

Proceedings of the 3rd Asia-Pacific Regional Conference on Underwater Cultural Heritage



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Brian Fahy, Sila Tripati, Veronica Walker-Vadillo, Bill Jeffery, Jun Kimura

Editors

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Contents

Acknowledgements	13
Forward	15
Conference Overview	17
General Setting	21
List of Conference Sponsors	23
Session 1. Underwater and maritime archaeology and capacity building in the Pacific Islands	
➤ Trade in Ceramics on Guam in the Wake of the Manila Galleon	31
<i>Lon Bulgrin</i>	
➤ Reinterpretation of Stone Fish Weirs mentioned to Freycinet in 1819 on Guam	51
<i>Boyd Dixon</i>	
➤ From safe haven to island abandonment - impacts of the growth of Pacific shipping on the Pitcairn Island community during the 19th century	65
<i>Nigel Erskine</i>	
➤ Lata's Wayfinding System and Climate Science	81
<i>Mimi George</i>	
➤ The Sacred and Cultural Maritime Sites of Fiji-An Inventory in the Making	105
<i>Elia Nakoro</i>	
➤ Exploring the Sunken Military Heritage of Midway Atoll	123
<i>Madeline Roth, Jason Raupp, Kelly Keogh</i>	

- **Underwater Cultural Heritage Management and Capacity Building in the Pacific Islands** **141**

Akatsuki Takahashi

- **Building Capacity in the South West Pacific – The Norfolk Island Maritime Archaeological Association** **155**

Andrew Viduka

Session 2. Maritime and Underwater Archaeology along the South American Pacific

- **Centering the margins: Capitalism and the Pacific World in Mid-nineteenth century Arequipa** **181**

Maria Fernanda Boza Cuadros

Session 3. Ceramic trade and cross-cultural exchange from Asian-Pacific region to the world

- **The Blues of the Santa Cruz: A study of porcelain color and Composition** **205**

Ellen Hsieh, Christian Fischer, Bobby Orillaneda

- **Ceramics and Other Archaeological Finds as Evidence of Ancient Ports Existence and Its Role in Eastern Coast of South Sumatra in Early Centuries** **221**

➤

Eka Asih Putrina Taim

- **Maritime Means and Mountain Ends: the origin of stoneware jars in mid 15th CE burial complexes of the Southern Cardamom Ranges, Cambodia** **235**

Peter Grave, Lisa Kealhofer, Nancy Beavan, Tep Sokha, Miriam Stark, and Ea Darith

Session 4. Ensuring a Sustainable Future for UCH: Museums and Public Engagement

- **Merging Museums with the Classroom: Using Collections to Teach Maritime Archaeology** **261**

Michelle Damian

- **Antiquities Homecoming : An Experience of Rescue Team of Cultural Relics** 277

Cheng Chun Tsai, Shuhan Guo, and Yuping Zhang

- **Forgotten Past? Alternative Forms for Museological Approach to interpret Egypt's Maritime Heritage** 295

Nevine Nizar Zakaria

Session 5. Iran's Maritime Cultural Landscape

- **Boat and ship Archaeology in Gilan Province (Iran)** 321

Hossien Tofighian and Ramin Adibi

- **A survey on a petroglyph illustrating a watercraft at the hinterland site of Dentai** 343

Mina Safa and Sahdi Kalantar

- **An Introduction to the Maritime Construct of Khashabat in the Persian Gulf** 363

Mostafa Karimi

- **Underwater Archeological investigation of Bushehr coastlines in Persian Gulf** 379

Hossien Tofighian and Ramin Adibi

6. History and Current Trends of Underwater Archaeology around East Asia

- **Basic Studies on the Western Shipwrecks Discovered in the Ryukyu Archipelago and Their Influence on Modern Society** 399

Chiaki Katagiri, Yumiko Nakanishi, Rintaro Ono, and Hiroki Miyagi

- **Who Were the Africans in Eastern Asia? : The Christian European Period 1500-1900 AD** 417

Clifford Pereira

- **European Ships of Discovery** **433**
Filipe Castro

- **The 17th Century Wooden Shipwreck off Hatsushima Island, Japan** **453**
Hayato Kondo, Akifumi Iwabuchi, Toshiaki Hayashibara

- **The Historical Transition of Lakefront Environment and Use in Lake Biwa, Japan** **469**
Hiashi Nakagawa

- **Legal Status of Sunken State Vessels and Sovereign Immunity** **483**
Kaè Oyama

- **Uraga Port between Manila and Acapulco** **501**
Kahoru Suzuki

- **A Methodology for Accurate and Quick Photogrammetric Recording of Underwater Cultural Heritage** **517**
Kotaro Yamafune

- **The Shared Underwater Cultural Heritage of Japan and the Netherlands: the Kanrin-maru** **539**
Leon Derksen and Akifumi Iwabuchi

- **The Iron Grapnel Supposed to Belong to the Sinan Shipwreck and Other Anchors in East Asia** **557**
Mitsuhiko Ogawa

- **A Preliminary Study on the Barrier of the Sino-French War of 1884 at Tamsui Estuary, Taiwan** **571**
Tai-Lung Lu

- **Seamanship and Navigation: Seafarers on Board Daily Skills in Chinese Junk** **583**
Xu Lu and Yu Long Fa
- **Development of the Sledge-Type Underwater Metal Detection System for Underwater Cultural Heritage Exploration** **603**
Yong-Hwa Jung, Young-Hyun Lee, Jin-Hoo Kim, Sang-He Lee, Hyun-Do Kim, and Yeong-Hyun Kim
- **Developing the Foundation for Sustainable Management of Underwater Cultural Heritage Starting from Local Involvement: Case Studies in Okinawa** **619**
Yumiko Nakanishi, Rintaro Ono, Norimitsu Sukagami, Hironobu Kan, and Chiaki Katagiri

7. Underwater Cultural Heritage Politics, Laws, Ethics and Values

- **The ethics behind climate change: Small Island Developing States in the Pacific as new underwater cultural heritage** **644**
Elena Perez-Alvaro
- **Preservation of Underwater Cultural Heritage in Taiwan: Legislation and Challenges** **662**
Ching-Ching Kuo, Chun-Pei Liao, and Wen-Yan Chiau
- **The elaboration of the UNESCO 2001 Convention on the Protection of the Underwater Cultural Heritage** **678**
Etienne Clement
- **A non-member State's practice on the incorporation of the UCH Convention: Taiwan's experience** **694**
Pei-Fu Wu
- **A Blueprint for the Conservation of Underwater Cultural Heritage in Taiwan** **710**
Ying-Ying Tung

8. Management of Underwater Cultural Heritage Sites and Conservation of Wet Archaeological Materials

- **Conservation of Artefacts from the Pearl Shell Fleet Mothership - Sanyo Maru 1937** **728**
Jon Carpenter

9. Maritime/Underwater Cultural Heritage in Southeast Asia

- **Maritime Activities in Ancient Bali** **754**
I Wayan Ardika
- **China's First Purpose Designed and Built Lighthouse: Findings from the Analysis of a Long Lost but Recently Rediscovered Photograph of the Xiyu Pagoda Light (李西山塔晚燈, Lixishanta Wangdeng)** **766**
Stephen Davies
- **Living and Trading: A Dual Approach to Studying Southeast Asian Port Cities** **786**
Charlotte Papillaud Looram
- **In Search of the Larpent's Survivors – Hazards and Securities of Sailing about Taiwan** **804**
Kuo-tung Chen
- **Conservation Of Maritime Cultural Heritage: View from the Angle of Quang Ngai Province (Vietnam)** **828**
Ngo The Bach and Nguyen Thi Thu Ha
- **Oil Spill Analysis on Ambon Bay, Moluccas, Indonesia: Its Influence on the SS Aquila Shipwreck Site** **846**
Ulung Wisha, Guntur Adhi Rahmawan, Nia Naelul Hasanah Ridwan, and Gunardi Kusumah

10. Underwater and maritime archaeology in South Asia (The Indian Ocean Region)

11. Amphibian Warfare in the Asia-Pacific region

12. The study of traditional boat technology: complementary approaches to maritime archaeology (maritime ethnography, archival research, iconography studies, museum collections etc.)

- **Almost a new logboat older than 8,000 years?** **870**
Miran Erič, Evgen Lazar, and Žiga Stopinšek
- **Filipino Indigenous Boats: The Impact of Technical Change since the Colonial Settlement** **892**
M.R. Stead

13. The Archaeology of Manila Galleons, Past, Present and Future

- **Early sixteenth-century shipbuilding in Mexico: Dimensions and tonnages of the vessels designed for Pacific Ocean navigation** **912**
José L. Casabán and Roberto Junco
- **Seeking Manila Galleon Trade Network through Exported Chinese Ceramics** **932**
Etsuko Miyata
- **Archaeological explorations on the San Francisco (1609) sunken off the coast of Chiba Prefecture** **948**
Jun Kimura
- **The trans-Pacific trade of Chinese porcelain to the Spanish colonies in the New World in the late 16th and early 17th centuries, and its impact on the local ceramic industry** **964**
Teresa Canepa

14. Beyond the South China Sea: cross-regional studies of maritime communities

- **One boat-building tradition? How can Lake Lugu in Yunnan/Sichuan province, Lake Suwa in Nagano prefecture, Lake Ohrid in Macedonia and Lake Cerknica in Slovenia be connected?**
Preliminary research **1006**
Miran Erič, Lailan Jaklič, and Nikola Paskali

- **Developing a new historiography – The Mao Kun map as a case study** **1028**
Clifford Pereira

15. World War Underwater Cultural Heritage in Asia-Pacific

- **P-38 Lightning Aircraft Wreck in Lae-lae Waters, South Sulawesi, Indonesia** **1044**
Andriany

- **“Ghost Battleships” of the Pacific: Metal Pirates, WWII Heritage and Environmental Protection** **1060**
Kim Browne

- **Surveying a World War II German Ship, MS Sophie Rickmers in Weh Island, Indonesia: A Preliminary Report** **1080**
Nia Naelul Hasanah Ridwan and Gunardi Kusumah

- **Japanese Shipwrecks and Human Remains from WWII** **1098**
Akifumi Iwabuchi

- **War in the Pacific: Difficult Heritage** **1114**
Jennifer McKinnon, Anne Ticknor, and Anna Froula

- **Naval History and Heritage Command-Underwater Archaeology in the Asia-Pacific Region** **1132**
Robert S Neyland

- **Naval shipwrecks in Indonesia** **1152**
Natali Pearson

- **Luso Asian Crewman in World War One** **1186**
Cliff Pereira

- **The President Coolidge: a Report by the Vanuatu Cultural Centre** **1202**
Edson Willie and Richard Shing

- **Perspectives on World War II Shipwrecks in Hawai`i and the Pacific** **1212**
Hans K. Van Tilburg

Session 12: The study of traditional boat technology: complementary approaches to maritime archaeology (maritime ethnography, archival research, iconography studies, museum collections etc.)

In addition to archaeology, and maritime archaeology in particular, a wide range of source material is available to those studying ancient boat technology. Maritime ethnographic surveys, ethno-historic boat studies, historical enquiries, archival repositories, iconographies, and boat models in museum collections are examples of complementary sources that the maritime archaeologist can consult. This session proposes to gather various research projects that explore ancient boat technology, based on archaeology as well as other source materials. This session's objective is thus to include multidisciplinary approaches to research that draw from a variety of sources. On one hand, this session will offer a panorama of different boatbuilding traditions from the Asia-Pacific region; on the other hand it will highlight the high potential of other source material.

Secondly, this session aims to offer a platform of discussion to explore the meaning of "traditional boatbuilding". It will show the great variety of "traditional boatbuilding" in the Asia-Pacific region and thus the need to define "tradition" with more precision. "Traditional boatbuilding" is disappearing rapidly, along with precious local knowledge on maritime aspects of culture. There is an urgent need to record and document these traditions and knowledge, and to develop means by which to use the data effectively for learning about the Asia-Pacific's maritime past.

In sum, this session will contribute to the discussion of boatbuilding traditions in the Asia-Pacific region by exploring evidence derived from archaeological evidence while discussing the quality and value of other source materials in adding to the understanding of these traditions. Approaching boatbuilding from such a broad perspective will undoubtedly contribute to revealing aspects of the maritime cultural landscapes and seascapes of the Asia-Pacific.

**Session Chairs: Jun Kimura
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Almost a new logboat older than 8,000 years?

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Abstract

Sometimes the ambition of researchers remains empty-handed although all the circumstances suggest that a positive outcome would have happened. This kind of situation took place just a few kilometres away from the 7,500-year-old Hotiza logboat in the Mura River. The first information from the road and riverbank reconstruction was that a carved log 7m below the surface was being explored.

However, during the excavation process, the situation got much more complicated when the first preliminary radiocarbon dating showed us that this log with a trace of carving was about 8000 years old. It was exciting when the around 3m long logboat-like trunk was re-examined from the beginning of the excavation. However, at the end of the excavation, the root system of that same trunk was discovered. After a consortium of wood specialist, dendrochronologists, forest researchers and archaeologist examined it, they decided that environmental circumstances had naturally formed a tree trunk into a logboat-like outline.

However, this information was not provided to the academics due to an 8000-year-old tree trunk, but we would like to discuss this artefact in the frame of special natural environmental processing that often gave humankind an easy way to craft and made vessels for travelling. Moreover, our ambition is also to refresh the knowledge of the excavated logboat older than 6000 years. We can find out that all around the world, a similar demand for vessels has been discovered in the specific

environments where the genotype of the forest was suitable for use in logboats.

Key words: Slovenia, Hotiza, Stone Age, logboat, Mura River

Introduction

During the reconstruction of the northern verge of the Trate - Gornja Radgona regional road in Pomurje, a northeast area of Slovenia, construction operators discovered two parallel trunks, at least 4m long, at a depth of 7m below the road surface (Fig. 1). The regional unit of the Institute for the Protection of Cultural Heritage of Slovenia was informed about the find. In April 2016, an archaeological inspection and preliminary documentation of the findings was conducted. The preliminary result revealed that at the bottom of the excavation was a fossil white maple (*Acer pseudoplatanus*) tree trunk lying parallel to another trunk. Later this year, a protective archaeological excavation followed.



Fig. 1: Location of the excavation in Trate Village and the Hotiza logboat in the northeastern part of Slovenia near the Mura River. (Gal-Peters Projection of World; Plan of Slovenia credit by www.freeworldmaps.net).

Discovering an 8,100-year-old maple tree trunk

Excavation: In total, 60m² were excavated and documented. The average depth of the excavation was 5.5m, and approximately 300m³ of sediments were removed. 30m³ of geological layers were removed manually. Only three of the documented 28 stratigraphic units contained human remains in the treated area. All three stratigraphic units were contemporary and are directly related to the modern reconstruction of the road and embankment. The excavated remains can be described as the result of geological processes that were occurring at the boundary between a landslide on the bank of the Mura River and the proluvial sediments of the nearby riverbed. Therefore, the excavated trunks were buried in river sediments. Because of their striking parallel arrangement,

we were almost sure before excavation that we had found the remains of a Mesolithic wooden structure (Lazar and Rižnar 2016).

Based on the data obtained during the early part of the archaeological excavation from the beginning part of the site, it was interpreted as a human walking surface and a possible manoeuvring area near the river. However, the stratigraphic layer was horizontal and located only a few centimetres above the trunk that was supposed to have been arranged parallel with the riverbed of the Mura River. Stone layers and trunks were interpreted as the remains of the archaeological structure, whose exact purpose could not be determined. Because of the small operating area, a surviving part of a towpath or road along the Mura River was assumed. This interpretation was very questionable after receiving the radiocarbon dating of wood. However, it could be proved correct if the protective archaeological investigations discovered possibly used fossil wood from the Mura River. Meanwhile, the fact is that several similar fossil trunks have been discovered in the Mura River and its backwaters in the Pomurje region (Fig. 2).



Fig. 2: The 'logboat' during the excavation. (Credit by Centre for Preventive Archaeology of Institute for the Protection of Cultural Heritage of Slovenia; Photo by Evgen Lazar).

This preliminary information and prediction were the basis and starting point for further archaeological research and excavations. During the archaeological excavations, numerous stratigraphic units were discovered and documented, all of which are of geological origin and were formed by the geological progress of the hillside and by flow activity from the east/south riverside and the Mura River. Following the extension at the beginning of the excavations, it was immediately noticed that the discovered trunk was partially hollowed out and the inside filled with sediment. Therefore the earlier interpretation as hardened towpaths along the Mura River was no longer believable.

Before continuing the excavation, some layers were interpreted as the remains of the Mesolithic logboat, which was washed up there by the Mura River or was possibly even originally carved at the place. Therefore, due to assuming possible traces of carving inside the tree trunk, which would indicate the human manufacturing of a logboat, the whole of the excavated sediment was examined a water sieved. Unfortunately, traces of processing wood have been detected the layers. After the meeting of the expert committee, geologists, biologists, foresters, conservators and archaeologists, it was estimated that the stones transported by Mura River could explain the traces on the wood. However, until we lifted and transported the trunk, we could not examine the outer side, but the question of uncontrolled wood drying meant that it was deliberately left in situ.

Dating and wood species: During the first exam of the site, the timbers were sampled for radiocarbon dating and identification of the species of

the wood. A sample was sent to the Beta Analytic Radiocarbon Dating Laboratory, where they performed radiocarbon dating. From the beginning of the site inspection, nobody was expecting spectacular data, so the results were very astonishing. However, the measurements (Beta-437481) of the conventional radiocarbon age of the wood was 8100 ± 30 BP with C^{13}/C^{12} variables of -24.7 ‰. By using the Intcal 13 calibrating application, the calibrated results within a 68% probability was 7127-7111 calBC and with a 95% probability 7189-7026 calBC. This result was highly significant from an archaeological point of view since no more than 30 miles downstream along the Mura River near Hotiza, a 7600y old oak logboat was discovered in 1989 – one of the oldest in the world. Meanwhile, at the Department of Geobotany of the Faculty of Natural Sciences and Mathematics, University of Maribor, the dendrological examination was conducted by Mitja Kaligarič and Igor Paušič. The trunk was recognised as maple (*Acer pseudoplatanus*) with around 68 tree rings.

The natural environment: The archaeological sites are located around 80m downstream from the bridge over the Mura River at Trate, the northeast region of Prekmurje in Slovenia. The location below the steep northern hillside of Vranji Vrh Hill is located in a few meters deep construction hollow below the road that runs along the right bank of the Mura River. Geologically, the steep slope above the road is a sedimentary rock of the Šentilj member as part of the Špilje formations, which consists of alternating clayey and silty marlstone and sandstone. On the described rock also forms the Hrastovec-Kresnica member of the Špilje formations, represented by the so-called lithothamnian limestone from the Badenian Middle Miocene age. In the broad area of the site, only two minor erosions of this a residual limestone are present on each side of the narrow gorge,

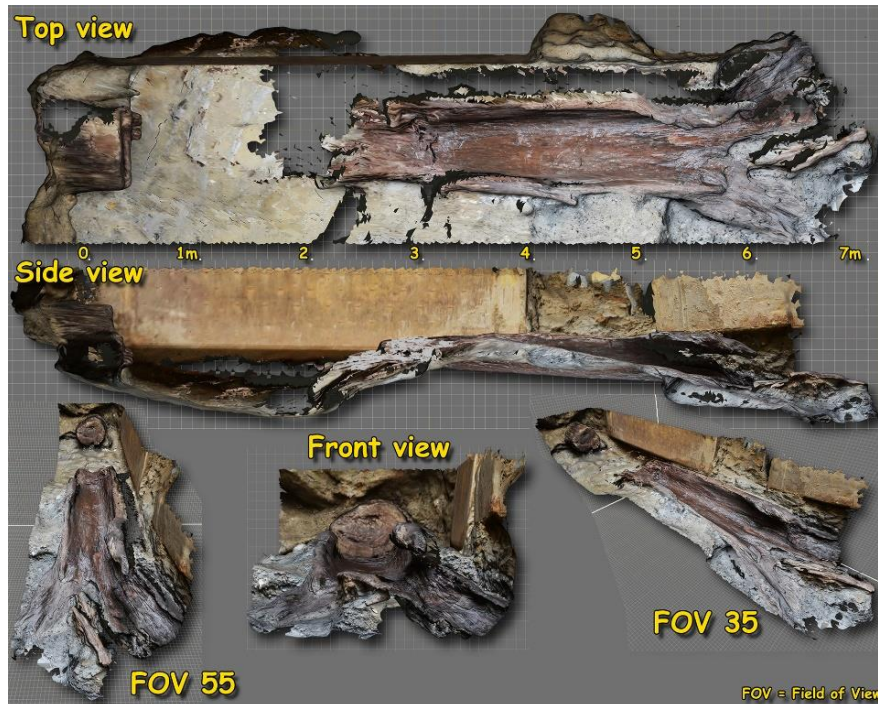
which flows into the Mura River. In the hinterland between Trate and Lokavec, rocks were described as covered by the Selnica member of the Špilje formations, which is formed by the interchange of sand, sandstone, marlstone, siltstones, clays and conglomerates, as well as local sandstone and algal and oolitic limestone (Jelen and Rifelj 2011; Žnidaršič and Mioč 1989).

Analysis of sediments in the stratigraphic layers at the site showed that poorly rounded and angular boulders of white Lithothamnium limestone do not belong in the common sedimentation structure of the Mura River. However, such rock outcrops are present along the Mura River basin to a small extent a few kilometres upstream. Since this pebble is a relatively soft limestone, it should be rounded and not angular if it originated from the Mura River basin. There was an unusually large share of these pebbles, representing up to 20% of all sediments. That is inconsistent with the small area of Neogene limestone on the surface of the Mura River basin. That is even truer for the marlstone pebbles since they would have decomposed after just a few hundred meters in the Mura River. However, if we can find very well abraded non-carbonate pebbles, poorly abraded soft Lithothamnium limestone pebbles and finally un-abraded neogen marlstone pebbles together in the same layer, it indicates the fact that it is proluvial sediment. It could be agreed that the site is part of the torrential stream cut into the deep gorge that flows out into the Mura River just a few meters downstream of the excavation. The bedrocks eroded by the torrential stream on its course contain all the components that make up the sediment that also contains the excavated trunks. However, the same also applies to the sediments that cover the described layer. The described layers, therefore, represent proluvial sediments from a nearby

torrent stream that Mura River has failed to erode (Lazar and Rižnar 2016).

Documentation: 3D point clouds and meshes were produced using Micmac (Rupnik et al. 2017), a semiautomated open-source multi-image photogrammetry software solution.

541 original images taken using a Nikon D7000 with a resolution of 4928 x 3264 were resized to 50 percent of their original size. The images were manually reviewed and divided into six sets of images with similar characteristics (distance to the object, illumination, coverage). Each set consisted of ten to eighty images and was processed separately using MicMac. Five of the six sets successfully produced dense point clouds and meshes with textures. The set with forty images produced the most accurate and well-covered dense point cloud of 1,808,200 points. Multi-image photogrammetry was done in eight stages: 1. automatic point matching using MicMac Tapioca MulScale; 2. computing the relative orientation using MicMac Tapas FraserBasic; 3. generating camera position visualization on the sparse point cloud using MicMac AperiCloud; 4. generating the dense point cloud using MicMac C3DC BigMac; 5. manually removing noise using CloudCompare software; 6. generating the mesh using MicMac TiPunch (Poisson reconstruction); 7. removing meshing noise using Meshlab software, and 8. generating textures using MicMac Tequila (Fig. 3).



*Fig. 3: 3D model of the maple tree trunk shaped like a 'logboat'.
(Photography set by Evgen Lazar 3D model Žiga Stopinšek with MicMac application)*

Results: During the excavation, it was revealed that the trunk is without inner part of the wood and the 'U' shape concavity allows us to gather that we might have discovered a logboat. During the excavation of the inner surface, small facets were spotted that were supposed to be traces of tools. However, during the cleaning of the end part of the "logboat", it was noticed that the trunk spread into the root system, which was the first sign that our preliminary interpretation might be wrong. When lifting the "logboat", several parts of bark on the outer surface of the trunk were observed. However, this obviously indicated that we were dealing with a fossil maple tree trunk, which was hollowed out by natural phenomena rather than human activity. Despite the fact that there was no trace of human activity in the trunk, the expert committee decided to preserve the excavated trunk in a safe watery environment, which enables the preservation of wood and further research.

The logboat from Hotiza

The paleochannels of the river Mura in Slovenia are used for digging gravel deposits. In one of them near Hotiza in Lendava, at a depth of about 6 to 7 meters, local workers in 1989 discovered a logboat over nine meters long. Colleagues from the Institute for the Protection of the Natural and Cultural Heritage of Maribor documented the discovered finds in the next few days (Tušek 1990).

The logboat was significantly damaged as it was several times grasped at the sides and part of the stern was broken by gravel basket lifting. The preserved length was 9.34m, a width of 1.10m and height 0.70m. The average thickness of the bottom was 17 to 22cm, and the sides are gradually thinner from the bottom to the top, with an average width ranging from 5 to 11cm. Around 2.5 meters from the stern, a transverse bottom rib was carved to reinforce the hull. The rib was a triangular shape, about 60cm wide and 35cm high. Another rib was carved about 8 meters from the preserved stern (Erič 1994a, 1994b; Erič and Kavur 2012). Structurally the ribs are an interesting and rare element with a triangular shape in the longitudinal cross-section (Arnold 1996a, 1996b), but an oval curve up to 15cm in a transverse cross-section of the convex with the intersection. However, as the logboat was already severely damaged by lifting it, more than half is missing. About 4 m from the stern was a circular drilled hole with a diameter of 14cm, which was filled by a plug of soft wood.

During the examination of the logboat, wooden samples were taken for dendrological, conservation and radiometric analysis. The Dendrological investigation showed that the logboat was made of oak (*Quercus robur*). The sample from the plug could not be determined due to the extremely degraded condition and severely damaged cell structure. However, it was concluded that it could be one of a range of porous wood species, such

as poplar (*Populus*), walnut (*Juglans*), beech (*Fagus*), hornbeam (*Carpinus*) or maple (*Acer*). For possible future conservation of the logboat, they also performed investigations of the condition of the wood. Three samples were collected from three parts of the trunk at distances of 2.5m. Finally, a single sample was collected from the plug on the bottom (Fig. 4).



Fig. 4: The Hotiza logboat during the first exam in 1989. (Photography by Marija Lubšina Tušek)

On the surface, small smoothed cleaved layers of wood were visible. Meanwhile, the inner side of the logboat showed a transverse hew with an average width of between 8 and 12cm, and some of them up to 22cm. It seems that the builders first cut an incision in the timber and then cut out a layer of rings. Later on, with the help of a chisel/wedge, the wood was chopped and lifted parallel to the course of the growth rings. On a surface area of 1m², up to 10 cuts were identified. It is believed that the logboat was carved using stone tools and the wedge was bone or antler (Fig. 5).



Fig. 5: Remains of the logboat in plan and sections. (drawn by Miha Erič based on the original drawing by Marija Lubšina Tušek).

The first date, as detected by radiometric dating, gave us a date on the wood as 7,300 years old. Due to the suspicion that there was something wrong with the sample and the values obtained, we repeated the analysis that shows nearly the same age of the wood (Erič 1994b; Obilić et al. 1994). Dating was carried out 27 years ago, so the raw data was calibrated using modern software (Bronk Ramsey 2013).

Since the large standard deviations cover a relatively large time span, the first two dates overlap between the 61st and 59th centuries BC. However, for the third date with a significantly lower standard deviation, the time overlap is significant. Consequently, with respect on the standard deviation, we can assume that the 61st century BC is where the result ranges of three datings overlap. Although the samples for dating were taken from the exterior of the sides, bearing in mind the age of the tree, it

is believed that the logboat was built and in use at the end of the 7th and beginning of the 6th millennium BC.

The logboat from Hotiza was made at the time when the central part of the Pannonian Plain saw the first agricultural communities associated with Starčevo culture. Moreover, in the region, a rare archaeological site related to this culture has been discovered. Radiocarbon dates indicate that the logboat was made in a late Mesolithic cultural environment. Pollen and charcoal analyses from the sediments around the nearby Lake Balaton has shown that communities in this area occasionally burned vegetation and probably handled bigger trees since the beginning of the 8th millennium BC. In the humid period of the mid-6th millennium, an increase in Neolithic settlements sites were discovered, mainly located right on the edge of Lake Balaton, suggesting that residents took advantage of the acceptable living conditions in the region. These specific sites in humid environments suggest that we will see more preserved remains of vessels, which was partially confirmed by the discovery of the logboat from Keszthely, which would also date from the Mesolithic age (Bánffy 2006).

According to the available dating, the closest Early Neolithic archaeological sites concomitant to the Hotiza logboat, which could be classified in a previous stage of Starčevo culture, were a few hundred miles south-east in the southern region of Slavonia (Minichreiter and Krajcar Bronić 2006; Krajcar Bronić 2007). At these sites, the oldest hammer-axes were discovered, an excellent tool for woodworking. Today it is assumed that it was mainly environmental circumstances that dictated the expanded range of the oldest agricultural communities (Kertész 2002). However, they colonised a wider area of western Transdanubia at the

middle of the sixth millennium BC as a regional form of late Starčevo culture (Kalicz 1990; Oross and Bánffy 2009; Whittle et al. 2002).

Therefore, the logboat remains an extraordinary discovery. It stands out in its size, in its early choice of hardwood from a broad-leaf tree, in its technological solutions and finally in its alleged carving techniques. The logboat is an extraordinary discovery, which, depending on its age, can be classified in the Late Mesolithic despite of the lack of other artefacts (Burov 1996). Meanwhile, in the wider area of eastern Slovenia, northern Croatia and western Hungary, no other sites or artefacts from that time are known. This discovery illustrates a particular community lifestyle and provides hints of its organisational capabilities and sophisticated crafts skills, which were used to deal with life in an environment where the rivers were the principal communication routes.

The oldest logboats around the world

Logboats of a similar age is very rare, with the most extraordinary artefacts originating from northern and western Europe, though they are also known in China and Africa. The ancient knowledge of the technology of cutting and carving objects from wood is also evidenced by the increasing number of examined paddles. However, a few decades ago, a study was performed to describe a typology that would allow the dating of logboats by the design details. Unfortunately, this had no useful results, though they showed that the use of elements to reinforce vessels was first seen around 5000y ago (Hirte 1987; Lanting 1998). However, this thesis is unsustainable given the reinforcement on the logboat from Hotiza.

The oldest documented logboat is still the 8200y old 3m long and 45cm wide pine wood (*Pinus*) boat from Pesse in the Netherlands, discovered in 1956 (Van Zeist 1957). Whether this artefact was used as a vessel or possibly as a feeding trough, Dutch archaeologists have hotly discussed.

However, the results of the radiocarbon dating discussion were interrupted (Beuker and Niekus 1997). Meanwhile, with this discovery, it was shown that the cutting and carving technology was already known from stone ages in northern Europe.

Around the world, it was discovered several similar ages logboats (**Fig. 6**). Nandy / Le Coudray-Montceaux is the site in France where was discovered 8060y and 7990y old logboats (Bonnin 2000) and a 7900y old logboat were found in Noyen-sur-Seine near Paris in France (Mordant and Mordant 1989). Logboats more than 7000 years old include examples from from Dümmerlohasen in the north of Germany (7700y; Hirte 1987), Dufuna in north-east Nigeria (7670y; Breunig 1996; Garba 1996), Hotiza in the north-east part of Slovenia (7340y; Erič 1994a, 1994b; Erič and Kavur 2012) and finally a logboat from Kuahuqiao near Shanghai in China (7070y; Jiang and Liu 2005).

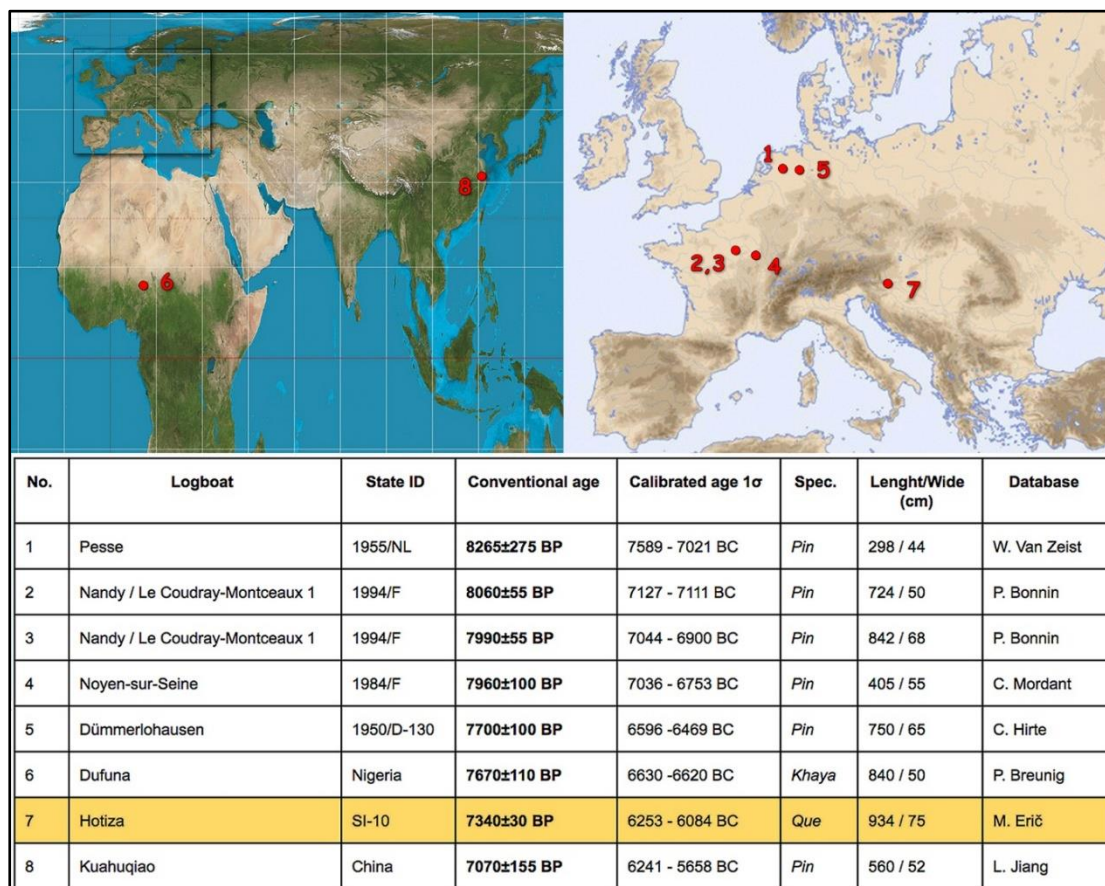


Fig. 6: Distribution of logboats older than 7000 year dated by radiocarbon dating.

After this short presentation, it is obvious that more than 7000 years ago, logboats were primarily carved from pine wood (*Pinus*), except for the one from Dufuna, carved from mahogany (*Khaya*), and from Hotiza made from oak (*Quercus*). The majority use of pine trees in the post-glacial period is almost predictable since its characteristics allow easy handling and especially because it was a dominant tree species in many regions around the world (e.g. Gumnior and Thiemeyer 2003; Carrión et al. 2010; Shang and Li 2010; Feurdean et al. 2014). However, at the end of the Atlantic Holocene and especially in the sub-boreal area, the pine tree slowly lost its dominance, and the oak tree started to dominate in many regions. Due to the general climatic changes, we can see that the oldest logboats (until the sixth millennia) were mainly made of pine wood and the more recent

logboats (until the second millennia) are made of oak (Arnold 1996a; 1996b).

Conclusion

The content of the presented studies is certainly insufficient for a description in an article since the final judgment of the experts was that in this case, the discovered trunk was not a human product but the result of an unexpected combination of natural environmental circumstances that made the trunk look similar to a logboat. Nevertheless, the result of this research also contributed valuable knowledge. First and foremost, the information is highly significant because we have discovered an 8,000-year-old tree trunk. We preserved an original that may hereafter provide referential data that can be applied to other sciences in the future for research purpose, such as paleo- environmental, botanical, hydrological and other kinds of studies. However, it is also an important message to archaeologists about the conscientious evaluation of research.

We have to be particularly vigilant when we are dealing with a fragmented artefact that does not contain enough trustworthy arguments to deciding on a human origin. In this case, from the beginning, the described object certainly provided adequate reasons to believe that it was a logboat. However, the later discovery of roots, tree bark on the outside and finally the insufficient traces of 'wood crafting' changed our conclusion. It presented a sufficient argument to conclude that this was not a logboat. However, if it were a logboat, it would certainly be among the three oldest in the world.

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