MoSS
March 2004

Newsletter

2/2004

A shipwreck research project funded by the European Union Culture 2000 Programme

contents

Theme: Monitoring

Education and Culture
Culture 2000

Sallamaria Tikkanen, Riikka Alvik

What is MoSS?

The MoSS project is based on four shipwrecks, all of which are of great significance from a European point of view and show a diversity of intercultural relationships throughout a long period of history. The wrecks are located in Netherlands, Germany, Sweden, and Finland, and they represent different vessel types. The oldest of the wrecks is dated to the 13th century whereas the youngest is from the middle of the 19th century. The wrecks are in different kinds of underwater environments; in sea, lake, and brackish waters, and the conditions on the sites are both stable and unstable. The wrecks have preserved extremely well; two of them are almost intact.

The MoSS project has three main themes: monitoring, safeguarding and visualizing shipwrecks. The first theme includes monitoring the condition of the wrecks, or in other words doing research on the degradation of shipwrecks under water.

The aim of this theme is to develop and improve the methods used in monitoring the physical and environmental conditions of shipwrecks. The second theme is safeguarding, which aims at outlining and developing models to protect shipwrecks so that also the needs of different public groups are taken into account. The third theme is visualizing. The four shipwreck sites will be made physically visible using underwater and other images. The project will be advertised multilingually to the European public.

The MoSS project consists of fieldwork, Internet site, publications, posters, leaflets, reports, articles, meetings, and seminars. One of the objectives is to produce information not only to the general public but also to the experts in the area of protecting the cultural heritage. The aim is to awaken European peoples' interest to our common underwater cultural heritage and to have the general public participate in protecting the heritage. The wrecks of the project – ships that sailed on European waters – act as examples of maritime history as they tell us about the many local and international dimensions of the European culture.

The MoSS project is organized by The Maritime Museum of Finland (coordinator), The Mary Rose Archaeological Services Ltd. (United Kingdom), The National Service for Archaeological Heritage: Netherlands Institute for Ship- and Underwater Archaeology ROB/NISA (the Netherlands), The National Museum of Denmark/Centre for Maritime Archaeology (Denmark), The Department for Preservation of Archaeological Sites and Monuments / Archaeological State Museum of Mecklenburg-Vorpommern (Germany), and Södertörns högskola – University College (Sweden).

The MoSS Project is the first international shipwreck project that European Community Culture 2000 Programme funds. The European Community Culture 2000 Programme is a programme that supports international cultural co-operation projects that involve organizers from several countries. The objectives are among other things to encourage co-operation, to promote the common European cultural heritage, and to disseminate the knowledge of the history and culture of the peoples of Europe. In 2001, it was the first time projects on sub-aquatic archaeology were especially called to take part in the program.

For more information, please contact Ms Riikka Alvik (Mrs. Tikkanen is on maternity leave), MoSS Project Leader, The Maritime Museum of Finland.
Tel. +358 9 4050 9057
Fax + 358 9 4050 9060
Email. riikka.alvik@nba.fi

Web site: http://www.mossproject.com

Introduction

P. Palma &
D. Gregory

With the ever-increasing discoveries of shipwreck finds and other submerged structures, there is a growing need to develop alternative methods of storage and stabilisation of these archaeological finds. This problem is threefold: first, the initial storage and conservation is costly; second, resources may not be available to provide full conservation; third, it may not always be desirable, or necessary, to excavate a submerged site, yet as part of the cultural resource it should be stabilised and managed *in situ*. Also it should not be forgotten that excavation is a destructive process and therefore should be chosen as a solution only when the right infrastructures exist and/or the archaeological and technological lessons to be learnt are rather unique.

This desire for *in situ* preservation has been politically galvanised in Rule 1 of the Annex of the UNESCO Convention on the Protection of the Underwater Cultural Heritage*, which states, "The protection of underwater cultural heritage through *in situ* preservation shall be considered as the first option".

Archaeological investigation can be a non-intrusive process, especially when it involves the study of marine environmental factors that act on site. The scientific study of the environmental conditions that underwater archaeological remains are subjected to, is fundamental for the investigation and interpretation of the site itself. It also provides essential information for more effective preservation methods to be applied *in situ* or for conservation of the artefacts in a situation where a structure is exposed. Organic and inorganic archaeological material in the pelagic and benthic environments are subject to different levels of threat, depending on factors such as whether they are buried or exposed, what is the chemistry and biology of the site, as well as the geomorphological, geophysical and ecological conditions they are exposed to.

In more general terms, an underwater archaeological structure is considered relatively stable and at equilibrium with its surroundings, after centuries of non-disturbance. When these factors change, either because the natural conditions of the site change or because of human interference, the equilibrium is altered, affecting the condition of the archaeological remains. The scientific study of the environmental and ecological conditions of a site, enables the identification of actual and potential threats to the archaeological heritage as well as the development of appropriate monitoring methods, suitable to the particular site and its environment.

* http://www.unesco.org/culture/laws/underwater/html_eng/convention.shtml

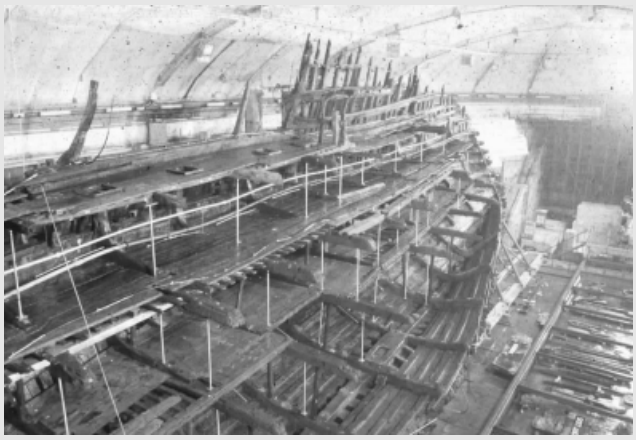
Who's who?

Mary Rose Archaeological Services Ltd (MRAS) is the organisation responsible for the Monitoring aspect of the MoSS project.

MRAS was started in 1996, with the objective to make available to the archaeological community, the wealth of experience acquired by the Mary Rose Trust over the last twenty-five years. MRAS is a wholly owned subsidiary of the Mary Rose Trust [MRT] and all profits are transferred to the MRT to contribute to the considerable cost of conserving the *Mary Rose*.

At present MRAS is involved in conservation the Guernsey Romano-Celtic ship, the Fiskerton and Gormanston Log Boats, all of which are two thousand years old. In 1999 MRAS completed the conservation of the Dover Bronze Age Boat, which is one of the oldest ships on display in the UK.

The Mary Rose Trust is the lead museum for Maritime Archaeology and Conservation in the UK.



Mary Rose Museum (Mary Rose Trust)

Paola Palma, Dr Mark Jones and Charles Barker from MRAS are actively involved in running and managing the Monitoring phase of the MoSS Project from a financial and scientific point of view.

David Gregory from the National Museum of Denmark is acting as a consultant for this phase, having a wide experience in deterioration of archaeological material in the marine environment.

David Gregory

Degradation of wooden shipwrecks: threats

The factors affecting wood in the marine environment vary depending upon whether the wood is exposed to seawater or buried within sediments.

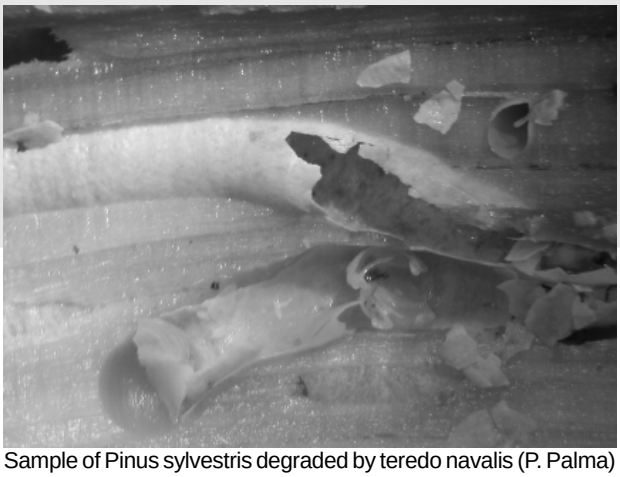
a. Physical Threat

When a wooden ship sinks it may come to rest on or in the seabed. The marine environment in many instances is very dynamic and physical processes, such as scour and sediment movement, around shipwreck sites are potentially the most damaging threat as they can destabilise a site leading to the rapid loss of archaeological material. If a shipwreck is not in immediate danger of being "washed away" by currents and tides, it will be progressively colonised by a variety of biological organisms.

b. Biological Threat

This is initiated by the attachment of bacteria to the surface, followed by other micro-organisms including diatoms, fungi, micro algae, protozoa and boring *crustacea* and *mollusca*. Bacteria and fungi produce extra cellular enzymes, which destroy the material on which they grow, while the crustaceans and mollusca bore into the wood, which they ingest and may subsequently utilise. Additionally there are fouling organisms such as *algae*, *polysoa*, *tunicata* and *mollusca*, which use the wood as a substrate to grow upon.

By far the most damaging of these organisms are the marine woodborers, which may cause damage and loss of archaeological information to exposed shipwrecks in a relatively short period of time. The major factors influencing the colonisation by marine borers are temperature, salinity, depth and the dissolved oxygen content of the water. The "determining" factor for colonisation by marine borers is the dissolved oxygen content; if there is little or no oxygen present they cannot respire and survive. After the marine borers, fungi and bacteria are the next agents of deterioration to consider. These micro-organisms have a relatively minor part to play in the total breakdown of wood in seawater but their activity will affect its long-term preservation. As with the woodborers oxygen is a limiting factor for most marine fungi and levels of less than 0.30 ml / litre (approximately 0.5mg / litre) have been reported to prevent their growth. Bacteria, unlike the marine borers and fungi, can survive in environments with very low oxygen concentrations. However, in a typical littoral marine sediment only the first few millimetres of the sediment are oxygenated, although bio-turbation by invertebrates, wave action or other cultural and natural processes may extend this oxygenated zone downwards. Depth of sediment does affect the numbers of micro-organisms present; relatively high numbers of aerobic bacteria and fungi occur in the first few centimetres of most marine sediments but numbers taper off in deeper sediment layers and it has been reported that anaerobic bacteria only survive to a depth of 50 - 62cm.



Sample of Pinus sylvestris degraded by teredo navalis (P. Palma)

c. Chemical Parameters

In open seawater parameters such as dissolved oxygen, salinity, temperature and depth will all affect colonisation of exposed timbers by woodborers. Within marine sediments oxygen levels are often very low, approaching anoxic. In addition to measuring dissolved oxygen information about the chemical processes of the sediments can be determined by measuring what is termed *redox potential*, (Eh), which gives an indication of the oxidising or reducing nature of the environment. Oxidising environments are those in which there is a tendency for chemical species to lose their electrons - this tendency can be measured in terms of the redox potential, Eh. Conversely, reducing environments are those where chemical species are encouraged to take up electrons from their surroundings. The acidity / basicity, or pH, is often measured in conjunction with redox potential as these two parameters together can aid characterisation of the natural environment and provide a better understanding of its chemical behaviour. Marine sediments exhibit a profile of chemical species distribution ranging from an oxidised zone at the surface, where levels of oxygen, nitrate and ferric ions are relatively high, through a transitional zone to a reduced zone where the concentration of the aforementioned ions is virtually zero and instead, levels of ferrous, sulphide and ammonium ions are appreciable. These chemical changes with depth in the sediment are connected to a change in habitat conditions from aerobic to anaerobic.

Paola Palma

Aims and goals

The aim of the MoSS project undertaken from June 2002, is to develop a methodology for monitoring the degradation of shipwreck sites *in situ*. The deterioration of material such as wood and textile are observed in relation to study of the biological, chemical and physical processes acting on the sites. A methodology for the preservation of shipwreck materials has been devised to scientifically understand the most suitable methods for protection *in situ*.

The three wreck sites considered in the monitoring phase of the MoSS Project are the Vrouw Maria in Finland, the Darss Kogge in Germany and the Burgzand Noord 10 in The Netherlands (see MoSS Newsletters 2003:I,II,IV for more information). All three sites have different environmental characteristics. This is an important factor in helping us to establish whether the same monitoring strategy is suitable in different circumstances.

The Vrouw Maria is relatively deep and the level of sedimentation is very low. This would suggest mainly aerobic conditions. The site is also affected by strong currents, water movements and low temperatures (between 2 - 4° C), which possibly reduces the activity of bacteria and fungi. The majority of the wreck is exposed. Altogether, this site is quite stable.

The Darss cog site is quite shallow (6 m) and with strong currents but these water movements do not prevent a high level of sedimentation. In fact only around 5% of the wreck is exposed and conditions are mainly anaerobic. Temperatures on this site vary from 3 - 16° C. This is considered a fairly stable site, despite intrusive human activities such as diving and fishing.

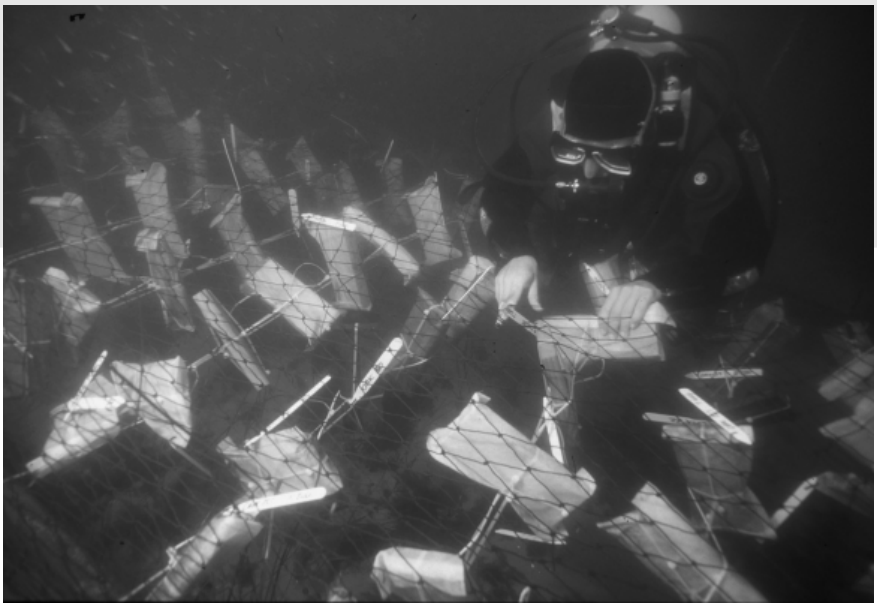
Burgzand Noord 10 is approximately 50% exposed due to the shallowness (8 - 10 m) of the site combined with strong currents and tidal movements. The very high level of sedimentation facilitates anaerobic conditions but in the exposed part of the wreck a high concentration of destructive organisms and fouling activities has been found. Temperatures here vary around 6 - 21°C. The site is considered unstable.

Map of the sites

Paola Palma

Methods and Logistics

To assess the degradation occurring within each site, wooden blocks of oak, pine and archaeological wood have been placed in both exposed and buried conditions. Also, a test fabric has been placed in the sediment adjacent to each site.
Data loggers have been deployed to investigate the physical and environmental characteristics, and geophysical investigations carried out.


Samples in aerobic environment (Archaeological State Museum of Mecklenburg-Vorpommern)

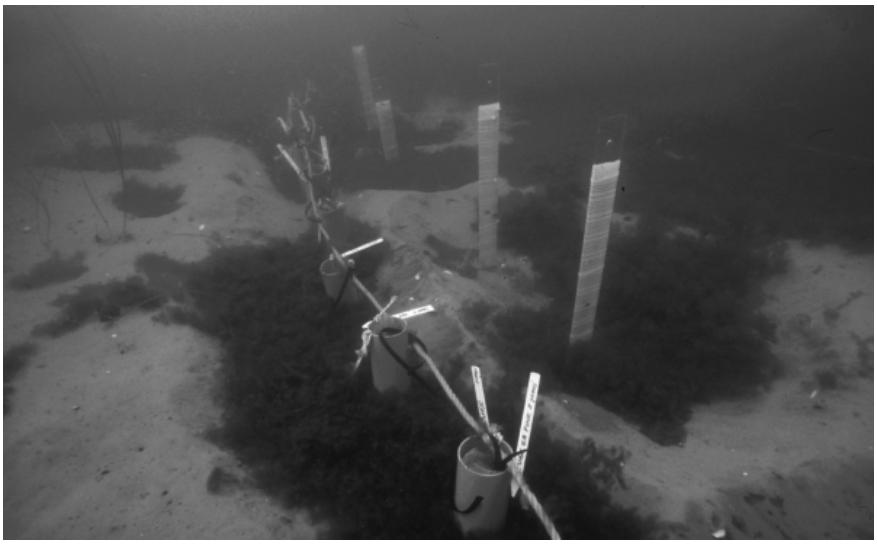
Samples in Aerobic Environment
To establish the deterioration of wood exposed on the seabed, a method was devised that deployed samples into aerobic conditions, aimed at understanding the factors that affect the wood and the nature and speed of degradation. It is well known that exposed wood is vulnerable to marine woodborers, fungi and aerobic bacteria and through this monitoring method, samples have been placed for subsequent collection and evaluation at regular intervals.

At each site, rows of wooden blocks (oak, pine and archaeological wood – in sets of three) have been placed in an exposed location above the sediment. After a period of 3 months the first set was collected. Already evidence of superficial change was visible to the naked eye.

A physical barrier system has been utilized for some of the wooden samples. This meant wrapping the samples in a synthetic “geotextile” called Terram, widely used in civil engineering. The deployment of the “geotextile” and initial results will be specified in the Newsletter about the Safeguarding Theme.

After three months of exposure on site, the first batch of wooden blocks has been collected and analyses started.
The second batch was collected after one year and analyses are ongoing. Samples remaining on the sites are due to be retrieved after 2, 3, 4 years and potentially after longer periods. Altogether around 450 wooden blocks


Preparation of samples (Mary Rose Trust)

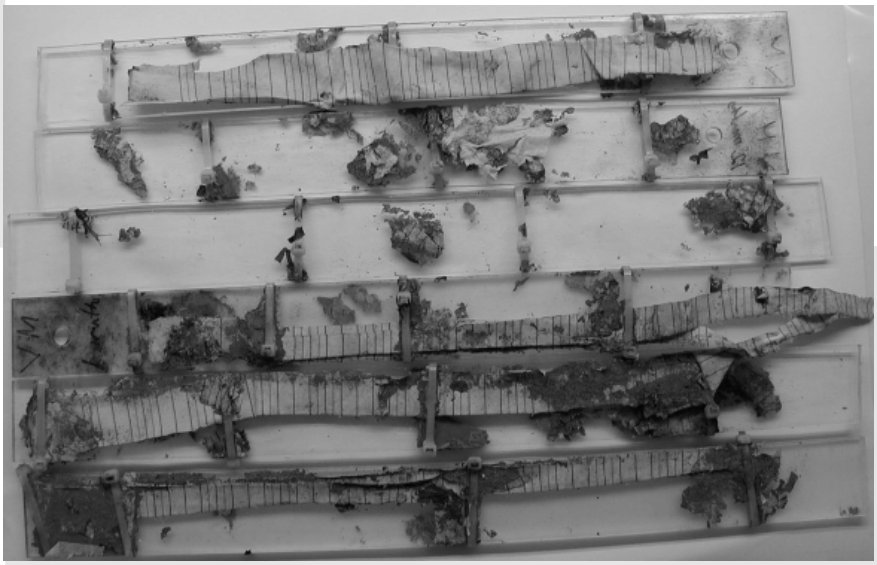

Samples in anaerobic environment (Archaeological State Museum of Mecklenburg-Vorpommern)

have been used in the aerobic wood phase.

Samples in Anaerobic Environment
To assess the processes that occur beneath the sediment in an underwater environment, the approach chosen for the MoSS Project has been to bury blocks of oak and pine in the proximity of each wreck site. To facilitate the placement and collection, samples have been assembled in rows and housed within plastic pipes with drilled holes. In total 840 small samples (5 x 2.5 x 3cm) have been used and collection has been scheduled for regular periods starting with a period on site of three months.

The extent of wood degradation is assessed by visual analysis, photography, X-Ray, Scanning Electron Microscopy and wood density, using the same methodologies described for the aerobic samples.
Underwater conditions where limited presence of oxygen occurs, may determine the degradation rate of buried wood. Erosion and tunnelling bacteria are likely to be found in these situations (Blanchette et al. 1990). The collection of samples at regular intervals will hopefully identify when the attack was initiated and the rate at which it proceeds.

Textile Samples
A control material, Shirley Textile, has also been placed within the sediment. The fabric consists of 96% cellulose and this enables the extent of attack caused by cellulose deteriorating bacteria and fungi to be determined; cellulose being a major component of wood. It may be that micro organisms which attack the material are not directly responsible for deterioration of wood but will give an indication of the likelihood of attack by cellulolytic organisms (DG).


Cotton fabric Shirley after three months on site (P. Palma)


Pine sample ready to be inserted in the pipe to be buried in the sediment (Mary Rose Trust)

The cotton fabric was cut into strips and attached using cable ties to Perspex bars for easier insertion into the sediment.
The samples were placed in the sediment and collected at regular intervals from three months to one year. The specimens were inspected and photographed, then allowed to dry in a fume cupboard for 48 hours before being removed for tensile testing by Dr Paul Wyeth of the University of Southampton, using an Instron instrument at the Textile Conservation Centre in Winchester.
The tests conducted so far have shown that quite a significant level of degradation of the fabric has occurred in all cases after only three months in the sediment. It also shows degradation was occurring at different rates at the different sites.
The soil burial cloth has been supplied by Shirley Dyeing and Finishing Ltd.

David Gregory

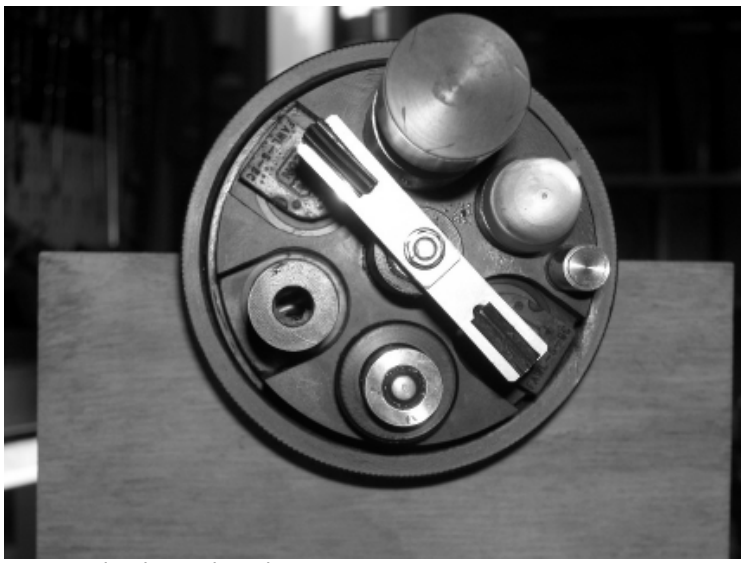
Data loggers

In order to measure the physical conditions in open seawater and the marine sediments at each site a data logging system, which is capable of logging the various parameters every hour for up to three months, has been developed in collaboration with the company Eauxsys in England.

The configuration of the data logger has been specifically developed for the MoSS project using Eauxsys' existing technology and adapting it to the projects purpose. In open seawater, the system measures temperature, depth, dissolved oxygen and conductivity (which can be converted to salinity). In addition sensors to measure turbidity and sediment movement are also being trialled to assess the movement of sediment around the BZN 10 and Darsser Cog. In the sediment itself, pH and redox potential are being measured.

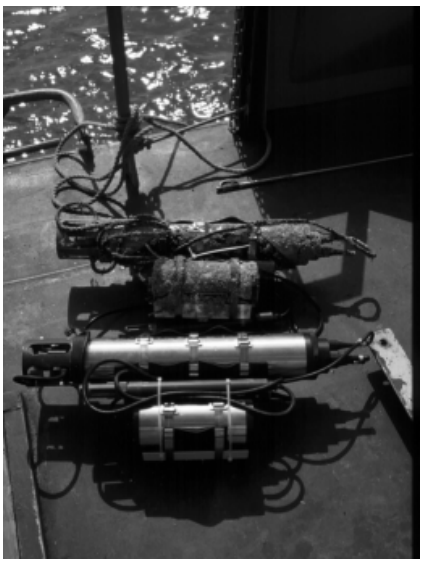
The system for measuring within the sediment is that sensors on "flying leads" are placed inside dipwells (perforated plastic tubes), which are placed within the sediment. The idea being that interstitial pore water from the sediment flows into the dipwells and the sensors measure the parameters within this water. Through this system it will be possible to see how the aforementioned parameters change with time and how they affect the sites in question.

The programme deployed two data loggers on the Darss cog and Burgzand Noord 10 sites - Water-Watch System 2681 - SebSea Logger from EauxSys (UK) Ltd. The systems deployed on the *Vrouw Maria* site are SBE16 plus SEACAT provided by Seabirds.



EauxSys data logger (NISA)

EauxSys datalogger after 3 months on site (NISA)



Brand new data logger (bottom) and data logger after one month on site (NISA)

Analyses

Geophysics

Geophysics is a useful non-intrusive method for the identification and interpretation of shipwreck sites that can be deployed as a pre-disturbance survey.

Many methods have been used to interpret the three sites within the MoSS project, including Side Scan Sonar, Sediment Sonar, Geo-radar and Acoustic Doppler Current Profiling. For each of these we refer you to the appropriate site newsletters already published (MoSS Newsletters 2003: I,II,III,IV).

The following tests are being completed for each set of samples recovered:

- Photography
- X-Ray
- Scanning Electron Microscopy
- Light Microscopy
- Weight Loss
- ID of marine organisms
- Wood Density
- Nuclear Magnetic Resonance

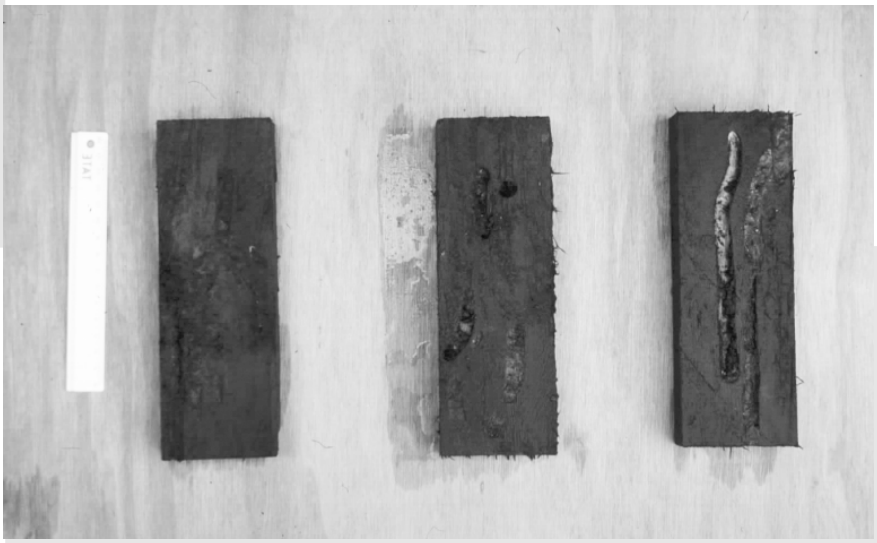
Photography

All samples are digitally photographed on reception. Those wrapped in Terram bags are photographed both with and without the geotextile. Blocks are photographed first with sediment and fouling organisms resulting from the stay on site. They are then carefully cleaned, photographed and analysed again. Degradation was evident even on superficial visual investigation of samples exposed for three and twelve months.

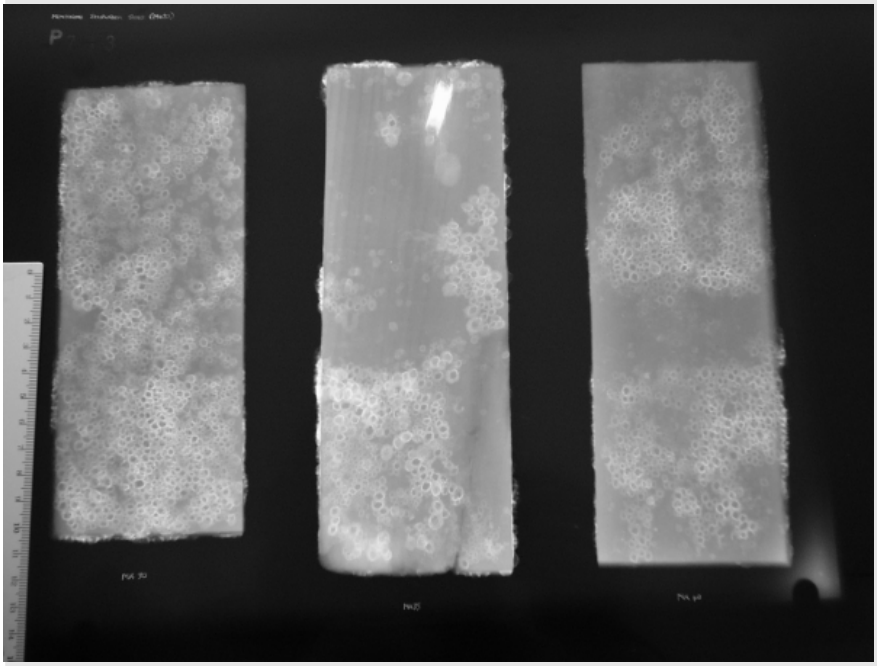
X-Ray

This procedure has been used as a diagnostic tool to establish if any infestation has occurred and what stage it may have reached.

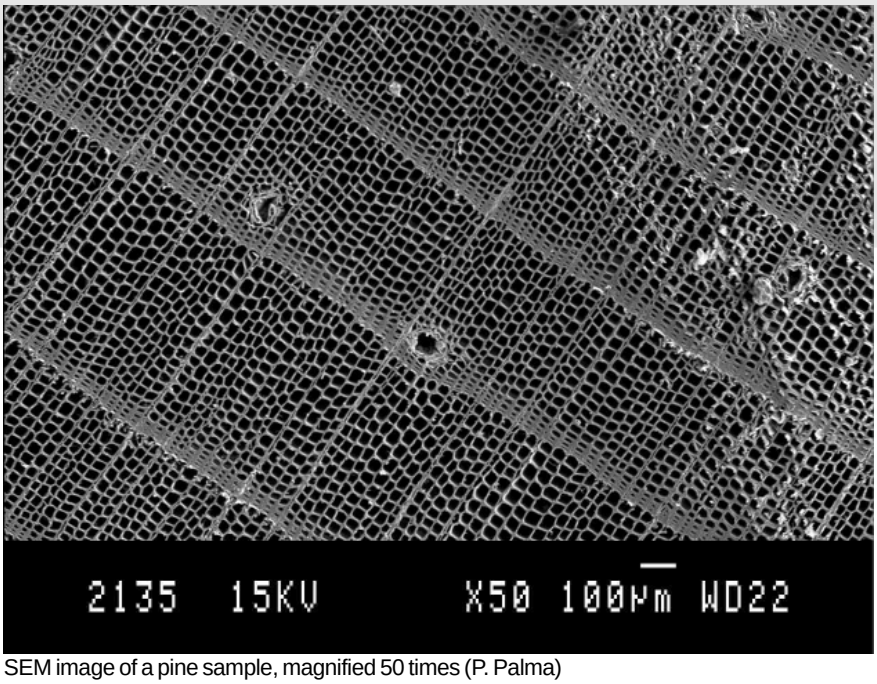
Once photographed, samples were taken to the English Heritage X-Ray lab at Fort Cumberland, Portsmouth. X-Rays have proven to be a very effective method for determining wood degradation. For each sample analysed with this system, images reflect the actual status of the timber sample, allowing the researcher to evaluate if more detailed tests have to be carried out or not. For example, attack from wood-boring organisms on samples from the Burgzand Noord 10 was detected at different stages. Heavily attacked blocks were subsequently opened for species analyses. On the other hand, some samples visually showing small superficial holes did not show further internal degradation when analysed by X-Ray. This may be a sign of initial attack at a larval stage.



Cross section of samples attacked by Teredo navalis. (P. Palma)



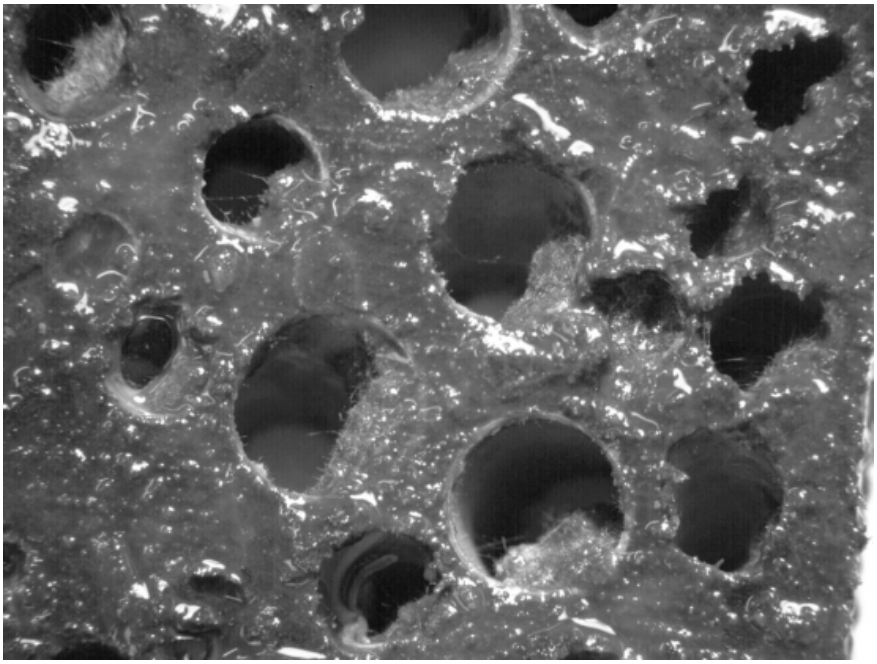
X-Ray of samples showing barnacles and Teredo attack (K. Graham)



SEM image of a pine sample, magnified 50 times (P. Palma)

Scanning Electron Microscopy
To identify bacterial and fungal activity, sections of wood 0.5 cm thick were fixed, dehydrated and dried using a Polaron E3000 critical point dryer. These were then mounted on aluminium stubs, gold coated and examined using a "Jeol" JSM-600 scanning microscope at different kVs.

Light Stereo Microscopy
Wooden hand-cut sections were examined using the Leica MZ6 Stereo Light Microscope. Images were captured digitally using Leica Q50 image analysis software.


LSM graph showing Teredo tunnels (P. Palma)

Weight Loss
To determine the level of biological degradation at each wreck site, weight loss in the samples is one of the most important factors to consider. This is determined using the moisture content of each sample after different periods of exposure on the site.
Once the sample has been retrieved and the surface sediment washed away, the sample is weighed then oven-dried overnight at a temperature of 105°C and weighed again. This process continues until the weight is stable.

A simple equation has been used from Kollmann and Côté (1968):

$$Moisture\ content = \frac{\text{Wet weight - Dry weight}}{\text{Dry weight}} \times 100$$

ID of Marine Organisms
For this investigation, samples were taken to the Marine Laboratory of the University of Portsmouth. Here marine zoologists and mycologists helped in the analysis of the blocks to identify species attacking the wood.
In many cases the presence of colonies of fungi and different species of fouling organisms was detected. Many samples have been found severely degraded by woodboring organisms such as a specimen belonging to the family *Teredinidae.*

The degree of attack on blocks is assessed by visual examination as well as by using a dissecting microscope. The degradation rate is evaluated on the basis of the extent of the galleries dug by these organisms into the wooden samples, over a given exposure period.
A point-rating scheme combining the American Society for Testing and Materials and the European rating

Grade No.	Description (ASTM)	Description (European)	% Surface Destruction
10	No more than trace	Intact Surface	0
9	Light attack	Slight decay of surface	1-19
8	-	Light decay of surface	10-39
7	Moderate attack	Moderate decay of surface	40-59
6	-	Heavy decay of surface	60-79
4	Heavy attack	Severe decay of surface	80-100
0	Destroyed by attack	Failure owing to decay	Failure

* From Pournou, 1999.

scheme, was adopted (see above table).

Wood Density

Basic density (R) is calculated in a number of ways and the MoSS Project utilized the oven-dried weight and wet waterlogged volume.

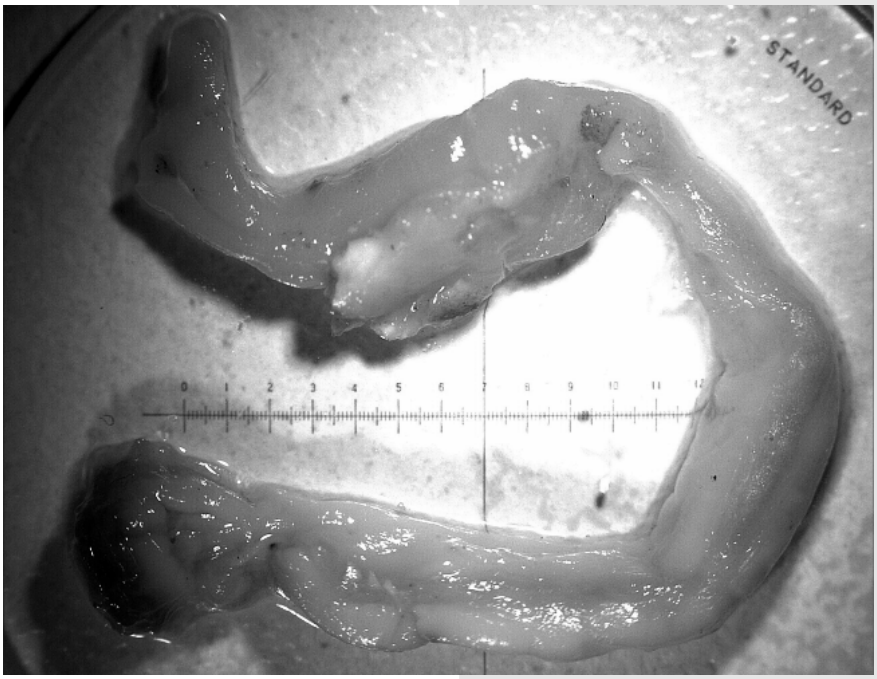
The following formula was used:

$$R = \frac{Oven\text{-}dried\ weight}{Wet\ volume}$$

Nuclear Magnetic Resonance

The chemistry of waterlogged wood varies under the influence of burial conditions such as water chemistry and presence of degrading organisms. NMR is an extensive method for the chemical analysis of the wood providing detailed analyses of the major carbon forms that can be linked to different lignin components. This technique provides information about the loss of wood components as well as the chemical transformation of the residual components (Hedges, 1990). From the original sample, a section of wood of roughly 7.5 x 3 x 2.5 cm is cut away and oven-dried at a temperature of 50°C. It is then cut into small fragments and subsequently milled and sieved.

This is a very expensive test and the preparation of each sample has to be carefully carried out to avoid contamination from different components.



Specimen of Teredo navalis found on one of the samples (P. Palma)

Reference:

Hedges J.I., 1990. The chemistry of archaeological wood. In: *Archaeological Wood. Properties, Chemistry and Preservation*. Ed. Rowell R.M. & Barbour R.J. American Chemical Society.

Kollmann F.F.P., Côté W.A., 1968. *Principles of wood science and technology I. Solid Wood*. Springer-Verlag.

Oxley I., 1998. *The environment of historic shipwreck sites: a review of the preservation of material, site formation and site environmental assessment.* Thesis for MSc. S. Andrews.

Panshin, A.J. and De Zeeuw, C., 1980. *Textbook of wood technology: Structure, identification, properties and uses of the commercial woods of the United States and Canada,* McGraw-Hill Book Company.

Pournou A., 1999. *In situ protection and conservation of the Zakynthos wreck.* PhD Thesis, Portsmouth.

Turner R.D. 1966. *A Survey and Illustrated Catalogue of the Teredinidae*. The Museum of comparative zoology. Harvard University, Cambridge.

Unger A., Schniewind A.P., Unger W., 2001. *Conservation of Wood Artifacts*. Springer.

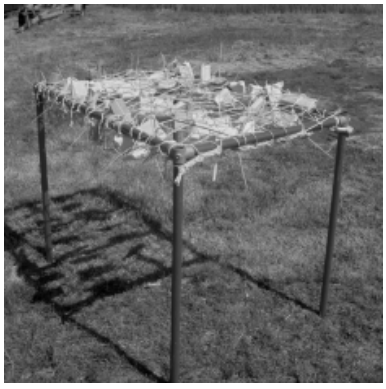
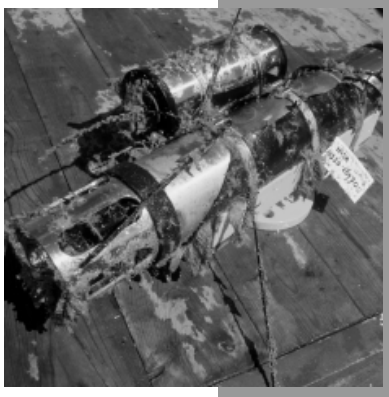
Thanks:

Special thanks are due Robert Loveridge and Derek Weights at the Dept of Geology, University of Portsmouth, Karla Graham at English Heritage, Luisa Borges, Chloe Delgery, Alan Rizzo, Rod Eaton and Simon Cragg, Dept. of Biology at the University of Portsmouth, Paul Wyeth at the University of Southampton, Mark E. Smith from Dept. of Physics of the University of Warwick, Gervais Sawyer form Buckinghamshire Chilterns University College, Alice Overmeer from NISA, Glenn M^{c}Connachie, Mark Jones, Chris Dobbs and Douglas M^{c}Elvogue from Mary Rose Trust.

what's on?





meetings & seminars

Meetings:

The project meetings are staged for discussion within the project and are mainly held by the representatives of the different nations in the project. At the meetings the participants discuss about the general issues of the project, the research work done at the sites and evaluating the methods and results of it. Important matters are also how the information is going to be published and used within the different themes of the project. There are also subgroups for the different themes in the project. The next meeting will be held in Portsmouth, England and will be arranged by the Mary Rose Archaeological Services Ltd.

Seminars:

Maritime archaeological scholars, experts and practitioners from around the world are invited to these open seminars to hear and discuss progress and evaluation of the project themes. One more seminar is scheduled, two have already been held.

The first open seminar was held in Schwerin on November 10 2002 on the theme of *"Documentation of Shipwreck Sites and Photogrammetry."*

The second seminar was held at the Vasa Museum in Stockholm the 27th of June and at Forsvik Shipyard Association, Karlsborg, on June 28 2003 on the theme of *"Visualization of Shipwrecks and Shipwreck Sites."*

The third seminar of the MoSS-project will be held in Portsmouth, UK on the 5th and the 6th of June 2004. The aims of the seminar are monitoring, safeguarding and managing the shipwreck sites. More detailed information will be available during spring 2004 in our Internet site www.mossproject.com and the forthcoming newsletters.

Publisher:
The National Board of Antiquities
PL 913, FIN-00101
Helsinki, Finland

Editor: Carl Olof Cederlund
Phone +46 8 608 4201
carl-olof.cederlund@sh.se

Theme coordinator:
Paola Palma
ppalma@maryrose-as.com

Layout: Vesa Hautsalo
Phone +358 9 4050 9072
vesa.hautsalo@nba.fi

MoSS newsletter

Published quartely with the support of the Culture 2000 Programme of the European union