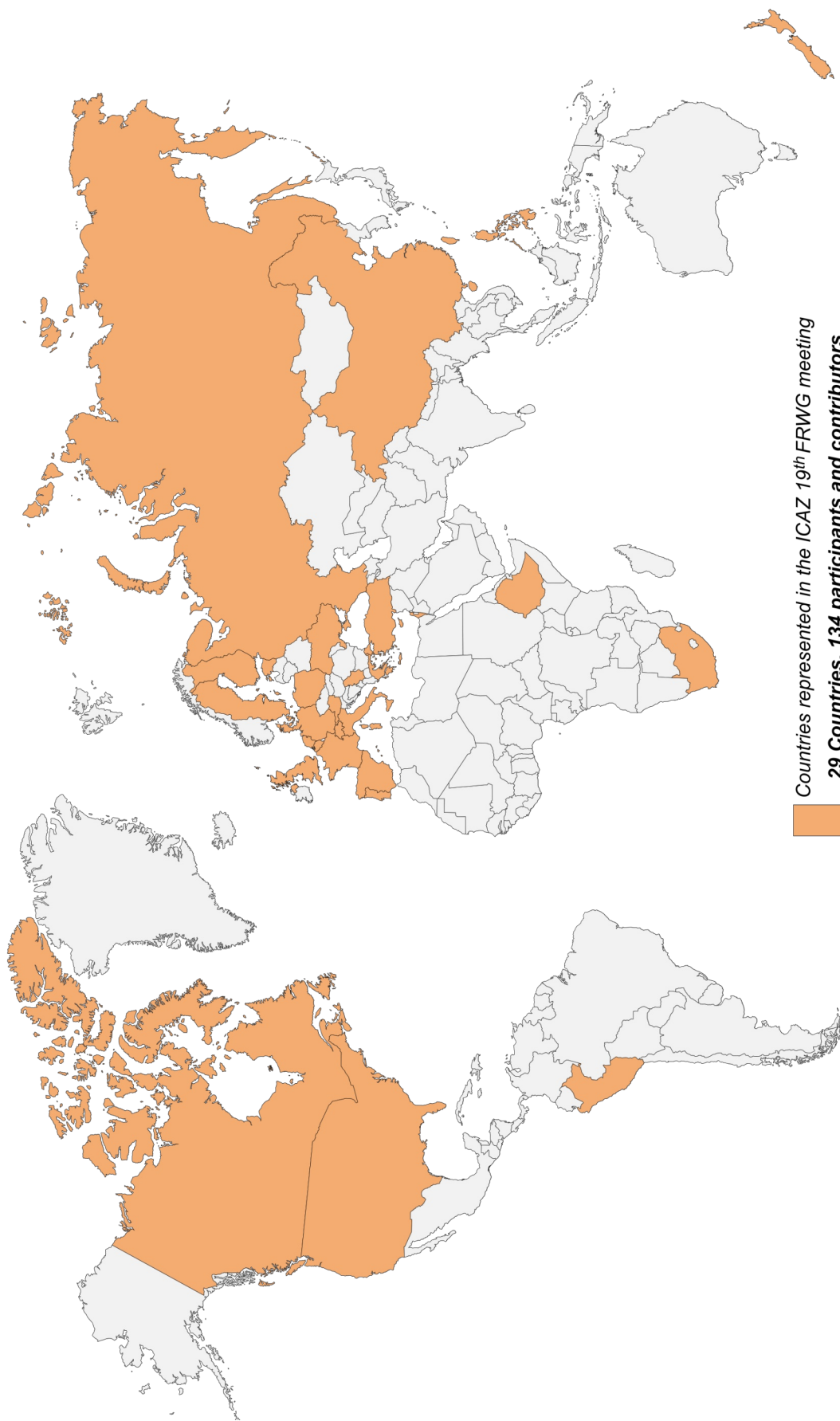
Keywords: Fishing; Mesolithic; Neolithic; Danube Gorges; Pannonian plain

The Mesolithic-Neolithic settlements in the Danube Gorges (North-Central Balkans) flourished in a specific landscape, with rapid changes in the riverbed, whirlpools, cataracts and strong river currents. These features were particularly favourable for fishing, and led to the prolonged stay of human communities during the Mesolithic (ca. 9500-6200 cal BC) and the emergence of permanent settlements in the Transformational Mesolithic-Neolithic phase (ca. 6200-5900 cal BC). Even with the appearance of domestic animals after 6000 cal BC, these settlements remained in use primarily as fishing centres, suggesting that subsistence strategies in the Danube Gorges remained unchanged even after the appearance of the first farming and stock breeding communities. Apart from the Danube Gorges, these 'new' communities settled in strikingly different landscapes – the hilly terrain of the Central Balkans and the flat terrain of the Pannonian plain, more suitable for farming and animal herding. However, the spatial clustering of Early Neolithic sites in the vicinity of rivers and lakes, as well as the occurrence of fish remains, signal that fishing occupied a significant role at least at some locations. The paper explores the role and extent of aquatic resource exploitation at the advent of food production, both in the Danube Gorges area where fishing represented a long local tradition, and in the newly established Neolithic sites in the Pannonian plain. The aim of this study, as well as future analyses of Early Neolithic faunal assemblages, is to problematise the presumed dichotomy between Mesolithic and Early Neolithic subsistence strategies, and the relationship between economic practices and particular landscapes.

NUMBER OF PARTICIPANTS, PAPERS AND POSTERS PRESENTED IN FORMER FRWG MEETINGS¹

Meeting		Participants	Papers	Posters
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
Lisboa	2015	71	42	16
Alghero – Stintino	2017	74	47	15

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, 7 (Environment and Culture, 7): 10; Zohar I. and Fradkin A. (eds.), 2013. *Fish and Fishing. Archaeological, Anthropological, Taphonomical and Ecological perspectives*. Archaeofauna, 22; Lôugas 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; Gabriel S., Davis S. J. M., Costa A. M. (eds.) 2015. *Fishing Through Time. Archaeoichthyology, Biodiversity, Ecology and Human Impact on Aquatic Environments, 18th Fish Remains Working Group Abstract book (Trabalhos do LARC, 8)*, Lisboa.



Countries represented in the ICAZ 19th FRWG meeting
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