Fishes – Culture – Environment Through Archaeoichthyology, Ethnography & History

Środowisko i Kultura
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Vol. 7

Editors:
Daniel Makowiecki,
Sheila Hamilton-Dyer, Ian Riddler,
Nicola Trzaska-Nartowski
& Mirosław Makohonienko

THE 15TH MEETING OF THE ICAZ FISH REMAINS WORKING GROUP (FRWG)

September 3–9, 2009 in Poznań & Toruń, Poland

Stowarzyszenie Archeologii Środowiskowej SAS
Instytut Archeologii UMK
PTPN
Muzeum Pierwszych Piastów na Lednicy
UAM Poznań Instytut Geoekologii i Geoinformacji

Fishes – Culture – Environment

15th Meeting
Fish Remains Working Group
September 2009, Poznań & Toruń, POLAND

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Through Archaeoichthyology, Ethnography & History

STOWARZYSZENIE ARCHEOLOGII ŚRODOWISKOWEJ SAS

ŚRODOWISKO I KULTURA

ENVIRONMENT AND CULTURE

VOL. 7

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Bogucki Wydawnictwo Naukowe, Poznań 2009

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Fishes – Culture – Environment
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organised by:

POLISH ASSOCIATION OF ENVIRONMENTAL ARCHAEOLOGY (SAS)
INSTITUTE OF ARCHAEOLOGY, NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
POZNAŃ SOCIETY FOR THE ADVANCEMENT OF THE ARTS AND SCIENCES
MUSEUM OF THE FIRST PIASTS AT LEDNICA
INSTITUTE OF GEOECOLOGY AND GEOINFORMATION, ADAM MICKIEWICZ UNIVERSITY IN POZNAŃ
& THE BRZESKI FAMILY FOUNDATION

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September 3-9, 2009 in Poznań & Toruń, Poland

Editors of this volume:
Daniel MAKOWIECKI,
Sheila HAMILTON-DYER, Ian RIDDLER,
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INSTITUTE OF GEOECOLOGY AND GEOINFORMATION, ADAM MICKIEWICZ UNIVERSITY
FISHING FARM at KUŹNICZKA, *Marek Raczkowski and Barbara Raczkowska*
COMPANY OF FISHERY PRODUCTION "MAJ" in Wągrowiec, *Marek Szeszycki*
FISH FARMSTEAD in BOGUCIN, *Roman Madaj*
MUSEUM OF THE FIRST PIASTS AT LEDNICA

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Poznań 23nd August 2009

Preface

Dear Colleagues

In 1995 Arturo Morales, in his opening paper of the 7th FRWG meeting in Madrid (Morales 1996) emphasised that a group of sixteen people taking part in the meeting in Copenhagen 1981, led by Inge Bødker and Knut Rosenlund, "had for years felt the need for a more systematic analysis of fish bones retrieved in archaeological sediments". His statistical analysis concerning the substance of fourteen years of activity (see table below) by the group testified to a „truly productive" proliferation of its ideas amongst researchers across the world. As a result, many publications were produced on archaeoichthology, concerning methods and historical considerations. This branch of archaeozoology (zooarchaeology) became a standard in the research of the archaeological sciences and in environmental archaeology. The development and propagation of archaeoichthyological analyses were of great importance in the constant quest for a new area of knowledge, which in this case was the history of fish and fishing, understood as an important component of the past environment and culture, and as essential research for members of the FRWG.

Initially, studies on the history of fish and fishing in Central Europe had developed well. They were carried out by archaeologists, historians, ethnographers and ichthyologists, who dealt primarily with economic problems and to a lesser degree with palaeoenvironmental issues. After various political and social turning-points of the 1980's, there followed a regression in the intensity of interest in these studies. Therefore, we expect that the 15th Meeting of the FRWG will supply a new impulse as follows:

1. *it will facilitate a renewed recognition of the importance of arthaeoichthyological studies as a significant link and resource for interdisciplinary investigations;*
2. *it will provide the opportunity to present different aspects of studies of the history of fish and fisheries, based on different categories of resources and methodological concepts;*
3. *it will allow the discussion of mutual and individual theses formulated on the basis of the scientific disciplines mentioned in the title;*
4. *it will contribute to the propagation and promotion of archaeoichthyological studies in the countries of Central and Eastern Europe.*

The number "15" for the FRWG Meeting represents a small anniversary of almost thirty years activity of the group. Therefore we feel it to be a special honour that Polish institutions are the hosts of an international team of such eminent researchers. Since, according to Arturo Morales-Muñiz's (2008) retrospective comments presented in the Antibes proceedings, the idea of the creation of the group was born in Poland, during the 3rd ICAZ Meeting in Szczecin in 1978, we are very happy that after almost thirty years of activity the group is hosted in Poznań and Toruń.

Last but not least let us provide some of the sorts of statistics initiated by Arturo Morales in 1995. We have reported in a special chronicle (see this book) all of the meetings from Copenhagen to Poznan. During 14 meetings more than 500 presentations were given – 450 papers and about 65 posters, by circa 600 colleagues (see table below). This meeting *contributes the next 43 papers and 7 posters from all of the main continents of the world. We would like to express our gratitude to every participant of the 15th Fish Remains Working Group.*

Dear participants, on behalf of the Polish Association of Environmental Archaeology (SAS), the Archaeological Institute of the Nicolaus Copernicus University in Toruń, the Poznań Society for the Advancement of the Arts and Sciences, the Museum of the First Piasts at Lednica, the Institute of Geoecology and Geoinformation and the Adam Mickiewicz University in Poznań, we would like to welcome you with great pleasure to the 15th Fish Remains Working Group Meeting of ICAZ 2009 in Poznań - Toruń. It is our privilege and honour that the conference takes place in the the Poznań Society for the Advancement of the Arts and Sciences, which two years ago celebrated the 150th anniversary of its origins. In this way, our conference will be recorded within the history of the wide and fruitful activities of the Society, including many very important events in all – both Polish and international research in the fields of the arts and sciences, as well as archaeoichthyological studies. We hope that the well-respected place selected for our meeting and its climate of 150 years of research activity will be an additional asset to our conference, contributing to the fruitfulness of our discussions.

Main features of the fifteen Fish Remains Working Group meetings

Meetings	Participants	Papers	Posters	Proceedings
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	0	-
Paihia 2001	56	39	0	-
Guadalajara 2003	45	34	0	+
Augusta Raurica, Basel 2005	45	31	6	+
Antibes 2007	87	38	17	+
Total 1981-2005	596	443	63	
Poznań – Toruń 2009	75	43	7	+

References:

Morales-Muñiz A., 1996: The evolution of the I.C.A.Z Fish Remains working group from 1981 to 1995, *Archaeofauna* 5: 13-20.

Morales-Muñiz A., 2008: Preface, In: P. Béarez, S. Grouard et B. Clavel (eds) *Archéologie du poisson, 30 ans d'archéo-ichtyologie au CNRS, Hommage aux travaux de Jean Desse et Nathalie Desse-Berset. Actes des XXVIIIe rencontres internationales d'archéologie et d'histoire d'Antibes, XIVth ICAZ Fish remains working group meeting, Éditions APDCA,* Antibes:13-14.

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&
Mirosław Makohonienko

15TH FISH REMAINS WORKING GROUP (FRWG) MEETING

Fishes – Culture – Environment
Through Archaeoichthyology, Ethnography & History

3rd –9th September 2009, Poznań & Toruń, Poland

Program

THURSDAY 3rd SEPTEMBER 2009

Meeting at Poznań-Ławica Airport or Poznań Railway Station and transfer to hotels
Accommodation in hotels
18:00 – 21:00 Registration and Dinner at the Restaurant "Estella",
Poznań, ul. Wieniawskiego 17/19

FRIDAY 4th SEPTEMBER 2009

7:00 – 8:00 *Breakfast - in hotels*

Venue:
POZNAŃSKIE TOWARZYSTWO PRZYJACIÓŁ NAUK (PTPN)
(POZNAŃ SOCIETY FOR THE ADVANCEMENT OF THE ARTS AND SCIENCES)
ul. Mielżyńskiego 27/29

7:30 – 8:15 Registration
8:15 – 8:35 Opening of the Conference
Chaired by **Arturo Morales Muñiz**

Welcome *and introduction by*
Daniel Makowiecki – on behalf of the Organizing Committee
Jacek Wiesiołowski – Chairman of the Poznań Society for the Advancement of the Arts and Sciences
Mirosław Makohonienko – Chairman of the Association for Environmental Archaeology

Session 1: Prehistoric and medieval fishing in the North Atlantic region (part 1)
Chaired by **Sheila Hamilton-Dyer**

8:35 – 8:55 **The medieval origins of commercial Sea Fishing Project: a preliminary synthesis**
James BARRETT, Cluny JOHNSTONE, Jennifer HARLAND, Wim VAN NEER, Anton ERVYNCK, Daniel MAKOWIECKI, Dirk HEINRICH, Anne Karin HUFTHAMMER, Inge BØDKER ENGHOFF, Colin AMUNDSEN, Andrew K. G. JONES, Alison LOCKER, Sheila HAMILTON-DYER, Leif JONSSON, Lembi LÕUGAS & Michael RICHARDS

8:55 – 9:15 **Freshwater fisheries in Belgium during medieval and postmedieval times: looking for markers for the onset of overfishing and pollution**
Wim VAN NEER, Anton ERVYNCK, Benjamin T. FULLER, Patrick DEGRYSE & Wim WOUTERS

9:15 – 9:35 **From Dover to New Romney: medieval fishing in south-east Kent, England**
Ian RIDDLER & Nicola TRZASKA-NARTOWSKI

9:35 – 9:50 *Discussion*
9:50 – 10:05 *Coffee/Tea Break*

Session 2: Prehistoric and medieval fishing in the North Atlantic region (part 2)
Chaired by **James Barrett**

10:05 – 10:25 **Pre-Columbian estuarine fishing along the lower St. Johns River, Florida, USA**
Arlene FRADKIN

10:25 – 10:45 **Cod, calves and clerics: the remains from Skriðuklaustur monastery, Iceland**
Sheila HAMILTON-DYER

10:45 – 11:05 **Puzzling out medieval herring from a pan-European perspective**
Richard C. HOFFMANN

11:05 – 11:20 *Discussion*
11:20 – 11:40 *Coffee/Tea Break*

Session 3: Fishes and fishery in the Baltic / Black Sea drainage basins (part 1)
Chaired by **Günter Karl Kunst**

11:40 – 12:00 **Palaeolithic fish from southern Poland: a palaeozoogeographical approach**
Lembi LÕUGAS

12:00 – 12:20 **Late Mesolithic fishing in Northwest Zealand, Denmark**
Ken RITCHIE

12:20 – 12:40 **Some aspects concerning the Holocene development of the vertebrate fauna and the related environmental change in the south-western Baltic area**
Dirk HEINRICH & Ulrich SCHMÖLCKE

12:40 – 12:55 *Discussion*
12:55 – 14:30 *Lunch*

Session 4: Fishes and fishery in the Baltic / Black Sea drainage basins (part 2)
Chaired by **Richard Hoffmann**

14:30 – 14:50 **Archaeoichthyology and archaeology in reference to fishing in Late Bronze Age and Early Iron Age in Polish Lowland**
Mirosława ZABILSKA

14:50 – 15:10 **Fish in the menu of the Cistercians from Łekno and Bierzwnik (Poland). An historical and archaeoichthyological consideration**
Andrzej M. WYRWA & Daniel MAKOWIECKI

15:10 – 15:30 **The fishes and fishery in the Teutonic Knights State in Prussia according to written and archaeozoological sources**
Adam CHĘĆ

15:30 – 15:50 **What do we know about the extinction of sturgeon in Poland?**
Stanisław CIOS

15:50 – 16:05 *Discussion*
16:05 – 16:20 *Coffee/Tea Break*

Session 5: Fishes and fishery in the Baltic / Black Sea drainage basins (part 3)
Chaired by **Lembi Lõugas**

16:20 – 16:40 **Fishery organization in medieval Pskov: fishing tool owners' marks as a historical source**
Elena SALMINA

16:40 – 17:00 **The governmental projects of modernization of herring fisheries in Russia (18th – 19th cc.)**
Alexei V. KRAIKOVSKI

17:00 – 17:20 **The ancient fishing of Belarusion Polessye**
Elona LYASHKEVICH

17:20 – 17:40 **Fish remains from a stratigraphic sequence from the Roman civil town of Carnuntum (Lower Austria)**
Alfred GALIK, Günther Karl KUNST & Silvia RADBAUER

17:40– 18:00 *Discussion*

19:00 – 22:00 ***Banquette in the Imperial Castle in Poznań***

SATURDAY 5th SEPTEMBER 2009

7:00 – 8:30 *Breakfast in hotels*

Venue:
POZNAŃSKIE TOWARZYSTWO PRZYJACIÓŁ NAUK (PTPN)
(POZNAŃ SOCIETY FOR THE ADVANCEMENT OF THE ARTS AND SCIENCES)
ul. Mielżyńskiego 27/29

Session 6: Fishes and fishing in Mediterranean region
Chaired by **Omri Lernau**

9:00 – 9:20 **Fish remains from the *Casa do Governador* - a Roman fish processing factory in *Lusitania***
Sónia GABRIEL, Carlos FABIÃO & Iola FILIPE

9:20 – 9:40 **The onset of commercial fishing in the western Mediterranean: Castro Marim (Algarve, Portugal) and Los Gavilanes (Murcia, Spain)**
Eufrasia ROSELLO IZQUIERDO & Arturo MORALES MUÑIZ

9:40 – 10:00 **Fish as a food source in Greek dietetics. An overview of late antique and early Byzantine doctrines**
Maciej KOKOSZKO

10:00 – 10:20 **Fishbones vs. fishhooks: a comparative study from the Neolithic lakeside settlement of Dispilio, Greece**
Tatiana THEODOROPOULOU & Georgia STRATOULI

10:20 – 10:40 *Discussion*
10:40 – 10:55 *Morning Coffee/Tea*

Session 7: Fishes and fishing in Mediterranean and Africa region
Chaired by **Wim Van Neer**

10:55– 11:15 **Fish speciation and endemism in the Paleo Lake Hula, Israel**
Irit ZOHAR & Rebecca BITON

11:15– 11:35 **The archaeology and archaeoichthyology of fish and fishing at Tell el Farkha, Egypt – predynastic and early dynastic times**
Marek CHŁODNICKI & Daniel MAKOWIECKI

11:35– 11:55 **Swahili fishing culture and fish consumption in coastal East Africa**
Eréndira Quintana MORALES

11:55– 12:10 *Discussion*
12:10– 13:45 *Lunch*

Session 8: Fishes and fishing in the West and North Pacific Ocean region
Chaired by **Arturo Morales Muñiz**

13:45 – 14:05 **Prehistoric fishing in the northern Philippines: ecological and cultural implications in islands of southeast Asia**
Fredeliza Z. CAMPOS

14:05 – 14:25 **Ancient transport in the Japanese archipelago revealed through carbon and nitrogen stable isotope ratios of excavated marine fishes**
Eriko ISHIMARU, Ichiro TAYASU, Tetsuya UMINO, Minoru YONEDA & Takakazu YUMOTO

14:25 – 14:45 **Fish remains from ancient Aleutian archaeological site (Adak island, Aleutian chain) and environmental changes**
Olga KRYLOVICH

14:45– 15:00 *Discussion*
15:00– 15:10 *Break*

15:10 – 16:10 ***Afternoon Tea and Poster Session***
Chaired by **Irit Zohar**

Fishing in the Netherlands in Roman times
Monica DÜTTING

Roman fish sauce: an experiment in archaeology
Sally GRAINGER

What kind of fish are these? Bones from the Bancho site and the Yokkaichi site of the Edo period (17th-19th century) in Japan
Eriko ISHIMARU

3000 Years of Fishing on Nayau, Lau Group, Fiji
Sharyn JONES

Evidence of ocean circulation change from European eel remains in archaeological and palaeontological sites
Anthony James KETTLE

Cyprinid fishing in Dobrudja (Romania) from prehistory to the Middle Ages
Simina STANC, Valentin RADU & Luminita BEJENARU

Osteological differences within the family of the Cyprinidae
Wim WOUTERS

Fish remains from the Site of Kal, a 5th – 7th century settlement in the Mazovian Lakeland. Preliminary data
Mirosława ZABILSKA, Jerzy M. ŁAPO & Janusz JANOWSKI

Session 9: Fishes and fishing in the East Pacific Ocean region (part 1)
Chaired by **Philippe Béarez**

16:20– 16:40 **Fishing at pre-Hispanic settlements on the Pearl Island archipelago (Panama, Pacific), I: Pedro González Island (4030-3630 cal BCE)**
Richard COOKE & Máximo JIMÉNEZ

16:40 – 17:00 **Fishing at pre-Hispanic settlements on the Pearl Island archipelago (Panama, Pacific), II: Bayoneta Island (900-1300 CE)**
María Fernanda MARTÍNEZ, Máximo JIMÉNEZ & Richard COOKE

17:00 – 17:20 **Fishing the Chilean Fjords in pre-Hispanic times. Evidence from Juan Stuven Island**
Philippe BÉAREZ

17:20 – 17:35 *Discussion*
17:35 – 17:50 *Afternoon Tea*

Session 10: Fishes and fishing in the East Pacific Ocean region (part 2)
Chaired by **Richard Cooke**

17:50– 18:10 **The golden fish. Subsistence changes and dietary implications of littoral fishing among sea nomads of Tierra del Fuego**
A. Francisco ZANGRANDO

18:10 – 18:30 **Zoomorphs of Shark and Rays in the Brazilian Prehistory**
Manoel M. B. GONZALEZ

18:30 – 18:45 *Discussion*
19:30- 21:00 *Dinner*

SUNDAY 6th SEPTEMBER 2009

7:00 – 8:00 *Breakfast in hotels*

Venue:
POZNAŃSKIE TOWARZYSTWO PRZYJACIÓŁ NAUK (PTPN)
(POZNAŃ SOCIETY FOR THE ADVANCEMENT OF THE ARTS AND SCIENCES)
ul. Mielżyńskiego 27/29

Session 11: Archaeoichthyology – methodology & methods
Chaired by **Dirk Heinrich**

8:30 – 8:50 **Length reconstruction of cyprinids from the measurement of vertebrae: methods and applications on azilian fish bones from Pont d'Ambon (Bourdeilles, Dordogne)**
Stéphanie CRAVINHO

8:50 – 9:10 **Zoo-MS: Zooarchaeology by Mass Spectrometry, collagen as a molecular fingerprint for fish remains?**
Matthew COLLINS, Jen HARLAND, Mike BUCKLEY & Andrew JONES

9:10 – 9:30 **Site formation processes and conservation in Neolithic lakeside settlements. Some examples from Arbon / Bleiche 3 (Lake Constance, Switzerland)**
Heide HÜSTER-PLOGMANN, Kristin ISMAIL-MEYER & Philippe RENTZEL

9:30 – 9:45 *Discussion*
9:45 – 10:00 *Morning Coffee/Tea*

Session 12: Fishes through ethnography
Chaired by **Ian Riddler**

10:00– 10:20 **Archaeoichthyology and museum. An exhibition about fish and fishing in the past**
Simone HÄBERLE

10:20– 10:40 **Fishing and fishermen. Collections, exhibitions and research of the Ethnographic Museum in Toruń**
Artur TRAPSZYC

10:40– 11:00 **Polish ethnological research on the traditional fishing**
Wojciech OLSZEWSKI

11:00– 11:20 **Loach - a poor man's fish**
Adriana GARBATOWSKA

11:20– 11:40 *Discussion*
11:40– 13:20 *Lunch*

13:20– 14:30 ***Summarising remarks and FRWG Business Meeting***
Chaired by **Richard Cooke**

14:30 – 18:30 **Sightseeing of Poznań**

19:00– 20:00 *Dinner*

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(with bold marked participants of the conference, plain text – coauthors of paper or poster presentations)

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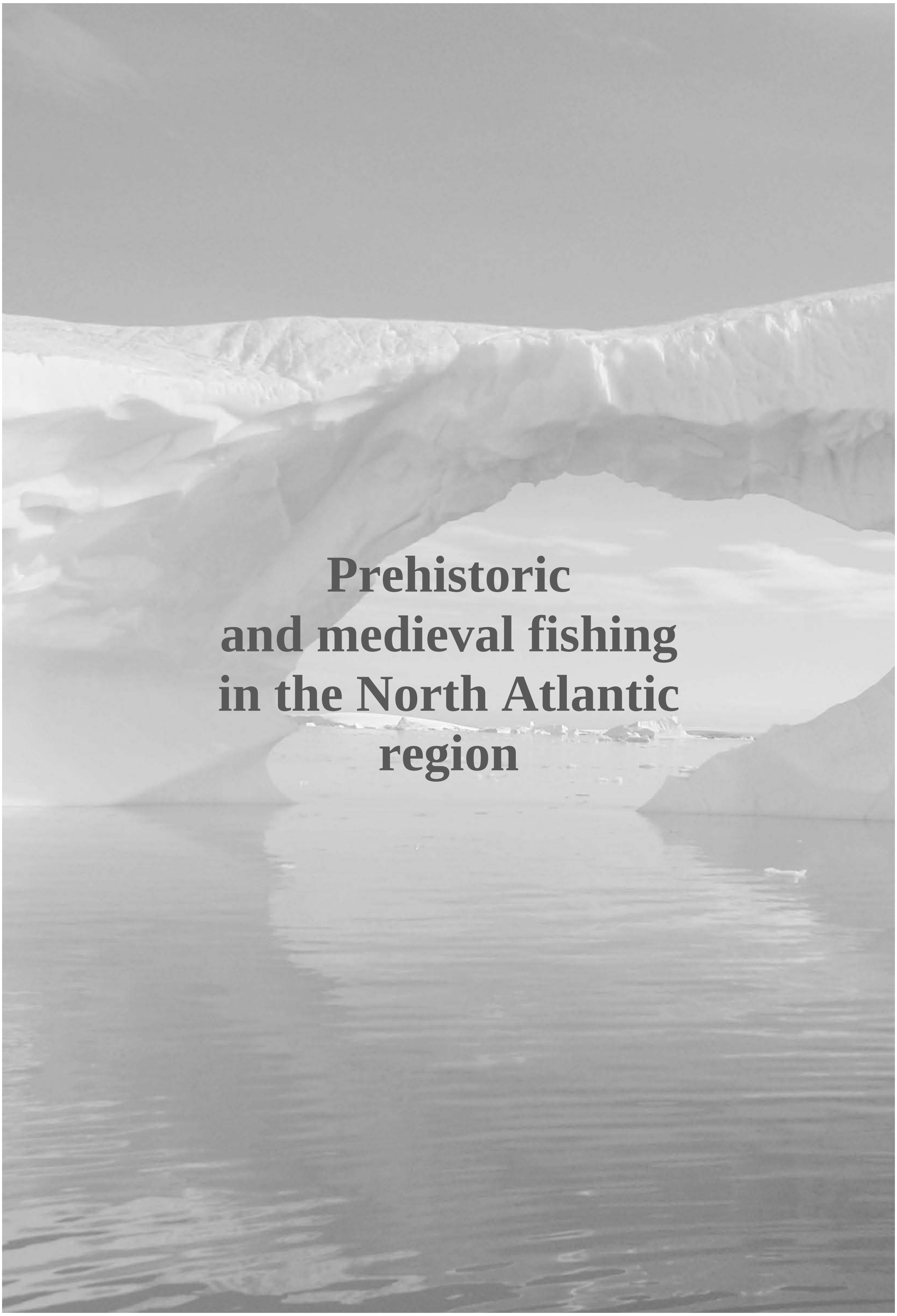

Prehistoric and medieval fishing in the North Atlantic region

The medieval origins of commercial Sea Fishing Project: a preliminary synthesis

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This paper is a preliminary synthesis of a three-year project using stable isotope analysis to clarify the chronology, causes and consequences of the growth of long-range fish trade in medieval Northern Europe. The study has focused on cod, being an abundant species with well understood migration patterns. Cod can be easily preserved by drying and was thus widely traded in the past.

The project has been conducted in two stages. The first stage established a set of control data using $\delta^{13}C$ and $\delta^{15}N$ isotope analysis of archaeological skull bones from Arctic Norway, the northern North Sea, the southern North Sea, the western Baltic Sea and the eastern Baltic Sea. These bones are interpreted as the products of local fishing and thus provide signatures for the isotopic characteristics of medieval cod from each region.

In a second stage, vertebrae and appendicular elements (that are more likely to remain in many dried cod products) were analysed from medieval settlements in Norway, Scotland, England, Belgium, Germany, Denmark, Sweden, Poland and Estonia. Based on the control data noted above, these specimens were attributed probable regions of catch using Discriminant Function Analysis. By examining changes in the relative abundance of ‘local’ and ‘distant’ catches it has been possible to infer the chronology of expanding long-range trade and/or expanding fishing effort (exploiting ever more distant fishing grounds).

The results illuminate differing regional histories of economic intensification and trade that are best interpreted by comparison with zooarchaeological evidence regarding trends in fishing – and in the context of broader archaeological and historical indications of economic, social and political change. Combining these lines of evidence, it is possible to argue that long-range fish trade began in medieval Northern Europe by the turn of the first and second millennia AD. Nevertheless, local coastal fishing was typically more important than trade in the earliest medieval sea fisheries.

The project's results help to illuminate both turning points and gradual developments in the medieval European economy. The data are patchy in space and time, but begin to establish a framework for present interpretation and future refinement.

Freshwater fisheries in Belgium during medieval and postmedieval times: looking for markers for the onset of overfishing and pollution

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Present day policy makers emphasise the desire to arrive at a sustainable use of resources. Of course, this does not imply that one wants a return to the 'genuine' condition of the environment (without any human predation pressure) but rather a restoration of a situation in which human predation has a low impact and is not destabilising for the prey populations. However, a major problem when trying to set goals for such restoration is the lack of knowledge about former environments. Scientific studies and detailed historical information typically do not have the ability to go back in time sufficiently to reveal low impact conditions. Archaeozoological data, however, do have the potential of providing much older baselines (closer to the 'pristine' conditions) against which the present situation can be compared. In this paper, a case study is presented in which archaeological fish remains from the Scheldt - a river basin in northern Belgium - are used to document the diachronic changes that took place during the last 1000 years. A goal of this study is to find early evidence for a decline of fish stocks, documenting the onset of overfishing and/or pollution, processes which are usually believed to have occurred only since the Industrial Revolution but are most probably much older in date.

When trying to document the growing impact of fishing, two lines of investigation are relevant, namely the observation of a decline or disappearance of species and the search for a decrease in average size of the fish. For the first phenomenon, the most sensitive species typically are the anadromous fish that undertake a yearly spawning run. Because this yearly migration period is predictable and because fish then occur in high concentrations, they can easily be captured in large numbers, both on the spawning grounds and on their migration routes to these areas. Anadromous species that typically suffered from overexploitation in Western Europe are Atlantic salmon (*Salmo salar*), houting (*Coregonus* spp.) and sturgeon (*Acipenser sturio*). It is striking, however, that the depletion of these stocks is not visible in the available faunal record of the Scheldt basin (Fig. 1). These taxa are always rare in the archaeo-ichthyological assemblages of the last 1000 years, possibly indicating that the fish had already been suffering from overfishing during the preceding centuries, as in the Elbe where a significant decline in sturgeon stocks is seen in early medieval times (Benecke, 1986).

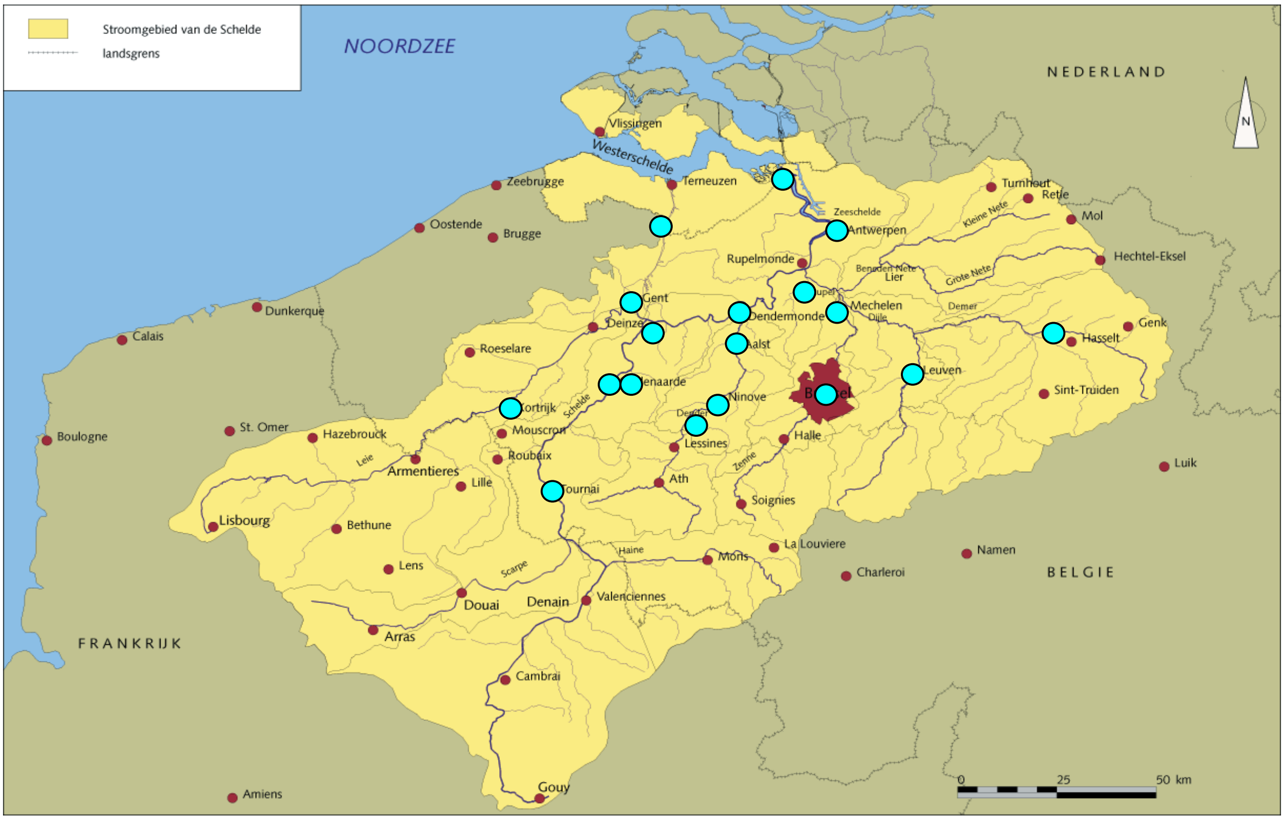

Fig. 1. The Scheldt basin with the major archaeological sites indicated (large dots).

An alternative explanation, however, could be that population densities of these taxa have always been low in the Scheldt, for instance because the river substrate was not very coarse and did therefore not match well the spawning requirements of these fish. Considering the non-migrating species, thus far, there is at least one of which the extinction could be documented: the European catfish (*Silurus glanis*) of which the latest occurrence in the Scheldt basin dates to the 12th century AD, possibly the first quarter of the 14th century. In the Meuse basin, farther south in Belgium, the last record of the species dates to the 15th century (Van Neer & Ervynck, in press). However, the extinction of the European catfish in Belgian waters probably was not only the result of anthropogenic influences, but also of climatic changes (Little Ice Age), in a marginal area of its distribution where population densities were always rather low. Construction of sluices and other water works may have made access to spawning grounds difficult, while the lower summer temperatures may have hampered the reproduction of this slow growing species that, in addition, matures rather late in life. In any case, the archaeozoological data demonstrate that *Silurus glanis* has to be considered as an indigenous component of the Scheldt fauna, an observation not always accepted by biologists.

Besides a decrease in the numbers, or the extinction, of sensitive species, a diminution in the average size of the freshwater fish may be another possible indicator of increasing fishing pressure. From the study of a large number of medieval rural and urban sites, the impression arose that, on average, the freshwater fish from towns are smaller. However, thus far, no detailed osteometric study has been carried out to confirm this impression, and it also remains to be investigated whether a size decrease can be documented within a time series from a single town. In principle, there is sufficient material available for such analyses, but there are some preliminary studies that need to be carried out first. While it may be possible to document the evolution of size in species that are easily identified, i.e. pike, it is more problematic to obtain sufficiently large samples for other species of which the identification is less straightforward. That is the case for the species of the cyprinid family which are not always easy to tell apart from each other because of the large number of species and their often similar osteomorphology. A detailed comparative study is ongoing to extend specific identifications of cyprinids to as many skeletal elements as possible, and thus obtaining larger samples for the various species (see Wouters, this volume). Parallel to this comparative study, the extensive modern material is used to establish regression formulae that should enable body length to be reconstructed from bone size.

When dealing with the effect of pollution on fish stocks, emphasis usually is on the Industrial Revolution and subsequent contamination of the environment. However, early modern, medieval, and possibly even Roman industries may have also had a significant impact on the species composition and on fish densities in rivers and lakes. There are numerous written, medieval records of pollution due to both organic and inorganic waste in Belgian towns (Thomas, 1994; Deligne, 2003). They deal with the disposal of domestic refuse and waste water in towns, and also with waste from industrial or artisanal activities for which water is needed, such as slaughtering, butchering, tanning, brewing, leather-working or wool-dying. Nowadays, pollution of freshwaters results in fish mortality and extinction, and in the development of undesirable and low-quality fish stocks (Dallinger *et al*., 1987). A possible way of documenting the ancient pollution from archaeozoological material may be shifts in the proportion of sensitive versus tolerant species. Increase through time in certain cyprinids, such as roach (*Rutilus rutilus*) or bream (*Abramis brama*), may be indicative of eutrophication (Wolter *et al*., 2000). Another possible good indication for poor water quality may be the proportion of eel (*Anguilla anguilla*), a species that is very resistant to both organic and inorganic pollution.

It is also possible to approach the pollution issue from a geochemical point of view through the study of heavy metals and stable isotopes. That archaeozoological material can document heavy metal pollution, has been shown by a geochemical study on the bones of a terrestrial species (goat) from Sagalassos, a Roman to Early Byzantine site in Turkey (Degryse *et al*., 2004). For the fish from the Scheldt basin, attention is first focussed on eel, a species that is used nowadays as a bio-monitor for lipophilic chemicals, such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs), but also for heavy metals. Within the pollutant monitoring network that has been established in the Scheldt basin, eels have been sampled and their muscles were analysed for pollutants (Maes *et al*., 2008). In an ongoing pilot study the bone tissue of these modern eel is analysed with Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) in order to verify to what extent the uptake of heavy metals (Cr, Cu, Ni, Zn, Cd, As, Pb, …) seen in the muscles is also reflected in the bone. If it appears that the bones are a good indicator for heavy metal pollution, then the analyses will be extended to archaeological eel bones. Remains of eel are available in high frequencies in most archaeological sites under study. Practically speaking, analyses will start with assemblages from relatively late, urban contexts where pollutant levels could *a priori* be elevated, and then gradually the analyses will be extended to older periods and to settlements in the country side. This approach has the potential to lead to the establishment of background levels of heavy metal contents in various parts of the Scheldt basin and to a better understanding of its historical pollution.

In addition, stable isotope ratio analysis of carbon, nitrogen, and sulphur from fish collagen will be used to examine possible markers for both organic and inorganic pollution in the Scheldt River Basin through time. The isotopic ratios of carbon and nitrogen have the ability to detect the input of sewage and fertilizer which can lead to eutrophication in an aquatic ecosystem (Macko and Ostrom, 1994; Schlacher *et al*., 2005). Sulphur isotopic analysis is capable of determining water quality and the rise and input of heavy industry such as mining, smelting, and coal production in an aquatic environment (Macko & Ostrom, 1994; Richards *et al*., 2001). The isotopic results will compliment the trace element and archaeozoological information to offer a clearer picture of how and why fish stocks decreased over the past 1000 years in Belgium and Europe.

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From Dover to New Romney: medieval fishing in south-east Kent, England

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Very little was known about fishing practices in Kent before 1996, but the results of a series of excavations at Dover, New Romney, Saltwood and *Sandtun* have allowed this part of England to become, in effect, a study area for the early medieval period. The major site of the region to have been excavated to date lies at Dover. The excavation of a part of the fishing settlement within the eastern suburb of the town provided over 88,000 fish bones, as well as a range of implements discarded across forty structures, occupied between *c* AD 1150 - 1300. Organic remains did not survive but it was possible to identify fish hooks and weights of ceramics, lead and stone, as well as indirect evidence of rope-making. Two broad phases of occupation could be identified across seven distinct building plots. Structures within each of the plots were replaced at regular intervals. They were generally small rectangular buildings, sometimes with accompanying yards, but quite unlike the burgage plots commonly seen in medieval urban sites, and densely packed into the eight plots identified within the excavated area. Floor surfaces were formed of rammed chalk or clay, with hearths present in around a quarter of them. At Dover it could be said that a new form of medieval structure had been firmly identified for the first time and some of the buildings may possibly have been fish-houses.

The fish remains were dominated by herring, which formed 80% of the sample, with cod well represented at 13% and other species occurring only in small quantities. The occurrence of herring, cod, whiting and mackerel suggested that fishing took place throughout most of the year, linked in all probability to the various fares established from historical sources for south-east England (Table 1).

Table 1. Fish fares in south-east England

Fare	*Season*	*Fishery*
Sprotfare	January to March	Sprats
Hokfare	February to May or June	Eel, Flatfish, Rays, Gurnards
?Hokfare	February to May or June	Cod
Shotfare	April and June	Mackerel
Saltfare	August	?Halibut, Ling, Cod
Flewfare and Yarmouth Fare	Late September to December	Herring

Herring would have been caught at Yarmouth in East Anglia and doubtless processed there, rather than at Dover. The Flewfare is likely to have taken place at Kent, a little later in the season. The evidence from Dover itself suggests that the herrings were processed whole, without further preparation. The late medieval records for Christ Church Priory in Canterbury note that Dover was a source of fish for the cathedral, providing on one occasion 400 greenfish, *ie* marine fish barrelled in salt and their own pickle. The site also produced a small quantity of porpoise remains and late medieval sources indicate that Dover fishermen actively pursued porpoises, possibly in order to sell them at Canterbury.

The Dover excavations allowed earlier work at West Hythe to be placed in context and it has been possible to compare the activities of the two settlements in the early medieval period. Hythe was a much smaller settlement and most of it has been destroyed by agricultural work and sand quarrying, but it formed part of a confederation of ports with Dover, and its fishery was also based largely on herrings, with sprats and mackerel also important there. Between Dover and Hythe lay an important woodland known as 'Saltwood', emphasising the requirement for salt within the Kent fishing ports. Indeed, West Hythe's origins may have been connected with a growing requirement for salt, noted in a charter of AD 732.

Subsequently, attention has turned to the town of New Romney, where small scale excavations of another contemporary settlement have revealed a broadly similar pattern of occupation and a readily recognisable material culture geared once again to fishing activities. The main focus of one set of excavations lay with a building constructed on the foreshore and destroyed in a single catastrophic event, most likely the documented storm of 1287. Further excavations have taken place at several locations nearby within the medieval town. The structural evidence consists largely of successions of clay floors, interleaved with deposits of sand. The sand represents either a deliberate attempt to raise structures above the level of sea inundation, or is possibly a direct consequence of that inundation itself. Beyond the structures lay rubbish pits, very few of which were seen at Dover. The structures themselves are larger than those seen at Dover, and may not represent the focus of fishing activity in the town. New Romney lay on a tidal inlet and this allowed it to participate also in kiddle fishing, something that was not possible at Dover. Most of the evidence for this form of fishing comes from medieval sources for the town.

All of these sites can be contrasted with contemporary inland rural settlements and they present a reasonably consistent image of fish catches and fishing practices. There are no freshwater fish from any of these sites. Herring is the dominant fish, but not before the later 12th century, a little later than might be expected, and that is the period at which fishing becomes an intensive activity, driven possibly by its secular and ecclesiastical markets. Prior to that date we have little evidence for any great interest in fish and fishing at all, despite the fact that the Cinque Ports confederation, which included the ports of Dover, Sandwich, Hythe, New Romney and Hastings, with Winchelsea and Rye joining at a later date, was in operation already in the 11th century.

Evidence for fishing activity can be sometimes be found in unexpected and indirect ways. At Dover, for example, a study of the weights of spindle whorls revealed an emphasis on rope making, rather than textile manufacture, which would accord well with the need for cordage and netting. Similarly, the unexpected presence of a few sherds of 13th-century ceramics from Rye in Sussex at a site in the City of London becomes perfectly understandable when it is realised that rippiers from Rye regularly delivered fish to London markets at that time. This serves to emphasise once again another important component of study, that of medieval documentary sources, which provide a rich vocabulary of fishing terms, and can be correlated with the archaeological evidence. These correlations include the nature and size of catches, the methods of fishing, the ownership of property, boats and fishing equipment and the family relationships of the fishing community. In putting all of this evidence together we can begin to understand how fishing was undertaken in southern Kent during the 12th and 13th centuries.

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Pre-Columbian estuarine fishing along the lower St. Johns River, Florida, USA

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Designated an American Heritage River (Belleville 2000), the St. Johns is the longest river within the State of Florida and one of the few major waterways in the United States that flows northward. The lower, or northern, reaches of this river form an extensive estuarine/tidal marsh system, which sustains an abundance of wildlife. And, according to archaeological evidence, this ecosystem provided a wealth of animal resources for its human occupants in the distant past as well.

This paper presents a synthesis of zooarchaeological research that has been conducted on a number of pre-Columbian sites in the lower St. Johns River region over the past 25 years (deFrance 1993; Fradkin 1998, 1999a, 1999b; Lee et al. 1984; Russo et al. 1993). All sites considered here are oyster shell middens that yielded substantial faunal samples representing different periods of human occupation. These faunal samples were collected using flotation or fine-gauge screens for optimal recovery and were subjected to in-depth study. Several of these analyses also involved applying methods for determining seasonal patterns of animal procurement.

In all faunal assemblages examined, ray-finned fish are the predominant vertebrate resource represented. Fish constitute from 84 percent to 98 percent of the MNI and contribute approximately 85 percent to 90 percent of the edible meat weight among the vertebrates in the various site samples. Fish are dominated by species that are typically found in shallow estuarine waters and that still occur in the St. Johns estuary today.

The taxa of fish identified and estimates of their number and size are presented. Those fish most abundant and identified in all or most of the study sites are menhaden (*Brevoortia* spp.) and other herrings (Clupeidae), mullet (*Mugil* spp.), and drums (Sciaenidae), including Atlantic croaker (*Micropogonias undulatus*) and silver perch (*Bairdiella chrysoura*). Less common fishes include several additional drum species–seatrout (*Cynoscion* spp.), star drum (*Stellifer lanceolatus*), red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), and spot (*Leiostomus xanthurus*)–as well as sheepshead (*Archosargus probatocephalus*) and sea catfishes (Ariidae), both hardhead (*Ariopsis felis*) and gafftopsail (*Bagre marinus*).

Fish measurements are used to determine fishing technology and seasonality of resource procurement. Measurements of fish vertebrae in several site faunal assemblages indicate that the fish caught varied in size, though the majority is small, evidence that the fish were taken en masse, using fine-mesh nets. At several sites, standard-length frequencies of archaeological fish specimens are compared to modern profiles of seasonal growth for particular species to determine season(s) of fishing by site inhabitants. Some of these fish species are represented by a significant number of young-of-the-year specimens, that is, under 1-year-old individuals.

The zooarchaeological evidence indicates that pre-Columbian peoples living in the lower St. Johns region along the northeast Florida coast maintained a similar lifestyle for hundreds of years and continued to use the same local animal resources with a focus upon fishing in the estuarine/tidal marsh ecosystem.

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Cod, calves and clerics: the remains from Skriðuklaustur monastery, Iceland

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The Augustinian monastery, Skriðuklaustur, was the youngest of the nine medieval monastic centres known in Iceland. Founded in 1493, Skriðuklaustur lasted only around 60 years as, together with all the monastic centres, it was abandoned shortly after 1550 with the Lutheran reformation, although the church itself was rebuilt in 1670 and continued in use until 1792. Being the only monastery from the East Iceland region Skriðuklaustur commanded very large tracts of land and rapidly became a wealthy establishment despite its late start. It was known to have a school and a substantial library.

The precise location of the monastery was unknown until trial trenching in 2000 revealed that it was centred round the still visible ruins of the church. Excavation has subsequently taken place each summer, led by Steinun Kristiánsdóttir of Reykjavik University, and have revealed a true monastery rather than a converted farmstead as had been previously suggested. Burials in the cemetery include a high proportion of women and children. Evidence from the skeletons, pollen and other finds support the suggestion that the monastery served as an important hospice (Kristiánsdóttir 2008). A number of artefacts associated with manuscript production have also been found.

The majority of the mammal remains are of sheep with cattle in second place. Other mammals are horse, dog, seals, arctic fox, cat and whale. Bird remains are mainly of swans, geese and ptarmigan.

Cattle remains are considerably less frequent than those of sheep, but at a higher level than for most sites, probably reflecting its high status. A relatively high number of the bones are of neonatal or very young calves, around 13% in comparison with only 0.3% for sheep. This emphasis on dairying is typical for Iceland from the time of the first settlements. In a monastic and hospice context the calves would have been especially useful, both for vellum production and also for feeding the young and sick. In this context the seals can be seen similarly as a dual purpose source of meat and also skins - traditionally used for binding the manuscripts. Likewise the swans and geese are an obvious supply of feathers for writing quills.

Fish bones account for just over 20% of the remains. The fish taxa list at Icelandic sites is usually very restricted and this is also true of Skriðuklaustur, with only five or six species. The majority of the fish bones are of gadids and most of these are definitely or probably of cod. Ling and haddock are also present in small numbers and a saithe was identified in the preliminary report (Pálsdóttir 2006). The other class of fish found is elasmobranch. These remains are unusual and will be described later.

The cod (and all gadid material) is not typical of earlier, Viking period, settlements nor is it the same as other late medieval assemblages. At other inland sites the fish remains are mainly of processed cod, klipfisk for example. In that type of assemblage the caudal vertebrae are dominant and apart from some cleithra there are no bones from the head area of the fish. In contrast, the bones from Skriðuklaustur do contain all the head bones as well as cleithra and vertebrae, both pre-caudal and caudal. A preponderance of head bones is usually restricted to coastal sites devoted to processing; clearly this is not an appropriate explanation for an inland monastic site.

There is bias within the elements; the numerically best represented bones are cleithrum, premaxilla, ceratohyal, posttemporal and vertebrae. This is likely to be mainly taphonomic; these are large sturdy bones but also the ones most easily recognised even when in a poor and fragmentary state. There are not enough vertebrae to match the other elements but precaudal as well as caudal are present in good numbers. The fish are also quite large; the size best suited to preserving is around 60-110 cm total length (e.g. Krivogorskaya *et al* 2005) but many of the bones at Skriðuklaustur would have come from fish well over 1m in length.

The implication must be that, while some of the fish may have been the standard processed type, whole fish (presumed fresh) were also being supplied to this settlement. It has been suggested that this ability to order fresh fish indicates the relative wealth of the monastery. Those in charge of provisions were either able to purchase from coastal processers or trading settlements, or were perhaps in direct control of a fishing station. It is also possible that some provisions were gifted.

In addition to the gadid material there are several elasmobranch vertebrae. These are large (over 30 mm across). More than half of these vertebrae, and perhaps all, have been modified; a hole has been pierced through the centrum to produce a large flat bead (Fig. 1). The bevelled edges and difference in colouration immediately round the perforation suggest wear, e.g. by the passage of a cord through the hole. The method of recording the finds from the excavation means that the precise location of each item will be available for analysis. Preliminary results of the distribution study show that these vertebrae were almost always recovered from inside the church (Fig. 2).

Stallibrass (2002, 2005) reported on perforated fish vertebrae from 13th-14th century deposits inside a chapel in northern England. These were thought to be from rosaries or paternosters. These perforated vertebrae have also been found elsewhere, including Poland (Makowiekci 2003). Here, and in other countries, fishbone necklaces have been associated with fertility and warding off evil. The adoption into Christianity, with the obvious association with fish and fishermen, may have drawn on these existing beliefs.

Acknowledgements:
The investigation at the monastery at Skriða is a collaborative project between the National Museum of Iceland in Reykjavík, the East Iceland Heritage Museum in Egilsstaðir and the Gunnar Gunnarson Institute at Skriðuklaustur. The project manager is archaeologist Dr. Steinunn Kristjánsdóttir, assistant professor at the National Museum of Iceland and University of Iceland in Reykjavik, Iceland. Funding is provided by the Icelandic Government, European Union funds, Research Council of Iceland, University of Iceland Research Fund, Icelandic Student´s Innovation Fund, and the three institutions directly involved.

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Fig. 1. Shark vertebrae modified as beads, scale in cm.

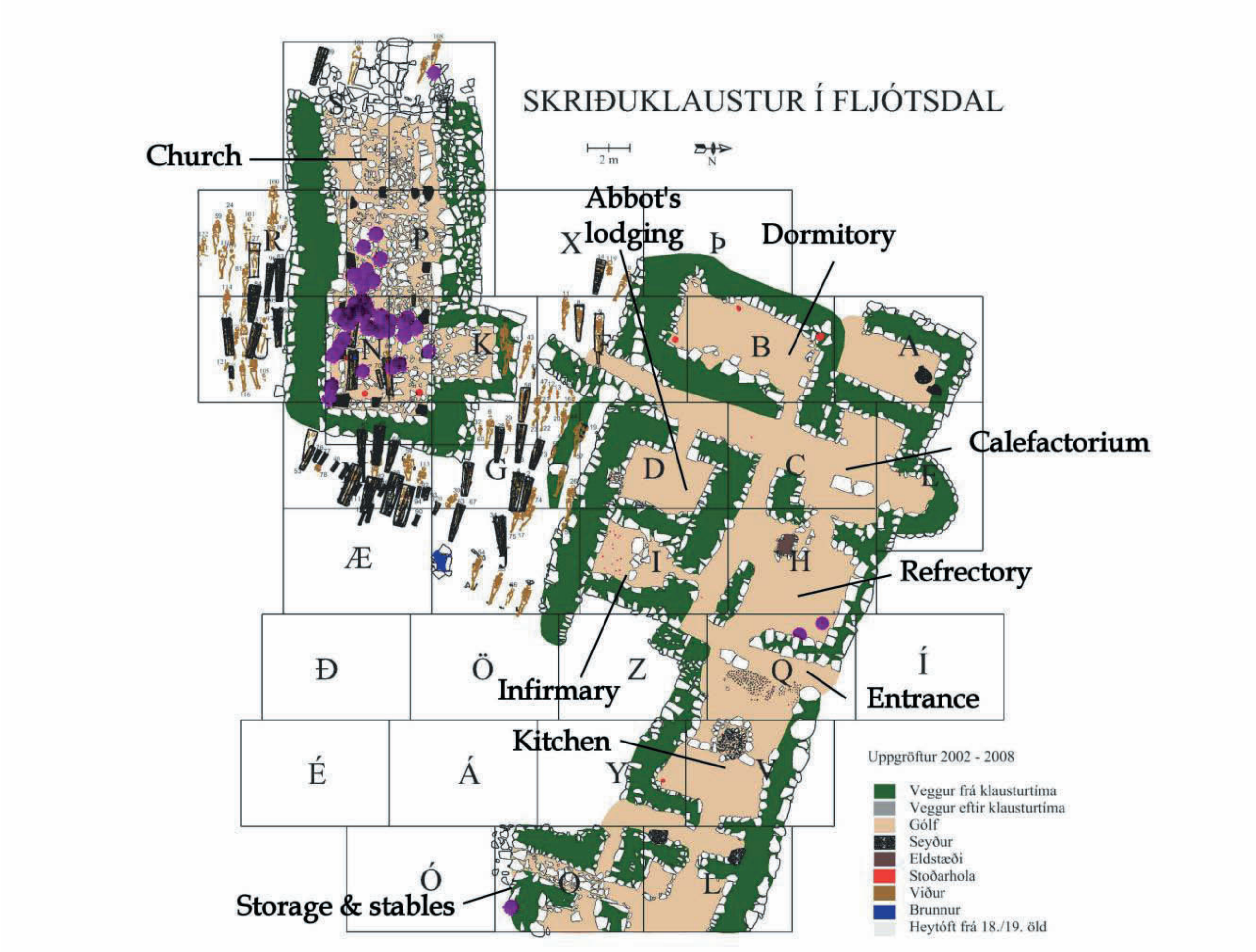

Fig. 2. Site plan of Skriðuklaustur, including locations of shark beads (purple spots).

Puzzling out medieval herring from a pan-European perspective

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Despite the economic and dietary fame of herring (*Clupea harengus* L.) in medieval Europe, knowledge of this fishery remains fragmented and obscure. The many scholars who have written on the subject worked from limited national, regional, or local perspectives and most of them without benefit of palaeoscience. *Clupea harengus*, however, inhabited one large marine ecosystem where it obeyed no human laws. By the later Middle Ages this animal was feeding human consumers far from any waters where it might actually be found. This paper, a report on metaresearch in progress, brings together at the European scale three bodies of information not hitherto so associated, namely the ecology, consumption, and commerce in herring to identify features in the interaction between medieval human societies and populations of this marine creature.

A first essential is the ecology of herring and the circumstances under which medieval Europeans caught them. As pelagic plankton eaters, herring, like others of their family around the world, comprise a large but volatile and cyclic biomass near the consuming base of aquatic food webs. Northeastern Atlantic waters contain three distinct populations (races) of herring, but medieval fishers exploited mainly North Sea and Baltic stocks. These follow seasonal migratory patterns that result in the reproductive segregation of local spawning groups, some inshore, others in more open waters. Plankton and the fishes which consume them are highly sensitive to variations in sea water temperature and chemistry. Fluctuating climatic anomalies, long-term environmental changes, and the commercial collapse of certain heavily-exploited local herring stocks are identified with reasonable precision during the later Middle Ages.

Demand drives the economic activity of fisheries. Who was eating herring in medieval Europe? A provisional review of the archaeozoological evidence (109 sites) and the written record (47 verbal references) for the first local signs of herring consumption yields distribution maps which indicate a rather slow spread in centuries after 1000 CE. Written records closely associate herring consumption with the calendar of religious taboos against eating meat. Inland from coastal areas with easy access to fresh or lightly-cured supplies of fast-spoiling herring, secular consumers especially long avoided preserved fish on medical and gustatory grounds. Those who could afford to be fussy ate much less herring than those who could not. The overall result was a seasonal mass market acutely sensitive to price.

Competitive medieval markets for herring reflected the interplay between demand and the supply of a changing resource. By the last medieval centuries commerce in herring increasingly operated at a European scale with prices everywhere showing characteristic long-term evolution and short-term volatility. Herring are the only fish prices available for serial study from medieval Europe. Published data for long-term price movements is now available in twenty series extending across northern Europe from the British Isles to Kraków. Eighteen of these data sets from eight locations provide annual prices in series significantly predating the 1540s. These include markets close to the production zones of the North Sea and Baltic and others well inland where herring was purely a consumption good. While each individual price series has hitherto been considered to reflect local circumstances and/or meaningless random variations, their collective simultaneous study establishes several hitherto unnoticed convergences, periods of a few years when three or more locations experienced notable price peaks. These can in turn be associated with independently-documented decade-scale climatic events and other changes in the biosphere.

Competitive market behaviour as well as common exploitation of what was one seasonally segmented wild stock of herring requires that the history of medieval European herring fisheries, trades, and consumption be understood as the fluid outcome of a complex and changing synergy between human actions and environmental variability. Great volatility of herring catches occurred in a context of continual environmental change and intense human predation on defined local stocks. No individual local study should be completed without reference to climatic and marine conditions in the area of supply and to the behaviours of competitive capture fisheries, markets, and traders on a European scale.

The paper is largely metaresearch, collating and synthesizing several different kinds of analyses and evidence. Some exemplary references include:

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Fishing in the Netherlands in Roman times

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Organic material in the Netherlands is usually well preserved beacause of favourable circumstances. Fish remains are known from several archaeological sites dating from the Mesolithic until modern times. Research on these remains, however, is not always carried out and in some cases only to the level of identification. In addition, no comprehensive study of a region or time period has been carried out. The research project "Fishing in the Netherlands in Roman times", of which the initial steps are presented here, aims at filling one of these knowledge gaps.

The first Romans arrived in the Netherlands during the Augustan campaigns. In 19 BC they set up a legionary camp in the east, at present-day Nijmegen. Later on, forts were constructed, mainly along the river Rhine, that eventually became the *limes*, the northern border of the Roman Empire. Recent studies in the Netherlands have produced a window on life, both within the Roman Empire and on its fringes.

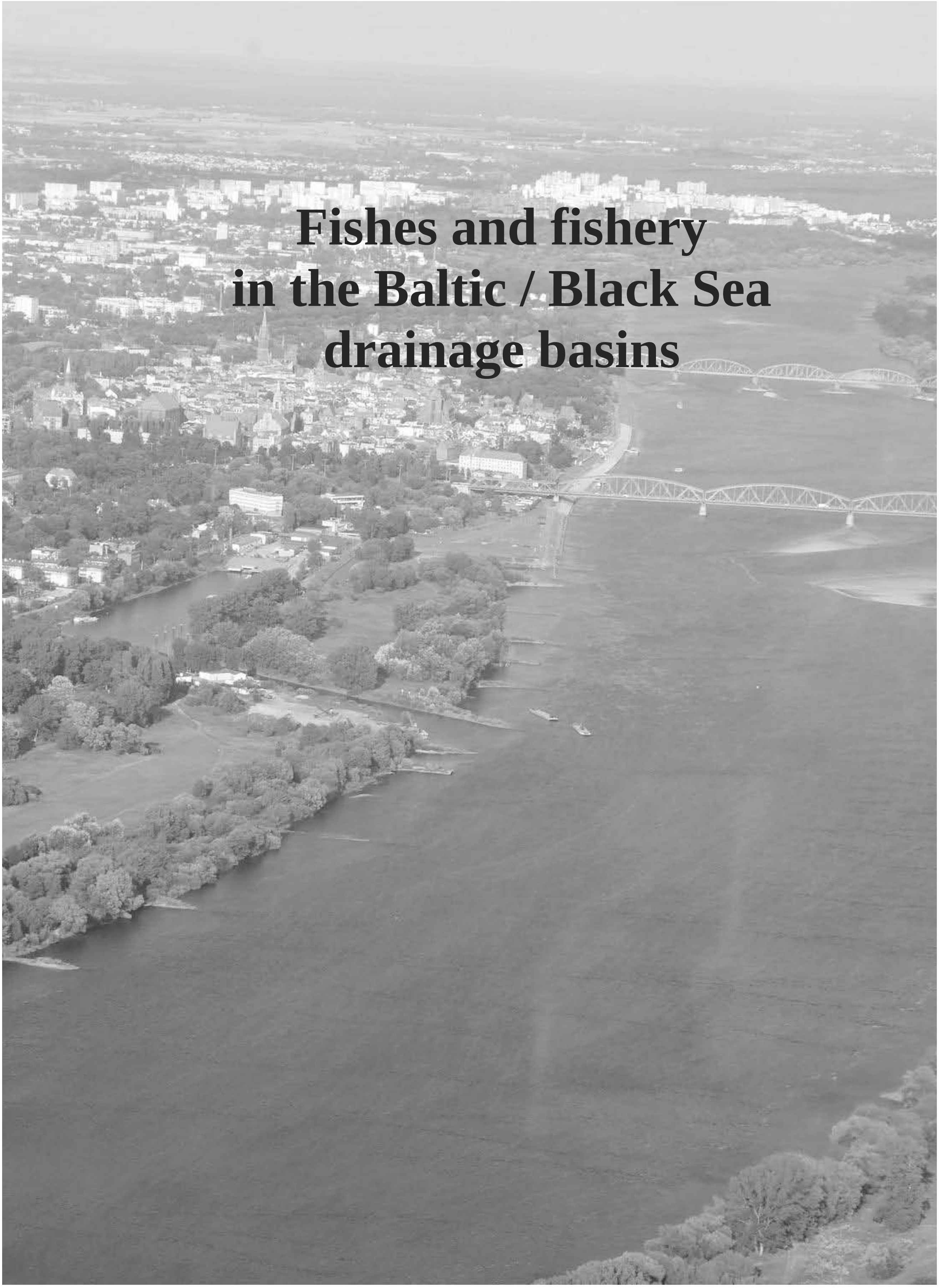
The assumption made here is that the Roman occupation in the Netherlands marked a turning point in the way that society was organized. Fishing played a part in this. I assume that social, economic and technological aspects were changed by the occupation. In my study Roman sites are compared to sites from the Late Iron Age (250 – 19 BC). Late Roman sites are also taken into account as the Late Roman period (270 – 450 AD) saw a gradual collapse of the Roman system. It is thought that by studying two transitional periods, maximum insight is gained.

Fish remains recovered from archaeological sites are studied in relation to secondary archaeological evidence (fishing gear, containers, and pictorial and epigraphic data). Additionally, information on Roman legal fishing rights, taxes, fish prices and organization of the fish trade will be looked into.

Questions to be answered are:
- Was there a difference in fishing and fish consumption and trade inside and outside the empire?
- Are there any differences between military and civilian sites, between towns and countryside, 'Roman' sites and 'local' sites?
- How was the fishing organized?
- Is there a difference or a change in technology?
- Is there a difference and/or change in food preference?
- What was the economic meaning of fishing and how was trade organized?
- What does the location of sites (sea, river, lake) say in comparison with the excavated fish remains?

One of the first steps in this research has been the compilation of an inventory of all the Dutch sites that contain fish bones. The first results have led to an additional and intriguing question: If intensive sieving has come up with anything (snake, toad, mouse etc) *except* fish bones, and the site is located near both sea and freshwater, and contemporary sites in the same region *do* show fish bones, then what does that mean? Food preference? Lack of fishing rights? No fishing gear and knowledge available? Religious aspects?

Fishes and fishery in the Baltic / Black Sea drainage basins



Palaeolithic fish from southern Poland: a palaeozoogeographical approach

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The current study forms one part of the research project ‘Man, environment, technology: a role of the archaeofauna in ancient societies’ (led by Lembi Lõugas and Piotr Wojtal) supported by the bilateral exchange program of the Estonian and Polish Academy of Sciences and partly by the Estonian Science Foundation. Analysis of Palaeolithic fish bones from beyond the Last Glacial Maximal (LGM) range offers the possibility of reconstruction of the palaeozoogeography of that faunal group before the ’opening’ of the Baltic Sea basin from the glaciers.

A case study in this research concerns Obłazowa Cave, southern Poland (Figure 1). Other examples are Krucza Skala Rock Shelter (Kroczyckie Rocks) and Nad Tunelem Cave (Ojców National Park). The latter is considered a naturally accumulated deposition, but in Obłazowa and Krucza Skała anthropogenic factors also played an important role.

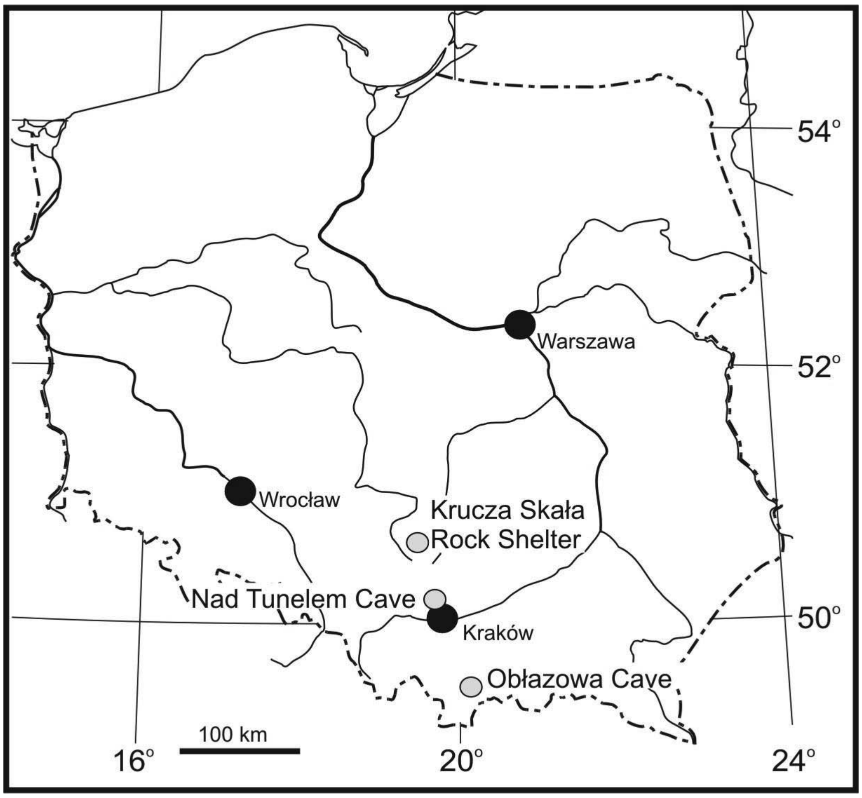

Fig. 1. Map of Poland with the locations of sites mentioned in text (modified by P. Wojtal).

According to Valde-Novak *et al*. (2003) the Nowa Biała 2 archaeological site – Obłazowa Cave – is located in the southwest section of Obłazowa Rock at an altitude of approximately 7 m above the Białka River. Two exposed limestone rocks: Obłazowa (670 m) and Kramnica (688 m), lying on the opposite bank of the Białka River. The investigations took place in the cave for eight seasons in 1985 – 1992 (with one break in 1991) and in 1995. The Białka riverbed was previously at a higher level where it washed out cracked limestone leaving a small cave along the layers of rock. The cave is a spacious chamber (9 m long, 5 m wide and 3 m high) with a little corridor running from the entrance arcade. The cave was inhabited during the Middle and Upper Palaeolithic periods. Zooarchaeological analyses show that it was used only as a short term camp by Palaeolithic hunters. The Obłazowa Cave is well known for a "boomerang" made from mammoth tusk. Given the great value of the boomerang and other artefacts, this suggests that the site had a ceremonial function and was of special significance, probably related to magic during Gravettian times.

The fish bones from the Palaeolithic cave deposits of Obłazowa were studied previously by E.K. Sytchevskaya (Valde-Novak *et al*. 2003). She analysed a total of 254 fish remains, but only 144 fragments were determined to species level. In that material at least four fish genera are represented: *Thymallus*, *Salmo*, *Salvelinus* and *Esox*. The identification of *Salvelinus* has a little uncertainty.

In addition to the previously discovered fish, a new study of 53 fish remains gave two more genera: *Cottus* and *Coregonus*. Most probably *Cottus gobio* is represented, but exact determination of the *Coregonus* was not possible. The latter needs special consideration since this fish does not occur in the area now, but may have had a population in any of the mountain lakes before the LGM.

As new studies of DNA of *Thymallus*, *Cottus* and *Salmonidae* are now available (e.g. Bernatchez and Dodson 1994; King *et al*. 2007; Kontula 2003; Säisä *et al*. 2007; Šlechtova *et al*. 2004; Gross *et al*. 2001;) these assist our understanding of the palaeozoogeographical distribution of these fish during the Palaeolithic time.

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Late Mesolithic Fishing in Northwest Zealand, Denmark

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The site of Asnæs Havnemark was discovered in 1993, when avocational archaeologist Egon Iversen reported flint tools, pottery, animal bones and shells eroding out of the beach face along the northern coast of the peninsula of Asnæs, in the northwestern corner of Zealand, Denmark (Fig. 1). Continued coastal erosion threatened the site, so in 2007 an excavation was conducted under the direction of Dr. T. Douglas Price, in conjunction with the Kalundborg Museum, to recover as much information as possible before it was destroyed. In five weeks of field work, three trenches were opened and a total of approximately 40 square meters were excavated. In addition to a large quantity of flint tools and debitage, Ertebølle and TRB pottery as well as animal remains (bones and antler) were recovered. A large portion of the animal bone was fish, which forms the basis of this project. Radiocarbon dating places the site at the end of the Ertebølle/ beginning of the TRB period (calibrated ca. 4000-3800BC) – in line with the material culture. Excavation of the trenches was carried out by means of trowel and shovel, with the matrix from 18 square meters being water-screened in the field through 4mm mesh-size sieves. Fourteen bulk samples (one of five liters and the rest, two liters) were washed through nested geologic screens of 8, 4, 2 and 1mm mesh-size to examine the effects of screen size on the recovery of fish remains.

sites:

1. Asnæs Havnemark

2. Smakkerup Huse

3. Dragsholm and Bøgebjerg

4. Fårevejle

5. Norsminde

6. Nederst

7. Ertebølle and Bjørnsholm.

Fig. 1. Map of Denmark with sites from the text

A total of 44,382 specimens were identified from the materials recovered by water-screening using 4mm mesh-size screens, and an additional 2329 were identified from the samples recovered from the 2 and 4mm geologic screens (see Tables 1 and 2). From the 1mm fraction came 309 vertebrae, which are not yet analyzed. Unidentified materials amounted to an additional 1887 vertebrae from the water-screened materials and 213 from the samples processed with the geologic screens. Of the 1887 vertebrae, over half (963) were unidentifiable because of the matrix adhering to them. Particularly noteworthy are the 909 gadoid otoliths recovered from the 4mm mesh sieving operations. A preliminary evaluation of taphonomic effects suggests that while these may have had some impact on the assemblage, the archaeological remains are likely to be representative of fish use at this site.

It is immediately obvious that gadoids are the predominant fish in the assemblage, comprising around 85% of the total. This percentage decreases to 68% when just the bulk samples that were screened with 2 and 4mm mesh are considered, but still is more than three times the proportion of the next most common fish (eel – *Anguilla anguilla*). The representation of eel is a more complex issue, as it constitutes about 10% of the regular assemblage, but doubles to 20% when the 2mm fraction is included. Herring (*Clupea harengus*) presents a more extreme example of this – rising from ~0.4% to over 4.0%. Bull-rout (*Myoxocephalus scorpius*) and mackerel (*Scomber scombrus*) also more than double their percentage representation in the assemblage that comes from the geologic screens. Flatfish (Heterosomata) show little difference between the two assemblages and the other species are present in such small numbers that any differences can probably be considered insignificant. Overall, gadoids and eel account for the vast majority of the identified assemblage.

Table 1: Fish remains recovered by water-sieving with 4mm mesh-size screens.

	Vertebra	% of vertebra	Non-vertebra	NISP	% of NISP
Gadidae	32578	84,81%	5479	38057	85,75%
Heterosomata	858	2,23%	39	897	2,02%
Anguilla	3709	9,66%	318	4027	9,07%
Clupea	138	0,36%	4	142	0,32%
Myoxocephalus	482	1,25%	92	574	1,29%
Squalus	30	0,08%	9	39	0,09%
Scomber	440	1,15%	0	440	0,99%
Belone	41	0,11%	4	45	0,10%
Eutrigla/Trigla	93	0,24%	21	114	0,26%
Trachinus	31	0,08%	1	32	0,07%
Salmo	13	0,03%	0	13	0,03%
Zoarces	2	0,01%	0	2	0,00%
Totals	38415		5967	44382	

Table 2: Fish remains recovered from bulk samples washed through nested 4 and 2mm geologic screens (combined results).

	Vertebra	% of vertebra	Non-vertebra	NISP	% of NISP
Gadidae	1449	67,93%	187	1636	70,24%
Heterosomata	47	2,20%	1	48	2,06%
Anguilla	424	19,88%	4	428	18,38%
Clupea	89	4,17%	0	89	3,82%
Myoxocephalus	69	3,23%	4	73	3,13%
Squalus	0	0,00%	0	0	0,00%
Scomber	52	2,44%	0	52	2,23%
Belone	1	0,05%	0	1	0,04%
Eutrigla/Trigla	1	0,05%	0	1	0,04%
Trachinus	0	0,00%	0	0	0,00%
Salmo	1	0,05%	0	1	0,04%
Zoarces	0	0,00%	0	0	0,00%
Totals	2133		196	2329	

Eight other coastal Ertebølle sites with sizeable assemblages of fishbone have been selected for comparison with the material from Asnæs Havnemark. Dragsholm, Bøgebjerg and Fårevejle, all in northwestern Zealand, and a sample from Nederst, on the Djursland peninsula of Jutland, were analyzed by the author. Smakkerup Huse, also in northwestern Zealand, has an assemblage identified by Charlotte Sedlacek Larsen (Larsen 2005). The sites of Ertebølle and Bjørnsholm, both on the Limfjord in northern Jutland, and Norsminde, approximately 15km south of the city of Århus on the eastern coast of Jutland, were analyzed by Inge Bødker Enghoff (Enghoff 1986, 1989 and 1991). Five of the sites (Ertebølle, Bjørnsholm, Norsminde, Nederst and Fårevejle) are classic *køkkenmøddinger* (shell middens), while the rest provide materials that were mainly the result of outcast zones in near-shore environments. Although differences in excavation technique, site type and possibly chronology must be considered, it is thought that these differences are not so significant as to preclude a comparison of the sites. The following comparisons will only incorporate the percentages of vertebrae (as opposed to total NISP) present in the assemblages.

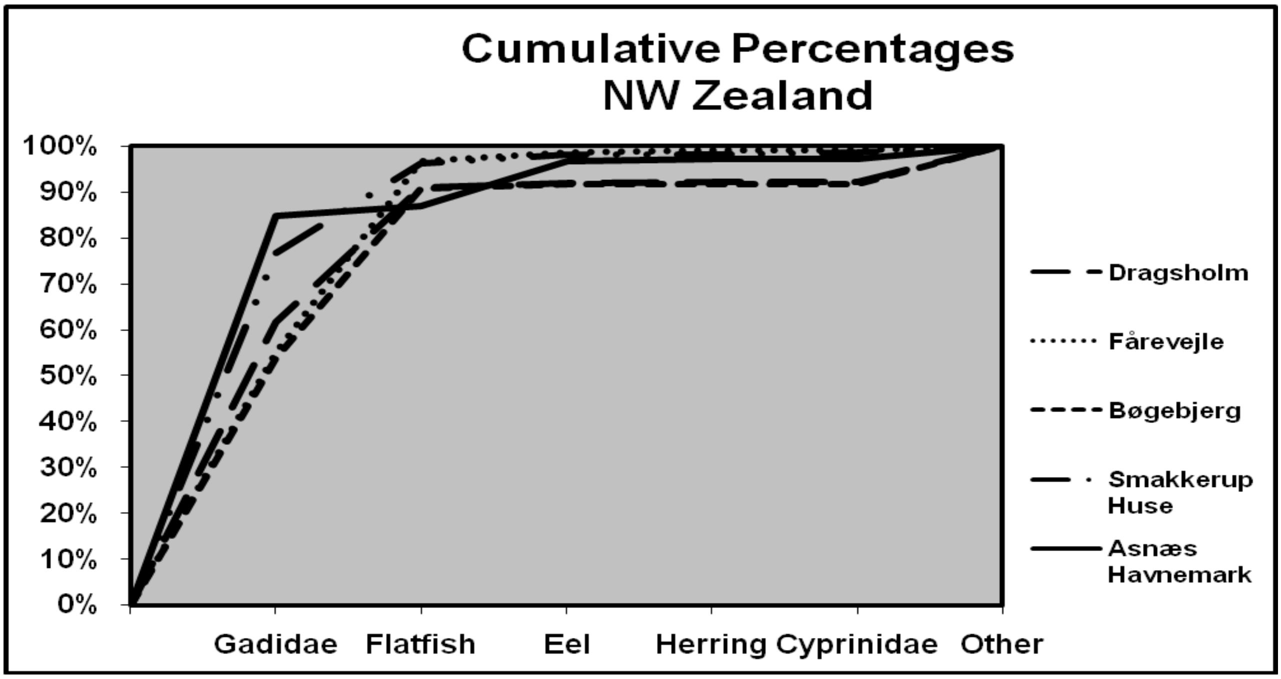

Fig. 2. Graph showing the cumulative percentage of fish vertebrae from 5 sites in Northwest Zealand, Denmark.

Based on the cumulative percentages displayed in Figures 2 and 3, it seems clear that the two regions of Denmark are represented by some distinctly different fishbone assemblages. Eastern Denmark (represented by the five sites in northwestern Zealand) has a relatively homogenous pattern, with a predominance of gadoids and flatfish, with other species contributing only a small amount. In contrast, western Denmark (represented by four sites on the Jutland peninsula) displays more variety between the assemblages, with different types of fish predominating at different sites. Some possible reasons for the differences in the fish assemblages involve environmental, seasonal and technological factors – and it must be stressed that these categories are not intended as mutually exclusive explanations. Regardless of the cause of the variation, its existence is important for an understanding of Late Mesolithic society.

Differences in material culture between eastern and western Denmark during the Ertebølle period have been observed for some time. The Great Belt between the islands of Fyn and Zealand seems to represent a sort of cultural frontier, separating regional groups within the larger Ertebølle tradition of Denmark. To the west of this body of water are commonly found T-shaped antler axes, bone combs and rings, and Type A (straight) antler harpoons, while these are rare or absent east of the Great Belt. In contrast, to the east are found Limhamn axes, Type B (curved) antler harpoons and a majority of the shoe-last axes known from Denmark (Fischer 2003; Vang Petersen 1984).

Differences in the form and decoration of pottery have also been described (Andersen in press). Adding subsistence practices to the list of differences between the two regions is an important step towards understanding these groups.

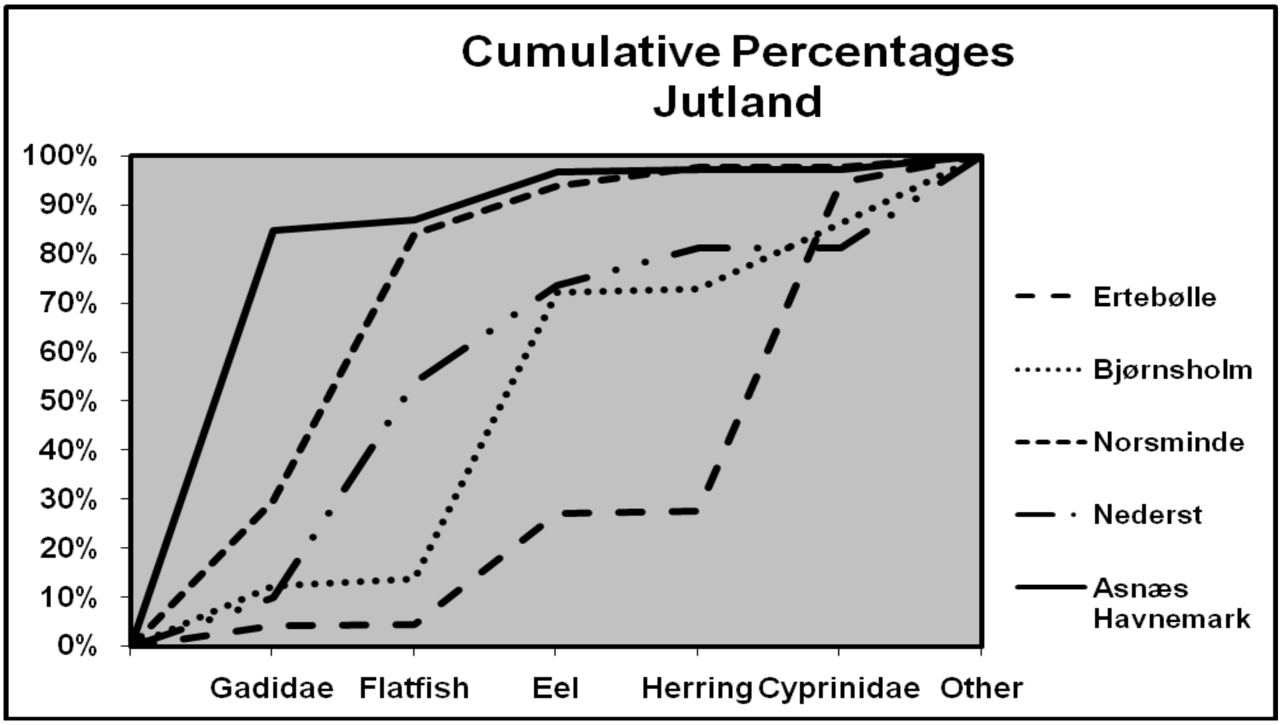

Fig. 3. Graph showing the cumulative percentage of fish vertebrae from Asnæs Havnemark compared with four sites on the peninsula of Jutland, Denmark.

Multiple lines of evidence, including great quantities of fishbone, varied and complex fishing technologies, site locations, as well as the marine signature from stable isotopes analyzed from human skeletons, all point to the great importance of fishing and marine resources to the Ertebølle subsistence economy. Closer examination of the evidence reveals differences in the way that marine resources were utilized between sites, and perhaps even between different regions in Denmark. This variation must not be overlooked in an attempt to see broad patterns in culture, but instead, presents the opportunity to see significant differences between regional groups that may have profoundly affected how and why they made the change from a hunter-gatherer economy to one based on domesticated resources.

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Some aspects concerning the Holocene development of the vertebrate fauna and the related environmental change in the south-western Baltic area

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It is well known that the deglaciation of Scandinavia led to several alterations in space and time concerning the Baltic basin. In particular there were isostatic and eustatic sea level changes together with several freshwater stages caused by isostatic processes in this area. The last one of these freshwater phases in the development of the Baltic was the Ancylus-Lake, which lasted from around 8800-7000 calBC. This lake did not cover the whole area in question apart from a short interval when a relatively small bight extended across the Darss Sill threshold into the Fehmarn Belt and the Mecklenburg Bay of today (Jensen et al. 1999, Lemke 2005), and when, especially, in its later phase the whole area between Mecklenburg-Vorpommern, Schleswig-Holstein, and the Danish Islands was terrestrial, apart from local lakes, for around 1000 years. This was the time of the Maglemose- and the younger Kongemose-Culture of hunters and gatherers in southern Denmark and northern Germany and probably also in the now lost land in-between (Fischer 1993). Accordingly fish remains from that area and time are from freshwater species, for instance perch (*Perca fluviatilis*), pike (*Esox lucius*), and some cyprinids.

Around 7000 calBC, the sea level rise began that is known as the Littorina transgression: The land between the Danish Islands of today and the shoreline of the modern south-western Baltic drowned very quickly – from 6700-6100 calBC the sea level rose about 15 m (Kliewe and Janke 1982). Afterwards, until 4000 calBC, there was only a gradual rising to 1 m below the present sea level (bsl; Lemke 2005). The sudden rise in the earlier phase of the Littorina transgression made processes of erosion and accumulation nearly impossible. Thus, the shoreline was characterized by lots of islands, bights, and inlets, which later on drowned as well (Meyer 2002).

It was the aim of the archaeozoological investigations within the research group SINCOS (Sinking Coasts – Geosphere, Ecosphere and Anthroposphere of the Holocene Southern Baltic Sea) to obtain detailed information about the faunal changes, especially during the Littorina transgression. The data would hopefully allow reconstruction, to a certain degree, of the past environmental and geological processes. The analyses show that a sudden shift from a terrestrial and limnic environment to a marine and coastal one took place in this phase: The marine character of the ichthyofauna is evident with a preponderance of cod (*Gadus morhua*) and flatfishes (Pleuronectidae). Eel (*Anguilla anguilla*) is the most abundant migratory fish species; seals (Phocidae) and small whales (*Phocoena phocoena*, Delphinidae) are added to the – until now – exclusively terrestrial mammalian fauna. For man, it must have been a changing world for he lost not only dwelling places, which perhaps had been used for centuries, but probably also newly founded ones, within a short time.

Earlier, there was controversy whether the influx of saltwater occurred via the Øresund, or even Middle Sweden, or mainly via the Great Belt (Lemke 2005), but it now seems evident that the first inflow of marine water occurred via the latter. It could be shown that the Darss Sill threshold must have been a natural barrier against marine influence for a certain time span. Thus it was possible to recognize, by differences in the species composition of findings – the remains of limnic or marine vertebrates – from sites of this time situated to the west and to the east of this barrier, that this influx of saltwater first occurred in the west (see below).

In any case, it is possible to trace the shift from a limnic to a marine environment together with and dependent on the displacement of settlements on a large scale. This is shown for different sites near the island Poel in the Wismar Bight and in the north-western part of the Mecklenburg Bay. The sites in question near the island Poel that have yielded sufficient animal remains are: Timmendorf-Nordmole I, Timmendorf-Nordmole II, and Jäckelberg-Huk; Jäckelberg-Nord is also included. Those from eastern Holstein at the north-western coast of the Mecklenburg Bay are Rosenhof, Rosenfelde, and Neustadt (Fig. 1). Corresponding sites in the Rügen area are Breetzer Ort, Lietzow Buddelin and Parow.

Mecklenburg Bay

In the vicinity of Poel, the settlement of Jäckelberg-Huk is situated most distantly from this island and accordingly, with 8.5 m bsl, the deepest one as compared with the sea level of today. It is dated between 6300 and 6000 calBC. At this time, the area was clearly still terrestrial or limnic, as shown by the species composition of fishes: apart from sporadic remains of marine fishes and some of migratory species such as eel, only bones from freshwater fishes were found, mainly perch (61%). Pike and cyprinids were also common. Mammal remains (e.g. *Cervus elaphus, Capreolus capreolus*) were rare at this site, probably because of its special function as a fishery.

The adjacent site Jäckelberg-Nord is situated 7 m bsl. The settlement is dated around 5300-5100 calBC. At this place, apart from remains of freshwater species, marine ones like cod, herring (*Clupea harengus*), pleuronectids, and garfish (*Belone belone*) were also found. Therefore, it is suggested – despite the very small sample size, that the Littorina transgression had already reached the surroundings. However, the small portion of mammals (*Cervus elaphus, Sus scrofa*, some rodents) is still exclusively terrestrial.

At least between 5100 and 4800 calBC the transgression must have extended completely into the vicinity as is shown by remains from Timmendorf-Nordmole II. As expected according to the rising sea level, this younger site is located still closer to the modern coast at a depth of 5 m bsl. The marine and diadromous portion of the fishbone material, not only the afore-mentioned species but also further ones, dominate by far compared with freshwater species which amount to only to 6%. These results correspond to a certain extent to those obtained from fish remains excavated at Rosenhof, a settlement of somewhat younger time, that is from 4800 to 4600 calBC, situated at the north-western coast of Mecklenburg Bay. However, whereas the main portion of fish remains at Timmendorf-Nordmole II is derived from eel, at Rosenhof mainly marine species, especially cod, were identified; eel amounts to only around 7%. Beyond that, both sites are characterized by species that are related to inshore waters or even lagoons with eelgrass and seaweeds, such as bull-rout (*Myoxocephalus scorpius*), black goby (*Gobius niger*), and three-spined stickleback (*Gasterosteus aculeatus*).

The difference between these two sites in the amount of eel points, either to differences in the occurrence of this species nearby, or to distinct economic purposes of the dwellers. This second case is the most probable as, for instance, people also concentrated on eel at Rosenfelde. This site is dated to a similar time, i.e. from 5000-4800 calBC, and is situated near Rosenhof. The archaeological evidence – e.g. parts of eel-spears and of weir-baskets – as well as the specific bone material, indicates a special fishing place. Marine mammals must have been a new resource from this time onward as is shown, for instance, by some remains of seals in the Rosenhof material. However, on the whole, the afore-mentioned terrestrial mammals were still dominant.

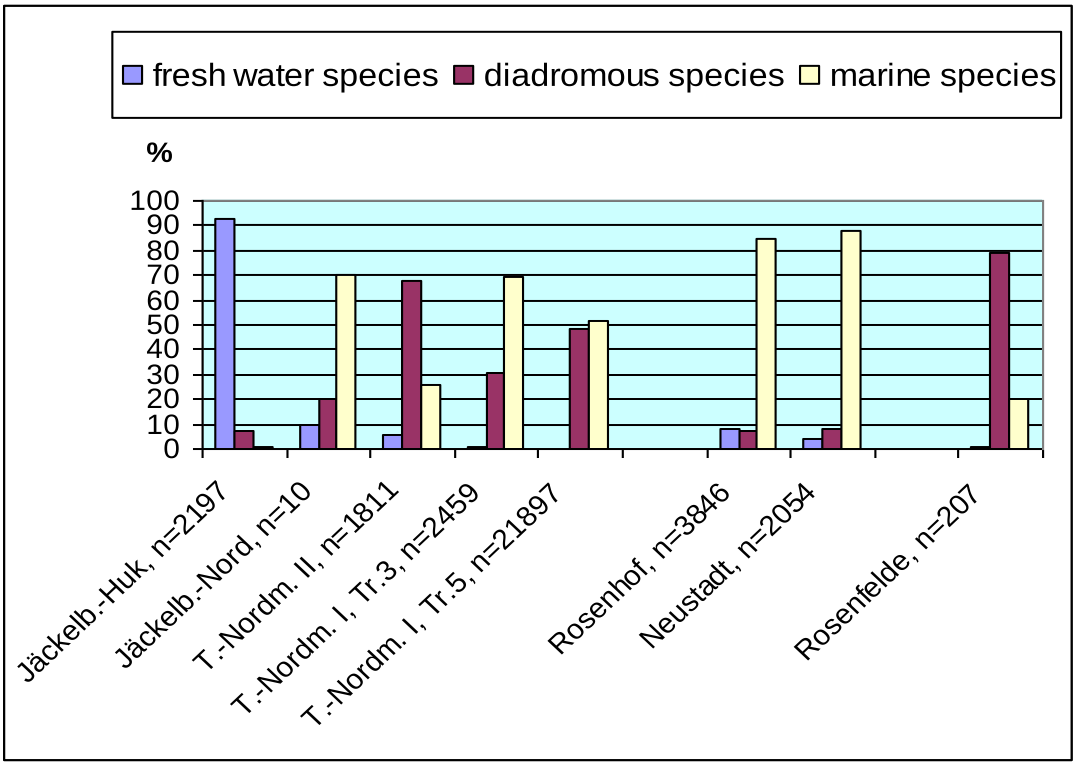

Fig. 1: Mecklenburg Bay – fishes, relative frequencies of identified specimens classified in different species groups

Later on, when the Littorina transgression was already diminishing and the coast increasingly characterized by cliffs and strand barriers with lagoons behind them, the marine component of the fauna was augmented, not only by the preponderance of marine fish species in the bone materials, but also by increasing amounts of marine mammals. Bird remains, as far as this vertebrate class is present, are derived mainly from waterfowl. All this is shown by the faunal remains from Timmendorf-Nordmole I, situated at a depth of 2.5 to 4 m bsl and thus even closer to the coast than Timmendorf-Nordmole II, and by those from Neustadt at the inner part of the Mecklenburg Bay; both sites are dated to almost the same time span, that is 4400-4100 calBC and 4500-4100 calBC, respectively. At both sites, marine fish species are dominant: in Neustadt, the cod remains amount to 55% and the pleuronectid ones to 22%, in Timmendorf-Nordmole I (trench 5) the corresponding proportions are 38% and 11%. However, these relatively low rates are due to the high amount of 47% for eel in this material whereas in the faunal remains from Neustadt less than 3% belong to this species. Thus, as far as the amount of this migratory species is concerned there are similar differences between the sites as the ones already pointed out for Rosenfelde, and partly for Timmendorf-Nordmole II on the one hand and Rosenhof on the other. Thus, Timmendorf-Nordmole I was probably a special dwelling place for fishing and game hunting. The site of Neustadt, however, could be characterized as a base camp according to the character of the vertebrate remains, especially in the high proportion of mammals, as well as the archaeological findings.

At both sites, as far as marine mammals are concerned, it should be emphasized that their portion is increased compared with the afore-mentioned ones: at Timmendorf-Nordmole I around one third of the mammal bones is from seals and that is also true for Neustadt (35%) where, apart from remains of seals, some of whales, mainly porpoise (*Phocoena phocoena*), were also found. If only mammalian game is considered, the portions are even at 38% and 39% respectively. Thus, in spite of the assumed differences in the function of both sites several similarities are obvious, too.

Taken together, the composition and frequencies of the different species and species groups of the diverse dwelling-places show – especially for the vicinity of Poel – the process of the

Littorina transgression. It started here perhaps around 5500 calBC, i.e. some time before the site Jäckelberg-Nord was founded and occupied. This site has yielded only a few fish remains so far. At the time of Timmendorf-Nordmole I and Neustadt between 4400 and 4100 calBC, the Littorina transgression was more or less completed. The process of erosion and accumulation was advanced by this time, as is clearly shown by the presence of species which are related to shallow and partly brackish waters like lagoons.

The Rügen area

In the eastern part of the investigation area the situation is not yet as clear, due partly to alterations of landscape and seascape and partly to the small number of sites of which remains have been analysed so far. Only Parow near Stralsund as well as Lietzow-Buddelin and Breetzer Ort situated at the Bodden coast in the northern part of Rügen can be mentioned in this context. Although Lietzow-Buddelin and Parow are relatively young – the dates point to an occupation around 4400-4100 calBC and 4500-4000 calBC respectively and are thus corresponding to Timmendorf-Nordmole I and Neustadt – the marine component in both fish bone materials is relatively low: in Lietzow-Buddelin it amounts only to 22% (excavation 2002), in Parow only to 17%. In both cases pleuronectids dominate with cod taking second place. Perch, on the other hand, as the main freshwater species amounts to 70%, and 69% respectively. However, whereas marine mammals are totally lacking at Parow, some remains were found in a small sample at Lietzow-Buddelin, accordingly pointing to some differences. Breetzer Ort, a settlement of somewhat older time, was occupied between 4750 and 4550 calBC. Thus it is dated to the time of Rosenhof which has yielded fish remains of mainly marine origin. However, the fishbone material from Breetzer Ort comprises almost exclusively freshwater species with mainly perch – 94% of all fish remains are from this species – whereas the marine component, not only of the fish material but also of mammal remains, is negligible.

Although the vertebrate material from the Rügen area as a whole is not yet sufficient for definitive statements, the comparison with the materials from Mecklenburg Bay shows that the marine influence probably occurred later in the Rügen area than in Mecklenburg Bay. This is an indication, with regard to the faunal remains, that the Littorina transgression proceeded via the Great Belt.

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Archaeoichthyology and archaeology in reference to fishing in Late Bronze Age and Early Iron Age in Polish Lowland

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Introduction

The Polish lowland adjacent to the southern part of the Baltic sea is exceptional in terms of its network of lakes and rivers, in comparison with the zones of the upland parts of Poland. In the Late Bronze Age and the Early Iron Age, the Polish lowland was settled by a population of the Lusatian culture, defined by its West-Baltic grave-mounds and Pomeranian material remains. For people living there in those times, the principal source of food lay with animal breeding. Because of the favourable conditions for fishing, one can suppose that this was another important source of subsistence. However, thus far fishing activity is poorly documented in archaeoichthyological materials (Makowiecki 2003). In the older literature (e.g. Lubicz-Niezabitowski 1936, 1938), this situation was explained by the fact that fishing played only a marginal role in the year-round cycle of occupations carried out by the population living at the defensive settlement of Biskupin. This conclusion was based on the fact that few remains of fish were found amidst the assemblages of animal remains discovered both at Biskupin and in other settlements. However, it has not been taken into consideration that the share of ichthyological remains in the excavation material is not a straightforward reflection of the fishing activity of the inhabitants and of fish consumption in their diet, but it follows on directly from taphonomical factors and is heavily biased by the use of inadequate techniques of collecting faunal material.

In spite of the fact that our present reflections concerning the presence of fish in the subfossil collection allow us to discard this way of reasoning and to surmount these problems, nevertheless, the range of archaeoichthhyological data for the Early Bronze Age and Early Iron Age is still very limited, in comparison with the data from the Neolithic period and from Early Middle Ages. That is why the analysis of the importance of fishing for the people of the Early Bronze Age and the Early Iron Age should include broader archaeological sources as well as the ichthyological data. The present paper is an attempt to realise just such an approach.

Fish remains

Most numerous archaeoichthyological data originate from the defensive settlement dated to the Hallstatt period inhabited by populations of the so-called Lusatian culture and the West-Baltic Grave-Mound Culture (table 1). In contrast, very few materials originate from the sites of the Pomeranian culture.

The greatest number of sites of the Lusatian culture with archaeoichthyological collections were found on the Wielkopolska-Kuyavia lakeland in Biskupin (site 4), Sobiejuchy (site 1), Bonin (sites 2a and 2b), Komorowo (site 1), Objezierze (site 1), Kruszwica (site 1), Łagiewniki (sites 5/7) and Ruda (sited 3-6). A few fish remains were also found on the Szczecin sea-coast, at the lower Oder river, in the Lubuski Lakeland and in Mazovia. Equally, numerous ichthyological remains originated from the localities of the West-Baltic grave-mounds from the Gdańsk sea-coast: at Tolkmicko (site 1) and Łęcze (site 1). A smaller collection came from the area of the Mazovia Lakeland in the locality of Żubronajcie (site 2).

Table 1. Remains of fish - Hallstatt C-D. (according to Makowiecki 2003)

Pisces	Fortified settlements										Settlements		
	Szczecin, site 2 (Wzgórze Zamkowe) KŁ*	Szczecin, site 2 (ul. Grodzka) KŁ	Ustowo, site 1 KŁ	Tolkmicko, site 1 KKZB*	Łęcze, site 1 KKZB	Biskupin, site 4 KŁ	Bnin, site 2a KŁ	Komorowo, site 1 KŁ	Objezierze, stan. 1 KŁ	Sobiejuchy, site 1 KŁ	Bnin, stan. 2b KŁ	Żubronajcie, site 2 KKZB	Święty Wojciech, site 10 KPK*
Esox lucius	1	0	0	45	0	5	0	9	1	157	1	1	0
Cyprinidae	0	0	0	0	0	0	0	4	0	0	0	1	1
Rutilus rutilus	1	0	0	215	4	X*	1	0	0	38	1	0	0
Leuciscus leuciscus	0	0	0	0	0	0	0	0	0	0	0	0	0
Leuciscus cephalus	0	0	0	0	0	0	0	0	0	4	0	0	0
Leuciscus idus	0	0	0	1	0	0	0	0	0	12	0	0	0
Scardinius erythrophthalmus	0	0	0	0	0	0	0	0	0	9	0	0	0
Aspius aspius	0	0	0	11	0	0	0	0	0	0	0	0	0
Tinca tinca	0	0	0	0	0	0	0	0	1	11	0	0	0
Blicca björkna	0	0	0	92	1	X	0	0	0	18	0	0	0
Abramis brama	9	0	1	2757	34	9	0	1	X	3	1	0	0
Vimba vimba	0	0	0	1	0	0	0	0	0	0	0	0	0
Pelecus cultratus	0	0	0	112	2	0	0	0	0	0	0	0	0
Carassius carassius	0	0	0	1	0	0	0	0	0	0	1	0	0
Gobio gobio	0	0	0	0	0	0	0	0	0	5	0	0	0
Alburnus alburnus	0	0	0	0	0	0	0	0	0	3	0	0	0
Chondrostoma nasus	0	0	0	0	0	0	0	0	0	2	0	0	0
Barbus barbus	0	0	0	0	0	0	0	0	0	1	0	0	0
Silurus glanis	2	0	0	5	0	+/- 95	0	7	0	0	0	0	0
Perca fluviatilis	0	0	0	55	0	5	1	1	0	32	1	0	0
Stizostedion lucioperca	2	0	4	393	1	0	0	0	0	12	1	0	0
Lota lota	0	0	0	2	0	0	0	0	0	7	0	0	0
Salmo salar/Salmo trutta	0	0	0	1	3	0	0	0	0	4	0	0	0
Acipenser sp.	1	3	0	36	1	0	0	0	0	0	0	0	0
Anguilla anguilla	0	0	0	0	0	0	0	0	0	17	0	0	0
Gasterosteus aculeatus	0	0	0	0	0	0	0	0	0	14	0	0	0
Total identified	16	3	5	3727	46	114	2	22	2	349	6	2	1
Not identiefied	0	7	1	69	0	?	0	19	0	287	0	0	0

*: KŁ – Lusatian culture, KKZB – Baltic culture of cairns, KPK – Pomeranian culture, X- scales.

Data presented in the table indicates that the fishing of both population groups understandably developed on the basis of the ichthyological water resources. The species composition certainly depended to a high degree on the type of water. Differences between the sea zone, the estuary zone and the lakeland zone are visible in the presence of pike-perch and Atlantic sturgeon (in the sea zone). A characteristic feature of fishing by the people living in the strongholds in the Wielkopolska Lakeland was the presence of two carnivorous species: catfish and pike. In the case of catfish, they were frequently represented by large individuals exceeding 1.5 m in length, whilst pike exceeded 80 cm. Both of these species were fished, together with other species of the *Cyprinidae* family.

Fishing tools

During the excavations, the most frequently encountered tools associated with fishing were represented by different types of hooks. The majority of them were made of bronze (copper alloy), and less frequently of iron and of organic materials. Bronze hooks were also found in cemeteries of the Lusatian culture. In the excavated material, one can distinguish two basic types of hook: 1) specimens made of wire, 2) items forged from an iron bar or iron band and provided with a spike or barb. Specimens of type 1 are the most numerous and two sub-types can be distinguished: a) with a blade provided with a spike or barb and b) a blade without any barb. Both variants had an eye, ie the upper end of the wire was coiled over to form a loop, to enable a line to be fixed to it.

Alongside these types, there also occurred other hooks of different types. Unfortunately, some specimens found in cremation graves were destroyed because of the high temperatures of incinceration, so that a reconstruction of their shape and size was not possible.

Hooks made of iron are found sporadically. Significantly more numerous are spindle-shaped hooks (or gorges) with elongated ends and with sharpened tips, made of bone or antler. Such specimens occur in the majority of strongholds of the Lusatian culture: Biskupin (Drzewicz 2004), Jankowo (Ostoja Zagórskii 1978), Izdebno, site 5 (Romanowska-Grabowska 1982), Sobiejuchy (Bukowski 1959-1960), Gzin, site 1 (Chudziakowa 1992), Kruszwica (Chudziakowa 1975), Kamieniec (Zielonka 1955), Smuszewo, site 3 (Durczewski 1985), Słupca, site 1 (Malinowski 1958) and in some cemeteries of the Hallstatt period. Some researchers do not regard these implements as fishing tools. They believe that they represent double-sided prickers (Łukaszewicz and Rajewski 1938, 47), whilst others have suggested that they were small spindle-shaped firing pins (A. Drzewicz 2004), or spikes (Durczewski 1985). Only a few researchers expressed the opinion that the hooks or gorges served for fishing, although they do not have any hook-like bent blade (T. Malinowski 1958). Recently, A Drzewicz (2004) expressed her opinion that at least some of these hooks, depending on the needs of the settlement, were used for different funtions (Drzewicz 2004, 32). Specimens with a collosity located at the central part of the blade could well have played the role of spindle-shaped hooks in angling for large carnivorous fish – particularly pikes and catfish.

So far, in the localities of the period under discussion, no fishing nets have been found. However, the fact that nets had been used is shown indirectly by the presence of floats made of bark, clay and stone net sinkers and tools used for the weaving and repair of nets. Such tools were represented by bone or wooden nippers, needles and prickers made of antler or bone, as well as wooden and stone rollers for the adjustment of net meshes. The forms of these tools are similar to those known from the Early Middle Ages and even from modern times, when they were used in conventional local fisheries.

Patterns of fishing

The establishment of numerous settlement groups in the neighbourhood of lakes and water courses limited the effort necessary for the organisation of fishing. Fish could be caught without any long–distance travel, which frequently was required in the case of hunting for wild animals. The techniques of fishing seemed to be simple because the spawning of the majority of the caught fish took place nearby at the seashore coast. The absence of a natural fear instinct on the part of the fish facilitated fishing by the use of the simplest methods, which have been used until recently by the lakeland fishers. They used some trap tools and nets and sometimes they even caught fish with their bare hands.

It is supposed that fishing was practised the whole year round, albeit in different intensities, by the whole local population. Certainly in the spring the demand for fish increased because of the shortage of other food (vegetation or domestic animals). The gathering of fish into large herds during spawning also facilitated fishing in the spring.

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Fish in the menu of the Cistercians from Łekno and Bierzwnik (Poland). An historical and archaeoichthyological consideration

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Introduction

Menus, methods of obtaining products and their preparation for consumption reflect different cultural traditions. These in turn, at least in some measure, are the effect of the ability to utilize the resources of natural environment in the given geographical region and particularly, they result from human beliefs and rituals. One can assume that the particular principles of menus applied by monks in medieval Europe were realized based on the above-mentioned conditions.

In Poland, one of the oldest orders that introduced new monastic cultural customs, among others in the menus, was the Cistercians (Sacer Ordo Cisterciensis). Between the mid-12th century AD and the beginning of the 14th century, 26 monasteries and about 20 cloisters were established on Polish land (Monasticon 1999). The monks were ruled by the Benedictine norms initiated by St. Benedict from Nursja, who in his Rules devoted as many as eight chapters to the principles of food consumption, its type, quality, time during the day, and place of consumption (Holzherr 1988).

In the 1980s, all Cistercian orders were the object of detailed interdisciplinary investigations with the participation, among others, of historians, archaeologists, anthropologists, archaeozoologists and paleobotanists. In the elaborations, different aspects of life and culture of the Cistercian order were analysed. One of the fields was the everyday life of the monks. Thanks to excavation works carried out at the former monasteries in Łekno and Bierzwnik (Fig. 1), animal and plant remains were recovered that consisted of consumption refuse. The studies on the consumption patterns of the Cistercians included this archaeozoological and archaeobotanical data instead of being based only on the historical resources (Wyrwa 2004).

Fig. 1. Bierzwnik, Łekno and other Cistercian monasteries in Poland

Fish bones were found among the animal remains. Taking into consideration that, according to written sources, fish were one of the basic objects in the fasting menu of the monks, the results of those studies will contribute to a better understanding of the economics and customs of Cistercians life. Therefore, our paper presents archaeoichthyological data in the context of selected historical information.

Fasting and meals according to the rule of St. Benedict from Nursja

Cistercians, as with other monks, were obliged to consume meals without animal meat during the whole of Advent (except for the first Advent Sunday), on Mondays and Tuesdays before the beginning of Lent, on the eve of Pentecost, in the first week of September (Dry Days), on the eve of St. John the Baptist (on the 13th of June), on the 28th of June (the day of St. Peter and St. Paul), on the 9th of August (St. Laurentius Day), on Assumption Day (14th of August), on the Day of St. Matthew the Apostle (20th of September), on the Day of St. Simon and St. Juda Thaddeus (17th of October), on All Saints Day (31st of October), and on St. Andrew's Day (29th of November) (Canivez 1931). It was also recommended to abstain from animal meat on Saturdays and during monastic fast-days, from the 14th of September until Easter.

Next to the fast-days (totalling 199 days in the year) and the types of food connected with them, the daily time-table was very important in the everyday life of monks, since there was a strictly defined time for meals and for their total daily number. The mealtime of the monks was not only to satisfy hunger, but it was also a religious ritual combined with prayers (Hollzherr 1988). According to the Rule of St. Benedict, from the 14th of September, i.e. from the day of Holy Cross Elevation, until Lent, was the time of fasting and the monks could only consume selected food, including fish. However, the Cistercians very willingly consumed fish during the whole year, independent of the fast-days. In addition to the meat of fish, the monastic rule did not prohibit the consumption of the meat of beaver and this animal was eaten in many monasteries. Beaver was regarded at that time (and not only in Poland) as fast-day meat. The reason being that, because the beaver's tail appears covered with scales, it was regarded by the Church as a fish. Besides, the tail itself was a very tasty meal and it was eagerly consumed on fast-days. Otter was treated in a similar way; therefore monks caught both of these animals and served them at table on fast-days (Foster 1979).

Water resources and fishing by the Cistercian monks

According to the written reports collected so far, it is known that in the years 1198 – 1306, as many as 86 % of permissions for fishing were given to Church institutions, only 11 % to the Order of Knights and 3 % to town inhabitants (Matuszewski 1936; Szczygielski 1967). One can assume that such a high number of permissions given to Church institutions resulted from their obligation to practice fast-days and from the possibility of acquiring fish from their own water resources. That is why monasteries sometimes received lakes in their foundation documents, together with the fishing permissions for those lakes. They were also permitted to fish in rivers and in other water reservoirs. Such a situation was the case for the Cistercians from Łekno, who were given Lake Ragielskie in the foundation document of 1153. The abbey was located on the eastern bank of Łekneńskie Lake. It is one of three lake branches in the Ragielskie lake complex. As a result of successive donations, the Cistercians became the owners of several further lakes, Lake Bracholińskie and Lake Prusieckie among others (Wyrwa 1995). Next to the lakes, the monks also possessed water areas in Eastern Pomerania, where they probably owned four lakes (Wyrwa 1995). Since the end of the 13th century, the Cistercians had the right to catch all fish species and they used two boats for this purpose on Puck Bay near Żelistrzew (Łęga 1949, Wyrwa 1995, 2004).

Archaeoichthyological data

Łekno, site 3

In Łekno, two collections of fish bones were studied: a) hand collected, originating from many excavations, b) hand collected, uncovered within the kitchen area of the monastery. The fish bones belonged to freshwater fish, migratory fish and sea fish (Table 1).

Table 1. Fish remains from Łekno, site 3 and Bierzwnik, site 25

Taxon	Bierzwnik hand collected 13th/14th-century	Łekno wet sieved 1153 AD-14th century	Łekno hand collected 1153 AD-14th century
Pike – *Esox lucius*	16	49	195
Cyprinidae	65	77	434
Roach – *Rutilus rutilus*	1	7	8
Ide – *Leuciscus idus*		1	1
Rudd – *Scardinius erythrophthalmus*		1	2
Tench – *Tinca tinca*	7	13	8
Bleak – *Alburnus alburnus*		1	4
White bream – *Blicca björkna*		1	
Bream – *Abramis brama*		9	22
Catfish – *Silurus glanis*	2	12	6
Percidae	3	2	5
Perch – *Perca fluviatilis*	21	32	108
Salmonidae			3
Salmon/Trout –*Salmo salar*/*Salmo trutta*			6
Sturgeon – *Acipenser* sp.		4	9
Herring – *Clupea harengus* L.		5	122
Not identified	49	213	2722

A distinct domination of freshwater fish, including Cyprinidae and pike suggests that the Cistercians based their fish supply primarily on their own lake ichthyofauna. Among Cyprinidae, they consumed bream, trench and roach. Among fish not belonging to Cyprinidae, pike was the most numerous fish. Sturgeon remains indicated that the Cistercians from Łekno also consumed some fish not originating from local lakes. On the other hand, the comparatively low percentage of such special fish may indicate deliberate austerity in the fish menu of these monks. Sturgeon was probably fished in the Noteć and Warta rivers and the fish must have been supplied to the monastery. Within the kitchen premises of the monastery, a great number of herring remains were also found. So far, the sample of herring bones uncovered in Łekno is the largest found in the localities of Polish Lowland in the Middle Ages. Reconstruction of the total length (TL) of herrings revealed the presence of individuals measuring from 25 to 31 cm, however, the greatest number was represented by fish of 26-28 cm length (Fig. 2).

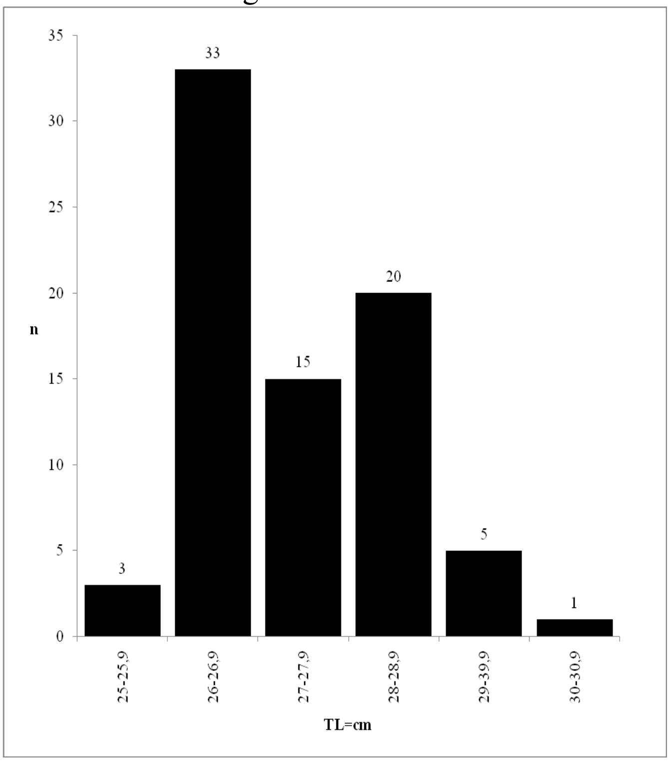

Fig. 2. Łekno, site 3. Herring (*Clupea harengus*) – size reconstruction of TL (n=77)

Regarding the total length (TL)

(Table 2), among the Cyprinidae, one can discern two groups: individuals of 5-10 cm to 25-30 cm long (bleak, roach, rudd) and fish 30-35 cm to about 65 cm long (tench, bream). Fish distribution in the particular TL classes in pike (table 3) has a single mode character, with the most numerous class including 40-50 cm individuals. One can assume that the distribution refers to the spring spawning population of this species.

Table 2. Łekno, site 3. Size reconstruction of Cyprinidae and perch

TL (cm)	Cyprinidae	*Abramis brama*	*Blicca björkna*	*Tinca tinca*	*Leuciscus idus*	*Rutilus rutilus*	*Scardinius erythrophthalmus*	*Alburnus alburnus*	*Perca fluviatilis*
05-10	3					1		2	
10-15	3					1	1	2	2
15-20	7					4			4
20-25	16	1				1			24
25-30	8	5		1		1	1		9
30-35	5	2		5	1				13
35-40	25	7	1	4	1				12
40-45	13	6		6					6
45-50	14	3		1					1
50-55	1	4							
55-60	1								
60-65	1								

Bierzwnik, site 23

The abbey in Bierzwnik was founded in 1268 by the Post-Branderburgian margraves at the Bierwnik Lake. In the surroundings of this locality, there are also other lakes of the Dobiegniewski Lakeland. During the archaeological and architectonical studies, fish remains were excavated in the household part of the post-monastic complex. The chronology of the collection was determined to the turn of the 13th century (Makowiecki 2003). Similarly as in Łekno, the list of identified taxa indicated that they were fished from the nearby lakes. Cyprinidae dominated (including tench and roach), but pike, perch and catfish were also present (table 1). The fact that fish played an important role in the diet of the monks can be inferred from the high proportion of fish bones (41 %) among all the vertebrate remains investigated so far.

Methods of fish preparation and consumption in monasteries

Historical data indicate that, in the Middle Ages, fish were consumed in different forms; they were eaten fresh, dried, salted and even marinated (Szczygielski 1967). Therefore, one can assume that the fish were consumed in similar forms by the Cistercians from Łekno and Bierzwnik. In the materials from Łekno, some of the Cyprinidae and perch bones originated from small individuals (not exceeding 10cm). Pike measuring 20-40 cm can also be regarded as small fish. Such small fish were used for cooking fish soup called *liquamne*. The soup was made of ground fish. Burnt traces of such fish soup were found on the bottom of a pot uncovered within the kitchen premises of the monastery from Łekno. Fish meals were also served as fried, roasted or smoked fish. Fish were used for the preparation of a dense sauce-purée (called *garum*) made of ground salted fish (including herring) (Dembińska 1987, p.63; Wyrwa 2004).

Table 3. Size reconstruction of pike, catfish and sturgeon

TL limes (cm)	*Esox lucius*	*Silurus glanis*	*Asipenser* sp.
20-30	3		
30-40	17		
40-50	44		
50-60	34	1	
60-70	18		
70-80	11	3	
80-90	5	2	
90-100	1		
100-110	1	1	
110-120		1	
140-150		1	
150-200			1

Concluding remarks

When we look on the map showing so many Cistercian monasteries, we can state that ichthyological data only from two localities are not enough to draw general conclusions referring to the entire monastic order. On the other hand, results from Łekno and Bierzwnik allow us to draw some conclusions referred to problems indicated in the title of our paper. We could infer that the monks of both monasteries acquired fish in a similar way because, in both situations, freshwater ichthyofauna dominated, most probably gained from the local lakes. The only marine species was the herring recorded in Łekno. The absence of herring in Bierzwnik does not necessarily suggest that those monks did not consume this kind of fish. It must be remembered that herring was a traditional component in the menus of different social groups from at least the 10-11th century (Dembińska 1963, 1985; Makowiecki 2003). The absence of herring remains follows rather from the fact that only a small part of the collection was investigated and also from the manual technique of faunal collection. On the other hand, the presence of herring bones in the material from Łekno probably reflects the importation of fish from the Baltic Sea fishing grounds, or from Puck Bay, where the monks received a fishing permission from Mestowin II, the duke of Pomerania (Łęga 10949).

Referring to the distribution of the fast-days in the calendar year, and taking into consideration the seasonal abundance of fishing in that zone of Europe, one can perceive the following problem connected with the fast-days and the consumption of fish by the monks.

Since the greatest number of fish was traditionally fished from spring to summer, the thesis can be advanced that, in this period, the menu of Cistercians consisted mainly of freshwater fish. So, it was very easy for the monks to keep the fast-day rules by eating fish during Easter, on the eve of St. John the Baptist (13^{th} of June), or on June 28 (the Day of St. Peter and St. Paul). Some problems in obeying the fasting rules appeared during the remaining rather numerous fast-days occurring in the second half of the year (autumn and winter). In the Middle Ages, although freshwater fish were caught the whole year round, one can suppose that, in autumn and winter, the gaining of fish meat was not so easy as in spring. The only way of storing fish was by preservation. In the Middle Ages, among such conserved fish, there were salted, smoked or dried herring. This may also explain the fact that in such situations, beaver and otter were also used on fast-days for food, because they were also living in water and regarded as fish.

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The fishes and fishery in the Teutonic Knights State in Prussia according to written and archaeozoological sources

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The location of the territory of the Teutonic state in Prussia had very favourable natural conditions for the development of fisheries. The abundance of inland waters (numerous rivers, lakes and ponds) and the long coast of the Baltic Sea gave possibilities for fishing diverse species of freshwater and marine fish. Fish was a very valuable food in the Middle Ages, which was particularly popular not only because of its high nutrition value, low price and easy access, but also because it was a basic ingredient of the diet during fasting. It was especially important in the Teutonic castles, where the chapters of monastery rule were strictly kept with respect to the meals during fasts.

Information about the fishery on the territory of the Teutonic state in Prussia can be gained firstly from the numerous written sources. The most important of these were published. We can use the inventory books of Teutonic castles and farms, in which we can find a lot of information about fish and fishery. Among other things they mention the supplies of fish in the cellars, about the ways of its conservation, about the containers, nets and other equipment serving for fishing and for storage of fish and about the office of fishmaster (Fischamt), which concerned the fish economy (*MÄB* 1916; *GÄB* 1921). Particularly valuable are the account books – giving, for example, information about the prices of fish and about details concerning the offices of the fishmaster (*MTB* 1896; *AMH* 1911; *MKB* 1913; *Księga rachunkowa* 1997). Legal regulations applying to fishing for peasants, citizens of towns and knights we can find in the privileges for towns and villages (np. *Ziemia chełmińska* 1961, s. 18, 20, 34, 42). We also have archaeozoological analysis of the fish remains from the Teutonic castles in Mała Nieszawka, Toruń and Malbork. On the basis of those researches it is possible to establish, for example, that sea fish were also consumed in the southern parts of the Teutonic state in Prussia. The river Vistula was often used for transport (Iwaszkiewicz 1991; Domagała, Franczuk 1992, s. 49-50).

Fishery knowledge can be augmented with ethnological exhibits concerning fishery, because the traditional fishing equipment changed little from the Middle Ages to the 20th century.

All sea waters, rivers, lakes and ponds within the territory of the Teutonic state in Prussia belonged to the ruler, that means to the Teutonic order. The possibilities and range of use were determined in the privileges. Mostly this concerned certain lakes or sectors of rivers, on which there was the possibility to catch fish only for personal needs using a net, with the exception of nets called “niewód” (*Ziemia chełmińska* 1961, s. 18, 20, 34, 40, 42).

The matter of fish supply in the castles and farms of the Teutonic order played a very important role in view of the large quantities of fish consumed during fasts. For this purpose the special office of fishmaster (Fischmeister) was founded. This was one of the brothers of the Teutonic order, who had great competence in the area of finances. His headquarters were usually in the Teutonic castle or in the farm near the castle. To his duties belonged not only the fish supply, but also the delivery of eggs, cheese, charcoal and other products. The fishmasters resided in the farms in the neighbourhood of the castles – for example in Szkarpawa (Malbork governance), Puck

(Gdańsk governance), Charzykowy (Człuchów governance), on the bank of Drużno lake (Dzierzgoń governance) or in the castles of the Teutonic order – for example in Elbląg, Bałga and Grudziądz (Willam 1961, s. 77; Sarnowsky 1993).

In the storerooms of the castles and farms there were supplies of different fish species. They were stored primarily in barrels – especially tasty were the fresh fish, but we also have mention of several ways of conservation – fish were dried, smoked or salted. On the grounds of frequency of record we can establish that the most popular kind of fish were herring and cod. Also very popular were pike, eel, bream, sturgeon, crucian carp, common carp, tench, salmon, perch, roach and zander. From this source, we can also obtain information about the equipment using for fishing: there is a plethora of different kinds of nets – nets for autumn and winter fishing, nets for fishing in rivers, nets for fishing from boats, so called "żaki" and "niewód". Boats were also used for fishing: as well as standard fishing boats there were special ships for cod and sturgeon fishing. They also served for transportation of the fish on the rivers, lakes and seas. For this purpose, special carts (*fischwayn*) were also used. Fish transportation was carried out with barrels, boxes, baskets, wheelbarrows, kettles and bags. If it was possible, there was also transportation of the living fish, to keep it fresh for longer. The fishing equipment also included different kinds of ropes made of hemp, poles for installing the nets in the water, boat–hooks, net weights, axes for making holes in ice, winches for pulling out the nets, and so on.

Together with the fishmasters, the fishermen and other workers are mentioned. Net masters, helpers and servants, who worked at the fishing and transportation are also listed. The written sources also mention the fish merchants and horses.

In the state of the Teutonic order in Prussia not only the fishery was developed but also fish breeding in ponds. It was not so popular in this area because there were plenty of natural reservoirs. Ponds at the Czech properties of the Teutonic Order serve as a model for the ponds in Prussia. There were ponds at Toruń castle and Malbork castle. Especially numerous are entries about the ponds in the neighbourhood of the capital of the Teutonic Order. According to the written sources they existed between 1396-1420 and delivered fresh fish, especially for the kitchens in Malbork castle. The ponds were situated east and north of the Low Castle over an area of four hectares. It was the so-called "bead system" (one pond after the other connected with one ditch). In the courtyard of the Low Castle there was also a pond for living fish. In the case of siege the water level in the ponds was dammed up to serve as the defence. The ponds were used for fish of different ages: there was the pond for spawning and for the youngest fish, the pond for growing and finally for fattening. In the written sources several activities at the ponds were mentioned: making fences for pond security, building the sluices, making holes in ice to deliver air for fish in winter time, letting out the water from the pond and cultivating the pond bottom. The servants hunted otters and ducks, because they ate fish (Chmielewski 1976).

An important branch of fishery was sturgeon fishing – a rare and precious fish. There are references to the special equipment needed for fishing sturgeon. The transportation of living sturgeons was also mentioned, for example in the year 1403 – it was delivered to the court of Pomesanian bishop in Prabuty (Riesenburg) and to the castle of Pomesanian chapter in Kwidzyn (Marienwerder). This fish was thus perceived as a very valuable gift for important persons – just like falcons, horses or dogs (*MTB* 1896, s. 253; Długokęcki 1996, s. 115-119).

In spite of fish being plentiful in the Teutonic state in Prussia, several species were imported from other countries: for example herrings from Bornholm (*Bornholmisch heryng*) or smoked fish from England (*englisch bucking*). There were a lot of fish species, which came from certain regions – in this case we can call it a "regional product" – for example herrings from Hel (*heilisch hering*) or pike from Kuronian Bay (*kurisch hechte*) (MTB 1896, s. 84, 108; GÄB 1921, s. 128, 502, 684, 691).

These records about fishery help us to understand that this branch of the medieval economy played an important role in the Teutonic state in delivering one of the most important food products.

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What do we know about the extinction of sturgeon in Poland?

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The author presents information on the economic importance, methods of fishing, catch and export statistics, as well as the protection of the sturgeon in Poland until the end of the 19th century.

Historical sources indicate that a sharp decline in the exports of sturgeon from Poland started at the end of the 17th century. By the end of the 18th century they practically ceased altogether. Though economic factors may be behind this process, it is postulated that the main reason was a drop in the sturgeon population in Polish waters as a result of overfishing and a lack of the management or adequate protection of the fish stock. The next sharp drop in the population occurred at the end of the 19th century. This was related not only to overfishing, but also to the destruction of the aquatic habitat through channelisation in the 1860's, especially of the Vistula in the vicinity of Kraków, where some of the best spawning grounds of the sturgeon existed hitherto.

Introduction

The identity and extinction of the sturgeon in the Baltic Sea is amongst the most topical issues of research, of importance not only for ichthyologists, but also archaeologists and historians. A better understanding of these issues has considerable implications for work on the restitution of the sturgeon in Europe.

In this paper I present the results of my research into the history of sturgeon in Poland, which sheds some light on the demise of this fish in historical times. I concentrate on the period from the Middle Ages until the late 19th century. Most of the material, with a full list of sources, has already been published in Polish (Cios 2007).

The information in this paper concerns mainly the river Vistula and areas close to its mouth – the Vistula Firth and the Bay of Gdańsk. In the Vistula the sturgeon reached the areas upstream of Kraków, where there were good spawning grounds. The fish also entered several tributaries, not only large ones like the Dunajec and San, but also occasionally some smaller ones, especially during high water.

There is relatively little information in Polish sources on the sturgeon in other waters. The fish used to be quite common in the river Oder. Until the end of the 19th century this fish was still found in its tributary – the river Noteć, and further upstream in the river Warta (Cios, in prep). The sturgeon entered rivers in Pomerania which flowed directly to the Baltic Sea, but it is unclear whether reproduction occurred there.

Economic importance of the sturgeon

The sturgeon was amongst the most highly prized of all fish in Poland. In the northern parts of the country fishermen were obliged to give or sell all specimens to the landowner or noble. The right to fish for sturgeon was already included in several privileges from the 13th century onwards.

In some parts of the country, fishermen were obliged to give only a certain number of their catch. It could be every second fish, every tenth one, or just one fish annually. In case the fishermen weren't able to catch any sturgeon, they had to pay a certain amount in cash in tribute. In some places sturgeon fishing was taxed.

In the area close to the mouth of the Vistula the fishermen were obliged to sell larger sturgeon to some cities. This is the case with Gdańsk in 1625 and Tolkmicko. Even the right to fish for sturgeon in this area was the subject of disputes from the 16th to the 18th centuries.

Methods of capture of sturgeon in Poland

Sturgeon were caught mainly with large nets, both in flowing and in still waters. In Polish they are called *wierzchownik*, *dryga*, *fola* and *łąka* (*lanka*). The last term already appears in documents from the period 1276-1342 in connection with the German names *Stürlanke*, *Sturlanke*, *Storlanke*, *lance* (*Codex*… 1842, II:60, 1848, III:3, 42, 46, Kujot 1875, 69-70, Perlbach 1881 no 492). A description of fishing with a *fola* net in the Vistula is presented by Sapalski (1862, 91): „it is a net with four sides, made of a thick line, fixed to two sticks. Two persons sit in a boat. One is rowing, while the other one – standing in the anterior part of the boat – holds in his hands the sticks attached to the net. One end of the line is attached to the net, while the other end – to the fisherman's finger. Thus, when a fish touches the net, what is felt through the line attached to the finger, the sticks are quickly joined, the net is closed and pulled out from the water together with the sturgeon".

Many sturgeon were also caught in weirs, in Polish *jaz jesietrzy*, *jesiotrzynia*, *jesiotrnia*, *płot* and *tama*. The Latin name *clausura sturionum* appears in documents from the years 1249-1295 (Perlbach 1881 no 122, 345, 360, 530). The weirs consisted of a number of wooden poles fixed vertically into the bed of the river. In the middle there was an opening, in which a basket trap was placed.

In 1447 legislation was passed, which provided for unimpeded navigation on major rivers in Poland. Weirs were considered as obstacles and as such were forbidden. Fishing was supposed to be conducted with nets and not weirs. But this legislation remained only on paper, because until the end of the 18th century at almost every session of the Sejm (parliament of the nobility) there were voices criticising the illegal use of weirs. The conflict between sturgeon (as well as salmon) fishermen and tradesmen was impossible to resolve because of the high profits involved.

Some fish were caught with spears, especially when they were in shallow water. In the foreign literature an account of such fishing in the Vistula was presented by Sir Jerome Horsey, who was in Poland in 1589: „the eaveninge I parted from Warsovia I past over a river upon the side whereof laye a crocadille serpent dead, which my men brake with bore spears" (*Russia*... 1856, 251). This so-called crocodile was no doubt a sturgeon.

In no document did I find any reference to fishing for sturgeon with a hook and bait in Polish rivers flowing into the Baltic Sea. Moreover, the hook method widely used in rivers flowing into the Black and Caspian Seas (Rohan-Csermak 1963) was not in use in Poland, although it was known; it appears in accounts of travels in the Black Sea region in the 17th century, and in fisheries literature in the 19th century. Both regions were under Russian influence. Perhaps this method wasn't efficient in the case of the river Vistula.

In the Vistula Firth the fish were caught mainly prior to the upstream migration, which takes place in March and April, and after the descent, in August and September (Reichard 1818, 169). In the river Vistula fishing started in March, but the highest catches were from May to July. Post-spawning fish were rarely netted, probably because they quickly returned to the open sea.

How many sturgeon were caught?

In general, fishing statistics for the period until the end of the 19th century in Poland are scarce, because illiterate fishermen did not bother with such bureaucracy. However, amongst all fish, data dealing with sturgeon is the most extensive, due to its importance and value. In tables 1 and 2, I present data assembled from the lists of merchandise passing through Gdańsk and other ports in the region in the years 1581-1789. It appears that in the period until the middle of the 17th century the export of sturgeon remained on a similar level and no major fluctuations are visible.

The peak export period from Piława (today called Baltijsk in the Kaliningrad District) was in the 1670's. This was followed by a systematic drop until 1708. In terms of the later period only data for Gdańsk is available. It is difficult to comment on the total volume of exports from this city or to compare it directly with data for Piława, since Gdańsk also acted as a transit port. Therefore the registered volume may also embrace exports from other ports in the region. However, the most interesting fact is the strong downward drop in export volume in the latter half of the 18th century. At the end of this period exporting practically ceased to exist (Table 2).

It may be assumed that the volume of export does to a large extent reflect the catch. This in turn may serve as an indication of the size of the fish population. However, in the 18th century in Western Europe, where almost all of the Baltic sturgeon was sold, there was a crisis in the fisheries. The result was a drop in fish prices, reducing the profitability of this sector of the economy. This could have had a negative impact on the export of sturgeon. Therefore the question is – does the data presented indicate a genuine drop in the fish population? I argue that the answer to this question is yes. The following arguments speak in favour of my view.

First of all, the data on the taxes levied on sturgeon fishing show a similar downward tendency. This is evident from the following figures presented by Filuk (1968).

Year/period	Unit: Gulden
1678	750
1693	600
1716	600
1720	400
1757	180
1762-1787	190

Similar data occurs concerning taxes levied by Prussia on fishing one of the estuaries in the Vistula delta (*Izsledovanija* ... 1860, 62; Karpiński 1873).

Year/period	Unit: Talar
Before 18th century	1000
Early 18th century	500
Ca. 1750	400
1820 (one fisherman)	30

Secondly, an impression of the popularity of sturgeon among Polish society may be gained from the number of references to this fish in Polish literature in the period from the 16th to the 19th century. Incidental accounts in poetry and prose (fiction) may serve as an indication of the availability of this fish on the market. The data in Table 4 indicate that in relative terms the highest popularity of this fish was in the 16th and first half of the 17th century. Later the drop in the popularity of the fish reflects the decline in sturgeon fishing. In absolute terms the figure for the 19th century seems high. However, it must be borne in mind that in this period literature itself is much more abundant (perhaps by a hundredfold) than in the previous periods. Besides, in the 19th century some references to sturgeon may actually pertain to other fish from the Acipenseridae family (especially sterlet), which had become common in Poland, as a result of imports from Russia, or from the frequent travels of Poles to this country.

The data presented indicates that a strong drop in sturgeon fishing in the Vistula and in areas in the vicinity of its mouth started in the second half of the 17th century. Filuk (1968) discerned this fact, indicating overfishing as the primary cause, but not excluding the possibility of some biological factors. Surprisingly similar observations were presented by Michell (1977, 182-183). From the 1680's onwards in Europe a clear drop in the volume of marine fish caught is visible. For example, after 1689 herring stocks have disappeared from Calais. He indicated that although there may be several factors operating in this case, one should seriously consider natural phenomena. In this period there were discernible climate changes, as evidenced in grape crops and the melting of glaciers.

However, there are some indications that the process had started already in the first half of the 16th century. This may be inferred from the following references – in 1636 sturgeon fishing in Nogat (one of the estuaries of the Vistula delta) had stopped, in 1660 in Słuszczyn (upstream of Warsaw) there were no longer any sturgeon fishermen and in 1675 – a sturgeon weir in Szonorst (on the lower Vistula) was lying idle. In documents from the years 1628, 1659 and 1660 there is also information about the "extinction" of sturgeon fishermen. In part this may be explained by the ravaging wars of the first part of the 17th century, during which the fisheries sector was amongst the most strongly affected by military operations and looting. However, the abandonment of sturgeon fishing many years before the peak in the 1670's is striking. Even more puzzling is the rise in sturgeon catches until 1680, whilst the number of fishermen declined !

Some light on the reduction in the sturgeon population is shed in a Russian source (*Izsledovanija*... 1860, 62). The Prussians were not interested in protecting this fish in the area of the mouth of the Vistula because one of the estuaries was in Polish territory. Through this estuary most of the fish swam upstream. In the middle of the 19th century in Königsberg annually there were between 20-30 sturgeon sold on the market, while in Gdańsk this figure was slightly higher, because this city was closer to the fishing grounds. Also it seems that the Polish authorities did not appear to care much about protecting the sturgeon.

Further information on the extinction of sturgeon in the upper Vistula has been presented by Sasorski (1902). In 1856 on a short stretch of the river Vistula near Kraków about 70 large fish were still being caught. Soon afterwards, in the 1860's, the river was channelled in the vicinity of Kraków. After the destruction of deep pools, necessary for the fish during the spawning period, sturgeon fishing dropped rapidly in the following years. The most important spawning areas were probably in this part of the river. It seems that pollution has to be ruled out as an important factor in the extinction process. It appeared much later, since even in 1906 a grayling (a fish typically thriving in oligotrophic water) was caught in the river Vistula in Kraków.

How many fish were caught in the past? As regards the Vistula Firth, the highest export numbers (5,159 achtel barrels) were in 1678. Is it possible to calculate the number of fish killed in order to arrive at this figure? If it is assumed that 12 barrels formed one last, whilst one last was about two tons, and 50 kg[1] of clean meat was obtained from one sturgeon, then in this single year about 17,200 fish were killed! Even if we assume that an achtel barrel was just one-eight of a normal barrel, than the figure would still be 2,150 fish. If less flesh was obtained from a fish, then the figure would have to be raised. In any case, from the historical sources it seems clear that in the 17th century several thousand fish were caught annually in the lower Vistula region. No sturgeon population could sustain such a massacre in the long run.

My estimation is supported by information presented by Rzączyński (1742, 202) that in his lifetime, in one spring over 1,200 sturgeon were caught in the river Vistula in the vicinity of Warsaw. As regards the 19th century, Sapalski (1862, 90-92) described the spawning areas of sturgeon in the river Vistula between Warsaw and Kraków. He estimated that the annual catch of sturgeon in this section alone was still about 600 in number. In each city along this river there were fishermen interested in this fish.

Protection of the sturgeon

Already in the Middle Ages several restrictions were imposed on sturgeon fishing, either because there were not enough fish to meet the needs of the feudal lords, or because a clear drop in the population of the fish – due to overfishing - was already visible. The use of sturgeon nets *Stürlanke* in Schönewik and Fischhausen (today Primorsk) in the area of the Vistula Firth, was restricted in documents from the years 1298 and 1305 (*Codex*… 1842, II:60, 1848, III:3). In 1318

[1] I assume that ca. 50% of the weight of the fish was used for sale. In the years 1919-1930 in the lower part of the river Vistula 39 sturgeon were caught, with a total weight of 3,774 kg, giving an average of 97 kg per fish (Przyjaciel Przyrody 1931). However, the official size limit before the 19th century for exported fish was 5 feet (=142 cm) (Groth 1990a), so the fish could have been smaller.

the use of a net called *Cütel*, which was detrimental to fish, was prohibited in Frombork (*Codex*… 1842, II:106). Later on laws were alternately passed, as for example by king Stefan Batory in 1578 (*Akta*… 1882, 27), which either allowed (because the tax revenue was high) or forbade the use of the net. However, this did not result in any improvement of the situation, because once again in 1717 it was forbidden to use sturgeon nets with a small mesh in the vicinity of deeper areas, where these fish thrived. Further laws were passed in 1721, 1738 and 1787. Overfishing was probably the underlying factor behind laws passed in 1484 and 1572, prohibiting the fishermen from Tolkmicko scaring fish and driving them into nets (Filuk 1968, 153-154, 159, Ropelewski 1996, 40-41).

All these restrictions pertain to the region in the vicinity of the mouth of the river Vistula. No documents have been found pertaining to the particular protection of the sturgeon stock in the rivers upstream before the end of the 19th century.

Conclusions

The economic importance of sturgeon in Poland was similar to that reported for other countries in Western Europe (Brinkhuizen 1979, Desse-Berset 1994, Fleta 1955, 100, Hoffmann 1996, Mane 1991, Sicard 1953, 124, Venditelli 1992, 409-410). The major difference between Poland and the other countries is that a large part of the catch in Polish waters was intended for export to Western Europe.

The results of archeological research indicate that the sturgeon was an important fish in the economy of Gdańsk from as early as the Middle Ages. The remains of this fish constituted a major part of the finds evidence (Dąbczewski 1952, Susłowska 1966, Susłowska and Urbanowicz 1967). On the basis of a drop in the number of sturgeon remains in layers from the 10th-12th centuries, Urbanowicz (1965) concluded that in this period either a visible reduction of sturgeon catch took place, due to overfishing, or there was a change in the system of tributes (more fish were given to the feudal lords). A similar conclusion has been drawn by Chełkowski et al. (1998) in the case of Szczecin, where sturgeon also played a strong rôle in the economy (Chełkowski 1959, Filipiak and Chełkowski 1999, 2000a, 2000b).

Strong demand and the high price of sturgeon, as well as high taxes levied on sturgeon fishing, led to a depletion of the stock. Laws adopted from the Middle Ages onwards did little, if anything, to reverse the decline of the sturgeon population, at least in the long run. Probably they were not respected, since the incentive or temptation to catch the sturgeon was simply too strong. Also there was a lack of genuine interest in protecting the fish on the part of the authorities (as mentioned in the case of Gdańsk and Prussia).

From the available written material in Poland it is difficult to state when the North American sturgeon *Acipenser oxyrinchus* (Ludwig et al. 2002) established itself in Polish waters. Perhaps the key to this lies in a better understanding of the changes in the natural environment taking place in the 17th and 18th centuries.

Table 1. Export of sturgeon from various ports at the mouth of the River Vistula in the years 1581-1708.

Year	Gdańsk[1)]	Braniewo[2)]	Elbląg[2)]		Königsberg[)]	Mierzeja Gdańska[2)]	Piława[2)]
	Barrel	Achtel	Achtel	Viertel	Achtel	Achtel	Achtel
1581					24		
1585			93	360			
1586			122	528			
1587			42	233			
1590			5				
1594				147½			
1596				54			
1597			30				
1599				98			
1600			40				

1601			34				
1607				23 vasks			
1618			70				
1620			160	625			
1621					150		
1623				144			
1625					44		
1631					196		
1634	231				210		
1635					404		
1637					110		
1638			130		395		
1640					55		
1641	299						
1643					1		
1649	246						
1651			85				
1652			374				
1653			18				
1654		50	195				
1655			448				
1656			30				
1657			1092				
1658			651				
1659		100				90	
1660			120				
1661			315				20
1663			1831				2300
1664		18	1867				2679
1665		10	164				1892
1666			106			277	409
1667			28			59	324
1668			50			949½	82
1669			1040			415	
1670			212			1288	
1671			2			552	
1672						153½	
1673						689	43
1674			326			1361	3742
1675		674½	614				2000
1676		1044				1058	3450
1677		2198	58			503	3069
1678						757½	5159
1679		4712	1543				
1680			232			448	
1681			14			824	
1682			1122				
1683						894	
1684						270	
1688						256	
1689						209	1859
1690							1695
1691							1852
1692							1923
1693							1092
1694							1600
1696							995
1700			57				
1701			150				
1702			150				

1705		42					
1708			168				
1708							800
1712			260				

Source: [1] Bogucka 1970, [2] Groth 1990b.

Table 2. Export of sturgeon from Gdańsk in the years 1745-1789.

Year	Achtel	Year	Achtel	Year	Achtel	Year	Achtel
1745	2513½	1762	1279	1772	645	1781	202
1746	3583	1763	1252	1773	455	1782	514
1751	2930	1764	259	1774	312	1783	239
1752	2785	1765	783	1775	504	1784	124
1753	1746	1766	709	1776	319	1785	20
1754	2465½	1767	898	1777	241	1786	42
1759	1442	1769	681	1778	237	1787	16
1760	1285	1770	860	1779	332	1788	225
1761	823	1771	563	1780	184	1789	4

Source: Biernat 1962.

Table 3. Export of sturgeon from Gdańsk, 1751-1789 (average for 5-years periods).

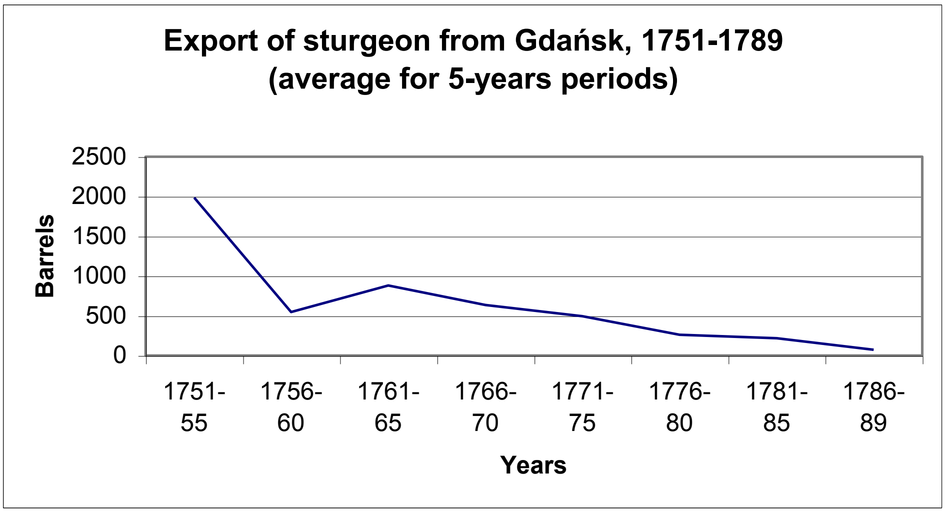

Table 4. Number of references to sturgeon in Polish "fiction" literature (poetry and prose), 16^{th}-19^{th} centuries.

	16^{th}		17^{th}		18^{th}		19^{th}	
	I half	II half	I half	II half	I half	II half	I half	II half
	2	3	6	3	4	1	2	10
Total	5		9		5		12	

Source: own research

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Historical accounts of grayling, *Thymallus thymallus* (L.), in Poland, during the 14^{th}-19^{th} centuries

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Introduction

Since time immemorial fish have played an important rôle in man's diet and daily life. Therefore it is natural that the history of fishing has attracted the attention of many researchers. However, most of the research has focused on well-known or easily available texts, on archaeological finds, iconography, or certain specific topics (such as fish-ponds, sea fishing, fishing techniques, etc).

One of the most important and underestimated areas of research is the rôle of various fish species in the past. Roehl's (1976) statement that fish, as an important item in the diet, "is a topic very much in need and deserving of further research" still remains valid today, though our knowledge has increased in the last thirty years. Such knowledge may be used not only for historical research, but also in current fishery management programmes dealing with the repopulation of waters with fish, which have disappeared due to the activities of man.

The history of grayling, a fish of considerable importance both in the past and today, is still an inadequately researched topic. This article forms part of my studies on the history of fish and fisheries in Poland. Some aspects of the history of grayling in Poland have already been presented in Polish (Cios 2007a) and in English in the Journal of the Grayling Society (Cios 1997, 1998, 2000, 2003a). This article embraces all the accounts of grayling in Polish sources known to me until the end of the 18^{th} century, as well as the most interesting ones from the 19^{th} and early 20^{th} centuries.

Brief review of the historical sources

The historic Polish ichthyological literature is relatively scarce, especially when compared to publications in Western Europe. The main works are by Kluk (1780), Leśniewski (1837) and Gawarecki and Kohn (1860), but today they have limited value, since most of the information was copied from foreign sources. Many other publications in the 19^{th} century also contain relatively little original or valuable information. Only works on pond-culture (Strumieński 1573, Strojnowski 1609 and the translation of Dubravius 1600) represent a high state of knowledge, because they deal with technical aspects of a fishery.

However, abundant material on fish and fishing is available from other sources. The most important are documents of a legal character, which describe privileges, town laws, lists of feudal duties and services, etc. Especially valuable are documents explaining villein service.

Next in importance are both poetry and prose, greatly extending beyond the contemporary concept of fiction. Other sources are financial documents concerning accounts, price lists, customs tariffs, and then letters, memoirs, diaries, travel accounts and even books studying the Polish language or theological dissertations. There is no such historic publication, which *a priori* I would omit. I have even found a reference to fishing in a funeral oration!

References to grayling are relatively scarce, especially when compared to trout and salmon. This may be due to the restricted distribution of this fish to certain parts of the country (submontane rivers, Pomerania and the north-east region), which were sparsely populated. Thus men of letters rarely had the opportunity to become acquainted with grayling.

Feudalism in Poland persisted until the second half of the 19th century. In formal terms it was dismantled in 1864, but some traditions relating both to fish and fishing continued even until the second half of the 20th century. In 1879 the Polish Fisheries Association was established, marking a new era for fisheries in Poland.

Nomenclature

The most common name for grayling in Poland was and still is *lipień*. In the south-east, in the mountains, the name *pyr* (*per* or *pir*) was also used.

In the north-eastern part of the country in the River Niemen basin the name *toporek* (= an axe) was used. Umiński (1917) stated that the name of the fish derived from the similarity in shape of the grayling's liver to that of an axe. In my opinion the resemblance is actually to the dorsal fin.

Today the nick-name *kardynał* (cardinal) is applied to trophy fish (longer than 40 cm). It derives from the bishops' violet attire, resembling the colour of the dorsal fin found in older grayling. This name is a modern one, reflecting the importance of grayling to fly anglers.

Financial documents

The first mention of grayling in the Polish sources is contained in financial accounts. On 3rd October 1394 in Kraków, grayling worth one skojec and one kwartnik (a rather small amount of money) were bought for Queen Jadwiga (Piekosiński 1896). In the same set of documents there is another reference to grayling, worth 9 szkojce, having been bought in February 1412 in Nowy Sącz.

Further information, of great interest, may be found in accounts relating to King Władysław Jagiełło published by Wajs (1993). The documents pertain to the king's stay in the year 1412 in the city of Nowy Sącz, in the southern part of the country, close to the River Dunajec, once famous for its grayling, sea trout and salmon.

All together, grayling are mentioned 86(!) times in the bills. Between 17th February and 9th March, as well as 31st March and 2nd April, grayling were bought practically every day for the King, his wife and his entourage – these included the Duke of Racibórz, Duke Ziemowit, Hungarian palatine Geramiclus, a cardinal, the Count of Cylia and some Saxons. According to the accounts, the fish were caught mainly for dinner; but twice they were also intended for supper. All were fresh (*recentibus*), since in 82 cases this was duly noted.

On each occasion the payment for the fish was between 3 and 12 szkojce. The number of transactions for each individual, relating to the value of the fish, is presented in Table 1.

Table 1. The purchased grayling in 1412 arranged according to value and person.

Value (szkojce):	3	4	5	6	7	8	9	10	11	12	**Total**
King			10			3	4	3	1		**21**
Queen			7		2	11		2			**22**
Duke of Racibórz	1	2		4	6	4					**17**
Duke Ziemowit		1		10	2						**13**
Count			1			1		1		1	**4**
Palatine						3				1	**4**
Cardinal				3							**3**
Saxons		2									**2**
Total:	1	5	18	17	10	22	4	6	1	2	86

After arranging the transactions I was able to draw some interesting conclusions. The price of the fish bought for the King, and partly for the Queen, was concentrated at 5 and 8-10 szkojce. This suggests that the price of one big grayling was 5 szkojce. Therefore in ten cases the King received one fish, whilst in eleven cases he received two fish. A similar situation can be seen in the case of the Queen - seven times she received one fish and fifteen times two fish. A different story may be told for the other gentlemen. Most of the purchases are in the range of 6-8 szkojce. This means that they usually bought two fish, each priced at 3-4 szkojce. They did not buy the largest fish priced at 5 szkojce. From this one can draw the following conclusions:

1. The fish bought for the King and also for the Queen were the largest ones available on the market. The other gentlemen had to be content with smaller grayling. This is very much in line with the old tradition that persons occupying a higher social position were entitled to larger and better fish.
2. From the middle of February to the beginning of April it was rather difficult to catch grayling in the River Dunajec near Nowy Sącz. Thus the King and the Queen, taking advantage of their social position, bought almost half of the grayling available. The other individuals had to be content with other fish.

The almost daily consumption of grayling by the King and the Queen indicates the very high status of this fish. Besides which, in all the bills grayling headed the list of items. This may confirm the status given to this fish.

Also of interest is the period of the year when the fish were bought. It indicates that fishing in the River Dunajec was undertaken even in winter. Probably nets were used, since in general it is difficult to catch grayling in weirs and other fixed traps.

Together with grayling, fish called *salmone* appear in the bills. They were either salmon or sea trout. It is of interest to note that not a single trout was bought, in spite of the fact that it was also a highly prized fish in Poland at this time, as indeed it still is today. Probably trout was difficult to procure in the vicinity of Nowy Sącz in winter.

There are 73 references to *salmone* in the bills, but the word fresh - in contrast to its use prefacing grayling - doesn't appear anywhere. Hence it is difficult to assess the provenance of these fish and their date of capture. In each reference a single fish was bought. This is stated explicitly in four bills, but the price of each fish is similar. The number of transactions of *salmone* per person, depending on the value of the fish, is presented in Table 2.

Table 2. The purchased *salmone* in 1412 arranged according to value and person.

Value (szkojce):	13	14	15	16	17	18	19	20	**Total**
King					3	12	1	3	**19**
Queen				8	3	9	1		**21**
Duke of Racibórz	2		6	1	1				**10**
Duke Ziemowit	1	1	6		1				**9**
Count			2	1		2			**5**
Palatine			2	1		2			**5**
Cardinal	3	1							**4**
Total:	6	2	16	11	8	25	2	3	73

The purchase of *salmone*, similarly to the case of grayling, reflects the social hierarchy of the individuals. The most expensive and the largest fish were naturally bought for the King. Slightly smaller ones were intended for the Queen. Next in order were the Count and Palatine. Then came the two dukes, followed by the cardinal. There was not a single day, when any of the gentlemen would buy a fish, which was more expensive than the one bought for the royal couple. However, on 1st March a *salmone* priced 19 szkojce was bought for the Queen, while the King had a *salmone* worth 18 szkojce. A detailed analysis of the two bills offers an interesting explanation. On that day, the King received two grayling worth 9 szkojce, while the Queen only one worth 5 szkojce. Thus the larger *salmone* for the Queen made up for the deficiency of grayling. This in turn indicates that grayling were preferred over *salmone*.

The price relationship between grayling and *salmone* also confirms the higher monetary value of the former. The price of a grayling weighing about 300-500 grams was 5 szkojce, while that of a *salmone* in the order of 2-3 kg - around 18 szkojce. The difference in weight would be around 4-10 times, but in price only 3-4 times.

I cannot refrain from commenting on the excellent appetite of the people living in the Middle Ages. Their meals were almost certainly larger than ours. A specific idea about appetite in general in England may be gained from the information presented by Mead (1967). However, the feast presented on the 18th September 1661 in Łańcut in Poland, on the occasion of an aristocratic marriage, is the most remarkable one to my knowledge. Apart from thousands of animals and birds with wings, hooves and horns, there were also 700 pike, 800 carp, 1500 large Crucian carp, 1500 large perch, 500 large tench, 10 stones of stockfish, 6 stones of flatfish, 3 barrels of lampreys, 10 salmon and one stone of herring. That was served on the Tuesday. It wasn't enough, because on the Wednesday on the tables were found in addition some 1190 pike, 1260 carp, 720 Crucian carp, 720 perch, 2400 tench, 1440 bream and 24 fresh salmon (Czerniecki 1697)!

I may add here, that Pawiński (1893), when describing the youth of King Zygmunt Stary at the beginning of the 16th century in Kraków, stated that salmon was a rare fish on his table, but other "cheap fish", like roach, gudgeon, loach, Crucian carp, perch bream and grayling, were more common. Unfortunately, he didn't indicate the source. Probably this distinguished historian saw some financial documents, which I hope to trace, if they still exist or were ever published.

Dictionaries

The oldest reference to grayling in Poland is in the so-called *Kladdenbuch* of the Wrocław Duchy, written in German in the middle of the 14th century (Witkowski and Żerelik 2001). It contains a list of 44 fish species living in the river Odra, among which is the term *Aschen*.

As regards the Polish sources there are five 15th century Polish dictionaries in which fish names appear. However grayling is mentioned in the latest (dated 1472) and most comprehensive one, written by Jan Stanko (Rostafiński 1900). Grayling ("lypen") is in the company of 28 other fish species. From then onwards, starting with the dictionary written in the years 1510-1520 (Erzepki 1908) grayling swims in all dictionaries.

Poetry and plays

There are a few references to grayling in poetry. Andrzej Zbylitowski (1893) (1565 - 1608) twice mentions grayling. In the first, he included grayling among riverine fish (barbel, vimba, trout, loach, asp, carp, bream, Crucian carp and pike), as being good for a dinner or supper. In the second, he made a remark about "grayling from fast water".

Hieronim Morsztyn (1990, 1995) (*c* 1580 - *c* 1626) also twice mentions grayling, as part of a good table. In the first instance grayling was in the company of salmon and a large pike, in the second it is coupled with loach, gudgeon (these two fish species were highly prized in Poland), trout and salmon.

The next reference is in an anonymous political poem (Czubek 1916, I:97) from the years 1606-1608. The author states that for each Friday (a fast day) salmon, grayling and trout were bought.

Hiacynt Przetocki (1911) (end of 16th century - *c* 1655), in a poem that is difficult to interpret today, states that grayling, a fish without bones, is good only for the elderly. He also refers to the large dorsal fin.

Wacław Potocki (1907) (1625 - 1696) mentions tasty fish species: loach, salmon, trout, grayling and dace. Andrzej Komoniecki (1987) (*c* 1658 - 1729), describing the region of the upper River Soła, states that salmon, trout and grayling are born there.

Wojciech Bogusławski (1956) (1757 - 1829) twice mentions grayling in a play that was set in the mountains. In the first reference he mentions cheese and grayling as typical local products, whilst the second is a description of a boy skilfully catching grayling.

Biological, agricultural and fisheries literature

There are two references to grayling in a herbarius by Falimirz (1534):

- Capitulum 119 (devoted to grayling): „Grayling: also is born in the same waters as trout, but it is different, because it does not have scales on the body, is naked, having only skin on itself. It is good, sweet and healthy for eating; being a fish from fast water it is better and healthier". In a later version of this book (Siennik 1568) grayling is described as being covered with scales.
- Capitulum 120: „Fish, which suck the stones, are not so good, as fish which eat the herbs, because stones are raw [probably meaning indigestible]; thus grayling and trout are not as good as roach".

These fragments are something of a challenge to interpret, since Falimirz contradicts himself, as regards the culinary values of grayling. Probably he had poor knowledge, if any, of the fish. His herbarius was definitely based on similar foreign publications of his time, but he could possibly have made a mistake when copying from some other source.

In 1616 Teodor Zawacki (1891, 92) published a book on farming. In a section devoted to fish he wrote that the "best and healthiest fish are from rivers and stony water, like pike, perch, salmon, trout, grayling and other fish with a strong body, not the ones from turbid and filthy waters".

Schwenckfeld (1603), in his description of Silesian fish, mentioned that gold was found in grayling stomachs. Similar information may also be found in foreign sources - Gesner (1558), Rondelet (1558) and Izaak Walton in 1653 (see also Francese S.a.). Today this piece of information may be considered, at best, as anecdotal. However, similar information, concerning trout in Poprad Lake in the Tatra Mountains (Belius 1723), led me to the conclusion, that in these old accounts, some of which are independent, they are making a simple reference to stones from caddis cases found in fish stomachs (Cios 2004).

Rząnative (1721) mentioned grayling from Poprad. In his later work (Rzączyński 1742, 200, 218) he stated that grayling are found in clean and cold mountain running waters with strong current, while its meat is similar to that of trout. He indicated that grayling thrive in Radunia, Wierzyca, Poprad and Soła (and its tributaries, the Koszarawa and the Świeca). Dunczewski (1766) repeated after Rzączyński, that grayling thrive in Soła.

Schwenckfeld (1603) and Rzączyński (1742, 213) mentioned that lampreys were used as bait for grayling, eels, pike and other fish. Similar information may be found also in foreign literature, for example Gesner (1558), Colero (1645) and Willughby (1686, 105). I will not dwell on the point of who copied from whom (the original source seems to be Gesner), but whether the lampreys were really used to catch grayling. I consider it highly probable, since lampreys have been found in the stomachs of grayling in Denmark (Dahl 1962) and Sweden (Peterson 1968), whilst small fish (I have found bullheads, minnows and even pike) are a common item in the diet of grayling in the Nordic countries. Besides, in the United Kingdom minnows were used as bait for grayling (Platts 1939), while in central Finland in the 20th century large grayling were at times caught in autumn and winter on hooks baited with bullhead when fishing for burbot (Tarmo Kallio - oral information). Even today grayling may be caught with large lures or a wobbler, which I can confirm from my own experience in Poland and Finland. In Northern Europe it is common, but less so in central and southern parts of the continent.

Pietruski (1847) in a brief note on fishing in the River Stryj (today in the Western Ukraine), stated - "angling, which is well known, is also very common here, and doesn't need a broader description. However, it merits interest, since to facilitate angling for trout and grayling, instead of a natural bait (i.e. a fish or a worm), on the hook they place an imitation of an insect made of the hair of a bear. With this bait they catch the tasty, but indeed lacking intellect, fish". This is the oldest known reference to fly fishing in Poland.

Nowicki (1867) stated that in the River Dunajec grayling fishing was performed throughout the whole year in the rapids.

In the Russian literature Kurbatov (1887) presented information on angling in north-east Poland. He stated that in the Rotniczanka stream, a tributary of the river Niemen (nowadays flowing from Belarus to Lithuania), grayling were caught with a rod only during a short period in April. The bait was a humble worm.

In the historic Polish and foreign biological literature there are several references to the use of the fat of grayling as a medicine for curing eye and ear sickness. In an article by Łomnicki (1878), on fish in the north-eastern Carpathians, there is explicit information that the fat was still used by the peasants to cure eye sickness.

Other sources

In the submontane part of the country grayling was included on the list of items that the peasants had to present as a tribute to the feudal lords. In 1564 we read that four times a year 60 dried grayling or trout were presented (Lustracja... 1962. I:170, 177). In 1619 there is a reference to grayling as tribute in the Orawa region (Semkowicz 1939, II:132). Eljasz-Radzikowski (1901, 145) mentioned that in documents from the 17^{th} century, describing disputes between peasants and feudal landlords, there are many references to the duty to catch trout and grayling in the River Dunajec.

In a book dealing with the history of Poland written by Marcin Kromer (1512 - 1589) and published in Latin in 1568, there is a section devoted to fisheries. Grayling is mentioned among riverine fish, but is not among the tastiest species.

In the years 1606-1608 Stanisław Niemojewski (1899, 170) visited Russia. In his account he stated, among other things, that "there are many fine and big fish, except carp, barbel and grayling". Evidently, this noble was well aware of grayling from his native country, Poland.

In 1647 King Władysław IV issued an instruction for his steward, describing his duties relating to the visit of the court physician. For fast days he was supposed to provide special dainties, which included loach, trout, grayling and salmon (Vorbek-Lettow 1968, 146).

In 1775 an instruction was issued in Kraków, which regulated the trade of fish in this city. We read in it that "dried fish, trout, grayling and salmon, both smoked and fresh, as well as salted and marinated fish [...] brought by the mountain and other people, may be sold in the city" (Tobiasz 1962, 83).

Tomkowicz (1839) in a description of the surroundings of the River Soła, mentioned „black-speckled grayling" thriving in this river. The editor of this work stated in a footnote that grayling resemble trout in both taste and appearance.

In the foreign literature Belius (1723, 73; 1777, 186) listed grayling, as well as trout, salmon and eel, amongst the most common fish in the rivers Poprad and Dunajec. Bloch (1795, 130) stated that grayling is not present in the river Noteć (= Netze), but large numbers thrive in the rivers Gwda (Kuddow) and Drawa (Drago). These three rivers lie in Pomerania. Heckel and Kner (1858) reported grayling from the rivers Styr and Opór in the south-eastern part of the country, nowadays part of the Ukraine).

Artificial propagation and reproduction

In Kluk (1780) there is a reference to the fact that grayling „are found in stony rivers, and when held in ponds, they need similar water as trout". This indicates that grayling were sometimes kept in ponds. In my opinion this information does not pertain to Poland, though the cultivation or farming of trout was common (Cios 2005a). It may even be considered doubtful, in view of the statement by Cuvier and Valenciennes (1848, 445) - "on ne peut pas le faire prospérer dans les eaux tranquilles". The only other reference, know to me, of keeping grayling in ponds is in J. Turton's (1836) "The Angler's Manual" (see Magee 1993).

Stocking with grayling is well documented for the years 1879-1884 (Rozwadowski 1904). The fish were placed in the tributaries of the upper Vistula, as well as the Dniestr and the Prut (the last two now in the Ukraine). Stocking was achieved on the basis of eggs imported from Germany and Austria. Later this activity was discontinued, because grayling was considered to be abundant and a threat to trout and salmon.

It is likely also that the river Hańcza (Eastern Mazury) was stocked with grayling in the 1860's by the Prussian authorities. This may be deduced from the capture of grayling in this river only during this period (Cios 2003b).

The first successful artificial reproduction of these fish in Poland took place in 1908 (Anon. 1908a, 1908b). It was a short-lived exercise and did not continue on any larger scale.

Curiously it is claimed that in the 1950's a "successful" attempt was made to produce a hybrid between grayling and rainbow trout, with a view to the development of fly fishing (Anon. 1955). There is no physical evidence of such hybrids, so this seems to be a possible product of communist propaganda and an idealistic belief that man can master nature in every respect.

Archaeological finds

In Poland an abundance of fish bones have been found and studied by archaeoichthyologists. However only nine fragments, probably belonging to a single grayling, have been identified so far (Hensel and Hilczer-Kurnatowska 1987, tab. 5). This unique and significant fish was found in a medieval stronghold, dated ca. 950-1050 A.D., near Santok in Pomerania, close to the River Noteć. The fish could have been caught in the rivers Noteć or Drawa.

Discussion and conclusions

Role of grayling

Almost all of the oldest historical records clearly indicate that grayling was a highly prized fish in Poland, worthy even of a royal table. It was even preferred to salmon, at least in the Middle Ages. Critical remarks about grayling, as a species competing with trout and salmon, appear at the end of the 19th and beginning of the 20th century. For example, Dixon (1924), following foreign sources, concluded that grayling and trout should be eliminated to protect the salmon.

In spite of the fact that grayling was held in such high esteem, there are no accounts from Poland indicating that fishing for this fish (or trout) was reserved for the nobility; such a reference for Germany may be found in Bloch 1785, 129 and to the River Po in Italy in ancient times in Carignani 2000. However, in central and southern Poland only salmon and sturgeon were reserved for the nobility. Probably the relatively large number of grayling in the submontane waters did not necessitate any restrictions on its fishing.

The fish was well known in the southern submontane part of the country, especially near Kraków. It was caught in the tributaries of the River Vistula, mainly the Soła, Skawa, Raba and Dunajec. Reference to grayling in the company of other rheophilic fish indicates that some writers had a relatively good knowledge of the local ichthyofauna and its biology, that is its living in fast water environments, together with trout and salmon.

Grayling was of a certain economic importance. It was among the fish the peasants had to present to the feudal lords. More importantly, it was an object of trade in the southern part of the country already by the 14th century, brought mainly to the major cities by peasants from the mountains. This situation lasted at least until the end of the 19th century. Skłodowski (1861, 278) mentioned that smoked grayling were often traded in his time. Beill (1880) stated that in Stanisławów (currently Western Ukraine) grayling were common on the market from March till May.

However, compared to other fish species in Poland, grayling was of minor importance. An indication of this may be gained from the number of references to various fish species which appear in poetry, plays and prose (fiction) until the year 1870. Numerically the first place is held by pike (379 references), while grayling is closer to the bottom (just 10). In contrast, salmon holds the sixth place (99) and trout the tenth (57).

Fishing methods

Grayling were caught throughout the whole year. The bills from 1412 indicate that even in winter the fisherman had the skill to catch them, though probably in smaller numbers. Additionally fishing was practiced on a daily basis in the river Dunajec. In my opinion the fish mentioned in the accounts were caught with a net, since fixed traps are not as efficient in catching grayling. Probably the fish were caught in the slower stretches of the river, as I postulated for a similar case in Italy (Cios 2006).

The oldest primary reference method of fishing for grayling lies in Pietruski (1847). His description, combined with later accounts on the role of the mayfly *Oligoneuriella rhenana* in fly fishing, played a key role in the determination of the insect *hippurus* in Aelian's writings and shed important light on the origins of fly fishing in Europe (Cios 2000, 2005b). Fly fishing for grayling was undertaken mainly (or solely) in summer and autumn.

In contrast, Kurbatov's (1887) account indicates that grayling were caught only in the spawning streams, but with a natural bait. In the River Niemen, which is quite large, grayling preferred to stay in midstream in the fastest and deepest stretches. Hence, given the tackle available at that time, it was probably too difficult to catch grayling with a rod and line in wide highland rivers.

Probably spring fishing (the term "barbarian poaching" might be more appropriate) was also important in some streams in the southern part of the country. The River Czarny Dunajec is known as an excellent spawning and nursery stream for grayling. My father, who was born and lived in the city of Czarny Dunajec, informed me that in his childhood (1930's) in April he often saw men wading in the stream and flailing the water with an iron rod and collecting the injured grayling. The river was full of fish at that time and it was easy to fill up a creel in a relatively short time.

In the literature there is a similar, but more recent account (Anon. 1953). In another source (Anon. 1921) it is stated that in spring in the river Dunajec near Nowy Targ during spawning several hundreds of grayling were killed by poachers. The method was probably a similar one. In view of the simplicity and effectiveness of this rather crude, barbarian way to procure fish, it must have longer historical roots.

Rozwadowski (1897) stated that in the mountains, peasants caught grayling mainly with hand nets in July and August during low water. After locating a school of fish, they would insert a net upstream. Then they would cast stones below where the fish were feeding, disturbing them and, disorientated, they would rush upstream and swim into the net. The fisherman would pull in the net with the fish caught inside. He noted that a rod in the hands of a peasant was not an effective instrument for catching grayling, in contrast to trout.

Historical versus current distribution

Most of the aforementioned accounts pertain to grayling in the southern part of the country, where the fish was abundant and well known. As regards the northern part, apart from the earlier brief references to grayling in the rivers Radunia, Wierzyca, Drawa and Gwda, there are just a few others from the 19^{th} century. Jundziłł (1807) and Korev (1861) mentioned that grayling was a common fish in the River Wilja near Vilnius (modern Lithuania). Wałecki (1863) referred to the rivers Hańcza and Szeszupa, while Kurbatov (1887) discussed the river Niemen basin. In the majority of these rivers grayling may still be found to this day.

In contrast to grayling, there are abundant historical sources, discussed elsewhere (Cios 2003b, 2007b), indicating that trout and salmon thrived in many waters almost throughout the entire country. These fish became extinct in many places by the middle of the 19^{th} century, as a result of the deterioration of the natural environment due to man's activities.

The available sources therefore indicate that the historical distribution of grayling was very similar to the current one. The reason for the lack of grayling in other waters, where trout and salmon were present, is unclear. However, it seems probable that the lesser propensity to migrate could have played a certain rôle. Or had the fish disappeared, before man had even recorded their presence?

Acknowledgments
I would like to thank the Editor of the Journal of the Grayling Society for the permission to use here some parts of my material published in the Journal.

Fish remains from the Site of Kal, a 5th – 7th century settlement in the Mazurian Lakeland. Preliminary data

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Introduction

This presentation contains the preliminary results of the identification of ichthyological materials uncovered during excavations as a part of the „Węgorapy Valley" study project, in in the Kal locality 20 (Węgorzewo district, Warmia and Mazovia province), in the year 2008. The excavation work was supervised by J.M. Łapo from the Museum of Folk Culture in Węgorzewo and J. Janowski from Warsaw University.

The study area is a multi-period settlement with four recognisable settlement phases: 1) the late Neolithic, 2) the late 5th – 7th century, 3) the 10th – 12th century and 4) the 17th – 19th century. Ichthyological material derives from layers dated to the second and third phases, that is broadly the late 5th to 12th centuries. Fish remains were obtained by sieving techniques with sieves of 1 mm mesh diameter. The site is situated at Święcajty lake which is an element of the lake complex known as Mamry, in the Land of the Great Mazovian Lakes, occupying an area of 175 ha. The maximum depth of the lake is 12 m whilst the mean depth is 4.5 m. The actual ichthyofauna composition includes such species as: roach, rudd, eel, common whitefish, vendace, pike, tench, perch, bream, pikeperch and catfish.

Methods

The archaeoichthyological remains were subjected to a macroscopic analysis according to the analytical research procedures contained in the works of R.D. Casteela (1976) and A. Wheeler and A.K.G. Jones (1989). The first stage was the separation of fish remains from the available samples that also contained single bones of small mammals and birds, shells of snails, plant macro-remains and charcoals. In the species and anatomical classification of bone elements, the following anatomical fish atlases were consulted: J. Lepiksaar 1981, M. Długosz, J.K.. Demska-Zakęś 1995, 1997 and W. Janec-Susłowska 1957, as well as the collection of comparative material made available by D. Makowiecki.

A reconstruction of the total length (TL) was also carried out, mainly on the basis of comparative analysis of the subfossil collection of elements from actual fish skeletons. In the estimations, regression equations produced by D.C. Brinkhuizen (1989) for beam, pike and perch were used, as well as skeleton measurements produced by N. Benecke (1987) for bream. Measurements of bones were carried out according to the recommendations of A. Morales and K. Rosenlund (1979), as well as those of the aforementioned authors. Results of the total length estimations were arranged into classes within 10 cm intervals.

The condition of preservation of the remains allowed us to identify about 75% of the collection. Other bones were defined as general fish remains (about 21%). The remaining 4% of the bones were mainly from small mammals. In addition, scales of Cyprinidae and Percidae were also identified.

Results

Within the analysed collection of fish bone remains, twelve ichthyological taxons have been recognised (fig. 1). The remains of *Cyprinidae* were the most numerous; they included remains of *Abramis brama, Tinca tinca, Rutilus rutilus, Leuciseus idus* and *Carassius carassius.* Beyond the *Cyprinidae*, a significant proportion consisted of the remains of *Esox lucius* and *Perca fluviatilis*. Several bones of *Anguilla anguilla* L. and two fragments of *Silurus glanis* ribs were also identified.

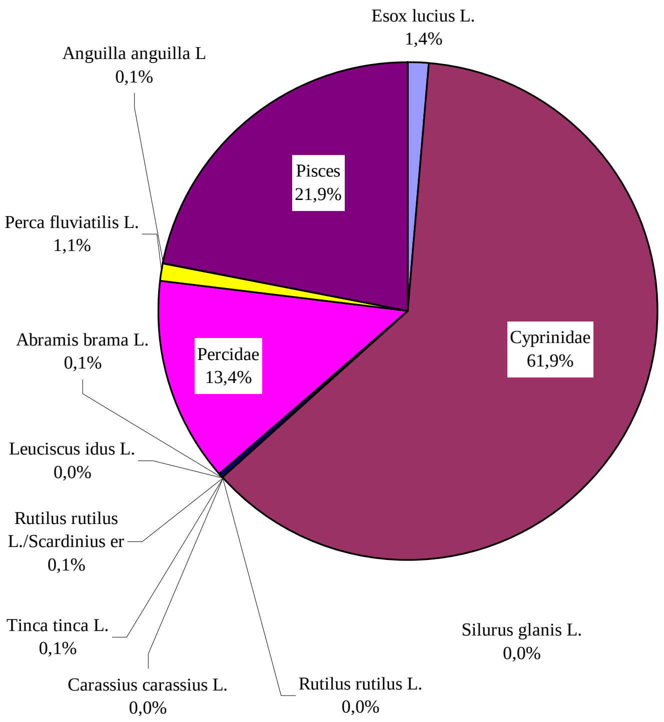

Fig.1. Kal, site 20. Percentage of ichthyological taxons on the basis of identified bone remains

Among the *Cyprinidae* bones, their ribs (52.3% of the collection) were especially numerous and some specimens were recognized as belonging to large individuals (most likely to represent bream). Over 34.5% of the *Cyprinidae* remains were vertebrae and included both small specimens belonging to the category roach/rudd (i.e. 20-30 cm), as well as big individuals exceeding 60 cm TL. Bones from fish heads comprised only 12.8% of the collection, and most of these were badly preserved, making their species identification impossible. The TL estimates allow us to say that among the *Cyprinidae* the most numerous individuals were in the range of 40 – 50 cm TL, and specimens of 50 – 60 cm and 30 – 40 cm long were less frequent.

Bream was identified on the basis of 18 bones (mainly ossa pharyngea inferiora). Tench was mainly represented by ossa pharygea inferiora and cleithrum. The recognised remains of both species belonged to individuals from three size categories, the most numerous was the size range of 40 – 50 cm (about 60% of the collection) and the remainder were in the ranges of 30 – 40 and 50 – 60 cm.

Small fish from the *Cyprinidae* family, like roach/rudd, were mainly identified on the basis of the presence of ossa pharyngea inferiora, comprising about 82% of this taxon's remains. These remains belonged to individuals from three size classes, among which the most numerous included fragments 15-20 cm long, with the remainder contained in the interval ranges of 20-25 and 30-35 cm. Roach was differentiated on the basis of its two first vertebrae. Roach belonged to individuals with a total body length of 24 and over 30 cm.

Such species as ide and crucian carp were represented merely by single bone elements. In case of ide, only the pharingeal bone was recognized; the TL of that individual extended up to 30 cm. Crucian carp was represented by a cleithrum originating from an individual measuring about 35-40 cm and by a supracleithrum originating probably from a specimen reaching over 60 cm in total length.

Amongst the bones of pike, the most numerous group consisted of cranium elements, at around 45%, whilst the bones of vertebrae represented 32.5%. The reconstructed total length of pike indicated that the most frequently caught individuals were in the range of 60-70 cm in length. Specimens in the ranges of 50-60, 70-80 and 80-90 cm long provided a smaller but still significant share of the fish bone remains. Very few bones belonged either to small specimens, i.e. those between 30-40 cm, or to very large fish exceeding 100 cm in length.

In terms of perch, bones of the skeleton represented 57.6% and a slightly lower figure was represented by the vertebrae at 41.9%. The estimated total length of perch was dominated by individuals measuring 20-30 cm and 30-40 cm.

Eel was mainly recognized on the basis of nine vertebrae, representing 56.3% of the bone collection of this species, and by single cranium elements. The majority of bones belonged to sizeable individuals measuring 70-80 cm, with a slightly smaller number of bones belonging to fish in the range of 50-60 and 60-70 cm. The largest pieces, reaching about 79 and 89 cm, were identified on the basis of the cleithrum.

The collection thus identified does not differ intrinsically from the archaeoichthyological materials studied from the area of Mazuria (Makowiecki 2003; Łapo 2007). In the most part, as at Kal, the dominant component belonged to fish from the *Cyprinidae* family and from pike.

Conclusions

Comparing the actual ichthyofauna of the Świętajty lake with the list of fish from the archaeological assemblage, the most noticeable characteristic is the absence of the common whitefish and cisco. Taking into consideration the fact that the natural development of ichthyofauna of the waters of the Polish lowland ended almost completely at the beginning of the Atlantic period (Makowiecki 2003), one should exclude the presence of these two species in these lakes in the 5th to 7th centuries, but not necessarily later. Therefore, one must infer that such a situation was not caused by environmental conditions but by the angling techniques used by the fishermen of that particular period. The absence in the study sample of common whitefish and cisco seems to be a good indicator of the identification of the season of the year and the lake zone in which the fishing of the species recorded in the assemblage was carried out. The natural zone of existence for the aforementioned fish is the pelagic zone, whilst they rarely appear in the bank zone. These fish spawn in the autumn, in contrast to the other fish, the *Cyprinidae* and the carnivorous fish (pike and perch), recorded in the assemblage, who settle in the littoral zone, and are particularly numerous during the period of spring spawning.

According to ethnographic data, very simple forms of catching techniques work extremely well for these species. Basic or elementary techniques like basket traps or spearing individual fish would have been very successful. Larger specimens could be caught by anglers using hooks and bait, either from the shoreline or by boat. The use of nets is also possible, if not demonstrable.

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Fishery organization in medieval Pskov: fishing tool owners' marks as a historical source

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The fishing implements collection from the excavation in medieval Pskov numbers about 3000 objects. The fishing tackle represented is rich and diverse. Among the finds there are often marked fishing implements. Most often the sinkers and floats for large nets and seines ("nevods") – more than 10% of the whole are marked.

There are several groups of markings. A number of floats and sinkers are decorated by ornamentation round the central hole. The net image is commonly portrayed (sometimes it is a small fishing net implement or a net with a catch). We can often trace the image of the cross (both straight and diagonal), a pentagonal star, a ship, signs representing "animals", "birds" and "birds claw". Letters and letter-like images are frequent. They may be separate letters, monograms, entire words and names, but heraldic symbols are rare.

There are no clear differentiating criteria in the marks used. Besides taking into consideration the accidental usage of the sign, we can also suppose that a number of marks and images, despite their utilitarian fishing inventory usage, could have been used as decorative elements, thus having aesthetic value. Some marks could have served as talismans for luck (stars, cross, ship, a net).

But we still insist that primarily they were used as owners' marks and property signs.

Identifying the marks with different complex tackle, plotting their appearance in the areas of the medieval city and studying the diachronic changes we can trace many interesting and important processes in medieval city life.

Thus the increasing proportion of marked objects is obvious in the XIII-XIV-th centuries. The widest use of the most productive fishing tackle – large nets and seines ("nevods") and new catch areas also refer to the same period. We suppose that is connected with great changes in fishing organization and its shaping into a separate independent occupation and branch of medieval city economy. Fishing stops being just an auxiliary economic branch. It becomes a separate commodity production (Chernetzov A.V., Kuza A.V., Kirjanova N.A., 1985; Kuza A. V., 1970).

What also substantially distinguishes the period, which started in the XIII-th century, is the change and enlargement of the city's catching area, expanding into the open area of Pskov and Chudskoye (Peipsi) lakes (Salmina E.V., 1999, 2001).

It is largely connected with the XIII-th century extreme natural phenomena which led to the whole series of "hungry years" in the North-West of Russia (Borisenkov E.P., Pasetzkij V.M., 1983; Pashuto V.T., 1964). It is only natural that the search for the way out of crisis and increasing demands on the food supply in a non-chernozem zone, rich in water resources, was thus connected with their optimal usage and intensive exploitation.

Most often the marked finds come from large and varied groups of material. Very often it is possible to assign them to particular properties. In case of fire (when the items were found in the archaeological context of fire and made a complete set of net sinkers) the collection almost always shows marked objects.

The property estates within the Pskov study area where the marked fishing objects were found are rather evenly distributed for the whole medieval period.

The fact that marked objects are often found on the properties of the wealthy citizens estates is of special interest. Fishing could not have been the only or a substantial source of their existence. The general finds composition identifies these estates as belonging to merchants, jewellers and smiths.

Moreover in 30% of cases the general finds composition (among it imported objects, Eastern glassware and status markers such as weapons and lead seals) is an indication of great material wealth and even to a high social position of their owners.

We suppose that the wealthy citizens could have possessed such expensive fishing implements and could have hired seasonal fishermen or let out the gear for the fishing season.

It was very profitable for wealthy owners to possess such means of production as nets, seines ("nevods") or seine parts ("deli"). We can suppose that there existed the practice of letting the fishing tackle or seasonal hiring of the fishing concession. Fishing could have been done with the sole aim of catch for trade.

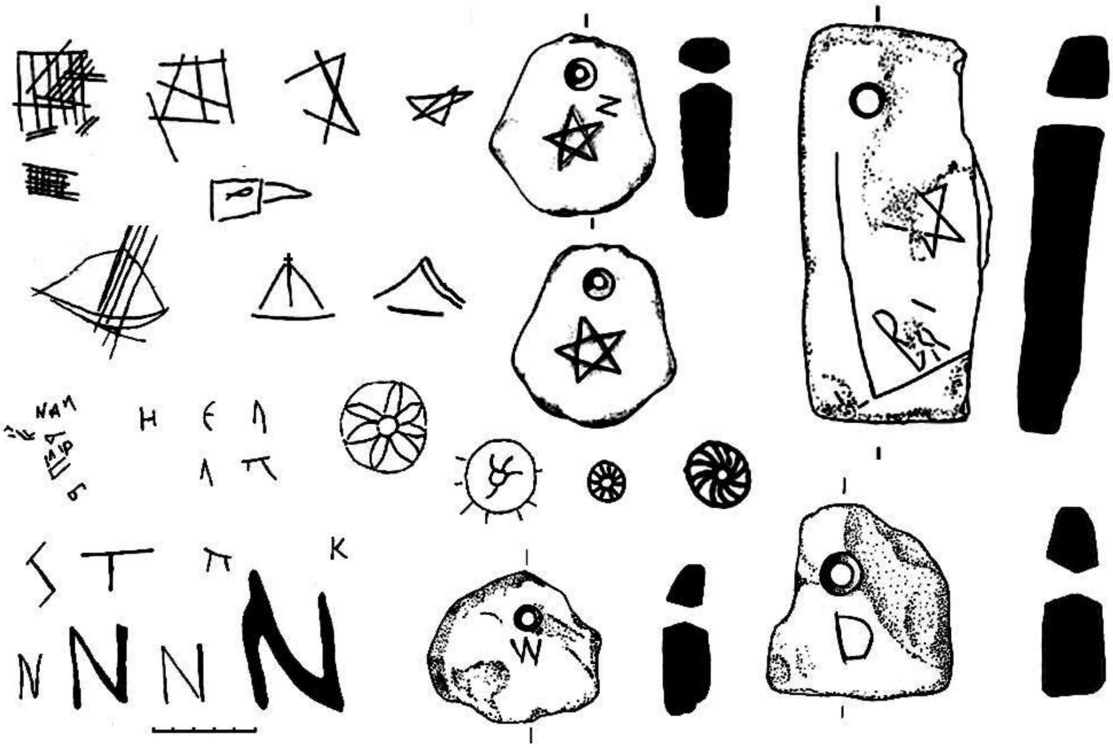

Fig. 1: Examples of signs on sinkers and floats from Pskov archaeological collections

According to our opinion the process of change or combination of marks testifies to the long process of reformation of small economic units connected with fishing. It may be explained by heritage issues (inheritance or division) and also by the process of uniting smaller units into a large one. We can guess that those united into one co-operative or those who worked for one master (the tackle owner or the catching area owner) had the same mark. The specially marked sinker came to become a document certifying the catch rights on a definite water territory.

We can't but emphasize that floats are more rarely marked than the sinkers. This can be partially explained by the poorer preservation of organic materials. But the general tendency and representative proportion of marked floats is approximately the same despite its general small amount. Thus the mark was not intended to be seen when it was used in the water. The Pskov collection thus differs from some other old Russian and Baltic cities collections (S. Tilko, 1986; J. Indans 1982; G. V. Caune , 1990). There the float marks help to identify the net during the catch extraction. The Pskov data makes it possible to suppose that the origin of the net was distinguished in some other way.

The written sources (most importantly the Pskov Judicial Chapter ("Pskovskaya Sudnaya Gramota") – the document dated to 1467, which characterized the civil law regulations of the XIV-XV-th century) tell us about the existence of various forms and restrictions of any kind of areas to let. These were arable lands, reaping fields and vegetable grounds (Alexeev Yu.G., 1997). We also know that according to scribes' books of the XVI c. the rivers were divided into very definite areas. The net set on a certain area could have belonged only to a definite owner or the person who rented it. The usage of any differentiating marks was not needed.

It is possible that in the earlier period the place of net fishing by an individual fisherman was also fixed. A large number of marked sinkers testifies to the fact that it was necessary to identify the nets during the process of drying or in places of mutual keeping. It may also be possible that the large fishing areas of river Velikaya allowed for wide spacing of the nets.

We wish to emphasize that according to the materials from the other Pskov land sites, the problem of needing owner's marks on the fishing tackle was of particular importance only for a large city. We think that it also points to the links of this phenomenon with the changes in the Pskov city economy.

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The governmental projects of modernization of herring fisheries in Russia (18^{th} – 19^{th} cc.)

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The 18^{th} century AD is the most important period in the history of Russian modernization and westernization. The reforms of Peter the Great provided an impetus for further changes to Russian life. In the second half of the century, Catherine II began reforms in the social, economic and military spheres. As a result, in the 19^{th} century, Russia could be recognized as a European country, at least if we are speaking about the educated classes, nobility and officialdom.

The history of the Russian modernization in the 18^{th} century is studied in numerous books and articles by Russian and foreign authors. The problems studied are mostly connected to the political, social, military and economic issues. At the same time, the problem of environment and the use of natural resources was not considered from the point of view of modernization. The paper will be dedicated to the history of the introduction of European herring into the economic and everyday life of Russia.

Herring in the 16^{th} – 17^{th} cc. Russia. The trade, the prices, the place in the consumption structure. Symbolic importance of the commodity

Salted herring was one of the most important export goods transported by European merchants to the different ports of Europe in the 16^{th} – 18^{th} centuries. Russia was one of the consumers for this commodity and it was imported actively through the Baltic ports as well as through the Northern region (White and Barents Sea area) throughout this period.

The quantities of herring sold in Russia were insignificant in comparison with the total turnover of export-import operations between Russia and Europe, but it was important for the Russian consumers. The herring is mentioned in Russian documents since the 16^{th} century. Russia possessed rich waters and many valuable fish, including salmon and sturgeon, were caught there. Nevertheless, herring prepared according to the European (initially Dutch) technology occupied a niche in the Russian market, in the commodities for wealthy people. The special image of the European herring in Russia appeared during the 16^{th} – 17^{th} centuries.

The Russian herring fisheries were not able to provide a suitably high quality commodity because of primitive technology. In the 16^{th} and 17^{th} centuries the herring fisheries in Russia were operating in the White and Baltic Sea basins.

The Baltic herring fisheries were located on the western border of Russia in the late 16^{th} century, and some Baltic herring was sold at the Novgorod market in the early 17^{th} century, but this territory was occupied by Sweden during the 17^{th} century.

In the White Sea, the herring fisheries were controlled by Solovetsky monastery. As far as we know from the monastic documents, the monks and the dependent peasants usually produced smoked herring rather than salted ones.

"Domostroi", the Russian 16th century housekeeping instruction, mentions many meals prepared with herring, but as a rule boiled or stewed ones, not from salted herring. The same methods are mentioned as traditional for the cuisine of the Russian North until today.

Technologies and commodities – the Dutch and the Russian methods, the question of Salt

The Russian technology of herring preservation corresponded strongly with the Russian methods of fish preservation in general. We know from documents that the quality of the Russian fish was rather low from the European point of view. In the 18th century the Russian observer Vassiliy Krestinin noted that the herring prepared using the Russian traditional technology "cannot be consumed by the man who has any idea of honour and nobility". In the 19th century the situation was very much the same. Only in the late 19th century do we have the first mention of improvement of the situation.

The main difference between the Russian and the Dutch technology was the salt used and the dressing method. The Russians used Russian salt produced in the White Sea area. It was cheap, but very dirty and of poor quality. Additionally, the Russian fishermen did not dress the fish in a proper way, being sure that their consumers will eat it anyway. The Dutch herring required high quality salt, Portuguese for example, which was far more expensive. The fish were also much bigger and fatter, being caught in the North Sea rather than the White Sea. Finally – herring was dressed accurately. Thus, the commodity supplied by Dutch fishermen was of a superior quality.

Since the early 18th century the state power in Russia made attempts to introduce the western (Dutch, English etc.) methods of herring conservation. The foreign experts were invited and Russian spies were sent secretly to get to know the technology.

The modernization of the 18th c. – ideology and practice

In the 18th century, the European herring became a symbolic commodity for the Russian government. The process of modernization and westernization of the Russian Empire needed some symbols, and the technology of preparing of herring became such a symbol of modernization of the fisheries. Herring fisheries improvement projects started in Peter the Great's time and then we know of a number of ventures of similar type in the 18th and 19th centuries in the Russian North and in the Black Sea areas. For example, Catherine II waged the Dutch experts in 1766 and sent them to the White Sea. In the early 19th century, the White Sea Company tried to introduce the European methods of herring preservation in the Russian North. In the middle of the 19th century the Governor of Novorossia (the name of the Black and Azov Sea region), M. Vorontsov, tried to introduce the British methods of herring preservation in the Cossack regions of the Russian South (Azov Sea basin). A lot of money was invested and time spent but the result was insignificant. According to the official reports, the Russian herring was of similar quality to the Dutch one but still it had no commercial success. The consumers still preferred the Dutch herring. The practice of the modernization as well as the symbolic significance of the herring will be discussed in the paper.

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The ancient fishing of Belarusion Polessye

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Polessye is a unique natural, ethnographic and archaeological region in the south of Belarus. The territory of Polessye covers the basin of the river Pripyat to its confluence with the Dnieper. It stretches for 300 km from the west to the east. About 100 years ago there were vast territories of swamps covered with bushes and forests or open. The villages were situated in so called islands not far from each other. Very often fishing was the only way to provide food because of the shortage of agricultural land. For some villages this was the sole source of income. However, the mainly sandy soils of Polessye do not promote the preservation of archaeo-ichthyological material.

The earliest archaeological evidence of the existence of fishing in Polessye goes back to the Mesolithic (many-tooth harpoons of Ozernoe 2). The implements of late Stone Age – early Bronze Age are represented by bone fish hooks up to 8 cm length and single-tooth harpoons (Kamen-8) (fig. 1). Pike was the most important fish species in yield (Kuzmichi-1, 4700+-90–3810+-60 BP).

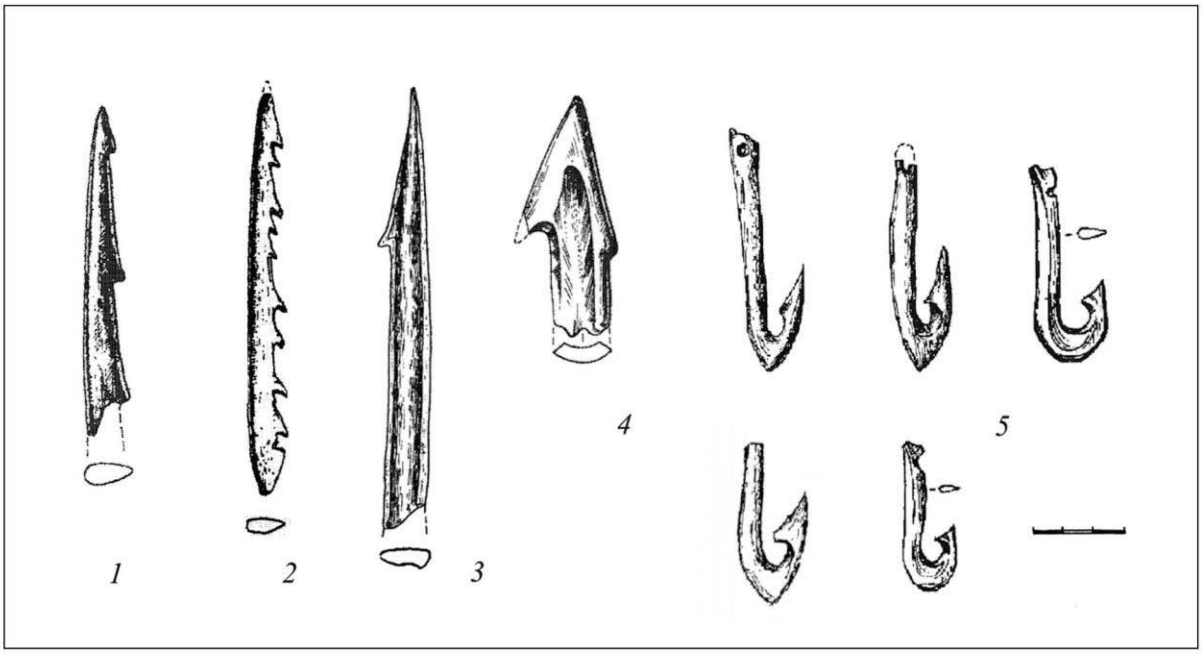

Fig. 1. Fishing implements from Stone Age sites of Belarusian Polessye
(after. N.N. Kryvaltsevich, V.F. Isaenko)

Fishing equipment of the end of the 1st millennium BC to the second quarter AD is represented by hooks and clay disc sinkers (Yastrebka, Hotomel-2, Ivan, Lemeshevichy). The trade involved 7 kinds of fish, among which cyprinids (bream, roach), perch and catfish were identified (Chaplin). Fishing by spear and then by hooks predominated in 5^{th} – 10^{th} centuries AD in the early Slavic settlements of Polessye (Hotomel, Gorodische, Kolochin, Petrikov-2), as the finds of fishing net sinkers are rather rare (fig. 2). Sturgeon also appeared in the catch in this period (Sniadin).

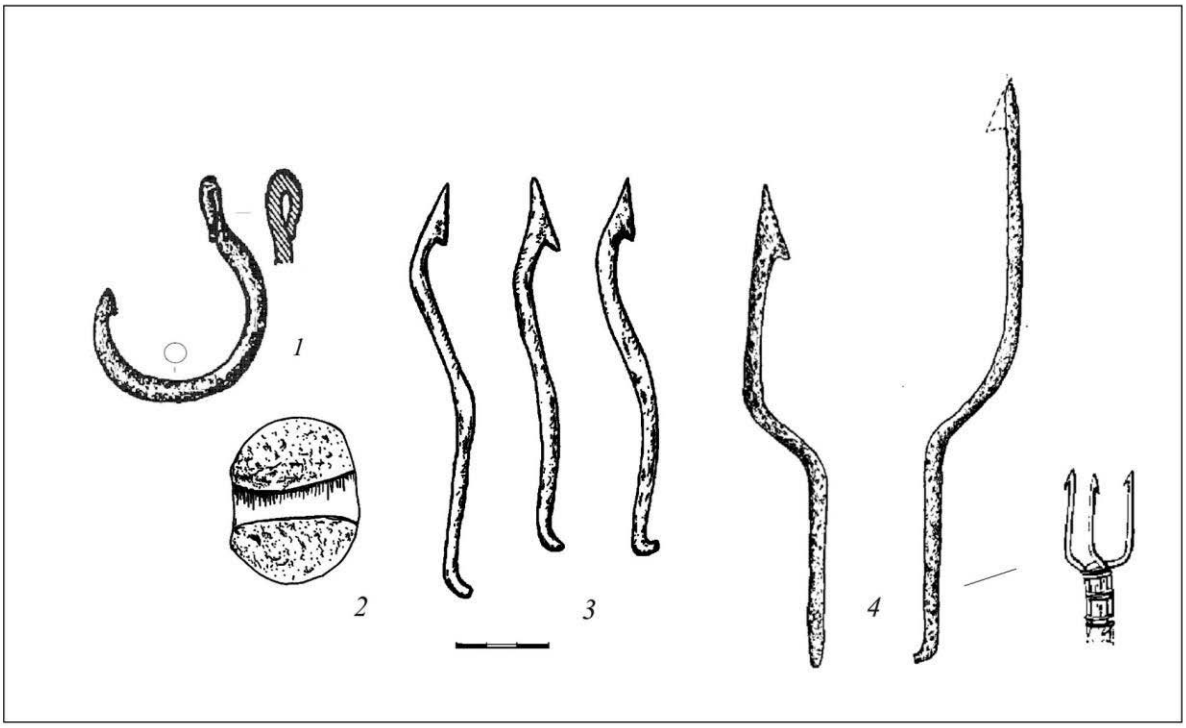

Fig. 2. Fishing implements from early Slavic settlement, 5th-10th c. (after V.S. Vergej and others)

The best collections of artefacts, which illustrate the fishing trade of Polessye, are accumulated in the medieval cities and towns (fig. 3). For instance, about 140 items are gathered in Brest, 70% of them from the 12th — 13th centuries. The lead position of the fishing trade was occupied by net-fishing in the majority of Polessye's cities and towns, its evidential remains are represented by roundish pine-bark floats, averaging 6–8 cm diameter, barrel-shaped clay sinkers, and lead sinkers. Starting from the 14th century the clay fishing net sinkers increase in weight, required for use with larger nets. The fish hook equipment didn't spread as widely as nets, except for the late medieval town Mozyr. The length of the hooks in the Middle Ages reached 13 cm, of the spinner-'dorojek' – 14 cm. Fish-spears represent a small proportion of fishing equipment. Children's wooden toys are also evidence of the significance of medieval fishing (Brest, David-Gorodok). Among the ichthyological remains the most frequent are pike and Acipenseridae (A. gueldenstaedtii, A. stellatus, A. ruthenus) from Turov, pike and perch from settlement Struga-2, sacral object, and perch and cyprinid from Jurovichi.

Ethnographic material of Polessye gives evidence that the most popular fishing gear of the 19th – 20th centuries, as well as of the medieval times, were nets and different types of traps, which were made of wickerwork or wood laths. Fish catches were plentiful, especially the easily caught loach, *Misgurnus fossilis*. They used fish-spears, spinners-'dorojek' and hooks in the larger water bodies.

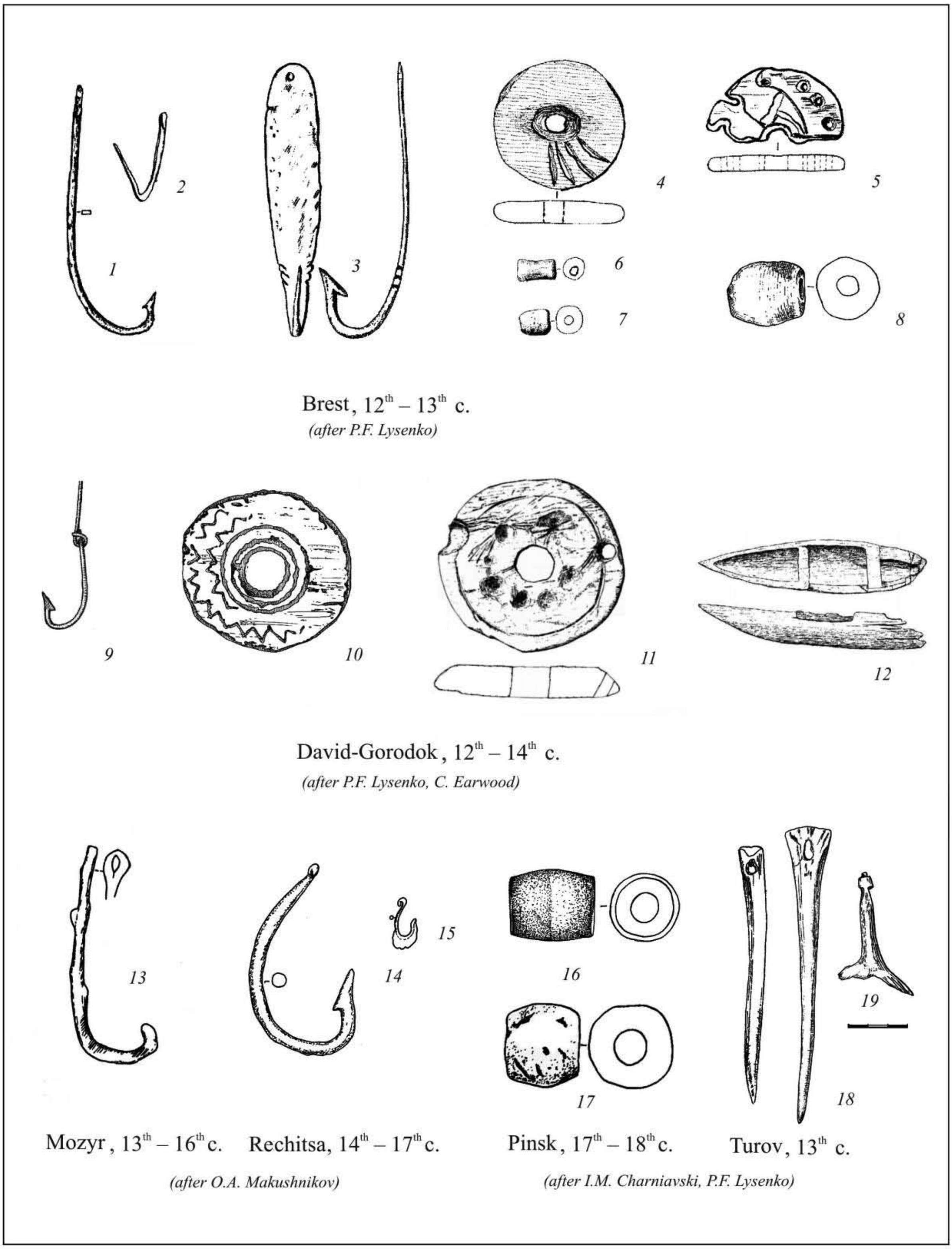

Fig. 3. Fishing implements from Brest, David-Gorodok (3) and tools from the bones of *Acipenseridae* from Turov (5). 12^{th} — 13^{th} centuries.

Table 1. Fish remains from sites of Belarusian Polessye

	Kuzmichi 4700+-90–3810+-60 BP	**Chaplin hill-fort** 3rd c. BC— 2nd c. AD (after E.A. Tsepkin, 1960), author	**David-Gorodok settlement** end 1st — 2nd c.	**Sniadin**, 5th — 7th c.	**Turov town**, 13th — 16th c.	**Sluck town**, 11th —13th c.	**Struga-2 settlement**, sacral object, 13th c.	**Jurovichi settlement** 10th c.
Acipenser gueldenstaedtii	–	–	–	–	23	1	–	1
Acipenser stellatus	–	–	–	–	5 + (11?)	–	–	–
Acipenser ruthenus	–	–	–	–	2	–	–	1
Acipenseridae	–	–	–	8	12	–	+	–
Esox lucius	103	3	14	38	57	16	133	15
Abramis brama	–	7	10	9	1	–	–	10
Aspius aspius	–	–	–	4	–	–	–	–
Blicca bjoerkna	–	–	–	1	–	–	–	–
Carassuis carassius	2	–	–	2	2	–	1	–
Leuciscus cephalus	–	–	1	–	–	–	1	–
Leuciscus idus	–	–	–	1	2	1	8	–
Rutilus rutilus	–	4	–	–	10	1	8	1
Rutilus frisii	–	–	–	–	4	–	–	–
Tinca tinca	–	1	1	4	5	–	3	–
Cyprinidae	5	92	4	–	7	9	6	32
Silurus glanis	–	7	–	7	16	–	–	1
Perca fluviatilis	3	8	–	10	17	39	38	45
Stizostedion lucioperca	–	–	–	–	–	1	–	–
Scardinius erythrophthalmus	–	–	–	1	–	–	–	–
Percidae					–	–	3	–
Unidentified	3	174	24	50	27	–	70	77
Total	**116**	**296**	**54**	**136**	**201**	**68**	**271**	**183**
Fishing implements	–	hook	–	sinker	spinner, sinkers, spears	hook, net float	–	–

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Fish remains from a stratigraphic sequence from the Roman civil town of Carnuntum (Lower Austria)

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Carnuntum

The Roman town of Carnuntum developed alongside a military camp on the Danubian limes, on the right bank of the river Danube, just 15km to the west of the modern border of Slovakia and Austria. The history of the site has been recently summarized by Kandler (2004), while Gassner *et al* (2002) provide an overview of the *Austria Romana* in general. The location of the settlement, occupying a nearby iron-age hilltop settlement, was obviously chosen by the Romans for strategic reasons, as east-west (the river Danube) and north-south (the so-called Amber Road) trade and traffic routes meet in this area. After the implementation of the legionary fort, which can be traced back to the Claudian era (middle of 1st c. AD), further military structures, secondary agglomerations and, on the westernmost part, a civilian town developed. It became the capital of the Roman province of *Pannonia superior*, when the province of *Pannonia* was split under the reign of Trajan (AD 98-117) and was granted the state of a *municipium* during the reign of Hadrian (117-138). A decisive stage of urban development was reached in the Severian period (1st half of 3rd century AD), when the town became a *colonia*, seeing a lot of building activity and investment into the public infrastructure and comprising an estimated population of 50,000 people. The civilian structures of the Carnuntine area became more and more abandoned in the late antique period, a heavy earthquake occurring around the middle of the 4th century being one of the probable causes.

Archaeological Research in the civilian town of Carnuntum

At Carnuntum, archaeological research had begun by the 19th century, but comparatively little is known of the civilian town (Kandler 2004). Mostly in the early post-war period, two settlement terraces in the south-eastern part of the town, gently sloping towards the river Danube in the north, were superficially excavated. The northern terrace, delimited by four urban streets, represents a classical, rectangular *insula*. Inside this so-called *insula VI*, public and private buildings, including a bath and adjacent structures, were identified. This area now forms the core of an open-air museum, administrated by the *Archaeological Park Carnuntum (APC)*. Within an ongoing project, financed through a public-private partnership run by the APC and headed by Franz Humer, the wider area of the post-war excavations has been studied anew, including thorough excavations by modern standards and the reconstruction of some of the buildings.

Excavations in the Weststrasse (Western Street)

In 2002-03 comprehensive archaeological investigations were undertaken along the so-called *Weststrasse* (Western Street), a paved street delimiting *insula VI* for about 70m along all of its western border and sloping northwards, towards the Danube. This natural slope, enhanced by further earthworks, provided the Roman engineers with the opportunity to integrate the water supply and drainage systems of the adjacent town quarters into the bedding of the street. Thus, the excavations yielded a wide array of archaeological features dating from the end of the 1st century AD to the middle of the 5th century (*phases 1 – 6* ; Radbauer and Humer 2004; Humer and Radbauer 2004). Principally, the features excavated in the area of the *Weststrasse* belong to two different groups: strata connected to the construction, repair and occupation of the street itself, and substructures related to the sanitary and drainage system. The substructures consisted of sewers and several freshwater channels, including the supply and drainage system for the public bath. As elements of the drainage and the freshwater system were successively put out of use, they were allowed to fill up with the solid waste from the sewage, or other material was even deliberately dumped into them. Within the backfill of the later sewer, a stratigraphic sequence, probably corresponding with a complete use and abandonment cycle, could be documented: a sandy layer with assemblages of animal bones, pottery fragments and building debris, obviously accumulated during normal use, was sealed by a mudflow, indicating the final abandonment of the system.

Most of the archaeological material, including the zoological and botanical remains, was derived from the backfill of the substructures and the construction layers of the street, along with parts of the adjacent buildings, including two latrines. Most strata from the *Weststrasse* accumulated during a short span of time and can be reliably dated by means of the associated artefacts. Regarding the analysis of the finds, this high degree of time-resolution and the clear-cut stratigraphy allow for a detailed, diachronic consideration. Furthermore, as some periods are represented by roughly contemporaneous, yet differently generated sediments, the influence of the taphonomic environment upon sample composition can be studied. This appears especially relevant for the composition of the faunal samples, determined by the consumption and disposal behaviour of an urban population and the preservation conditions. Conceivably, these conditions vary according to context, e.g. if street layers and strata from the backfill of the sewers are compared.

Animal remains from the *Weststrasse*

The stages in urban development are mirrored in the successive accumulations of anthropogenic and natural sediments along the *Weststrasse*. Clearly, this sequence represents a series of discrete events, linked to the street development, rather than a constant input of material. The amount of animal remains retrieved from the various strata differs widely according to size and type of the respective contexts. The backfill of the later sewer and the repair layers in the freshwater channels from *phase 4* (c AD 270-285) each yielded over 2,500 determinable bone specimens. The NISP values for the street layers from the phases 2 and 3 and the backfill from the earlier sewer (*phase 3*; c AD 190-210) range from 1,100 to 1,500, while the very early and the late phases contributed about 500 or less. Thus, the well documented time span encompasses about two centuries. Most samples are dominated by the remains of the major domestic mammals, but domestic and wild birds and fish have a constant appearance throughout the material. As can be expected within an urban setting, the mammal bones exhibit a high amount of regularity regarding skeletal part representation and fragment type.

Fish remains

In total, 532 fish remains were recovered from the various contexts of the *Weststrasse*, 366 of which could be determined to species or higher taxonomic categories. However, the fish bones are not evenly distributed across the stratigraphic sequence, as well over 200 specimens were collected in the backfill of the freshwater channels (*phase 4*) alone. Fine-grained sediments were allowed to accumulate within these structures when their wooden covering broke in and the street had to be repaired, providing favourable conditions for the preservation of delicate remains from birds, fishes and small mammals. In some horizons, the number of fish remains may reach levels of over 10% of the NISP of the major domesticates. Other “hot spots” of high relative and absolute fish numbers were encountered in the areas of some of the inlets into the later sewer, deriving from the nearby latrines. In comparison, both the early and the later sewers, dominated by coarse-grained waste, yielded only about 60 and 90 fish remains, respectively, and the numbers for the street sediments proper are even lower. Nevertheless, there was a high consistency in the presence of fish throughout the whole excavation area, although the whole material was hand-collected, albeit in a meticulous manner. The flotation samples taken for botanical purposes did not contribute much additional fish bone material.

Because of the uneven distribution of the fish remains, it is hard to demonstrate a chronological evolution in the importance of certain species and taxonomic groups. In essence, fish were consumed from the river Danube and its corresponding water systems. Exploitation of acipenserids can be detected from *phase 2* up to *phase 4*. One fin ray can be attributed to the large and migratory Beluga sturgeon (*Huso huso*), while other identifiable remains belong to the sterlet (*Acipenser ruthenus*), a smaller species living permanently in these parts of the Danube. Cyprinids, by far, were the most commonly exploited group. Among the remains identified to species level, carp (*Cyprinus carpio*) is most abundant. Other cyprinid bones point to an opportunistic fishery regime seeking all kinds of fish like bream (*Abramis brama*), bleak (*Alburnus alburnus*), asp (*Aspius aspius*), river barbel (*Barbus barbus*), sneep (*Chondrostoma nasus*), species of *Leuciscus* and *Rutilus*, rudd (*Scardinius erythrophthalmus*) and tench (*Tinca tinca*). Besides the cyprinids, some predatory fishes occur regularly in nearly all phases: pike (*Esox lucius*), European catfish (*Silurus glanis*) and pikeperch (*Sander lucioperca*. Among the other species of the Percidae present in the Danube, only perch (*Perca fluviatilis*) occurs in negligible amounts in *phase 4*. As for the salmonids, trout bones were not found, but a single example of huchen (*Hucho hucho*) was uncovered in *phase 4*. Besides the native species, some remains of an imported marine mackerel (*Scomber sp.*) appeared within a gravel horizon of *phase 3* and in the backfill of the freshwater channels in *phase 4*.

A bias toward large cyprinid individuals and species may have been caused either by artificial selection during the excavation or by selective consumption behaviour of the inhabitants at Carnuntum. However, the carp remains, apparently being frequently available, point at an exploitation of small to very large individuals (Figure 1). The size distribution of European catfish, on the other hand, indicates mainly catches of specimens of approximately one metre, but the full size range reveals individuals from 50 centimetres up to large fish with a total length of more than two metres (Figure 2). The catch sizes of pikeperch are similarly distributed. They range from small individuals up to extremely large ones. Most of them were caught at approximately 50 centimetres in length (Figure 2). Astonishingly, the pike remains reveal a completely different pattern. Extremes towards large fishes are completely missing, and their sizes accumulate at approximately 50 centimetres (Figure 2). This pattern is probably caused by the specific consumption preferences of the inhabitants. On the other hand, this extraordinarily narrow size distribution might be the result of length standardization of the exploited pikes, to be expected in the use of preserved or dried specimens.

The distribution of cranial and axial body elements also reveals differences. The cyprinid sample exhibits a higher representation of axial skeletal elements, whereas the predatory fishes like catfish, pikeperch and, especially, pike indicate higher amounts of cranial bones. The different distribution of skeletal elements may also reflect different behaviour in the processing of cyprinids on one hand and predatory species on the other. Besides the vertebrae of mackerel, which were already identified in some other Central European sites, a premaxilla from this genus appeared in Carnuntum as well. It remains unclear whether the mackerel were traded completely, or if this cranial bone entered the presumed vessel, containing the preserved fish, only accidentally.

The archaeoichthyological remains from *Carnuntum-Weststrasse* yielded the first extensive results of fish consumption within a Roman civil town in Austria, and of the organisation of the fishery supplying its markets, widening the picture obtained from the fish samples of *Virunum-amphitheatre* (Galik 2004). They demonstrate the importance of freshwater fishes, caught in the Danube, in the diet of the urban population. At least some of the inhabitants purchased, according to the “Roman cuisine”, imported preserved marine mackerel to enlarge their fish menu beyond the selection of locally available species (see also Hüster Plogmann 2006).

Besides these cultural historical questions concerning former food habits, the animal bone samples from the *Weststrasse* provided insights into the dependence of certain taxonomic groups on specific taphonomic conditions, linked with the formation processes of urban sediments. As the remains of both birds and fish are widely used as indicators of status, these taphonomic factors have to be taken into account.

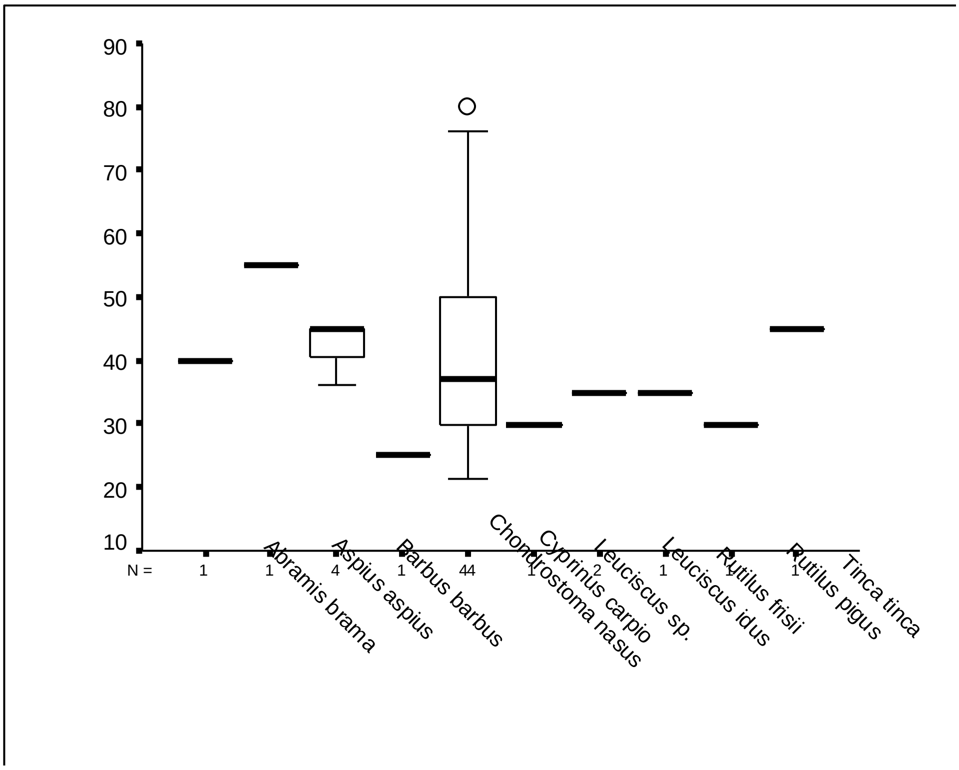

Fig. 1. Carnuntum-Weststrasse, total length calculations of cyprinids.

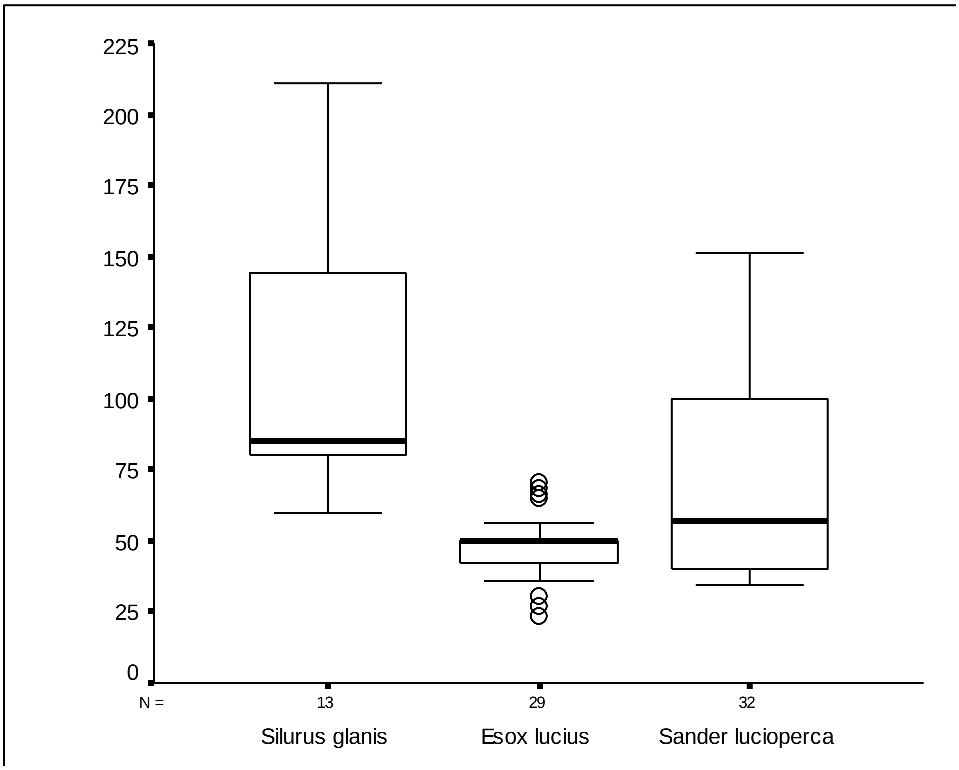

Fig. 2. Carnuntum-Weststrasse, total length calculations of predatory fishes.

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Cyprinid fishing in Dobrudja (Romania) from prehistory to the Middle Ages

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The studied settlements lie in the area between the Danube and the Black Sea; they are located on rivers (Slava), lakes (Oltina, Babadag, Razim-Sinoe) or the Danube. There were optimum places for fishing next to these sites. For the settlements of this area, in all the historical periods, fishing represented an important occupation, which ensured a remarkable amount of animal protein for feeding people. This is reflected in the amount of fish remains; in some samples, they are at a very high amount, over 50% of the entire faunal sample: Harsova – the developed Eneolithic level (91.88%), Slava Rusa (78.97%), Navodari (70.26%), Isaccea – former Eneolithic level (66.19%), Harsova – former Eneolithic level (66.61%) and Luncavita (50.38%). Fish remains are at about 20% in the samples from Dumbraveni (27.61%), Capidava (25.34%), Hamangia (23.48%) and Oltina (23.52%).

The method applied in order to collect the fish remains differs, which also explains the differences in the sizes of the studied samples. The small amount of fish remains in the samples from the 1st and 2nd millennia A.C. is due to hand collection. The Eneolithic samples were collected both by hand and by sieving a certain amount of sediment; with this method, the number of fish remains is much bigger (see Table 1).

Archaeozoological studies that refer to the most ancient cyprinid remains from Dobrudja are from settlements dating to the Eneolithic period (5000 – 3700 B.C.). Then, for a period of about four millennia, in the area between the Danube and the Black Sea, material from just two sites has been analyzed. One should not conclude from this lack that fishing was not popular, but rather that it reflects the lack of research in the referred area. Another group of samples belongs to the 1st and 2nd millennia A.C.

The diversity of sample size, as well as method of analysis, created difficulties for comparison. For the Carcaliu, Dinogetia, Capidava sites, the number of remains for each of the determined species is not specified, though the total number of remains is mentioned.

Along with the cyprinid remains, one could also observe the remains of *Acipenser* sp., *Silurus glanis*, *Perca fluviatilis*, *Stizostedion lucioperca* and *Esox lucius*. Among the Cyprinidae, 11 species could be identified: *Abramis brama* (bream), *Alburnus alburnus* (bleak), *Aspius aspius* (asp), *Blicca bjoerkna* (white bream), *Carassius carassius* (crucian carp), *Cyprinus carpio* (common carp), *Leuciscus idus* (ide), *Pelecus cultratus* (ziege), *Rutilus rutilus* (roach), *Scardinius erythrophthalmus* (rudd) and *Tinca tinca* (tench).

The greatest diversity of species is found at the settlements of Harsova, Luncavita, Slava Rusa and Oltina. Among the cyprinid species, the highest percentage belongs to the common carp; this species is followed (in terms of the percentage) by *Abramis brama* and *Rutilus rutilus*. *Abamis brama* (bream) was identified in ten of the studied samples, while *Rutilus rutilus* (roach) occurs in eight of them. The carp appears at almost all sites, except for the samples from Techirghiol and

Table 1. Cyprinid remains quantification

Historical dating	Assemblage	References	Pisces total	Cyprinidae unididentified	Bream *Abramis brama*	Asp *Aspius aspius*	Bleak *Alburnus alburnus*	White bream *Blicca bjoerkna*	Crucian carp *Carassius carassius*	Common carp *Cyprinus carpio*	Ide *Leuciscus idus*	Ziege *Pelecus cultratus*	Roach *Rutilus rutilus*	Rudd *Scardinius erythrophthalmus*	Tench *Tinca tinca*	Cyprinidae. identified
former Eneolithic 5000-4500 B.C.	Techirghiol	Necrasov, Haimovici, 1962	17		1											1
	Hamangia	Haimovici, 1987	27	19						1						1
	Cernavoda	Balasescu *et al*., 2005	2							2						2
	Isaccea	Balasescu *et al*., 2005	8021	218	41					594		1	4		5	645
	Harsova	Balasescu, Radu, 2004	5095	1002	40	1		4		506		1	14		3	569
developed Eneolithic 4600/4500-3800/3700 B.C.	Luncavita	Haimovici, Dardan, 1970	39							1						1
	Carcaliu	Haimovici, 1996	41							+						
	Harsova	Balasescu *et al*., 2005	260478	77843	1868	102	14	491	2	6448	78	166	1680	421	47	11317
	Luncavita	Balasescu *et al*., 2005	1853	127	7	2				212	1		4	1	6	233
	Navodari	Radu, 2001	1278	133						114			46			160
	Harsova	Balasescu *et al*., 2005	12329	4056	44	3	6	11		481	3		32	17	1	598
Babadag X-IXth centuries B.C.	Argamum	Radu, 2006	284	2						57						59
Geto-Daci 2th century B.C.	Satu Nou	Radu, inedit	97							40						40
2-3th centuries A.D.	Isaccea	Stanc, Bejenaru, 2009	12							4						4
	Horia	Haimovici, 1996	11	9						2						

Historical dating	Assemblage	References	Pisces total	Cyprinidae unididentified	Bream *Abramis brama*	Asp *Aspius aspius*	Bleak *Alburnus alburnus*	White bream *Blicca bjoerkna*	Crucian carp *Carassius carassius*	Common carp *Cyprinus carpio*	Ide *Leuciscus idus*	Ziege *Pelecus cultratus*	Roach *Rutilus rutilus*	Rudd *Scardinius erythrophthalmus*	Tench *Tinca tinca*	Cyprinidae. identified
	Telita Amza	Haimovici, 2003	7	2						1						
4-6th centuries A.D.	Slava Rusa	Stanc, 2009	240		1					59						
		Stanc *et al*., 2008	8337	242	33	9		3		1135		6	24	3	3	1216
4-6th centuries A.D.	Dinogetia	Haimovici, 1991	28							+						-
6th century A.D.	Adamclisi	Haimovici, 2001; Stanc, 2006	3							2						
10-11th centuries A.D.	Oltina	Stanc *et al*., 2006	580		4	4				126		1	2		1	138
10-11th centuries A.D.	Capidava	Haimovici, Ureche, 1979	370		+	+			+	+						-
11-13th centuries A.D.	Harsova	Bejenaru, 2003	600							+					+	-
9-12th centuries A.D.	Dinogetia	Haimovici *et al*., 1994	-			+				+						-
9-10th centuries A.D.	Dumbraveni	Haimovici, 2000	174						1	4						5
11-13th centuries A.D.	Isaccea	Bejenaru, 2003	148	8												-

Isaccea (medieval) (see Table 1). The common carp bones, which attain the largest dimensions among cyprinids, were collected more frequently than those of other Cyprinidae.

Table 2 contains the data concerning the dimensions of the cyprinids from the studied samples.

Table 2. Cyprinid size reconstruction.

Species	Assemblage	MNI	TL range (mm)	Mean TL (mm)	Weight range (g)
Abramis brama	Isaccea – former Eneolithic	9	376 - 510	454.77	648 - 1741
	Harsova – former Eneolithic	4	319 - 446	393.25	379 - 1122
	Harsova – developed Eneolithic	240	101 - 562	310.32	10 - 2381
	Luncavita – developed Eneolithic	1	509	-	1723
	Slava Rusa	14	229 – 588.5	367	130 – 2757
	Oltina	4	400.2 – 470	429.3	790.2 – 1330.3
Aspius aspius	Harsova – former Eneolithic	1	499	-	1241
	Harsova – developed Eneolithic	22	271 - 656	478.59	177 - 2966
	Luncavita – developed Eneolithic	2	548; 590	-	1670; 2113
	Slava Rusa	2	405; 585	-	636; 2055
	Oltina	3	477.2 – 532.8	503.66	1075.2 – 1527.4
Cyprinus cyprinus	Isaccea – former Eneolithic	35	437 - 1257	727.31	1269 - 28902
	Harsova – former Eneolithic	13	418 - 803	661.54	1112 - 7667
	Harsova – developed Eneolithic	289	96 - 1216	587.81	15 - 26186
	Luncavita – developed Eneolithic	20	454 - 1021	672.2	1420 - 7189
	Slava Rusa	52	20 – 1092	679	120 - 19063
	Oltina	31	370.2 – 886	-	776.7 – 10259.8
Rutilus rutilus	Isaccea – former Eneolithic	2	155; 487	-	43; 2025
	Harsova – former Eneolithic	6	143 - 317	216,66	32 - 475
	Harsova – developed Eneolithic	321	85 - 404	216.95	6 - 1082
	Luncavita – developed Eneolithic	2	270; 317	-	276; 475
	Slava Rusa		231 – 380	293	165 – 873
	Oltina	2	310; 363	-	439; 753
Scardinius erythrophthalmus	Harsova – developed Eneolithic	79	98-389	214.35	10 - 973
	Slava Rusa	2	315; 414	-	483.5; 1191.5
Blicca bjoerkna	Slava Rusa	2	245; 310	-	157; 266
	Harsova – former Eneolithic	3	147 - 164	158.33	51 - 65
	Harsova – developed Eneolithic	177	88 - 295	179.51	17 - 239
Pelecus cultratus	Slava Rusa	1	320	-	200
	Harsova – former Eneolithic	1	268	-	148
	Harsova – developed Eneolithic	36	133 - 427	245.08	41 - 312

Acknowledgements
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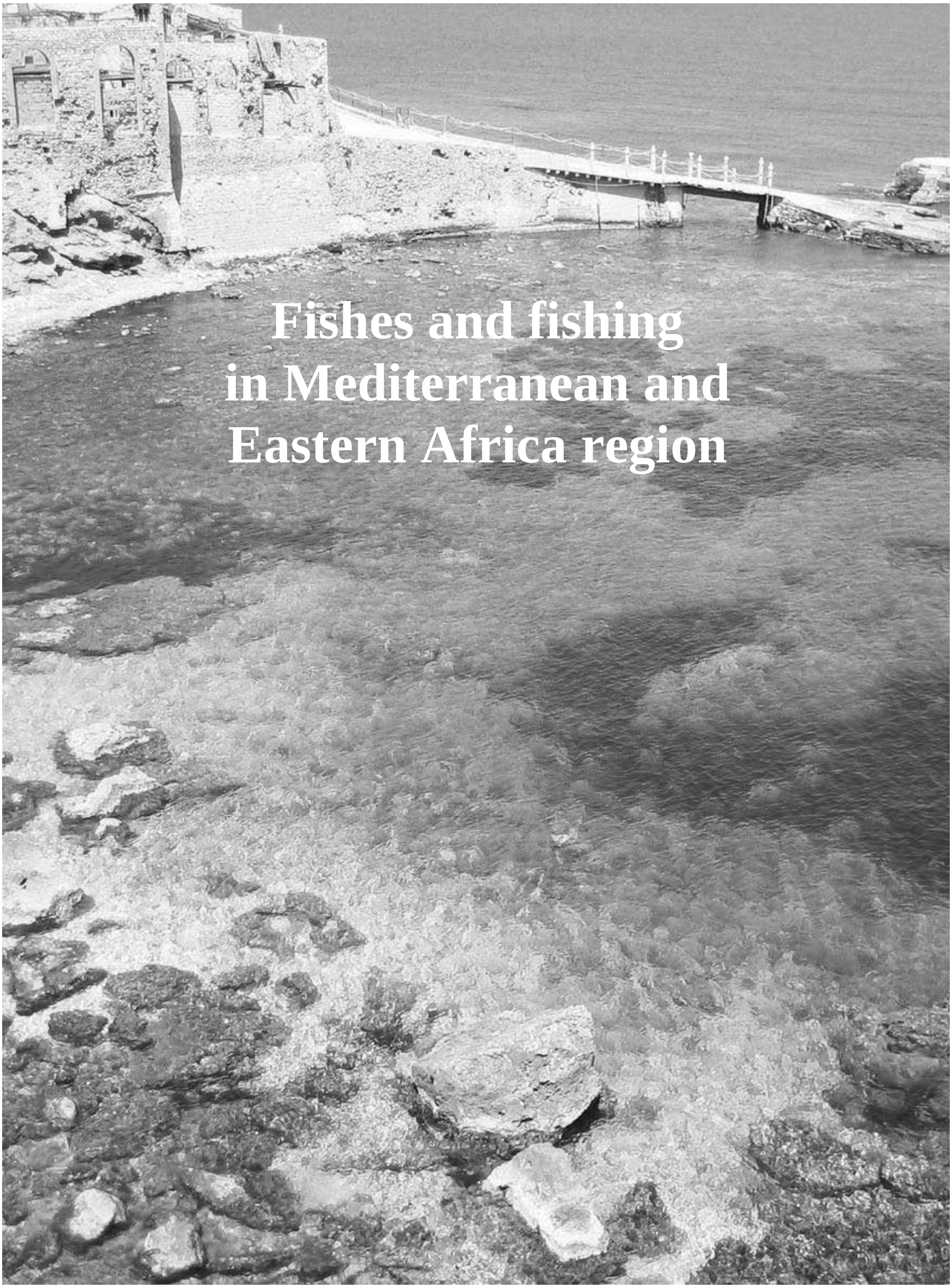
Fishes and fishing in Mediterranean and Eastern Africa region



Fish remains from the *Casa do Governador* - a Roman fish processing factory in *Lusitania*

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The "Casa do Governador da Torre de Belém" is a former Roman fish processing factory located in Belém, near the ancient town of *Olissipo*- present-day Lisbon. Belém is ideally located in relation to the Tejo's river and the adjacent Atlantic coast. Firm evidence is still lacking on the dates of operation of "Casa do Governador", but while the factory appears to have been in use for a long time (probably for at least four centuries), all the fish remains come from the later phase (fourth-fifth century AD).

The social and economic contexts of the "Casa do Governador" factory are relevant because *Olissipo* was a city that registered substantial activities associated with the exploitation of marine resources. Since part of the factory was destroyed, after later urban building development, there is no definitive idea as to what might have been the general context of the "Casa do Governador" factory in its early and late phases. However, it seems more plausible that the factory was part of a large complex (such as an industrial *vicus*) than it was a small factory related to a *villa* (Filipe, Fabião 2009).

During 2005 and 2006 the site was excavated by one of us (IF), in the course of a field evaluation intended to assess the presence of archaeological structures in the area (since the historical building was going to be converted to a hotel). The importance of the discovery and the obvious interest in a more detailed knowledge of a major aspect of *Lusitania*'s economy- the exploitation of marine resources-, provided the motivation for a multidisciplinary project under the direction of one of us (CF), to understand the manufacture of fish products, exported in amphorae to other parts of the Roman Empire (work in progress) (Fabião et al., 2008).

The analysis of fish remains found at the "Casa do Governador" factory tanks will yield information that can be compared with other archaeological data and information presented in several written sources. With our zooarchaeological approach we hope to discover the fish species used and their sizes, the kinds of fish products manufactured (chiefly known from literary sources but poorly evidenced zooarchaeologically), and to describe the fishing activities involved in the capture of the raw goods.

In this study we present data from a preliminary analysis of the ichthyologic material found in 17 of the 34 tanks preserved at the site (Fig. 1) - those still functioning in the later phase. Our aim is to provide an initial characterization of the contents found in the different tanks of the factory.

Sediments containing massive numbers of fish bones were present in seventeen tanks (T): $T_{4,5,6(a,b),7,8,9,10,11,12,13,14,17,20,26,30,32}$ and $T_{33(a,b)}$ (Fig. 1); these were recovered and packed for future study.

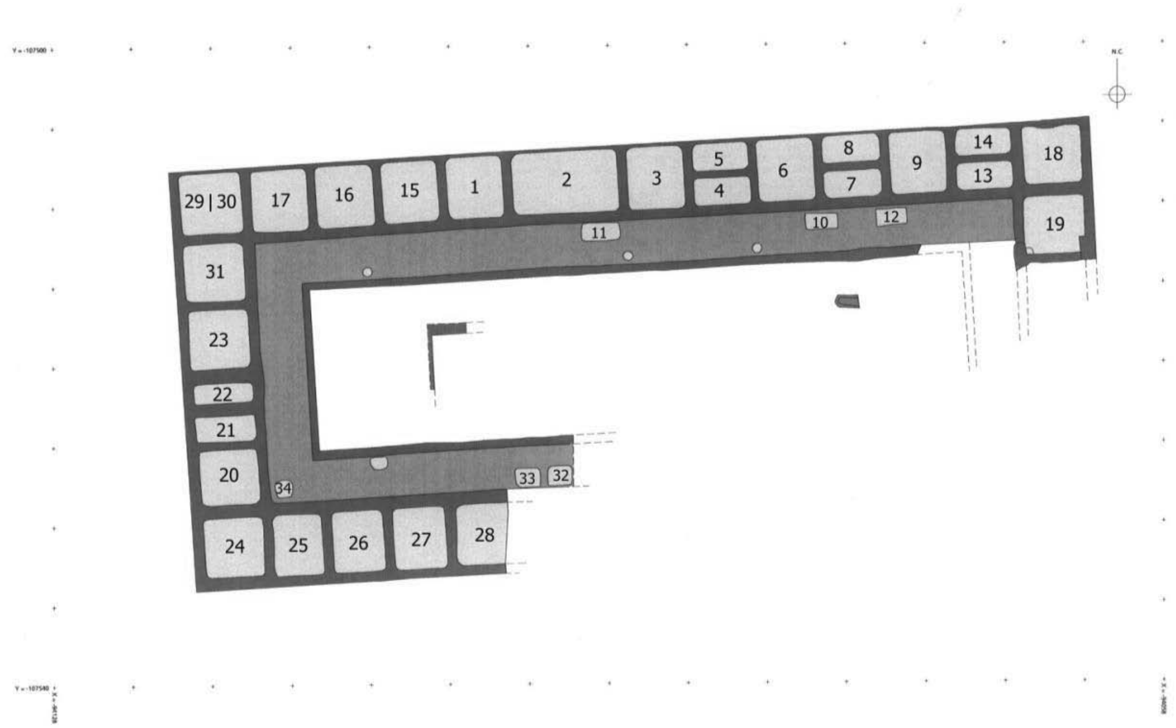

Fig. 1. Schematic plan of the "Casa do Governador" factory (Filipe, Fabião 2009).

Considering the constraints imposed by the massive amount of material that was collected, and the limited time and personnel that were available for sorting and identification, the sediments recovered in the field were sampled. To recover all existing skeletal elements, and other possible remains (such as botanical and/or insect remains, etc.), all samples were gently washed through a set of sieves with 1mm, 500μm, and 75 μm meshes, before being dried and stored. The results presented here represent the bones left in sieves bearing a 1mm mesh.

A total of eighteen samples were analyzed. The bones appeared to be reasonably homogeneous: huge numbers of vertebrae and other bones suggesting the presence of entire fish (except in T_{30} where only one vertebra was recovered, and T_{33} where low numbers of vertebrae were found). Samples $T_{4,\ 5,\ 6(a.b),\ 7,\ 8,\ 9,\ 10,\ 11,\ 12,\ 13,\ 14,\ 17,\ 20,\ 26}$ and T_{32}, have large numbers of fish remains. Compared to those, samples T_{33a} and T_{33b} had an insignificant number of remains.

The vertebrae were the most commonly represented bone in all samples. *Sardina pilchardus* (sardine) was the principal component of the content found in the tanks. Virtually all bones of the species were represented in samples $T_{4,\ 5,\ 6(a.b),\ 7,\ 8,\ 9,\ 10,\ 11,\ 12,\ 13,\ 14,\ 17,\ 20,\ 26}$, and T_{32}. The atlas was used for size estimation and variations were apparent in the size of the specimens collected from the different tanks. Although less numerous there were other taxa present in the samples (e.g. Scombridae, among others). An isolated vertebra recovered in T_{30} corresponded to a shark (possibly Triakidae family).

Several historical texts mention the ichthyologic diversity of the Tagus estuary. Sardine is a pelagic fish native in the Tagus estuary and the adjacent Atlantic coast and its abundance and importance have also been pointed out in several ethno-historic essays (Silva 1891). And even today it is one of the principal fish to be consumed locally. The fact that virtually the whole range of bones of *S.pilchardus* were represented in samples $T_{4,\ 5,\ 6(a.b),\ 7,\ 8,\ 9,\ 10,\ 11,\ 12,\ 13,\ 14,\ 17,\ 20,\ 26}$, and T_{32} suggests the use of entire sardines to produce some sort of sauce or salation. Among fish sauces *allec* has the best chances of being documented by bone finds, because it still contains numerous bones, whereas *garum*, *liquamenn* and *muria* were salty liquids that were fairly clear if strained (Van Neer, Parker 2008).

Archaeozoologically *salsamenta* can be attested when made from entire fish or from cut up pieces still containing bones. We wonder whether more than one fish product was being manufactured at "Casa do Governador". The small number of remains found in samples T_{33a} and

T_{33b}, the vertebra found in T_{30} and the "empty tanks" (e.g. where no fish remains were recovered) may be considered in relation to this issue. Although there must be fish for fish products to exist, it does not follow that there must be fish remnants everywhere fish products were manufactured. In fact, classical writers mention various types of salted fish products which must have contained none or almost no fish bones (e.g., *salsamenta*, *tetragona*, *trigona*, *cubia* and *melandrya*) and therefore will be difficult to identify even if produced in "Casa do Governador's" fish tanks.

While we await more study of the collection of fish bones recovered from the site, it is already evident that there is a similarity with other contemporary factories from *Lusitania*. This is particularly evident with those from *Olissipo* (e.g., "Núcleo Arqueológico da Rua dos Correeiros" and "Mandarim Chinês"), where sardine was also the key component of the contents found in the tanks (Assis, Amaro 2006). Despite the fact that both the intensity of production and the magnitude of fishing are unattainable, it seems clear that a very significant part of the production should have been based on the exploitation of this particular species. The accurate estimation of size will allow us to discuss the capture of sardine both in ecological and cultural terms (probable period of fishing and fishing techniques likely to be used).

From our results, it is evident that the economic importance of "Casa do Governador" and its association with other sites in *Lusitania* will be an issue of substantial archaeological discussion in the near future. However, for now it seems already fair to state that in late Antiquity, sardine was a most important ingredient in the manufacturing of fish products.

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The onset of commercial fishing in the western Mediterranean: Castro Marim (Algarve, Portugal) and Los Gavilanes (Murcia, Spain)

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Granting the difficulties involved in the detection of commercial/large scale fishing in the absence of documentary information, this paper tries to address the issue from strictly archaeozoological grounds in the case of the Iberian Peninsula during pre-Classical antiquity. Even though most matters concerning this subject still dwell in the realm of strict speculation, the consensus among historians seems to be that commercial fishing in Iberia was an externally triggered phenomenon that one must somehow connect with trans-Mediterranean colonists arriving during the first millennium BC. Several problems remain with this model, the presence of four independent waves of such colonists (i.e., Phoenicians, Phocoean Greeks, Carthaginians/Punic and Romans) to whom one could ascribe the paternity of the phenomenon, not being one of the easiest ones to deal with. A second problem, the scarcity of data on fishing during the Iberian Bronze Age (i.e., the second millennium BC), prevents one from setting some sort of baseline that could help us define the nature and features of the presumably subsistence fishing that was being undertaken previous to the arrival of those trans-Mediterranean colonists.

As matters presently stand, the earliest evidence of fish trade, in the form of tuna fish remains in amphorae, date back to the Phoenicians (i.e., Acinipo (prov. Cádiz); VIIth century BC), whereas the oldest of the so-called "fish factories" appear in the Bay of Cádiz (Las Redes) not earlier than the Vth century, thus are presumably Punic in origin. It will take another three full centuries for the first of the Roman fish factories to appear, even though these constitute the paradigm of fishing on a commercial scale and will remain a prominent feature of the Iberian and northern African coasts for another six full centuries.

Previous studies undertaken on the subject evidence that, from an archaeozoological perspective, the onset of fishing on a large scale exhibited a series of peculiar signatures. The most prominent of these is the "faunal turnover" that the Bluefin tuna (*Thunnus thynnus*) exemplifies. Remains of this large pelagic fish constitute rare items previous to the first millennium BC, the majority of the fish assemblages until that time being dominated by littoral, sedentary and demersal taxa. Of these, the seabreams (family Sparidae) are the most emblematic but by no means the essential group, since fishes such as groupers (family Serranidae), mullets (families Mullidae and Mugilidae) and meagres (family Sciaenidae), along with several taxa of sharks and rays (Chondrichthyes) may occasionally figure prominently in the assemblages. It is not known specifically when tunas started to be fished in a systematic way, but their presence in the archaeological record signals a shift to seasonal fishing that had been up until that moment very poorly documented (tunas appear in Iberian waters during the warmest months of the year, meaning from April to September). Again, although Bluefin tuna is not the only taxon that evidences such kind of seasonal fishing in Iberia, it appears as the most emblematic of all, and also, for all we know, as the earliest one on the archaeological record (e.g., Acinipo, see above).

In order to study the timing and changing nature of the pre-Classical Iberian "fisheries", in particular the role played by tuna in the development of commercial scale fishing, on strict archaeozoological grounds, one would at least need to: (1) gather data from well excavated coastal sites where fishes have been always part of the local economies, (2) study long-lived sequences that would not only incorporate evidences from the various colonial episodes, but also bridge the gap from the second to the first millennium BC, to have some sort of baseline on the character of the "fishery" prior to the appearance of tuna, and (3) work with sizable samples that would minimize the problem of any potential changes in the faunal composition being due to purely random phenomena. At the time of writing, no such sites have been documented in Iberia.

For all these reasons, the data that we have gathered on the fish assemblages from the sites of Los Gavilanes (province Murcia, Spain) and Castro Marim (Algarve, Portugal), constitute a unique testimony concerning the origin and development of the Iberian pre-Classical and Classical fisheries, a testimony bound to become a reference for years to come. Although both sites are located on the ecotonic interface where the sea meets freshwaters and both have suffered dramatic changes during their more than 1,000 years sequences, both differ in important ways. Among these, Los Gavilanes is a Mediterranean site located on biologically unproductive waters whereas Castro Marim is an Atlantic site located close to one of the most productive upwelling ecosystems of Iberia. Similarities and differences among the fish assemblages of both sites will thus help illustrate the different responses taken by the trans-Mediterranean colonists after setting foot on these lands

KEYWORDS: FISHES, COMMERCIAL FISHING, SPAIN, PORTUGAL, BRONZE AGE, IRON AGE, BLUEFIN TUNA, *Thunnus thynnus*

Fish as a food source in Greek dietetics. An overview of late antique and early Byzantine doctrines

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Fish were an important source of food for both the ancient as well as the Byzantine world. Its importance is still visible in preserved medical writings of famous Greek physicians, who highly valued the qualities of marine produce (Galen, Oribasius, Aetius of Amida, Paul of Aegina and others). As a result, they elaborated a fairly consistent set of principles according to which they would evaluate and classify fish.

As regards fresh fish, experts determined two main quality assessment criteria, namely the place of origin and the size of fish. Thus, fish were divided into three main classes, i.e. sea fish, sea bay fish and fresh water fish. Sea fish were further subdivided into ones caught in in-shore waters, such as rock fish, and species living in open seas. Sea bay fish were considered as a single group. Fresh water fish were divided into those inhabiting either flowing or stagnant waters. The influence of contaminants generated by large agglomerations on the natural environment, and thereby on the quality of meat, was also noted and therefore some comments made on the subject by Galen would repeat later in early Byzantine medical treatises.

It was considered that sea fish were superior to bay fish, and that the latter were better than fresh water ones. Within the sea fish group, deep sea species and those inhabiting coastal rocks were valued most highly. As regards fresh water fish, river fish were considered superior to those caught in lakes and ponds. The worst specimens came from silted reservoirs and waters contaminated by a human or other factors.

The criterion of size made a considerable imprint on the nomenclature applied in dietetics. First and foremost, it is most clearly visible, on the one hand, in medical discussions concerning the term *ketodeis* (from *kete*, i.e. the largest genera or specimens) and, on the other hand, in passages on the term *afye* (small fry). Generally, fish were divided into very large, medium sized and small species. No exact dimensions were given, however, for example, *thynnoi* (tuna fish) were classified as very large, *kestreis* (grey mullet) as medium sized, and *membrades* (sprat) as small. This classification model is also reflected in the relations between the terms used to refer to specimens of the same species, for instance *agnotidion*, *myllos* and *platistakos* (most probably grey mullet).

From the point of view of dietetics, very large and large fish were included in the group of fish with hard meat (*sklerosarkoi ichthyes*). On top of the characteristic, they were classified as fatty and having an unpleasant aroma. The latter was brought about by their thick and usually malodorous juices present in their bodies. As food they were considered as wholesome, but heavy and contributing to the generation of unfavourable juices in the consumer's body (in particular they contributed to the production of large amounts of crude juices). In order to neutralise these properties, it was recommended to boil and roast the meat, and also to serve it with additives facilitating digestion (herbs and spices which diluted the thickness of the juices, i.e. oregano, pepper, mustard, vinegar, which would be recommended either separately or would constitute an addition (s) to the final dish in a form of a sauce [usually termed *hypotrimma* or *halme*]).

As for dietetic value of particular parts of a fish body, Greek physicians gave most details in their treatment of the method of cutting up large fish (tuna, sharks, rays etc.). Having simplified the principles put forward by dieticians, one may state that according to ancient and Byzantine doctrines, the *nota* (dorsum) of fish was the hardest, the *ouraia* (tail parts) were intermediate, while the *hypogastria* (abdomen) were the most delicate. In culinary practice this meant that the *hypogastria* were suitable for stewing, boiling and roasting, the *ouraia* for stewing, roasting (but only if the meat had been protected against drying) and boiling, while the *nota* - only for boiling or stewing.

Medium sized fish were neither hard nor excessively soft. They were considered as wholesome and contributing to the maintenance of a harmony of humours in the body. Dieticians pointed out that they could be prepared in every which way. Thus, they could be stewed, boiled, fried and roasted.

Small fish, such as the rock fish, were distinguished by their very soft meat. As such, they were not wholesome, and were recommended particularly for persons requiring easily digestible foods. They could be boiled, roasted and fried. They were best when prepared au naturel, with only a minimal quantity of spices.

Dieticians placed considerable emphasis on due care in the selection of fish products. In many instances they recommended the organoleptic inspection of the carcass, or even an examination of the entrails (the information is frequently present in the physicians' discussion on red mullets, which, as the sources maintained, would feed on small crabs).

Less valuable fish and portions of meat (for example excessively fatty specimens from standing waters, inferior parts of the ketodeis fish, etc.) should first be salted, for the preservation process lessened their harmfulness by means of diluting dangerous for their consumer's juices in the fish meat. Fish preserves were most frequently termed *tarichos* (later *pasta*) and constituted one of the main subjects of the considerations of Greek dieticians. They were subdivided according to three criteria - the period of preservation, the hardness of meat, and the content of fat. Accordingly, the first group included the *prosfaton tarichos*, *mesochronion tarichos*, *teleion tarichos* and the *palaion tarichos*. The second group included the *sklerosarkon tarichos*, *hapalon tarichos* and the *hygropages tarichos*. The third and final category is represented by the *apimelon tarichos* and the *empimelon tarichos*. We should add that Greek literature also contains terms originating from the place of production of specific types of preserves, for example *Byzantion tarichos* (salt fish from Byzantium), and relating to the technology of production, i.e. *tilton tarichos* (preserves from scaled fish).

In general, dietetics considered the tariche as wholesome and valuable, with an unpleasant smell being the only negative feature. Physicians referred to their application not only in culinary art, but also in the treatment of numerous afflictions.

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Fishbones vs. fishhooks: a comparative study from the Neolithic lakeside settlement of Dispilio, Greece

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The prehistoric settlement of Dispilio in Northern Greece offers a unique opportunity in Greek prehistory to have a clear insight into the fishing activities of a Neolithic community living by the lake.

The site lies by the lake Orestis in Kastoria district, NW Greece and seems to have been occupied over a long period, at least from the late Middle Neolithic to the Final Neolithic (*ca.* 5400 - 3500 BC) (Fig. 1). Its earlier deposits are currently waterlogged, which accounts for the good preservation of a large number of organic remains. Important finds include bioarchaeological material, such as seeds and bones, wooden architectural/structural elements, ceramics, figurines, ornaments and musical instruments (Hourmouziadis 2002).

Fig. 1. Reconstruction of the prehistoric settlement of Dispilio in Northern Greece

Turning to subsistence strategies, the inhabitants of Dispilio enjoyed a rich and diversified environment, comprising woodlands, an eutrophic lake, and well-drained areas for farming. The study of mammal bones suggests that they relied more on the land for their livelihood and survival rather than on hunting (Phoca-Cosmetatou 2008). The paucity of wild animal remains is a feature identified at other lake-settlement sites (Schibler 2004).

On the other hand, the considerable quantities of fishbones recovered at Dispilio offer evidence of a lake-turned community (Theodoropoulou 2007, 2008). The image of a fishermen's lakeside village is further reinforced by the presence of a significant fishing gear assemblage, including fishhooks and net weights (Almatzi 2002) (Fig. 2); an amount of more than 40 antler fishhooks, recovered from the Neolithic layers of Dispilio, accounts for the most abundant fishhook assemblage from prehistoric Aegean (Stratouli 2008)**.**

The important quantities of fishbones and fishhooks recovered from Neolithic Dispilio are the object of a thorough multidisciplinary study in order to assess the role of this fishing tackle within the fishing activities of the settlement, as well as to reconstruct possible fishing strategies related to the lake environment. At the same time, this combined approach attempts an alternative interpretation of the presence of fishhooks within a Neolithic farming-fishing community.

Fig. 2. Dispilio site - fishing gear assemblage including fishhooks and net weights

The archaeoichthyological record is particularly abundant (over 10,000 fishbones have been recorded so far) and offers important information on species identification, ecological and quantitative reconstruction through the phases of the settlement as well as questions regarding fishing, quantities and sizes of fish. Fish stocks from the lake must have been a staple food throughout the use of the site, particularly during the middle phase of occupation (Phase B). Fishermen used to fish in the neighbouring shallow silty waters of the lake. Important catches of catfish (*Silurus glanis*), carp (*Cyprinus carpio*) as well as a range of other Cyprinids (*Abramis* *brama*, *Scardinius erythrophthalmus*, *Alburnus alburnus*, *Carassius carassius*, *Tinca tinca*, *Rhodeus sp.*, *Leuciscus cephalus*, *Barbus sp.*, *Chondrostoma sp.*) would have arrived at the village on a regular basis, mainly from spring to autumn, sometimes also during winter. The reconstructed lengths of the two main species, *Silurus glanis* and *Cyprinus carpio* cover the whole range of sizes, namely with two important groups of medium- to large-sized fish (30-80 cm for the carp; generally 40-100 cm for the catfish as well as over 100 cm, with isolated specimens up to 180 cm) (Fig. 3). Reconstructed size frequencies per phase of occupation, combined with ecological information on prevailing species, can be compared with the available data on fishing tackle.

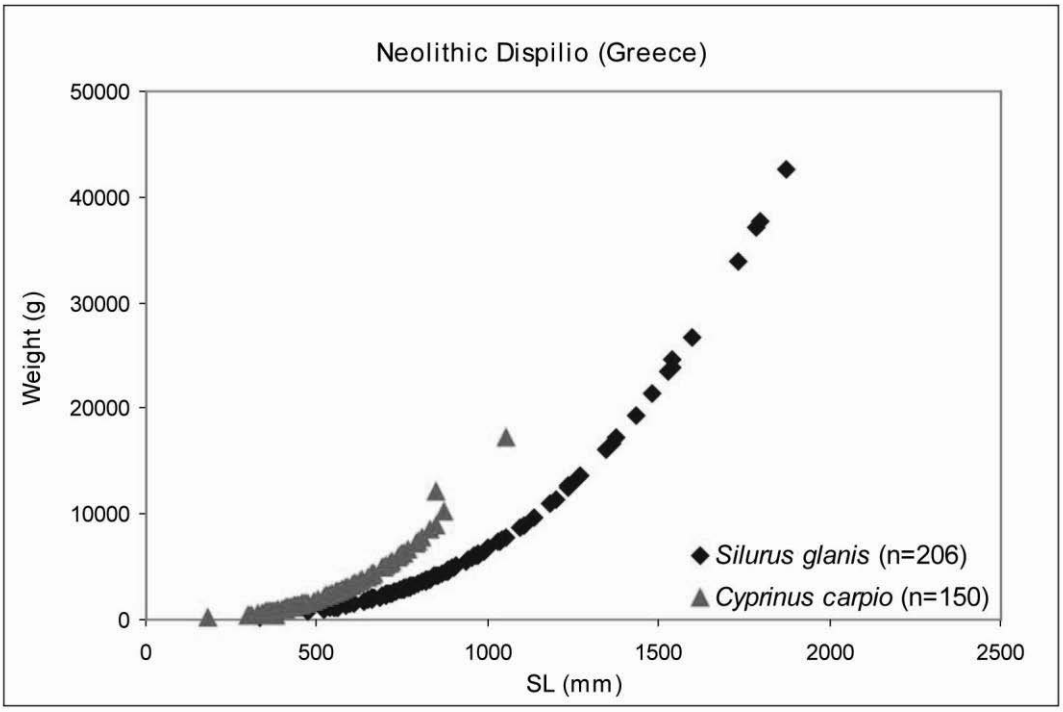

Fig. 3. The reconstructed lengths of the two main species, *Silurus glanis* and *Cyprinus carpio*, from the Dispilio site.

The Neolithic site of Dispilio provides evidence of various fishing methods, namely nets, hook and line, probably harpoons/projectiles and fishtraps, represented in the archaeological record by netweights, hooks and antler projectile points. The most significant fishing-related remains are fishhooks. The largest part of this assemblage was unearthed in the lower deposits of the site (Phase A), which are dated to the late Middle Neolithic/early Late Neolithic. Almost all the fish hooks from Phase A are made from prepared antler blanks and a degree of standardization is further reflected in the techniques involved in the production of the hooks (e.g. drilling of holes and extensive scraping in forming the bend as well as their general form, which is a pointed shank with one or two groove/-s for fastening the thread and a simple point without barb/-s) (Fig. 4). The size of the artefacts varies between ca. 18-46 mm in length and they can be divided into three size classes: a) less than 20 mm in length, b) between 20-30 mm, and c) over 30 mm. The various technological aspects of these artefacts are linked to the ways these hooks were used. Suggested fishing methods related to fishhooks are then compared with available data on fish catches and fish sizes (see above).

In a second step of analysis, a diachronical approach of fishbones and fishhooks is attempted. What is of interest in the settlement is the fact that the presence of hooks through time is gradually reduced, namely from phase A to phase B, reversely to the significantly larger quantities of recovered fishbones in this same period of time. For this, both taphonomical and human parameters are encountered. Emphasis is put on the shift towards more productive fishing methods as well as to more selective fish sizes. At the same time, other issues such as the change of shapes of fishhooks and the ratio of the presence of carp/catfish, are discussed under both archaeoichthyological and social hypotheses.

Fig. 4. Dispilio site - fish hooks from Phase A.

The concluding remarks of the paper put forward the limited economic value of the hook and line methods within a rich lake environment. The shrinking importance of fishhooks from the first to the second phase of occupation is indirectly connected to the need for a more intensive and generalised exploitation of the lake environment. On the other hand, angling remains a discrete fishing method throughout the use of the site. In this respect, fishing with hooks in the lake may be seen as more than a subsistence strategy, reflecting social activities and bearing symbolic meanings at Neolithic Dispilio.

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Fish speciation and endemism in the Paleo Lake Hula, Israel

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Introduction

Theories regarding the origin and distribution of freshwater fish in the southern Levant have been widely discussed in the literature. Researchers agree that the modern fish population evolved from several routes of migration from Africa and Eurasia (Tchernov 1988, Por 1989, Goren, Ortal 1999, Werner, Mokady 2004). Lake Hula, situated at the northern part of the Jordan Rift Valley, had an important role in this dynamic system. Having a long geological history since at least the Early Pleistocene (Horowitz 1988), and periods of hydrological isolation, Lake Hula created a perfect habitat for speciation and endemism of freshwater fauna (Krupp 1987, Goren, Ortal 1999).

Evidence of such processes can be found in the modern freshwater fish, which include three endemic species: *Tristamella simonis intermedia* (Cichlidae), *Mirogrex* (*Acanthobrama*) *hulensis* (Cyprinidae), and *Nun Galilaeus* (Balitoridae). However, due to the lack of paleontological studies, the time in which fish speciation and endemism occurred at Lake Hula, is unknown (Werner, Mokady 2004).

The water-logged site of Gesher Benot Ya'aqov (GBY), located in the northern Jordan Valley, provides a unique opportunity to study the paleo fish community from Lake Hula. The site was excavated in several areas, and a 34 m depositional sequence was exposed (Goren-Inbar 1992, Goren-Inbar et al. 1992, Goren-Inbar and Belfer-Cohen 1998, Goren-Inbar et al. 2000), estimated to represent changes in the paleo lake, 780,000 years ago, during a period of 100,000 years (Feibel 2004). Archaeological layers with lithic artefacts, assigned to the Acheulian culture, botanical and faunal remains were recovered (Goren-Inbar et al. 2000, Goren-Inbar et al. 2001, Ashkenazi et al. 2005, Rabinovich et al. 2008). Large numbers of fossil fish remains appeared in all excavated units.

In this study we present the preliminary results from analysis of a sample of more than 5,000 fish remains recovered from the different layers and areas. In order to test the rate of fish speciation and endemism in the paleo Lake Hula, 780,000 years ago, we will examine the taxonomic composition of the paleo lake and compare them with the modern fish community.

Methodology

We used extensive and diverse reference collections of modern and fossil fish. These collections included modern fish fauna from Lake Kinneret, Jordan Valley and the coastal rivers of Israel (Zohar 2003); modern and palaeontological reference collections of fish from Syria, Lebanon, Turkey, Egypt, and Africa housed at the Natural History Museum in Brussels, Belgium and in London, UK; and published data.

The bones were identified under a binocular microscope. Identification to family level was possible for most of the bones, while fewer bones were species specific. Species richness (S) was calculated as the number of genera identified in each sample, and species diversity was calculated using the Brillouin Index (HB) (Krebs 1999).

Results and Discussion

Of the five native freshwater fish families that inhabited Lake Hula today (Cyprinidae, Clariidae, Cichlidae, Cyprinodontidae, Balitoridae (Goren, Ortal 1999), the three first families were identified at GBY. In all, the Cyprinidae (carps) are highly abundant, although their relative abundance differed by depositional location.

Table 1. List of freshwater fish from Lake Hula (Goren, Ortal 1999) and their appearance at GBY (endemic species marked bold).

Lake Hula Fish	GBY
Cyprinidae:	
Acanthobrama lissneri	+
Carasobarbus canis	+
Barbus longiceps	+
Capoeta damascina	+
Garra rufa	+
Hemigrammocapoeta nana	+
Mirogrex hulensis	+
Pseudophoxinus kervillei	+
Balitoridae:	
Nemacheilus jordanicus	-
Nemacheilus panthera	-
Nun galilaeus	-
Clariidae:	
Clarias gariepinus	+
Cyprinodontidae:	
Aphanius mento	-
Cichlidae:	
Oreochromis aureus	+
Sarotherodon galilaeus	+
Tilapia zillii	+
Tristamella simonis intermedia	+

Although fewer bones were species-specific, from the three identified families full taxonomic composition was found (Table-1). In addition, several undescribed species belonging to Cyprinidae and Clariidae were recognized. These included remains of a large *Barbus* sp. nov. characterized by large molariform teeth (Figure-1). The tooth diameters testify that they belonged to fishes of more than one metre in length that specialized in mollusc crushing.

Fig. 1. A molariform tooth of large *Barbus* sp. nov from Gesher Benot Ya'aqov

In sum, the fish remains from GBY allow us to discuss the evolution of freshwater fish at Lake Hula. They show, for the first time, that the paleo fish community of Lake Hula had a much more diverse taxonomic composition and higher rate of speciation and endemism than that described from the modern community. These results are in accordance with Por (Por 1989) that the Rift Valley was an important centre of migration, speciation and endemism for the inland water fauna.

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The archaeology and archaeoichthyology of fish and fishing at Tell el Farkha, Egypt – predynastic and early dynastic times

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Tell el Farkha is a site located in the eastern part of the Nile delta, about 120 km to the north-east of Kair, not far from the ancient city of Mendes, the capital of the 16th nom of Lower Egypt (Fig. 1) Systematic archaeological studies were initiated there in 1998 by a Polish research team from Poznań and Kraków. This has provided data referring to the history and culture of the population who inhabited the settlement established on three hills in the Pre-Dynastic and Early Dynastic period. It is known that the settlement was established around 3700 bc and it lasted until nearly 2700 bc. The origin and development of this settlement took place thanks to the growth of inland trade with Kannan.

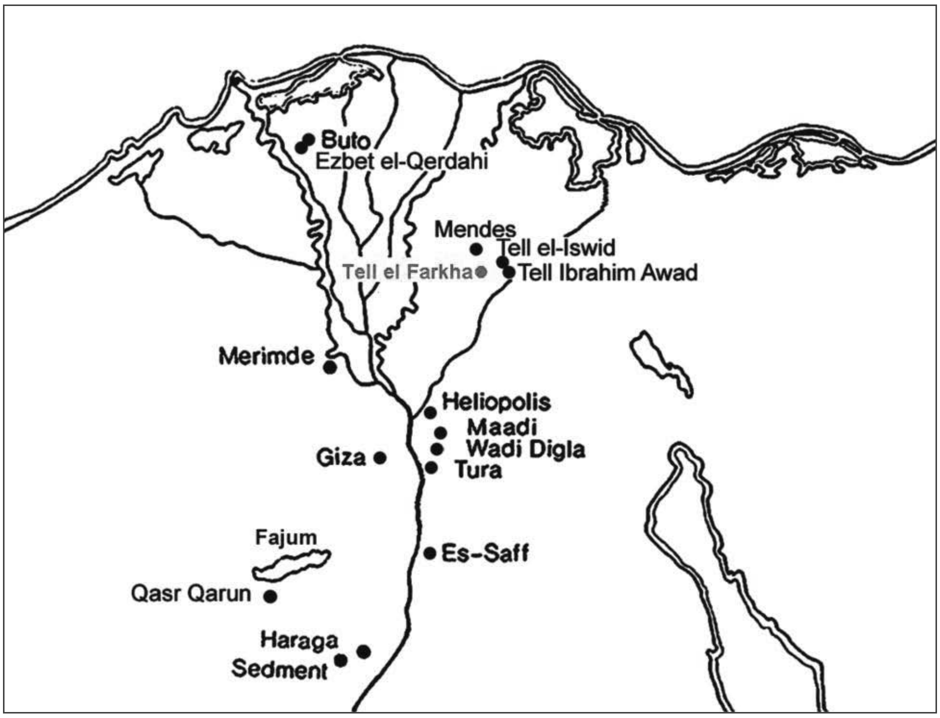

Fig. l. Tell el Farkha in Nile Delta

The localisation of the settlement in the vicinity of water and the natural resources of ichthyofauna in the river Nile created excellent conditions for the development of fishing. The fact that the inhabitants practised fishing has been confirmed by a few archaeological sources and by the numerous fish remains. This paper presents contextual evidence of the history and culture of fish and fishing in ancient Egypt and its importance in daily life. Furthermore, for the purpose of comparison, some information is given from modern times.

Fish as a Cultural Symbol

Tell el Farkha was situated in an area whose patron was the goddess Hat-Mehit defined as „The Fish of Fishes' and „The Foremost of the Fishes". She was represented as a woman with a fish on her head and her symbol was itself a fish. Zoological identification of that fish is not certain. It is supposed that it was a Schilbid catfish (*Schilbe mystus*), a fish that frequently occurs in the form of an amulet in the Late Period. Some Egyptologists believe that the attribute of that goddess was actually the catfish (*Barbus bynni*).

The aforementioned goddess enjoyed a particular cult in the early period of Egyptian history. One can believe that her importance resulted from the high significance of fishing at that time, particularly in the Nile delta. There are not many details referring to the cult of this goddess, however, amongst other evidence some ceramics were uncovered which were devoted to her cult. It is not clear how long the goddess had been an important independent deity; however, during the II dynasty, when the cult of the ram, the god Benebjedet became popular, Hat-Mehit received the status of Benebjedet's wife and her own importance apparently decreased. However, the Schilbe fish is a „synonym" of the „Mendes fish" and it is the only fish used by the ancient Egyptians as a nome standard (Brewer and Friedman 1989). Different provinces of Egypt regarded a particular fish species as a sacred one, therefore a fish which was a taboo in one area, could be consumed in another region. Fish enjoyed a rather ambiguous position in ancient Egypt. Sometimes a fish was regarded as sacred, sometimes it was scorned, some people consumed it and others were denied it (Shaw and Nicholson 1996). Because of ritualistic reasons, the king and the clergy were not allowed to eat fish. Fish was the everyday basic meal of an ordinary Egyptian, but even a simple Egyptian was not allowed to freely consume some species of fish. A fish called by the Greeks Oxyrynchos (*Marmyrus kannume*) was regarded as sacred in the town bearing that name in the Fayoum area. Nile perch could not be eaten by the inhabitants of the Latapolitan nom (Esna), because it was regarded there as a saintly animal.

Some remarks on fish and fishing in the past and in the present

Fishing was one of the most important food sources for the Egyptians in the early period of civilization and particularly in the Nile delta, where it constituted the elemental food of the lower social class. Fish was distributed all over the country in dried form. At the beginning of Egyptian civilization, fish drying was the sole domain of the state authorities.

Fishing had a seasonal character. Diodorus Sicilus wrote that fishing was carried out mainly in the period when the Nile waters were low. Such was the situation at the oasis of Fajum, where Clarias was caught primarily in the spring and early summer, and at the end of summer and the beginning of autumn (Brewer 1987). Fish were caught by different methods using either passively or actively operated fishing gear. Large fish, like the Nile perch, were hunted using harpoons. Also hooks bound to a string held in the hands were used instead of fishing rod which started to be used in the New State. The hooks and harpoons were made of both animal bone and of shell. Hooks were already in use by the type of the Merimde Pre-Dynastic culture. Originally, they were made of bone or shell, while after the appearance of copper in the archaeological record, copper alloy hooks started to be produced. Fish hooks made of shell have been excavated in El Omari (Debono 1948: 567) and hooks made of copper alloy have been found in Maadi (Menuhin and Amer 1936:48).

In both the Old State and the New State, fishing had almost an industrial character because of the use of sizeable nets. Fishing was also carried out using crawfish traps sunk down from a boat. Also fish traps were sometimes used, which can be recognised from drawings made on rocks; these were known from at least the Late Palaeolithic (Winkler 1938). On tomb wall paintings, no representations of more advanced traps than these have been preserved, but small basket traps were not uncommon in the Old Kingdom of Mastaba at Sakkara. In the shallow waters of the Mariut lake or the White Nile, the fishermen used to drive fish into the traps. The ancient fishermen probably used the same method during low water in the Nile delta. Since the traps were made of organic materials, no material remains of them have been preserved. On the basis of iconographic representations on tomb walls of the Old State, it is known that a common method of fishing was the use of seine nets. They were huge nets requiring the co-operation of a team of fishermen working together. Also smaller nets were used, which were thrown from a boat, or from the river bank or lakeside. Among the Dinka and Nuer inhabitants, the majority of fishermen were net throwers, usually working in communal groups (Boss 1945).

Larger fish were caught from a boat using hooks on lines with bait fixed to them. Large fish were also caught using harpoons similar to those used for catching hippopotamuses (Boss 1945).

Table 1. Order of fish according to nutritional value and preference (after Babiker 1981) and fish identified in Tell el Farkha

Place	Nutrition Value	Preference	Tell el Farkha NISP=7955	
1	Hydrocyon	Lates	Clarias	78,9%
2	Tilapia	Tilapia	Synodontis	13,7%
3	Lates	Hydrocyon	Lates	3,0%
4	Haplochromis	Bagrus	Tilapia	1,7%
5	Labeo	Haplochromis	Polypterus	0,6%
6	Bagrus	Labeo	Bagrus	0,5%
7	Chrysichthys	Eutropius	Heterobranchus	0,5%
8	Eutropius	Barbus	Mormyrus	0,1%
9	Distichodus	Schilbe	Tetraodon	0,03%
10	Clarias	Mormyrops		
11	Synodontis	Synodontis		
12	Barbus	Alestes		
13	Schilbe	Chrysichthys		
14	Tertaodon	Distichodus		
15	Clarotes	Mormyrus		
16	Gnathonemus	Gnathonemus		
17	Mormyrops	Clarias		
18	Heterotis	Heterobranchus		
19	Heterobranchus	Clarotes		
20	Alestes	Heterotis		
21	Auchenoglanis	Auchenoglanis		
22	Malapterurus	Malapterurus		
23	Mormyrus	Tetraodon		

The Nile river offered a huge abundance of species, but fish with the highest nutritional values not always were preferred. In spite of the fact that in the Nile waters, edible fish from 23 families are present, only only a limited number of species are consumed, whilst the other ones are completely ignored (Babiker 1981). The species preferred by the populations inhabiting the banks of the upper Nile include such fish as: Lates, Tilapia and Hydrocyon. The eleventh position on the fish list belongs to Synodonthis, while Clarias is placed near the end of the list (Table 1). When we take a look at the nutritional value, the ranking of fish is very different. The first position is taken by Hydrocyon. Lates is moved into the third position and Clarias occupies a significantly higher place.

Fish and fishing in Tell el Farkha

Fishing in this locality has been confirmed by archaeological evidence. Amongst this evidence there is an impression of a net with a mesh size of more than 1 cm (Fig. 2). This impression lay on the reverse of an early dynastic seal impression from Tell el Farkha. Other objects include stones with bored openings that could have been used as sinkers for nets. There are also copper alloy hooks with hook rings of about 2 cm in diameter. The hook dimensions are similar to the hooks found in Maadi (Menuhin and Amer 1936:48) and in other areas. The dimensions of these hooks may suggest that they were used for catching large fish. In Tell el Farkha, harpoons were excavated as well, made of copper alloy, and also of bone (Fig. 3).

All of these were of the same type, possessing two snares and some form of a ring for fastening string. The harpoons were 11 cm long. In one early-dynastic grave in Tell E., two copper alloy harpoons were found. In the same Tell, in the early-dynastic settlement layer, another identical harpoon was found. There is a high probability that it also came from a grave, but that was destroyed by grave robbers. A bone harpoon was found in the Tell C settlement in the layer dated to 0 Dynasty.

Fig. 2. Tell el Farkha. Impression of a net

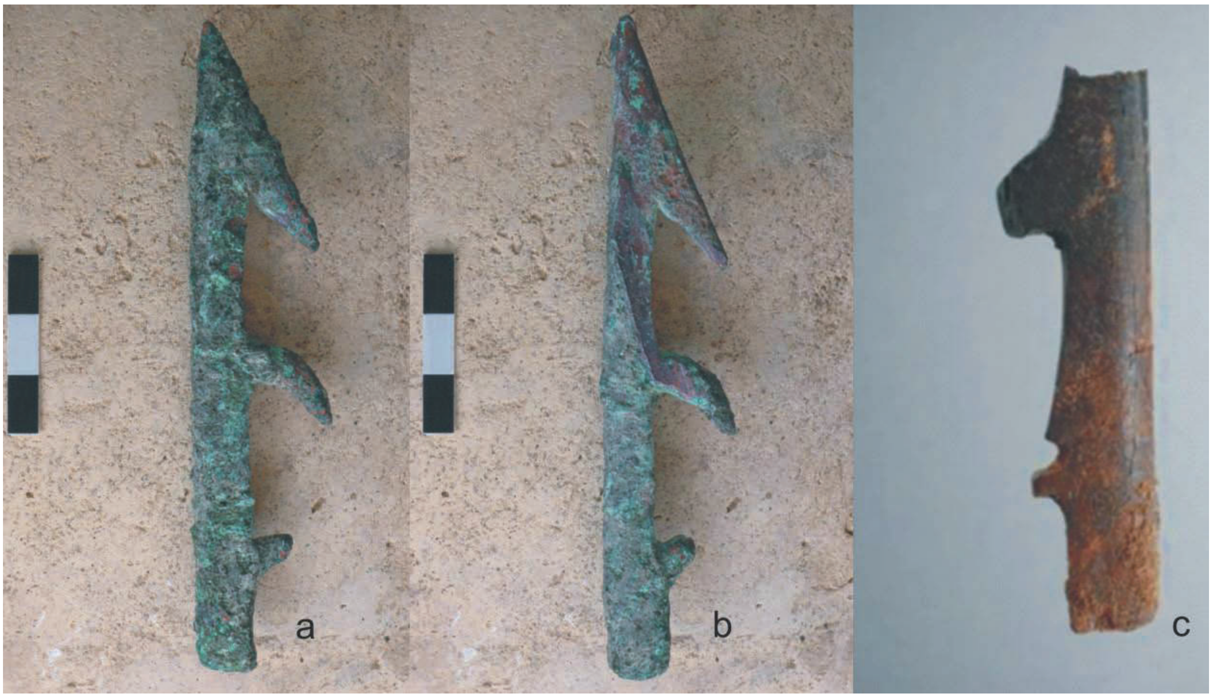

Fig. 3. Tell el Farkha. Harpoons made of copper (a, b) and bone (c).

The high importance of fish has been reflected in the art of the settlement inhabitants. The form of a fish was frequently given to cosmetic pallets. Two of these objects, measuring about 9 cm, were found and a third one, represented only by a fragment, must have been about three times larger. In the temple deposit in Tell W., a 5 cm long figure of Tilapia was found, which most probably is made of hippopotamus tusk (Fig. 4).

Fig. 4. Tell el Farkha. Figure of tilapia.

Other artefacts represented models of boats and their prototypes could have been made by the fishermen from Tell el Farkha for the setting and dragging of trawl nets, and for the throwing of fish nets.

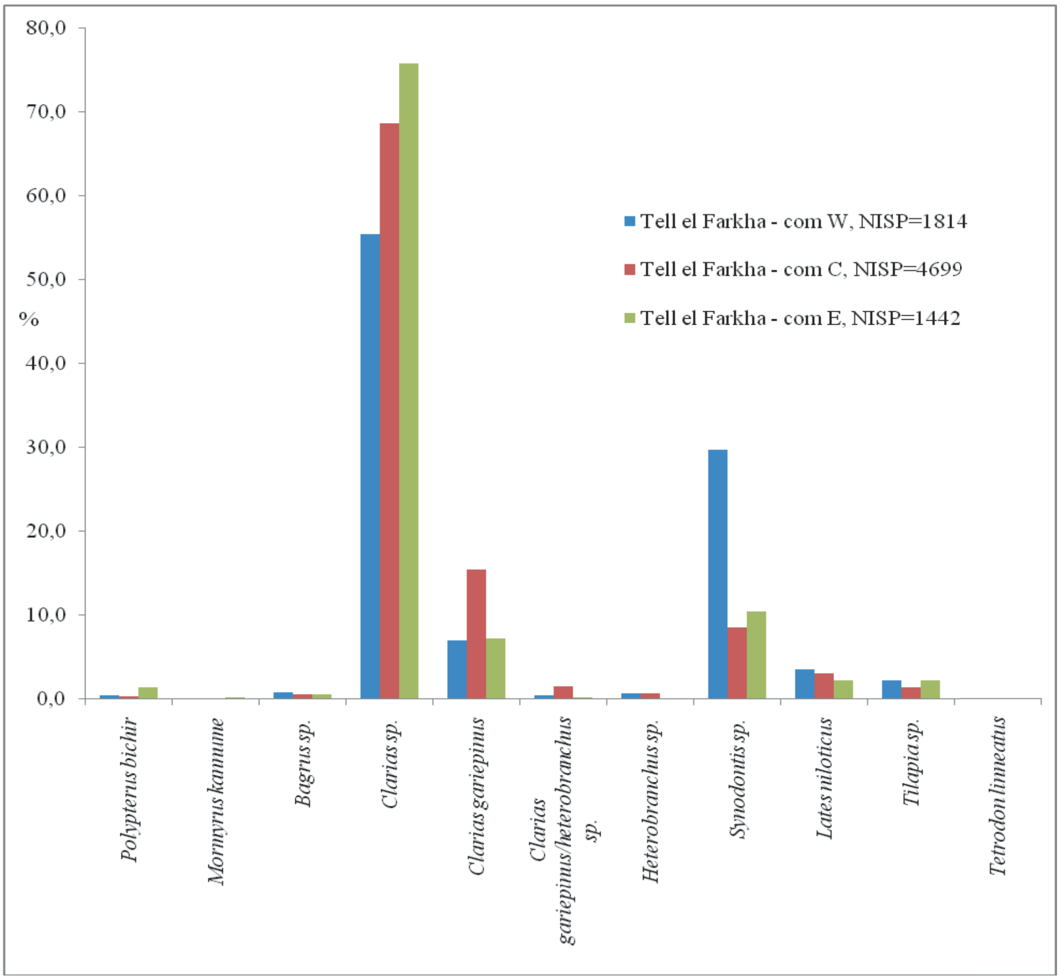

Fig. 5. Tell el Farkha. Percentage composition of fish taxa in every tells

The most numerous categories of finds testifying fishing and fish consumption are the fish remains themselves (Makowiecki 2007). So far, over 1000 remains have been investigated and about 800 have been identified. The number of taxons is not large and the most numerous is *Clarias* sp. (Table 1) followed by *Sunodontis* sp. and *Lates niloticus*, the remaining ones making up only a small percentage of the collection. The indicated sequence of taxons was the same in all Tells (Fig. 5). Principally they represent the remains of cranium elements. The majority of remains bear traces of black and grey colouration, which may have originated as a result of the fish coming into contact with fire when they were being prepared for consumption or during the utilisation of their remains by carbonising them, as is done by the modern Egyptians. These traces are the basis for regarding them as food remains.

Only the bones of Sunodontis, i.e. its pectoral spines, were collected in order to use them as arrow heads. This is confirmed by a collection of bone uncovered in Tell W (Makowiecki 2007). A similar deposit is known from the settlement in Maadi, in the South of Cairo (A. Driesch 1986). The fact that the pectoral spine was used for this purpose is demonstrated by specimens with traces of manual working.

In respect of the division of fish into groups (according to Van Neer 2004), one can state that the share of flood plain dwellers (Claris, Tilapia) was about 81% and it was clearly higher than that of the open water species (Lates, Bagrus, Synodontis), which make up the remaining percentage. Therefore, one might suppose that fishing was carried out mainly during times of low water level in the Nile river, i.e. before and after the period of inundation.

Acknowledgements

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Swahili fishing culture and fish consumption in coastal East Africa

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This paper outlines research conducted in Kenya during June 2009. The paper explores the connection between social dynamics related to traditional fishing practices on the Swahili coast and excavated material remains. This summer I have documented the main fishing methods in three villages in the southern Kenya coast. I examine the types of gear, the organization of fishers and ritual activity related to fishing in this area. My summer fieldwork will be followed by an investigation of trends in excavated fish bone data as part of my PhD research.

Context

Swahili settlements are distributed along the East African coast from Somalia to Mozambique (Kusimba 1999, Horton and Middleton 2001). Over time, Swahili towns developed into a complex cultural system essential to the historical Indian Ocean trading system. My project explores an aspect of Swahili culture and identity that has been mostly assumed without being well understood. The occurrence of fishing and fish consumption on the Swahili coast is easily acknowledged by archaeologists; excavated fish and shell remains are clear evidence for this. I will use this evidence to contribute to current archaeologies of social dynamics, identity, and change.

I hypothesize that fish bones can explain dynamics of social structure, such as differences in status and gender. I argue that we can learn about social dynamics from complex choices leading to the types of fish represented in the archaeology. I believe questions of identity, social structure and technology related to fishing practices and consumption contribute to current lines of research in Swahili archaeology that increasingly focus on the reconstruction of daily life. In contrast to the static, descriptive view of Swahili culture that characterizes early work (Kirkman 1966; Chittick 1974), current research on the Swahili coast discusses concepts of dynamic social behaviour through the use of material remains, such as in the production and use of local pottery (Wynne-Jones 2007), household activities (Flexner, Fleisher et al. 2008), identity (LaViolette 2008) and food consumption (Walshaw 2005). These works emphasize the role of agency in the use of material remains rather than simply describing trends of artefact types. My work adds to these social archaeologies by seeking to understand the social dynamics of fishing practices in the daily lives of people inhabiting the coast. This goal is the basis of the ethnoarchaeology component of my research and the interpretation of the fish remains data.

Methodology

In June 2009 I conducted a preliminary ethnoarchaeology study in Vanga town and nearby Jasini and Jimbo villages in the south coast of Kenya. The goal was to understand the link between material evidence in archaeology and contemporary human practice through the use of analogy. Vanga is a coastal fishing town where traditional fishing practices continue to be of economic importance. Jasini and Jimbo villages are also involved in traditional fishing and represent different dynamics associated with smaller settlement size.

The study is based on more than fifty interviews and participant observation. Participants were selected from the pool of adult members of the public, including men and women, for their involvement in fishing activities, including, but not limited to, the capture and collection, processing, and consumption of fish and shellfish.

Three main themes were used to structure the data gathering and questions. The first includes the symbolic and ethnic associations with fishing, such as in the incorporation of fishing in folklore and ritual. The second relates to social structure, exploring the relationship between fishing practices, gender and status. Thirdly, I look at the technology associated with different types of activities such as in capturing, preparing and cooking fish and shellfish. Close attention is made to the types of traces of material remains that result from the different behaviours associated with fishing.

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Roman fish sauce: an experiment in archaeology.

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Introduction

The aim of this project is to duplicate, using experimental archaeology, the processes involved in the manufacture of the various kinds of Roman fish sauce. These fish sauces were transported in considerable bulk throughout the Roman Empire in amphorae and yet were also highly valued by Roman gourmets. There is little agreement as to the precise nature of, or relationship between *garum, liquamen, muria* and *allec* and also confusion as to the relative value of the different types of sauce designation that are recorded on the *tituli picti:* labels on amphorae. The objective of the project is to provide data on the potential yields of sauce from a particular batch of fish, to understand the nature of the salting and maceration process and to generate residues both of bone and other material that can be compared with the residues found in ancient amphora. The project will also generate bone residues for further study by zooarchaeologists. Ultimately it is hoped that it will be possible to develop a greater understanding of the nature of the various kinds of Roman fish sauce and to clarify some of the complex issues surrounding nomenclature. It is also planned that the sauces will be transferred to replica amphorae in order to observe the residue formation.

Roman fish sauce: the evidence

There is a huge body of evidence concerning the nature of Roman fish sauce but with each the evidence is difficult to interpret.

- We have fish sauce amphorae from Roman shipwrecks and land sites which sometimes contain remarkably well preserved fish bones specifically mackerel (*Scomber japonicus*) and numerous *clueiformes* such as sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasiculos*) as well as numerous small *sparidae* such as *pagellus acarne* or bream. (Desse-Berset and Desse 2000, Delussi and Wilkens 2000, Bruschi and Wilkens 1996, Cotton *et al* 1996, Studer 1994, Wheeler and Locker 1985). The amphorae are rarely sufficiently sealed to be certain if there has not been an increase or reduction in the content and we cannot as yet determine with certainty whether fish sauce or salted fish were being transported.
- The general distribution and quantity of fish amphora on a given site can tell us about general consumption but we are not able to define the product sold from specific amphora. (Martin Kilcher 2003) This is because amphora were reused and also because the sauces were probably sold on in smaller vessels.
- The amphora are sometimes labelled with *tituli picti* which tell use about the various names for fish sauce (*garum*, *liquamen, muria, allec)* and also the nature, quality and quantity of the sauces but archaeology lacks a precise definitions. (Curtis 1991, CIL IV and XV)
- The fish sauce factories on the coast of Spain and North Africa can tell us about the process of manufacture through their layout and structure. These factories also have salting vats that

contain large amounts of fish remains specifically the smallest *clupiformes* varieties. (Curtis 1991, Ponsich and Taradell 1965)

- There is a large body of literary evidence that is complex and hard to interpret but nonetheless a valuable source of information. (Grocock and Grainger 2006) Basic recipes for these sauces survive and will serve as the basis for our experiments. (*Geoponica* 20.46,1-6)
- The modern day fish sauce manufacturing process in South-East Asia can also offer valuable information. It is by no means clear that these methods are exactly the same but similarity with structure of factories, size of fish and the decanting processes do provide vital evidence. (http://www.thaifoodandtravel.com/features/fishsauce1.html)

Despite all this evidence, it is an indication of the complexity of these issues, that we have so little agreement about the basics of Roman fish sauce. The linguistic debate is crucial to understanding these sauces but is rarely integrated with the archaeological evidence. (Curtis 1984, Grocock and Grainger 2006: 373ff). Question such as "who is consuming which variety and how much?" also need to be asked. The answer has far wider implications for both our interpretation of the economy of the ancient world and the very nature of Romanisation and its effect on ordinary people. How we define the relative 'value' of these products determines how we define the status of the consumer and if we do not know what the difference is between *garum flos* and *garum scombri* or *liquamen* and *liquamen scombri* and what that meant to a Roman in Italy or to a native in Britain, then we cannot give it a value. Curtis points out the perceived anomaly, that though *garum flos* is considered a high value product it is the most common of the *tituli picti* on amphora in Pompeii and is also found in modest houses (Curtis 1991:174). Van Neer and Ervynck have also noted the perceived anomaly that though *allec* is considered the most commonplace fish sauce and the cheapest it is by far the most frequently identified in examples of fish remains surviving in ship wrecks and in residues that are considered discarded (Van Neer & Ervynck 2002: 208). We should also note that the relationship between *allec* and *garum/liquamen* is by no means clear. It is hoped that this project will be able to clarify some of these questions by generating its own *allec* using sardine, sprat and mackerel and determining its true nature through observation and various laboratory based experiments.

The experiments

The most basic method of production of fish sauce seems to have been to mix fresh un-gutted relatively small fish with salt and allow them to dissolve, ferment and separate out into a clear liquor which was removed. Then it is assumed that more brine was added to allow a 2nd grade and possible 3rd grade sauce to be produced. The size of the fish used varies from the tiniest forms only 3-5 cm long where there is no doubt that a fish sauce is being made to *clupiformes* well over 10 cm in length where it is not possible to determine whether the fish was preserved whole or meant to be a fish sauce. The variety of sauce made with 'little fish' is specifically called *liquamen* by Isidore of Seville in the late Empire (*Etymologiae* 20.3.20). This definition is elsewhere contradicted as we find other late scholar declaring that *garum* and *liquamen* were the same thing and therefore clarity is difficult to achieve (*Caelius Aurelianus Tard.II.1.40)*

Experiment 1

With this issue in mind the first experiment has been undertaken is to make a sardine variety using a size corresponding to the apparent transition between sauce and salted fish. The mature sardines (10kg. = 108 individual fish) used were between 8cm-24cm, the majority were over 10cm and a third were at least 15cm in length. They weighed between 50-100gm each and the average body depth measurement was at least 4cm. The fish were left whole, layered in a fish tanks A and B and a ratio of 7-1 salt to fish, recommended by the *Geoponica* was added (20.46.1-6). It was possible to acquire Portuguese *flor de sall* (a soft textured salt taken from the surface of the brine while liquid and before the crystals form) to use for the experiments.

Experiment 2

The second experiment involves producing large quantities of 'small fry' *allec* from the most readily available small fish *srattus sprattus*. The fish were between 5-8 cm in length but with only 2cm body depth and with an average weight of 4-5 gm. A total of 8 kg (1,941 individual fish) were used and they were treated in the same way as the sardine.

There is no doubt that the smallest fish were left whole so that the small amount of blood and viscera could facilitate the enzyme breakdown of the fish flesh. The combined evidence we have does not indicate whether larger fish were left whole, cut up but left with their viscera or gutted but unwashed. It is clear that fish intended to be salted and sold as fish was fully cleaned and, as indicated by the cut on the cranium to allow the blood to be flushed out, noted by Desse-Berset and Desse (2000: 76), considerable effort may have been undertaken to ensure no blood contaminated the salted fish. It is by no means clear whether the cut cranium was a universal practise for salted fish or that uncut crania indicated sauce rather then fish. However if enzyme breakdown was the intention then the viscera may have been left inside even larger fish to break down the fish flesh and 'burst open' the cavity as indicated by references to just such a process from Manilius (*Astro.*5.672). It is even possible that extra blood may have been added to speed up the process. In effect: enzymes working to break up the fish from the inside and the outside. It has been suggested that direct heat i.e. cooking the fish, as described by the *Geoponica* (20.46.6) may have been used in combination with fermentation to break up the fish (Desse-Berset and Desse 2000:93). It is unlikely that the two methods would have been combined as the necessary fermentation would have been halted by the heat. We have noted that within the first week of fermentation the anchovies in tanks A and B had already burst open and a number of vertebrae had become exposed: the flesh having been dispersed into a suspension.

Experiment 3

The literary evidence suggests that fish of even larger size such as mackerel were used to make sauces when cut up. The third experiment seeks to determine whether drained but unwashed mackerel will have sufficient enzymes to break down fish flesh into a non-*garum* fish sauce i.e a *liquamen* and how it compares in respect to taste with a sauce containing viscera. A cleaned fish sauce is made today in South East Asia. Ten kilograms of larger mackerel, on average 400-450 gm., 30-38 cm. in length and with a body depth of 6 cm. were cut up into 3 pieces; to quote Manilius 'cut into their limbs', (*Astro*. 5.669) and the viscera removed but they have not been washed (the blood will be used to make blood *garum*). The Salt is added at a similar ratio as before.

Preliminary results

Currently all tanks have an agreeable odor. The dominant smell is of malt. All three varieties failed to produce sufficient natural brine to cover the flesh. All therefore have had brine and wine (according to the recipe from the *Geoponica*) added to ensure the fish was submerged. The fish which produced the most brine was the sardine, followed by the sprat and the drained mackerel was particularly poor. The sardines and sprat began to disintegrate within days and by day 7 it was possible to see some entirely exposed vertebrae even on the sardines. It is, as expected, very apparent that viscera were a crucial part of fish sauce production and its presence or absence fundamental to the speed of production, taste and value of the sauces. A further observation is that the sardine variety has produced a very thick, viscous, and saturated emulsion, which appears to be unable to dissolve anymore flesh; though many of the vertebrae are exposed, just as many are still recognizably whole fish. It is conjectured that the 2nd and 3rd grade fish sauces taken from a single batch of larger fish would still potentially be nutritionally and gastronomically valuable, in these circumstances, which is of considerable interest. The project will develop in other ways as the fish sauces progress and new evidence presents itself.

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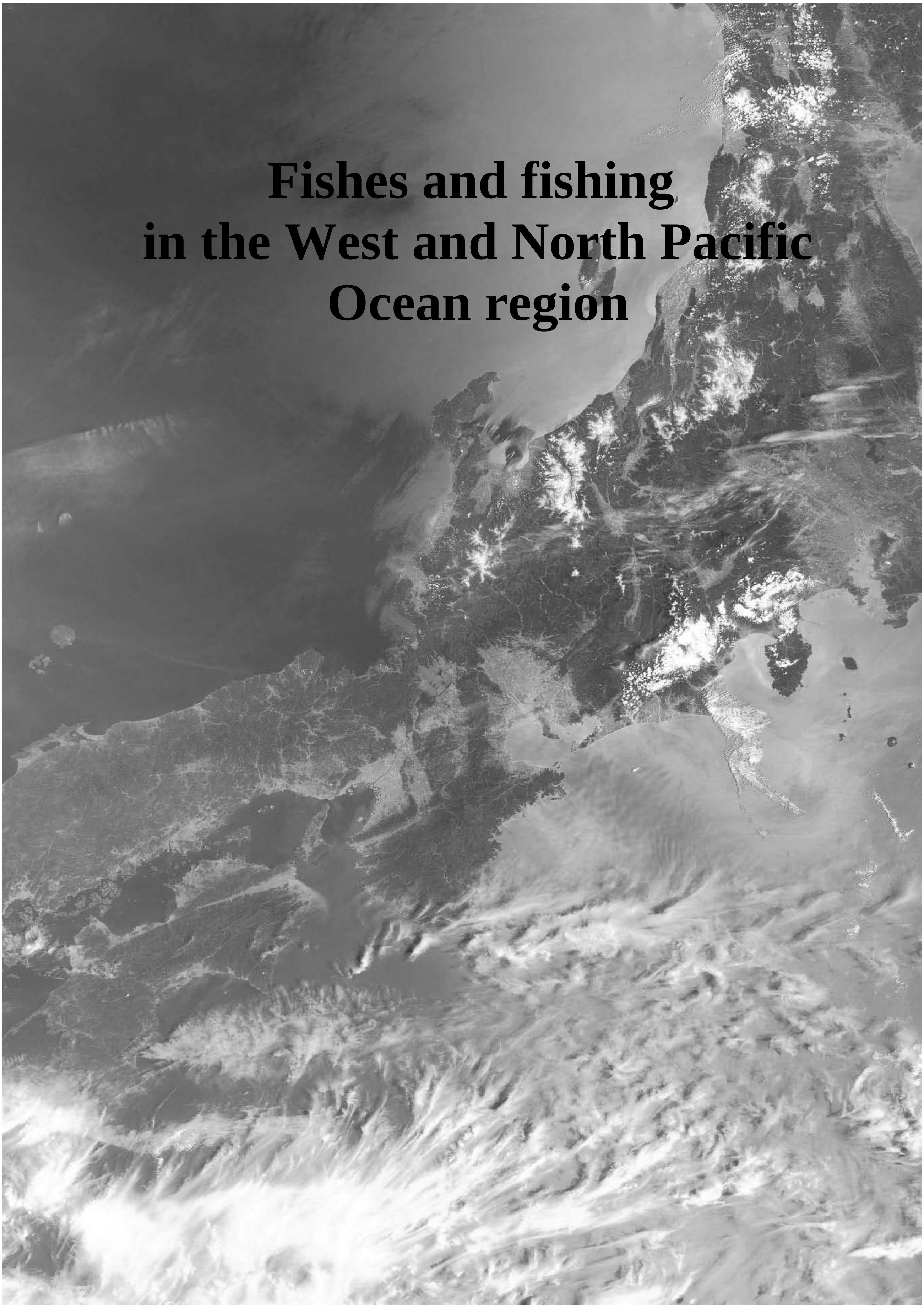
Fishes and fishing in the West and North Pacific Ocean region



Prehistoric fishing in the northern Philippines: ecological and cultural implications in islands of southeast Asia

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Fishing is amongst the most ancient forms of human subsistence. Within the southeast Asian region, it is regarded as a basic hunter-gatherer skill that is an integral part of both past and present human life systems (Higham 1989). However, the antiquity of fishing as an unassailable component of the Philippines prehistoric past was mostly realised through ethnohistographic records, and in the case of archaeology, through the analysis of fishing-related artifacts. Outside these parameters are indirect perspectives of what was actually being caught since despite its persistent occurrence in the archaeological record, the zooarchaeological analysis of fish bones remains underexplored in the country.

In the history of the Philippines, fish is a prominent economic resource and a long-established cultural subject, as documented by Pigafetta in prehispanic Manila, where fish were sacrificed for the anitos (spirits) (in Jocano 1975:109). This is not an isolated and certainly not an obsolete case. Fish, particularly the common dolphinfish, Coryphaena hippurus L., 1758 is a much revered fauna in the Batanes, laden with mythical undertones (Datar 2006; Gonzales 1966; Hornedo 1976, 2000; Mangahas 1994, 1996). The system of Mahi-mahi, dorado, or arayu as it is called by local inhabitants parallels age-old chronicles of the barter of fish and its role in trade and cultural systems in the past. The Batanes Islands (see map, Figure 1) have been central in producing a wealth of information on prehistory and correlations within neighbouring regions. Since the beginning of the 1980s, a more enthusiastic programme of archaeological survey and excavation has been conducted in this northernmost end of the country (Bellwood, et al. 2003; Bellwood and Dizon 2005; Dizon and Santiago 1994; Dizon 1997, 1998; Koomoto 1983; Paz, et al. 1998). This paper presents the first occurrence of the dolphinfish in the Philippines archaeological record, highlighting its presence more than 3,000 years ago and its cultural implications within the larger Indo-Pacific region with similar reported fauna in Taiwan (Li 2001) and Micronesia (Amesbury 2008; Leach and Davidson 2006). The in-depth analysis of the fish remains containing substantial indications of anthropogenic marks leads the research to a provocative investigation of cultural choices and paleoecological aspects that might prove important in present-day concerns for heritage and ecological management.

Together with other fish bones recovered in varying spatial and temporal conditions, this is also a pioneering project in the ichthyoarchaeological realm as it tackles methodological issues and taphonomic aspects within the burgeoning field of zooarchaeology in Southeast Asia. One chief concern is the establishment of a modern fish comparative collection, providing precise identifications to allow substantial archaeological interpretation for a particular site. Although a vast literature on this subject has been published (Casteel 1976; Dye and Longenecker 2004; e.g., Leach 1997; Lepiksaar 1983; Wheeler and Jones 1989), the insurmountable diversity and abundance of tropical fishes generates extra if not unique hurdles for anyone embarking on a similar endeavour.

Finally, the initial database and images of both archaeological and modern fish bones (Fig. 2 and 3) set the much-needed basis in the ongoing zooarchaeological research of this important but neglected fauna in the country and the fulfilment of its potential in making important contributions to the wider archaeological community.

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Ancient transport in the Japanese archipelago revealed through carbon and nitrogen stable isotope ratios of excavated marine fishes

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Introduction

This study aims to establish a methodology to identify the origin of excavated marine remains products in order to determine the conditions of their exchange between areas. If the origins of animal remains can be identified, we can obtain strong evidence of such exchanges .

We have made efforts to identify the fishing grounds of fish remains which have been transported to inland areas (Ishimaru et al. 2008, Ishimaru et al. 2006). This type of study has also started in Europe with the detection of the cod trade (Barrett et al. 2008). The present report discusses the determination of excavated marine fish from inland or mountain sites dating from the medieval and early modern periods in the Japanese archipelago.

Materials and Methods

For our study, we chose red sea bream (*Pagrus major*), black porgy (*Acanthopagrus schlegelii*), and Japanese sea bass (*Lateolabrax japonicus*), which are often excavated from Japanese sites. We have analyzed the carbon and nitrogen isotope ratios of bone collagen from modern fish caught from several sea areas around the Japanese archipelago and of fish remains excavated from sites located in western Japan. We have basically selected the parts which allow the identification of species, like the frontal and supraoccipital of red sea bream or the opercle of Japanese sea bass. In addition, we analyzed the carbon and nitrogen isotopes of girella (*Girella punctata*), a modern fish, for which a significant regional difference is not revealed by DNA analysis. As this fish is not farmed nowadays we can more easily identify its original habitat .

The Yokkaichi site is located in the inland area of Higashi-Hiroshima city (Figure1.-A). It prospered as a post station along a thoroughfare in the early modern period. Although it is located far from the coast, many kinds of marine fish were excavated from buried jars, wooden tubs and wells. Red sea bream is the most abundantspecies to be found. Remains showed many cutting marks revealing a very common Japanese way of preparing the fish for cooking.

The former capital Heian-kyo, nowadays Kyoto-city, was established in 794 AD, and is also located in the inland area (Figure1.-B). Archaeological investigations of Heian-kyo were carried out in the Kyoto Imperial Palace site. There are many excavated faunal remains including fish like the red sea bream, conger pike (*Muraenesox* sp.), cod (*Gadus macrocephalus*), yellowtail (*Seriola quinqueradiata*) and the flathead (*Platycephalus* sp.). As the Yokkaichi site the red sea bream is the most commonly found fish. After the medieval period, marine products circulated widely in Japan.

We have also analysed marine fish excavated from sites like Kusado, Matsuyama, Kaminagahama and Yonago, located in coastal areas, to compare with the inland areas.

The main question addressed here is where these fishes have been transported from.

Results

As for the modern fish, the $\delta^{15}N$ values in three species differed significantly between the fish of the Sea of Japan, the inland Sea and the Pacific Ocean (one-way ANOVA $p<0.05$, followed by Scheffe's post hoc test) (Figure 2,3). Moreover, significant differences were found among the regions within those sea areas. The $\delta^{15}N$ value was the highest at the Inland Sea, followed by the Pacific Ocean, while the Sea of Japan showed the lowest $\delta^{15}N$ value. The difference was very distinctive in the case of the red sea bream and the Japanese sea bass, but not in the case of black porgy due to its wide range of $\delta^{15}N$ values. In the case of the girella, the $\delta^{15}N$ value was also the highest at the Inland Sea, followed by the Pacific Ocean, and the Sea of Japan, where it was obtained (Figure 4.). The results suggest that there exists a difference in the $\delta^{15}N$ values of fish between the sea areas in general.

Furthermore, the relationship of $\delta^{15}N$ values between the sea areas was also found in the fish remains. Clear differences in $\delta^{15}N$ values among the Inland sea and the Sea of Japan were observed both in black porgy and Japanese sea bass, but we need more specimens for a valid comparison. Overall distributions of $\delta^{15}N$ values of fish remains were similar to those of modern fish, which indicates that the $\delta^{15}N$ value was mostly constant from the medieval period until the present day. This probably reaches back as far as to the Jomon period, too (Ishimaru et al. 2008). It is suggested that the human impact on the ecosystems, e.g. eutrophication in the modern period, did not affect the $\delta^{15}N$ value on fish remains.

Therefore, we propose the$\delta^{15}N$ value as a potential indicator of sea areas where the fish remains were originally caught. Figures 5 and 6 show that the $\delta^{15}N$ value of Kusado or Matsuyama, located in the Inland Sea areas, were higher than in Kaminagahama or Yonago from the Sea of Japan. Thus, we have identified that the red sea bream of Yokkaichi were transported from the Inland Sea area. Furthermore, the $\delta^{15}N$ value of Heian-kyo shows both high and low values. Therefore we concluded that marine fish caught in several areas were transported to Heian-kyo, indicating the prosperity of the ancient capital. We will present the results for black porgy and Japanese sea bass at on the meeting.

We are trying to obtain more data to confirm the validity of this methodology. This methodology would be useful in revealing the origin of marine species, including marine fish transportd into the inland region, in order to reconstruct the historical trade routes of the Japanese archipelago.

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What kind of fish are these?
Bones from the Bancho site and the Yokkaichi site of the Edo period (17^{th}-19^{th} century) in Japan

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Introduction

Japanese archeozoologists identified a great number of species or parts of fish remains from several sites. Research has also been done on cutting marks andon body length. In view of the great number of fish species in the world there are still species for which we could not collect all skeletal specimens, therefore some species or families have not yet been identfied. In this presentation I would like to invite you to take a look at some of these kinds of fish from Japanese archaeological sites. I hope to obtain some feedback from the many scholars at this meeting and to have some discussions about the latest research.

Summary of the Sites

1. Bancho site

The Bancho site is located in Matsuyama city on Shikoku Island (Fig. 2.-1). The resul ts of the archaeological excavation show that the site represents a former samurai residence of the Edo period (1603-1868). The main site use dates from the latter half of the 17th century to the first half of the 19th century. Many kinds of objects such as ceramics, wooden implements , roof tiles, metal artifacts, clay objects and animal remains have been excavated.

In 2008 I reported on several kinds of animal remains excavated from that site (Ishimaru 2008). The assemblage includes red sea bream (*Pagrus major*), striped mullet (Mugilidae), Serranidae and parrot fish (*Oplegnathus* sp.). Besides them, there is an unidentified frontal (A bone: Photo 1) which looks like a red sea bream, but I still doubt it. I suppose that it is one of the Sparidae.

2. Yokkaichi site

The Yokkaichi site is located in Higashi-Hiroshima city on Honshu, the main island of Japan (Fig. 2.-2). The main site use dates from the beginning of the 17th century to the middle of the 19th century. Yokkaichi prospered as a post station along a thoroughfare from where objects such as a column base of a house, a sake brewery, buried jars or wells were excavated. Many kinds of ceramic ware which were produced at various places in Japan were excavated, as well as coins, stone objects and animal remains. Though its location is inland, far from the sea, many fish and shellfish remains were excavated. I reported conger pike (*Muraenesox* sp.), carp (Cyprinidae), striped mullet (Mugilidae), yellowtail (*Seriola* sp.), red sea bream, flounder (*Paralichthys olivaceus*) and other species (Ishimaru 2007). Red sea bream is the most frequent finding, therefore we can deduce that it was especially preferred in those days.

Some remains could not be identified such as an opercular (type B bone) (Photo 2), preopercular (type C bone) (Photo 3), and a cleithrum. They look like bones of a freshwater fish, resembling an arapaima (*Arapaima gigas*), a fish which does not live in Japan. I compared these skeletons with one of the sturgeon (Acipenseridae), but they are not the same. Seen from the skeletal viewpoint, Type B bone and Type C bone are the same kind of fish.

3. Other related sites

The above Type A bone was discovered from the Adaka shell mound in Kumamoto, located on the Kyushu Island, dating to the middle and late Jomon period (ca. 3000 - 1000 BC) (Toizumi 2005). Type B bone is also found at the Hamazume site of the late Jomon period (ca. 3000 - 2000 BC)(Kyoto prefecture) located at the coastal area of the Honshu Island near the Sea of Japan (Matsui 1993).

We could not identify Ariidae from the Hikozaki shell mound for a long time (Ishimaru and Tomioka 2006) (Photo 4). Fortunately we have been able to firmly identify the species recently. A great number of bones were excavated from several layers at Hikozaki dating from the early to the end of the Jomon period (ca. 4000 - 1000 BC.);, no other site in Japan has reported the finding of this fish. It is the first report of Ariidae in the Japanese archipelago, and it can now be supposed that people probably made use of it.

Overview of Japanese fish remains research

The Japanese people have used many kinds of fish from the Jomon period onwards and even today they prepare various kinds of fish. Eating and processing fish is an important feature of Japanese food culture. As shown above, there are some fish remains from Japanese archaeological sites which we could not identify as species, family or parts.

If we can identify the species of these fishes, we will be able to refine our knowledge of the use of fish resources. It will contribute important information to the development of Japanese zooarchaeology. I would be very happy to discuss with you and exchange ideas about those species.

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3000 Years of Fishing on Nayau, Lau Group, Fiji

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This poster describes data I have collected from the Lau Island Group of Fiji and my emerging interpretations. I present research investigating biodiversity and human interaction with the local environment through multiple perspectives on four diverse islands. My interdisciplinary research in central Lau combines the methods of biology, historical ecology, ethnography, and archaeology. First, I generated long-term data on marine diversity and exploitation through zooarchaeological analyses of fauna from sites spanning the region's 3000-year prehistoric human occupation. The study areas are representative of regional fauna and local geographic variation in island size and structure. Each island also varies in terms of human occupation and degree of impacts on marine and terrestrial environments. Second, my ethnographic work recorded modern marine exploitation patterns by Lauan communities. Third, marine biological surveys documented living faunas. Together this information is used to explore the marine environment over the three millennia of human occupation. Using data derived from my multi-pronged study I discuss potential causes of ecological change in this tropical marine setting. My findings include the following: 1) data indicate that the relative intensity of human occupation and exploitation determines the modern composition and biological diversity of marine communities as human disturbance occurred more extensively on larger islands than on smaller islands in Lau; 2) Lauans appear to have targeted similar suites of marine fauna across their 3000 years of history on these islands; 3) Lauans have had a selective effect on marine biodiversity as particular species are and were targeted according to local standards of ranking and preference; 4) marine resources existing today have withstood over 3000 years of human impacts and therefore may have life history traits supporting resilience and making conservation efforts worthwhile.

Perhaps one of the biggest debates among archaeologists and biogeographers who study the Pacific Islands has centered on natural versus human causes of environmental change. Strong arguments have been made on both sides of the debate (Allen 2006; Butler 2001, Morrison and Cochrane 2008; Nunn 2000; Steadman 2006). Determining causality from archaeological data is difficult due to equifinality, the principle that a single outcome--resource change and depletion---can result from different causes. Some researchers have concluded that, "…scientists should stop arguing about the relative importance of different causes of coral reef decline: overfishing, pollution, disease, and climate change. Instead, we must simultaneously reduce all threats to have any hope of reversing the decline" (Pandolfi et al. 2005:1725). Pandolfi and colleagues view the methods of historical ecology as especially valuable in providing comparisons between the past and the present, while also providing a baseline for determining if restoration efforts succeed "in ameliorating or reversing change" (Pandolfi et al. 2005:1726).

Historical ecology fundamentally denies an either/or dichotomy of human versus natural induced changes in the environment; rather, environmental change should be approached through an understanding of the 'landscape,' the human-environment interaction sphere (Balée 1998; Balée and Erickson 2006; Crumley 1994). This perspective argues that the landscape is imbued with meaning and is the product of the collision between nature and culture, which may be examined as a form of architecture, or material culture (Balée and Erickson 2006). I adopt this approach, extending the concepts of historical ecology and landscape to the 'seascape,' associated with islands in Fiji's central Lau Group.

My multidisciplinary research in the Lau Islands contributes a more robust understanding of biodiversity and long-term human interactions with the local marine environment through three perspectives on four diverse islands. This multi-pronged approach incorporates data derived from ethnographic, archaeological, and marine biological research with the aims of characterizing the reef environment, documenting species and biological diversity, and identifying potential changes in the marine ecosystem. The Fiji islands are rich in cultural and biological history with human occupation extending back to approximately 3100 BP (Nunn et al. 2004; Nunn 2007). Fiji's Lau Group is an archipelago of 80 islands, located about 200 km east and 100 km south of the main Fijian islands of Viti Levu and Vanua Levu. The Lau Group is composed of volcanic and coralline limestone islands that are located relatively close together and support extensive reef systems, rich in marine faunal resources. The region has an incredible diversity of marine life and a vibrant traditional culture that is actively engaged in marine-oriented subsistence activities, making it an ideal location to focus research examining marine biodiversity and human exploitation of marine environments over a broad temporal scale. Food is still largely locally derived in this contemporary Pacific community and importantly, compared to other areas in Fiji, the coral reefs of Lau have had relatively little impact by tourism, extensive modern developments, commercial fishing, and high population levels. Moreover, central Lau has been the subject of archaeological and ethnographic research by myself and others, which has laid the groundwork for this project (Best 1984; Hocart 1929; Jones et al. 2007a; Jones et al. 2007b; O'Day 2004; O'Day et al. 2003; Thomas et al. 2004; Thompson 1940).

To explore biodiversity and marine exploitation over the past three millennia, my study investigated four diverse islands in the Lau Group, including Lakeba, Nayau, Aiwa Levu, and Aiwa Lailai. Each island varies in terms of human occupation and the degree of impacts on marine and terrestrial environments. Lakeba is the largest of the study sites (55.84 km^2) and is occupied by about 2100 people. Nayau (18.44 km^2) has a population of approximately 400 people. In contrast, the small islands of Aiwa Levu (1.21 km^2) and Aiwa Lailai (1.0 km^2) are currently uninhabited, lack a fresh water source, and are used primarily as temporary camps for fisher people from Lakeba (12 km away). Geologically the Aiwas consist entirely of limestone and have very little agricultural potential. Lakeba is the most varied topographically and geologically, having limestone regions and large areas of volcanic soils and bedrock (andesitic and dacitic lava) where fresh water is locally available and agriculture is practiced extensively. People living on Lakeba and Nayau maintain dryland and wetland agricultural crops (especially taro, cassava, sweet potato, and yam). Conversely, Aiwa supports diverse native forests with little if any area suitable for agriculture (Jones et al. 2007a). The archaeological sites on these four islands span central Lau's prehistoric occupation, extending from the Lapita period to European contact in 1774. Like Lakeba, Nayau is almost entirely modified by human occupation, with continuous man-made features across the landscape (including gardens, habitation sites, trails, and resource collection areas). The Aiwas also exhibit signs of use island-wide, but this is limited to light surface scatters of artifacts and ecofacts (stone tools, Giant Clam shells, and midden, for example). The reefs surrounding each of the four islands are similar in terms of structure and potential habitat. However, modern development and occupation on Lakeba are much more intensive than that on Nayau (and the uninhabited Aiwas), therefore Lakeba's inshore reefs are likely the most heavily exploited of the study islands. Importantly, Lauans travel to exploit reefs near their islands. This was very likely the case in the past as well. For example, 11 miles east of Lakeba is an area of shallow water where a reef encloses a lagoon; this reef is called Bukatatanoa, a well-known Lakeban fishing ground that is 5 times the size of the reefs surrounding Lakeba. Fisherman travel there in small boats almost daily. While the most obvious and frequently exploited marine areas are those in close proximity to the villages, Lauans do not look upon the sea as a barrier, rather they utilize a variety of environments and frequently move beyond their home shores.

Using the past as a baseline for comparison with the present in order to explore change, the interview and fishing expedition data provide important information about the status of the coral reefs, methods and technologies of exploitation, changes in this environment and presence, absence, or shifts in the local availability of particular resources. A wide range of species are regularly exploited, that is a total of 112 taxa for all three islands. The biological surveys recorded over 200 species of fishes and the archaeological bone identifications include over 50 fish taxa. While there are many factors that influence the outcome of the summary data for each line of evidence, these measures do indicate an overlap in the available resources past and present, and continuity in the way that the marine fauna have been used throughout Lauan history.

Allen (2006) predicts that central Pacific marine productivity declines due to heightened ENSO activity during the LCO-LIA shift around 700 BP, had an obvious signature on marine zooarchaeological assemblages, that is, these climatic changes resulted in environmentally induced cultural change. On Viti Levu Field (2004) documented shifts to fortified settlements around AD 1300-1500 that was accompanied by a broadening diet breadth. The Mid-late period archaeological data from Nayau and Aiwa exhibits minor shifts in the diversity of exploited taxa. A slightly greater diversity in boney fish exploitation occurred during the Mid-late period occupations on Nayau, where a more diverse group of invertebrates were exploited over time. However, there is no evidence for *intensive* declines in marine productivity from the Lauan archaeological data. More obvious declines in invertebrates and large-bodied fishes appear in the modern data, rather than in the archaeological past. Perhaps the data illustrate both Lauan stability and flexibility in marine exploitation patterns, just as D'Arcy suggested for all the inhabitants of Remote Oceania, who have been subject to highly variable climatic shifts throughout their history (2006:21).

The responsible management and conservation of marine ecosystems is critical for Fijians. In the remote Lauan archipelago, the entire population lives on the coast and relies heavily on marine resources for food and their livelihoods. Like coastal ecosystems worldwide, Fiji's marine biodiversity faces the growing threat of overfishing and impacts resulting from pollution, land development, climatic change, and coral bleaching. Compared to other areas of Fiji, the Lau Group is less well studied, but exhibits great marine diversity as the result of smaller human populations, less development, partial isolation, little or no commercial fisheries, and lacks a tourist infrastructure. My multidisciplinary approach contributes to the understanding of Lauan biodiversity through three perspectives, archaeological, ethnographic, and biological. Together this information was used to better understand the marine environment and human interactions with it over the three millennia of human occupation on the study islands. Ultimately, I expect that an evolutionary perspective will facilitate the development of programs for sustainable use of marine resources in the study area and beyond.

Methodologically, this study indicates that each level of data (ethnographic, archaeological, and marine biological) produces different but overlapping results. A better understanding of environmental problems and solutions for dealing with them will come from multi-disciplinary collaborations and the examination of biological complexity over the long term (Biggs et al. 2006; Jackson et al. 2001; Lovejoy 1997). Combining multiple approaches and methodologies will enhance understanding of the issues related to marine changes on local and global scales. A multidisciplinary historical ecological approach holds much promise for the future of research in Fiji and in marine ecosystems worldwide.

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Fish remains from ancient Aleutian archaeological site (Adak island, Aleutian chain) and environmental changes

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In 1997 an ancient midden was found on the Adak Island (Aleutian Islands, Alaska) at the precipitous coast of Clam Lagoon, with numerous remains of invertebrates, mammals, birds and fish (archaeological site ADK-171) (Luttrell and Corbett 2000). In 1999 and 2005 the midden was excavated by members of «The Western Aleutian Archaeological and Paleobiological Project (WAAPP)» and abundant archaeozoological material was collected.

All of the material was water screened in 0.3 cm mesh sieves. The fish remains were identified to the most specific taxon possible, including identifications to order, family, genus, and species. For the quantification of bones we used the number of identified specimens (NISP). In order to ascertain the changes in taxonomic composition, we used the percentage proportion of each species.

Three radiocarbon dates, taken from fish bone collagen, show that the cultural layer was formed about 6,000 years ago (6141±123 yr BP, IEMAE-1281; 6172±192 yr BP, IEMAE-1248; 6525±94 yr BP, IEMAE-1296). These data confirm that ADK-171 is the most ancient site on the central Aleutian Islands and the oldest site with a rich deposit of faunal remains on all of the Aleutian Islands. The midden has a good stratigraphic sequence and includes two layers separated by a layer of redeposited volcanic ash.

The aim of this work was to determine the taxonomic composition of fish from the oldest coastal midden on Adak Island and to compare the results with modern ichthyofauna around the Adak Island.

A total of 30,000 fish bones and otoliths recovered from ADK-171 were analysed. Of these, nearly 13% of the fish remains were identified to family level or beyond (Table 1). At least eight taxons of teleosts were identified in the assemblage.

Of the identifiable fish bones, the overwhelming majority are from greenlings, representing only by *Hexagrammos* genera, and from cod.

The sample produced over 4,114 greenling bones, representing approximately half of all the identified fish remains (48.9%). At the present time four species of the genus *Hexagrammos* are abundant along the Aleutian Archipelago (Isakson *et al* 1971; Simenstad and Nakatani, 1977; Simenstad *et al* 1978; Mecklenburg *et al* 2002). Representatives of this genus are difficult to distinguish from each other and are generally gathered together under the category “greenling” for quantification purposes.

Greenlings are followed in order of occurrence by cod, with 40.8% of the identified NISP (3,430 fragments). Pacific Cod (*Gadus macrocephalus*) remains are not numerous (26 fragments). Basically the material consists of small cod bones and otoliths. Some of the bones of the head and vertebrae and all otoliths discovered belong to the Saffron cod (*Eleginus gracilis;* NISP=454).

Table 1. Fish remains from ADK-171 archaeological site (NISP and relative frequency).

Common name	Scientific name	Lower layer		Upper layer		Total identified (NISP/NSP)	
		NISP	%	NISP	%	NISP	%
Greenlings	*Hexagrammos* sp.	1053	55.4	3061	47.0	4114	48.9
Cod	Gadidae	736	38.7	2694	41.3	3430	40.8
Among them:							
Saffron Cod	*Eleginus gracilis*	93	12.6	361	13.4	454	13.2
Pacific Cod	*Gadus macrocephalus*	17	2.3	9	0,3	26	0.8
Flatfish	Pleuronectidae	100	5.3	675	10.4	775	9.2
Among them:							
Pacific Halibut	*Hippoglossus stenolepis*	33	33.0	151	22.4	184	23.7
Starry flounder	*Platichthys stellatus*	15	15.0	70	10.4	85	11.0
Rockfish	Sebastidae	3	0.2	34	0.5	37	0.4
Sculpins	Cottidae	3	0.2	50	0.8	53	0.6
Salmonids	Salmonidae	3	0.2	2	<0.1	5	0.1
Total identified (NISP)		1898		6516		8414	
Total examined (NISP)		7528		22,804		30,332	

Flatfish comprise 9.2% of the identified remains (N=775). The majority of the flatfish remains stem from small-scale fish. Part of the assemblage belongs to Halibut (23.7%; N=184) and the Starry flounder, dermal "stars" of which were found (11.0%; 85 pieces). Mostly the Halibut remains are heavily fragmented bones and complete elements are very few.

The relative shares of rock-fish (*Sebastidae*) and sculpins (*Cottidae*) are 0.5% and 0.8%, respectively.

Remains of salmonids are very few; only five bones of *Oncorhynchus* sp. were found.

In present days all of the species or groups of species which were found in the material from ADK-171 are abundant in waters around Adak Island, except for Saffron Cod. Saffron Cod is very rare in the area of the Western and Central part of the Aleutian Islands (Howes, 1991; Mecklenburg et al., 2002). Remains of Saffron Cod were not found in material from later archaeological sites on Adak Island (Orchard, 2003; Crockford 2006), nor in archaeozoological material from other Aleutian islands (Lefevre *et al* 1997). In contrast, the remains of Pacific Cod are almost always numerous in assemblages from Aleutian archaeological sites of different periods (Aigner, 1976; Orchard, 2003; Crockford 2004, 2006).

Saffron cod is a demersal dweller, but also enters brackish waters and rivers up to the limit of tidal influence. Adults exhibit seasonal movements: inshore during winter for purposes of spawning and offshore during summer for feeding. Throughout its distribution area, spawning occurs during January-February in the coastal zones of bays and inlets on sand-gravel substrate and in strong tidal currents with low temperatures (down to –1.8˚C). Saffron Cod prefers a polar climate (Cohen et al., 1990) and, in comparison with Pacific Cod, Saffron Cod prefers a cooler environment and at the present time mostly inhabits the shelf area where shore ice exists in winter time.

Therefore we can suppose that during the time of the ADK-171 settlement the environment was cooler and Saffron Cod was able to inhabit waters around the Adak Island. According to the diatom analysis data, it was the coldest period across the Holocene (Savinetsky *et al* in press). Clam Lagoon, with a soft bottom surface, was the acceptable place for Saffron Cod spawning and local people took the opportunity to fish for Saffron Cod in the winter time.

Viewed in percentage terms from the lower layer to the upper, the proportion of greenlings decreased slightly but the quantity of flatfish almost doubled. The percentage of cod showed little change. But amongst them the part played by the Pacific cod altered significantly, decreasing noticeably from the lower layer to the upper layer. The most significant change lay in the share of flatfish. The abundance of the main species – greenlings and cod – did not change appreciably.

Previous analysis of the marine mammal remains showed that the most commonly hunted species were sea lion, sea otter, fur seal and harbor seal (Krylovich 2007). All of these species, except for fur seals, live around the Adak Island at the present time. The analysis of the invertebrate remains shows that all of the species found in the archaeological deposits live in the coastal zone of Adak Island nowadays (Antipushina 2006). But the molluscs taxonomic composition changed significantly during the existence of the settlement. The share of the mussel remains and other epifaunal species (chitons, gastropods and barnacles) is halved from the lower layer to the upper layer. And the share of Nuttall's cockle increased with time, as well as the share of other bivalves inhabiting the sand ground, and sea urchins (Antipushina 2006). Two reasons were proposed to explain this situation. The first reason was the changing of the lagoon tidal zone substrate character (rocky vs. sand bottom) and consequently the change in invertebrate fauna (epifaunal species vs. inhabitants of sandy ground). The second possible reason is that the hunting for sea otter in an almost closed lagoon resulted in a decrease of their abundance there. This in turn brought the increased abundance of clams and sea urchins in the lagoon and accordingly into the diet of the ancient settlers.

The change in flatfish proportions can be connected with both suggested hypotheses – the alteration of the bottom substrate character or the decreased sea otter population. Flatfish in the region of the Adak Island are inhabitants by preference of bare soft substrates (Mecklenburg *et al* 2002). After the reduction of sea otter predation on sea urchins, sea urchins by their grazing activity thinned out vegetation in the lagoon and thereby created more open parcels of sea bottom – an environment preferred by flatfish.

Six thousands years ago settlers of the Clam Lagoon caught Greenlings and small gadoids in large quantities. Flatfish, sculpins and rock-fish were captured in lesser quantities. Large scale Pacific Cod and Halibut were rarely obtained. All of these species, except Saffron Cod, are abundant in the coastal waters of Adak Island nowadays. During the period of the settlement the abundance of the main species did not change, except for the increased presence of flatfish. Two reasons might have affected the flatfish population - changes in the bottom substrate character or a decrease in the sea otter population. The remains of Saffron Cod indicate winter fishing and confirm the presence of a cooler environment 6,000 years ago.

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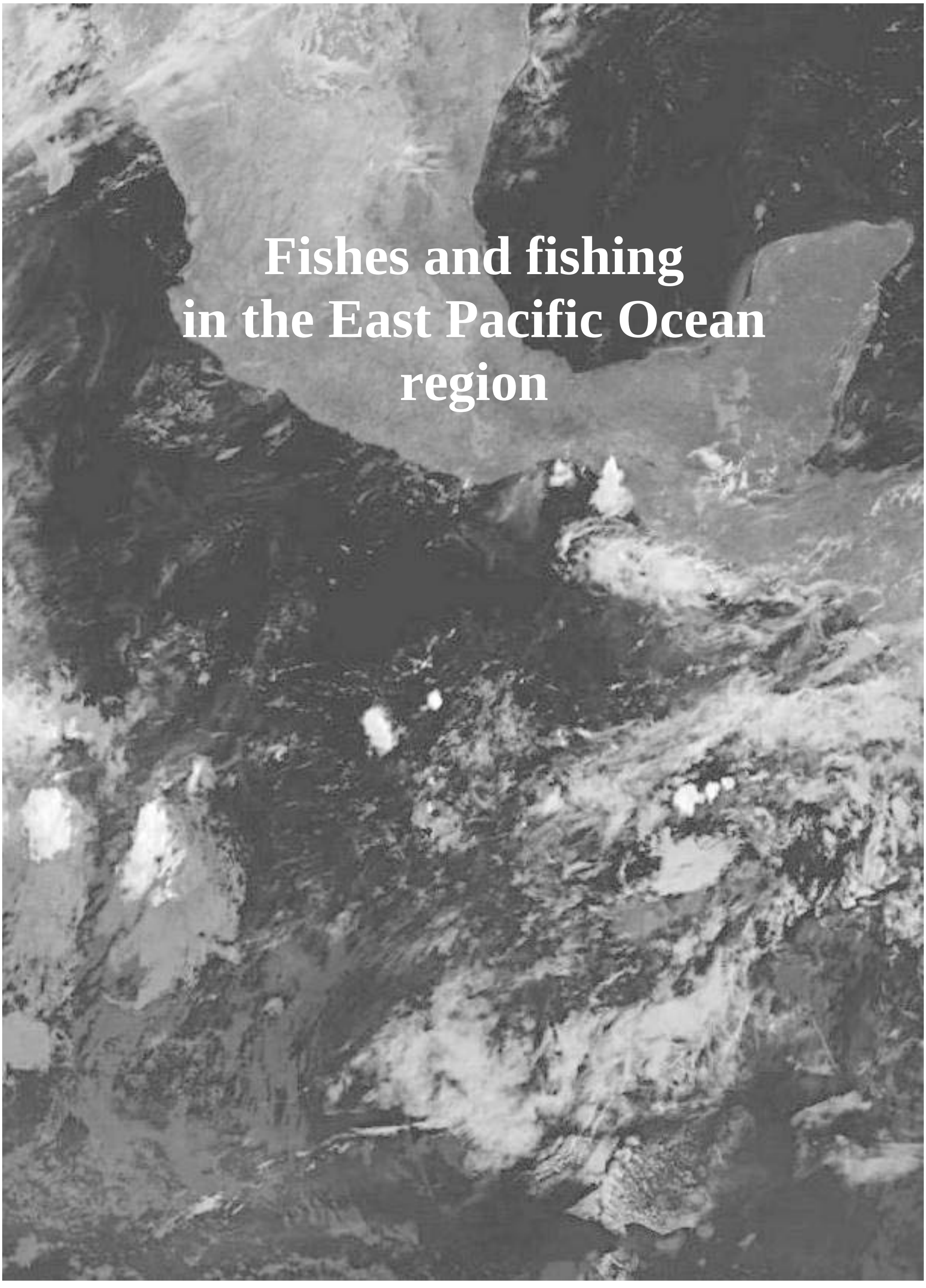
Simenstad C.A., Nakatani R.E., 1977: Near shore fish communities of Attu Island, Alaska. Fisheries Research Institute, Anchorage).


Fishes and fishing
in the East Pacific Ocean
region

Fishing at pre-Hispanic settlements on the Pearl Island archipelago (Panama, Pacific), I: Pedro González Island (4030-3630 cal BCE)

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The Pearl Island archipelago lies 50-80 km off the Pacific coast of Panama (Fig.1). Swedish archaeologist Sigvald Linné surveyed five islands in the 1920s. He recorded several shell-bearing middens containing sherds belonging to two pottery complexes; but only described mollusc remains (Linné, 1929). In 2006 Panama's National Secretariat for Science, Technology and Innovation (SENACYT) funded surveys and test-excavations under the supervision of R. Cooke.

Fig. 1. Location of the Pearl Islands

Our principal objective was to mitigate impacts of forthcoming construction projects by transmitting the scientific importance of island archaeological resources in the context of cultural and biological diversity. Many important books and articles about island zoogeographical theory have discussed Pearl Island faunas (e.g., MacArthur & Wilson, 1967; MacArthur *et al.*, 1972).

Pre-European humans are known to have exterminated or extirpated many animal species on island groups all over the world (e.g., Anderton, 2002; Jones, 2007; Mann *et al*., 2008; Steadman, 2006; Wing, 1989; Worthy & Holdaway, 2002). They presumably impacted Pearl Island faunas as well.

To date, over 100 archaeological localities have been identified on ten islands (underlined in Fig. 2). One site on Pedro González Island is Preceramic. Six calibrated radiocarbon dates anchor its occupation to 4030-3630 BCE. All other sites contain decorated pottery belonging to three different complexes (1/ 200 BCE - 250 CE, 2/ 550-700 CE and 3/ 1000-1200 CE). We are unsure whether these complexes represent different occupations separated by temporal hiatuses. Spanish chronicles written at contact (1515 CE) describe Isla del Rey as well populated and amply cultivated. Its chieftain would attack mainland villages with canoes. His power seems to have been enhanced by controlling the acquisition of pearls and mother-of-pearl, which were important exchange items all over tropical America. Mortuary features at site L-100 (Pedro González) provided evidence for portable luxury items (polished greenstone nose decorations). Spindle whorls found at this site vouch for the local production of cotton textiles.

Fig. 2. Archaeological localities on the Pearl Island archipelago.

At this conference we will present preliminary evaluations of fishing at the Preceramic site on Pedro González Island and at a Ceramic site (BY-10) on nearby Bayoneta Island whose pottery suggests occupation between 900 and 1300 BCE.

The Preceramic site is located alongside a sandy beach, which will soon be developed for international tourism (red arrow in Figure 3, left). Sea level would have been 5-10 m lower ~5800 BP. Therefore the site would not have been as close to the marine shore as it is today. Soil auger soundings indicate that the Preceramic shell-bearing midden covers ca. 1300 m^2. Our two small test pits (1x1 m [2008] and 1x2 m [2008-9]) revealed that the Preceramic midden lies under a shell-less ceramic-age soil, and is between 0.8 and 2.6 m deep. The overlapping (at 2σ) of six radiocarbon dates from top to bottom alludes to a single sea-borne colonization event (Fig. 4).

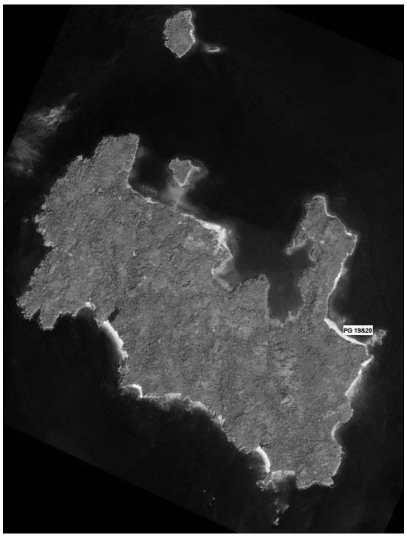

Fig. 3. Pedro González Island

Immigrants cleared and burnt island vegetation and impacted the terrestrial fauna. Starch grains on a one-hand grinding stone show they cultivated maize. Deer and opossum bones dominate the non-fish vertebrate simple. Neither taxon is present on this island today. Mud turtles (*Kinosternon* spp.) and monkeys (cf *Cebus*), also present, have not been recorded anywhere on the archipelago. Adult deer bones are smaller than the three extant deer species found in Panama today. Dwarfing in island mammals (van Valen, 1973) has been reported elsewhere in Panama (Anderson & Handley, 2002).

Fish remains flood the vertebrate bone samples. In the 2x1m test pit (PG-20, 2009), fish represent 96.3% of the 24,250 vertebrate specimens recovered in the field over 1/8" (3.2 mm). To date, 25 families, 49 genera and at least 70 species have been identified in a sample of ~1100 taxonomically significant bones. One level (105-115 cm) in cut PG-19 (2008) was sieved through geological screens to 0.125 m. Fig. 5 summarizes the distribution of fish NISP at the genus level. The five most frequent genera are: grunts (*Haemulon;* five species), sergeant-majors (*Abudefuf*, two species), jacks (*Caranx*, three species), groupers (Serranidae, six species), and parrot-fsh (*Scarus*). All these taxa are abundant today around the rocky shores, sandy beaches and small fringing reefs of the archipelago. We estimate that most grunt and grouper individuals in the Preceramic sample had a body mass of <500g when fished. The two sergeant-majors rarely exceed 150 g. Today they are abundant around rocks and quays and are often caught by small children using hook and line. Most parrot fish individuals are estimated to have weighed 2-4 kg. Some hawkfish (*Cirrhitus rivulatus*), Mexican hogfish (*Bodianus diplotaenia*) and scorpion fish (*Scorpaena mystes*) weighed ~2 kg. Intuitively, it appears that the Preceramic colonists were able to exploit a healthy reef fauna. There are many eel remains (*Gymnothorax* and *Muraena*). In the near future we expect to be able to establish size ranges using allometry because the samples preserve many intact and measurable bones.

The Preceramic fisherfolk took some species that swim in clear water currents near the surface. 80% of *Caranx* bones in the fine-screened sub-sample from PG-19 represent the green jack (*Caranx caballus*). Black skipjack (*Euthynnus lineatus*), amberjack (*Seriola* spp.) and shad mackerel (*Decapterus* sp.) were also captured.

Fig. 4. North wall of test pit PG-19 at Playa Don Bernardo showing the radiocarbon ages of the Preceramic shell-bearing midden

Some amberjack (*Seriola rivoliana*) and skipjack probably weighed >2.5 kg. Although it is possible that these species were taken with hooks, we have not found evidence for this fishing method in the cultural record. A clue that they may have been *netted* is provided by finds of over 100 dolphin (Delphinidae) bones and teeth. According to Thomas Wake, who generously identified the material at the Los Angeles County Museum, three species are present: bottle-nosed dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*) and a species of oceanic dolphin (*Stenella*). Periotic bones point to at least three individuals of common dolphin (Figure 6). Unlike oft-stranded sperm whales (*Physeter catodon*), whose teeth were carved into ornaments in pre-Columbian Panama (Cooke 2004), dolphins are agile animals that rarely beach. We propose that schools of jacks, skipjack and other fast swimming species, which habitually make forays around shallow clear-water bays, were taken with nets extended from rocky promontories near Playa Don Bernardo using dug-outs; from time to time, dolphins would become enmeshed as they pursued the incoming schools of fish. A basioccipital bone of a common dolphin has a puncture wound that may have been made with a weapon.

The presence of some benthic species in the Preceramic sample (e.g., toadfish [*Daector* spp.], sea catfish (Ariidae spp.) and porcupine fish [*Diodon* spp.]) suggests that the stone-walled intertidal traps that are found around all the larger islands may have been in use at this time. (Some of these appear to have been constructed when sea level was lower than today) (*see* next paper for additional details).

The distribution of sea catfish (Ariidae) species in the Preceramic site mirrors the results we reported on at the last FRWG conference: only the cominate sea-catfish (*Occidentarius platypogon*), an apparently un-described *Notarius* species, and the chili sea catfish (*Notarius troschelii*) have been identified. The high frequency of the first species (NISP-17, 58% diagnostic ariid bones) accords with its more marine and less estuarine propensities than those of other eastern tropical Pacific sea catfish (Cooke & Jiménez, 2008).

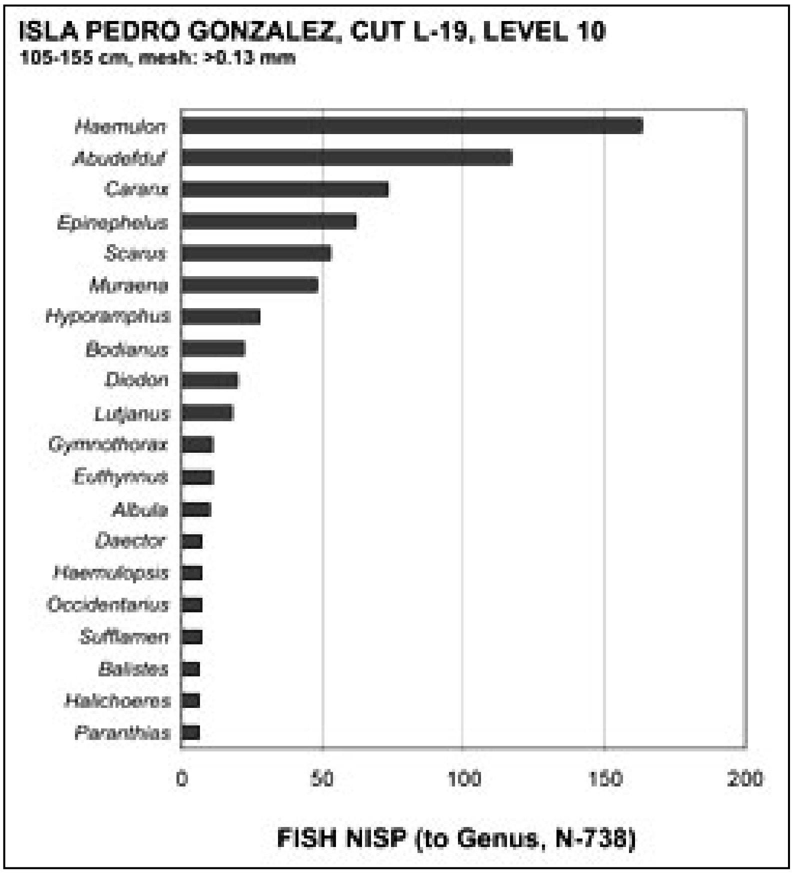

Fig. 5. Distribution of fish NISP at the genus level.

Summing up, our preliminary observations on the fishing strategies of the earliest inhabitants of the Pearl Island archipelago in Panama (~4000-3600 BCE) point towards fishing around reefs, rocks and sandy beaches near the site. The use of nets is inferred by captures of dolphins (Delphinidae spp.) and schooling pelagic fish species that often enter shallow bays hugging the coastline. Swedish ethnographer Nordenskiőld (1928: 28) mentioned that islanders of African descent fished with hook-and-line and poison. These methods seem the most appropriate for capturing the smallish grunts, groupers, sergeant-majors and other reef fish that the Preceramic settlers on Pedro González beach captured most frequently. The next stage in this research is to undertake a more detailed evaluation of changes in the exploited fish faunas through time by comparing Preceramic and Ceramic archaeo-ichthyofaunas taxonomically and allometrically.

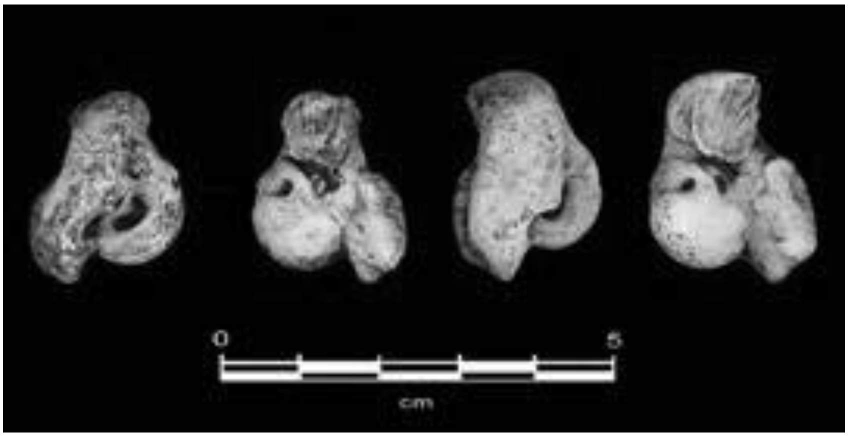

Fig. 6. Two common dolphin (*Delphinus delphis*) periotics found in cut PG-19 at the Preceramic site on Playa Don Bernardo. Id: T. Wake, Cotsen Institute of Archaeology

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Fishing at pre-Hispanic settlements on the Pearl Island archipelago (Panama, Pacific), II: Bayoneta Island (900-1300CE)

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The Pearl Island survey and text-excavation project directed by R. Cooke and supported by Panama's National Secretariat for Science, Technology and Innovation (SENACYT), included an evaluation of archaeological sites on Bayoneta Island (Fig. 1). Surveys undertaken by J.G. Martín, D.R. Carvajal and A. Lara in 2007 identified clusters of shell-bearing middens in four areas of the island (1/ BY-5 & 6 and Loc 7, 2/ BY 2, 3 & 4, 3/ BY 7 & 8, and 4/ BY 9-12 [Fig. 2]). In 2008 Mexican archaeologists Ana Katalina Celis and Saraí Borreiro cleared and mapped the last two site clusters, which appear to have been groups of dwellings and their shell-bearing middens (Fig. 1). The BY 9-12 cluster appears to have been occupied later in time that the others. Pottery found here is similar to wares reported at two mainland sites: Cocolí (1270-1390 CE) and Panamá La Vieja (900-1260 CE). We are assuming therefore that the fish bone sample referred to below is likely to date between ca. 900 and 1300 CE.

Fig. 1: Vista of shell-bearing midden clusters at BY-10., Bayoneta Island, Pearl Island archipelago

Celis and Borreiro recovered abundant invertebrate and vertebrate remains in test excavations and as column samples. In 2007, Maria Fernanda Martínez was awarded a Short-Term Student Fellowship at the Smithsonian Tropical Research Institute in Panama in order to study a sample of fish bones from a 1 x 1 m test excavation (BY 10-CM-B1), level II (66-133 cm). These bones were collected in the field over a 1/8" (3.2 mm) wire mesh. Bones recovered over nested geological sieves (to 0.13 mm) have not yet been analyzed. In spite of this bias these samples invite comparison with others taken in the same fashion at the Preceramic site on Pedro González Island (~4000-3600 BCE). Ninety-nine percent of the 2216 vertebrate remains were Fish. Of these, 1877 (84%) were considered to be diagnostic to Family, 1635 (74%) to genus and 1581 (71%) to species (assuming that the species present in pre-Columbian time are the same ones that inhabit Panamanian inshore waters today). Twenty-seven families, 54 genera and at least 92 species are represented. Only four elasmobranch bones were recovered from three taxa (possible hammerhead shark [*Sphyrna*], electric ray *[Narcine*] and reef shark [*Carcarhinus*]). This much lower elasmobranch frequency than at mainland Panamanian sites (e.g. Cooke and Ranere, 1999; Jiménez & Cooke, 2001) probably reflects low input from estuarine habitats.

The top twenty genera by NISP at BY-10 are presented in Fig. 3. Small fish of the reef-loving genera *Haemulon* (Haemulidae), *Abudefduf* (Pomacentridae) and *Epinephelus* (Serranidae) – many of whose species congregate in shoals - make up 28% NISP. These genera together represent 45% NISP in the Preceramic sample from Pedro González Island (taken with the same mesh size).

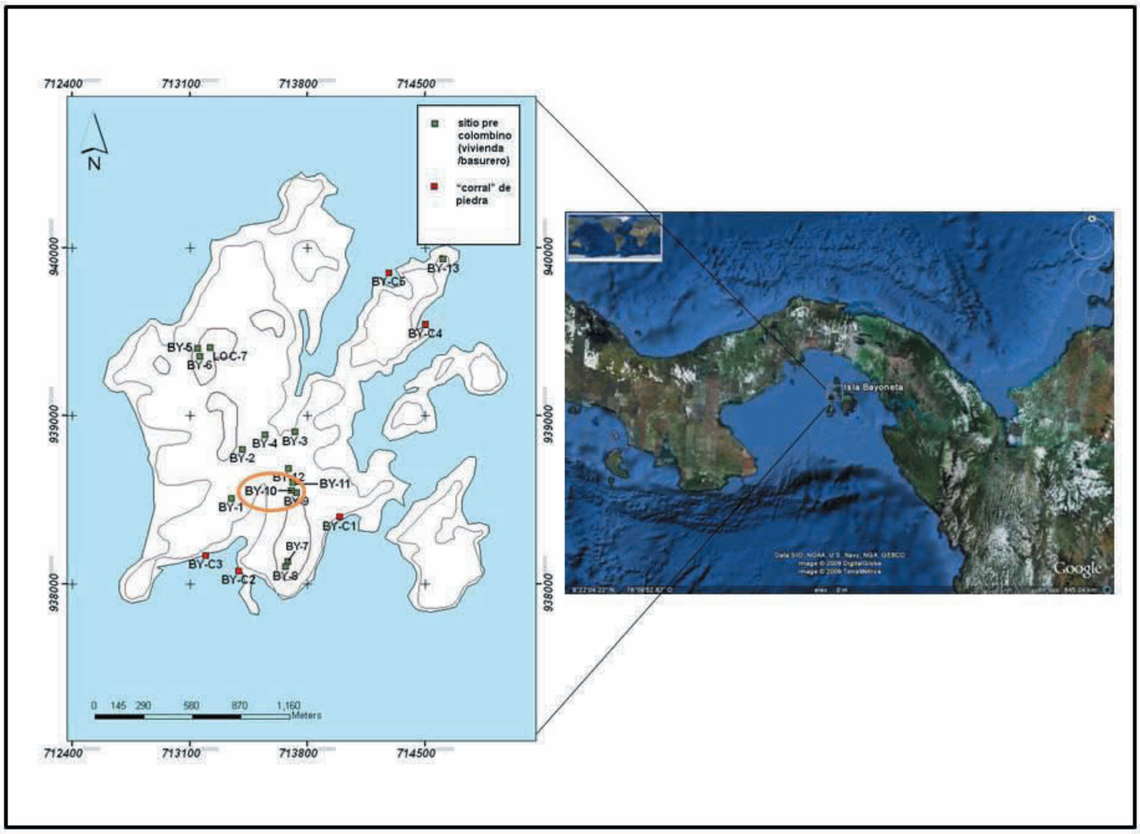

Fig. 2: Bayoneta Island, showing the location of pre-Columbian sites

The top-ranked genus at BY-10 is *Orthopristis* (Haemulidae), represented by a single species in Panama - the humpback grunt (*O. chalceus*). This species is found near reefs but tends to congregate over sand or rubble bottoms (Robertson and Allen, 2006). The fact that it is extremely rare in the Preceramic site draws attention to other differences with BY-10, which may be the result of 1) different fishing techniques, 2) human impacts through time (over-fishing) or 3) differences in habitat distribution on the two islands. It is worthy of note that the humpback grunt is frequent at ceramic-age sites along the central Pacific coast of Panama, but uncommon at the Preceramic site of Cerro Mangote (Cooke & Ranere, 1999). In figures 4 and 5, we have compared the distribution of the ten top-ranked fish genera and species at each site. Other genera that are significantly more frequent at BY-10 are toadfish (*Batrachoides* and *Daector*) and porcupine-fish (*Diodon*). Cooke and Jiménez suggested in the former paper that the greater frequency, not only of benthic fish, like toadfish and sea catfish (Ariidae), but also porcupine fish, may be related to the increasing use in Ceramic times of the stone-walled semicircular traps that have been located around most islands (Fig. 6). Ana Celis recovered fish in traps at two islands (Saboga and Gibraleón) in 2008.

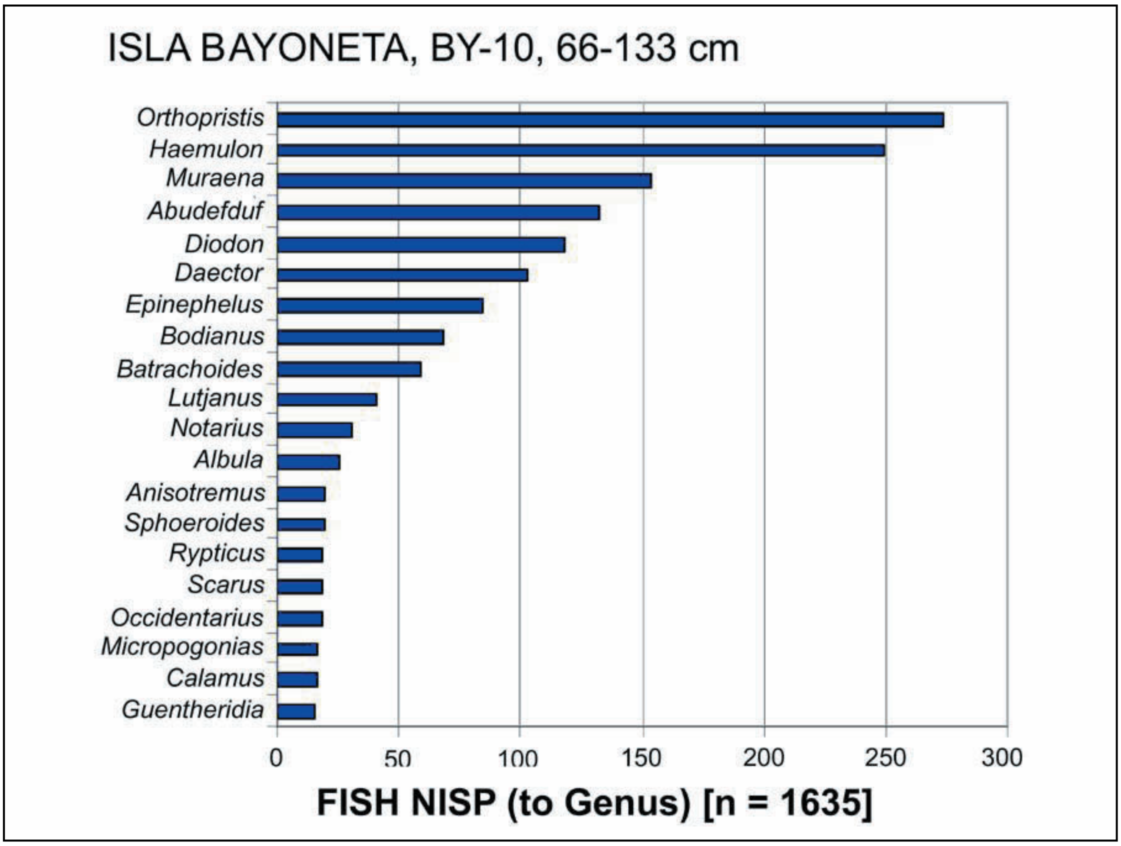

Fig. 3. Isla Bayoneta - the top twenty genera by NISP at BY-10

She collected fifteen *Diodon holocanthus*, one *D. hystrix*, one houndfish (*Tylosurus crocodilus*) and one puffer-fish (*Guentheridia formosa*) in a stone trap without a superstructure; and one porcupine fish, four sea catfish (*Ariopsis seemanni*), two chub (*Kyphosus elegans*) and one grouper (*Epinephelus labriformis*) in a damaged corral mended with pieces of gill net. It is imperative that we make more formal and regular collections to ascertain the fish species that can be caught in this way.

It is interesting that parrot fish (*Scarus* spp.) were taken more regularly at the Preceramic than at the Ceramic site. Intuitive evaluation of the sizes of parrot fish in the two samples (by the comparative method) suggest that the body mass of parrot fish diminished in size between Preceramic and Ceramic times. We expect to investigate this hypothesis more carefully in the near future by using bone dimension allometry.

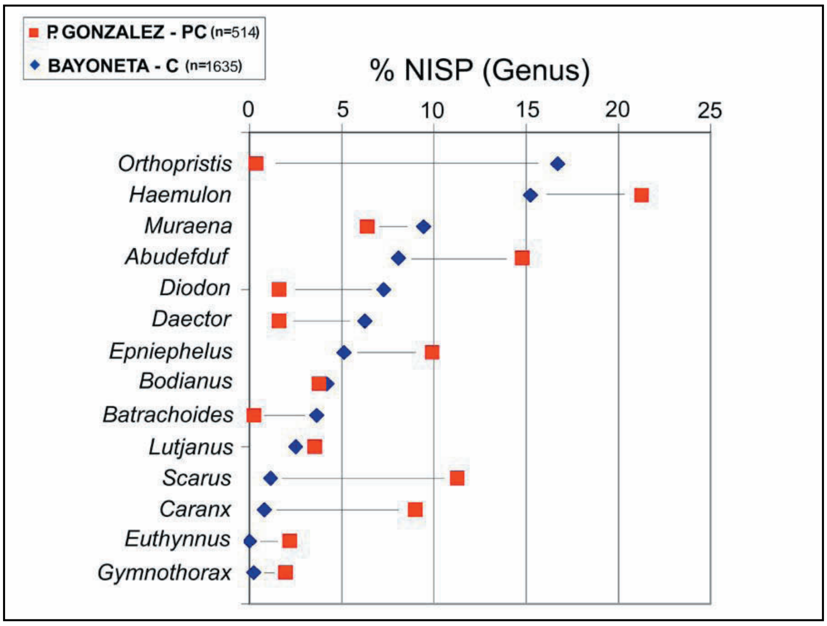

Fig. 4. Distribution of the ten top-ranked fish genera at each site

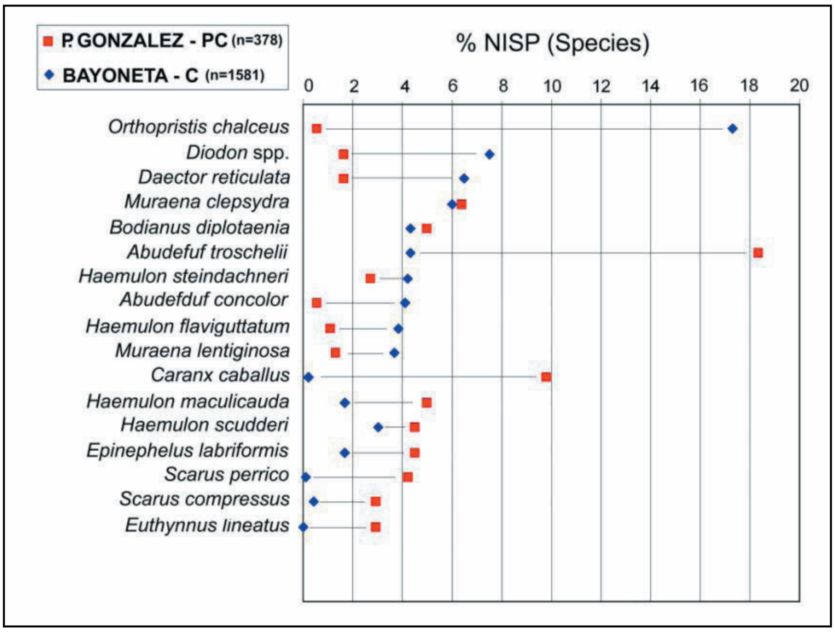

Fig. 5. distribution of the ten top-ranked fish species at each site

Cooke & Jiménez pointed out in the earlier paper that the green jack (*Caranx caballus*) was frequently taken at the Preceramic site. The striped skipjack (*Euthynnus lineatus*) is another species that frequents clear water currents near the surface. The latter species was not recorded at the Ceramic site on Bayoneta Island while the green jack was considerably less frequent (Fig. 5). These differences suggest that Ceramic peoples did not actively seek out these fish, perhaps because they were less adept at using boats and gill-nets, perhaps because fishing with stone-walled traps was more efficient.

Lastly, this preliminary evaluation of the differences between Preceramic and Ceramic fishing suggests that some species were taken with similar frequency during both time-periods, e.g. the Mexican hogfish (*Bodianus diplotaenia*), eels (*Muraena* spp. and *Gymnothorax* spp.) and snappers (*Lutjanus*).

Fig. 6. Stone fish weir, of presumed pre-Columbian age, on Pedro González island

As this project advances, we will analyze more samples across and within sites. This will fine-tune spatial and temporal comparisons. We will also compare bone dimensions in prehistoric and modern fish. We hope that these developments will turn preliminary observations into strong hypotheses concerning changes in fishing strategies and techniques, and the human exploitation and over-exploitation of tropical island fish faunas.

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Fishing the Chilean Fjords in pre-Hispanic times. Evidence from Juan Stuven Island

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The occupational history of the Patagonian channels is still not clearly understood. One unsolved research question is how far the influence of two cultural or ethnic groups extended: namely the « Alakaluf » in the south and the « Chono » in the north. Another question is the degree to which their adaptations were maritime in nature. Aside from a few ethnographic observations and data from Curry's (1991, 1999) surveys around Puerto Edén, nothing is known about the pre-contact economy of these two groups in the central zone of the archipelago.

In order to investigate these specific questions, the French Archaeological Programme « Les voies de peuplement des archipels de Patagonie » undertook a survey of northern Patagonia, between Chiloé Island and Puerto Éden, during the austral summer months of 2003-2005. In January 2005 the Stuven-1 site was discovered. This is a large shell midden at the northwest end of Juan Stuven Island, close to the northern entrance to the Messier Channel (*c* 48°S), in the southern part of the Gulf of Penas.

Previously, only middens dating from the Christian Era have been observed in this area (Legoupil *et al* 2007). The Stuven-1 site furnished a date of 2225 ± 45 BP for the deepest level (level 7) and one of 1340 ± 30 BP for level 3.

Estimated to cover 150-200 m^2, this site is located on a terrace in a small sheltered creek, 3 to 4 m above sea level. A 4 by 1 m trench was excavated roughly perpendicular to the shore. Cultural deposits reached a depth of almost 2 m. The resulting 8 m^3 of sediments produced 10,940 vertebrate bones, more than 50,000 shell remains, and some thirty artifacts, mostly made of bone. About 55% of the vertebrate remains could be identified. Fish represented 81% of the vertebrate NISP, marine mammals 12% and birds, 7%. Fish diversity is relatively low since only seven species were recognized (Table 1).

Table 1. Proportions of fish species : NISP, MNI and weight (g).

		NISP	**%NISP**	**MNI**	**%MNI**	**W**	**%W**
Scorpaenidae	*Sebastes oculatus*	3141	70.24	271	66.75	373.9	39.99
Gempylidae	*Thyrsites atun*	1227	27.44	91	22.41	529.9	56.68
Moridae	*Salilota australis*	72	1.61	26	6.40	15.1	1.62
Carangidae	*Trachurus murphyi*	27	0.60	14	3.45	15.2	1.63
Eleginopidae	*Eleginops maclovinus*	3	0.07	2	0.49	0.2	0.02
Ophidiidae	*Genypterus blacodes*	1	0.02	1	0.25	0.1	0.01
Polyprionidae	*Polyprion oxygeneios*	1	0.02	1	0.25	0.5	0.05
UID		3586				224.1	
Total NISP		**4472**		**406**		**934.9**	
Grand total		**8058**		**406**		**1159**	
Identification ratio		55%				81%	

The two dominant fish species in the the Stuven-1 faunal sample represent nearly 98% NISP:

a) the barracouta or sierra, *Thyrsites atun*, is a coastal pelagic fish that comes to the surface at night. It occurs all along the Chilean littoral. It is a schooling predator, which can exceed 1 m in length. Individuals in the sample are estimated to have weighed 1-4 kg (average - 2.5 kg);
b) the Patagonian redfish or cabrilla, *Sebastes oculatus*, a basal species that lives on coastal rock beds, from 5 to 10 m depth. It rarely exceeds 0.40 m in length and 1 kg in weight. The specimens recovered are estimated to be from individuals weighing between 100 and 1,500 g. Average weight is approximately 300 g.

The deepest midden layers, especially levels 6 and 7, are the richest. They contain mainly fish bones, which are considerably more abundant than in the upper layers where marine mammals and birds gain importance. The number of barracouta increases with time: it is nearly absent from the lower levels, but it approaches the abundance of the redfish in the higher levels (Fig. 1). This change seems to have occurred between levels 6 and 5.

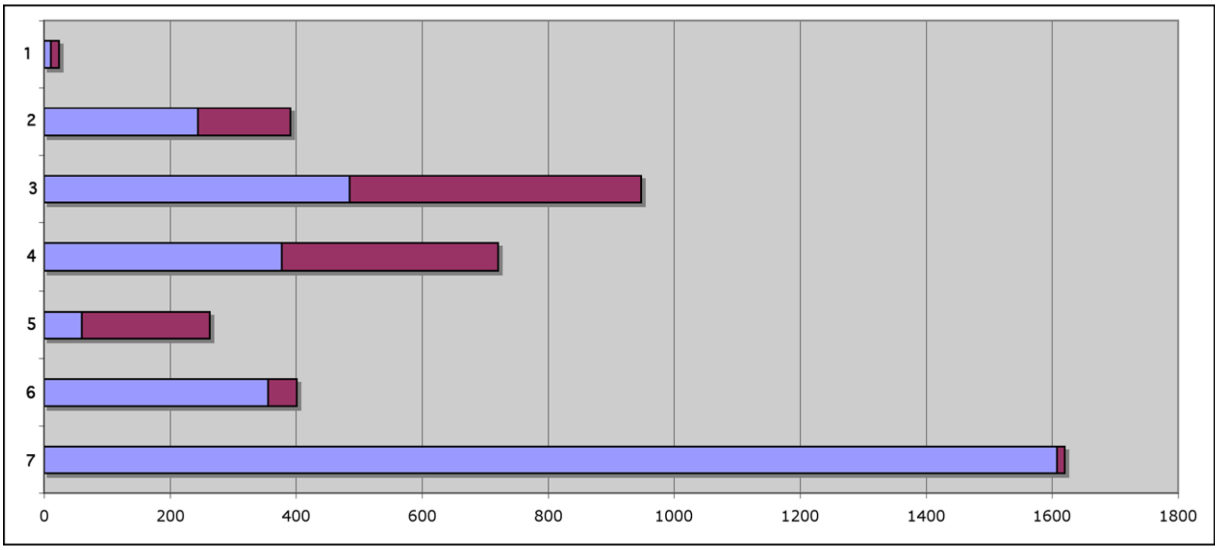

Fig. 1. Evolution of NISP of redfish (blue) and barracouta (red) through the stratigraphic sequence (levels 7 to 1).

The ichthyofaunal record informs us about the habitats that pre-Hispanic fishermen exploited and the fishing techniques that they may have used. Two groups of fish can be distinguished on the basis of behaviour and predicted habitat: 1) *benthic* -with the redfish as target species, and the tadpole codling (*Salilota australis*) and wreckfish (*Polyprion oxygeneios*) as by-product catches; 2) *pelagic* -with the barracouta as target species, and the horse mackerel (*Trachurus murphyi*) captured occasionally. These two groups of fish would have been taken over rocky bottoms in water at least 5 m in depth (probably from 10 to 30 m). Line-fishing from canoes is the most likely method of capture, sometimes with lines on the bottom, and sometimes with the hook left half way down the water column in order to exploit other groups of fish simultaneously. This mode of exploitation seems to us to be the simplest. Nets may also have been used ; but they would require more elaborate tools for their manufacture. We recovered no artifacts, however, which would confirm the use either of hook-and-line or nets. Most bone artifacts are harpoon-heads, which we presume were used to hunt sea-lions.

Our data show that the horse mackerel ventured into the Patagonian channels during the period 2500 -1300 BP. It is reasonable to suppose that it did so during summer months. Whether its present-day absence from this latitude in Chile is due to climate change or defective modern records, remains to be seen.

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The golden fish. Subsistence changes and dietary implications of littoral fishing among sea nomads of Tierra del Fuego

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Introduction

In previous papers it has been shown that an increase in fish exploitation and an improvement in fishing strategies in hunter-gatherer subsistence happened around 500 years BP in the Fuegian Archipelago (Figure 1). This process was characterized by a significant increase in littoral fishing and a diversification in offshore fishing (Zangrando 2007, 2008, 2009). This paper addresses this issue by assessing the relative dietary contribution of littoral fishing in a long-term scale. The "weight method" approach is applied to evaluate the relative meat and caloric yields of littoral fish species. This analysis allows us to evaluate properly the implications of littoral fishing in subsistence change among hunter-gatherer populations of the southern end of South America.

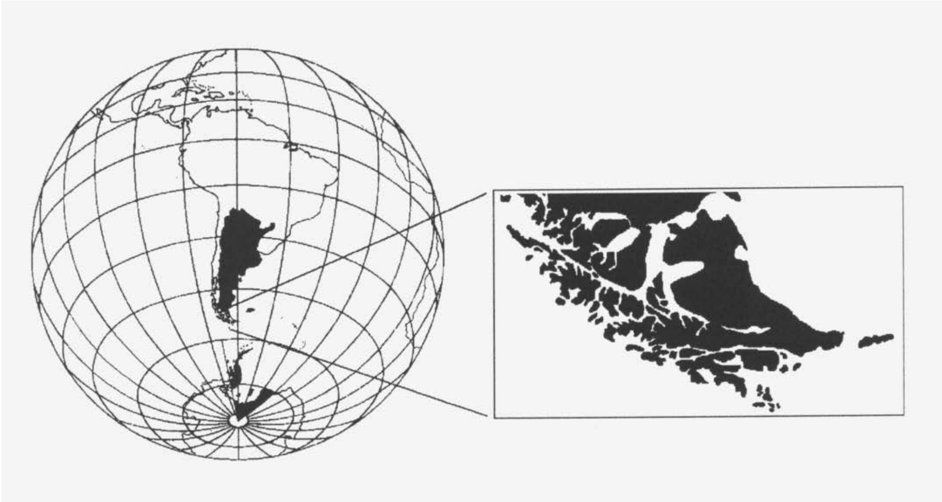

Fig. 1. Fuegian Archipelago

Zooarchaeological data of littoral fishing on the Beagle Channel Region: the state of the art

The exploitation of littoral and marine fish resources is evidenced throughout the archaeological sequence of the Beagle Channel region, starting approximately 6400 years BP (Zangrando 2008). The fish remains represent 11 species belonging to 8 families, and almost all the bone elements of the different species are represented. Previous taphonomic studies indicate that there is no correlation between the mineral density of each bone and its respective MAU% in assemblages with diverse radiocarbon dates (Zangrando 2003, 2007, 2008). This suggests that there was not a significant bone loss through time.

Concerning littoral fish, remains of *Paranotothenia magellanica* and *Patagonotothen* sp. dominate the fishbone assemblages of the whole archaeological sequence. With the exceptions of two assemblages (layer F of Mischiúen I and Fifth Component of Túnel I), these taxa contribute 80% of the remains identified as littoral species. In contrast, other species which inhabited onshore waters, such as *Austrolycus* sp., *Cottoperca gobio* and *A. nigricans*, are sparsely represented. The low representations of the first two taxa are expected because of their low potential yield; nevertheless, a larger representation of *A. nigricans* would be expected because of its gregarious behaviour. The low frequency of *Eleginops maclovinus* in late assemblages of the archaeological sequence was also unexpected, since it is the coastal species with the highest biomass and distribution in the Beagle Channel (López *et al*. 1996). It is important to point out that no species of the *Nototheniidae* family present gregarious behaviour; consequently it is difficult to propose relative differences in relation to this factor. On the other hand, there is a wide variety of fishing strategies throughout the whole archaeological sequence, which were used in diverse environmental settings. Therefore, there seems to be no basis to argue that the lack of *Eleginops maclovinus* in the archaeological record was a consequence of technical limitations. In a previous paper, we suggest that the low consumption of this resource of high potential yield implies a social "restriction," "prohibition" or "avoidance" in the subsistence sphere (Fiore and Zangrando 2006).

In sum, the relative abundance of fish remains increases significantly in recent archaeological assemblages, but the ichthyoarchaeological data reveal that this augment in fish exploitation took place specifically on *Paranotothenia magellanica* y *Patagonotothen* sp.

Exploring dietary contributions of *Paranotothenia magellanica*

The present analysis is based on column and subunit samples with standardized volumes, which were taken from the already studied archaeological assemblages of the Beagle Channel region. The core and column samples were used in this analysis for two reasons. First, there are important differences between sample sizes of excavation units in the Beagle Channel sequence; since frequencies of fish remains are sensitive to assemblage size, I normalized the comparisons using core and column samples. Second, excavation strategies of extensive units were exposed to biases in sampling of fish remains, which underrepresented small species in the archaeological contexts of the Beagle Channel (Zangrando 2008).

To estimate the quantity of fish meat available on the basis of their bone remains, a modern comparative sample of 37 individuals of *Paranotothenia magellanica* was used in this study. This species was chosen because it dominates among littoral fish representations; on the other hand, the modern samples of another littoral fish are still small to obtain accurate equations. The sample of *Paranotothenia magellanica* had standard lengths ranging from 97.4 to 209.0 mm with a mean of 156.7 ± 22.9 mm. The statistic information related to total weight, gutted weight and meat weight of this species is presented in Table 2. I have used the energy density in meat for *Paranotothenia magellanica* (1.13 Kcal g^{-1} wet weight) presented by Fernández *et al*. (2009).

Table 2. Statistical information of weight data of the modern comparative sample of *Paranotothenia magellanica*

Weights	Mean	Maximum	Minimum	Standard deviation
Total weight (g)	89.7	197.4	17.8	39.6
Gutted weight (g)	82.7	184.4	15.8	36.8
Meat weight (g)	57.1	140.8	8.3	29.2
Meat weight (%)	61.8	73.2	42.6	7.8

To evaluate the relative potential meat and caloric yields, equations relating dry bone weight and meat and Kcal contributions per individual were estimated. The statistical data of bone weights related to different anatomical regions of *Paranotothenia magellanica* is presented in Table 3. The square regressions for estimating meat and Kcal yield (Y) from bone weights (X) are shown in Figures 2 and 3. The bone weights of vertebrates were used because it is the most abundant anatomical unit in archaeological samples, with more than 90 % of specimens in all assemblages.

Table 3. Statistic information of bone weights of *Paranotothenia magellanica*

Bone weights (g)	Mean	Maximum	Minimum	Standard deviation
Head	1.1153	3.0160	2.2504	0.5847
Vertebrate column	0.5704	1.4936	0.1287	0.2952
Total	1.6847	4.5096	0.3791	0.8746

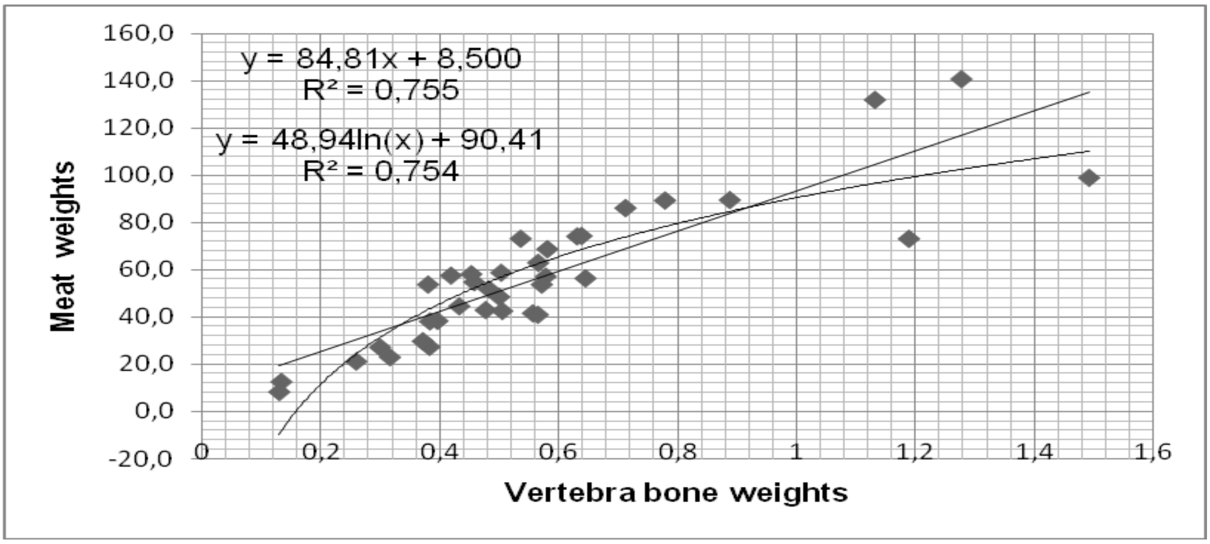

Fig. 2. Regression analysis of the relationship between dry bone weight and meat weight of *Paranotothenia magellanica*

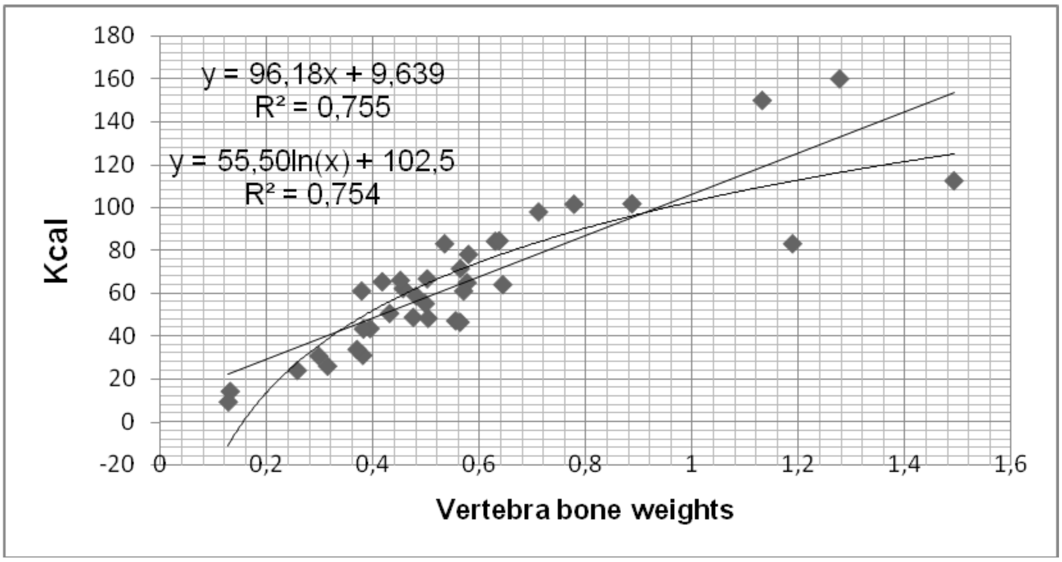

Fig. 3. Regression analysis of the relationship between dry bone weight and energy density of *Paranotothenia magellanica*

Table 4 summarizes the results obtained for samples of three sites, which represent different points of the archaeological sequence of the Beagle Channel region. The number of identified specimens of *Paranotothenia magellanica* together with meat weights and energy densities from 30 samples were plotted on an XY scattergram (Figure 4); the coefficient of determination was high (r^2 = 0.97). Clearly, in agreement with our expectations, the dietary contribution of *Paranotothenia magellania* was significantly increased in later times in terms of quantity of meat and energy inferred from the archaeological record.

Table 4. Mean values of bone weight, meat weight and energy density per sample

Site	Chronology (^{14}C BP)	N samples	Bone weight (g)	Meat weight (g)	Energy density (Kcal)
Túnel I (layer D)	6400 – 4600	13	0.19 ± 0.16	24.66 ± 14.10	27.96 ± 15.99
Shamakush I	1020 – 940	10	0.08 ± 0.05	15.40 ± 4.87	17.46 ± 5.53
Túnel VII	100	7	1.19 ± 0.69	109.90 ± 59.08	124.64 ± 67.00

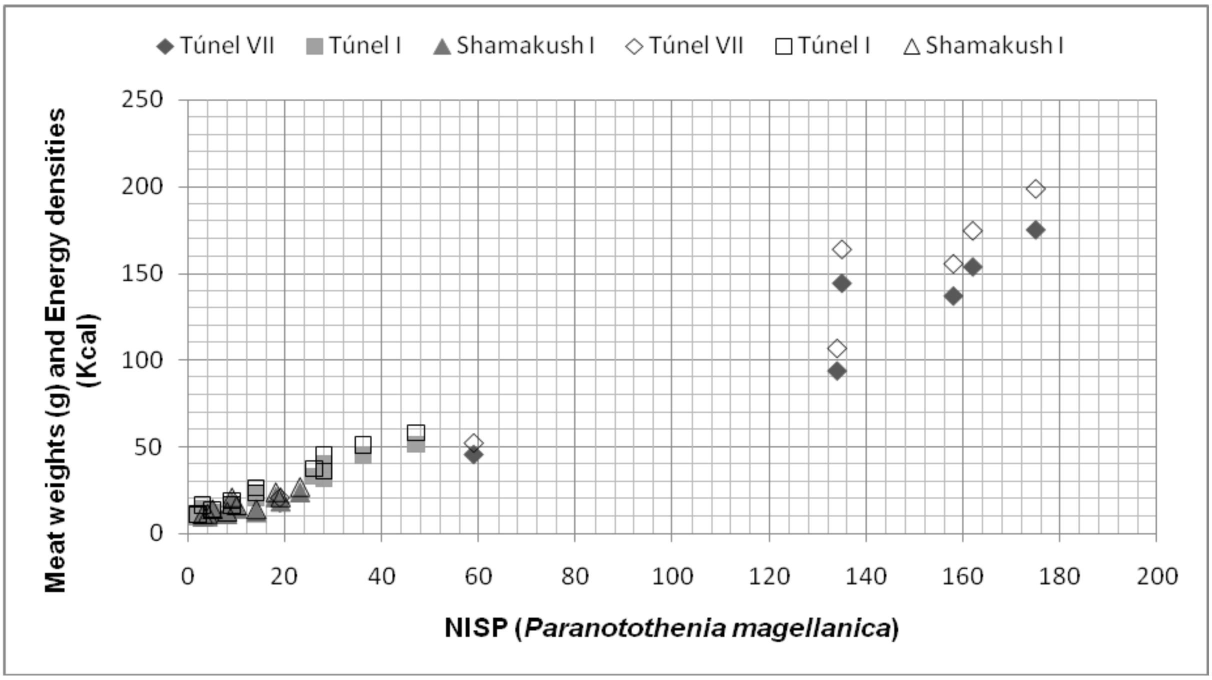

Fig. 4. Regression analysis between archaeological representations of meat weights (filled figures) and energy densities (empty figures) with NISP of *Paratothenia magellanica*

The 'Weight Method' and implications for littoral fishing among sea nomads of Tierra del Fuego

The results presented above contribute important information in evaluating the position held by the *Paranotothenia magellanica* in a context of subsistence strategies among the Fuegian sea nomads during the last 500 years. The dietary contribution of this species increased significantly through time up to the caloric levels inferred for sea and terrestrial mammals (Zangrando 2008). This significant increase may be related to a resource depression of larger prey types within coastal and inland areas (*e.g.* fur seals and guanacos). The weight method has been heavily criticized (*e.g.* Casteel 1978, Grayson 1984) and almost abandoned by zooarchaeologists. This approach was also limited to the prediction of relative 'available meat', rather than 'utilized meat' (Lyman 1979). Even so, the problem of discerning available and utilized resources is a subject of archaeological interpretation common to all methods of measuring faunal remains (Barrett 1993).

Thus, the potential of this method should be reassessed. Current models based on ecological principles suggest that the effects of a resource depression can be documented by measuring variations in foraging efficiency (the net return per unit of time) and/or diet breadth (the number of exploited resources) (*e.g.* Broughton 1994). It is assumed that more energy is harnessed from a patch of land or sea exploiting high-value resources such as small fish, which could become the focus of human subsistence. Body size of the resources represented in the archaeological material is often used to elaborate expectations about net returns, which are commonly contrasted against the numbers of identified specimens present in the archaeological record. Nevertheless, the changes in proportional abundances of large and small-sized prey are not necessarily correlated with significant changes in net returns. This relationship should be established, not assumed. In this sense, the weight method provides complementary evidence to reinforce our interpretations about human palaeoeconomy.

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Zoomorphs of Shark and Rays in the Brazilian Prehistory

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Introduction

Sharks are today viewed by most as dangerous predators and marine killers to be feared. This is very different from the thinking of people who live or have lived in a close relationship with the sea and have a great awareness of the true nature of its inhabitants (Compagno *et al* 2005).

Inhabitants of the islands of the Pacific and Indian oceans, and particularly members of fishing communities, have traditional views on sharks. Many attributes imbued in sharks may be related to the belief in supernatural powers and in the protection of fishermen, and can even generate the desire for human sacrifice in some cultures. Many tribes venerate sharks and their ancestors. The practice of attracting the shark was and is still important to many peoples of the Pacific islands and this fish has a huge impact in the culture and folklore of the peoples of Melanesia, West Africa, Australia and the Amazon basin. Elements of large sharks and rays have been found in Aztec temples located in central Mexico, associated with the bones of crocodiles and with human burials, often depicting idealized leviathan gods of mythology (Compagno *et al* 2005).

Since the nineteenth century there has been a continuous study of zoomorphic sculptures in Brazilian archeology, and this has led to several theories about the construction of these artifacts. Prehistoric cultures could strive to capture the essence of an animal in its natural habitat by replicating its form in art, in this case in stone. The combination of several factors of intangible culture can lead to a specific choice of species, due to its important cultural significance (Ribeiro *et al* 1977).

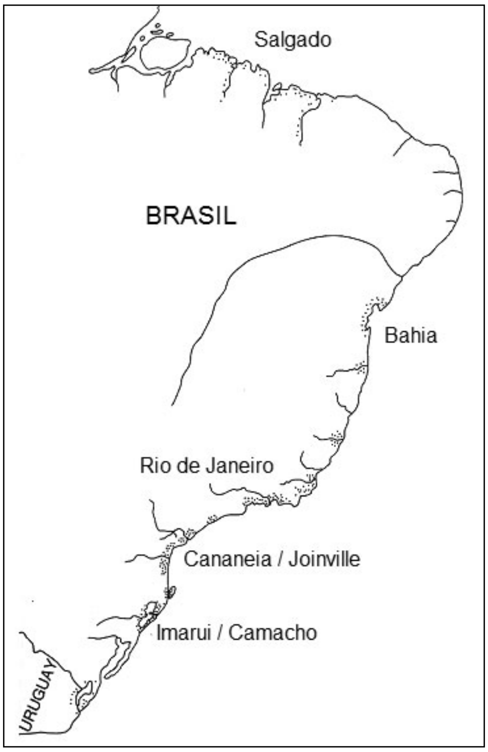

Fig. 1. Shell mounds along the Brazilian coast

Materials and methods

We analyzed four zoomorphs of elasmobranchs from the states of Santa Catarina and Rio Grande do Sul (Figure 1). The material is deposited in the collections of the Museu Nacional do Rio de Janeiro and the Laboratório de Educação e Pesquisa em Antropologia e Arqueologia da Universidde Federal de Pelotas. The aim was to identify some specific aspects in the description of each zoomorph: namely raw material and technique of preparation, preservation, shape and color, size, morphology and zoological identification.

Results

After studying the zoormophs, we obtained identifications of two species, namely sharks and rays: a great white shark, *Carcharodon carcharias* with dimensions 572 x 223 x 135 mm

(Figure 2), from Rio Grande do Sul; a hammerhead shark with dimensions 250 x 180 x 60 mm, from Santa Catarina; a ray of Family Myliobatidae with dimensions 185 x 131 x 38 mm, from Santa Catarina and a ray of Family Narcinidae with dimensions 147 x 71 x 40 mm from Santa Catarina (Prous 1974).

Fig. 2. Great White Shark zoomorph, found in Santa Catarina State

Discussion

Thinking about these sculptures produced by prehistoric fishing-gathering groups reinforces the importance of interpretations based on studies of socio-symbolic structures, especially when they are viewed as having a religious meaning (Gaspar 1998).

We can theorise also on their cultural meaning, both in terms of the actual world in which they were created and the imaginary world they represent. These possibilities are presented in two main areas of study: the area of cultural representations and the social milieu (Bigarella *et al* 1954). On the one hand, ideas of symbolic elements correlate with mental structures relating to their intangible cultural meaning. These ideas are based on studies of the cultural meanings of these artifacts, in the strict sense of their symbolic representation as material and cultural divinities (Gaspar 1998).

On the other hand, there are opportunities to understand the work processes that are involved in the manufacture of these sculptures, particularly in the case of the lithic pieces. In this case, one can understand the cultural elements that influenced the production of the artwork, in terms of micro social relationships, style definitions, knowledge of the possibilities and limits of production, technical and artistic considerations, amongst other things.

Whilst zoomorphs of sharks and rays have only been found in the states of Santa Catarina and Rio Grande do Sul, the fishing-gathering communities that inhabited the entire coastline left a rich archaeological testimony. The main evidence connecting the fishing-gathering groups of other regions and the elasmobranchs lies in the combination of teeth and vertebrae of sharks and rays and rays spines from burials found in coastal settlements and shell mounds (Gonzalez 2005a) (Figure 1).

Sharks and rays may have been regarded as sacred animals, used as elements in rites of passage (from young to adult life) and in differentiating the status of individuals in the same group (Gonzalez 2005b).

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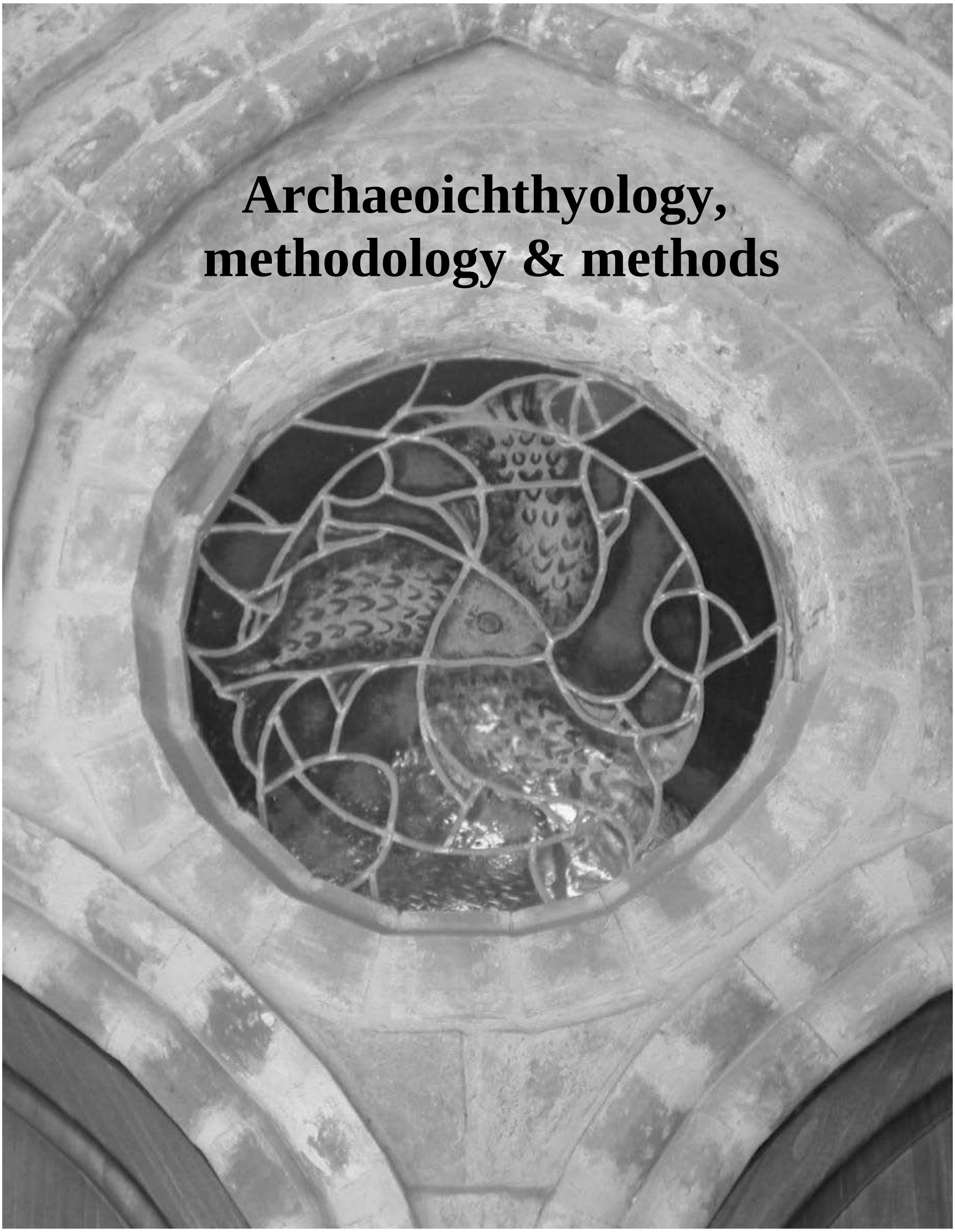
Archaeoichthyology, methodology & methods



Length reconstruction of cyprinids from the measurement of vertebrae: methods and applications on azilian fish bones from Pont d'Ambon (Bourdeilles, Dordogne)

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Methods of length reconstruction from archaeological samples have been developed since the 1970's, based essentially on cranial elements. The Global Rachidian Profiles (PRG) method (Desse *et al.* 1989 ; Desse & Desse-Berset 1996) has contributed to the use of vertebral data to estimate specimen length, comparing bone metric data with osteometric indexes, and also to estimate the Minimum Number of Individuals (MNI).

Collections of palaeolithic settlements are composed of more than 75% of vertebral elements. The application of the PRG method, which implies the range determination of vertebrae, makes the management of the data and the results more difficult when the sample is large. This situation has led to the utilisation of osteometric studies based on the exploitation of vertebral data and their application to archaeological collections using linear regression. This work has taken place as part of a Phd about freshwater fish in the settlement of the Upper Palaeolithic in France, particularly the re-examination of fish remains from Pont d'Ambon (Bourdeilles, France) (Le Gall & Pannoux 1994 ; Célérier 1998).

The species chosen for this study are cyprinids which are mostly represented by vertebrae in French azilian settlements: European chub (*Squalius cephalus*) and roach (*Rutilus rutilus*) were studied. The indices are composed from cranial and vertebrae data. Their study was helped by several institutions (Fédération Française de Pêche, CEMAGREF, LOGRAMI) that provided thirty specimens of each species, which were then dissected in order to collect bone elements.

The objective was to use the metrical data from these bone elements to quantify a collection with the largest number of elements, cranial or vertebral. But it is difficult to attribute a vertebral range to a fragmented vertebra. Morphological description of rachis, based on observation of the Pont d'Ambon collection, has been used for the two species studied.

This description contributed to distinguishing some classes of vertebral range, considering the fragmentation of the palaeolithic material. The three measurements M1, M2 and M3 can be associated with each class, each of which is based on averages. For each measurement an average is calculated with all vertebrae composing a range class. We obtain an average of M1, M2 and M3 for each range of vertebral class. Associated standard deviations do not exceed 0.5, so averages can be considered as representative of each class. For each class, there are three values representing M1, M2 and M3 that permit linear regression. These values are obtained by an average of all measurements of each vertebra from a class.

Linear regression equations are calculated associating one measurement (M1, M2, M3) with one of the three lengths of a specimen (Total length, Fork length, Standard length). There are nine equations for each class.

Some tests of validity have been used to evaluate the applicability of this method on fish bones, as well as its limitations.

Two parameters are used:

1. The percentage of difference between the real length and the calculated length (positive for over-representation and negative for under-representation), for the first and last vertebrae of a range of vertebral class.
2. The difference of the calculated length between the first and the last vertebrae of a range of vertebral class.

The averages of these parameter values, calculated with all specimens, demonstrate the validity of the test and represent the error limits when we obtain length reconstitutions with a large sample (> 30 bone elements). On the other hand, when the length reconstitutions concern a smaller sample, the error limits are represented by minimum and maximum values of the results. The test results are satisfactory for the European chub and for the roach. They allow us to apply this method to archaeological collections.

This method has been applied to fish bones found in Pont d'Ambon. All vertebrae are determined at the range of the family of cyprinids and were considered in the same way. Firstly the length reconstitutions have been done with the two indexes and then they were compared. Results have shown that the lengths obtained for the same vertebra was almost the same (difference less than 2 cm). The fact that only one genus of cyprinid is established at Pont d'Ambon (*Leuciscus* spp.) and that the results show only a small difference between the two indices has contributed to the use of only one index: the European chub. The systematic use of this method on elements which have at least one measurement enabled a maximum of length reconstitution and an optimal estimation of NMI to be obtained by collating results with those of cranial elements.

The calculation of weight for each taxon and each level of the Pont d'Ambon site has been achieved systematically. We can observe that interpretations of the relative importance of species based on the number of tests do not correspond entirely with the new data. Indeed, the pike, at first considered as marginal because of the low strength of tests, constitutes in fact a secondary species to the eel.

The calculation of optimised MNI of each taxon constitutes another advantage for studying an archaeological set. Indeed, anatomic representation can be shown with the MNI expressed in survey percentage. Under-representations of each cranial and vertebral element can be demonstrated with this value, as well as the species. The results we obtained show a wide under-representation of elements for all taxon, equating to about 75 %. Thus the quantity of fish meat calculated is below the real quantity of fish brought to the settlement.

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Zoo-MS: Zooarchaeology by Mass Spectrometry, collagen as a molecular fingerprint for fish remains?

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Molecular data can aid in both the identification and the analysis of evolutionary processes, as evidenced by the expansion of molecular phylogenies and molecular fingerprinting. Much attention has been focused on DNA, but the molecule degrades and the analysis is costly. We have therefore been exploring another molecule, the bone protein collagen. Analysis of variation on collagen sequences suggests that the protein has the potential to be a useful phylogenetic tool across the vertebrate kingdom. Collagen peptides can be sequenced using soft-ionization mass spectrometry, an approach that has proved particularly suitable for the analysis of partially degraded ancient proteins. We propose this approach for use in the identification of archaeological fish bones and scales

Introduction

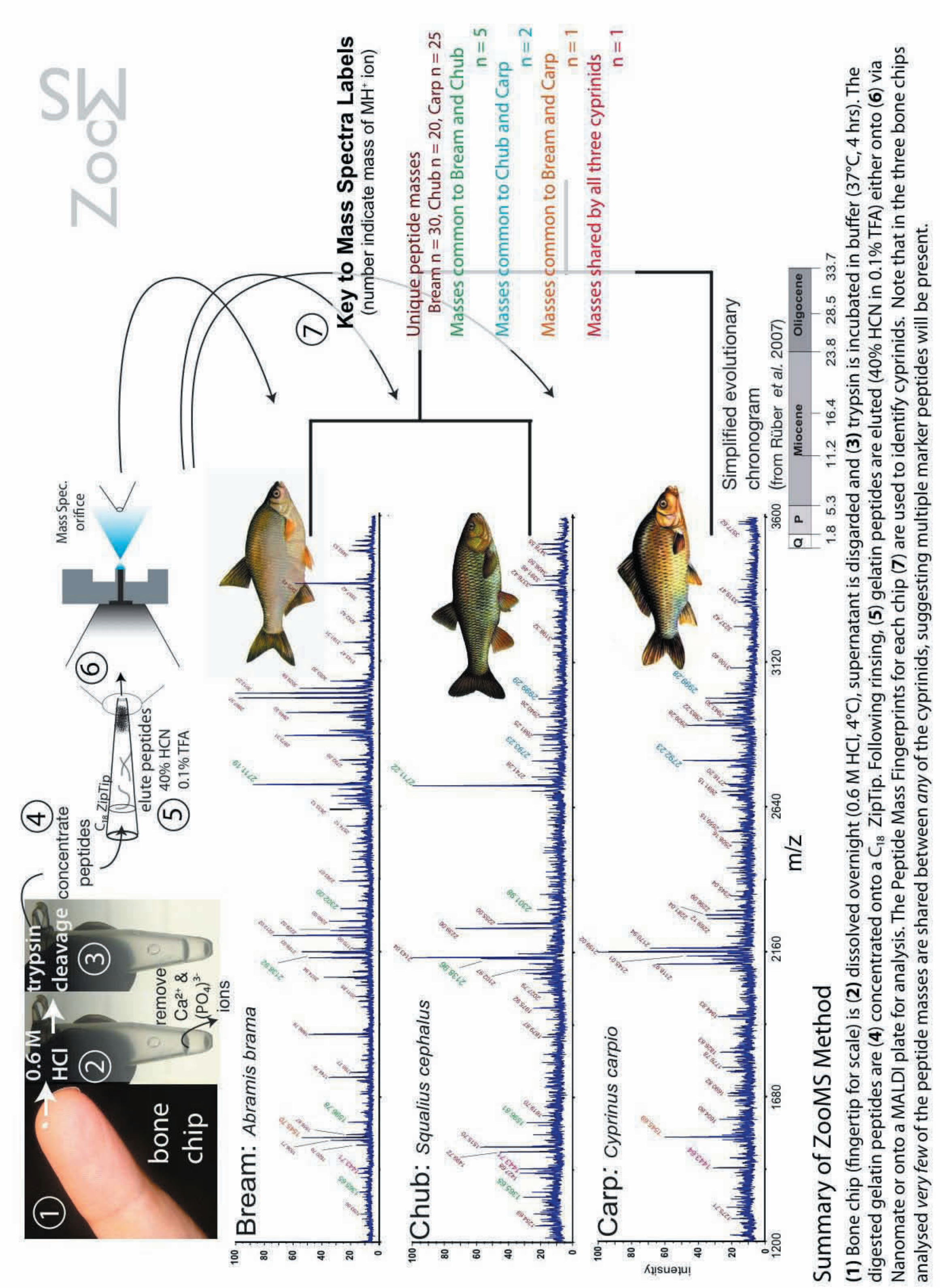
Upwards of 95% of fish bones are not diagnostic and many remains survive as fragments that are so small that they lack the characteristic morphology required to identify them to species. However *every* unburnt fragment contains a **molecular barcode** in the collagen that comprises about half the total volume of most mineralized tissues. Collagen consists of two or (in the case of most teleosts) three chains each of more than 1000 amino-acid residues. Combine the abundance of the protein and its variation between organisms with a sensitive method of detection and you have a novel method for identification of samples; **Zooarchaeology** by **Mass Spectrometry** (ZooMS).

A bone barcode

We believe that using these collagen fingerprints we can rapidly and cheaply identify every fragment, even fish scales. The approach is both obvious and remarkable. **Obvious**, because collagen varies between organisms and the protein is routinely extracted for both radiocarbon and stable isotope analysis. **Remarkable,** because collagen persists in almost all archaeological samples and, using mass spectrometry, differences between sequences can be rapidly and cheaply identified. These differences are the molecular fingerprint of the sample; a ‘bone barcode’.

ZooMS; peptide rather than DNA fingerprints?

DNA fingerprinting uses enzymes to cut DNA at specific sites, revealing differences in sequence as differences in mass. ZooMS works in the same way, but uses bone collagen. ZooMS works by cutting the collagen into a series of peptides and uses the differences between peptide masses, measured by mass spectrometry to identify fish species, in much the same way that DNA fingerprints are used to detect individuals.



Unlike DNA, which is present often in vanishingly small quantities, and can easily be contaminated, collagen *is* the bone or fish scale. There is no need to amplify the signal and the masses can be measured at a rate of one sample every few seconds. As well as reducing the risk of contamination, lack of an amplification step, reduces time and cost. It is also possible to identify the presence of different species in a mixture. Blind tests of powdered mixed bone meal autoclaved for

20 minutes at 146 ºC (equivalent to ageing for 90,000 years at 10°C) identified components present in >5% of the sample in 16/16 samples prepared by the Veterinary Laboratories Agency.

The amounts required for ZooMS are so small that they are difficult to grasp (both literally and metaphorically). The equivalent of a 2mm cube of bone (50 mg) suffices even when collagen has fallen to 0.1% of modern levels. We are now working on 250 um particles.

Applications of ZooMS

The key to exploiting these new technologies is to try to ensure that archaeology and not technology drives these enquiries and this is why we wish to discuss the technology with the ICAZ working group. In our first application we plan to test out ZooMS to monitor changes in frequency of different cyprinids over time, enabling us to examine changes in medieval water quality (as reflected in cyprinid distribution) and fish farming practices. If successful it would also mean that in future studies we could rapidly assess the presence of 'fishponds' and their cyprinid stocks from relatively non-invasive 100 mm cores.

Although other methods of identification already exist, the speed and cost of ZooMS means that we may wish to reconsider the art of the possible. If we can now identify all the tiny bone fragments in a sample, does this change how we sample and the questions we ask?

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Site formation processes and conservation in Neolithic lakeside settlements. Some examples from Arbon / Bleiche 3 (Lake Constance, Switzerland)

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The Neolithic settlement of Arbon Bleiche 3 was originally located directly on the bank of a bay on Lake Constance. Between 1993 and 1995 almost 1100 m² of the site was excavated, revealing the existence of the ground plans of 26 houses, all built during a short period between 3384 and 3376 BC dendro (Leuzinger 2000). One can assume that a third or, at best, half of the settlement was uncovered in the excavation. From a paleoclimatic point of view, occupation took place during a cool climatic phase that occurred globally between c. 3650 and 3250 BC (Rotmoos 2 or Piora 2 fluctuation) with predominantly high lake levels in the northern foothills of the Alps (Magny 2004). Short favourable phases of warmer climate also occurred, which led to falling lake levels (Fig.1).

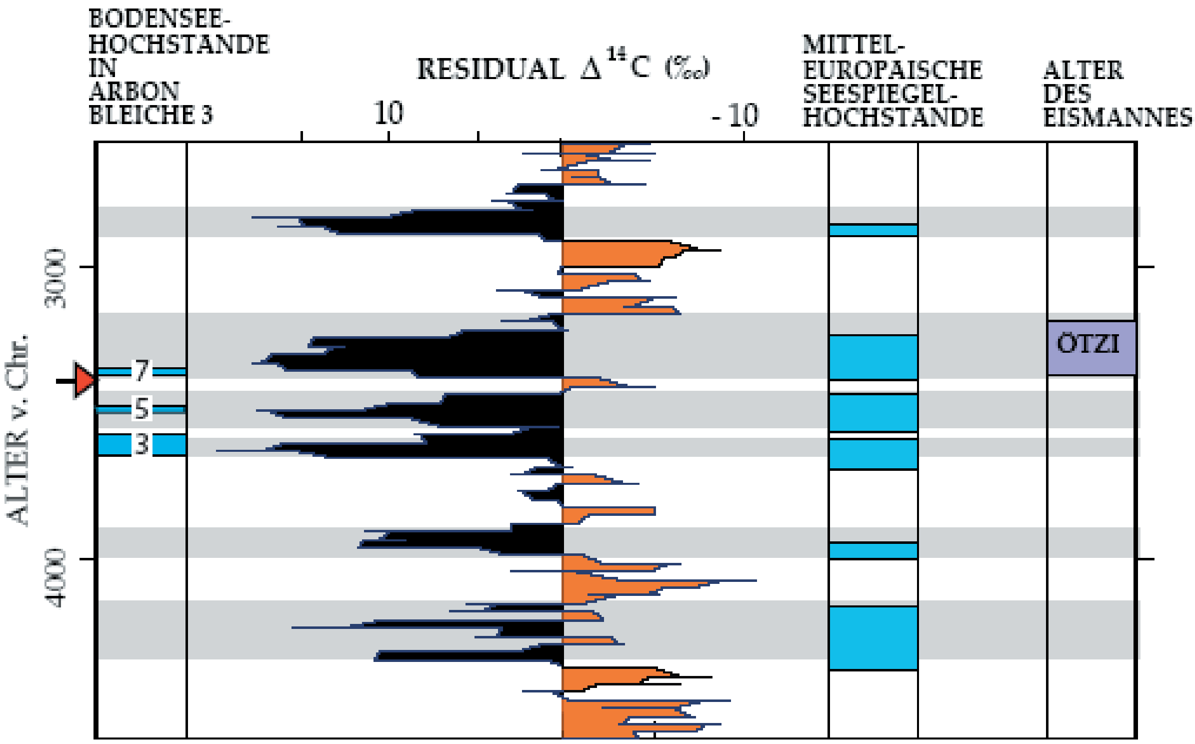


Fig. 1. Comparison between high-level phases of Lake Constance, the curve of the atmospheric concentration of C14 and other high-level phases of several Lakes in Central Europe.

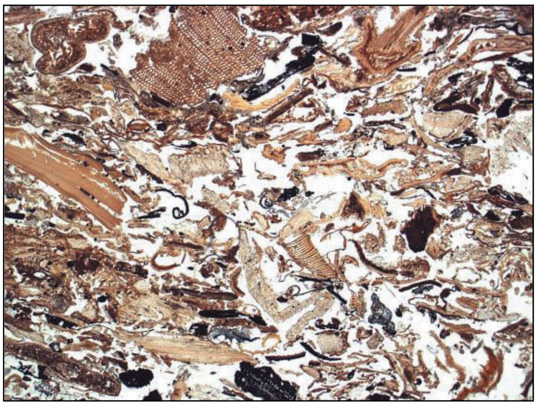
One of these could be identified in the excavated area and it took place shortly before the first houses were built. In the global carbon isotope curve this phase corresponds with an atmospheric C^{14} minimum, hence referring to a phase of rather high solar activity. Features of such periods, as opposed to the long-term average, would be less precipitation and warmer summers, i.e. favourable, dry and warm climatic conditions, leading to a receding water level.

The settlement outlasted the end of this short-term phase of favourable climate. About midway through the settlement's lifespan the climate had already changed and a period of reduced solar activity had begun again. The run of the C^{14} curve shows that the climate must have become noticeably cooler and more humid. Around 3370 BC a catastrophic fire destroyed the village, followed by a resurgence of the lake water levels, which then covered the cultural remains with a thick layer of sand.

Field observations pointed to the existence of raised house floors, leading to organic accumulation between and beneath the houses with a permanently moist building ground and therefore excellent conditions of preservation. During excavation, samples were taken for archaeobiological and geoarchaeological analysis in order to elucidate the composition of the organic layers and site formation processes (Fig.2).

The presentation will show results of a multi-disciplinary approach (sedi-mentology, micromorphology, archa- eobotany, archaeozoology, ichthyology, Fig.3) which allowed an assessment of the depositional environment and, for some structures, a highly detailed reconstruction of the human activities within.

Fig.2: Arbon. Sedimentation of Lake marl (2), littoral sand (4), installation horizon (5), cultural layer (5-6), catastrophic fire, transgression and reworked debris (6.5 onwards).



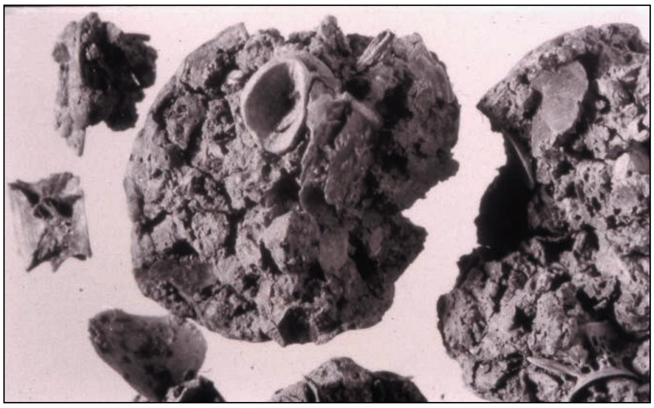


Fig. 3: Arbon. Horizontally bedded organic remains: wood, charcoal, bones, domestic plant remains, dung, bark, loam (left). Excrements containing fish vertebrae (right). These bones show very typical deformations. The cranial and caudal view is not circular but oval and in the length they are broken in a specific way.

To work in this specific way requires aims. These are in our case to extend the analysis of excavated prehistoric material, to better understand taphonomic processes and – last but not least – to assess the interpretation of archaeological structures. This requires that specialists from various disciplines cooperate closely from the planning stage of the excavation onwards, furthermore that research questions and suitable methods of investigation are jointly developed, that intermediate results are compared and discussed at regular intervals and that a well-organized team enhances the work discipline of each collaborator.

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Osteological differences within the family of the Cyprinidae

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The identification of Cyprinidae bones is generally considered difficult beacause of the large number of species that can be expected and the supposedly rather similar osteomorphology of the various species. For that reason the number of elements that are regularly used for species identification is rather limited and as a consequence the proportion of specifically identified cyprinids in faunal assemblages is often very low. However, it would be desirable to have a greater number of bones identified to species, since only then does it become feasible to follow diachronic trends with precision in the species spectrum (due to extinction, introduction, invasion), in the proportion of the various species, and in the size distribution of the individual species. With the aim of establishing more diagnostic criteria, a study is undertaken of 42 different skeletal elements, whereby attention is focussed not only on the morphology of the complete bones, but also on the possibilities of identifying more fragmentary remains.

For this work over 500 specimens, belonging to 18 species, are available of which thus far 120 have been considered. A system was developed to allow easy access to the bones of the different species and to specimens of different sizes. A preliminary evaluation of the diagnostic value of the various elements is already possible. Although some of the investigated bones clearly offer little potential for detailed identification, there are several that seem very promising. In a next step, these skeletal parts will be described in detail so that quick and reliable identifications will become possible. The same will be done for partial elements, e.g. the dorsal and anterior part of the pharyngeal plate. It also appeared throughout the study that certain species are more easily recognised than others. Of the Belgian cyprinids this is the case for *Abramis brama*, *Cyprinus carpio*, *Carassius carrassius*, *Chondrostoma nasus*, *Gobio gobio*, *Barbus barbus* and *Tinca tinca*. The success of identification also depends on the size of the fish: bones from specimens measuring 20 cm and over are more easily identified than those from smaller ones.

The preliminary results obtained on the modern skeletons have been applied to two medieval sites, each located along a different river basin. In one case, the obtained species spectrum corresponded completely to the fish fauna documented through fishery studies and historical records. In the material from the other site, four cyprinid species were identified that are not found in the historical records. Two small species, *Rhodeus sericeus* and *Leucaspius delineatus*, known from modern surveys, were not represented in the archaeological material, but this may be due to taphonomic factors.

Table: List of investigated species. Species that are believed to be introduced are indicated with an asterisk

Abramis brama	*Scardinius erytrhophthalmus*
Barbus barbus	*Tinca tinca*
Blicca bjoerkna	*Chondrostoma nasus*

** Cyprinus carpio*
Gobio gobio
Leuciscus cephalus
Leuciscus leuciscus
Leuciscus idus
Rutilus rutilus
**Carassius carassius*
Alburnus alburnus
Phoxinus phoxinus
Leucaspius delineatus
Alburnoides bipunctatus
Rhodeus sericeus

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Fishes
through ethnography

Archaeoichthyology and museum. An exhibition about fish and fishing in the past

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Basel, Switzerland

FISCH RESSOURCE AUS DEM WASSER
LE POISSON RESSOURCE ISSUE DES EAUX

Introduction

The rôle of fish and fishing in past cultures is mostly neglected in Swiss archaeological museums. This year, the Museum Schwab in Biel focuses on this subject in the special exhibition "**Fisch – Ressource aus dem Wasser -** Eine Geschichte um Mensch und Fisch, Beute und Fangtechnik" ("**Fish – a resource from the water.** A story about men and fish, prey and methods of fishing").

The Museum Schwab is situated in the city of Biel-Bienne on Lake Biel, which is famous for its Neolithic and Bronze Age lake dwellings.

Fig. 1. Reconstruction of the fixed fishing installation at Sutz-Lattrigen, Lake Biel. © Archäologischer Dienst des Kantons Bern

The construction of the fixed fishing installation at the lake site of Sutz-Lattrigen in 2007 as well as the first investigation of fish bones from another Neolithic lake site on Lake Biel (Sutz-Lattrigen Rütte) inspired the exhibition preparations in April 2008.
Since fishing – as a profession as well as a leisure activity or sport - has a long tradition in the Lake Biel area, as well as in the whole of Switzerland, an exhibition about fish and fishing is certain to create not only regional but also national interest.

Main topics of the exhibition

The title of the exhibition "Fish – a resource from the water" relates not only to the rôle of fish in human diets and the variety of fishing methods in the past, but it also includes the human handling of the resource of fish from past to present times, relating to environmental questions. Within this topic the emergence of a specialized fishery, the rise of professional fishers and the roots of fishing as a sport and leisure activity are considered. The main focus is on Switzerland, especially the region around Lake Biel, but notable European research results are also mentioned.

Contemporary issues such as human impact on fish diversity, the extinction of fish species and current efforts to reintroduce fish to Swiss freshwater systems are also addressed.
An important part of the exhibition is to present archaeoichthyology as a discipline. An overview of the last twenty years of archaeoichthyological research in Switzerland and its results are presented. Additionally, the exhibition includes an introduction to the methods of the investigation and evaluation of fishbones from archaeological sites.

The exhibition turned into an interdisciplinary project because such diverse topics require a collaboration of several different scientific disciplines.

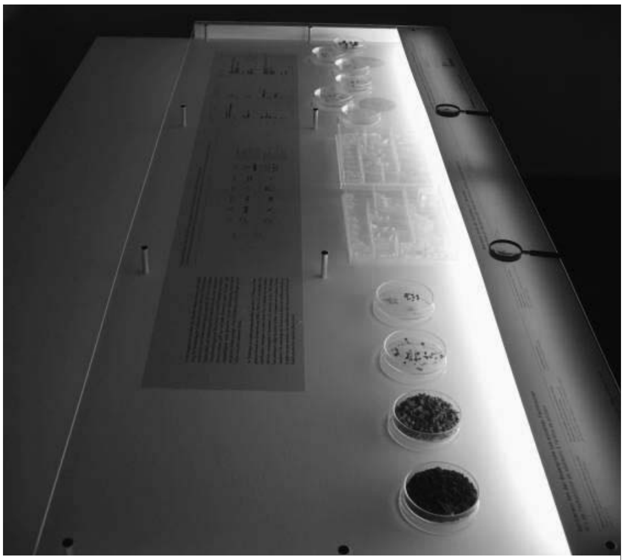

Fig. 2. Table" of archaeoichthyologic methods. Photo: Simone Häberle

Collaboration of different scientific fields

The Schwab Museum acts therefore as an interface between science and the public, offering a fertile ground for these two to meet.
The current exhibition presents the subject of fish and fishing in a variety of ways and delivers insight into archaeoichthyological research in connection with other related fields.

The support of different specialists made it possible to create a wide and interesting spectrum for the exhibition topic. The core team was composed of archaeoichthyologists, archaeobiologists, archaeologists, historians, experimental archaeologists and fishery supervisors. For some questions biologists, environmental specialists, professional and leisure fishermen were consulted (See table 1).

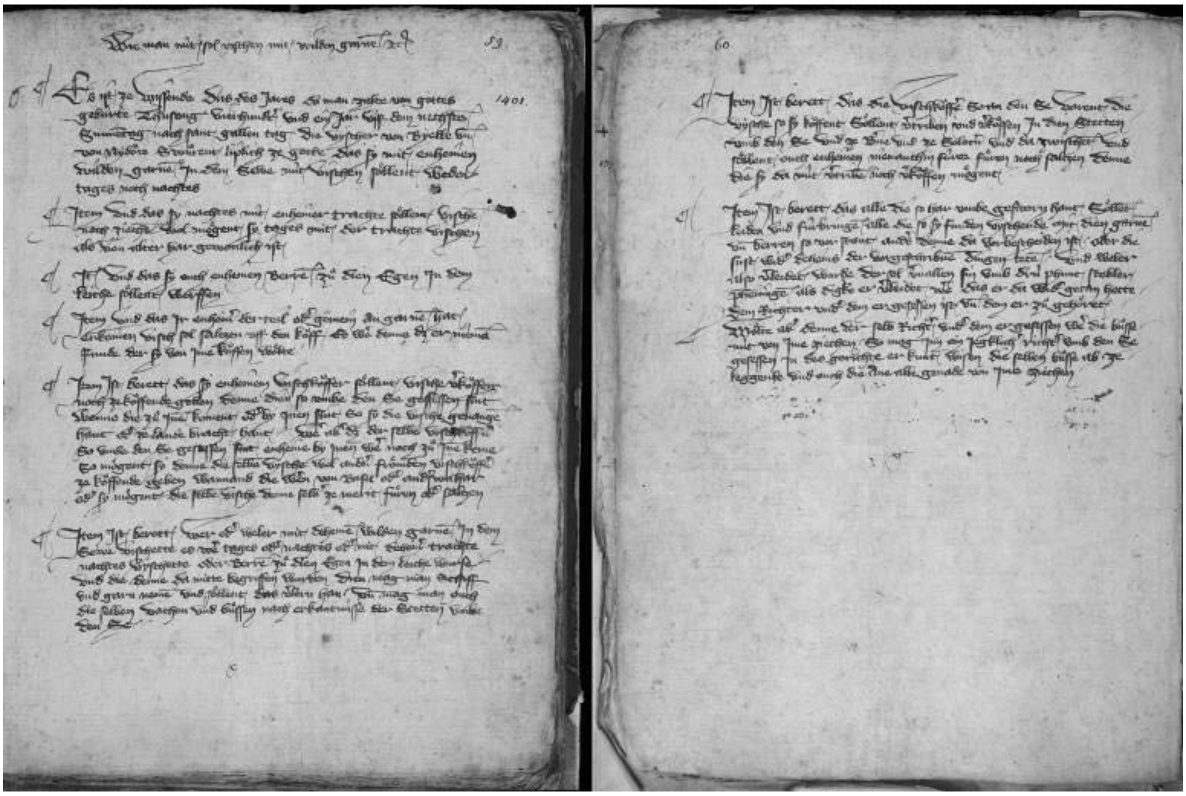

Fig. 3. First fishing ordinances for Lake Biel, 1401.
Foto: Stadtarchiv Biel (1, 235, CCXLVII, t. 12, p. 59)

Fig. 4: Kurt Mischler, experimental archaeologist, reconstructed a fish trap (fyke) based on a Mesolithic find from Denmark for the exhibition. Photo: Ursula Räss

Table 1: Exhibition "Fish – a resource from the water", contribution of different disciplines: Subjects, aims and realisation.

Field	Subject /Aim	Realisation
Archaeoichthyology	Explanation of investigation- and evaluation methods of fishbones from archaeological sites Presenting conclusions: for example fish diversity linked to human impact, diet and environment Close collaboration with the neighbouring disciplines of archaeobotany, archaeozoology, geoarchaeology	Film about archaeoichthyological research at the ***Institute*** for ***Prehistory*** and Archaeological Science at ***Basle*** University "Table of Methods": From soil sample to fish vertebra, drawing on the lake site dwelling Zürich Mozartstrasse Aquarium: "Fishes from Lake Biel, today and 5000 years ago": Reconstruction of verified fish species from the lake site dwelling Sutz-Lattrigen Rütte, Lake Biel.
Archaeology	Presentation of archaeological catching methods and fishing equipment in specific context (site, dating, archaeological culture etc.) Reconstruction of the history of over 10 millenia of fishery in Switzerland. Explaining the function, and evolution of fishing equipment as well as its changes over time	Common part of the exhibition with archaeological objects, supplemented by interpretive charts, pictures, photos of excavations and archaeological reconstruction drawings
History	Examination of medieval written and illustrated sources, especially the fishing ordinances concerning Lake Biel dating back to 1401 Information about the social status and living conditions of professional fishers in medieval times	Powerpoint presentation with background text Overview of the decrees which professional and leisure fishermen on Lake Biel had to follow Presentation of the decrees which show the role of fishermen in society and the creation of fishing guilds Remarkable: medieval decrees for fish protection and orders against overfishing ***which are largely comparable to modern-day protective provisions***
Experimental archaeology	Reconstruction of fishing equipment and catching methods of the past	Manufacture and experimental use of harpoons and fish traps (fykes) based on archaeological finds Photographic documentation of the manufacturing process
Fishery inspection	Introduction to the work of a fishery supervisor: protection of the aquatic fauna, fish breeding, biotope renaturation, resettlement projects and more	Film and photo-story about fish breeding Original "Zuger-glass" funnel incubation system Literature on current projects
Biology and environmental science	Reflexions of human impact on fish diversity, overfishing, extinction of fish species and present efforts of resettlement in Swiss freshwater systems	Comparison of the present with the past, using the example of the reaction of men in times of climate deterioration and environmental change History of extinct fish in Switzerland, especially the destiny of the vanished salmon (*Salmo salar*) and the endangered eel (*Anguilla anguilla*).

Professional fishery	Presentation of the working methods of a professional fisherman on Lake Biel	Explanation of the methods by photo-stories, original fishing gear in exhibition (fishing net and fyke).
Leisure fishery	Presentation of the different fishing methods of leisure fishers on Lake Biel (fly-fishing, trolling etc.)	Explanation of the methods by photo-stories, original fishing gear on display in exhibition, photos of fishermen and their prey.

Implementation and presentation of current scientific knowledge

The realisation of the exhibition necessitated a topic selection and a partial simplification to present the theme to the public. With the help of an experienced exhibition organizer and a skilled graphic artist, it was possible to bring the different subjects to life and to reach a compromise between comprehensibility and science. The showcases are divided internally into various levels to represent the different scientific rubrics of one single theme (net fishing stands as an example, see Fig. 5). This allows visitors to comprehend the scientific diversity, whilst simplifying the making of meaningful selections from the information available.

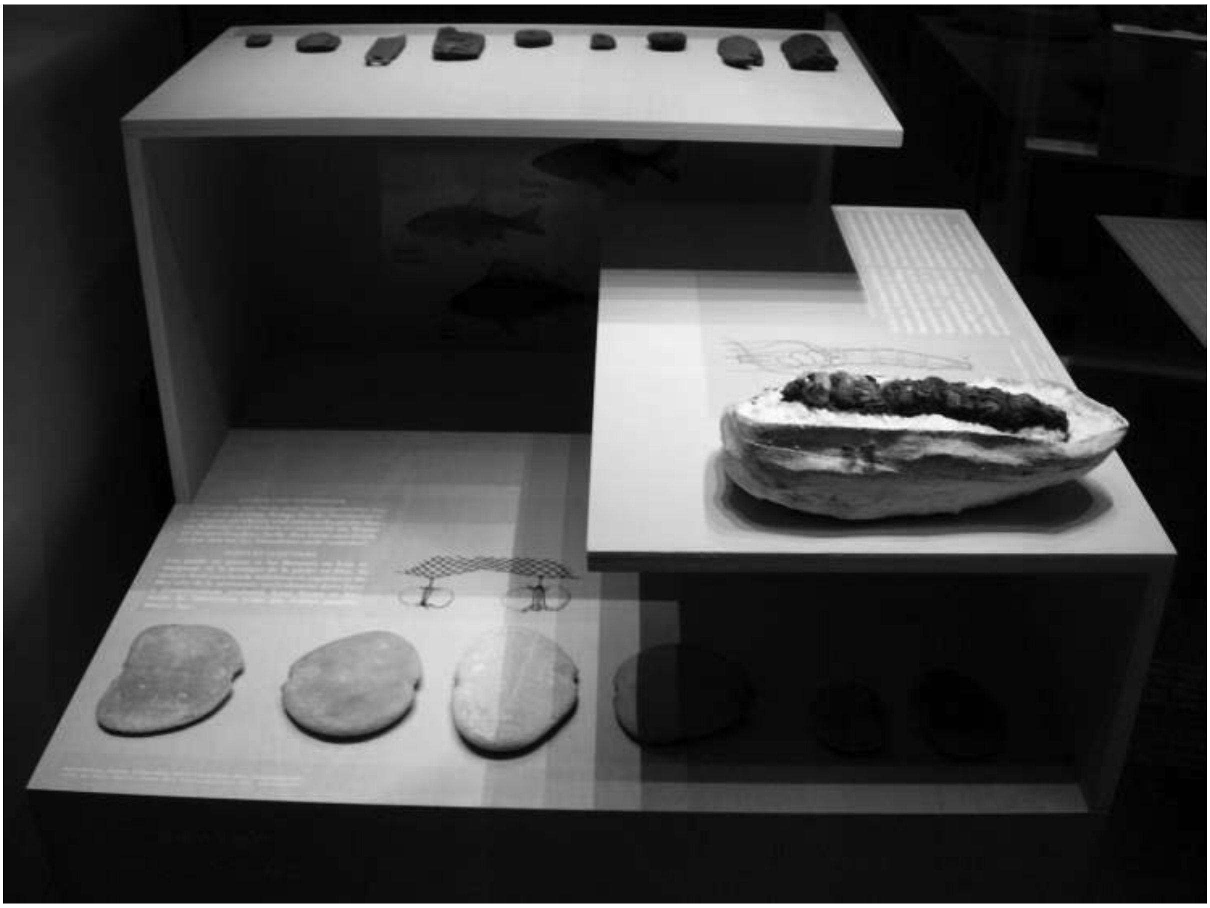

Fig. 5. Example of a showcase with different internal subdivisions (Photo: Simone Häberle)

Conclusions

The importance of interdisciplinary collaboration became evident during the working process.

The diverse scientific background of this transdiciplinary exhibition project arouses the interest of a similarly diverse audience.

Furthermore, the large attendance figures for the exhibition demonstrates that the public is interested in current methods and specialisation in archaeology, in particular in archaeoichthyology.

Research always depends on the support of the public. This is another reason to ensure the important connection between science and the public is maintained and to define the key elements of scientific work in public relations.

KEYWORDS: Objects, Function, notable information and research results from relevant scientific fields.

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Polish Ethnological Research on Traditional Fishing

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Fishing has never been a particularly popular research subject in Polish ethnology. The reasons for this lie in its relatively small importance in Poland as a means of obtaining food (on a countrywide scale), as well as the methodological and ideological conditions under which Polish ethnology has developed since its beginnings until the present. However, I will not elaborate on this so as not to trivialize the problem. A thorough presentation of all circumstances which had led to this state of Polish ethnological research on fishing would require a separate and lengthy article. It is true, however, that in the history of Polish ethnology to date, there have been only four researchers whose works dealt with selected aspects of fishing (rather than the entire set of issues related to it) on a nationwide or a wider basis. In chronological order, they were: Kazimierz Moszyński, who devoted approximately forty pages to fishing in his monograph entitled *Kultura ludowa Słowian* (1967; 1^{th} ed. 1929); Maria Znamierowska-Prüfferowa, whose works include the impressive *Thrusting Implements for* **Fishing** *in Poland and Neighboring Countries* (Znamierowska-Prüffer 1966; in polish: Znamierowska-Prüfferowa 1957) and *Tradycyjne rybołówstwo ludowe w Polsce na tle zbiorów i badań terenowych Muzeum Etnograficznego w Toruniu* (1988); Zygmunt Kłodnicki with his postdoctoral thesis entitled *Tradycyjne rybołówstwo śródlądowe w Polsce. Zarys historii sposobów, narzędzi i urządzeń rybackich w świetle metody retrogresywnej* (1992); and Wojciech Olszewski, the author of the book entitled *Z dziejów wędkarstwa polskiego od końca wieku XIX do czasów współczesnych. Studium etnograficzne* (1993). Similarly, the entire area of Poland and issues very closely related to fishing are the subject of any extensive study by Jerzy Litwin: *Polskie* **szkutnictwo ludowe** *XX wieku* (1995).

In addition to the works listed here, each of the authors mentioned above published several to several dozen texts dedicated either to less extensive areas of research, or selected and more detailed issues related to fishing.

The book by Kazimierz Moszyński, who combined elements of evolutionism and the ethnogeographic method in his ethnology pursuits, is a comprehensive study documenting the occurrence of fishing tools, methods and fish names in Slavic lands, and presenting numerous notes on their origin and proliferation. Moszyński also created his own catalogue of fishing tools and methods, which he categorized in his book from what he considered the simplest to the ones most technically complicated. This classification, dating back to 1929, has been copied to this day by many Polish ethnologists, often with only minor changes, both at the stage of research design as well as the presentation of the material collected in the process.

An excellent example of a similar approach in contemporary Polish ethnology is Zygmunt Kłodnicki's book mentioned above. The author also concentrated on documenting 'traditional' tools and fishing methods used in Poland, as well as their geographical distribution, applying Moszyński's classification with only minor modifications.

Kłodnicki's text is in part a summary of previous Polish ethnographic research on this subject, whose results the author found in over three hundred publications of various importance, and this is perhaps its greatest strength. Kłodnicki obtained the remaining source material from research conducted in approximately six hundred Polish localities (the book contains a detailed list of such places, along with research dates and numerous maps presenting the findings). Unfortunately, the research was usually random and fragmentary, thus failing to provide a complete image of fishing in Poland. To give justice to the author, it should be added that when he was collecting material for his book, most of the fishing tools and methods were only or predominantly used by poachers. Therefore, while conducting in-depth field research, the ethnologist often had to enter into close relationships with the 'social underclass,' and in many cases, he was forced to operate on the margins of the law and risk his own safety.

In Kazimierz Moszyński's and Zygmunt Kłodnicki's publications, one will find a wealth of information on fishing tools and methods, their origins, and etymology; the man using them can hardly be seen. An entirely different research attitude can be seen in the works of Maria Znamierowska-Prüfferowa. A student of Kazimierz Moszyński (among others), she frequently used his classification of fishing tools and methods in her publications. However, in her case, it was always just a means of structuring research material. Consistently, even in her book on the classification of thrusting implements, she paid much attention to the social and cultural context: the fisherman's lot. An excellent example is her very first book entitled *Rybołówstwo Jezior Trockich,* the outcome of research carried out between 1927 and 1929 (Znamierowska-Prüfferowa 1930).

The book presents a very accurate and detailed description of fishing tools and fishing techniques used on Trakai Lakes, as well as fishermen's customs and 'superstitions' (from both the beginning of the 20th century and the end of the 19th century). For an ethnologist or linguist, the 116 names of lakes provide a very valuable resource. These include: Galvė, Bernardinai, Akmena, Skaistis and Totoriškės (two linguistic versions exist, depending on the ethnic and cultural identities of the fishermen). The contemporary ethnologist finds it important to portray fishing in the context of the social, cultural and natural environment. This requires recognizing identity relations, local socio-economic and demographic relations (including a list of names and surnames of nearly fifty fishermen, along with information on their place of residence at the time of research, marital status, number of children, faith, national identity, literacy and numeracy, education, main and secondary profession, areas of expertise in fishing, ownership of housing assets, farm animals, and the amount of land owned or rented).

Maria Znamierowska-Prüfferowa has been the most prominent figure in the history of Polish ethnological research on fishing, significantly surpassing others with her prolific output. Her research achievements are evidenced not only by publications, but also museum collections, particularly at the pre-war Ethnographic Museum of Stefan Batory University in Vilnius (today, a separate ethnographic museum in that town) and the Ethnographic Museum in Toruń (currently named after her). She achieved her success in spite of a tremendous setback which, in the field of research on fishing, was her gender (a serious conversation about professional matters with a woman seemed demeaning to a fisherman in Poland and in other countries).

I had the honor of participating in the research conducted by her in the last years of her life, and witnessed the esteem with which she was regarded by both professional fishermen and poachers – members of the 'social underclass.' These experiences, combined with the study of her works, allow me to put forward the thesis that Maria Znamierowska-Prüfferowa's research success was rooted in her 'missionary' vision of ethnology. To her, this discipline had never been just 'pure' science; it was meant to improve relationships between people, and protect endangered values – especially human dignity. Today, I am certain that Maria Znamierowska-Prüfferowa's interest in fishermen, and her research and publications that contain a great wealth of ethnographic, linguistic and historical material were all the result of her particular circumstances. In the 1920s, when she began her career as an ethnologist, the Vilnius region was inhabited by the poorest of the poor, and thus she wanted to attract the attention of the society and local and state authorities to their plight, hoping to change their lives for the better with her research. This attitude is especially visible in her touching brochure entitled *Rybacy – ludzie zapomniani* (1935).

As previously mentioned, Polish ethnological research on fishing has predominantly relied on the classification of fishing tools and methods proposed by Kazimierz Moszyński. The position of a fishing tool on the list was determined by its morphology and technical simplicity. This led to numerous misunderstandings in interpretation, resulting mainly from the omission of the cultural, social and economic context. Perhaps the greatest misunderstanding of this kind was the fact that all researchers have consistently treated the fishing rod as a very simple tool in technical terms, and therefore, following the logic of the prevailing classification, it was considered a tool of little importance and was almost entirely excluded from research. Polish ethnologists failed to notice not only that the fishing rod was the most popular fishing tool, but also that angling, of all methods used for catching fish, caused the greatest social, cultural and economic consequences: in the context of mid-20th century Poland, it was relevant to as many as one to three million families.

In the 1980s and 1990s, I conducted ethnological research on angling, which led to a subsequent monograph on this discipline of fishery and helped complement the exhibits at the Ethnographic Museum in Toruń (Maria Znamierowska-Prüfferowa had supported me in this initiative until her death in 1990). This research put emphasis on the cultural contexts of angling, its social significance, as well as the role of angling organizations in the development of a civil society. To my surprise, the results of this research were regularly presented to the general public in the *Wędkarz Polski* monthly (a privately-owned commercial magazine, but with social and educational aspirations) in the 1990s. This became one of the factors leading to the rebirth of independent angling associations, which bore ideological resemblance to the positivist organizations of the early 20th century, and strove for the protection of the environment and the development of local self-government. In recent years, the findings of my ethnological analyses into angling as a social and cultural phenomenon have been used on several occasions by groups affiliated with angling societies in their disputes with the government (Dębicki 2009).

An important part of the overall Polish ethnological research on fishing are works concerning the idea of *maszoperias*, informal organizations of Kashubian sea fishermen that regulate the division of fishing grounds, work and profits, and ensure the social welfare of widows and children of deceased fishermen. These institutions, still operating in their simplest form today, are undoubtedly a local phenomenon, yet a very significant one in terms of exemplifying social solidarity at its best. They were also studied by Znamierowska-Prüfferowa, although most of her research findings on the subject have not been published. Still, it was the works of Zdzisław Batorowicz and Jadwiga Kucharska that contributed the most to the understanding of *maszoperias* (Batorowicz 1971; Kucharska 1968; 1991).

Referring to the output of Polish ethnology in the areas discussed here, one should recognize several monographs on fishing in selected areas. The most significant ones, dating back to the beginning of the 20th century, are clearly Chętnik's articles from 1911, 1912 and 1928 concerning fishing done on the Narew river and the Serafin lake, published in the *Ziemia* magazine, and Władysław Jagiełło's work entitled *Rybołówstwo Borowiaków Tucholskich* (written just before the onset of the Second World War, yet not published until 2009). I would also like to acknowledge the following literary works from the post-war period: *Rybołówstwo na terenie kurpiowskiej Puszczy Zielonej* by Jacek Olędzki (1962), *Rybołówstwo ludowe na Lubelszczyźnie* by Alfred Gauda (1969), *Rybołówstwo na Pojezierzu Łęczyńsko-Włodawskim* by Ciesielski (1961), and the historical and ethnographic depiction of fishing in the Wielkopolska region by S. Chmielewski (1960). These monographs cannot match the aforementioned *Rybołówstwo Jezior Trockich* by Maria Znamierowska-Prüfferowa, published in 1930, but they do provide a solid description of fishing implements and methods in selected regions. Information of similar type, yet of lesser proportions, can also be found in numerous studies on folk culture (Kłodnicki mentioned some of the most significant ones: 1992, 13).

To conclude, it has to be noted that Polish ethnologists have been fairly successful in documenting the traditional fishing tools and methods used in their country. Unfortunately, the majority of texts make little or no effort to go beyond that (astonishingly, they emulate the same scheme, even though it has long lost its methodological justification). Few researchers have made the effort to place the aspects of fishing that they studied in a broader social and cultural context.

This is probably why most of these works only attract the attention of a small group of professionals, mainly museologists, and fail to resonate more broadly either in ethnologist circles or beyond.

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Fishing and fishermen. Collections, exhibitions and research of the Ethnographic Museum in Toruń

Artur TRAPSZYC

Ethnographic Museum in Toruń, Poland

The research and collection programmes of ethnographic museums in Poland usually cover culture as a whole. This is true of both regional and national institutions. It does not interfere with the fact, however, that particular museums develop certain areas of specialisation, which affect the image of the institution as a whole. They are based most frequently on extended collections amassed by museum employees interested in a particular research area.

This is the way we should approach the collection of fishing in the Maria Znamierowska-Prüfferowa Ethnographic Museum in Toruń. This collection, amounting to over three thousand exhibits, was amassed by the founder and the patroness of the said museum, who came to live here from Vilnius after World War II. Organising ethnographic museology, Professor Znamierowska-Prüfferowa firstly opened (in 1949) an Ethnographic Department at the City Museum and then, in 1959, the independent Ethnographic Museum. In 1962, together with the museum construction, a specially designed building was erected with an exhibition hall where, in 1963, the permanent exhibition "Traditional Folk Fishing in Poland" was opened. The value of this subject, treated as the research specialisation of the museum, was increased by the creation of a separate division dealing with fishing and aquatic culture in general.

The origin of the collection in question and the said exhibition, however, goes back to earlier periods. Maria Znamierowska, an ethnographer educated at the Stefan Batory University in Vilnius, spent the first years of her work (1927-1939) in the ethnology department of this university and in the University Ethnographic Museum. While staying in the Vilnius area she also began her field research on fishing, collecting a vast (counting almost 1000 exhibits) set of fishing tools and auxiliary equipment. In 1933 and 1936 Maria Znamierowska-Prüfferowa opened two temporary fishing exhibitions. They accompanied "Northern Fairs" in Vilnius organised by the Society for Folk Manufacturing Promotion (Trapszyc 2001: 146). Her first publications, devoted mainly to lake fishing (Znamierowska-Prüfferowa 1930, 1939), also appeared in Vilnius. This period of development of the collections and exhibition activity was interrupted by the outbreak of World War II.

After the war, therefore, Maria Znamierowska returned to the idea of a permanent exhibition of fishing in Toruń. She started the project by compiling a completely new collection that, in its structure, referred to the collected set left in Vilnius. The greater part of it consisted of fishing spears, one of the most interesting groups, which became a source for the paper published later under the title: "Fishing spears in Poland and Neighbouring Countries" (Znamierowska-Prüfferowa 1957). In 1948, still within the organisational remit of the Ethnographic Department at the Toruń City Museum, the first permanent ethnographic exhibition was opened in the building of the former Town Hall. A separate and impressive part of this exhibition concerned inland and maritime fishing. With the acquisition of new exhibits (poems, fish-pots, landing nets, drag nets, single- and multi-wall nets, fishing rods, ropes and fish-bones) in 1952, the second, richer, exhibition of fishing was opened (Znamierowska-Prüfferowa 1962: 3,9,17-19).

The greatest exhibition undertaking on this subject, and a national one, was, however, the mentioned “Traditional Folk Fishing in Poland” exhibition. Functioning between 1963-2005 in the Ethnographic Museum in Torun, the exhibition showed professional fishermen’s work and folk people using traditional methods in open waters. The exceptionally vast exhibition area (1320 m2) displayed almost 600 exhibits, mostly from northern parts of Poland. This exhibition was a culmination of the authoress’ exhibition activity and the keystone of her long research work.

The exhibition narration was based on the presentation of fishing in the evolutionary development cycle, an explanatory model (hermeneutic), which was an almost binding canon in Poland in the 1960s. It started with the simplest tools and fishing methods (catching by hand, spearing, clubbing and poisoning) performed individually, or in a group in the sphere of coastal waters. Continuity of usage of certain, more archaic, tool forms, was emphasised in the exhibition by showing, next to ethnographic exhibits, appropriate archaeological monuments (medieval). The presentation closed with team boat fishing which was undertaken in large water bodies and which required organisational work as well as using huge fishing nets which were difficult to operate.

Fishermen’s tools and auxiliary equipment for maritime coastal fishing deserve special mention. These were exceptionally valuable exhibits acquired by the exhibition authoress in Kaszuby district after the World War II, i.e. in the period of common use of traditional methods and tools. They include a wide range of obsolete items – fish-gigs (tridents), special wading nets used as fishing lures, clubs and baskets, as well as a row-sail stave-built boat. Many of the fishing tools presented were withdrawn from usage due to technical developments and for legal regulations forbidding fishing of some sea fauna species (e.g. seal fishing equipment).

River fishing was shown mainly by means of tools used by fishermen from the Vistula, Bug and Narew rivers - the biggest water courses in Poland. They were nets and auxiliary equipment for active current fishing as well as pond fishing traps installed in river bank environs. The exhibition also presents boat building objects: single-trunk rowing boats (dug-out canoes) still in use until the middle of the 20th century on Eastern Poland waters (Mazowsze, Podlasie, Lubelskie district) and, displacing them, stave-built boats of combined sail-row power.

Winter fishing, in turn, was mostly a presentation of fishing on lakes. This part of the exhibition includes, amongst others, auxiliary tools used for hole making in ice (axes – *bociany*, spears - *pieśnie*), for drawing and finding nets under ice (forks, *finders*, anchors) and for pulling nets out (lifts, winches – *baby*). *Niewód* – a type of drag net, commonly used on lakes, hang under the ceiling of the exhibition hall. Lake fishing exhibits came mostly from such ethnographic regions as Kujawy, Chełmno Region, Dobrzyń Region, Bory Tucholskie and Kaszuby.

The inventory of, so called, minor fishing, consisted of tools used commonly in professional and non-professional fishing practiced on all water bodies in Poland. This model of fishing concentrated on the shallow coastal waters with the use of small tools used by individuals: landing nets (so called *kaszorki*), various types of *kłoń* (kinds of small nets), hand thrown nets (*rzutki*) as well as rods and various types of gaffs. Their place in the Toruń exhibition is a testament to the persistence of some archaic tools and fishing methods in the 20th century, especially in non-professional fishing (in poaching).

Iconography comprised a significant part of the exhibition. They were drawings (contemporary and historical) and photographs showing the way the particular tools were used by fishermen. This valuable collection, stored in Toruń Ethnographic Museum archives, is a result of numerous excursions and archival inquiries conducted by Maria Znamierowska-Prüfferowa from the 1970s and by her successors who continued her work.

In connection with the redevelopment of the exhibition hall, the fishing exhibition had to be dismantled in 2005. Presently, all the exhibits are stored in the Museum depositories.

It is worth emphasizing that the uniqueness of the collection described here is largely because its main part was completed in the first years after World War II. The period of the mid 20th century was the time of widespread use of hand made tools, made of natural materials and with the use of traditional manufacturing methods. Other components were added to the collection later.

Among these, small architectural objects should be distinguished. These are so called fisherman's houses on water. The tiny wooden boats moored in ports and harbours belonged to the landscape of riverside towns until the middle of the last century (Olszewski 1990; 53-56; Trapszyc 1997; 121-126; Znamierowska-Prüfferowa 1988; 139-140). Three such objects, reflecting a specific life model of people working on the Vistula River, are presently displayed in the two museum ethnographic parks.

There is one more angling collection worth mentioning. It was established by Wojciech Olszewski in the 1980s. Among these exhibits, tools and equipment made by anglers themselves are of interest, as they were made during the period of economic crisis in the last decade of the socialist system in Poland.

Toruń museum also has a great collection of traditional boats. This is a result of research on folk boat building conducted by employees of the Department of Fishing and Water Activities, particularly in the 1990s (Trapszyc 1999a. 1999b, 2007).

Presently, the research subjects of the Department of Fishing concentrate on problems of cultural ecology and professional subcultures connected with rivers (Trapszyc 2007). The Museum is also planning to open a new exhibition of fishing.

The fishing collection and exhibition described above determined the specificity of the Ethnographic Museum in Toruń for many years. (Znamierowska-Prüfferowa 1988). Our institution is willing to develop this specificity and retain it as its own distinctive image.

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Loach - a poor man's fish

Adriana GARBATOWSKA

Wielkopolska Etnographical Park at Dziekanowice, Poland

The area of Wielkopolska is a region of Poland that is rich in post-glacial lakes with a well developed network of freshwater rivers. The very earliest settlements therefore developed just above the waterline, where the prehistoric hunter-gatherers could readily supplement their diets with easily accessible fish, before more settled means of farming developed.

Later in history, access to these abundant waters was limited by royal and feudal privileges and this noble monopoly led to a sharp decline in fishing activity. The further development of fishing guilds and laws concerning the leasing of lakes and rivers contributed significantly to a continuing decline in fishing and therefore to fish as a food product. However, fish were a valuable food resource in terms of diet and such regulation only resulted in increasing illegal activity, namely the crime of poaching.

Fishing, instead of being a major activity, became the stuff of myth and legend. The title „*Ubogiemu piskorz*" refers to some proverbs like *„Chudobie wszędy piskorz"*, „*Ubogiemu wszędzie ledwo piskorz się dostaje"*...and becomes a reference point in the discussion of just how marginal fish were, both as a food source and to the economy. *Piskorz* or loach, a small fish whose habitat is the muddy ditch, shallow lake foreshore and overgrown river bed, was available to the peasantry only in times of famine. The monopolisation of fishing by royal and noble edicts cause the near absence of any form of fish from the peasant diet – such presence as is seen, is only as a result of extreme circumstances such as famine conditions, for treating or providing protein during illness or death.

Denied access to such local produce, farming became the major means of subsistence, Wielkopolska being an excellent area for agriculture. Therefore the diet of this region, even during special periods such as Lent, was markedly poor in terms of fish. An interesting aspect of this study would be an examination of the regulations of the Catholic church, in respect of compliance with its teachings regarding diet, and how local villages/settlements responded to these.

The technology of fishing in this area has been discussed in great detail in the extensive essays „Folk culture of Wielkopolska" and „Language atlas and folk culture in Wielkopolska". Maria Znamierowska - Prüfferowa (1935-7) has gathered crucial information from her ethnographic studies of fishing, when it was a more individual occupation before the advent of mechanisation and ultimately industrialisation. My study supplements this by concentrating on the issues of privilege, superstition and legend.

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THE 15TH MEETING OF THE ICAZ
FISH REMAINS WORKING GROUP (FRWG)

Field Trip

Poznań-Stobnica-Kuźniczka-Biskupin-Toruń-Gniezno-Dziekanowice/Ostrów Lednicki-Poznań

MONDAY 7th SEPTEMBER 2009

Time	*Field trip stages*
7:00 – 8:00	Breakfast
8:00	Departure from Poznan
8:45 – 10:00	Stobnica Wolf Park – Poznan University of Life Sciences
11:30 – 13:00	Kuźniczka – Farm for sturgeon breeding, hosted by Mr. Marek Raczkowski
13:00 – 14:00	Lunch
14:00 – 16:00	Trip to Biskupin
16:00-17:30	Biskupin - fortified settlement from the 7th c. BC.

17:30 – 19:00	Trip to Toruń – the town of Nicolaus Copernicus
19:00	Dinner
20:30	Accommodation

TUESDAY 8th SEPTEMBER 2009

Time	*Field Trip stages*
7:00 – 9:00	Breakfast
9:00-10:00	Walk along the Old Town streets of Torun
10:00 – 11:00	The House of Nicolaus Copernicus
11:00 – 12:30	Trip to Gniezno
12:30 – 13:30	Gniezno – Museum of the Origins of the Polish State
13:30 – 14:00	Trip to Dziekanowice/Ostrów Lednicki
14:00 – 15:00	Museum of The First Piasts at Lednica Manor House of Studzieniec - Welcome meeting with Prof. Andrzej Wyrwa, the Director of the Museum Lunch
15:00-16:00	Visit to the Great Poland Ethnographical Park
16:00 – 17:00	Sightseeing at the archaeological exhibition “The Lednica Island - a return to the past”
17:00 – 18:00	Sightseeing of “Little Skansen” with presentation of some traditional fishing
18:00	Ferry crossing to the Lednica Island
18:00 – 21:00	Fish consumption and accounts of the environmental archaeology of the Lednica Island settlement complex
21:00 – 21:30	Return to Poznan
21:30	Accommodation

THE HOSTING INSTITUTIONS

First Day:

STOBNICA RESEARCH STATION (Wolf Park),
Poznań University of Life Sciences
Aleksandra Kraśkiewicz, Tadeusz Mizera and Jacek Więckowski

FISHING FARM at Kuźniczka near Wieleń
Marek Raczkowski and Barbara Raczkowska

ARCHAEOLOGICAL MUSEUM (Muzeum Archeologiczne w Biskupinie)
A National Cultural Monument
Szymon Nowaczyk and Marta Nowaczyk

Second Day:

THE DISTRICT MUSEUM OF TORUŃ
Marek Rubnikowicz and Iwona Urbańska

MUSEUM OF THE FIRST PIASTS AT LEDNICA
(Muzeum Pierwszych Piastów na Lednicy)
A National Cultural Monument
Andrzej Wyrwa, Jacek Wrzesiński, Adriana Garbatowska and Antoni Pelczyk

sponsors of the Lednica Party:

COMPANY OF FISHERY PRODUCTION "MAJ"
Wągrowiec, Rogozińska 95
Marek Szeszycki

FISH FARMSTEAD in BOGUCIN
Bogucin, Zielona 2
Roman Madej

Chronicle of the I.C.A.Z.
Fish Remains Working Group Meetings – from 1981 to 2009

Daniel Makowiecki, Mirosław Makohonienko

(from 1981 to 1995 after Arturo Morales Muñiz, Archaeofauna 5, 1996: 13-20)

ICAZ FRWG

1th MEETING – 1981: København, Denmark (August 28th -29th)

„1th Fish Osteoarchaeology" – organized by Knud Rosenlund, Inge Bødker-Enghoff and Jane Richter

1. A. K. G. Jones: Reconstruction of fishing techniques from assemblages of fish bones.
2. R. Lil Jegren: Taphonomy.
3. J. Desse: Presentation of a new method of discrimination by x-ray diagnostics.
4. D. Heinrich: Standardization of measurements and size/weight reconstructions of fish.
5. N. Nøe-Nygaard: Use of growth rings to determine age of fish and season of catch.
6. H. Lernau: Fish remains from excavations in the Negev and the Sinai deserts and their connection with the Nile, the Mediterranean and the Red Sea.
7. H. Lernau: Special methods for defining vertebrae of bony and cartilaginous fish.

2nd MEETING – 1983: Valbonne, Sophia Antipolis, France (October 14th -16th)

„2nd Fish Osteoarchaeology" – organized by Jean Desse and Natalie Desse-Berset

1. F. J. Meunier: Sur la détermination histologique de vertèbres de poissons trouvées dans les sites archéologiques.
2. G. Desse: Nouvelle contribution à la diagnose des pièces rachidiennes des poissons.
3. A. Morales Muñiz: A study on the representativity and taxonomy of the fish faunas from two mousterian sites on northern Spain with special reference to the trout (*Salmo trutta* L., 1758).
4. A. K. G. Jones: Some effects of the mammalian digestive system on fish bones.
5. J. Desse: Propositions pour une réalisation collective d'un corpus: fiches d'identification et d'exploitation métrique du squelette des poissons.
6. O. Le Gall: L'exploitation de l'ichtyofaune par les Paléolithiques. Quelques exemples.
7. N. Juan-Muns: Le problème de la signifaction des restes ichtyofauniques fossiles.
8. S. M. Colley: Some methodological problems in the interpretation of fish remains from archaeological sites in Orkney.
9. T. Trolle-Lassen: A preliminary report on the archaeological and zoological evidence of fish exploitation from a submerged site in mesolithic Denmark.

10. K. ROSENLUND: The fish-bone material from a medieval Danish monastery and an 18th century mission station in Greenland. An investigation of materials with a known key.
11. W. VAN NEER: The use of fish remains in African archaeozoology.
12. E.S. WING: Faunal remains from seven sites in the Big Cypress national preserve.
13. J. RIVALLAIN: L'importance de la pêche dans les activités littorales du passé des Alladian, Côte d'Ivoire.
14. A. BOISSIER: Un habitat et un mode de vie traditionnels à l'étang de Salses (P.O., France). Exemples ethnographiques et implication archéologique.
15. N. NØE-NYGAARD: Seasonality determination, a tool in separating fish accumulations of mixed origin on Mesolithic island sites.
16. J. RICHTER: Indication of selection of different fish species at various seasons in the Neolithic.
17. M. S. GORECKI: Détermination des temperatures de dévelopement durant le cycle de vie de certains poissons pour la mesure des rapports d'oxygéne isotopique dans les otolithes.
18. P. LAHTIPERÄ: Measurements of Gadidae; problems and possibilities.
19. M. LERNAU: Nouvelles techniques de préparation et de rangement des collections de réference.

3rd MEETING – 1985: Groningen, The Netherlands (September 12th -14th)

„Fish and Archaeology” – organized by Anneke CLASON and Dick BRINKHUIZEN

1. A. T. CLASON: Fish and Archaeology.
2. N. BENECKE: Some remakrs on sturgeon fishing in the Southern Baltic region in Medieval times.
3. D. C. BRINKHUIZEN: Features observed on the skeletons of some recent European Acipenseridae: their importance for the study of excavated remains of sturgeon.
4. S. M. COLLEY: Site formation and archaeological fish remains. An ethnohistorical example from the Northern Isles, Scotland.
5. D. HEINRICH: Fishing and consumption of Cod (*Gadus morhua* Linnaeus, 1758) in the Middle Ages.
6. A. K. G. JONES: Fish bone survival in the digestive systems of the pig, dog and man: some experiments.
7. L. JONSSON: Fish bones in Late Mesolithic human graves at Skateholm, Scania, South Sweden.
8. A. LENTACKER: Archaeozoology of Late Prehistoric Portuguese sites with marine and riverine resources.
9. H. LERNAU: Fish bones excavated in two Late Roman-Byzantine Castella in the southern desert of Israel.
10. W. VAN NEER: Some notes on the fish remains from Wadi Kubbaniya (Upper Egypt; Late Palaeolithic).
11. W. PRUMMEL: The presence of bones of eel, *Anguilla anguilla*, in relation to taphonomic processes, cultural factors and the abundance of eel.
12. K. ROSENLUND: The sting ray, *Dasyatis pastinaca* (L.) in Denmark.

13. M. SEEMAN: Fish remains from Smeerenburg, a 17th century Dutch whaling station on the Westcoast of Spitsbergen.
14. J. DESSE: Les poissons du Grand Louvre.
15 I. BØDKER-ENGHOFF: New results from the classical shell midden in Ertebølle, Denmark.

4th MEETING – 1987: York, United Kingdom (September 9th -12th)

organized by Andrew JONES

1. P. V. ADDYMAN: Fish out of water: An Archaeologists' view of Archaeoichthyology.
2. K. M. STEWART: Fish remains at Olduvai Gorge.
3. W. VAN NEER: Fish remains from a Holocene site in Wadi Howar, Sudan.
4. V. L. BUTLER: Natural versus cultural salmon bones: a preliminary assessment of the Dalles «Roadcut» remains.
5. B. GHALEB: Fish and Women on a Western Torres Strait Island, Northern Australia.
6. I. TAKÁCS: Fish exploitation in Hungary.
7. M. ROSE: Prehistoric Fishing in the Aegean.
8. E. ROSELLÓ & A. MORALES: Cultural typification of Spanish pre-and protohistorical sites through the study of fish assemblages: proposal of a new methodology of study.
9. A. LENTACKER: The mesolithic Muge shell-middens of Portugal.
10. A. MORALES & E.ROSELLÓ: Casual or intentional? Comments on fish taxa skeletal representation from Spanish archaeological settlements.
11. E. S. WING: A Modern midden experiment.
12. A. E. BULLOCK: Dispersal of Fish waste: a modern experiement.
13. S. COLLEY: Cooking fish on a fire: an experiment in differential burning.
14. A. K. G. JONES: Walking the cod.
15. A. MORALES, E. ROSELLÓ, K. ROSENLUND & J. L. LÓPEZ GORDO: Spanish and Danish ichthyofaunal assemblages: patterns of diversity and abundance commented from a paleocultural perspective.
16. D. HEINRICH: Some remarks on fish remains from late- and postglacial sites near Hamburg.
17. I. BØDKER-ENGHOFF: Fishing at Mesolithic Bjørnsholm, Denmark, compared with the neighbouring settlement: the Ertebølle locus classicus. Principally eel-fishing sites?.
18. I. BØDKER-ENGHOFF: Rare species of fish in the Mesolithic Bjørnsholm Shell-midden, Denmark - indicators of a warmer climate.
19. L. JONSSON: Middle Mesolithic Fishing strategies and the marine environment on the Swedish west coast.
20. L. BARTOSIEWICZ: Size reconstruction of pike, *Esox lucius*, L.
21. I. TAKÁCS: Size reconstruction of catfish, *Silurus glanis*.
22. M. COLBURN: Cranial osteology of Redcar sunfish.
23. M. DUTTING & B. BEERENHOUT: Distribution analysis of the fish remains of a Roman Castellum at Velsen, the Netherlands.

24. R. C. HOFFMANN: Pike (*Esox lucius*) in late Medieval Culture: from illiterate empiricism to literate traditions.
25. J. COY: Saxon evidence from the river Thames.
26. D. SERJEANTSON: Fish Remains from a Monastic Site: St. Albans Abbey, Hertfordshire, England.
27. N. PAAP & M. SEEMAN,: Focussing on Fish eyes.
28. D. BRINKHUIZEN: Some remarks on seasonal dating of fish remains by means of growth ring analysis.
29. A. ROJO: X-rays to differentiate vertebrae from the Gadidae family.
30. D. WARD: A machine for processing clay to extract fish remains.
31. J. COY: Medieval documentation and the fish trade.
32. R. NICHOLSON: Fish remains from excavations near the river front at Newcastle, England.
33. L. JONSSON: Osteological evidence of medieval fish trade in Scandinavia.
34. R. KEMP: Fishing at Bylands Abbey, Yorkshire.
35. J. DESSE & N. DESSE-BERSET: Use and exchange of osteometric data for ichthofauna.
36. E. S. WING: Comparative fish skeleton collections.

5th MEETING – 1989: Stora-Kornö, Sweden (September 5th-9th)

organized by Leif JONSSON

1. L. JONSSON: An introduction to Stora Kornö and its village and the roots of an archaeoichthyologist.
2. W. VAN NEER: Fish remains from the Middle Palaeolithic site Bir Tarfawi (Eastern Desert, Egypt).
3. N. BENECKE: Seasonal dating of fish remains from the Hoabinian site Can-Cave (Vietnam).
4. E. WING: Prehistoric Fishing in the West Indies.
5. R. LARJE: Favourite fish dish of the Romans in Carthage.
6. E. AURA TORTOSA: A preliminary report about marine exploitation on the Andalusian coast: the Fish gorges from the Cave of Nerja (Málaga, Spain).
7. B. WILKENS: The importance of fishery in the economy of the Fucino Basin (Italy) from Upper Palaeolithic to Neolithic Times.
8. D. HEINRICH: Fish remains from Flem, a Stone Age settlement at Skulöy, Norway.
9. M. STERNBERG: La pêche et la consommation du poisson sur le site de Lattara (France, Hérault) du IIIe au Iere s. AV. J.C.
10. E. GEHASSE: Fish as salinity and tidal indicators at P14, a late Neolithic - early Bronce age site in the Netherlands.
11. L. BARTOSIEWICZ: Pre-depositional modifications on fish bone from Hungarian Excavations.
12. W. PRUMMEL: Fishing methods in Oldenburg (Holstein).
13. P. LAHTIPERÄ: Big Ling from Lofoten area from Stone age and Iron age.
14. S. HAMILTON-DYER: Fish in the Tudor Naval diet.

15. R. HOFFMANN: «*Carpes pour le duc ...*» The operation of fish ponds at La Perriere -sur-saune, Burgundy, 1338-1352.
16. L. JONSSON: Violet is nice. Comparative bone collections and the illustration of fish bones.
17. I. TAKÁCS: Osteomorphological studies on great sturgeon (*Huso huso*) from Hungary.
18. L. JONSSON: The Holocene History of western Sweden, geology, fishes, history of research.
19. R. NICHOLSON: Burnt fish bones: what value to archaeology?
20. A. K. G. JONES: How many fish bones do we need from a site?
21. D. HEINRICH: Some remarks on the term «Thanatocoenosis», especially «anthropogenic thanatocoenosis».
22. A. ROJO: x-Ray as a tool to identify the fish specimens of subfossil vertebrate from archaeological sites.
23. A. LEAK: An assessment of the value of the scales of the grayling *Thymallus thymallus* (L.) to the archaeologist for deriving information about the fish found in archaeological deposits.
24. A. LENTACKER: A Growthline study on the otoliths of *Argyrosomus regius*.
25. B. BERENHOUT: Velsen 1: Indications of water pollution in Roman times.
26. E. ROSELLÓ& A. MORALES: Castillo de Doña Blanca: fish remains from the oldest phoenician site on the Iberian Peninsula.
27. M. ROSE: Polished otoliths from archaeological contexts.
28. M. ARNAY-de-la-ROSA: Osteometrical analysis of *Sparisoma cretense*.
29. E. ROSELLÓ & A. MORALES: Comparative osteomorphology of the sardine (*Sardina pilchardus*) and round sardinella (*Sardinella aurita*).
30. S. STEN: Medieval and post-reformative fish finds from urban contexts as indicators of fish trade.
31. K. ROSENLUND: Computerized estimates of fish size based on osteometric data: presentation of a program.

6th MEETING – 1991: Schleswig, Germany (September 3rd-7th)

organized by Dirk HEINRICH

1. V. VOGEL: Excavations in the ancient centre of Schleswig, the archaeological background to the conference-town.
2. A. BULLOCK: Evidence for the exploitation of fishes from Tudor deposits and the Little Prickle excavations in 1989, Surrey, England.
3. I. BØDKER-ENGHOFF: Fishing from medieval Holbaek.
4. A. ERVYNCK & W. VAN NEER: Fish remains in medieval castles and towns (Flanders, Belgium): a preliminary survey.
5. E. ROSELLÓ & A. MORALES: Cartuja: Fish remains from a late medieval monastery in Seville (Spain).
6. P. MOREL: Medieval fish remains from a site near Basel.

7. N. IVANOVA: Fish remains from archaeological sites of the northern part of the Black Sea Region.
8. D. C. BRINKHUIZEN & E. ROSELLÓ: Laminak II: Marine fishes within a paleolithic limnetic ichthyocenosis from the Spanish Basque country.
9. A. LENTACKER: Fish remains from Saltés (Huelva, Spain).
10. L. JONSSON: Fish bone measurements. Gadiformes. Review and proposals.
11. W. VAN NEER: Fish size reconstructions: How accurate should they be?
12. D. HEINRICH: Fish remains from Durankulak and from some other sites - are they biased by the excavator?
13. J. STUDER: Fish and water: influence of a lake on the distribution of ichthyological remains.
14. M. MEZES & L. BARTOSIEWICZ: Fish bone preservation and fat content.
15. R. G. COOKE & J. BORT: A comparison between prehistoric and modern artisanal fishing in a small estuarine embayment on the Pacific coast of Panama.
16. A. SANCHEZ MOSQUERA: Fishing patterns in the continental coast of Ecuador.
17. N. JUAN-MUNS: Fishing strategy in the Beagle channel: an ethnoarchaeological approach.
18. R. C. HOFFMANN: The craft of fishing Alpine lakes, ca A.D. 1500.
19. C. G. RODRÍGUEZ SANTANA: The role of fishing in a prehistoric settlement on the island of La Palma (Canary Islands, Spain).
20. B. BEERENHOUT: What conclusions can be drawn from mature haddock bones in a neolithic coastal site in the Netherlands?
21. W. R. BELCHER: Fish utilization in the Harappan civilization: a view from the type site of Harappa.
22. D. SERJEANTSON, J. EVANS & S. WALES: Fish in latter prehistoric Britain.
23. L. JONSSON: Fish processing before salting and drying - historical evidence from Scandinavia.
24. Mª J. RODRIGO GARCÍA: The paleoecological implications of the presence of *Melanogrammus aeglefinus* (L., 1758) in the transition Upper Pleistocene-Holocene levels in Nerja Cave (Málaga, Spain).
25. I. SZEKELYHIDY, I. TAKÁCS & L. BARTOSIEWICZ: Size variability by geographic regions of some fish species in Hungary.
26. A. BULLOCK: Cost tradeoffs of mesh size and sieving rate in enrionmental processing.
27. R. LARJE: Are dermestid beetles safe for fish bones?
28. D. C. BRINKHUIZEN: Pathologies and anomalies in recent and subfossil fish bones.
29. A. MORALES & W. VAN NEER: Abundance indexes as potential discriminators of natural and anthropogenic paleoichthyocenosis.
30. D. C. BRINKHUIZEN: The diet of recent otter (*Lutra lutra*) from two regions in the northern Netherlands.
31. W. PRUMMEL: Bird and sea mammal catching during fishing.
32. B. IRVING: Possible evidence for Roman fish farming at Nicopolis ad Istrum, Bulgaria.
33. S. HAMILTON-DYER: Fish remains from Mons Claudianus – a Graeco-roman site in the Eastern desert of Egypt.

34. R. C. HOFFMANN: European subfossil carp (interim report).
35. D. PATÓN & E. ROSELLÓ: A computerized procedure for the classification of Mugilid remains from archaeological sites.
36. Ch. RADTKE: Medieval fishing with «*herring-fences*» in the Schlei.
37. A. SÁNCHEZ MOSQUERA: The evolution of Ecuatorian Archaeozoology.

7th MEETING – 1993: Leuven, Belgium (September 6th-10th)

"Fish Exploitation in the Past" – organized by Wim VAN NEER

1. J. H. BARRETT: Bone weight and the intraclass comparison of fish taxa.
2. O. LERNAU & M. BEN-HORIN: Taphonomic curve and index: a preliminary exploration of a new concept.
3. F. FALABELLA, M. LORETO VARGAS & R. MELENDEZ: Differential preservation and recovery of fish remains in Central Chile.
4. A. VON DEN DRIESCH: Hyperostosis in fish.
5. F. J. MEUNIER & J. DESSE: Histological structure of hyperostotic cranial remains of Pomadasys hasta (Osteichthyes, Perciformes, Haemulidae) from archaeological sites of the Arabian Gulf and the Indian Ocean.
6. L. BARTOSIEWICZ; I. TAKÁCS & I. SZEKELY-HIDY: Problems of size determination in common carp (*Cyprinus carpio*).
7. M. STERNBERG: Reconstitution de la taille de Dicentrarchus labrax provenant de Lattes (Iléme Age du Fer-début de la romanisation).
8. J. DESSE & N. DESSE-BERSET: Osteometry and fishing strategies at Cape Andreas Kastros (Cyprus, 8th millennium BP).
9. N. DESSE-BERSET: Sturgeons of the Rhone during Protohistory in Arles (6th-2nd century BC).
10. O. LE GALL: Quelques remarques sur l'adaptation à court et à long termes chez les poissons d'eau douce du sud de la France.
11. R. COOKE & G. TAPIA RODRIGUEZ: Marine and freshwater fish amphidromy in a small tropical river on the Pacific coast of Panama: a preliminary evaluation based on gill-net and hook-and-line captures.
12. L. BARTOSIEWICZ; E. HERTELENDI & A. FIGLER: Seasonal dating of hand-collected fish remains from a prehistoric settlement in Hungary.
13. W. R. BELCHER: A regional approach to fish remains and seasonality in East Penobscot Bay, Maine.
14. O. J. POLACO & A. F. GUZMÁN: Fishes in some Spanish sixteenth century chronicles.
15. T. DE JONG: Fish consumption at Eindhoven Castle: archaeological remains versus historical sources.
16. R. C. HOFFMANN: Remains and verbal evidence of carp (*Cyprinus carpio*) in medieval Europe.
17. L. VAN BUYTEN: Données historiques sur le commerce de poissons à Louvain (Brabant, Belgique) au 18ème siècle et leur apport à l'archéozoologie.
18. S. CROCKFORD: New archaeological and ethnographic evidence of an extinct fishery for giant bluefin tuna (*Thunnus thynnus orientalis*) on the Pacific Northwest Coast of North America.

19. W. R. Belcher: Butchery practices and the ethnoarchaeology of South Asian fisherfolk.
20. A. M. Choyke & L. Bartosiewicz: Angling with bones.
21. W. Z. Wendrich & W. Van Neer: Preliminary notes on fishing gear and fish at the late Roman fort at 'Abu Sha'ar (Egyptian Red Sea coast).
22. J. Studer: Roman fish sauce in Petra, Jordan.
23. D. C. Brinkhuizen: Some notes on fish remains from the late 16th century merchant vessel Scheurrak SO1.
24. R. Ceron-Carrasco: The investigation of fish remains from an Orkney farm mound.
25. D. Heinrich: Fish remains of two medieval castles and of an urban context – a comparison.
26. W. Van Neer & A. Ervynck: New data on fish remains from Belgian archaeological sites.
27. I. Zohar, T. Dayan, E. Spanier, E. Galili & O. Lernau: Exploitation of grey triggerfish (*Balistes carolinensis*) by the prehistoric inhabitants of Atlit-Yam, Israel: a preliminary report.
28. C. Cartwright: Preliminary results of the study of fish remains from a 3rd millennium BC site, HD1, at Ra's al-Hadd, Oman.
29. K. C. MacDonald & W. Van Neer: Specialised fishing peoples in the Later Holocene of the Mema Region (Mali).
30. A. Morales, E. Roselló & J. M. Cañas: Cueva de Nerja (prov. Málaga): a close look at a twelve thousand year ichthyofaunal sequence from southern Spain.
31. A. Lentacker: Fish remains from Portugal: preliminary analysis of the Mesolithic shell-midden sites of Cabeco da Amoreira and Cabeco da Arruda.
32. B. Irving: Identification to family or species in ichthyofaunal studies. The importance of a filter where osteologically similar species share the same habitat niche: examples from the site of Saar, Bahrain.
33. I. Bødker-Enghoff: Fishing from Denmark in the Ertebølle-period.
34. H. Hüster-Plogmann: Neolithic fish remains from the Zurich-lake region: difficulties and possibilities.
35. N. Juan-Muns & C. Rodríguez Santana: Sant Pere de Rodes (Empordá, Catalonia, Spain): an analysis of the eighteenth century ichthyofauna.
36. W. Van Neer, S. Augustynen & T. Linkowski: Daily growth increments on fish otoliths as seasonality indicators on archaeological sites: the tilapia from late palaeolithic Makhadma in Egypt.

8th MEETING – 1995: Madrid (Cantoblanco), Spain (October 3rd -11th)

organized by Eufrasia ROSELLÓ and Arturo MORALES

1. Arturo MORALES MUÑIZ: ICAZ's Fish Remains Working Group: A Retrospective look (1981-1995).

SESSION: FISHING AND OVERFISHING IN THE PAST

2. José A. PEREIRO: Fishery Research: a long way and some conclusions.
3. Thomas AMOROSI: Scaly headaches within the Atlantic stock-fish trade: problems in interpreting numbers, recovery and scalar regional perspectives .
4. Sophia PERDIKARIS: Scaly Heads & Tales: Detecting commercialization in Early Fisheries.
5. Richard HOFFMANN: Economic expansion, habitat destruction and depletion of inland fisheries in medieval Europe.
6. Foss B. LEACH: The overfishing hypothesis in prehistoric New Zealand.
7. Lembi LÔUGAS: Stone Age Fishing strategies in Estonia - What have they been depending on?
8. Atholl J. ANDERSON: Regional variation in the prehistoric Maori fish catch.
9. Amelia SÁNCHEZ MOSQUERA: Patrones de pesca precolombinos en la costa central ecuatoriana.
10. Norbert BENECKE: Fish exploitation during the Neolithic: some new data from Northern central Europe.
11. Qlivier LE GALL: Aspects de 1'ichthyologie et de pêches prehistoriques en Europe occidentale.
12. Inge BØDKER ENGHOFF: A Medieval Herring industry in Denmark.
13. Myriam STERNBERG: La pêche sur le littoral mediterrannéen entre le IVe et le IIeme s.av.n.é: une activité saisoniére ou annouelle?
14. Omri LERNAU, Hannah COTTON & Yuval GOREN: Salted fish and fish sauces from Masada.
15. Wim VAN NEER: A study on the otoliths of plaice from Raversijde, a late medieval coastal site in Belgium.

POSTERS OF RELATED INTEREST FOR THE "FISHING AND OVERFISHING" SESSION

16. Amelia SANCHEZ MOSQUERA: Pesca durante el desarrollo regional: el caso Guangala
17. Pippa SMITH: The identification of a local cornish fishing industry
18. Barbara WILKENS: Different kinds offish preserved from four roman amphorae

SESSION: METHODS I: TAFONOMY

19. William BELCHER: Site function and fish remains: comparison of village and elite contexts within the Indus Valley tradition (ca. 2600-1600 BC).
20. Irit ZOHAR & Richard COOKE: Contemporary fish processing at Parita Bay, Panamá: an osteological approach.
21. Suzanne NEEDS-HOWARTH: Intra-site differences in fish bone discard at the Carson site, a prehistoric Iroquoian village near lake Simcoe (Canada).
22. Rebecca NICHOLSON: Fish bone diagenesis in different soils.

SESSION: METHODS II: OSTEOLOGY AND OSTEOMETRY

23. Jean DESSE: On the boundaries of osteometry applied to fish.
24. Lászlo BARTOSIEWICZ: Pike (*Esox lucius* L., 1758) bones from a Turkish Period military fort in Hungary.
25. Jean DESSE & Nathalie DESSE-BERSET: Archaeozoology of groupers (Epinephelinae) in the Mediterranean and the Arabian Gulf: identification, osteometry and keys to interpretation.

SESSION: METHODS III: PHYSICO-CHEMICAL AND NUMERICAL METHODS

26. Susan J. CROCKFORD: Analysis of ancient fish DNA.
27. Heidemarie HÜSTER-PLOGMANN: Correlation between sample size and relative abundance of fishbones: examples from the excavation ARBON/TG BLEICHE 3
28. Cedric A. POGGENPOEL: The application of Br/Sr ratio's in fish as a means to determine fish habitat changes during the Holocene in the Southwestem Cape, South Africa.
29. Carmen G. RODRĹGUEZ SANTANA: On the Quantification of Archaeozoological Ichthyofaunas: looking for solutions to specific problems.

POSTERS OF RELATED INTEREST FOR THE "PHYSICO-CHEMICAL AND NUMERICAL METHODS" SESSION

30. Omri LERNAU: Fish bones in archaeological excavations: suggestions for an explicit way of
31. Jørn ZEILER: Archaeobone: Archaeological Research Bureau

SESSION: HISTORICAL STUDIES

32. Jennie COY: Medieval records vs. excavation results. Examples from central Southern England.
33. Dirk HEINRICH: Information about fish from tales and myths.
34. Wim VAN NEER & Anton ERVYNCK: Food rules and status: patterns of fish consumption in a monastic community (Ename, Belgium).
35. Juan ZOZAYA STAHBEL-HANSEN: Fishes in pots.
36. Myriam STERNBERG: A propos de la romanisation: qu'en est-il de la pêche. Le cas du littoral languedocien.
37. Angelika LAMPEN: Medieval fish-weirs: the archaeological and historical evidence.

POSTER OF RELATED INTEREST FOR THE "HISTORICAL STUDIES" SESSION

38. Mª Jesús BIELZA DÍAZ-CANEJA: El pescado en la dieta de los cartujos de El Paular en el siglo XVI

39. Film session: "Haddrah et Gargour, pêche traditionelle à Bahreim", produced by Nathalie DESSE-BERSET.

SESSION: REGIONAL STUDIES

40. Bea DE CUPERE; Local and imported fish from the classical site of Sagalassos (Burdur province, Turkey).
41. Ana Fabiola GUZMAN & Oscar POLACO: The fishes from the offering 23 of the Templo Mayor, México.
42. Judith POWELL: The fishbone assemblage from the Cave of Cyclops, Youra, Alonnessos.
43. Daniel MAKOWIECKI: Fish remains from prehistoric and medieval sites in Poland: a survey of old and new data.
44. Manuel PELLICER CATALAN & Carmen G. RODRÍGUEZ SANTANA: Fishers of the Cave of Nerja: from hunter-gatherers to producers.
45. An LENTACKER: Aquatic and terrestrial resources at two roman sites along the Red Sea Coast, Egypt.
46. Annica CARDELL: Coastal Fishing during the Early Medieval period in Simrishamm, Sweden.
47. Mark ROSE: Fishing at Minoan Pseira: Formation and seasonality of a Late Bronze Age fish assemblage from Crete.

POSTERS OF RELATED INTEREST FOR THE "REGIONAL STUDIES" SESSION

48. Mark BEECH: New evidence for an 'Ubaid period fish processing site, Abu Dhabi Emirate, U.A.E.
49. Jacob S. JAYA RAJ: Aquatic remains in archaeological sites: an archaeological survey of India
50. Suzanne NEEDS-HOWARTH: Lake sturgeon bones from prehistoric Iroquoian sites near lake Simcoe
51. Mark ROSE: Fishing in a changing environment: Franchthi Cave, Greece, 11,000-5,000 B.P.
52. Barbara WILKENS: Fish remains from the roman ship of Grado, Italy

9th MEETING – 1997: Panama City & Chitre, Republica de Panama (March 16th -22nd)

organized by Richard COOKE

Oral presentations:

1. Arturo ACERO: Importance of Osteological Studies for Systematics and Biogeography.
2. James BARRETT, Ruby CERON-CARRASCO, and Rebecca NICHOLSON: The Prehistory of Marine Resource Use in the Highlands and Islands of Scotland.

3. László BARTOSIEWICZ: Early History of Fish Exploitation in Hungary and the Lower Danube Region.
4. László BARTOSIEWICZ: Relative Size Estimation of Archaeological Fish Using Computerized Mass Measurement of Vertebrae.
5. M.J. BEECH: History of Fishing in the United Arab Emirates.
6. Inge BØDKER ENGHOFF: Prehistoric Fishing in the Baltic.
7. A.T. CLASON: Traditional Fishing on the South Coast of West Java, Indonesia.
8. Richard COOKE: Fishing in Lower Central America from 7,000 BP to the SpanishConquest.
9. Anton ERVYNCK, Wim VAN NEER, and Dick BRINKHUIZEN: Evolution of Fisheries and the Fish Trade in the Low Countries.
10. Ana Fabiola GUZMAN: Archaeoichthyological Analysis of Offering 23 from the Templo Mayor of Tenochtitlan.
11. Ruth GREENSPAN: The Use of Gear Selectivity Models in the Interpretation of Archaeological Fish Remains: a Case Study from the Harney Basin, Oregon, USA.
12. Sheila HAMILTON-DYER: Fishing in Mediaeval Novgorod, Russia.
13. Máximo JIMÉNEZ: Fishing at Cerro Juan Diaz, a Precolumbian Village on the Central Pacific Coast of Panama.
14. Foss LEACH: A Review of 35,000 Years of Fishing in the Pacific.
15. Lembi LÕUGAS: A Regional Study of Stone Age Fish Remains in the Eastern Baltic.
16. Daniel MAKOWIECKI: Fishing in Poland during the Prehistoric and Historic Periods.
17. Laetitita MATHIEU: An Assessment of the Diet of the Great Cormorant (*Phalacrocorax carbo sinensis*) Based on the Osteological Analysis of Regurgitated Pellets.
18. Peter MILLER: Identification of gobiid fish remains.
19. Arturo MORALES: Bone Fracture Patterns of Sea Breams (Sparidae) from Spanish Archaeological Sites.
20. S. NEEDS-HOWARTH: Iroquoian Fishing around Lake Simcoe, Ontario, Canada.
21. S. NEEDS-HOWARTH: Seasonality from Scales and other Structures: an Application of Fisheries Methods.
22. S. PERDIKARIS: The Commercial Fisheries of Mediaeval Arctic Norway.
23. German PENA: Precolumbian Fishing in Colombian Rivers and Freshwater Lakes.
24. Oscar POLACO: A Fish Offering of the Tarascan Culture, Mexico.
25. Elizabeth RAMOS ROCA: Precolumbian Fishing along the Atlantic Coast of Colombia.
26. Teresa ROSALES THAN and Victor VASQUEZ SANCHEZ: The Sciaenidae in the Prehistory of the North Coast of Peru.
27. Eufrasia ROSELLO: Comparative Osteology of Spanish Sea Breams (Sparidae): a Reference for Ichthyoarchaeologists.
28. Amelia SANCHEZ: Fishing during the Valdivia and Machalilla Periods on the Ecuadoran Coast.
29. Dale SERJEANTSON: Fish Consumption in Southern England in the Middle Ages.
30. Jacqueline STUDER: Fish in Jordan: Food Source and Model for Mosaics.
31. Wim VAN NEER: Prehistoric Fishing along the Egyptian and Sudanese Nile.

32. Wim VAN NEER: An Overview of Archaeoichthyology at Turkish and Syrian Sites.
33. Barbara VOORHIES: Preceramic Fishing in the Estuaries of Chiapas (Mexico).
34. Irit ZOHAR: Prehistoric Fishing in Israel.

Poster presentations:

35. Richard COOKE and Conrado TAPIA: Hyperosteosis: a Preliminary Guide for Archeologists in the Eastern Tropical Pacific.
36. Alison LOCKER, Dale SERJEANTSON: The Demise of Stockfish and Herring in British Armed Forces Rations in the Late 17th. and Early 18th. Centuries.
37. Lembi LÕUGAS, Wim VAN NEER: Growth Ring Studies of Fish Remains from Archaeological Sites: a Methodological Approach.

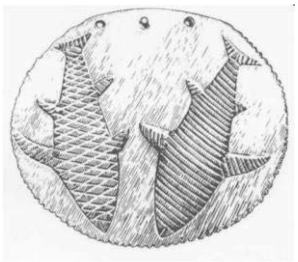
10th MEETING – 1999: New York City, USA (September 24th – October 2nd)

organized by Sophia PERDIKARIS

1. Thomas H. MCGOVERN, Clayton TINSLEY, Ragnar EDVARDSSON, Colin AMUNDSEN: Fishing in the Mid Atlantic: Recent and ongoing NABO projects in Iceland - Group presentation.
2. Inge BØDKER ENGHOFF: Aspects of Fishing in the Baltic and North Sea Region from the 5th century BC to the 16th century AD.
3. Annica HEPP CARDELL: "Lost and Found" A Methodological Study of Fish Retrieval
4. Ruby CERON CARRASCO: The fish remains from Bostadh Beach, Great Bernera, Isle of Lewis, Scotland.
5. Andrew JONES: Fish bones and public archaeology. Why we must involve children and prisoners.
6. Sophia PERDIKARIS: Commercial Signatures across the North Atlantic: The saga of Gadus morhua.
7. Richard HOFFMAN: Exotic Food: Medieval Europeans eating fish from outside natural local ecosystems.
8. Claudia MILNE & Pamela CRABTREE: From Sea to City: Commercial Fishing in 19th Century New York City.
9. Ruth GREENSPAN: Prehistoric Fishing on the Southern Northwest of North America.
10. Virginia BUTLER: Human caused resource depression in the late Holocene: an example from the Lower Columbia River, Oregon, USA.
11. Andrew JONES: Workshop: Presenting fish bone work to the general public.
12. Wim VAN NEER: Short and long-distance trade of fish in Turkey.
13. Irit ZOHAR, Wim VAN NEER, Nadel DANI: Cyprinid Exploitation at the Sea of Galilee by Early Epipalaeolithic Hunter-Gatherers: Preliminary results.
14. Foss LEACH and Janet DAVIDSON: Estimating Fish Size from Archaeological Bones within one family: A detailed look at three species of Labridae.
15. Greg MONKS: How much is enough?: An approach to sampling ichthyofaunas.
16. Margarethe UERPMANN: Significance of fishing at sites of different time periods in the Arabian Gulf area.
17. Bill BELCHER: Households and Fish Remains at Balakot and Harappa - Comparisons

from the Indus Valley Civilization.

18. Mark BEECH and Mohamed SALEM: Modelling the ancient seasonal exploitation of marine resources in the southern Arabian Gulf: a study of archaeological otoliths and modern fisheries data.
19. Omri LERNAU: "Fish and Chips" for the audience of King Herods' "Amphitheatron" in Cesarea.
20. Judith POWELL: Fishing in the North Aegean Mesolithic and Neolithic - evidence from Youra, Greece.
21. Chris MOSSERI-MARLIO: The fat is in the Fire: A Bronze Age Dolphin Processing Site at Ra's al'Hadd, Oman.
22. Irit ZOHAR: Large Molariform Fish Teeth from the Lower/Middle Pleistocene Acheulian Site of Gesher Benot Ya'aqov, Israel: A brief communication.
23. Foss LEACH: Review of Fishing in the Pacific.
24. Alfred GALIK: Fish scale morphology of Fresh Water.
25. Heide HÜSTER-PLOGMANN and Andre Rehazek: Historical record versus archaeological data. Fish remains from roman and medieval sites in Switzerland.
26. Daniel MAKOWIECKI: The Evolution of Fish Fauna in the Lowland of Northern Central Europe.
27. László BARTOSIEWICZ: Bronze Age Fish Remains in the Tisza River Region, Hungary.
28. Alfred GALIK: Historical and ichthyological evidence of fish consumption in Medieval Austria.
29. Heather BUILTH: Aboriginal occupation and migrating eels, a GIS approach to cultural landscapes.
30. Kristin BOSMA: Roman Period fishing in the Dutch terpen region.
31. Ana Fabiola GUZMÁN and OSCAR POLACO: Fishes consumed in a XVI century house of Mexico City.
32. Phillipe BÉAREZ: Archaic Fishing in Southern Peru Coast.
33. Arturo ACERO: The CGSM (Colombian Caribbean): Fisheries in the Past and Present.
34. Sandrine GROUARD: Methodological approach in the body size reconstruction of two fish familes (Lutjanidae and Scaridae) from cranial bones. Applications to the ichthyoarchaeological remains of Anse a la Gourde (Guadeloupe, West-indies) from the period holocene Saladoid.
35. A. MORALES, E. ROSELLÓ, V. VASQUEZ and T. ROSALES: The Fishes from Mo Che (Peru)



11th MEETING – 2001: Paihia, New Zealand (October 8th –15th)

organized by Foss LEACH

1. László BARTOSIEWICZ, Vasile SISU and Clive BONSALL: The history of sturgeon fishing in the Danube.
2. Philippe BÉAREZ. Sciaenids' otoliths: A useful tool for size reconstruction of consumed fishes in southern Peru archaeological sites and a help for understanding fishing strategies.
3. William BELCHER: Maritime adaptation on the Downeast Coast of Maine (USA): Fish remains and seasonality of the Roque Island Archipelago.
4. Heather BUILTH: Lipids as archaeological bio-markers for testing Gunditjmara settlement in south eastern Australia.
5. Matthew CAMPBELL: Taphonomy and archaeofaunal analysis of fish bone from Pleasant River Mouth, New Zealand.
6. Richard COOKE: Fishing by habitat in tropical tidal estuaries: A case study from Parita Bay, Panama.
7. Janet DAVIDSON, Foss LEACH and Christophe SAND: 3000 years of fishing in New Caledonia and the Loyalty Islands: A Pacific anomaly?
8. Jean DESSE and Nathalie DESSE: Tunas (Thunnus, Euthynnus, Katsuwonus) and Scaridae (parrot fishes) from Polynesia to the Indo-Pacific: Skeletal exploitation and archaeological interpretations.
9. Arlene FRADKIN and Omri LERNAU: The fishing economy at Caesarea Maritima, Israel.
10. Ruth GREENSPAN: Patterns of fish use and processing in contrasting coastal environments.
11. Ana Fabiola GUZMÁN and Oscar POLACO RAMOS: A comparative analysis of fish remains from some Mexica offerings.
12. Ana GUZMÁN and Oscar POLACO RAMOS: Hyperostosis in Mexican fishes.
13. Lucy JOHNSON: Prehistoric fishing technologies and species targeted in the Aleutian Islands: Archaeological and ethnohistoric evidence.
14. Sharyn JONES-O'DAY: Change in marine resource exploitation patterns in prehistoric Jamaica: Human impacts on a Caribbean island environment.
15. Leif JONSSON and Louise JONSSON: Fish hooks and marine fishes exploited during the Mesolithic and Neolithic stone age periods on the Swedish west coast.
16. Tonya LARGY, Peter BURNS, Elizabeth CHILTON and Diana DOUCETTE: Lucy Vincent Beach: Another look at the prehistoric exploitation of Piscine resources off the coast of Massachusetts, U.S.A.
17. Foss LEACH and Janet DAVIDSON: Freshwater and marine eels: food avoidance behaviour and/or differential preservation in the Pacific and New Zealand.

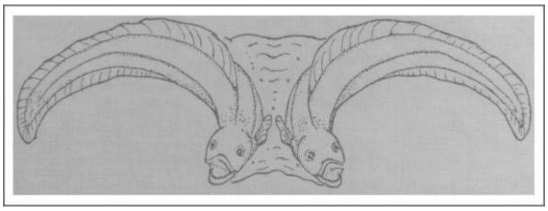
18. Tony LEGGE: The Third wave: colonisation and the acclimatisation of Salmondids in New Zealand.
19. Omri LERNAU and Dani GOLANI: The political significance of fish in Lachish.
20. Alison LOCKER: Fish as food: Evidence of stored fish in domestic deposits and comparison of herring and the gadids by 'portion' versus bone numbers.
21. Akira MATSUI and Osamu TAKAHASHI: The significance of anadoromus Salmonidae in Japan.
22. Rebecca NICHOLSON. Social storage and the rise of fish as an economic resource in Shetland.
23. Alaric NICHOLLS, Melinda ALLEN and Elizabeth MATISOO-SMITH: Application of mtDNA to problems in Polynesian fisheries studies.
24. Patrick O'DAY: Exploitation of freshwater shellfish (Unionidae) from Stallings Island.
25. Rintaro ONO: First study of prehistoric marine fishing in Borneo: The analysis of bones excavated from Neolithic site in Sabah, Borneo Island.
26. Sophia PERDIKARIS: Nabone data products.
27. Fiona PETCHEY: Problems and prospects of radiocarbon dating archaeological fish bones.
28. Tony PITCHER: Back to the future: Why tommorrow's fisheries need fish remains archaeologists.
29. Elizabeth REITZ: Archaeological evidence for change in marine fishes off the southeastern United States.
30. Eufrasia ROSELLÓ IZQUIERDO and Arturo MORALES-MUÑIZ: A new look at the fish remains from Cueva De Nerja (Costa Del Sol, Spain): a paleocultural and biogeographic perspective.
31. Jim SAMSON: Metrical and other characteristics of tarakihi (Family: Cheilodactylidae, Species: Nemadactylus macropterus).
32. Ian Smith: New Zealand fishing in nutritional perspective.
33. Sue STALLIBRASS: Fishers of men: Archaeology, art, religion and dead fish.
34. Ian STREETER: Reconstructing season of capture from growth increments on archaeological rockfish (Sebastes sp.) vertebrae: Implications for seasonality and settlement patterns on the west coast of Vancouver Island.
35. Hans-Peter UERPMANN: Fishing gear from Stone Age sites in the Oman Peninsula.
36. Margarethe UERPMANN: Changing patterns of coastal fisheries in SE-Arabia from the 5th to the 1st millennium BC.
37. Deborah VALE: Marine faunal assemblages on the mid-north coast of New South Wales, Australia.
38. Marshall WEISLER and Chris LALAS: When is enough, enough?: Sampling fish bones from archaeological sites for estimating length-frequency distributions of prey species.
39. Elizabeth WING: To catch a shark: Prehistoric shark fishing in the circum-Caribbean.

12th MEETING – 2003: Guadalajara, Jalisco, México (September 4th-12th)

“Presencia de la arqueoictiología en México. *Presence of the archaeoichthyology in México*” – organized by Ana Fabiola GUZMÁN, Óscar J. POLACO and Felisa J. AGUILAR

1. Colin AMUNDSEN: Early medieval fishing activity in the Kola Peninsula.
2. László BARTOSIEWICZ: Eat not this fish-a matter of scaling.
3. Philippe BÉAREZ & Richard LUNNISS: Scombrid fishing at Salango (Manabí, Ecuador) during the first millenium BC.
4. Ruby CERON-CARRASCO: Caravan trails in antiquity.
5. María Isabel GONZÁLEZ de BONAVERI, Damián MOCCIOLA & Gabriel Gustavo GIACOBONE: Identificación de vértebras de peces explotados durante el Holoceno tardío en la región Pampeana Argentina.
6. Ruth L. GREENSPAN: Environmental reconstruction at seaside, Oregon: contributions of the fish bone assemblages.
7. Sandrine GROUARD: Pre-Columbian fishing strategies in Guadeloupe archipelago (FWI).
8. Ana Fabiola GUZMÁN & Óscar J. POLACO: Archaeological record of shark, ray, and sawfish remains in México.
9. Sheila HAMILTON-DYER: Exploitation of marine resources at Quseir, Egypt: Same stuff, different date?
10. Abraham KOBELKOWSKY: Comparative osteology of the mojarras (Pisces: Gerreidae).
11. Lembi LÕUGAS: Did Stone Age people eat fish or meat: stable isotope and archaeozoology data.
12. Daniel MAKOWIECKI: Neolithic fishing on the Polish area.
13. Daniel MAKOWIECKI: Culture and fishes in the past.
14. Nina MANASERYAN: The fishes of the ancient Armenia.
15. Sónia MARQUES GABRIEL: La ictiofauna de los concheros mesolíticos del Valle del Sado (Portugal) - propuesta de estudio e integración.
16. Arturo MORALES & Eufrasia ROSELLÓ: Gihayu: A 6th millennium BC fishing station on the coast of Yemen.
17. Argentina Javier MUSALI, Alejandro ACOSTA & Daniel LOPONTE: Methodological issues: an attempt to assess bone representation of Pampa’s Wetlands ichthyoarchaeological record.
18. Anna C. NOAH: Status and fish consumption: inter-household variability in a simple chiefdom society on the California Coast.
19. Sophia PERDIKARIS: Freshwater and marine fish in inland sites in North Iceland.
20. Sophia P. PERDIKARIS, Thomas MCGOVERN, Yekaterina KRIVOGORSKAYA & Matthew WAXMAN: Early modern fisher-farmers at Finnbogastadir and Gjogur in Northwest Iceland.
21. Fermín REYGADAS DAHL & Gerardo González BARBA: Ornamento elaborado con dientes de tiburón impregnado a un cráneo humano del sitio prehispánico El Conchalito (Ensenada de La Paz), Baja California Sur, México.
22. César Antonio RODRÍGUEZ ARCE: Nueva metodología para el estudio de los remanentes faunísticos de los sitios arqueológicos en Cuba.

23. Eufrasia ROSELLÓ, Arturo MORALES, Darío BERNAL & Alicia ARÉVALO: Salsas de pescado de la factoría romana de Baelo Claudia (Cádiz, España).
24. Christophe SAND: Fish hooks and other fishing implements found in archaeological contexts in New Caledonia: new perspectives on fishing techniques during southern Melanesia's prehistory.
25. Thomas A. WAKE: Prehistoric fisheries of the greater Soconusco region, pacific coastal Chiapas and adjacent Guatemala.
26. Wim VAN NEER, Anton ERVYNCK, Loes J. BOLLE, Adriaan D. RIJNSDORP & Richard S. MILLNER: Seasonality only works in certain parts of the year. The reconstruction of fishing seasons through otolith analysis.

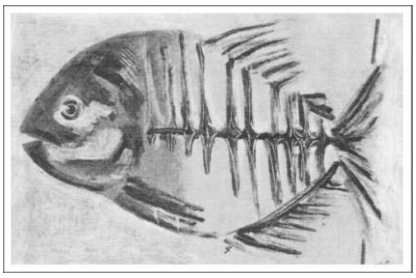


13th MEETING – 2005: Augusta Raurica, Basel/Augst, Switzerland (October 4th-9th)

"The Role of Fish in Ancient Time" – organized by Heide HÜSTER-PLOGMANN

1. R.-M. ARBOGAST, B. CLAVEL: Hunting, fishing and ancient Neolithic traditions in the North of France.
2. J. BARRETT: Freshwater Fishing in Early Medieval England: The evidence from Flixborough.
3. M. BAZZANELLA, U. WIERER: Mesolithic wetland exploitation at Galgenbühel/ Dos de la Forca (Bozen, Eastern Alps).
4. Ph. BÉAREZ: Inland fisheries in the Llanos de Mojos, Bolivian Amazonia. The site of Loma Mendoza (400 – 1400 A.D.).
5. L. BEJENARU, S. STANC, C. TARCAN: Fishing on the territory of Romania during Medieval times.
6. N. BENECKE, K. PRIVAT, J. SCHNEEWEISS: Fish as a food resource in the Late Bronze Age of Western Siberia: faunal evidence versus palaeodietary analysis of human remains and residues from ceramic vessels.
7. I. BØDKER ENGHOF: Viking age freshwater fishing at Viborg, Denmark. Results from an interdisciplinary research project with special focus on methods of excavation.
8. R. CERÓN-CARRASCO, D. STONE, C. BONSALL – MaRS: An introduction to a database of Marine Resource exploitation in Scotland.
9. J. DESSE, N. DESSE-BERSET : Exploitation du milieu marin par les populations du litoral au Bélouchistan (Pakistan), et leur contacts aves les oasis de l'intérieur, dés la fin du Vème millénaire BC.
10. A. ERVYNCK: Fish and fishing at the late medival coastal settlement of Walraverside (Flanders, Belgium).
11. A. FRADKIN: Pre-Columbian fishing in the Everglades, South Florisa, USA.
12. A. GALIK: Fish consumption, economical and social impact in late Hellenistic and Roman Ephesos.

13. R. L. GREENSPAN: The Distribution and Interpretation of Pacific Hake (Merluccius Productus) Remains from Archaeological Sites along the West Coast of North America.
14. A. F. GUZMÁN, O. J. POLACO: Fishing in Prehispanic México.
15. D. HEINRICH: Some remarks on the postglacial immigration of wels (*Silurus glanis*), pikeperch (*Stizostedion lucioperca*) and asp (*Aspius aspius*) into Scandinavia and northwestern Central Europe.
16. R. HOFFMANN: “Strekfusz”: a competitor to imported stockfish in late medieval eastern Europe.
17. J. KILROY: The Pedantic Hansa? An unusual fish bone assemblage from the Knowe of Skea, Orkney, Scotland.
18. A. KRAIKOVSKI, I. TARASOV: The project “The Russian Baltic fisheries on the base of the Russian cadastres of the 16^{th} and 18^{th} cc. and their comparison with the 19^{th} c. documents” – first results and future perspectives.
19. Y. KRIVOGORSKAYA: Fish and Fishing: A profile of marine fish exploitaion in the Westfjords of Iceland.
20. L. LÕUGAS, A. JÜRGENSON: The history of fishery in Estonia on the basis of archaeological and ethnographical data.
21. A. LUDWIG, U. ARNDT, L. DEBUS, D. MAKOWIECKI, N. BENECKE: What ancient DNA analysis tell us for the present day restoration of Baltic sturgeon.
22. D. MAKOWIECKI: Preliminary results of fish identification from Tell el-Farkha (Delta of Nile).
23. L. MIRANDA MUÑOZ: The importanceof the anchovis and sardine in the diet, the economy and the emergence of the complex late archaic society in Caral-Supe, Peru.
24. R. PARKS: Sea and Sand: seasonal fishing in the Mesolithic of Scotland in the “Fish Event Horizon”: Results from Quoygrew and Earl’s Bu, Viking Age and Medieval sites from Orkney, Scotland.
25. G. A. PEÑA: Ancient seasonal fishermen of the Magdalena River in Colombia.
26. S. PERDIKARIS: Dead Fish Swim Upstream: Inland consumption of fish in Myvatn, Iceland.
27. A. REHAZEK, M. NUSSBAUMER: Fish remains from a 16^{th} century noble household in Unterseen, Bernese Oberland, Switzerland.
28. J. STUDER: Like a fish out of water : The role of fish in the diet of Classical and Medieval populations living in the Petra region (Jordan).
29. G. THÜRY: Freshwaterfish on Roman Tables. What Roman Authors wrote about Culinary Ichthyology.
30. W. VAN NEER, A. ERVYNCK, S. HAMILTON-DYER: A review of archaeozoological evidence for fish sauces and salsamenta in Europe, northern Africa and the Near East.
31. A. F. ZANGRANDO: Fishbone assemblages in the Beagle Channel region: the implication of fish in the subsistence of southern South American sea-nomads.



14th MEETING – 2007: Antibes, France (October 18th -20th)

"ARCHÉOLOGIE DU POISSON - Exploitations et impacts, transformations et usages, paléoenvironnements" - 30 ans d'archéo-ichtyologie au CNRS: Hommage aux travaux de Jean Desse et Nathalie Desse-Berset – organized by Philippe BÉAREZ, Sandrine GROUARD and Benoît CLAVEL

Oral presentations:

1. James BARRETT, Jennifer HARLAND: Why Do People Fish ? A Viking Age Perspective.
2. Luminita BEJENARU: Information concerning the fish in the historical documents of lasi City (Romania).
3. Megan CALDWELL: Fish traps and shell middens : Examinig the role of fish traps in Comox Harbour, British Columbia, Canada.
4. Diana Rocio CARVAJAL CONTRERAS: Fish Heads and Fish Tails : Taphonomy of fishing at a coastal rockshelter in Panama.
5. Ruby CERON-CARRASCO: Fish remains in domestic contacts : 'A question of scales'. A study from a Late Iron Age settlement in Lewis, Western Isles of Scotland.
6. 6. Louis CHAIX, Salah El-Din MOHAMED-AHMED: Une sauce plurimillénaire, le tirkine soudanais.
7. Richard COOKE, Maximo JIMENEZ: Marine catfish of the eastern tropical Pacific : taxonomy, ecology and role in pre-colombian subsistence.
8. Michelle COURTEMANCHE: Aperçu de la pêche à l'Anguille d'Amérique *(Anguilla rostrata)* dans le Haut-Saint-Laurent (Canada) préhistorique.
9. Anton ERVYNCK, Wim VAN NEER: Fish processing and consumption at the ancient city of Chersonesos (Crimean peninsula, Ukraine).
10. Arlene FRADKIN, H. Sorayya CARR: Middle Formative Fishing at Cuello, Belize.
11. Ruth L. GREENSPAN: « Garden Hunting » in Canals : Artificial Extension of Aquatic Habitats as a By-Product of Canal Irrigation in the American Desert Southwest.
12. Ana Fabiola GUZMAN CAMACHO, Salvador GUILLIEM, Oscar J. POLACO: The fishes from a XVIth century waterbos at Tlatelolco, Central Mexico.
13. Jennifer HARLAND, Cluny JOHNSTONE, Andrew JONES, Mike RICHARDS: A Case Study from the Medieval Origins of Commercial Fishing Project : Zooarchaeological and isotopic results from York.
14. Richard C. HOFFMANN: Aquaculture in champagne before the Black Death (1348-50).
15. Máximo JIMÉNEZ , Richard COOKE : Pre-columbian and early colonial fishing at a coastal site in Panama (Panama la Vieja).
16. Olivier LE GALL: Les poissons des eaux douces pléistocènes sont-ils des indicateurs paléoclimatiques ? Une approche élargie à l'Europe.

17. Richard LUNNISS, Philippe BÉAREZ: The archaeo-ichthyological evidence from the Machalilla phase village at Salango and its implications for the history of fishing on the central coast of Ecuador.
18. Daniel MAKOWIECKI : Fishing of sturgeon in Polish Lowland during Holocene.
19. Luis MIRANDA MUNOZ : The importance of the anchovies and sardine in the diet, the economy and the emergence of the complex late archaic society in Caral-Supe, Peru.
20. Arturo MORALES, Eufrasia ROSELLO: Iruña-Veleia (Alava, Spain) : A third century ad roman site from the basque country.
21. Werner MULLER: The fish remains of the Upper Palaeolithic sites Champréveyers and Monruz (Neuchâtel, Switzerland).
22. Tarek OUESLATI: Paleo-Christian trade and consumption of fish in Limenas (VII th c. A.D., Thasos, Greece).
23. Albina Hulda PALSDOTTIR: The Tjarnargata 3C archaeofauna : Fishing industry and the rise of urbanism in pre-modern Iceland.
24. Sophia PERDIKARIS, Thomas H. MCGOVERN: Codfish and Kings, Seals and Subsistence : Norse Marine Resource Use in the North Atlantic.
25. Valentin RADU, Marjan MASHKOUR: Ancient carp (Cyprinidae) on the Iranian Plateau : the case of Yafteh cave and tappeh Hessar.
26. Carmen Gloria RODRIGUEZ SANTANA, Véronica ALBERTO BARROSO, Abel GALINDO RODRIGUEZ: Escamas y cuernos: a proposito de asociaciones insolitas en el yacimiento del Lomo de los Melones (Telde, Gran Canaria).
27. Elena SALMINA: Medieval fishing in Pskov-Peipsi lake (North-West Russia) on the archaeological data.
28. Tony SILVINO, Catherine HANNI, Gaël PIQUES: Salaisons et sauces commercialisées à *Lugdunum* (Lyon, France) aux III^{e} et IV^{e} siècles : analyse pluridisciplinaire des restes de poissons marins issus des contextes stratigraphiques de la fouille du Parc Saint-Georges.
29. Simina STANC: Analyse archéozoologique des restes de poissons provenant du site de Slava Rusa (Roumanie).
30. Myriam STERNBERG: La pêche dans l'économie des sociétés méditerranéennes du VIIIe s. av. n.-è. au IIIe S. de n.-è. : apports de l'archéo-ichtyologie.
31. Jacqueline STUDER: Like a fish out of water: The role of fish in the diet of Classical and Medieval populations living in the Petra region (Jordan).
32. Tatiana THEODOROPOULOU: Évolution de l'exploitation des ressources aquatiques au passage du Néolithique à l'âge du Bronze en Égée septentrionale : paramètres culturels ou environnementaux ?
33. Günther E. THÜRY: Species of Fresh Water Fish in Roman Culinary Use. The Testimonies of Literary Sources.
34. Teresa TROST : Effects of Identifying a Subset of Fish Skeletal Elements on Archaeological Interpretation of a Site.
35. Wim VAN NEER, James BARRETT, Cluny JOHNSTONE, Jennifer HARLAND, Anton ERVYNCK, Inge ENGHOFF, Anne Karin HUFTHAMMER, Colin AMUNDSEN, Sheila HAMILTON-DYER, Dirk HEINRICH, Andrew JONES, Leif JONSSON, Alison LOCKER, Lembi LOUGAS, Daniel MAKOWICKI, Wietske PRUMMEL, Callum ROBERTS, Mike RICHARDS: Origines de l'intensification des pêches maritimes dans le Nord de l'Europe aux 1er et 2^{e} millénaires de notre ère.

36. Wim WOUTERS, Luc MUYLAERT, Wim VAN NEER: Osteomorphological distinction between plaice *(Pleuronectes platessa),* flounder *(Platichthys flesus)* and dab *(Limanda limanda)* : how and why?
37. Michael ZEHETER: To Prevent a Disorder in the Lake: The Regulation of Lake Constance Fisheries c. 1350-1800.
38. Irit ZOHAR, Miriam BELMAKER: Fish, fishing and the environment within: A taphonomical case study from Lake Kinneret, Israel.

Poster presentations:

39. Patrick BERREBI, Nathalie DESSE-BERSET, Marie PAGES, Laurent BROSSE, Christelle TOUGARD, Catherine HANNI: Identification spécifique de la population éteinte d’esturgeons du Rhône par séquençage de l’ADN mitochondrial de restes osseux datant du 6^{e} au 2^{e} siècle avant J.-C.
40. Vincent CARPENTIER, Bruno FAJAL: La gestion des ressources piscicoles d’une abbaye normande au XVIII^{e} siècle d’après un registre d’exploitation inédit.
41. Giovanni DISTEFANO: Fauna ittica fra la Sicilia e l’Africa. Esempi da repertori musivi bizantini.
42. Yvon DREANO: Etude de la vieille commune (*Labrus bergylta*) du site de la Tène final de l’île aux Moutons, Finistère.
43. Elise DUFOUR, Philippe BEAREZ: Reconstruction of palaeoenvironments based on otolith geochemical tracers.
44. Manoel GONZALEZ: Use of *Carcharias taurus* (Elasmobranchii, Lamnidae), by Fishing-Gatherers on the Coast of Sao Paulo, Brazil.
45. Sandrine GROUARD: Reconstitution de la taille de huit familles de poissons par l’ostéométrie (Acanthuridae, Carangidae, Haemulidae, Holocentride, Lutjanidae, Scaridae, Scombridae, Serranidae) : application aux restes archéoichtyologiques de la Caraïbe.
46. Ramona HARRISON: A Fish puzzle – Preliminary results on fish remains from the high medieval trading station at Gásir, N Iceland.
47. Sharyn JONES: Zoo-and ethno-archaeological contributions to marine ecology : A long-term perspective on change.
48. Evelyn KEAVENEY: Radiocarbon Reservoir Corrections for Freshwater Fish in Britain and Ireland.
49. Rita LARJE, Leif JONSSON: Combined length estimation and vertebral number identification in Atlantic Bluefin tuna Thunnus thynnus (Scombridae).
50. Lembi LOUGAS: Fishing during the Viking Age in the eastern and western Baltic Sea.
51. Ricard MARLASCA MARTIN: Les restes d’ichtyo-faune de la grotte cova Riuets (Formentera, Baléares).
52. Carina OLSON: Neolithic Cod (*Gadus morhua*) and Herring (*Clupea harengus*) Fisheries in the Baltic Sea.
53. Hannah RUSS: Taphonomy and Human Accumulation of Fish Remains at Palaeolithic sites in Europe. Grotto di Pozzo ; A Case Study.
54. Konrad SMIAROWSKI: Preliminary Analysis of Ichtiological Remains from an Early Medieval Trading Emporium at Janów Pomorski (Truso) in Northern Poland.
55. Justine VORENGER, Benoît CLAVEL: Pêche à la fin du Néolithique ancien en basse vallée de la Marne (le cas de Fresnes-sur-Marne).

15th MEETING – 2009: Poznań & Toruń, Poland (September 3rd -9th)

"Fishes – Culture – Environment. Through Archaeoichthology, Ethnography & History" – organizing comittee: Daniel MAKOWIECKI, Wojciech CHUDZIAK, Andrzej M. WYRWA, Michał BRZOSTOWICZ, Mirosław MAKOHONIENKO

SESSION: PREHISTORIC AND MEDIEVAL FISHING IN THE NORTH ATLANTIC REGION

1. James BARRETT, Cluny JOHNSTONE, Jennifer HARLAND, Wim VAN NEER, Anton ERVYNCK, Daniel MAKOWIECKI, Dirk HEINRICH, Anne Karin HUFTHAMMER, Inge BØDKER ENGHOFF, Colin AMUNDSEN, Andrew K. G. JONES, Alison LOCKER, Sheila HAMILTON-DYER, Leif JONSSON, Lembi LÕUGAS & Michael RICHARDS: The medieval origins of commercial Sea Fishing Project: a preliminary synthesis.
2. Wim VAN NEER, Anton ERVYNCK, Benjamin T. FULLER, Patrick DEGRYSE & Wim WOUTERS: Freshwater fisheries in Belgium during medieval and postmedieval times: looking for markers for the onset of overfishing and pollution.
3. Ian RIDDLER & Nicola TRZASKA-NARTOWSKI: From Dover to New Romney: medieval fishing in south-east Kent, England.
4. Arlene FRADKIN: Pre-Columbian estuarine fishing along the lower St. Johns River, Florida, USA.
5. Sheila HAMILTON-DYER: Cod, calves and clerics: the remains from Skriðuklaustur monastery, Iceland.
6. Richard C. HOFFMANN: Puzzling out medieval herring from a pan-European perspective.
7. Monica DÜTTING: Fishing in the Netherlands in Roman times.

SESSION: FISHES AND FISHERY IN THE BALTIC / BLACK SEA DRAINAGE BASINS

8. Lembi LÕUGAS: Palaeolithic fish from southern Poland: a palaeozoogeographical approach.
9. Ken RITCHIE: Late Mesolithic fishing in Northwest Zealand, Denmark.
10. Dirk HEINRICH & Ulrich SCHMÖLCKE: Some aspects concerning the Holocene development of the vertebrate fauna and the related environmental change in the south-western Baltic area.
11. Mirosława ZABILSKA: Archaeoichthyology and archaeology in reference to fishing in Late Bronze Age and Early Iron Age in Polish Lowland.
12. Mirosława ZABILSKA, Jerzy M. ŁAPO & Janusz JANOWSKI: Fish remains from the Site of Kal, a 5th – 7th century settlement in the Mazovian Lakeland. Preliminary data.
13. Andrzej M. WYRWA & Daniel MAKOWIECKI: Fish in the menu of the Cistercians from Łekno and Bierzwnik (Poland). An historical and archaeoichthyological consideration.

14. Adam CHĘĆ: The fishes and fishery in the Teutonic Knights State in Prussia according to written and archaeozoological sources.
15. Stanisław CIOS: What do we know about the extinction of sturgeon in Poland?
16. Elena SALMINA: Fishery organization in medieval Pskov: fishing tool owners' marks as a historical source.
17. Alexei V. KRAIKOVSKI: The governmental projects of modernization of herring fisheries in Russia (18^{th} – 19^{th} cc.).
18. Elona LYASHKEVICH: The ancient fishing of Belarusion Polessye.
19. Alfred GALIK, Günther Karl KUNST & Silvia RADBAUER: Fish remains from a stratigraphic sequence from the Roman civil town of Carnuntum (Lower Austria).

SESSION: FISHES AND FISHING IN MEDITERRANEAN AND AFRICA REGION

20. Sónia GABRIEL, Carlos FABIÃO & Iola FILIPE: Fish remains from the *Casa do Governador* - a Roman fish processing factory in *Lusitania*.
21. Eufrasia ROSELLO IZQUIERDO & Arturo MORALES MUÑIZ: The onset of commercial fishing in the western Mediterranean: Castro Marim (Algarve, Portugal) and Los Gavilanes (Murcia, Spain).
22. Tatiana THEODOROPOULOU & Georgia STRATOULI: Fishbones vs. fishhooks: a comparative study from the Neolithic lakeside settlement of Dispilio, Greece.
23. Irit ZOHAR & Rebecca BITON: Fish speciation and endemism in the Paleo Lake Hula, Israel.
24. Marek CHŁODNICKI & Daniel MAKOWIECKI: The archaeology and archaeoichthyology of fish and fishing at Tell el Farkha (Egypt – predynastic and early dynastic times).
25. Eréndira Quintana MORALES: Swahili fishing culture and fish consumption in coastal East Africa.

SESSION: FISHES AND FISHING IN THE WEST AND NORTH PACIFIC OCEAN REGION

26. Fredeliza Z. CAMPOS: Prehistoric fishing in the northern Philippines: ecological and cultural implications in islands of southeast Asia.
27. Eriko ISHIMARU, Ichiro TAYASU, Tetsuya UMINO, Minoru YONEDA & Takakazu YUMOTO: Ancient transport in the Japanese archipelago revealed through carbon and nitrogen stable isotope ratios of excavated marine fishes.
28. Eriko ISHIMARU: What kind of fish are these? Bones from the Bancho site and the Yokkaichi site of the Edo period (17^{th}-19^{th} century) in Japan.
29. Sharyn JONES: 3000 Years of Fishing on Nayau, Lau Group, Fiji.
30. Olga KRYLOVICH: Fish remains from ancient Aleutian archaeological site (Adak island, Aleutian chain) and environmental changes.

SESSION: FISHES AND FISHING IN THE EAST PACIFIC OCEAN REGION

31. Richard COOKE & Máximo JIMÉNEZ: Fishing at pre-Hispanic settlements on the Pearl Island archipelago (Panama, Pacific), I: Pedro González Island (4030-3630 cal BCE).
32. María Fernanda MARTÍNEZ, Máximo JIMÉNEZ & Richard COOKE: Fishing at pre-Hispanic settlements on the Pearl Island archipelago (Panama, Pacific), II: Bayoneta Island (900-1300CE).
33. Philippe BÉAREZ: Fishing the Chilean Fjords in pre-Hispanic times. Evidence from Juan Stuven Island.

34. Atilio Francisco ZANGRANDO: The golden fish. Subsistence changes and dietary implications of littoral fishing among sea nomads of Tierra del Fuego.
35. Manoel M. B. GONZALEZ: Zoomorphs of Shark and Rays in the Brazilian Prehistory.

SESSION: ARCHAEOICHTHYOLOGY – METHODOLOGY & METHODS

36. Stéphanie CRAVINHO: Length reconstruction of cyprinids from the measurement of vertebrae: methods and applications on azilian fish bones from Pont d'Ambon (Bourdeilles, Dordogne).
37. Matthew COLLINS, Jennifer HARLAND, Mike BUCKLEY & Andrew JONES: Zoo-MS: Zooarchaeology by Mass Spectrometry, collagen as a molecular fingerprint for fish remains?
38. Heide HÜSTER-PLOGMANN, Kristin ISMAIL-MEYER & Philippe RENTZEL: Site formation processes and conservation in Neolithic lakeside settlements. Some examples from Arbon / Bleiche 3 (Lake Constance, Switzerland).
39. Wim WOUTERS: Osteological differences within the family of the Cyprinidae.

SESSION: FISHES THROUGH ETHNOGRAPHY

40. Simone HÄBERLE: Archaeo ichthyology and museum. An exhibition about fish and fishing in the past.
41. Artur TRAPSZYC: Fishing and fishermen. Collections , exhibitions and research of the Ethnographic Museum in Torun.
42. Wojciech OLSZEWSKI: Polish ethnological research on the traditional fishing.
43. Adriana GARBATOWSKA: Loach - a poor man's fish.

POSTERS:

44. Monica DÜTTING: Fishing in the Netherlands in Roman times
45. Sally GRAINGER: Roman fish sauce: an experiment in archaeology
46. Eriko ISHIMARU: What kind of fish are these? Bones from the Bancho site and the Yokkaichi site of the Edo period (17^{th}-19^{th} century) in Japan
47. Sharyn JONES: 3000 Years of Fishing on Nayau, Lau Group, Fiji
48. Anthony James KETTLE: Evidence of ocean circulation change from European eel remains in archaeological and palaeontological sites
49. Simina STANC, Valentin RADU & Luminita BEJENARU: Cyprinid fishing in Dobrudja (Romania) from prehistory to the Middle Ages
50. Wim WOUTERS: Osteological differences within the family of the Cyprinidae
51. Mirosława ZABILSKA, Jerzy M. ŁAPO & Janusz JANOWSKI: Fish remains from the Site of Kal, a 5^{th} – 7^{th} century settlement in the Mazovian Lakeland. Preliminary data

A terracotta plate (14th century) with the immage of Cyprynids (cf. carps),
Cistercian Monastery at Bierzwnik
(with kind permision of Barbara Stolpiak & Teresa Świercz)