Archaeology:
Just Add Water

volume II

2019

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Archaeology:
Just Add Water
Underwater Research at the University of Warsaw

Ministerstwo Nauki i Szkolnictwa Wyższego

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Preface

Dear Colleagues,

It is our great pleasure to present to you the second volume of the U Supplement Series of the "Światowit" periodical. To a large extent it is based on the papers presented during the *3rd Warsaw Seminar on Underwater Archaeology*, which took place at the University of Warsaw on the 17th and 18th of January 2019.

An efficient and prompt process of editing we owe to the funding from the Ministry of Science and Higher Education, grant no. 959/P-DUN/2018.

Organization of the Seminar and publication of the hereby volume was possible thanks to the co-operation with the Polish Chapter of the Explorers Club, in particular its President, Professor Mariusz Ziółkowski, and the Vice-President, Marcin Jamkowski, to whom we are deeply grateful.

We would also like to acknowledge and appreciate the support of the University of Warsaw, namely the Vice-Rector Ph.D. habil. Maciej Duszczyk, the Dean of the Faculty of History, Ph.D. habil. Małgorzata Karpińska, Professor UW, as well as the Director's Board of the Institute of Archaeology: Ph.D. habil. Krzysztof Jakubiak, Ph.D. Michał Starski, and Ph.D. Marta Żuchowska.

The special thank you we traditionally owe to the Diving Museum by the Warsaw Diving Club, especially the Museum's Curator, Karina Kowalska, and the Club's President, D.Sc. Grzegorz Kowalski, who have been supporting our activities for many years, and constantly guide and help us in numerous enterprises.

We would like to extend our gratitude to all the Authors and Reviewers, who have been extremely diligent and punctual to keep up with our strict deadlines.

During the editing of the volume we have received invaluable consultations in the matter of ancient languages by Tomasz Płóciennik and Ph.D. Joanna Wegner, who we would also like to thank with all our hearts. The post-editing process was successful due to the the kind assistance of Ph.D. Rafał Dmowski, who we owe enormous gratitude.

The whole book was once again skilfully supervised and managed by the one and only irreplaceable Ph.D. habil. Bartosz Kontny, Professor UW. Him we would like to thank for all the advice and help with difficult choices, as well as the dedication to the organizational matters, even though the really tight schedule.

Last but not least, we would like to thank all the Readers who have reached for the hereby volume. We sincerely hope you will enjoy the outcome of our efforts and wish you pleasant reading!

Aleksandra Chołuj

Małgorzata Mileszczyk

Magdalena Nowakowska

3rd Warsaw Seminar on Underwater Archaeology

3rd Warsaw Seminar on Underwater Archaeology held on 17th-18th of January 2019
at the University of Warsaw
(photos by: M. Sugalska)

Foreword

The volume, which we hereby present to our esteemed Readers, is the vivid proof that underwater archaeology at the University of Warsaw is doing more than well. It is the second publication in the ***"Światowit" Supplement Series U: Underwater Archaeology***, issued for now (and we hope this pace will be sustained!) with a frequency of a periodical. Within the book one might find i.a. the texts being an outcome of the international ***3rd Warsaw Seminar on Underwater Archaeology***, organized in the Institute of Archaeology, University of Warsaw. The Readers will discover here the articles presenting broad chronological and geographical range of issues: from the Prehistory until the Second World War, from Guatemala and Peru to Poland and Slovakia. We are trying to reflect this diversified character also by the choice of photographs on the cover.

The leitmotif of all this vast range of archaeological issues is **water**: realm bearing a magnificent symbolic character. Changing its colour (even during the day – from the blackness, through greyness, then blue, until the bloody-red at the sunset, turning again into black) and visibility, it has manifested also other features, which can be contemplated as signs of its animation, such as movement: horizontal (currents, waves, tides) and vertical (fluctuations of the surface). It was also the source of life quite literally, providing food and dihydrogen monoxide, essential for living.

Along with its whole mystery and dangerousness, water may also serve as a refuge (lake settlements from the early Iron Age) and a trade route, at the end of which there is a (hopefully) safe harbour. That is how underwater archaeology marches onto the land... Although, it is neither place nor time for the deliberation about the definitions of archaeology related to water environment; the discussion in this matter has lasted for many years, abound in more and more new terminological propositions, still being far from any resolutions. Whichever position we assume in the aforementioned debate, it is impossible not to notice that the symbolism, the rituals, and everyday casual activities essential for life and connected with water pass through each other, which is well-exemplified by the hereby volume. Objects lost during transportation and other kinds of exploitation of water basins, items put in the water as a matter of rituals, military aspects connected with watery environment, lake settlements, harbours, and trade – all of that and even more you can discover in *Just Add Water 2*. To all the Readers, who are going to immerse themselves into this topic, I wish a pleasant intellectual adventure and... good dives!

Bartosz Kontny

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Naval Supply Lines for the Roman Army in *Moesia Inferior* – Basic Considerations for the Danube Underwater Heritage Project

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Abstract:

Around the Black Sea significant settlements were created during the Greek colonization. Towards the middle of the 1st century A.D. the area known as Moesia was stepwise developed into a province and equipped with fortifications, as the limes was following the Danube. Supplies and resources that could not be acquired locally, but were needed by the garrisons, had to be brought in, preferably by ship. Eventually, army camps were built along the last stretch of the Danube between the Yantra tributary and the river delta, facilitating even more intense ship traffic and connecting the Greek cities, which functioned as supply bases. The overall idea of the Danube Underwater Heritage Project is to examine and assess archaeological remains at the bottom of the Danube River in its delta, the nearby Razim-Sinoe lagoon, and selected spots on the Romanian Black Sea coastline. An important scientific problem is the evaluation of the sediment in the river delta and the resulting limitations for underwater investigations. The Roman period is of particular interest; the first season of the non-invasive underwater project took place in September 2017, when various sites within the Danube Delta were verified.

Key words:

Roman *limes*, army supply, army logistics, naval supply, *Histria*, *Argamum*, Danube Delta, underwater archaeology, *Moesia Inferior, Scythia*

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Introduction

In the early days of the Empire the initial tendency to keep a permanent border, which turned into a fact commonly known as the *limes* (a good introduction to this transition: Campbell 2010; *vide*: Eich 2009: 565; Ørsted 1985: 20; Polak and Kooistra 2013: 359), led to a significant reorganization of the troops in order to provision the units now stationed on the frontiers. After all, the Roman army was by far the biggest organization in the Empire (Speidel 2009: 283) and with its wide range of tasks beyond the simple border security (Sarnowski 1988: 69; Duch 2015 *passim*; Lemke 2016: 10–12) still had to find the time and personnel to implement a complex logistical system, because military success was heavily dependent on a continuous provision of supplies: soldiers at frontier outposts simply needed to eat. With the Rhine and Danube forming the *limes* across Europe, most legionary camps in the Empire were located on a major river and in *Moesia Inferior* a bulk of the supplies was transported on the Danube and its tributaries, while the access point for long range supplies led through the Black Sea and – obviously – the Danube Delta.

Around the Black Sea, significant settlements had appeared during the Greek colonization, and a number of these Pontic cities were located on what would after 86 A.D. become the coastline of *Moesia Inferior* and *Scythia Minor* in Late Antiquity. There is a well-grounded theory that Rome chose to include the area today known as the Dobrudja/Dobrogea in the 1st century A.D. for reasons of logistical security: the Danube was the most important communication and supply route for the existing and developing *limes* outposts below the Iron Gates (particularly during the Dacian campaigns of Trajan, *cf.* Poulter 1986; on *Scythia*, *vide*: Matthews 2018). It was crucial to control the Lower Danube on its entire length and also to offer sufficient protection to the Pontic cities (see below) which played a major role in the supply chains (**Fig. 1**).

The *Danube Underwater Heritage Project* was started in 2017 as the result of a co-operation agreement between the Eco-Museum Research Institute "Gavrilă Simion" in Tulcea[1] (Tulcea County, Dobrudja region, Romania) and the Antiquity of Southeastern Europe Research Centre of the University of Warsaw[2]. The overall idea is to examine and assess archaeological remains on the bottom of the Danube River in its delta as well as the nearby Lake Sinoe, the Razim lagoon, and selected spots on the Romanian Black Sea continental shelf (Lemke *et al.*, forthcoming). Finds from the Roman period are of particular interest, even

[1] Romanian: *Institutul de Cercetări Eco-Muzeale "Gavrilă Simion", Tulcea.*
[2] Polish: *Ośrodek Badań nad Antykiem Europy Południowo-Wschodniej Uniwersytetu Warszawskiego*.

though any information regarding the overall research conditions and preserved finds on the seabed will be considered valuable. An important scientific problem is the evaluation of the sediment in the river delta and the resulting limitations for underwater investigations.

The Danube Delta

The delta of the Danube was once described by the Prussian strategist Helmuth von Moltke as a heaving sea of ten feet high reed beds (Moltke 1845: 46). In Antiquity, the Delta was considerably smaller than it is today, and during the 20th century the area has been managed considerably, but it is still a separate geographical unit with its old corridors, lakes, islands, and a specific flora and fauna (Panin and Overmars 2012; Panin *et al*. 2016). The Delta was created from a former lagoon (Panin 1983: 177), similar to the alluvial areas of lagoons and shallows, located along the coast south of the Delta. The large lakes of Razim, Sinoe, and Goloviţa, nowadays called the Razim-Sinoe lagoon, are the remains of a former sea bay called *Halmyrys* (Zahariade 2006a: 169). In the period between the 5th century B.C. and the 2nd century A.D., the main distributary of the Danube, which had previously been the Sulina, changed into the Delta. At that time the branch of Sfântu Gheorghe (*Peuce, Hieron Stoma*), previously silted, was reactivated, creating an additional branch at the city of Dunavăţi with an outlet to Razim Lake (Panin 1983: 182; Bony *et al.* 2015: 190) – a fact of great importance for navigation in ancient times, which also generated a freshwater lagoon environment (Bony *et al.* 2015: 201).

Roman Army Logistics and the Danube Delta

Legionary camps and forts were obviously meant to be as self-sufficient as possible, but the garrisons were heavily interconnected with one another and with other centres near and far, to ensure stable supply routes. Provisioning an army locally may have always been the most economic option, but only when certain prerequisites had been fulfilled. Regarding the province of *Moesia Inferior*, the supply system had become considerably reliable in the times of Vespasian, when this stretch of the frontier was significantly strengthened as part of the reorganization of the Empire defences (Lemke 2016: 15). However, Trajan's Dacian campaigns with the eventual annexation of Scythia (modern-day Dobrudja) made the dislocation of another legion into the region necessary, including additional *auxilia*, which was difficult considering obligations in other parts of the Empire (Poulter 1986: 521) and the sometimes tricky conditions for local supply (Lemke 2016: 15; Poulter 1980: 731–738). The solution for increased requirements could have been an intensified settlement programme (Poulter 1980: 736; Matthews 2018: 213) or an import of grain/food by ships from a distance, for instance Asia Minor (see below) or possibly the Crimea region (Matthews 2018: 31).

In spite of a certain risk connected with water travelling, the Roman army seems to have preferred this type of transportation, as it was cheaper and quicker than overland movement and much more convenient for heavy loads (Aricescu 1980: 114; Roth 1999: 190–191; Rickman 1980: 120; *cf*. Livy on moving army supplies by ship: Liv. 38.3.11.); even though it has to be kept in mind that it was considerably easier to move ships downstream a river than upstream.[3]

While the fleet possessed war-ships (in the case of *Moesia* particularly the *legio I Italica*, *cf.* Fiederling *et al.*2017: 289) and was supposed to patrol the *limes* and deny enemies the possibility of crossing the river (while also suppressing smuggling activities), a major task was also delivering supplies to the camps. Stamped legionary tiles, found in cities on the coast of the Black Sea, give proof of intensive shipping of building materials not only to, but also from army camps, where the bricks and tiles were produced and from where they were distributed (Sarnowski 1988: 78). Wine, olive oil, wood, and stone were regularly transported by ships (Casson 1965: 31; Sarnowski 1997: 498), so was grain, on *naves frumentariae*.

The Moesian fleet, operating since Claudius or Nero (Sarnowski 2006: 89), was reorganized by Vespasian after 69/70 A.D., receiving the title of *Flavia* at some point. *Noviodunum* (Isaccea, Tulcea County, Dobruja, Romania) was the seat of the *praefectus classis*, where in the 2nd and 3rd centuries a *vexillatio* of the *I Italica* was stationed. This site not far from the Delta is largely considered the main base of the Moesian fleet (Aricescu 1980: 31; Bounegru 2006: 109; *vide*: Fiederling *et al.* 2017: 288–289).

[3] Steve Matthews prefers the idea of intensive land transport (2018: 32). However, upon stating that: "*so maybe luxury goods were moved upriver* (…), *but not staples*" (Matthews 2018: 264), one has to bear in mind the numerous examples of transports of stone from the Hotnica quarries (near Veliko Tarnovo, Bulgaria) to *Novae* on the *limes* near Svishtov, Bulgaria, which will certainly have occurred travelling the Yantra River downstream and then upstream on the Danube (Skoczylas 1999: 130). Similarly, it seems extremely unlikely that the supplies brought to Novae within the *pastus militum* from Asia Minor would have been transported overland. An upon noting that "(…) *on the lower reaches* [of the Danube] *there are extensive marshes today, and surely there were in antiquity also, that would have excluded towing*" (Matthews 2018: 264) one should bear in mind that even though in Antiquity there were more stretches of marshland on either bank of the unmanaged Danube; by virtue of geography it is the left bank which is affected most (Lemke 2015: 845) and towing ships along the right 'provincial' bank cannot be categorically excluded.

Regarding structures resembling a port, it has to be kept in mind that even when transporting heavy goods, a quay or similar construction was not a precondition for unloading a ship. Small light barges were used for this purpose, connecting with a natural port on a river bank (Houston 1988: 561–563). Still, remains of more or less solid ports were found at *Novae*, *Dimum* (Bulgarian Danube), *Halmyrys*, *Flaviana*, *Capidava*, *Axiopolis* as well as *Carsium* (Romanian Danube; *vide*: Sarnowski and Trynkowski 1986: 540; Bounegru and Zahariade 1996: 85; Bounegru 2006: 109). However, one should be sceptical of the ideas of Mitova--Džonova (1986 and 1994) regarding a rather sophisticated dock at Belene/*Dimum*. For the fleet headquarters at *Noviodunum* a port can be postulated, but the results of earlier research likewise need to be treated with care (Fiederling *et al.* 2017: 293).

The Pontic Cities

The economic activity in the Black Sea area was concentrated around coastal urban agglomerations. Since the late Archaic Period cities have been built and developed there, achieving great importance in the Hellenistic Period. During the Mithridatic Wars these cities – organized as a community – attracted the attention of Rome. Marcus Terentius Varro Lucullus, proconsul of *Macedonia*, conquered several Greek Black Sea towns in 72–71 B.C., but they were lost again ten years later. Rome annexed them anew in 29–28 B.C., handing the rest of the Dobrudja area to the kingdom of Thrace (for an introduction on the Roman control of the western Pontus *vide*: Matei-Popescu 2017; 2014a; 2014b; Nawotka 1997; Jones 2016: 125). The cities possibly became autonomous colonies, *civitates foederatae*, late in Augustus' reign (contra: Matei-Popescu 2014a: 179–180) and Rome certainly gave them a sense of security, guaranteeing the stability of the entire region (Bărbulescu and Buzoianu 2014; Matei-Popescu 2014b; Jones 2016).[4] A recently found and quite fascinating inscription concerning *Histria* (Bărbulescu and Buzoianu 2014; Jones 2016) sheds new light on the nature of this security, confirming Anton von Premerstein's deductive reasoning. The monument acknowledges the help of the Roman commander Iulius Vestalis, who saved the town from abandonment, stating verbatim: "(…) *sent by Tiberius* (…) *for the preservation and safety of the Greek cities* (…) *and especially of our city because we are situated very close to the barbarians (…)*" (Jones 2016: 124). The association of six cities (*Histria*, *Tomis*, *Callatis*, *Dionysopolis*,

[4] Among the many woes of an exiled poet Ovid there was the obligatory duty in the city guard of Tomis (Constanța, Constanța County), before Rome provided protection by the army (Ov. *Trist*. 4.1.69; *Pont*. 1.8.7).

Odessos in *Moesia Inferior* and *Mesembria* in *Thracia*) and the community known as κοινόν (*koinon*; Nawotka 1990), to which the above cities, among others, belonged, retained a somewhat unique status.

These rather densely populated cities (*cf*. Matthews 2018: 132–134 for a discussion on the quantification of inhabitants) possessed extensive territories with fertile soils suitable for both land cultivation and livestock farming, and had a strong political, economic, and cultural impact on the surrounding population, playing a significant role in supplying the garrisons of *Moesia Inferior*. Traces of grape cultivation have also been found. Facilitating maritime trade between the Black Sea regions and the Eastern Mediterranean was also important. Wine, olive oil, and fish were the main commodities (Prešlenov 2008: 301).

For the context of this contribution, it seems helpful to briefly mention three selected sites and three documents (or document types). The two Pontic cities on the Razim-Sinoe lagoon are of particular interest because of their vicinity to the delta: *Argamum* and *Histria*. Additionally, *Axiopolis* (Cernavodă, Northern Dobruja, Romania) deserves some attention, even though its significance seems rather understated in the contemporary literature.

Axiopolis

Axiopolis, near modern day Cernavodă, is not located in the project area *per se*. However, it lies in a peculiar spot, which can be appreciated best while looking at a map. The course of the Danube turns sharply north, because the Dobrudja massif blocks the shortest way to the Black Sea. This is why the Danube–Black Sea Canal was built here (opened in 1984), which allows ships to bypass the long way through the delta. While the canal itself is a modern phenomenon, its route – on land – had already been of importance even before Rome established a province here and possibly also in the 3rd century when *Scythia* (Dobrudja) found itself outside a second defensive perimeter marked by the *Valul lui Traian* (Trajan's Wall) connecting *Axiopolis* and *Tomis* (a possibility which is currently under investigation; Hanson and Oltean 2012; Rankov 2015) had not yet been included into the area protected by the Lower Danube *limes*. This route connected the Pontic cities, primarily *Tomis*, with the lower Danube, thus providing Greek merchants with a connection to the distant hinterland of barbarian territories. It has been suggested that the origins of this colony – with a Greek name rare among the Danube sites in *Moesia Inferior* – are connected with the expeditions of Lysimachus in the 3rd century B.C.

(Aricescu 1980: 36), when *Axiopolis* was possibly created as an emporium (Matei-Popescu 2017: 25 fn. 60). The city can be seen as an example of the Roman army seizing Thracian strongholds and adapting them to their needs (Matei-Popescu 2017: 25), a variation on the common theme of taking advantage of existing settlements for logistic convenience (Lemke 2016: 27). Certainly, since the beginning of the 2nd century A.D. *Axiopolis* had been an important seat for the *classis Moesica*. Stamped bricks also suggest the presence of *cohors II Commagenorum* (Gudea 2005: 446). Additionally, *Axiopolis* not only was a trading outpost, but also a significant place of ceramics production (Dyczek 2009: 166); and it possessed a huge quarry, exploited during the construction of the city and fortifications, where the connection to Hellenistic culture is highlighted by a depiction of Hercules carved into the rock (Radulescu 1972: 190–195; Florescu 1937; Rabadjiev 1990).

<u>*Argamum*</u>

Argamum and *Histria* are two Pontic cities within the research area of the *Danube Underwater Heritage Project*. Both were founded at the same time, in the mid-7th century B.C., but in spite of their proximity to each other, they have developed very differently, because of the dynamic geographic conditions (Bony *et al.* 2015: 200). *Argamum* (originally Greek *Orgame*) is located about 5 km east of the small town of Jurilovca, on the vast Razim lagoon (Bilde *et al.* 2007/2008; Coja 1972; 2005; Anghel and Brustur 2007). The town, founded by Greek colonists, have continued a settlement since the Iron Age. Stamped amphorae from the Hellenistic Period indicate very intensive trade contacts with the cities of the Hellespont and the Mediterranean (Lungu 1992: 71). The Roman period was not published more widely (*cf.* Coja 2005: 30–35), but it seems likely that the city continued to function in a similar way. The development of *Orgame*/*Argamum* has recently been investigated in the context of geological changes along the Danube Delta and the adjacent Black Sea coastline (Bony *et al.* 2015). The population mediated trade between the areas of Dobrudja and Dacia and the Mediterranean Sea and, like the inhabitants of nearby *Histria*, was engaged in fishing in the Razim Bay.

<u>*Histria*</u>

Histria (initially a colony of *Miletus* by the name of *Istros* which was also the Greek name for the Lower Danube) is currently also located on a vast lagoon stretching along the coast, in its southern part, on a small peninsula (Bilde *et al.* 2007/2008: 126–127; Höckmann 1999; 2001; Höckmann *et al*. 1997; 1996/1998; Bounegru 2003; Dabîca 2010; Avram 2006). The Greeks attracted indigenous people into their city (Avram 2006: 63), which functioned well under Roman control, but due to its northern position it fell early under the invasions of the 3rd century (Suceveanu 1969: 364). Many agricultural sites around *Histria* were created during the period of the Moesian colonization (Avram 2006: 59). In the 2nd century, the city was expanded and occupied an area of 24–30 hectares within the walls, which is a lot more than in the Hellenistic times (Musielak 2003: 104). The inhabitants were engaged in shipping and trade, particularly of fish. There are also traces of iron mining near *Histria*. A convenient insight into the status of *Histria* and its potential is given by the set of documents presented on an inscription commonly known as the *horothesia* of Laberius.

The Horothesia *of Laberius and other Relevant Documents*

In 1914 two fragmentary copies of a dossier concerning the exploitation of a pine grove and the fishing rights of the *Histrians* were discovered in excavations at *Istros*/*Histria* (Inscription from *Istros/Histria*, after: Pippidi 1983: 67, 68; Oliver 1965; Pippidi 1956; 1958). The inscription consists of copies of eight juridical documents concerning the town and its citizens and named the *horothesia* of Laberius Maximus, who was the governor in the times of Trajan, although some of the relevant documents were first issued around the middle of the 1st century A.D. (Inscription from *Istros/Histria*, after: Oliver 1965). The importance of fishing in the Peuce/Razim branch for the local economy is emphasized here. The sale of salted fish was a major source of income for *Histria* (Bounegru 2009). At one point there had been a conflict between the residents of *Histria* and the chief officer of the customs area *ripae Thraciae*. Laberius Maximus defined the boundaries of *Histria*, while in the epistle of Pomponius Pius it is written:

"*In order that the rights of the city might be not only preserved but increased, I have decreed that the revenue from fishing below Peuce be yours with the same right as your ancestors and fathers obtained these dues by the grace of the emperors*" (Epistle of Pomponius Pius, after: Oliver 1965).

Further insight into Roman supply lines on the Moesian *limes* is given by a document known as Hunt's papyrus/*pridianum* (British Museum Papyrus 2851). It is almost a summary of the topic of Roman army logistics (a closer look at the document including the relevant literature: Lemke 2016), dated to the very beginning of the 2nd century (Speidel 2009: 299). Apart from the information on single soldiers and units, the system of army documentation included also data on quotidian issues like supplies of food, arms, equipment, raw material, and other goods, so the commanding officers knew what they had at their disposal and thus could anticipate and properly document the necessary expenses. The unit in question is the *cohors I Hispanorum veterana*, which belonged to the garrison of Egypt before it was moved to *Moesia*. Its strength was 546 soldiers (Hunt 1925: 268). The documents allow analysing certain aspects of the long distance supply routes: soldiers of this cohort were sent to *Gallia* for clothes and grain, and also, on horseback, beyond the unidentified *Erar* River. The grain guarded by the soldiers of the cohort was transported in ships, *naves frumentariae*. Added to many examples of local provisioning, this source highlights the importance of long range supply lines operated both by civilian contractors and the soldiers themselves.

Regarding civilian contractors, inscriptions concerning the *pastus militum* are another important source. For *Moesia Inferior* this is mostly a series of epigraphic monuments found in *Novae* (Epigraphic monuments from Novae, after: Sarnowski 1999; 2013). Starting around 300 A.D., the *primipilarii*, civil functionaries responsible for organizing supplies, resumed the tradition of setting votive statues in the headquarters courtyard, which had been started by their namesakes, the first centurions (*primipili*) of the legion (Sarnowski 1999; 2013). These civilians came from the Cyclades, *Hellespont,* and *Phoenicia*. The duty of the *primipilarii* was to transport supplies from the province in which they were collected (which was also their home province) to the location at which a given legion was stationed, so in the case of *Novae* the transports naturally had to come by ship, possibly through the Danube Delta. Supplying the legions of *Moesia Inferior* from rather distant provinces of the Mediterranean seems to have been a consequence of the devastations the Goths brought with them and the subsequent logistic complications (Sarnowski 2013: 144; Poulter [ed.] 2007: 37–38).

<u>*Underwater Archaeological Research in the Region*</u>

Details regarding the state and history of underwater research around the Danube Delta have been published elsewhere (Lemke *et al*., forthcoming). At this point, with the context of naval supply lines in mind, only a particular and recent example should be brought to mind, probably the most important underwater discovery in recent years in Romania: wreck Portița A, discovered in 2016 by a joint team from the Eco-Museum Research Institute in Tulcea, the Bavarian Society for Underwater Archaeology from Kempten[5], and the Ludwig Maximilian University of Munich[6] (Nuțu *et al.* 2017; Pflederer *et al.* 2016). This second-century-A.D. wreck sunk off Gura Portiței (the ancient entrance into the *Halmyris* bay, today known as the Razim--Sinoe lagoon), coming from the Black Sea. The cargo has been estimated to consist of over 1000 amphorae of the so-called 'light clay narrow neck' type (Shelov C/SinIVC), most of them entirely preserved and arranged in six rows. It is easy to conclude that this was a supply ship, even though a detailed report on the remains to be published at this point.

The 2017 Season of the Danube Underwater Heritage Project

The first season of the non-invasive *Danube Underwater Heritage Project* took place in September 2017. Various sites within the Danube Delta were verified. The prospection included Bazinul Mare (Sulina estuary), but also Lake Sinoe adjacent to ancient *Histria* and Lake Razim where the ancient *Argamum* is located (**Fig. 2**). The relevant spots had been chosen after consulting the archaeologists in charge of the excavations there.

In the fairly shallow Bazinul Mare (maximum depth 9–10 m) the area was investigated by sonar and sub-bottom profiler; selected points were verified by divers and, where possible, documented. Altogether, 21 anomalies have been identified, five of which looked like potential wrecks. Three points were verified, including the shipwreck named Sulina A – the best preserved of the discovered wrecks. The preserved length of the wooden hull with metal reinforcements is about 30 m (**Fig. 3a, 3b**). The wreck contains cannonballs and probably cannons and can be dated to the 19th century. Shipwrecks Sulina B and Sulina C are also wooden constructions, but less accessible.

The prospection was carried in the Razim-Sinoe lagoon (**Fig. 4a, 4b**). A part of the archaeological site of *Histria*, which investigations were possible thanks to the support of Mircea Angelescu, Ph.D. and Mircea Dabîca, Ph.D. is now under water. Local researchers suggest the existence of early Roman city walls underwater, and indeed, a stone structure under the layer of silt could be measured with a mobile RTK device, but further verification is needed. A photomosaic has also been prepared for the whole site.

There is a theory that a part of ancient *Orgame/Argamum*, located on a high cliff, has collapsed into Lake Razim during an earthquake. Sonar and sub-bottom profiler were employed to investigate

[5] German: *Bayerische Gesellschaft für Unterwasserarchäologie.*
[6] German: *Ludwig Maximilians Universität München.*

the area off *Argamum* towards Bisericuţa islet. Certain anomalies noticed there will be revisited in the future, as well as in the Delta itself. The Black Sea coastal waters between the mouths of the two Danube distributaries: Sulina and Sfântu Gheorghe will be prospected, too.[7]

A systematic and comprehensive survey along Romania's Black Sea coast is also foreseen as a future project. This will make it possible to reconstruct the course of the ancient coastline with settlements and the sea routes used by ships transporting, among other things, supplies for the legionary camps on the Danube, but also to evaluate whether there is any point in carrying underwater campaigns with divers on a larger scale.

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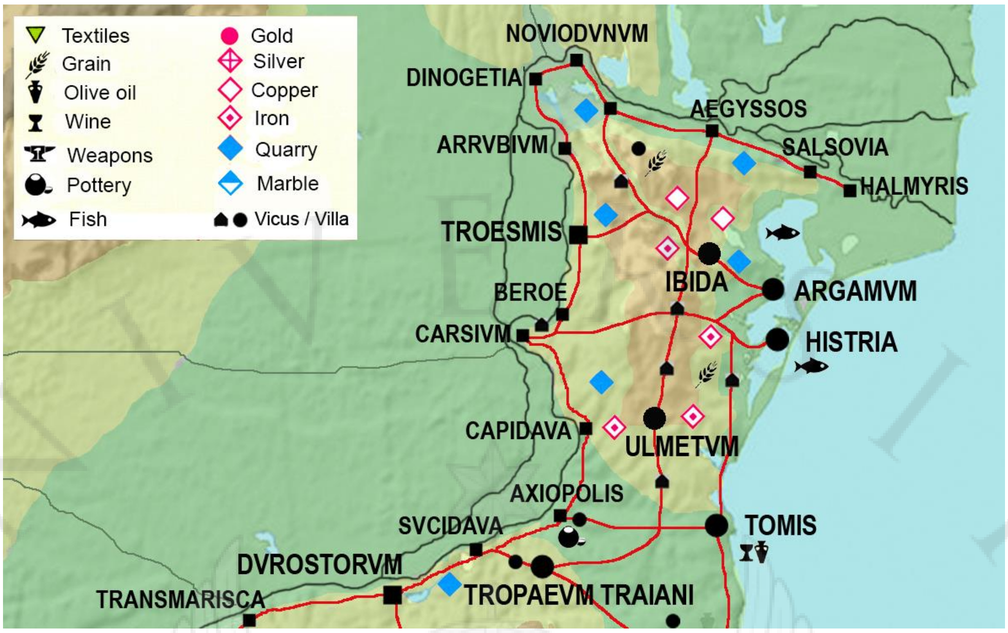

Fig. 1 – The Danube Delta in Roman times (after: Lemke 2016)

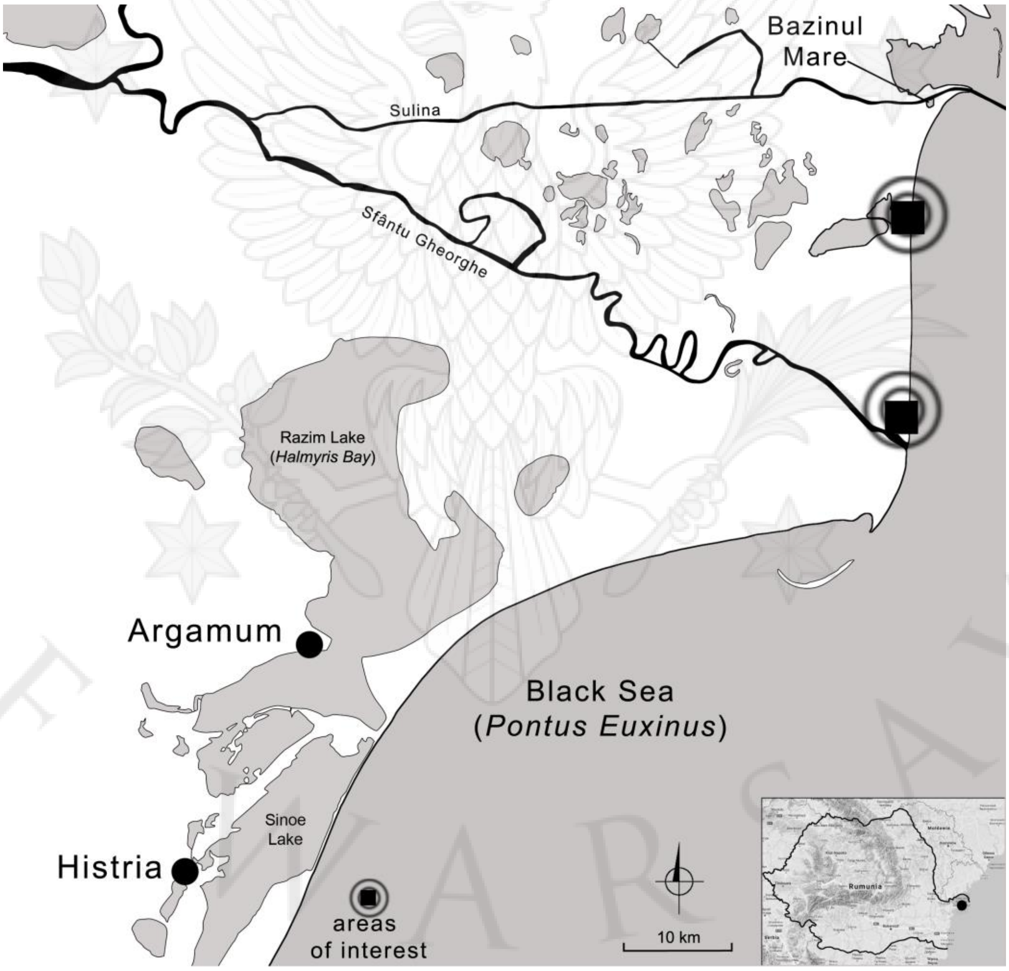

Fig. 2. – The area of interest for the Danube Underwater Heritage project today (elaborated by: M. Bajtler)

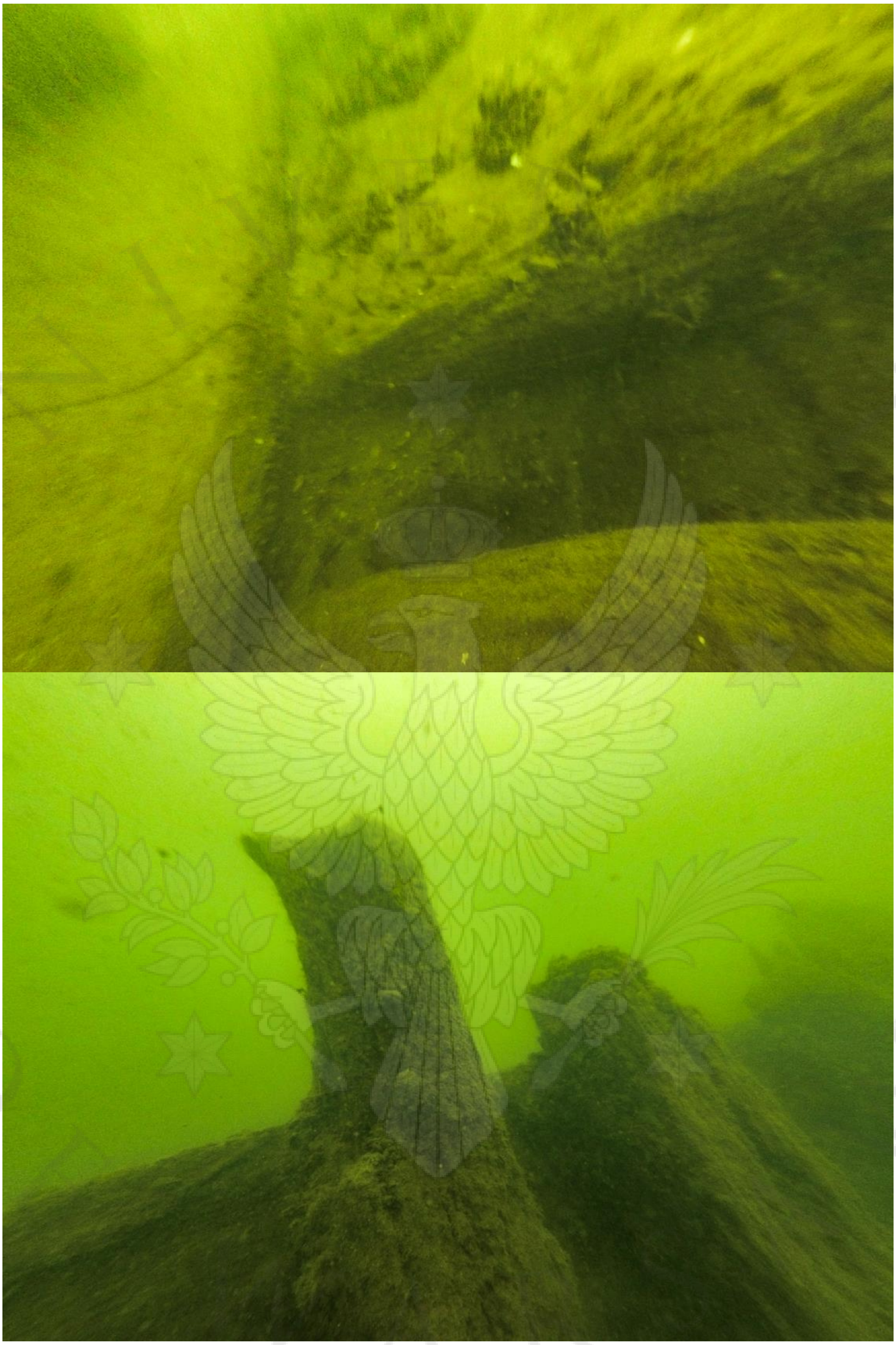

Fig. 3a, 3b – Sulina A shipwreck: up – keelson, bilge futtocks, garboards and planking; down – frames and planks (photo by: Danube Underwater Heritage Project)

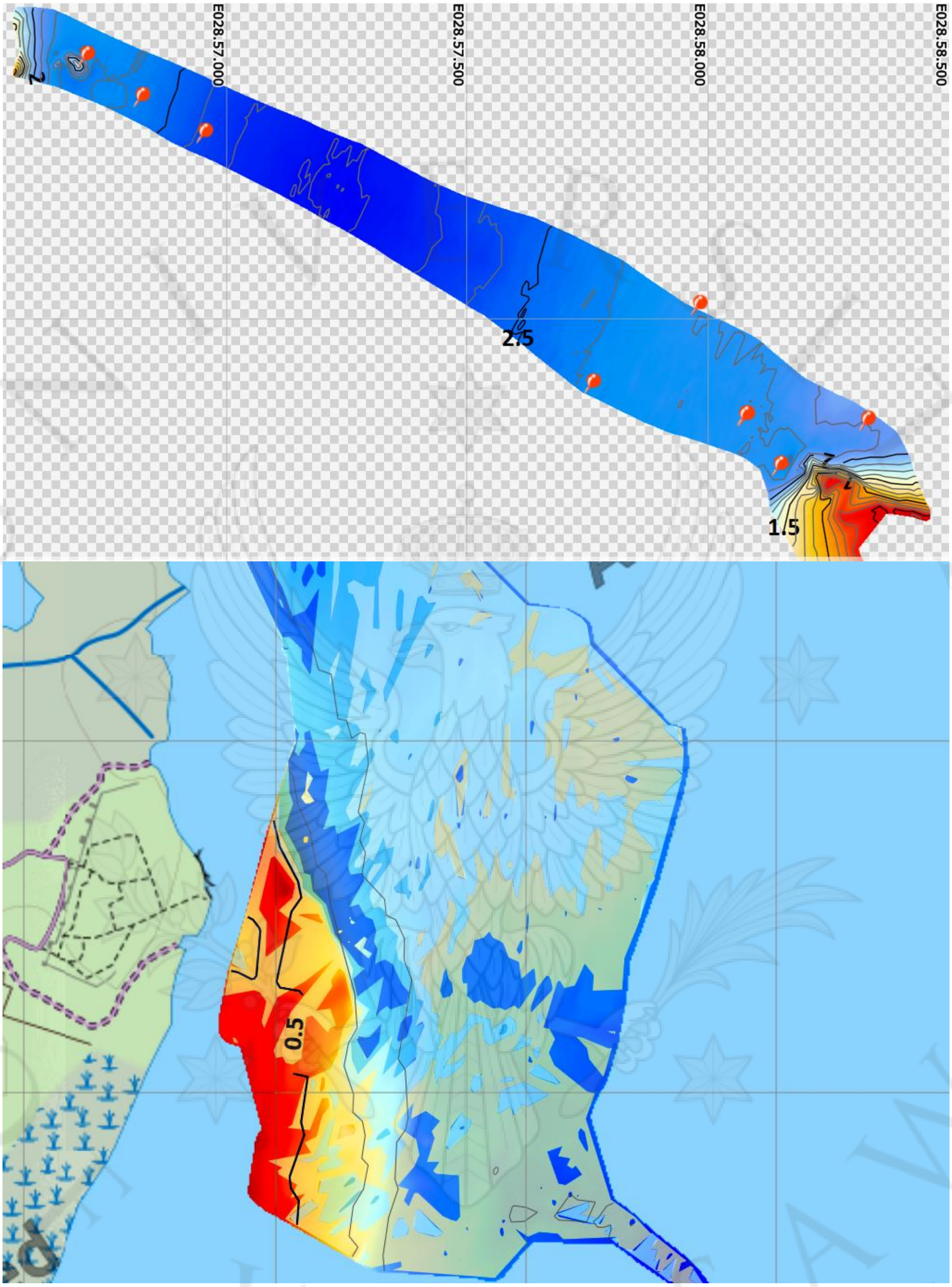

Fig. 4a, 4b – Bathymetry of *Histria* (up) and *Argamum* towards Bisericuța islet (down)
(elaborated by: Danube Underwater Heritage Project)

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The *Mercedes 2015–2017* Project: Exploration and Excavation of the Wreck *Nuestra Señora de las Mercedes* (1 138 m depth)

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Abstract:

Between 2015 and 2017 the National Museum of Underwater Archaeology completed three scientific expeditions to the wreck of the Nuestra Señora de las Mercedes (located in the Gulf of Cádiz, at a depth of over 1 100 m), collaborating with the Spanish Oceanographic Institute, the High Council of Scientific Research, and the Spanish Navy. This institutional coordination and multi-disciplinary collaboration made it possible to carry an archaeological intervention at a very unusual depth of over 1 100 m, counteracting the looting of the wreck by the 'treasure hunter' company Odyssey Marine Exploration in 2007.

The aims of these three campaigns were various, and included the definition of the location and extent of the wreck site, the documentation of its condition following the looting suffered, the compilation of an archaeological map of the materials which remained on the sea bed as well as the excavation and extraction of some of the materials which are mentioned in archive documents.

Keywords:

underwater archaeology, deep water archaeology, *Nuestra Señora de las Mercedes*, National Museum of Underwater Archaeology, ARQVA, ROV, culverins, howitzer, scrap silver, gold mortar

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Introduction

Background

The Spanish frigate *Nuestra Señora de las Mercedes* was sunk by the British Royal Navy on the 5th of October 1804, 30 nautical miles south of the Cape of Santa María in Portugal. The British attack was done in spite of the Peace Treaty signed in 1802 in Amiens between both nations. Having been struck by a cannonball in the gunpowder magazine, the frigate exploded and sank to the sea bed along with its cargo. 275 people have lost their lives as the outcome.

In 2007 the wreck was plundered by the treasure hunter company Odyssey Marine Exploration and the Spanish government reported the fact to the courts of the USA, claiming ownership of the items on board and demanding the application of international law (O'Donnell y Duque de Estrada 2013). In September 2011, the Court of Appeals of Atlanta (USA) recognized the Spanish ownership of the wreck. On the 14th of February 2012, the Supreme Court of Washington (USA) ruled in favour of Spain, and ordered the implementation of a sentence (Cabo de la Vega 2012; Goold and Cabo de la Vega 2014; Negueruela Martínez 2016: 51–57). That sentence obliged Odyssey to deliver to the State of Spain the items of cultural heritage plundered from the wreck of the *Mercedes* (almost 14 tons of objects, mostly silver coins), together with the relevant graphic documentation.

The objects arrived at Madrid on the 25th of February 2012 and were taken to the National Museum of Underwater Archaeology in Cartagena ARQVA[1] (Region of Murcia, Spain) in December 2012. On the 21st of May 2014 a Ministerial Order was published, by which these archaeological items were definitively assigned to the Cartagena Museum.

At the same time as work was undertaken to stabilize, preserve, and document the recovered cargo (Buendía Ortuño *et al.* 2013), a number of exhibitions were held in order to raise public awareness of the case. At the end of May 2014 the permanent exhibition at the National Museum of Underwater Archaeology in Cartagena was enlarged to include material from the wreck. In June 2014, a temporary exhibition opened at the National Archaeology Museum[2] and the Naval Museum[3] in Madrid (García Ramírez and Marcos Alonso [eds] 2014). This exhibition later travelled to Alicante (Valencian Community, Spain), Seville (Andalusia, Spain), and Mexico City (Mexico).

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[1] Spanish: *Museo Nacional de Arqueología Subacuática ARQVA.*
[2] Spanish: *Museo Arqueológico Nacional de Madrid.*
[3] Spanish: *Museo Naval de Madrid.*

An important legal battle had been won, but the scientific documentation and exploration of the site had yet to be undertaken.

Justification and Origins of the Project

With the legal proceedings having been successfully concluded, the next step was to begin archaeological work; the opinion of the director of the Museum was that the Spanish government, rather than accepting the data supplied by Odyssey, should verify the condition of the remains of the wreck and undertake its own scientific research.

The main hurdle to be overcome was the depth of the wreck, which involved two challenges: descending to such depths with scientific equipment and undertaking an archaeological intervention at a depth of over 1 100 m, at which no European country had previously carried an archaeological excavation.

In March 2014 the National Museum of Underwater Archaeology presented a proposal to the Ministry of Education, Culture and Sport[4] to undertake a scientific project of archaeological excavation at the site of the wreck, and eventually, in early 2015 the Ministry gave its approval to the *Mercedes Project: Underwater Archaeological Intervention at the Wreck of the Nuestra Señora de las Mercedes (1804);* this project has been completed in three campaigns, between 2015 and 2017.

Location

The frigate sank in the Gulf of Cádiz, south of the Cape of Santa María in Portugal, to a depth of between 1 130 and 1 140 m. The location is over 30 nautical miles from the coast – in other words, well outside both the 12-mile limit of Portuguese waters and the additional 12-mile Contiguous Zone.

General aims of the project were:

- to establish the exact location of the archaeological site in order to verify the coordinates supplied by Odyssey to the US courts;
- to document the ‘work’ and ‘operations’ carried by the treasure hunter company;
- to carry an acoustic exploration of the sea bed in order to compile a geomorphological description of the sinking zone and to obtain a detailed bathymetric profile: these data

[4] Spanish: *Ministerio de la Educación, Cultura y Deporte, Gobierno de España.*

was to be used as the reference for the safe use of the Remotely Operated Underwater Vehicle (hereinafter: the ROV) and side-scan sonar;

- to create video footage from the ROV in order to document the current state of the remaining elements of the wreck, establishing which material had survived both the sinking in 1804 and the looting by Odyssey, and in what condition;
- to create an archaeological map of the remains;
- to excavate some of the remaining material in order to discover more about the sunken vessel, and to provide archaeological verification of coincidences with extant documentary sources, thus corroborating the historical identification of the wreck;
- to deposit at the site of the wreck a plaque commemorating the civilians and military personnel who had perished in the sinking.

Institutions involved were:

- the Ministry of Education, Culture and Sport, through the Department of Protection

  of Historical Heritage[5] which financed the campaigns, and the National Museum of Underwater Archaeology in Cartagena, which oversaw the project and supplied various expert staff;
- the Ministry of the Economy and Competitiveness[6], through the Spanish Oceanographic Institute[7] (hereinafter: the IEO), which supplied the oceanographic research vessel *Ángeles Alvariño*, the ROV, and oceanographic equipment as well as experts; in addition, the Marine Technology Unit[8] (hereinafter: the UTM) of the High Council of Scientific Research[9] (hereinafter: CSIC) supplied the oceanographic research vessel *Sarmiento de Gamboa*, geophysical exploration equipment and specialized technicians;
- the Ministry of Defence[10], which provided two Navy observers for each campaign as well as logistical support for mooring and loading.

[5] Spanish: *Subdirección General de Protección del Patrimonio Histórico* (the SGPPH).
[6] Spanish: *Ministerio de la Economía y Competitividad, Gobierno de España.*
[7] Spanish: *Instituto Español de Oceanografía.*
[8] Spanish: *La Unidad de Tecnología Marina.*
[9] Spanish: *Consejo Superior de Investigaciones Científicas.*
[10] Spanish: *Ministerio de Defensa, Gobierno de España.*

Technical Equipment

The oceanographic research vessels used were the *Ángeles Alvariño* (belonging to the IEO) in 2015 and 2016, and the *Sarmiento de Gamboa* (belonging to CSIC) in 2017. These vessels measure 46 and 70 m in length respectively and are both equipped with Dynamic Positioning, the differential GPS, multibeam sonar, parametric sonar, sound velocity profilers, and various winches. In addition, for the 2017 campaign a side-scan sonar device installed on a towed unit belonging to the UTM of CSIC was also brought into use.

Furthermore, in all three campaigns the ROV was deployed; this was the Liropus 2000 belonging to the IEO, a device which can dive to depths of up to 2 000 m. In order to reach 30 m above the sea bed the ROV is housed within the TMS (Tether Management System), a cable management system which shelters and protects it during raising and lowering. This model of the ROV is fitted with six motors, five cameras (including one high definition and one for working in conditions with practically no light), the GPS, sonar, a sample collection drawer, and two hydraulic manipulator arms. During the first campaign one of the manipulator arms was supplied as standard and the other was specially created using titanium by the Advanced Crew and Ship Management (the ACSM)[11] and Grupo CIMA[12] of the University of Vigo. For the 2016 campaign the performance of the ROV was improved by the use of two titanium manipulators and a new camera; this meant that it was possible to achieve a far higher quality of archaeological documentation (than the one which was compiled by means of video footage) by taking excellent shots of the archaeological items and their surroundings from above, and to document the objects concerned in detail.

Implementation of the Project

The campaign diaries and detailed explanations of the work carried during the three campaigns at the wreck of *Mercedes* have been published in a series of monographs by the Ministry of Education, Culture and Sport and at international underwater archaeology congresses and conferences (DEGUWA[13] and IKUWA[14] 6), for which reason the following is no more than a brief summary. For more detailed information please consult specific publications (Negueruela *et al.* 2015; 2016a, 2016b; 2017a, 2017b, 2017c; forthcoming).

[11] The company within the IEO responsible for the management of the used ROV in these campaigns.
[12] A research group of the School of Industrial Engineering of the University of Vigo (Spanish: *Escuela de Ingeniería Industrial de la Universidade de Vigo*).
[13] German: *Deutsche Gesellschaft zur Förderung der Unterwasserarchäologie*.
[14] German: *Internationalen Kongress für Unterwasserarchäologie*.

The 2015 Campaign

The 2015 campaign took place between the 18th and 23rd of August 2015 on board of the oceanographic vessel *Ángeles Alvariño*. On the first day the wreck was located at a depth of between 1 136 and 1 138 m, confirming that the co-ordinates supplied by Odyssey during the trial were correct.

A sound velocity profile was compiled to calibrate the equipment and a geological survey of the area was performed using multibeam sonar and TOPAS (Topographic Parametric Sonar) device, providing a detailed bathymetric map and a reflectivity study in the area.

The next stage was an archaeological study using the Liropus ROV; hundreds of artefacts were referenced, positioned to a high degree of precision, and documented by means of video footage: these included anchors, iron and bronze cannon, copper and tin ingots, a silver dinner service and cutlery, silver candlesticks, a gold pestle, and others (**Fig. 1**).

In addition, an archaeological excavation was performed by means of the extremely careful use of a jet of water. The three variable parameters taken into account were the flow of water supplying the jet, the strength of the jet, and its precision; the aim having been to position and direct it exactly. By this means it was possible to clean one of the bronze Renaissance culverin and to document the presence of the rich, high-quality decoration.

Furthermore, in order to learn about other aspects of the frigate, 13 small items were documented, excavated (**Fig. 2**), and extracted; a small bronze three-pounder howitzer cannon, silver cutlery and tableware, candlesticks, and a gold pestle.

Finally, a bronze plaque was laid at the archaeological site in memory of the victims who perished on the 5th of October 1804, when the frigate *Mercedes* was attacked by a Royal Navy squadron despite Spain and the United Kingdom having signed the Treaty of Amiens two years previously, in 1802 (Negueruela *et al.* 2015; 2016a: 19–23, 33–39; 2016b).

The 2016 Campaign

The second campaign was scheduled from the 10th to the 18th of September 2016, but adverse meteorological conditions made it possible to work at the site only on the 16th of September, when the ROV undertook two long immersions.

This drastic reduction of the effective working timeframe to just one day meant that it was necessary to reduce the objectives which had been programmed for the second campaign. It was not possible to continue with the archaeological mapping of the site, or to extend the documentation of the areas to the south and south-east of the wreck, and thus it was decided to focus the work on the areas where individual items related to the description of the *Mercedes* in the General Archive of the Indies[15] (hereinafter: AGI) were located, in order to identify the wreck beyond any possible doubt.

The first intervention took place in the area of the scrap silver dinner service, where excavations had begun in 2015. Objects were excavated using a high-pressure water jet, and before extraction they were documented by means of overhead photography (**Fig. 3**). In total, 35 pieces were recovered in 2016, including a gold mortar and 34 items of silverware such as plates, cutlery, candlesticks, coins, and other artefacts.

Efforts were then made to tackle the extraction of one of the Renaissance culverins, but this was not possible due to the limitations of the on-board winches and worsening sea conditions. For further information on this campaign please consult other publications (*cf.* Negueruela *et al.* 2017b; 2017c; forthcoming).

The 2017 Campaign

The third campaign at the site took place between the 21st and 29th of August 2017, prior to which three days were spent in the port of Cádiz (Andalusia, Spain), fine-tuning all of the equipment needed on the S*armiento de Gamboa*, belonging to CSIC.

On this occasion the plan was to work around the clock: daylight hours would be devoted to archaeological work with the ROV and the hours of darkness would be occupied by oceanographic studies using remote sensing equipment.

One of the main objectives in 2017 was to excavate and extract the two Renaissance culverins; excavating the first of them proved to be more complicated than expected as it was lying on its side in a layer of extremely hard clay substrate, which was highly resistant to the water jet and therefore very difficult to remove (**Fig. 4**). Ditches were dug parallel to each of the longer sides of the culverin, but progress was slow and the clay became compact again as soon as work paused. For this reason, before excavating under the muzzle of the culverin the characteristics of the water jet were refined to extend it through an elbow joint (**Fig. 5**). After 38 hours of uninterrupted work with the jet, the culverin was freed.

In contrast, the documentation and extraction of the second culverin was far simpler and quicker as it was lying at an angle with the upper third free of sediment and this made its recovery easier.

[15] Spanish: *Archivo General de Indias.*

The strategy for extracting the two cannon was a complex and precise one. The IEO prepared two 25-metre loops of Dyneema® and the ROV was used to place the loops around the muzzles of the culverins. The other ends of the loops were then attached to a 1-ton dead weight, half-sunk into the sea bed near the cannon, which in turn was attached by a steel cable to the main on-board winch.

Dyneema®, a polyethylene of high molecular weight, is an ultra-resistant fibre which can work under tension of 20 tons and which minimized the abrasive effect on the cannon, avoiding scratches or any other damage during the raising process.

Once the Dyneema® was in place the raising procedure began, using steel cables and a combination of winches and lifting devices. This was a critical phase of the extraction operation, given the risks inherent in raising over two tons of cannon and allowing it to swing like a pendulum above the moving surface of the deck of a vessel in open seas. In order to control the movements of the cannon, various restraining ropes were used and two winches were operated simultaneously to deposit the cannon horizontally on the ship (**Fig. 6**).

On the stern deck of the *Sarmiento de Gamboa* a bed of polyethylene foam on top of a flexible structure was prepared to make sure that the cannon were safely secured to the deck, without suffering blows or scratches, while they were prepared for packing and onward transportation.

While they were in this position, first analyses of the decoration and inscriptions on both of them has been carried; it included various coats of arms, the name of the foundry where they were made, the year, and their names: 'Santa Bárbara' and 'Santa Rufina'. Once these first examinations and initial photographic documentation had been completed, appropriate conservation measures were implemented: for protection they were wrapped in an aluminized polyethylene and nylon film (Marvelshield®), which is resistant to water vapour and the oxygen in the atmosphere; then they were encased in wooden crates lined with foam and immobilized by the use of ratcheted tension cables.

Work then proceeded with the documentation, excavation, and recovery of other unusual items: a block with three bronze pulleys and wooden remains, which were found next to one of the large anchors; a bronze tap, a perforated copper air ventilation grill, and a small bronze three-pounder howitzer.

The ROV operations required the boat to be using the Dynamic Positioning system, but once this phase was over, the UTM team began their oceanographic exploration with the boat in motion. This work began with multibeam sonar and the sub-bottom profiler compiling information to elaborate the bathymetry of a wider area and obtain stratigraphic analysis of the sea bed. Operational tests were also carried on the TD1 multi-use container, which houses a side-scan sonar (hereinafter: SSS) device, and the SSS was used to explore the zones to the east and north of the wreck with the aim of determining its extent (Negueruela *et al.* 2017a: 169–173).

Results

Assessment of the Condition of the Site

Documentation work using the ROV made it possible to observe the nature of the sea bed and the state of preservation of the items of archaeological interest which had not been plundered by Odyssey.

The wreck lies at a depth of approximately 1 140 m over a wide flat area on the middle shelf of the Algarve Basin. The physiography of the continental margin of the Gulf of Cádiz is highly complex and is determined by tectonics as well as erosive and sedimentary processes in which the exchange of water between the Atlantic and the Mediterranean through the Strait of Gibraltar plays an important part (Hernández-Molina *et al.* 2003). The circulation of these water masses is characterized by the entry of surface water from the Atlantic into the Mediterranean, while at the same time a strong outward current of highly saline water, which is warmer and denser, flows out at depth towards the Atlantic following a course which is parallel to the continental shelf (SSE-NNW), creating a series of sedimentary contourite clay channels and plains. These conditions were observed in all three of the summer campaigns. In the area of the site the deep outward current is especially apparent at depths of greater than 750 m, presenting a more or less constant flow rate of 0.8 m per second, a flow direction of 120º and a stable temperature on the sea bed of 12ºC.

In the area where the wreck lies, the processes of diagenesis are conditioned by the interaction of the outward current from the Mediterranean with the sea bed and are especially intense, creating an area without sedimentation (Kelling and Stanley 1972). In geological terms, there is currently no accumulation in the area of the site, and the strong current near the sea bed prevents the deposition of any very fine particles which might arrive from the coast. In consequence, more than 200 years after sinking objects which were on board of *Mercedes* are still lying directly on the sea bed, hardly buried. The sediment in the surface layer was deposited when the sea level was different from its current altitude.

The sea bed consists of a dense, greyish, solidly cohesive substratum composed of very fine mineral particles. Diffracted X-ray analysis of a sediment sample taken shows the following mineral composition: 43% quartz, 26% calcite and calcite-dolomite, with the rest representing various clays (12% muscovite, 11% serpentine chlorites, and 8% albite).

The objects belonging to the wreck are deposited on this firm but plastic surface over a wide area, measuring 130 by 150 m. In case of the larger objects such as cannon, anchors or tin and copper ingots, it is possible to observe hollows around them, formed by the acceleration of the current as it makes its way around the obstacles. This effect also contributes to the lack of any sediment covering the objects, leaving them directly exposed to the current and the effects of erosion and degradation (Sierra Méndez, 2019).

As for the chemical composition of the sediment, although the alkalinity of the substratum could favour the preservation of certain items of archaeological interest, especially those made of metal, as they have not been buried; this has had few repercussions on their condition.

Throughout the wide area in which the remains are scattered there are numerous species of marine fauna – fish, crustaceans, sea urchins, sponges, molluscs, and others; this reveals the aerobic characteristics of the environment.

The fact that the artefacts have not been buried and lie directly on the sea bed, exposed to the strong prevailing current, allied to the aerobic profile of the environment and the warm sea temperature, has caused a good deal of corrosion in the objects made of iron, and after remaining in these conditions for over two hundred years they show thick layers of rust and build-up. It is hardly possible to ascertain the shape of the larger iron objects such as items of artillery, cannon, and shells, due to the flaky accretions which have accumulated and deformed the surfaces. Wrought iron objects, such as anchors and kedges, are not affected by these thick layers of build-up, but do present a certain degree of surface roughness due to the loss of material to rust. The smaller iron objects are scattered around the site in the form of rounded, shapeless lumps, making it impossible to deduce their original shape.

The silver objects are oxidized with a greenish layer (produced by the corrosion of the copper element used in the alloy) and with greenish-purple compounds due to the formation of soft, insoluble silver halides. Small artefacts, such as some of the tableware and cutlery items, have become sharp at the edges and are pockmarked with holes due to the combined actions of degradation by corrosion and the surface erosion caused by the prevailing current.

The objects made of bronze, which are harder and more resistant to corrosion, have endured the erosion and are therefore better preserved. In case where they have been partly buried, as with the two culverins which were on board the frigate, the decorative and structural details have been well preserved. However, the oxidative action of the water flowing around them has provoked the first stages of generalized surface corrosion in those objects which are exposed: these have become porous and holes have formed ('pitting corrosion'), meaning that some of the material is missing.

No organic remains such as wooden planks, textiles, or leather were found. In case these elements remain exposed, they are soon degraded by the marine fauna, molluscs, crustaceans, and microorganisms; only if they are buried there is a chance of them surviving, but in this case they would not be visible. Due to the stratigraphic weakness of the site it is highly unlikely that the large wooden structures of the frigate still survive.

Material Documented in situ

During the first campaign the archaeological material present at the site was mapped (**Fig. 7**). Hundreds of artefacts were referenced, positioned to a high level of precision, and documented with the video footage: anchors, iron and bronze cannon**,** copper and tin ingots, a dinner service and silver cutlery, silver candlesticks, a gold pestle, and others, including some which remain unidentified (Negueruela *et al.* 2016a: 19–23, 35–47).

Recovered Material

During the three campaigns the decision was made to extract a reduced number of items, selecting them on the grounds of their potential interest in the fields of history, culture, museums, conservation, juridical and archive material. The main criteria used were the following:

- pieces listed in documents of AGI or other archives, permitting the definitive corroboration of the identity of the wreck as the frigate *Nuestra Señora de las Mercedes* and the elimination of any scope for doubt to be expressed in future years and decades from any quarter, particularly the company Odyssey;
- unusual pieces which are not easily recognizable and which may shed new light on the era of the wreck;
- objects in danger of disintegration if left on the sea bed.

Out of the whole collection of hundreds of pieces found and mapped at the site of the wreck, only a few dozen were extracted. These included four bronze cannon (two large culverins and two smaller howitzer cannon), a collection of 45 pieces of scrap silver (including plates, cutlery, and candlesticks), two objects made of gold (a mortar and pestle), a bronze tap, sheet of copper, silver coins, and the remains of a lifting system consisting of three bronze pulleys and four fragments of wood. In total, these represent less than 1% of the archaeological material which remained at the site.

Condition of the Recovered Objects

During the three campaigns all necessary preservation measures were taken to ensure that the archaeological material was correctly transported from the site to the museum laboratory.

In the first campaign 12 objects were extracted: one small bronze cannon, a gold pestle, and various items of silver, including plates, candlesticks, and cutlery.

The gold and silver objects did not present any serious problems of conservation when lifted from the sea bed; and intervention was therefore minimal. They were wrapped in tissue paper lined with polyethylene (Lampraseal®), avoiding any risk of them being scratched or otherwise harmed by the use of a material which can easily adapt to any shape, and tailor--made packaging was then created for each of them in crates and boxes lined with polyethylene foam (Ethafoam®). In this way they were safely transported to the laboratory.

In case of the bronze cannon, there was some potential for accelerated corrosion if it were exposed to the non-marine environment, and for this reason it was protected against oxidation by the application of an alkaline chemical paste containing cellulose and 5% sodium sesquicarbonate (equimolecular mixture of carbonate and sodium bicarbonate) with a pH of 11, and of various layers of polyethylene and aluminium film. These measures ensured that the cannon was in the best possible condition for its conservation, with the access of oxidizing agents to the metal surface limited in such a way as to protect the object from corrosion. For transport purposes the objects were loaded into the refrigerated hold of the ship with a constant temperature of 4ºC in order to slow any oxidation reaction and stabilize them for their journey to the laboratory, which would last several days.

During the second expedition to the wreck in 2016 various more silver objects were recovered, including two candlesticks, eight plates, a large bowl, various forks and spoons as well as a gold mortar, which matched the pestle extracted in 2015. In addition, various silver coins were retrieved with the aim of documenting the original state of those artefacts at the site, as all coins already at the National Underwater Archaeology Museum had undergone restoration treatments by Odyssey. The condition of these items was similar to those described in relation to the previous campaign, and similar steps have been taken to guarantee their conservation until arrival at the museum laboratory.

The items recovered during the third campaign included two large heavy bronze cannon, items of unquestionable scientific and museographic value. The extraction of these pieces was also conditioned by the fact that far from being in a stable conditions, where the processes of degradation would be reduced to a minimum, the cannon were in an aggressive, erosive, and oxidizing environment, which would eventually lead to them gradually but irreversibly dissolving in the sea until they completely disappeared and became mineral accretions (Sierra Méndez 2019). It has been possible to see the onset of this process in the pieces recovered, which were severely affected by corrosion and had lost their original surfaces due to oxidation of the metal.

All of the items retrieved in 2017 were protected by a film barrier of aluminized polyethylene and nylon (Marvelshield®), which resists the permeation of water vapour and the oxygen in the atmosphere. The cannon were cased in wooden crates lined with foam and immobilized by the use of ratcheted tension slings, while the remaining objects were packed in the polyethylene foam.

Studies of Materials

The analysis and assessment of the archaeological pieces recovered during the three campaigns: two Renaissance culverins which were part of the cargo, two small bronze three-pounder howitzer, the silver dinner service, a gold mortar and its pestle, and other objects including a pulley block or sheave with three pulleys, a bronze tap, and a sheet of perforated copper followed the phase of exploration.

Renaissance Culverins

The main interest of these pieces lies in the fact that they are explicitly mentioned in two documents, one of which is held in AGI and another, which forms part of a private archive (Negueruela *et al.* 2017a: 173–174). The cargo manifest of the frigate when it set sail from the port of Callao in Peru in March 1804 mentions "*two worthless bronze cannons"*[16] (*Estado de los Caudales*...; **Fig. 8**). The document describing the 'state of lives and forces' of the frigate, signed in Montevideo (Uruguay) in August 1804, contains a reference in the first note on the back to "*two bronze culverins excluded"*[17] (*Estado General de la Fragata*...).

It is thus clear that they were a part of the frigate's cargo, and not her operative artillery.

Analysis of the inscriptions they bear has made it possible to determine that both were made in the late 16th and early 17th century by Bernardino de Tejeda, a founder from Seville, who was transferred to Peru by Philip II of Spain. Furthermore, the two have identical decorative elements – the coat of arms of Castile and León and the lifting handles, which have the form of a carnivorous animal instead of the more typical dolphins – and both have female names: 'Santa Bárbara' and 'Santa Rufina'. A detailed description of the two culverins, an analysis of their iconography and an assessment of their historical value have already been published (Negueruela *et al.* 2017a: 174–179), hence the summarizing of the most significant information here.

Culverin 1, 'Santa Bárbara'

The first of the culverins to be extracted from the site is an exceptional piece, in terms not only of its size and weight (4.33-metres-long and 58 quintals, or 2 633 kg) but also of the amount of information it provides and its numerous decorative details (**Fig. 9**).

The coats of arms depicted and the epigraph bear witness to the fact that the culverin named 'Santa Bárbara', owned by the Crown of Castile and León, was commissioned by the Count of Villar (*Conde del Villar*) to the founder, Bernardino de Tejeda, who completed it in 1586. The Count of Villar Dompardo, Fernando de Torres y Portugal, was the Viceroy of Peru from 1585 to 1589.

This culverin is richly decorated with two edgings which are repeated various times: one in which castles and rampant lions are juxtaposed, reproducing the emblems

[16] *"dos cañones de bronce inútiles"* (trad. the authors).
[17] *"dos culebrinas de bronce excluidas"* (trad. the authors).

of the Crown of Castile and León, and another in which the mythological motif of the Tritons of the marine *Thyassos* are reclining against a central amphora.

Besides this, both the lifting handles and the cascabel are decorated with the heads of animals (**Fig. 10**). Although in most cases these decorative animals are interpreted as being dolphins, in this case they are clearly carnivores due to the presence of ears, teeth, and a mane of hair which reaches down over the eyes: what is not clear is whether they are the heads of lions, wolves or dragons.

The choices of iconography made by the Viceroy to decorate this enormous culverin make it obvious that he wished to demonstrate quite clearly that it belonged to the Crown of Castile and León, a desire reflected by the prominent location of the coats of arms. This notion is strengthened by the edging motif containing the juxtaposition of the lions and castles of the coat of arms, and also by the omission of his own family coat of arms (he was the Count of Villar Dompardo, related on his mother's side to the royal family of Portugal): instead, his own identity is referred to only to state that it was he who commissioned the culverin (**Fig. 11**).

In other words, it is made abundantly clear that the Viceroy had absolutely no intention of making the piece his own, and insisted on making it obvious that the culverin belonged to the State (Negueruela *et al.* 2017a: 176–177).

Culverin 2, 'Santa Rufina'

The second of the culverins extracted from the site is 'Santa Rufina', dated 1601 (**Fig. 12**). It is smaller than 'Santa Bárbara', measuring 3.90 m in length and weighing 46 quintals, or 2 214 kg; it is a work of very high quality, produced by the same founder who made the larger culverin (Bernardino de Tejeda); although, it features fewer heraldic decorations and none referring to mythology (Negueruela *et al.* 2017a: 178–179).

On the muzzle there is a decorative design of acanthus leaves which shows clear classical influence, while the barrel of the culverin is adorned with two coats of arms, that of Castile and León and the family blazon of Luis de Velasco y Castilla, Viceroy of Peru between 1596 and 1604, who ordered it to be produced (**Fig. 13**). The two central lifting handles again represent carnivorous animals, but in this case the cascabel is a very simple central stem ending in a ball.

Two Small Bronze Three-Pounder Howitzer Cannon

Two small bronze three-pounder howitzer cannon were recovered during the 2015 and 2017 campaigns. The first of them is fully intact and measures 78 cm in length, while the second is missing the cascabel and is therefore shorter, at 72.5 cm. In other respects they are very similar: the only decoration is three bull motifs on the barrel, they retain the slots which were used as sights to aim the weapon, there is an inscription chiselled onto one of the trunnions (nº 14), and they present some loss of material caused by the explosion on board the frigate before it sank.

These kind of small cannon were installed on the prow, stern, and on the 'top', the platform around a third of the way up the main mast, for use in close combat and boarding operations. Their presence on the frigate is mentioned in various archive documents: for example, the *State of Lives and Forces of the Frigate Mercedes*[18] (*Estado General de la Fragata...*), which was signed in Callao on the 7th of August 1803, indicates that the vessel carried 12 bronze three-pounder cannon. During the three campaigns at the site four of these 12 small howitzers were located, and two of them retrieved.

Scrap Silver and Gold Mortar and Pestle

This group concerns a selection of silver objects (tableware, cutlery, candlesticks, etc.) as well as a gold mortar and pestle, which are mentioned in a document held in AGI. It is for this reason that they were excavated, in order to check the archive information against the archaeological remains.

11 pieces belonging to this group were documented and excavated on the last day of the 2015 campaign: the remains of two silver candlesticks, six pieces of silver cutlery, a group of three plates in very poor condition (encrusted together), a silver coin, and a gold pestle (Negueruela *et al.* 2016a: 46–47, 49, 53–56, 58–62).

In the 2016 campaign the prime objective was to finish the work in the area around the silver service. Excavations were completed and the whole process was documented by means of video footage and photography from above. 35 objects were recovered: the gold mortar corresponding to the pestle retrieved in 2015 and 34 pieces of silverware, including soup bowls, plates, two large but incomplete bowls, another large central bowl – complete with horizontal handles – and various spoons, forks, coins, and other items (Negueruela *et al.* 2017c: 55, 59–67). Several of the aforementioned elements had become

[18] "*Estado de Vida y Fuerza de la fragata Mercedes*" (trad. the authors). It is a short name of the original document (*Estado General de la Fragata...*).

encrusted to each other, but when they were analysed and documented on land some interesting aspects have emerged.

Another document held in AGI (1804) included many details of a private shipment (**Fig. 14**). There is a registry document stating that Francisco Antonio de Murrieta, Master of the royal frigate named *Mercedes*, notes a private shipment sent by Don J. Antonio Álvarez de Villar from Lima (Perú) to an individual in Cádiz. The goods are described as "*a trunk lined with leather, with a mark on the rim (XX), in the charge of Dr. d. José de la Encina, and commissioned in Cádiz for d. Juan Francisco de Espelosín, in his absence for d. Juan Matías de Vertiz*"[19]. It then specifies that the trunk "*contains 232 marks (i.e. 116 pounds) and one ounce of scrap silver, a six-mark gold mortar, and all '*quintado*' in these [royal] houses*"[20]. The document is signed in Lima, on the 28th of March 1804 (for the complete transcript *vide*: Negueruela *et al.* 2017c: 57).

Part of this information ('scrap silver') could correspond to any wreck on the shipping route between Spain and the Indies. However, there are specific details which it was hoped might be corroborated, such as the mark *XX*, the name *Encina* as the commissioner of some of the objects, the seals showing that the *quinto* tax had been paid and the weight of the gold mortar.

Once the items recovered in the 2015 and 2016 campaigns had been stabilized and documented in detail, it was possible to check them against the detailed archive documentation. The following details, mentioned in the AGI document (1804), were verified in the objects recovered:

- the mark *XX* which is registered on the rim of the AGI document has been identified on various of the plates which have become encrusted together (**Fig. 15.1**);
- the word *Ensina* is engraved on the handles of some of the pieces of cutlery recovered, corresponding to the surname of the *Dr. d. José de la Encina* mentioned in the document (**Fig. 15.2**);
- the expression "*all* quintado *in these Royal houses*"[21] refers to the fifth part (quinto real), a Royal tax. The seal of this Royal tax accredited that the corresponding tariffs had been paid. The symbol of the *quinto real* is a crown framed by a ring of dots, which has been documented on some of the plates and cutlery, and on the gold mortar and pestle (**Fig. 15.3**);

[19] "*Un cajón forrado en cuero con la marca del margen (XX) en c/r [cuenta y riesgo] del Dr. d. José de la Encina y a comisión en Cádiz a d. Juan Francisco de Espelosín, ausente a d. Juan Matías de Vertiz*" (trad. the authors).
[20] "*Contiene 232 marcos y una onza de plata chafalonía, un almirez de oro con seis marcos, todo quintado en estas R.S. [Reales] Casas*" (trad. the authors).
[21] "*todo quintado en estas RS Casas*" (trad. the authors).

- the "*6-mark gold mortar*"[22] mentioned in the document coincides with the weight of the gold pestle and mortar recovered (**Fig. 16.3**).

These four findings point unquestionably to the definitive identification of the wreck: the exact coincidences between the material recovered by the Museum in the 2015 and 2016 campaigns and the precise details of the AGI document quoted provide definite proof that the wreck under investigation is that of the frigate *Nuestra Señora de las Mercedes*, and provide a level of precision which is without precedent in the field of Spanish underwater archaeology (Negueruela *et al.* 2017b: 58; forthcoming).

Sheave with Three Pulleys

The incomplete sheave or block in which three bronze pulleys alternate with four fragments of wood (Negueruela *et al.* 2017a: 180–181) was also recovered. The bronze pulley wheels are disc-shaped and feature a groove on the outside of the rim (through which ropes would pass), as well as a circular hole in the centre and four oval-shaped holes around it. The wooden remains correspond to the housings where the pulleys were installed.

This pulley design was a feature of Spanish ships in the 18th century, and their location at the site, alongside one of the large anchors of the wreck, suggests that the block could have formed part of the apparatus used to drop and haul the anchor.

It is interesting that four fragments of wood should have remained intact on the sea bed in their original position between the bronze pulley wheels without any kind of sedimentation, despite the block being found on the sea bed. That these organic remains survived in an aerobic environment is due to the wood having been mineralized on account of the formation or iron and copper precipitates inside it as the iron axle and the bronze wheels of the fixture oxidized. Iron acts as an agent of consolidation while copper acts as a biocide, preventing the attack of macro--organisms like *Teredo navalis* (naval shipworm) and microorganisms such as fungi and bacteria, allowing these wooden remains to be preserved *in situ*.

Bronze Tap

A small bonze tap measuring 10.5 × 9 cm, with a barrel-cone-shaped housing, probably used as a barrel tap has been acquired as well. This kind of tap acted as a stopcock which was inserted into a wooden barrel with a hammer blow and was then opened and closed with just half a turn. The barrel might contain water, wine or liquor.

[22] "*almirez de oro con seis marcos*" (trad. the authors).

At the outer end of the device there is a rod which was used firstly to help insert the tap in wooden barrels and then to hang a bucket below it, or a container to catch leaking drops.

The tap was found on its own on the sea bed, making it impossible to deduce in which part of the ship it was located.

As far as it has been established, this is a unique piece on Spanish ships of the time. As such it is of incalculable value, and further studies will allow advances to be made in the knowledge of plumbing and life on board (Negueruela *et al.* 2017a: 179–180).

Perforated Copper Sheet

This complete rectangular copper sheet measures 42.8 × 29 × 3 cm and contains 113 holes with diameters of between 1.2 and 1.4 cm distributed in a non-uniform fashion on its surface. The edges show no sign of it having been attached to a hinge, pin, bolt or fastener of any description, and there is no decoration.

These three features – the irregular distribution of the circular holes, the lack of fastenings, and the lack of decoration – suggest that it could have been used as a ventilation grill for a service galley or hold, possibly an area used for the transport of live animals (Negueruela *et al.* 2017a: 180).

<u>Final Assessment</u>

The Legal Battle against the Plunder and Trading in Underwater Cultural Heritage

The case of the looting, subsequent lawsuits, and the recovery of the items on board, the frigate *Nuestra Señora de las Mercedes* is an extremely important one for the international management of Underwater Cultural Heritage (hereinafter: the UCH), and the case of the *Mercedes* has had wide-ranging international repercussions and attracted attention in the world's media.

It is important to highlight the relationship of the case with the UNESCO 2001 *Convention on the Protection of the Underwater Cultural Heritage*, although this international agreement was not used in the trial due to the document not having been signed by the USA. However, the case represented a juridical triumph for the States Parties which are fighting looting and are in favour of the Protection of UCH, one of the principal aims and purposes of the 2001 Convention. For this reason, at present the case of the *Mercedes* is one of the clearest demonstrations of the reasons for the Convention and the nature of its content.

Archaeological Project

One of the successful aspects of this project was the maximum level of coordination among the public institutions involved: the National Museum of Underwater Archaeology in Cartagena, which oversaw the project, the Directorate-General of Fine Arts and Cultural Heritage and the Deputy Directorate-General of Historical Heritage Protection which financed and managed the campaigns, the IEO, and the UTM of CSIC, which supplied the oceanographic research vessels, equipment and crew, and the Spanish Navy in its role as observer.

The high degree of collaboration among research institutions made it possible to carry three scientific campaigns at depth and achieve optimum results: the first underwater archaeological excavation in Europe at a depth of over 1 100 m, the precise positioning of hundreds of objects at the wreck, their photographic documentation and the excavation of some of them using a water jet, the extraction of a series of objects including two enormous cannon weighing over two tons each, and the establishing of correspondences between these materials and archive documents, to name but a few.

In addition, the project fostered international cooperation. The Portuguese government was kept informed at all times and officials were invited to visit the team during the campaigns. A German colleague and two Mexican underwater archaeologists were also invited. All of this serves to strengthen international cooperation in the protection of UCH, which is one of the main principles of the 2001 Convention.

Similarly, the archaeological project was conducted following several of the specific rules established in the *Annex of the UNESCO Convention*:

- the use of non-destructive techniques and methods of exploration; the decision has been made to use the geo-physical exploration techniques (multibeam and side-scan sonar) in a deep water archaeology project and the ROV designed for biological research was adapted to the needs of archaeological research (mapping and graphic documentation);
- priority given to preservation *in situ*; the archaeological mapping provided the high-precision positioning of hundreds of objects which remain *in situ* at the site after the looting of Odyssey;
- the unnecessary disturbance of human remains and revered sites should be avoided; in this case the site was a war grave, and efforts were made to disturb it as little as possible; furthermore, a commemorative plaque was installed at the wreck as a sign

of respect and homage to the victims who lost their lives in the sinking of the frigate *Nuestra Señora de las Mercedes*;

- selective excavation, then documentation, and selective recovery of objects; excavation was carried only at certain points in the site, and once the documentation had been completed it was decided to recover only a small selection of objects, using three selection criteria:

  a) risk inherent in leaving objects at the site due to their fragility and the lack of sedimentation in the area;

  b) unique or uncommon archaeological material which could contribute to widening of historical knowledge;

  c) objects which are mentioned in archive documentation.

Mention should be made of the perfection with which the documentary sources coincide with archaeological evidence in this case, a quite exceptional instance in archaeology not only under water but also on land, especially in the cases of the scrap silver dinner service and the two Renaissance culverins. The exact coincidence of the material recovered by the Museum in the 2015, 2016, and 2017 campaigns with the equally precise details given by the documents quoted in the Archive of the Indies and others confirm definitively that the wreck under investigation is the frigate *Nuestra Señora de las Mercedes*, and provides a level of exactitude hitherto unprecedented in European underwater archaeology.

Conservation and Documentation Programme

Since 2015, the conservation programme has been planned and carried by the experts in conservation and restoration at the museum. Initially, a specialist was on board the oceanographic research vessels during all three campaigns, taking charge of the preventive conservation of the few objects extracted and their transport in the best possible condition to the museum. In addition, once at the museum, the material has been stabilized, conserved, and restored; the material retrieved in 2015 and 2016 is already stabilized, while the objects brought to the museum in 2017 are still being treated.

At the same time, the task of documenting the deep-water archaeological activity and the material recovered has been addressed. On the one hand, the documentation of the material which remains *in situ* was performed at the site by mapping, photography, and video, and on the other hand, the objects recovered by the museum between 2015 and 2017 have been exhaustively documented at different points; while in their original position underwater, on being extracted, before, during, and after the conservation and restoration treatment, and, finally, with a studio photo and archaeological drawing (**Fig. 16**). In addition, in case of the two Renaissance culverins, a 3D digitalized model has been created by the technicians at the Technological Research Assistance Service[23] (SAIT) department of the Polytechnic University of Cartagena (Region of Murcia, Spain). These models open various possibilities regarding the culverins: the state of conservation and various alterations can be mapped, an exhaustive analysis can be made of their dimensions, technical characteristics and construction, and it is possible to create holograms and scale reproductions of them.

Scientific Dissemination and Awareness of the Project

Ever since the project began annual reports have been published in order to keep the public abreast of the work being carried. Among these are the reports of the three archaeological campaigns and publications at international underwater archaeology congresses: many of these publications are available online, ensuring that they reach the national and international scientific community.

In addition, to guarantee that the general public is aware of the project and its different phases (court victory, recovery of the looted items and scientific campaigns) numerous activities have been organized, including permanent and temporary exhibitions, conferences, public tributes, publications, concerts and dramatized visits.

The online publications mentioned, along with general information about the project, can be found at the museum website and a microsite of the Ministry of Education, Culture and Sport (Ministerio de Educación, Cultura y Deporte 2014).

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Fig. 1 – Location of the silver tableware set in 2015 campaign
(property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 2 – Progressive excavation of the silver tableware in 2015 campaign
(property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 3 – Extracting a group of silver plates by the ROV (campaign of 2016). In this zenithal snapshot a gold mortar is discovered and other silver objects are documented – crockery and cutlery, candelabra, coins (property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 4 – Location of a semi-buried bronze culverin in 2015 campaign
(property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 5 – Water jet with a new elbow-jointed extension that facilities excavating under the muzzle of the culverin during 2017 campaign (property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 6 – Arrival of one of the culverins to the oceanographic ship (campaign of 2017). On the deck, a bed of polyethylene foam on a flexible structure was prepared in order to guarantee an adequate safety of the cannon (property of the National Museum of Underwater Archaeology, ARQVA)

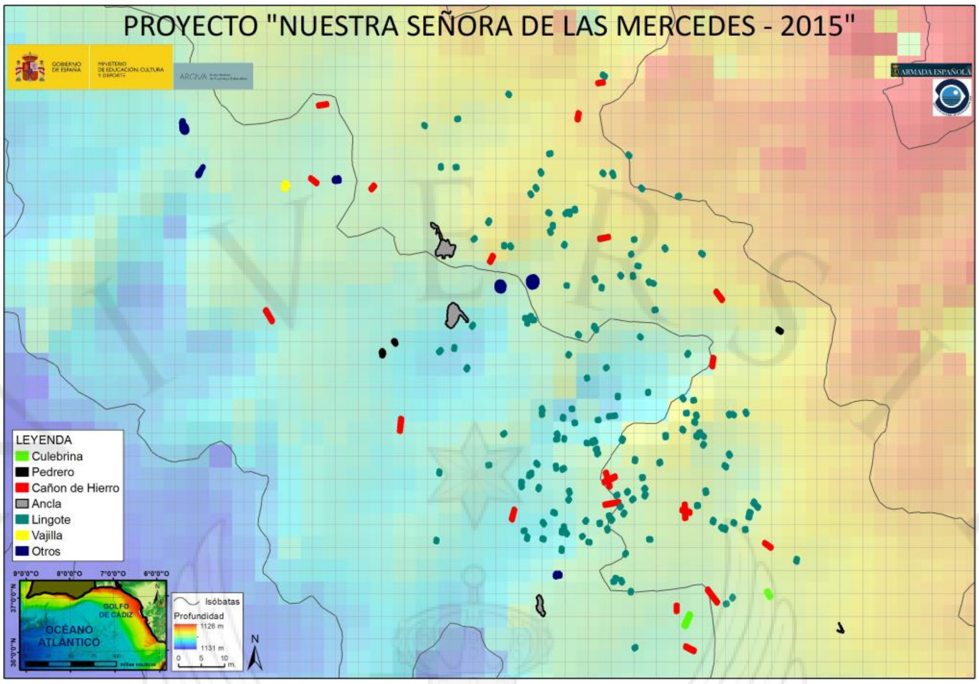


Fig. 7 – General map showing the location, dispersion and distribution of the artefacts on the shipwreck site (property of the National Museum of Underwater Archaeology, ARQVA)

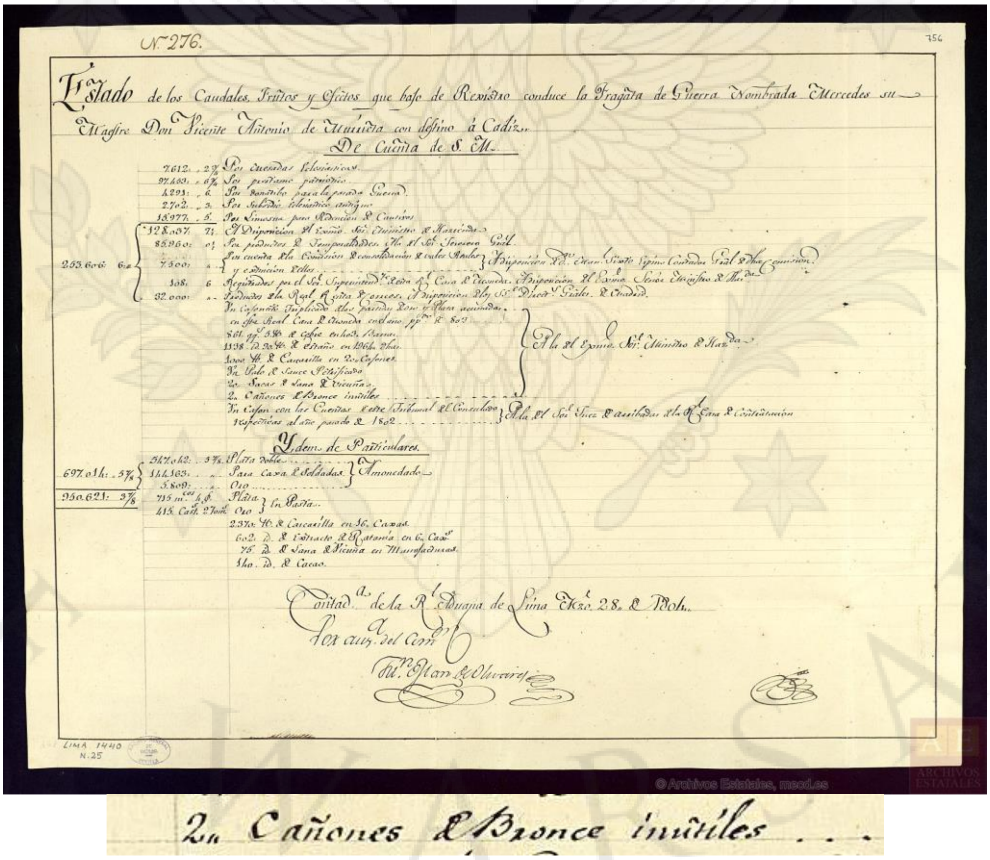


Fig. 8.1 – “State of the Wealth, Fruit and Effects which, under register, are carried by the war frigate named Mercedes captained by Don Vicente Antonio de Murrieta and sailing for Cádiz” (Andalusia, Spain).
8.2 Detail of previous document: “*dos cañones de bronce inútiles*” [“*two worthless bronze cannons*”]
(Spain, the Ministry of Culture and Sport, General Archives of the Indies, Lima, 1440, no. 25)

Fig. 9 – Panoramic photography of the *Santa Bárbara* culverin
(property of the National Museum of Underwater Archaeology, ARQVA)

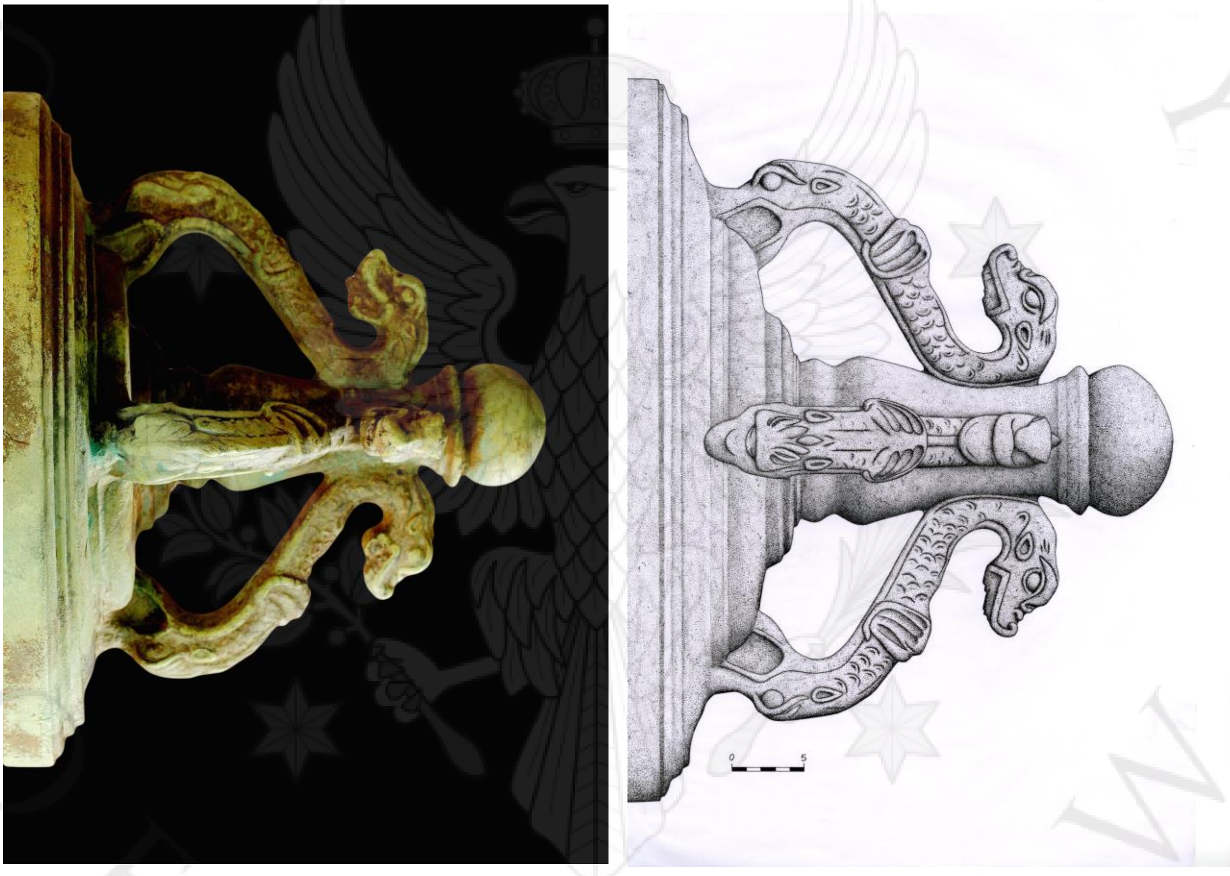
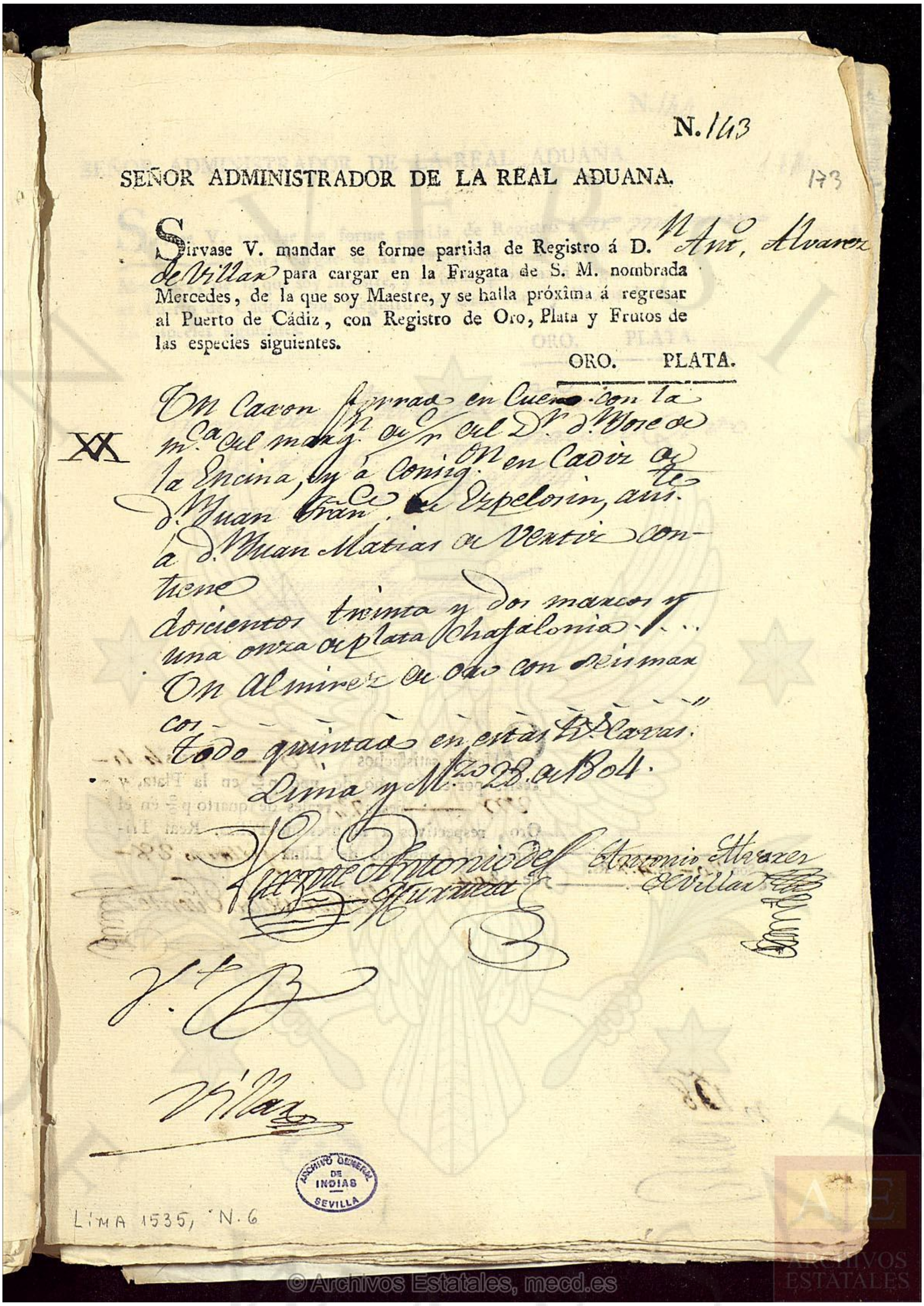


Fig. 10 – *Santa Barbara* cannon's cascabel, richly decorated with four double animal's head
(property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 11 – Shield with inscription, indicating who ordered the manufacture of the *Santa Barbara* culverin: the Count of *Villar Dompardo* (property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 12 – Panoramic photography of the *Santa Rufina* culverin (property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 13 – Coat of arms of the Viceroy *Don Luis de Velasco y Castilla* and the name of the culverin (property of the National Museum of Underwater Archaeology, ARQVA)


N. 143

SEÑOR ADMINISTRADOR DE LA REAL ADUANA.

Sirvase V. mandar se forme partida de Registro á D. Ant.° Alvarez de Villar para cargar en la Fragata de S. M. nombrada Mercedes, de la que soy Maestre, y se halla próxima á regresar al Puerto de Cádiz, con Registro de Oro, Plata y Frutos de las especies siguientes.

ORO. PLATA.

Lima 1535, N. 6

Fig. 14 – Document of the General Archive of the Indies that included details of a private shipment and its contents: a leather lined drawer containing scrap silver and a god mortar (Spain, the Ministry of Culture and Sport, General Archive of the Indies, Lima, 1535, no. 6, folio 173)

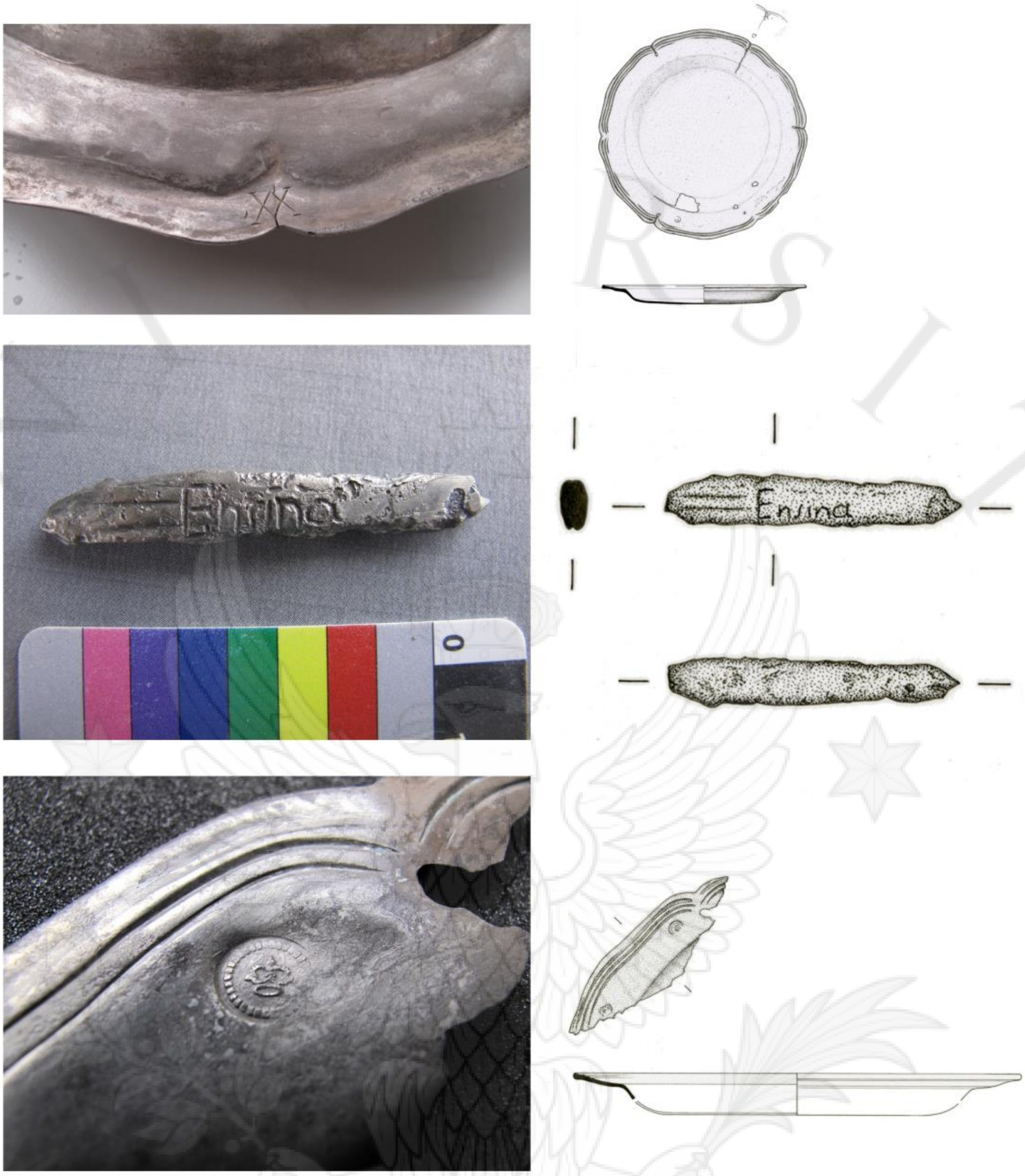


Fig. 15 – Marks cited in the General Archive of the Indies document and identified on the objects recovered in 2015–2016: *XX*, *Encina* and *quinto real*, the seal of the royal fifth tax (property of the National Museum of Underwater Archaeology, ARQVA)

Fig. 16 – Photographic documentation and dotwork archaeological drawings of a silver candlestick and fork, and a gold mortar with its pestle, after finishing its conservation and restoration process (property of the National Museum of Underwater Archaeology, ARQVA)

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Do not Mess with the Apus: Technical and Safety Aspects of the High Mountain Underwater Archaeology

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Abstract:

Since the 1960s underwater archaeology has developed into a thriving and well-established branch of archaeology. Some of its areas, such as underwater research conducted at very large depths or in inundated, hardly accessible caves, are still poorly researched, and such studies push the borders of our knowledge concerning not only the past of the human kind, but also what is known about our planet. Underwater archaeologists either dive themselves or use remotely operated vehicles to reach the places where no human being had been before them. This is why the reference materials on both sub-disciplines are so scarce. Exactly the same situation is observed in case of high-altitude underwater archaeology.

Searching for traces of any human activity in high mountain environment requires a state-of-the-art and innovative equipment, and also a pioneering approach to conducting research in extreme conditions. At an altitude of over 4 000 m a.s.l. underwater archaeological research has been conducted so far only in Sun Lake (Lago del Sol) and Moon Lake (Lago de la Luna) located in the crater of the Nevado de Toluca volcano, Mexico. Much more is known about Lake Titicaca (3 809 m a.s.l.; Bolivia and Peru), located at slightly lower altitude, due to a large number of expeditions, be it scientific or not. In 2016 and 2017 two seasons of underwater research were organised in the Machu Picchu region (Peru) in the lakes located at altitudes between 4 130 and 4 531 m a.s.l. In underwater research in such extreme conditions scientists had to use specially designed dive tables and diving equipment; they have also developed innovative strategy for their application. Emergency procedures for diving in a location far away from any roads and the GSM network needed to be implemented as well.

Keywords:

high mountain underwater archaeology, high altitude diving, diving equipment

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Nevado Salkantay (Peru) – Introduction

Towering over the Machu Picchu National Park (*Santuario histórico de Machu Picchu*, Peru), Salkantay (6 271 m a.s.l.) is the highest mountain in the Vilcabamba range (Cordillera de Vilcabamba) in the Peruvian Andes. As such, Salkantay is the axis of the sacred landscape of the Machu Picchu area, and *Apu*[1] *Salkantay* associated with the mountain is the strongest local deity in the region. It is surrounded by a network of ancient roads that used to be the arteries of the former Inca Empire. Some of these roads lead close to high mountain lakes, which, basing on accounts from the chronicles from the period after the Conquest, such as Felipe Guaman Poma de Ayala (*Nueva corónica y buen gobierno...*, after: Adorno [ed.] 2001: 263–267, 273), Pedro de Cieza de León (*Crónica Del Perú...*, after: Pease [ed.] 2005: 225, 261–262), Francisco de Avila (*Dioses y Hombres de Huarochirí...,* after: Arguedas [trad.] 1966: 72, 89–92, 95–98), or Inca Garcilaso de la Vega (*Comentarios...*, after: Herrera Villagra [ed.] 2018: 34–35, 66, 110, 123) could represent *huacas*[2], specific nodes in the network of *ceques*[3], invisible lines extending from Cuzco through the sacred Inca landscape (Szemiński and Ziółkowski 2014: 105–110, 421). These lakes became the subject of interest of the researchers from the Centre for Precolumbian Studies, University of Warsaw (hereinafter: OBP[4]) who in 2016–2017 in cooperation with the Peruvian Ministry of Culture[5], examined five of them as part of the project *The Function of Satellite Sites in the Machu Picchu Region: the Inkaraqay and Chachabamba Sites and High Mountain Lakes in Nevado Salkantay (Peru)* led by Professor Mariusz Ziółkowski[6] (Sobczyk *et al*., forthcoming).

Lakes: Humantay (4 270 m a.s.l./20 m depth; **Fig. 1**), Inka Chiriaska (4 735 m a.s.l./29 m depth), Salkantay Verde (4 460 m a.s.l./25 m depth), Soqtaqocha (4 531 m a.s.l/18 m depth; **Fig. 2**) and Yanaqocha (4 130 m a.s.l./5 m depth; **Fig. 3**), all Nevado Salkantay, Peru and several smaller pools were researched by means of a hydroacoustic equipment[7] in order to collect

[1] Title of the living mountains, the greater gods (Szemiński and Ziółkowski 2014: 448). Mythical ancestors that protect the people living in their vicinity. *Apus* also identify ethnically the territories occupied and attached to these peoples (Herrera Villagra 2018: 370).
[2] Local deity, oracle, sanctuary, temple ruins, one but in two parts, a pair of the ancestor-founders who sprouted from the earth (Szemiński and Ziółkowski 2014: 448). The *huacas* could be trees, rivers, lagoons, caverns, rocks, mountains, or natural places where the ancestors rest (Herrera Villagra 2018: 370).
[3] Zigzag, a procession route coming out of the main temple in Cusco and visiting various places of sacrifice – – *huacas* in turn (Szemiński and Ziółkowski 2014: 450).
[4] Polish: *Ośrodek Badań Prekolumbijskich, Uniwersytet Warszawski*.
[5] Spanish: *Ministerio de Cultura del Perú*.
[6] The research was funded by the *Dirección Desconcentrada de Cultura – Cusco, Ministerio de Cultura del Perú* (*sucursal regional en Cusco del Ministerio de Cultura del Perú*), Polish Ministry of Science and Higher Education (grant nr 4815/E 343/SPUB/2014/1) and Polish National Science Centre, Poland (grant No. UMO-2015/19/B/HS3/03557) as a part of the OPUS 10 call.
[7] Lowrance Echo Sounder HDS-12 Gen 3 ROW with the 83/200 kHz converter and Sonar StructureScan.

data for subsequent bathymetric maps and to select bodies of water for further underwater research. Due to the lack of visible traces of human activity in the pre-Columbian period lakes Inka Chiriaska and Salkantay Verde were excluded from them (Sobczyk *et al.* 2016; Sobczyk *et al.* 2017; Sobczyk *et al.*, forthcoming).

Although located at a similar altitude as Sun Lake (Lago del Sol) and Moon Lake (Lago de la Luna) in Nevado de Toluca (Mexico), the Andean lakes in the Machu Picchu National Park differ significantly from those in the Toluca volcano crater in terms of logistics.

While access to Humantay Lake takes only two hours of climbing from Soraypampa (3 908 m a.s.l.), the nearby guard station of the National Park Machu Picchu, where diving equipment can be still delivered by car, Soqtaqocha Lake (Laguna de Soqtaqocha) and Yanaqocha Lake (Laguna Yanaqocha), both Nevado Salkantay are far away from the last place accessible by car. Then the whole expedition equipment must be carried on the mules (**Fig. 4**) and shouldersof participants and it takes two full days of hiking to cover the long distance. A part of the route to the Soqtaqocha and Yanaqocha lakes leads through area of the wild nature. The last section is so harsh that even the mules cannot be used for transportation. This has a considerable impact on the quantity and weight of the expedition equipment. Consequently, the emergency procedures in the event of a diving accident in a place far beyond the access of the GSM network and far, far away from any communication routes need to be adjusted. An additional difficulty for the expedition is the lack of any diving industry infrastructure in the Cuzco area of Peru.

High Altitude Diving – Planning and Preparation

High altitude diving and high altitude underwater research require precise planning, including the logistics of trekking to the lakes and return to the camps. In terms of human physiology, diving at high altitudes does not begin when one submerges, nor does it end when one surfaces. Changes in altitude and atmospheric pressure before and after diving affect the body, specifically the process of saturating and de-saturating tissues from inert gases. Along with changes in altitude the repetitive groups widely known from the dive tables change. If the dive would be made immediately following trekking from sea level to altitude, the diver would carry in his tissues the nitrogen from the sea level and much longer decompression would be required. Upon ascent to altitude the body off-gases excess nitrogen to come into equilibrium with the lower partial pressure of nitrogen in the ambient environment. It also begins acclimatization to the lower partial pressure of oxygen. About twelve to over twenty four hours is required for full equilibration, but acclimatization takes much longer. The risk of contracting DCS[8] increases during the ascent to further altitude after diving, because of the rise in the nitrogen gradient between the body and the environment. Therefore, the planning of high altitude dives should not include only profiles of the dives themselves according to a dedicated algorithm or specially prepared tables for this purpose; in the planning of underwater research, both the time of acclimatization at an altitude close to the researched lake and the elevation differences between the surface of the reservoir and the camp, as well as the profile of the route linking the place where the research is carried to the camping place should always be taken into account (**Fig. 5**). The key safety factor during the diving itself is a specially limited ascent rate not only because of DCS risk, but also due to the hazard of fast exposure to hypoxia[9]. The safety and decompression stops, as well as the maximum operating depths for individual gases, are also shifted to the different depths. The safety stop and the surface interval must be significantly extended (Böni *et al.* 1976: 190–193; Bühlmann 1989; Egi and Brubakk 1995: 295; Kot 2016:1–6; Hennesy 1976: 40; Paulev and Zubieta-Calleja 2007; U. S. Navy 2016: 9-46–9-58; Wienke 1993). However, the exact explanation of these principles is not the purpose of this study.

There were plenty of solutions proposed for the safe high altitude diving since the Cross corrections were published for the first time in 1967.[10] Cross tables have not accounted for the difference in density between fresh and salty water, so Bell and Borgwardt (1976) created a new algorithm, dive tables, adjusted the ascent rates, depths, and lengths of decompression stops. Hennesy (1977) proposed new formulas for converting standard air decompression tables for no-stop diving at altitude. His predictions were more or less in agreement with the later Bühlmann's tables (1984). Two cases of paraplegia registered after a dive of Swiss Army divers at altitude of 1 800 m a.s.l. in 1969 gave the motivation for experimental work on dive algorithms and dive tables with reduced ambient pressure in Switzerland (Bühlmann 1989: 412). So, Böni, Schibli, Nussberger, and Bühlmann (1976) have developed CRE[11] algorithm and dive tables up to 3 200 m a.s.l. with an obligatory decompression stop at the depth of 2 m, but they were

[8] Decompression Sickness.
[9] Condition in which the body is deprived of adequate oxygen supply at the tissue level, may lead to unconsciousness without symptoms.
[10] The Cross corrections (CRT – constant ratio translation) use the ratio of atmospheric pressure at the relevant altitude to the pressure at sea level to calculate an equivalent sea level depth that represents the same relative pressure changes (*cf.* Cross 1967: 60; Cross 1970: 17–18, 59; both after: Bell and Borgwardt 1976; Basset 1982: 7; Egi and Brubakk 1995: 285–286, 294; Hennessy 1977: 39–41; Paulev and Zubieta-Calleja 2007: 214).
[11] Constant ratio extrapolation.

tested only up to 2 000 m a.s.l. in the Alps. Albert A. Bühlmann (1989) worked out ZHL-16 dive algorithm based partially on the data from the real 290 dives in Lake Titicaca (3 809 m a.s.l.; Bolivia and Peru). Egi and Brubakk (1995: 283) observed that existing algorithms did not take into account a possible change in the gas equations or DCS boundary[12] due to the hypoxic response of the diver body above 2 400 m a.s.l. They postulated the possibility of taking into account the length of acclimatization at a given altitude (Brubakk 1995: 295). Poul-Erik Paulev and Gustavo Zubieta-Calleja, Jr. (2007) proposed a standardized equivalent sea depth (SESD), a new conversion factor, but their simplified approach was addressed for recreational divers and was not tested before publication. So, when the NASA Astrobiology Institute mounted an expedition to the crater lake of the volcano Licancabur (5 913 m a.s.l., Bolivia) in November 2006, stating the absence of tested dive tables giving safe decompression and ascent rate limits for diving above 4 267 m a.s.l., NASA Diving Safety Office has extrapolated its own tables (Morris *et al.* 2007: 157). In order to plan underwater research in the Machu Picchu region, in the Peruvian Andes, The OBP has established cooperation with the National Centre for Hyperbaric Medicine[13] in Gdynia (hereinafter: KOMH). For the purposes of the project, Ph.D. habil. Jacek Kot, M.D. from KOMH has developed algorithms and dive tables taking into account the Cross corrections for US Navy air tables, with the adjusted depths and durations of decompression and safety stops and the principles of planning and implementation of safe diving and logistics for the altitudes at which the project activities were planned, such as i.e.: maximum ascent rate during a dive, minimum time of acclimatization at the altitude before a dive, maximum altitude difference after a dive, minimum surface interval etc. (Kot 2016: 1–6). All diving activities in the 2016 and 2017 research seasons were planned and implemented in accordance to these recommendations. According to KOMH's recommendations (Kot 2016: 7) the team also included a qualified diving rescue instructor of Divers Alert Network (DAN) with specializations, *i.a.* Advanced Oxygen Provider, Dive Medicine for Divers, and Neurotic Assessment On-Site at the instructor level. As part of the diving in the Alpine lakes in the area of Machu Picchu a collection of data on micro-bubbles formed in the human body by the Doppler meter, used for the purposes of the project by KOMH, was planned as well.

[12] Equivalent of M-value but measured in absolute ambient pressure not gauge ambient pressure.
[13] Polish: *Krajowy Ośrodek Medycyny Hiperbarycznej.*

Diving Equipment and Configuration

Tanks, Gases, Harness...

One of the main risks associated with the equipment when diving in cold water, especially at the high altitudes, where sudden and uncontrolled surfacing is far more dangerous than at the sea level, is the risk of the regulator's free-flow. For high altitude diving in the lakes around Nevado Salkantay the sidemount configuration has been chosen (**Fig. 6**), which, unlike back-mounted cylinders, enables reaching the proper cylinder valve immediately in the event of failure of any of the regulators. The sidemount configuration allows for the independent exploration diving. The sidemount has been proven in numerous exploration projects in the most demanding underwater environment, also an overhead one. The sidemount configuration provides full independence and continuity of diving in accordance with the safety rules even in the event of free-flow or other diving regulator failure.[14] Also it makes possible the convenient implementation of multi-gas diving with accelerated decompression included.[15] Due to the serious risk of DCS after a too fast ascent during high altitude diving, the sidemount configuration is recommended even for single-cylinder diving.[16] It then gives the diver an option of controlled opening and closing the cylinder valve only for the purpose of taking another breath, during an emergency ascent with safe speed after the failure of the diving regulator.

The gas recommended for diving in the lakes around Nevado Salkantay was EAN 40[17] (Kot 2016: 2), which maximum operational depth (hereinafter: MOD) does not exceed the maximum depth of any of them. Unfortunately, due to the lack of diving infrastructure in the Cuzco area, this gas could not be obtained. At the disposal of the participants of the expedition in 2016, however,was air and oxygen but the maximum pressure in the cylinders that was possible to obtain in Cuzco did not exceed 160 bar. As the result, the modification of the gas management algorithm for the sidemount was implemented, using air in the primary

[14] The safety procedure in overhead/technical diving with the sidemount configuration in an event of damage to one of the diving regulators and as a result of free-flow consists in, if possible, breathing from the same cylinder with a defective diving regulator first in order to maximize the use of the breathing gas and keeping a safety gas reserve in the other one. For this purpose, the cylinder with the defective diving regulator is opened and closed every time only for the diver to take a breath.

[15] In case when there are two different gases in each of the sidemount cylinders (oxygen and air) and the free--flow malfunction of air cylinder happens at the depth at which oxygen cannot be used due to a risk of oxygen toxicity, only the tank with the air can be used at this moment until a safety depth for breathing with oxygen is reached by a diver; a safe ascent rate needs to be maintained as well. In this case going up to the surface as fast as possible is not an option due to the serious risk of DCS. In case of a free-flow of the diving regulator attached to the oxygen cylinder one can always breathe the air from the other tank at the same depth.

[16] The safety procedure with the cylinder valve opening and closing mentioned before, especially in the case of a single diving cylinder placed on the back of a diver, seems to be at least inconvenient; therefore, there are other safety procedures to be used in the case of free flow in the backmount configuration.

[17] MOD for EAN 40 PO_2 1.4 ata at the altitude 5000 m a.s.l. is 29.7 m (Kot 2016: 2, 5).

tank, because in the event of a failure it was possible to breathe at any depth, which in the researched lakes did not exceed 30 m and medical oxygen in the secondary tank.[18] In this case, oxygen is recommended for breathing during the safety stop and possible decompression stops (Kot 2016: 2), providing additional protection in the event of DCS or AGE[19]. Additionally, the oxygen used from its MOD during an ascent phase of a dive should prevent a diver from the fast exposure for hypoxic ambient pressure during the last metres of ascent – the phenomenon clearly felt during an ascent in case of breathing air.[20]

Due to the lack of any diving infrastructure in the Cuzco area all diving cylinders for the purpose of research were transported from Poland. In 2017 the situation became even more difficult due to the failure of the air compressor in Cuzco. Diving in the lakes Yanaqocha and Soqtaqocha, was limited to the underwater survey of the coastal line to a depth of 8 m. The dives could be made with the use of pure oxygen. Thanks to the fact that there was the air in one of the tanks which remained from the previous year, diving was also carried to the bottom (20 m) of Humantay Lake to finally close the underwater survey of this reservoir.

A proper acclimatization protects the expedition team from AMS[21]; however, with longer stay at the high altitudes some degree of hypoxia could always be a problem as its effects pose a serious danger that increases with altitude (Egi and Brubakk 1995: 292, Morris *et al.* 2007: 157–159). In 2019 the expedition team had at his disposal an air compressor, but basing on the experience of two previous field seasons, to avoid a risk of problems caused by the decline in physical and mental performance, it has been set that divers should breath pure oxygen during all dives shallower than its $MOD^{1,4\,ata}$.

Weights – the Heavy Problem

The problem of diving weights in the Andes is primarily a logistics problem. Transporting extra weight requires the involvement of more mules, which entails additional costs for the expedition. What is more, no lead could be found near Cuzco so the project had only a few kilograms of diving weights to use. The missing weights were replaced with shopping bags filled with rocks collected on the shores of the lakes (**Fig. 3**). However, this is notan ideal solution due to the fact that the density of stones is lower than that of lead such weights take much more space. They can also dynamically change the centre of balanceof the diver, thus having a negative impact on his safety. The location of the ballast

[18] MOD for O_2 PO_2 1.4 ata at the altitude 5000 m a.s.l. is 8.7 m (Kot 2016: 2, 5).
[19] Arterial Gas Embolism.
[20] NASA Astrobiology Institute High Lakes Project due to safety reasons used oxygen for all dives in the Licancabur volcano crater (5 913 m a.s.l.; Bolivia) however its depth is no more than 4.8 m (Morris et al. 2007: 157–158).
[21] Acute mountain sickness.

under the body of the diver also causes trouble when undertaking any underwater activities that require manual work or swimming close to the bottom. Based on the experience of the past two seasons it is necessary to supplement the equipment with specially prepared casesfor rocks or gravel, which could be e.g. fastened on the back or to the diving cylinders.

How to Measure a Real Depth at an Altitude?

Information about the depth and time of diving is one of the basic factors that allows for the implementation of a safe dive, consistent with the previously planned profile. As the measuring equipment used for diving is usually calibrated for the sea-level, depth information provided by dive computers and other digital measuring devices in high mountain conditions may be seriously misleading (**Fig. 7, Fig. 8**). This is why high altitude underwater survey requires consideration of this problem and specific diving equipment preparation.

Due to the specific high mountain conditions – low atmospheric pressure, influencing the depth readings of the analogue submersible pressure gauges (SPG) and diving computers (Mackay 1976: 400–401, U. S. Navy 2016: 9–49), the depth line rulers were constructed in the form of a marked line reeled on wide spools made from PVC pipes, facilitating handling them in dry gloves (**Fig. 8**). The capillary gauges – the devices that implement Boyle–Mariotte's law – could be used for a safe high altitude diving in combination with the sea level dive tables as well (Mackay 1976: 401, Egi and Brubakk 1995: 286); however, the capillary gauges do not show true depth values at high altitudes, so they could not be simultaneously used for documentation purposes. The literature mentions some dive computers adapted for high altitude diving (Bühlmann 1989 :411,420, Egi and Brubakk 1995: 285–286, 290, 293–294) of which those based on Bühlmann's algorithms looked particularly interesting.[22] However, the manufacturers of the technical dive computers that the expedition team had at their disposal did not guarantee that these would work properly at the indicated heights and, as Buzzacot and Ruehle (2009) have shown, even computers certified by manufacturers for diving at altitudes like 4 000 – 6 000 m a.s.l. are no longer reliable at 3 000 m a.s.l. when it comes to the depth readings, so testing dive computers in the field conditions could only become a side thread of the expedition. An additional factor were safety issues – the need to constantly mark the position of the diver and,

[22] Work of Albert A. Bühlmann (1989) was based partially on the data from the real 290 dives in Lake Titicaca (3 809 m a.s.l.; Bolivia and Peru) gathered in 1987 and 254 dives accomplished in Switzerland at little lower altitudes of 1 000–2 600 m a.s.l. ZH-L16 algorithm was designed for the altitude diving; as an additional safety factor it assumes that the diver is fully saturated with sea level nitrogen regardless of the time spent at altitude (Bühlmann 1989, Egi and Brubakk 1995: 294, Egi *et al.* 2003: 233).

if so, the possibility of pulling the diver up to the surface. So, the depth line rulers were connected with surface buoy markers made of two empty bottles with a total displacement of 9 l. Additionally, due to safety reasons, the spools of depth line rulers and consequently surface buoy markers connected to them were attached to the diver's harness during a dive, enabling reaching the diver in case of serious problems, such as loss of consciousness underwater, etc. Because the environmental conditions, such as visibility or water temperature prevailing in the Andean lakes in the Machu Picchu area, had not been known before a bright yellow line was chosen as it is better visible in the water with thick suspension or sediment rising from the lacustrine bottom.

Different Methods of Marking the Lines for a Depth or Distance Measurements

The standard method of marking a line that serves as a tool for measuring distance or depth in water is a previously prepared rope with knots tied on it, the so-called knotted line (knots at a distance of three feet) or ‘rop-y-dop’ (knots at a distance of a foot). The first tool allows e.g. for total measurement of the length of the cave corridors/sizes of the reservoir (the knots are counted on the way back, after the reel is fully extended or the end of the corridor is reached). The second tool is usually three feet long and is used for more detailed measurements. Knotted line, however, does not allow determining the distance to the end/beginning of the rope in any place, unless the count of knots is kept in mind. It is therefore not suitable for efficient depth measurement during high mountain dives.

For shorter distances, up to several dozen meters, there are other solutions, allowing for safe laying of the rope on a spool or reel, as presented in the figure (**Fig. 9**), bar code # M1. Marking a rope with a bar every five metres is too imprecise for the needs of high altitude underwater archaeology, where the exact measurement of depth is a key issue for security.

In contrast to the # M1 bar code, where a bright line is marked every five metres with black bars each marking a further five metres of the rope length, a lines of depth line rulers, built for the purposes of the project were marked with an insulating tape every one meter with the maximally different colours: red and blue (**Fig. 10**).

Each blue bar denotes a depth of one metre (in the range of one to four metres), each red bar means five metres depth. For depth reading, the value of bars in a given part of the line needs to be added. It is similar to Maya arithmetic, based on vigesimal positional numeral system which was, however, additive on particular positions, in a range 0–19. Because already the depth of eight metres water column blocks the red colour, making both colours look almost the same, the team has additionally adopted the principle according to which the red stripes should be found underneath the blue stripes. The length of the string on the spool was 20 m, as it has been assumed that the dives in the 2016 and 2017 seasons should not have been deeper than 20 m.

In practice in the 2016 season no dives were deeper than eight metres. It was decided to make the most of the available time and limited resources (tanks) in order to survey the coastal zone of Humantay Lake (**Fig. 1**). In this area, the applied bar code worked perfectly well. In 2017 the very bottom of the Humantay Lake was surveyed as well (**Fig. 11**) and it occurred to be 20 metres deep that season. In this way the reliability of technical diving computers in the full range of depth for which diving can be carried in subsequent research seasons was also checked. None of the lakes in which further underwater archaeological research is to be performed exceeds 20 m of depth.

Summary

High mountain underwater archaeology opens new horizons, allowing researchers to reach places not previously surveyed by archaeologists. The implementation of underwater research in the extreme conditions in the Andes requires thorough physical and equipment preparation, proper acclimatization and precise route planning as well as precise diving planning. The biggest challenge for the human body is the effort associated with the need to reach the researched reservoirs and the reaction to long-term stay in high mountain conditions. The human body is influenced by such factors as: low air pressure with hypoxic partial pressure of oxygen (**Fig. 5**), very low air humidity and low temperatures, often going down well below zero at night. As shown by the results of the research in the regions of Nevado Salkantay (Sobczyk *et al*., forthcoming), Nevado de Toluca (Luna *et al.* [eds] 2009) or Lake Titicaca on the Peruvian and Bolivian border (Reinhard 1992; Delaere 2017) it is worth the effort.

Diving in low temperatures requires earlier preparation for work in a drysuit, and in particular with dry gloves due to the fact that the researchers of the Sun Lake and Moon Lake complained about the problem of low temperature of water and its impact on manual motoric skills during prolonged exposures (Junco 2009: 24). However, as it can be seen in their pictures, they probably did not use dry gloves. For a drysuit diving in these conditions, an appropriate undersuit should be used that can absorb a large amount of water, isolating it from the body of the diver in the event of failure and flooding of the drysuit. It is also worth considering electric heating with heated gloves as well.

High altitude diving requires special algorithms that change the acceptable ascent rate, depth, and duration of the decompression stops as well as that of a safety stop, while the logistics and planning of diving must include equilibration and acclimatization at a given altitude, trekking between the camps and the lakes taking into account the maximum elevation on the route and very long surface intervals after each dive. According to safety rules researchers should plan no more than one dive per day. Maximum operational depths (MOD) for particular gas mixes are also very different than at the sea level (Kot 2016:2, 5). KOMH rules and recommendations worked well for the Andean expedition thorough three field seasons in high mountain conditions, but how does high altitude affect the risk of DCS, especially after the longer time spent in the high mountains, and how diving affect the risk of AMS is still not known because of the absence of the wider research (Egi *et al.* 2003: 233; Morris *et al.* 2007:158). Egi and Brubakk (1995: 295) warned against high altitude diving after full acclimatization (10 days higher than 3 000 m a.s.l.) until controlled experiments will be carried about the DCS stress induced by subclinical development of HAPE[23] on the other site performing in the high mountain conditions requires longer acclimatization from the sojourners, so special precautions are always required.

In the case of research realized in the lakes located far from any roads, the weight of expedition equipment becomes quite a considerable problem. Due to these limitations, it seems quite important to design stable diving weight pockets for loose materials or stones. Research undertaken in areas located far from communication routes and the GSM network also implies the need to develop emergency procedures in case of diving accidents. Satellite or radio communications as well as adequate supplies of oxygen are a necessity in such a case.

Comparative depth measurements carried by means of various devices yield interesting results (**Fig. 7, Fig. 8, Fig. 11**). It has been proven that technical diving computers taking into account the value of atmospheric pressure on the surface of the water perform well with the measurement of depth underwater at high altitudes. However, this should not change the safety procedures involving the use of a spool permanently attached to the diver's harness and connected with the surface buoy marker, in case of serious problems, such as unconsciousness underwater. The most flexible and safe diving equipment configuration for high altitude diving appears to be sidemount configuration with possible modifications to the gas management algorithm: use of the air in one sidemount cylinder for a deeper part of a dive and the oxygen in the other one for a shallower part to protect a diver from the risk of exposure to hypoxic environment conditions when performing tasks underwater, as the high altitude diving is physically demanding and requires a full readiness and consciousness for safety.

[23] High altitude pulmonary edema.

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Fig. 1 – Humantay Lake (4 270 m a.s.l./20 m depth) at the feet of Humantay glacier (5473 m a.s.l.) in Nevado Salkantay, Andes, Peru (photo by: P.A. Trześniowski 2016)

Fig. 2 – Soqtaqocha Lake (4 531 m a.s.l./18 m depth) in Nevado Salkantay, Andes, Peru (photo by: P.A. Trześniowski 2017)

Fig. 3 – Yanacocha Lake (4 130 m a.s.l.; Nevado Salkantay, Peru), an improvised diving weights pocket made of materials available on the spot in Peru – a cumbersome and hardly safe solution (photo by: P.A. Trześniowski 2017)

Fig. 4 – Mules, the true heroes of every Andean expedition (photo by: P.A. Trześniowski 2017)

Fig. 5 – Taking the altitude, temperature and the oxygen partial pressure measurements. The red alert values on the screen of technical dive computer shows that oxygen partial pressure at the altitude of planned underwater research is hypoxic. Without proper acclimatization, this partial pressure of oxygen in the surrounding atmosphere could cause fainting. Therefore, in high altitude underwater archaeology, the planning of acclimatization is so important, both before the expedition and before working on particular sites at different altitudes (photo by: P.A. Trześniowski 2017)

Fig. 6 – Diving equipment used for high altitude underwater archaeology. On the left an analogue depth gauge made of water tanks and a reel with a marked line, in the centre a diver in the sidemount harness with the primary tank at the side where the air is located (in the Nevado Salkantay lakes you can always breath with air), on the right a prepared secondary tank with oxygen − MOD for PO_2 1.4 ata in the lakes researched by the project is 8.7 m (photo by: M. Sobczyk 2016)

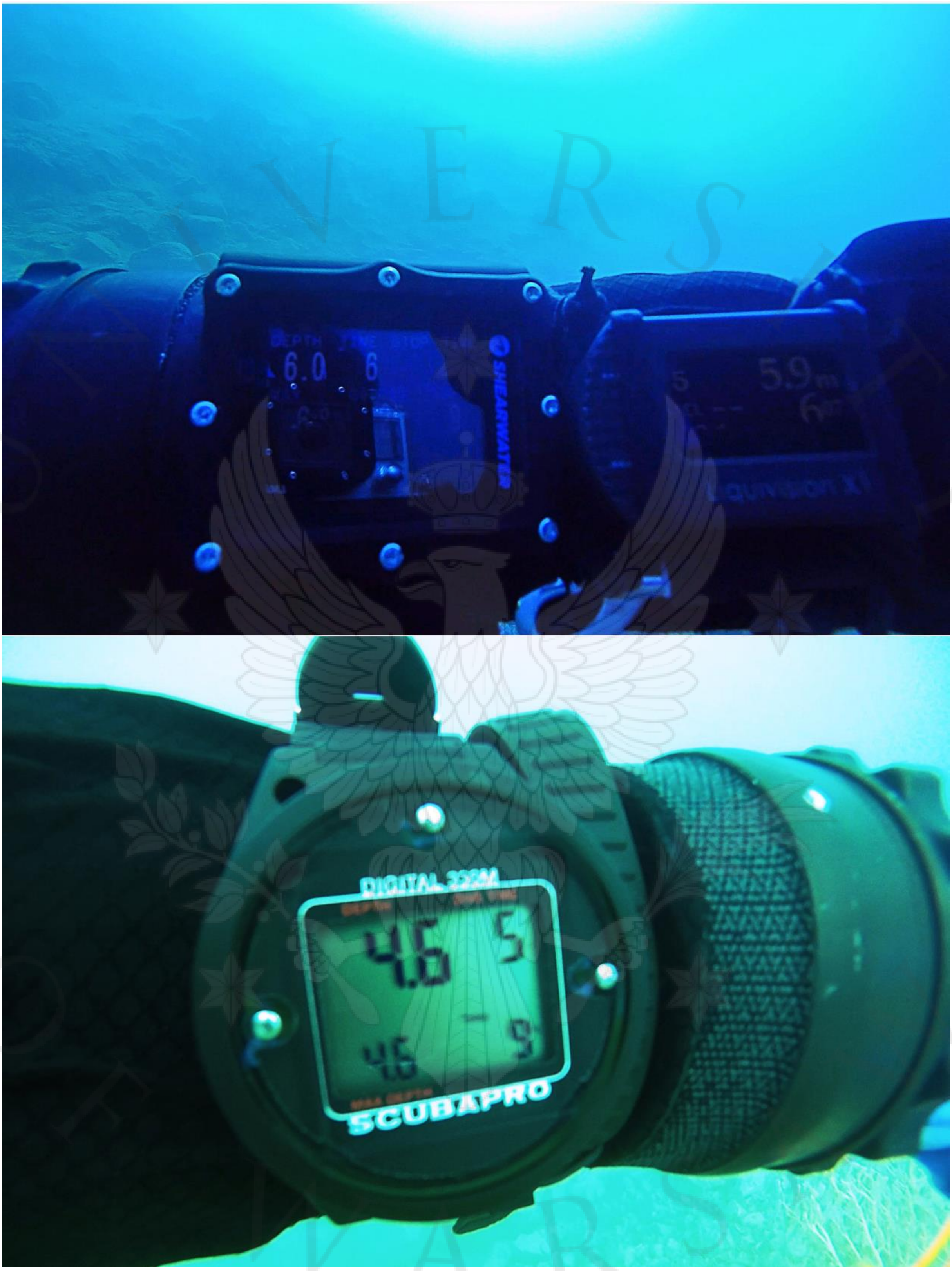

Fig. 7 – Comparative measurement of a depth of 6 m in Humantay Lake using various devices.
At the top the technical dive computers Shearwater Perdix and Liquivision X1, at the bottom Scubapro Digital at the same depth (photo by: P.A. Trześniowski 2016)

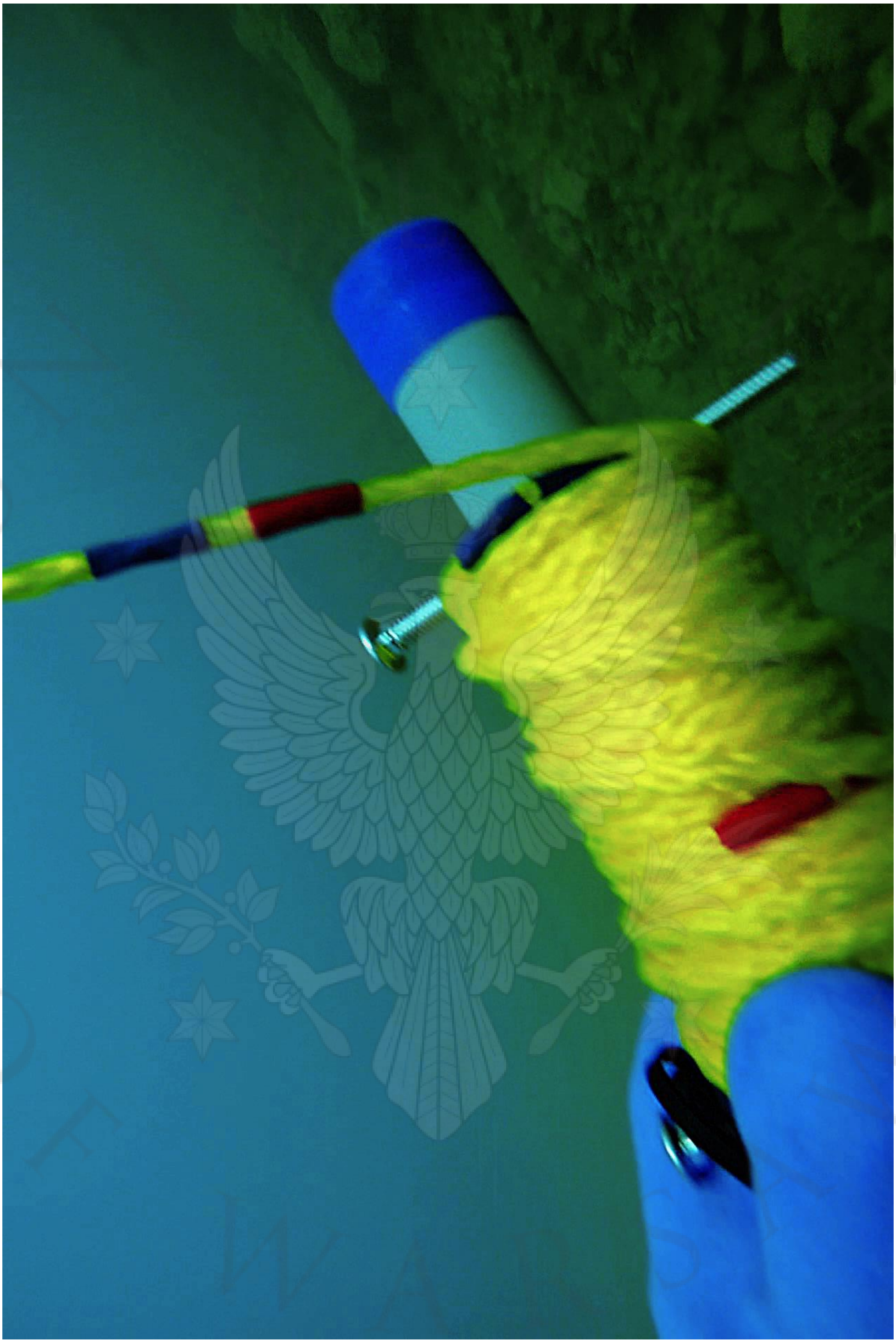

Fig. 8 – Comparative measurement of a depth of 6 m in Humantay Lake using an analogue depth gauge: an improvised spool with unsinkable line marked with # M2 bar code.
In the picture, a depth of Σ 5 m x (red stripes) + 1 m x (blue stripes) = 6 m
(photo by: P.A. Trześniowski 2016)

Barcode	Depth in meters
	5
	10
	15
	20
	25

Fig. 9 – Bar code #M1 for measuring the depth or distance on the diving reel or spool (elaborated by P.A. Trześniowski)

Barcode	Depth in meters
	1
	2
	3
	4
	5
	6
	7
	8
	9
	10
	11
	12

Fig. 10 – Bar code #M2 for measuring the depth or distance on the diving reel or spool (elaborated by P.A. Trześniowski)

Fig. 11 – Comparative measurement of a depth of 20 m at the bottom of Humantay Lake using technical diving computers that take into account the value of atmospheric pressure. An example of a voltage drop in the computer's battery on the left due to the ambient temperature is one of the problems to be taken into account when planning high altitude underwater expeditions (photo by: P.A. Trześniowski 2017)

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Petén Itzá Project – Results of the Underwater Reconnaissance in Lake Petén Itzá (Northern Guatemala)

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Abstract:

In 2018 in Lake Petén Itzá (Petén Department, northern Guatemala) underwater archaeological survey has been conducted by the Polish–Guatemalan group of archaeologists. During the first season underwater reconnaissance has been performed in seven zones of the southern part of the lake. The main surveyed areas were the surroundings of the islands: Flores, Santa Bárbara, El Hospital, two smaller nameless ones (currently submerged due to the increase of the water level), as well as some part of the coastal area of the Tayasal Peninsula (north of Flores). The main objective of the first phase of the project was to locate the traces of the ritual activities of the Maya peoples inhabiting the neighbourhood of the lake as well as capturing the evidence of the final naval battle between the Itza Maya and Spanish conquistadors which took place in 1697. The aim of the article is to present the results of the reconnaissance as well as hypotheses and preliminary interpretations of the discoveries based on the data acquired during the field research.

Keywords:

Lake Petén Itzá, *Nojpeten*, Guatemala, the Maya, the Itza, conquest, naval battle, ritual activity

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Introduction

Lake Petén Itzá, one of the largest in Guatemala, is a reservoir located in the central part of the Petén Department (northern part of the country), in the middle of the chain of lakes extending from west to east (**Fig. 1**). It is located in between the communities of San Andrés, San José, San Benito, and Flores at the level of 110 m a.s.l. Its surface covers ca. 99 km^2 and the depth in the northern, deeper basin is close to 160 m.

In the southern part of the lake there is an island, which inhabitants have played an important role in the history of the Maya. The settlement located there used to be called *Nojpeten* (in the Itza Maya language: 'the large island', sometimes called also *Taj Itza* – 'at [the place of] the Itza'], today being known as Flores (current capital of the Petén Department); before the Spanish conquest it was a capital of the powerful group of the Itza Maya. As it is assessed on the basis of some similarities both in the archaeological and linguistic data, in the mid-fifteenth century, as a result of the migrations, they arrived to Petén from the Yucatán Peninsula (present-day Mexico). The Itza Maya have established a very powerful state, which capital was resisting the Spanish conquistadors for 172 years – starting from the arrival of Hernán Cortés in 1525 until the end of the 17th century. *Nojpeten* was not captured until the 13th of March 1697; its demise was a result of the bloody attack led by the governor of Yucatán, Martín de Urzúa y Arizmendi (Jones 1998: 295).

History of the Itza in Petén

According to Grant D. Jones (1998: XIX), after leaving the Yucatec *Mayapan* (present-day Mayapán in Yucatán Department, Mexico) in the 15th century certain elite families (some of which have belonged do the *Mayapan* elites deriving from *Chichen Itza* [present-day Chichen Itza in Yucatán State, Mexico]) have migrated to the surroundings of Lake Petén Itzá. Even though no chronicle includes precise information about the place of origin of the Itza, as it was already mentioned, some archaeological and linguistic features might indicate that they have emerged exactly from the aforementioned areas. After arriving to the new terrains the Itza Maya occupied, among others, the island called by them *Nojpeten* (present-day Flores). In its central part they have built temples and palaces, which were the middle point of the large settlement having been surrounded by ca. 200 houses located at the peripheries (Jones 1998: 71–72). They have established their capital here, which in now famous in history as the last independent 'bastion of the Maya'.

Along with the Spanish conquest of the so-called New World the European invaders have started to systemically occur in the area of the lake. The beginning of the contacts of these two cultural units can be dated for 1525, when into the area of the lake basin the first of the Spanish leaders arrived: Hernán Cortés himself (Jones 1998: 5). The aim of the invaders was obvious: to conquer the Itza state, which was necessary to realize the pursuit to colonize the whole continent. In purpose of achieving their objectives the Spaniards have used various ways. According to Means (1917: 83) their activities can be divided into three main chapters: (1) the research phase, followed by (2) forcing on the indigenous peoples the Christian faith and, in the end, (3) stage of trade and military contacts.

From the aforementioned moment of the Cortés's arrival the visits of the Spanish leaders and missionaries have started to become the constant element in the region. The Itzas have demonstrated their approach towards the invaders stating their intentions quite clearly. A perfect example can be the story of the monks, Bartolomé de Fuensalida and Juan de Orbita, who have been chased by the Maya from their territories more than once. When in 1618 the Franciscans destroyed the figure of the stone horse, presumably connected with the story of Cortés's arrival (*vide*: Jones 1998: 36 –37, 44, 437 [fn. 29]), having a symbolic meaning for the Itzas, they have been banished for the second time. This event has definitely discouraged them to the continuation of their mission on this area (*Historia de Yucatán*, after 1971 [ed. F. Anders]: 212–238, based on an original copy of Fuensalida's account, now lost[1]). Although it is also worth mentioning, that much more tragic in the results demonstrations of the Itza opposing the Christianization processes had happened as well. The history of another Franciscan, Diego de Delgado, can be mentioned here. He has arrived to the Itza accompanied by 12 soldiers originating from Tipuj (Belize) and has been sacrificed at one of the western shores of the lake (*Documentos respectivos al servicio...*, after: Scholes and Adams 1936/1937: 160–173), which was not the only case like that. The similar effect had a visit of the missionaries, Cristobal de Prada and Jacinto de Vargas, whose aim was as well the Christianization of the inhabitants of the island. This has ended not only with the fiasco, but also death of the few Spaniards by the hands of the Itza (*Historia de la provincia...*, after 1973 [ed. F. Gall]: 422). The Maya have tried stopping the colonization plans

[1] Jones (1998: 439, fn. 53) informs on the margin of his work that a *"recently published manuscript presents a rather different account of both the 1618 and 1619 missions of Fuensalida and Orbita, also said to be based on Fuensalida's original account (San Buenaventura, 1994, pp. 107–133). The authenticity of the manuscript is highly suspect, and I have declined to rely on any part of it as a source of information".* The more thorough research into the original written sources is supposed to be one of the main objectives of further studies of the *Petén Itzá Project*; the information presented in the hereby article bases on the published volumes.

not only with the activities limiting the Christianization process. In the 1692 the Itza have also thwarted the plans of the governor of Yucatán, Martín de Ursúa y Arizmendi, who wanted to build a road joining the provinces, which was supposed to ensure the simplification of the conquest (Jones 1998: 111–112). The examples of the resistance to the Spanish invaders by the Itza have been quite numerous, as in result the attempts of capturing their state have lasted for about 172 years. The one, who has managed to do that, was the aforementioned Martín de Ursúa y Arizmendi; at the 13th of March 1697 he led the attack on *Nojpeten* from the galiot (built for that purpose in the camp at *Nixtun–Ch'ich'*), murdering incredible number of the Maya defenders. As the fight between the Itza and the soldiers with firearms, thrown weapons, and blades was very unequal, the Spaniards have captured the city the same day. Next, on the 14th of March, Martín de Ursúa y Arizmendi officially seized the island giving it a new name: *Nuestra Señora de los Remedios y San Pablo del Itzá* (Sharer and Traxler 2006: 757–779; Jones 1998: 304).

History of Research

The region inhabited once by the Itza Maya is an area of the large archaeological potential. Over the years a lot of projects have been conducted here, although most of them on the land. As an example might serve the *Tayasal* site, located on the peninsula north of *Nojpeten*. In the years 2009 to 2012 the archaeological research led by Timothy W. Pugh (*Proyecto Arqueológico Tayasal*) has been conducted there. The research has touched nearly every sphere of life of the inhabitants of the centre. In the reports one might learn a lot of information referring e.g. to the social relations, architecture, pottery, development of astronomy, as well as the ceremonial sphere, all of which have changed their character along with the influx of the Spanish colonizers (Pugh 2011).

Proyecto Arqueológico Tayasal is only one of a few projects having realized the thorough research in the region. Unfortunately, most of them did not employ the methods of underwater archaeology, which seems quite relevant in case of the studies of the region so strongly connected with the lake. Although, over the years some reconnaissance has been conducted in the lake as well; it has never lasted longer than one season. As an example may serve the penetration of some areas of the lake conducted in 1959 by the group of six scuba divers and amateur archaeologists. They have reported that at the bottom of the Petén Itzá some ceramic artefacts are present (among others they have recovered a unique whistle with the anthropomorphic depiction, originating from the Terminal Classic period [Mata 2002: 596]).

Those discoveries have caused quite an interest in the world of science and culture. Due to that in 1967 the French minister of culture, André Malraux, sent to Guatemala underwater expedition, in the aim of further recognition of bottom of Petén Itzá. Yet again the artefacts have been discovered, which are currently in the Institute of Anthropology and History in Guatemala[2] (Mata and Medrano 2011: 26).

Another opening on the topic of Lake Petén Itzá research occurred in 1992; this time the project has been conducted by the American archaeologist, Richard Hansen. Its objectives included the recognition of the bathymetry and stratigraphy of the lake. Specialist equipment has been used for that, for example sonar, the echo-sounder as well as devices for sediment studies (Mata 2002: 596–597). Apart from the analyses performed on the basis of the samples and measurements, the archaeologists have discovered 39 artefacts. Those were e.g. the ceramic items from the pre-Hispanic period as well as the residues of the stone buildings located north and north-east from Flores Island. Their analysis has suggested that before the ages the level of the lake was much lower (Mata 2002: 598; on the fluctuation of the water level *cf.* e.g. Pérez *et al.* 2010), which leads to conclusions that under the sediment there can be many more artefacts.

Recently also the participants of the land project *Itza Archaeology* have done a few dives in the area of Nixtun–Ch'ich' settlement, at the western part of the southern lake basin. The researchers have captured some traces, probably the residues of the harbour, which have to be verified during further research (*Itza Archaeology Goes Underwater* 2015[?]).

Petén Itzá Project – Research Objectives

Petén Itzá Project (hereinafter: PIP), which was launched in 2018, is a Polish–Guatemalan archaeological underwater enterprise. The main objective of the researchers is to acquire information in reference to everyday life and ritual activities of the Maya inhabiting the region of Lake Petén Itzá, as well as acquiring data concerning the final Maya–Spanish battle, which took place at the lake in 1697.

It is worth underlining that the team is focused on collecting information about the inhabitants of the region not only in the social and ideological aspect but also the economical

[2] Spanish: *Instituto de Antropología e Historia* (IDAEH).

and political one. The cooperative aims at acquiring data allowing further studies of both the inside and outside relations of the researched societies (both at the interstate and interregional level).

The interesting effect of the pottery analysis of the artefacts acquired from the lakebed might be also some new information about the chronological sequence concerning the settlement of the island itself, which is quite scarce up till now, because of the continuity of the settlement until present.

Activities of the researchers, apart from the fieldwork itself, are also aimed at engaging local community and authorities into the tasks concerning the protection of the cultural heritage, also the submerged kind.

First Research Season

In 2018 the first of the PIP's archaeological underwater survey has been conducted in seven areas of the southern part of Lake Petén Itzá (**Fig. 2**). Its purpose was first of all the recognition of the area and location of the sites where the traces of the warfare and ritual activities of the Maya are present. On its basis the spots have been chosen where the more comprehensive fieldwork can be planned for further seasons.

Area I – Flores Island

The area includes the zone around Flores Island (**Fig. 2**). The stone coating of the slope, present at the shore of the island, after ca. 10 m changes into solid sediment covering much flatter lakebed, with smaller stones and sand. Majority of artefacts have been located on top of that, although some of them were nearly wholly covered by the sediments. In case of those one might presume the objects being in fact the *in situ* sacrificial deposits. They have all been located in the same zone, north of Flores Island.

It seems that the information preliminarily confirms a very probable hypothesis stated by Stephan F. de Borhegyi (1963: 24), that this zone most probably has served the inhabitants of the island (presumably also the whole region) for the ritual activities. This presumption might be proved by the discoveries from the first research season: the aforementioned two deposits, which probably have been discovered *in situ*. One of them consists of three bowls, one inside another (**Fig. 3**). Inside the top vessel many fragments of the burnt wood, animal bones, and obsidian have been discovered. The bowls have been located on two larger flat vessels with three feet, on which the ca. twenty-centimetres-long obsidian blade has been deposited. Tools of this type are very often discovered in the ritual context and they are connected with the sacrifice offered to the deities. The vessels constructing this deposit have been dated to the Late Classic period (600–800 A.D.).

In the close proximity of the deposit, in the same zone of the lake, another object probably *in situ* has been located: quite rarely discovered vessel from the Proto-Classic period, 150 B.C.–250 A.D. (**Fig. 4**). This example is also connected with the ceremonial character due to the known analogical vessels with three or four feet from different periods discovered on sites in the ritual context (Źrałka *et al.* 2012: 4–6, fig. 5; Chase and Chase 2018: 6, fig. 2a). Its presence in this zone of the lake allows inferring that at least since that moment in history the area has been a place of some kind of cult.

In the same research zone, a little further north from the earlier mentioned discoveries, another artefact has been located which might confirm the hypothesis about the ceremonial character of the place (even though it has not been discovered *in situ*). It was a ceramic fragment of the incense burner with the anthropomorphic depiction (**Fig. 5**). Incense burners have been vessels used for burning the natural scented resin, copal, and rubber, although they were also used for burning other organic materials, such as maize and blood (Rice 1999: 25–28). During some ceremonies, such as termination rituals (which aim was a definite end of the connection of some architectural structure with a particular deity) such vessels were intentionally broken. Very often such fragments might be observed in the proximity of the Maya temples (Ferree 1972: 13–15). It cannot be excluded that the anthropomorphic fragment discovered in Péten Itzá might be an example of the aforementioned ritual practice and that is why another pieces of the vessel could not be found around the 'face'.

Chronology of the pottery discovered up till now indicates that the considered area located north of Flores Island might have been a place of cult at least from the Proto-Classic period, so it can be connect to the chronologically older settlement located in here before the arrival of the Itza Maya.

The area of Flores Island has provided not only the artefact collection with a huge probability proving the water-connected rituals of the inhabitants of the island but also about the warfare activities. Close to the western shore of the island a stone object has been located, which form indicates that it was probably a head of mace (**Fig. 6**). Majority of the sources indicate that the final battle between the inhabitants of *Nojpeten* and Spaniards have taken place west of the island (*Ursua to Real Acuerdo*, after: Jones 1998: 297, 492 [fn. 8]). It seems that the information provided by the Spanish accounts most probably has been confirmed by the archaeological sources.

Area II – Presumed Battleground

This zone includes the area expanding west from Flores Island (**Fig. 2**). According to the sources (*Ursúa to Real Acuerdo*, after: Jones 1998: 297) was the area of the battle between the defenders of *Nojpeten* and the Spaniards. Due to the fact, that the lakebed in between Flores and Santa Bárbara is covered with a thick layer of sediments, no artefacts have been recovered there in spite of attempts. Nevertheless, the aforementioned probable head of mace from the surroundings of the western shore of the Flores might be the proof that the battlefield is in fact the area further west, and that it might be covered with the artefacts of the military character.

Area III – Tayasal Peninsula

Activities of the project have been conducted also in the area along the Tayasal Peninsula, north of Flores (**Fig. 2**). Unfortunately, as in case of the previously mentioned zone, a very thick layer of silt made it impossible to collect any substantial artefacts (apart from the few pottery shards) during the non-invasive reconnaissance.

Area IV – Santa Bárbara Island

The next research area was the surroundings of Santa Bárbara Island, located west from Flores (**Fig. 2**). North of the islet, very close to its shore, the sandy lakebed is covered with stones of various dimensions and large tree trunks, further north turning into a thick layer of silt. At the south-eastern part the steep, stony slope ends in vast silt sediments, very often whitish in colour. Some pottery has been located in the surroundings of the island; one should distinguish quite characteristic pieces recovered so far only in the area of Santa Bárbara: vessels covered (or produced) with white clay (**Fig. 7**). It is quite possible that they might be the proof of the existence of the independent pottery workshop located on the island, but this hypothesis it is to be investigated, as the different colour of the pottery surface can also be the result of the water and sediment erosion.

Areas V and VI: Submerged Islands no. 1 and 2

These two separate operations have covered the area of the submerged islands located east (no. 1) and north-west (no. 2) from Flores (**Fig. 2**). Currently no part of dry land protrudes above the surface of the water. In the area of island no. 1 the stone covered lakebed was reported, as well as the thick layer of silt disabling the work; in case of island no. 2 the large stone slope is present. Second islet is a place of a significant archaeological potential, due to the significant amount of pottery present at the lakebed, which may be the clue for more artefacts under the sediments.

Area VII – Hospital Island

This zone covers the area around Hospital Island, which is located north-east from Flores (**Fig. 2**). On the stone and sludgy lakebed plenty of artefacts are located, dated from the Late Classic period, through the colonial times (1700–1821) until the modern epoch (1821–1950), when the hospital was located there (some of the collected artefacts are connected with its activity, e.g. glass ones, containers of medicines and other specimens, and maybe also few metal objects). They unique artefact from this area is undoubtedly a large ceramic vessel in quite unique form, on the surface of which an engraved ornament is visible (**Fig. 8**). The shapes of some decorations allow reflecting that it might have been the unsuccessful attempt of the glyphic writing, although at this phase of research it is not more than a bold hypothesis. In the close proximity of the vessel a large shell of the *Turbinella Angulata* type has been located, characteristic for the waters of the Caribbean Sea (Bandel 2003: 88; **Fig. 9**); its presence might indicate the contacts of the local inhabitants with the occupants of the Caribbean coast. Such a shell might have been used as a musical instrument (Moholy-Nagy and Ladd 1992: fig. 5.35) or has been the object of a large social significance, as in the Maya world it was connected with the elites (*Relación de las cosas de Yucatán...* after 1986: 39; Schele and Miller 1992: 66–71). It might also have been a symbolic item, as the shell in the Maya culture was closely connected with the birth (Thompson 1950: 133), as well as with sacrifices, warfare (Schele y Miller 1992: 215), underworld, and death (Thompson 1950*:* 49, 173, 278).

Synthesis and Conclusions

Lake Petén Itzá, or at least its preliminary surveyed southern part, is undoubtedly of a large archaeological potential. After the first research season of the project its participants have without a doubt observed some regularities and tendencies which will be verified during further research seasons.

First of all it has to be underlined that the research in 2018 season had a character of the reconnaissance aimed at recognizing the basin. It will result in efficient choice of the research methods as well as sites to perform more thorough excavations in the further planned seasons.

Even though it was only the reconnaissance, over 800 artefacts have been collected from the lakebed, the significant majority of which are the ceramic ones (**Fig. 10**). Only few objects were confirmed to be discovered in the place where they had been originally deposited. It has to be taken under consideration that over the centuries the water currents have been acting on the object located at the bottom, to some degree changing their location and position. Therefore, significant majority of the acquired artefacts was deprived of the context by natural means.

Majority of the collected material originates from the surroundings of Flores and Hospital Islands, specifically: the zone located between Flores and San Miguel (Tayasal Peninsula); the largest number of artefacts has been located north of Flores.

Thanks to establishing the chronology of the ceramic material one might observe how the human activity in the particular periods of time looked like. It has to be taken under consideration that the data has been acquired during the underwater survey research, not actual excavations, which (in the future) might indicate the wider context of the findings.

On the basis of the collection of vessels and the primarily established chronology of the 'sites' one might assess that the pottery from the Proto-Classic until the Late Classic period is mostly ceremonial and tableware; artefacts originating from the periods from the Terminal Classic (800–950 A.D.) until the Post-Classic (1000–1697) are the of the so-called applied character (they served first of all to prepare and store food and are the most numerous group of in the assemblage). The Colonial pottery consists mostly of jugs of the medium size.

Apart from pottery artefacts the metal, stone, shell, and glass ones have been located, although they establish a much smaller percentage of the objects.

Both the number and the type of artefacts might indicate the character of some parts of the lake. After the preliminary reconnaissance it seems very probable that the area connected with some kind of ritual activity has been located, as well as the probable battleground has been somehow captured with the discovery of the stone mace, where the activities during the final clash between the Maya and Spaniards might have happened.

It is also worth mentioning, that on the basis of research it has been established that the inhabitants of the region very probably have maintained some trade contacts with other societies, which were living in the area of the Caribbean Sea. The example of the artefact confirming this hypothesis is a shell of *Turbinella Angulata* of a Caribbean provenance.

During the first research season the attention has also been paid to other areas of the lake as well as the water reservoirs in its surroundings, to acquire information about the potential spots for further research. If the future allows using the professional research equipment, the verification of the hypotheses stated above will be possible, as will be acquiring new information about the settlement and activities of the Maya in this particular region.

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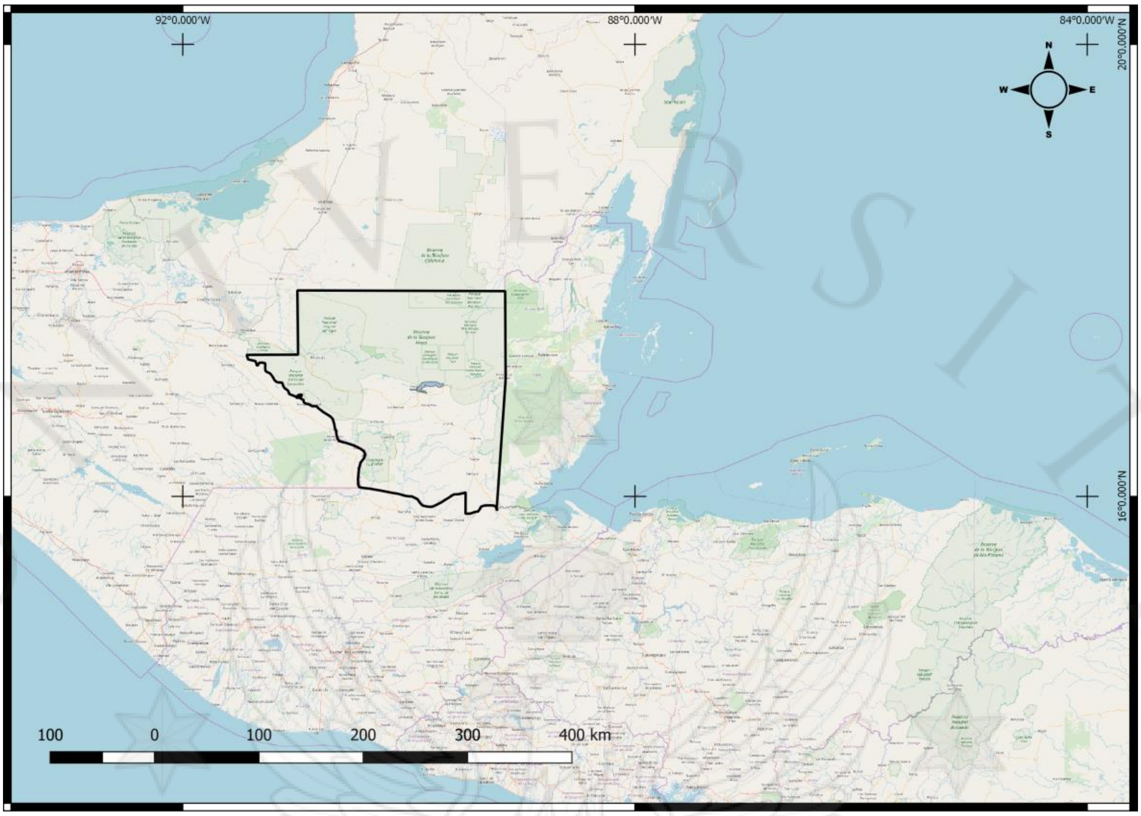

Fig. 1 – Map of the Petén Department with the location of Lake Petén Itzá (elaborated by: M. Popek)

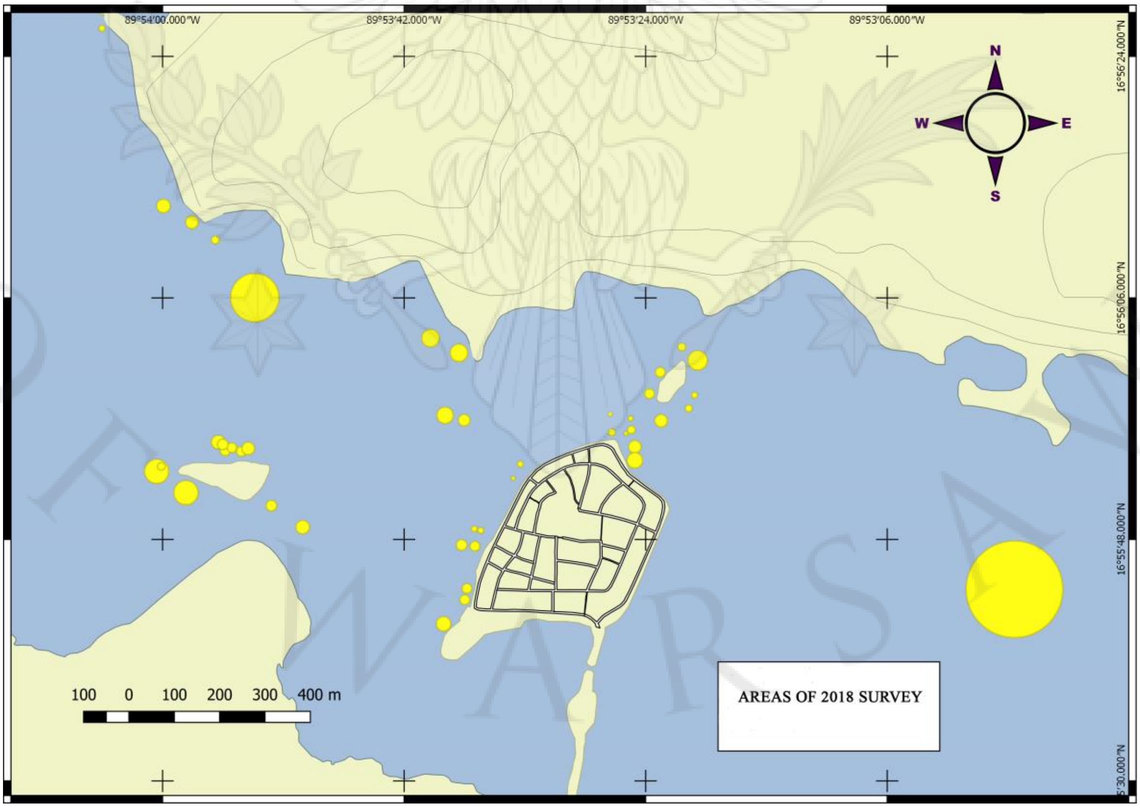

Fig. 2 – Map of the particular research areas (elaborated by: *Petén Itzá Project*)

Fig. 3 – Ritual deposit (photo by: *Petén Itzá Project*)

Fig. 4 – Ceramic vessel of a ritual character (photo by: *Petén Itzá Project*)

Fig. 5 – Fragment of an incense burner with the anthropomorphic figure (photo by: *Petén Itzá Project*)

Fig. 6 – Probable stone mace head (photo by: *Petén Itzá Project*)

Fig. 7 – Vessel covered with white clay (photo by: *Petén Itzá Project*)

Fig. 8 – Vessel with the engraved ornament (photo by: *Petén Itzá Project*)

Fig. 9 – Shell of the Caribbean provenance (photo by: *Petén Itzá Project*)

No.	AREA	RIMS	BOTTOMS	BODIES	HANDLES	FEET	TOTAL
I	Flores Island	83	52	379	9	31	554
III	Tayasal Peninsula	6	2	15	0	0	23
IV	Santa Bárbara Island	36	8	63	1	0	108
V	Submerged Island 1	0	1	0	0	0	1
VI	Submerged Island 2	6	0	4	1	0	11
VII	Hospital Island	35	5	47	4	7	98
TOTAL		166	68	508	15	38	795

Fig. 10 – Number of ceramic artefacts in the particular research areas (elaborated by: *Petén Itzá Project*)

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Significant Crossroads at the Lower Reaches of the River Váh[1]

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Abstract:

The Váh River is the longest Slovak river and at least from the Middle Ages it has been both an important traffic artery and a border, separating two banks that had to be connected with a bridge. For this purpose fords, ferries, and bridges have been used and the remains of these structures are still visible at some points when the water level is reduced. This paper will focus on the mapping of important traffic hubs at the lower reaches of the Váh River and look at their current conditions and their informative value. In particular, the area of the Váh near the town Hlohovec (Trnava Region, Slovakia), where numerous round structures are visible to the naked eye, attracts attention and in recent times has become a part of unwanted interest and the negative interference from the 'public'. In order to save as much information as possible, the attention of several scientific teams has, in recent years, begun to concentrate on the remains of the medieval (?) bridge.

Keywords:

river, the Váh, Hlohovec, Sereď, bridge, dendrochronology, ford

Introduction

Examination of monuments and sites under water is one of the priorities of the grant project of the Slovak team of underwater archaeologists. In spite of the effort to get the maximum data from the Slovak rivers and lakes, the research team is constantly facing several problems. Not only are the legislation and the methodological guidelines of the Monuments Board of the Slovak Republic insufficient, the methodology of the research itself is as well. The problem is also that there is a small number of experts able to perform work in the extremely adverse conditions of Slovak rivers. These factors greatly affect the possibilities of research. Because of these and other reasons, the research team has decided to focus on the lower reach of the Váh River (**Fig. 1**); they were interested in the region enclosed by the Hlohovec (Trnava Region, Slovakia) surroundings, along the estuary of the river, where it flows into

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the Danube. It is a territory rich in findings from the prehistoric period to the Modern Age. The Váh itself is the longest river in Slovakia (406 km) with a relatively large, but in many places shallow, riverbed. The river in the studied area flows approximately north to south, and its basin was in the west of the Slovakian part of the north-south Amber Road, which has been in use since the prehistoric times. Unique findings give evidence about the intensive life on the river since the last ice age. Fossilized remains of wood and bones of mammoths found in the Váh have been deposited at the Museum in Hlohovec. In the river a random finding has also been discovered, a part of a Neanderthal cranial bone found in the Šaľa area (Nitra Region, Slovakia), anywhere from 40 000 to 80 000 years old. The river has also been a source of water and livelihood in earlier periods. Numerous findings of fishing hooks provide evidence of fishing activities. Plenty of findings of various kinds in the shallowest places indicate the existence of fords across the river dating from the prehistoric times, and over time man has mastered the river so much that it has started to be used for transport more and more frequently. The oldest vessels on the Váh are boats from one piece of a tree trunk, so called monoxyla (also known as logboats or dugouts). They have been used for local fishing in the upper section of the Váh up until the last century. The last big functioning Váh monoxylon had been discovered in Chlmec (Žilina Region, Slovakia) and was added to the collections of the National Museum in Prague (Novotný 1951: 259). Rafts have also been largely used as a way of transportation on the river. The transfer of people and goods in this way has been documented since the 16th century. Even nowadays it is possible to see tourist rafts on the Danube River. For the river crossings, ferries have been used, that might have originated by merging separate smaller monoxyla. However, the difficulty and slowness of this way of crossing the river, not to mention the frequent floods, has later prompted the construction of bridges on the river as well as its regulation. The efforts to regulate the Váh appeared in the 16th century, when the landlords from the Nitra Region riverside area presented a request to parliament to reinforce the banks. Parliament started to deal with these requests with articles of law in the years 1659, 1687, and 1751 (Mezey 1899: 406). According to the research of the Slovak colleagues, the lower Váh River (within the section from Sereď to Komárno, Nitra Region) was intensively modified from the 17th century. The number of original meanders of the river, not having been listed during the *Second Military Survey of the Habsburg Empire (1806–1869)*, increased to 26 (Procházka and Pišút 2015: 45) and modifications continued for another 200 years. Floods were not the only reason for its modifications in lowland areas. The water in Slovakia is, as well as in other countries, used to generate energy. In the past large and small dams had been built to regulate the water flow. The most important reservoir in the researched area is the Kráľová Water Reservoir (44.2 to 78.6 kilometres of the river). The vast majority of the territory that has been regulated has gone underwater without any research. Even today, occasional cleanings and modifications to the riverbed and the banks devastate these areas.

For the archaeological public, rivers are a very difficult source of information to access. Despite the theoretical and archival research, areas that still have potential and can greatly help to gain new knowledge about the road infrastructure as well as other ways of usage of the Váh River have been defined. During 2018 intensive research focused on three locations of archaeological potential. Those were Hlohovec, Sereď/Šintava (Trnava Region, Slovakia) and the Neded areas (Nitra Region, Slovakia). This study concentrates only on two of them, Hlohovec and Sereď.

The Váh River near Hlohovec

Hlohovec city was originally established as a residence near the elevated cliffed coast, on which today lies a monumental Renaissance-Baroque castle. The Váh River flow is inherently linked to its history because there have been places near Hlohovec which could be crossed; therefore, contributing to the fact that there are places located not only directly in the city, but also in its close surroundings (**Fig. 2**).

The fact that the territory was inhabited in the prehistoric period has been proven by several well-known findings, not only from the surroundings of the river (settlement from the Bronze Age in Posádka; Kuzma and Bartík 2011: 159), but also directly from its riverbed. If the places are named from north to south, Zelenice (Trnava Region, Slovakia) is between Hlohovec and Dvorníky (Trnava Region, Slovakia). According to Urminsky's report, in 1994 when rafting on the river between Hlohovec and Zelenice, the city's inhabitants discovered "*a shaman's antler stick decorated with a set of notches and an aperture for the placement of a stoc,*" which dated back to the Mesolithic (Urminský 2018). One extremely rare finding from the Bronze Age is called 'Stabdolch'/Early Bronze Age (Halberd). It was found in 2017 in the St. Peter district (Hlohovec) of the Váh and after observing the condition, the Regional Monuments Board Trnava (according to Slovak legislation) awarded the finder with 100% of the finding's value. The place of the finding was further north of the current bridge across the Váh (Bača *et al.*, forthcoming; Daňová *et al.* 2018: 204, fig. 213) and could indicate a larger settlement or a crossing of the river above Hlohovec in the area of Koplotovce village (Trnava Region, Slovakia) has been existing during this period. Down the river there is the Dvorníky-Posádka location, where another ford has probably been located. Several findings from the Roman Period have been found, among which the finding of a Germanic snaffle in 1989 is the most interesting (**Fig. 3)**. It also points to the presence of the Germanic people in this area (Novosedlík 2013). Jozef Urminský specifies the chronology of the finding for the 2nd century A.D. (Urminský 2018). According to a study by Susane Wilbers-Rost, the different parts of the snaffle can be typologically assigned and complemented by analogies. The chain links correspond to the type Z 4b (Wilbers-Rost 1994: 46–47) and the analogies of this element are stated in a study from Sweden (Wilbers-Rost 1994: 194, Nr. 85; 197, Nr. 92) and Germany (Wilbers-Rost 1994: 184, Nr. 42). The chain rings correspond to the type R 1, which, according to the study, cannot be dated more precisely (Wilbers-Rost 1994: 56–57). The end of the snaffle chain cannot be typologically assigned more precisely, but its shape is similar to the type Rh 2a (Wilbers-Rost 1994: 59–60). They differ in the shape of the flat end (the snaffle from Hlohovec has it rectangularly shaped) and the specimen from Hlohovec is missing holes in the threads. The snaffle bit is similar to the Ks 4 type (Wilbers-Rost 1994: 56–57) which has analogies in the territory of Denmark (Wilbers-Rost 1994: 166, Nr. 14; 178–179, Nr. 28; 180, Nr. 33; 181–182, Nr. 35), Moravia (Wilbers-Rost 1994: 186, Nr. 52), Poland (Wilbers-Rost 1994: 189, Nr. 65; 193, Nr. 81), and Slovakia (Wilbers-Rost 1994: 212, Nr. 138). Basing on datable chain link analogies (Z 4b) and the bit (Ks 4), the Hlohovec snaffle can be assigned to the period C_{1b}–C_2. A La Tène quern-stone (Urminský 1997: 178), Celtic bronze jewellery, a clasp from the Roman Period, as well as bronze and iron fishing hooks, which are now part of the exhibition in the Homeland Museum Hlohovec[2], probably have their origin in this area (Urminský 2018). Unfortunately, some authors date the preserved remains of the bridges in Hlohovec to this period, which cannot be the case basing on reality (Patrov *et al.* 2016: 112). The presence of Roman troops in the territory of present-day Slovakia is undisputed at least during the Marcomannic Wars, but the preservation of bridges of any kind on Slovak rivers with the exception of the Danube would be rather unique. Other well-known objects from the Váh River are dated back to the High Middle Ages, despite the fact that the historians presume the presence of the Great Moravian settlement on Hlohovec castle hill. After the fall of Great Moravia, the territory of Hlohovec and the nearby Červeník

[2] Slovak: *Vlastivedné múzeum v Hlohovci.*

(further south) was apparently occupied by the first wave of the Old Hungarians as a significant support point (Gálik 2013: 263) and the character of the settlement and material monuments suggest that the area had to be defended against the enemies from the northwest, who could have crossed the Váh River near Hlohovec, Červeník or Šintava (Gálik 2013: 265). In the 11th century the fortified castle above the river ford had become the residence of the border committee and gradually developed into a flourishing town with market privileges (14th century) helped with the further development of the city. The undeniable cause of the city's economic prosperity was the construction of the passage across the Váh River, which was firstly a ford and later a bridge at the latest in 1270 (Gálik 2013: 283). Besides the dry toll for the bridge, a so-called wet toll for goods travelling on the Váh was collected, mostly timber, and 10% of the income belonged to the Bishop of Nitra (Gálik 2013: 283-284). There is also a large number of different melee weapons dated to the Middle Ages from the Váh riverbed between Madunice (Trnava Region, Slovakia) and Hlohovec (Urminský 2018 – iron swords from the 13th century), near Hlohovec (Labuda 2016: 62, 6.11 [fourteenth/fifteenth-century sword]) or the nearby Dvorníky, Posádka location (Labuda 2016: 115, 7.9 [fifteenth-century hunting sword]; Labuda 2016: 119, 8.1 [fourteenth-century sword]). The first known image of the Hlohovec Bridge is on the Lazio's map from the middle of the 16th century, where the city is shown as an important crossing; it documents its importance on the Czech Road (*Via Bohemica*), which at that time had been a centuries-old trade route. According to Urminský, the size and width of the built bridge should have been sufficient for two carriages going alongside each other (Bojničan 2016; **Fig. 4**). It stood in place (**Fig. 2.1**) at least until the 18th century, when (in 1727) its main role was taken by a bridge a little lower along the river flow (**Fig. 2.2**), closer to the Erdödy Castle in Hlohovec (Bojničan 2016) and remained so until 1905. In the 18th century, there were also some great changes in the riverbed above Hlohovec, when Emperor Charles VI attempted an unsuccessful modification in the flow of the Váh around Leopoldov (Pišút *et al.* 2016: 136–137). These could have affected and influenced the coastal life as well. The appearance of a wooden bridge from the 18th century is captured on the paintings (*Painting of Hlohovec I, Painting of Hlohovec II*, both after: Pišút *et al.* 2016: 226 fig. 184–185) as well as in the first photographs (*Hlohovec Bridge in 1899*). The bridge was replaced at the beginning of the 20th century by the reinforced concrete structure, which in April 1945 was destroyed by retreating German troops (Urminský 2018). Today's bridge was built in the 1960s a few hundred metres upstream from the medieval ones (**Fig. 2.3**).

A separate chapter of the findings from the Vah riverbed includes copper ingots, which are now stored in the collections of the Homeland Museum in Hlohovec. There are ten flat round objects, weighing from 2.5 to 6 kg. Urminský offers the theory that due to their quantity, somewhere near Hlohovec a vessel (raft) that was carrying the cargo of ingots, has capsized (Urminský 2018). Slovak researchers have been recording these findings for a long time; one of the oldest is an unpublished master thesis by Mária Novotná, who dates the first round of copper ingots from this area back to the Bronze Age (Novotná 1958: 96–97, 123–124). Some scholars still accept this information (Podolan 2003: 24). The new specimens of copper cakes from Hlohovec have not been subjected to any metallographic analysis yet; nevertheless, considering the findings from other locations, it can be assumed that the raw material found in Hlohovec originates from the territory of Central Slovakia. However, on the basis of analogies, dating may be earlier. The similar ingots can be traced beyond the northern borders of the Kingdom of Hungary. A Polish study reviewed copper ingot cargo from a medieval shipwreck in the Gulf of Gdańsk (Pomerania, Poland). Their features (Ossowski 2014: 244, fig. 2) are the same as those of the ingots from the Váh near Hlohovec. Waldemar Ossowski reports other cases of similar copper ingots in Europe (Ossowski 2014: 246, fig. 4). It seems that in case of the Slovak provenance of copper and its distribution to northern Europe, the Váh also significantly contributed, especially in the time of the Turkish threat – after the Battle of Mohács in 1526.

An integral part of life in Hlohovec was the system of water mills. Their most important centres were located at the Váh near Hlohovec, Sereď, and Šoporňa (Danterová 2007: 3). Urminský has referred to a significant discovery of the residues of an old mill during a dredging of a meander in the old Váh in Hlohovec (on Industrial Street); a millstone has also been found there, and thanks to the humid environment also the remains of blades (Urminský 2018). The number and distribution of water mills in Hlohovec has probably changed according with the alterations of the riverbed after the periods of high water level in spring and after floods. This is evidenced by comparing information from maps with vedute (see the information further in the text). For example, a relatively detailed study by Daniela Gräf, who focuses on documenting the number and types of mills, draws directly from the *Second Military Survey*... about Hlohovec and counted 28 water mills on both banks of the Váh (*Second military survey...*). According to the archives, representation of the Monuments Board is on vedute and sketches of Hlohovec town (*Painting of Hlohovec I*; *Painting of Hlohovec II*; *Painting of Hlohovec III*; all after: Urminský 2013: 16), and the number of water mills in the 19th century was diverse.

The interest of amateurs and the professional public has recently focused mainly on the poles that protrude from the Váh River below the current bridge. The historical value of these structures is repeatedly emphasised by archaeologist Jozef Urminský in his papers addressed to the public, while focusing on information about the medieval bridge (Urminský 2018; Bojničan 2016). According to the previously unpublished research by Urminský and Bárta, the piles are at the place of the medieval bridge, dated to the 17th century.[3] A local fisherman, who earned himself undesired attention, decided that he would sell two of them and advertised them on the Internet as 'piles from a medieval bridge' for 20–30 euro.[4] Thanks to the quick response of the Regional Monument Board Trnava (Trnava Region, Slovakia), in cooperation with the police of the Slovak Republic, both poles with iron forged reinforcement at sharpened ends have been secured and offered to archaeologists for documentation and to dendrochronologists for taking samples. Thanks to collaboration with Mojmír Choma (ADendro/ dendrolab.sk), on-going since November 2018, the research team knows that the poles are made of oak trees cut in the 19th century (the last measurable annual ring in both of them was in 1832).

The fisherman's activity encouraged the authors of the report to the field survey. The first one took place in June 2018, and during the low level of the river not only the remains of several bridge structures have been discovered, but also wooden piles along the banks that could have belonged to water mills or structures controlling river flow (**Fig. 5**). At the same time the authors recorded and documented several poles (**Fig. 6**) of similar construction as the ones found by the unreflective seller. The structure or precise location around Hlohovec to which they belong has not been identified so far. Subsequent drone documentation in the same month was inadequate to create a photogrammetric model with respect to the scope of the area (longer than 1200 m). The systematic documentation of preserved structures will be the biggest challenge for the authors of the hereby paper. The interdisciplinary cooperation with experts in history, dendrochronology, hydrology, landscaping, IT, etc. will be necessary for their subsequent understanding and presentation.

[3] Oral information from Jozef Urminský.
[4] The advertimsent on bazos.sk has been deleted during the police investigation.

The Váh River at Sereď and Šintava

Area of Sereď and Šintava (**Fig. 7**) is an important location, especially due to the existence of several fords across the Váh River, which have apparently already existed in the prehistoric period. In the 8th and 9th century they were protected by fortifications having been a part of an important route linking the West and the East. In the area of interest there is a well accessible link between the highlands of Nitra and Trnava (neither have been flooded) passing through the river flat made of several river bends, among which the higher-lying fluvial-eolic dunes are situated (Ištok 2002: 14). On the banks of the Váh River between Šintava and Sereď a castle has been built, dated back to the 12th century. The castle was the centre of the so-called 'border committee' (Slovak: *pohraničný komitat*), which formed the second line of kingdom defence against attacks from the western area of the Czech principality. In the same time, it also provided protection for the river crossings (the ford, and also the bridge) and has also served in the system of country's economic governance to collect tolls. The importance of the castle is also evidenced by its reconstruction from wood to stone, the first phase of which took place in the first third of the 13th century, during the reign of Andrew II (Chromeková 1998: 31). In the written sources, the long way (the Czech Road/*Via Bohemica*) from Sereď to the West is mentioned in the Nekýj restriction from 1324 (*Magyar Nemzeti Léveltár 2253,* after: Sedlák 2002: 42). In 1412 tolling while crossing Sereď is mentioned (*Magyar Nemzeti Léveltár 9869*, after: Sedlák 2002: 43).

The subject of our interest was to gain as much information as possible about the existence of a ford, bridge, or findings pointing to these places. The first mention of toll bridge in Šintava is dated back to 1508 – *The Register of Receives of the Šintava Castle from the Crossing the Bridge and Toll* [5] (*Magyar Nemzeti Léveltár 32 632*, after: Kerestéš 2016: 12, 14).

Another source of information is the maps. The oldest known map is the Lazio map of Hungary from 1556 (*Lazius map 1556*), which depicts Šintava Castle. The research team did not identify any marked passages on this map, although one can notice a clearly marked Hlohovec Bridge. Even on the next map from 1663 (*Extract, Wass A 1663,* after: Melníková 2002: 60), which captures the Turkish military campaign from 1663 in the Šintava surroundings, no passage across the river is depicted. The passage across the Váh River was marked for the first time in 1667 in the plans of the fortification reconstruction of Šintava Castle (*Landesarchiv Karlsruhe HfK XIII,* after: Petrovič 2006: 9). In addition to the bridge

[5] "*Regestrum… Matheii Porkolab de Zered provisorem castri Sempthe super proventi pontis et telloni*" (trad. the authors).

itself, a building (toll house) in near of it is also marked. It was identified by Engineer František Böhm[6] that on maps and plans from the earlier period, in addition to the bridges, a river modification has been made. In connection with the search for information, the research team member also interviewed museum workers in Sereď and Galanta (regional museums[7] where archaeological findings from the closest surroundings are deposited). The valuable information was provided by former museum workers Jozef Ižof and Pavol Ištok, who in the 1980s documented part of the bridge construction (pillars) at the time of the low water levels (**Fig. 8**). This information became the basis for field research in the area. A unique copper ingot with embossed signs was found in 1985 near the older bridge between Šintava and Sereď (Ragač 2008: 8). On the surface of the ingot the letter "M" is embossed, a circular seal with the symbols of the Fugger family and the inscription "FEP". Even this finding has not been metallographically analysed so far and published in detail.

In 2018 the first research was done in the area of bridge construction 1 (**Fig. 9**), which is the same as the bridges depicted on newer maps from the 18th–19th centuries (*Second Military Survey...*). The water level allowed photographic documentation of five pillars. This was well-worked wood in square shaped cross-sectional dimensions. The pillars were perpendicular and only a few centimetres were visible; the rest was under a thick layer of river gravel. Obliquely laid piles with a circular cross-sectional dimension were captured south of the bridge construction. It was a dense construction. After consultation with Pavol Ištok, it was found that this could be a technical work regulating the direction of the river flow, a so-called spur (diagonally from the bank to the flow protruding spikes of logs [tree trunks], reflecting the water flow, serving as protection against damage and erosion of the bank). Due to the unfavourable conditions – the strong current as well as the higher water level in the river channel and very poor visibility – it was not possible to examine the bridge structure 1 to a larger extent. The aim of the next season is to take samples from bridge 1 as well as to attempt to look for the rest of the structure 2 (south of bridge 1) that was identified in the 1990s. Today the structure 2 is located under approximately 50 cm of gravel silt.[8] During the period of the existence of the bridges, they were on many occasions subject to intentional and accidental destruction or damage – military conflicts, natural disasters (glaciers), high water level impact, tree trunks ripped out by floods (Kerestes 2016: 14).

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6 František Böhm was an Engineer and Geometer of Nitra County, serving also to Esterhazy family.
7 Municipal museum in Sereď (Slovak: *Mestské múzeum Sereď*); Municipal museum in Galanta (Slovak: *Vlastivedné múzeum v Galante*).
8 Oral information by Pavol Ištok.

A large amount of information about the bridges has brought forth many questions. How is the dating to be dealt with? From the previously mentioned written sources it is known that several shifts, re-buildings, and modifications have happened over the centuries. Parts of the bridges have been dismantled and then used in the construction of new ones. Archival research was important for the identification of structural elements in individual periods and for the recording of conversions and the construction of new bridges in the surrounding area. Historical mapping (*Second military survey...*) points to locations and also approximate dates. But what phase is captured by the pillars? At the moment we are facing the challenge of designing the research methods as efficient as possible in order to achieve the desired effect. It should result in the clarification of the dating of the bridges, identification of their re-building and modifications that occurred.

Conclusion

In the past, rivers had strategic importance. They formed boundaries but also connected remote areas. The Váh River also played this role. In 2018 the attention of the research team focused on exploring two positions: Sereď/Šintava and Hlohovec, which are located on the Váh River. Thanks to the fact that both cities are rich in history, archivists gave them due attention in the past. Archival research has uncovered much information in both cases, particularly in relation to toll collection when crossing the Váh River (Kerestéš 2016: 10–12). Both locations had about the same strategic position. They connected a significant European trade route (the so-called 'Czech Road') in the direction from the East to the West through the fords and bridges. The Váh River formed a separate river route in the north-south direction, and, in particular, it was convenient for the transportation of bulk cargo carried on rafts. Near the intersections there were water mills which could convert some of the raw materials into ready-made goods (such as driftwood for boards), and the settlement of the banks used the presence of the island in the middle of the Váh (in both cases). Thanks to the conducted archaeological survey it was possible to capture the position of several bridges. At the connectors of these two road types, unique intersections have been created, which served for the relocation of goods, the collection of tolls and information and technology transfer.

Archaeological findings are the evidence that both locations could have been crossroads in prehistoric and ancient times. The frequency of medieval trade and road building allowed for the formation of full-fledged intersections that required organisation and rules.

The protection of commercial interests, rules, and toll collection started to be relatively fast in both localities (Hlohovec, Sereď) by the fortified settlements of the elite to which the bridges belonged in the earlier period ($18^{th}/19^{th}$ century). Thanks to written documents, much more has been learnt about them, but only broad interdisciplinary research can provide a comprehensive view of these important crossroads on the lower Váh River in the future.

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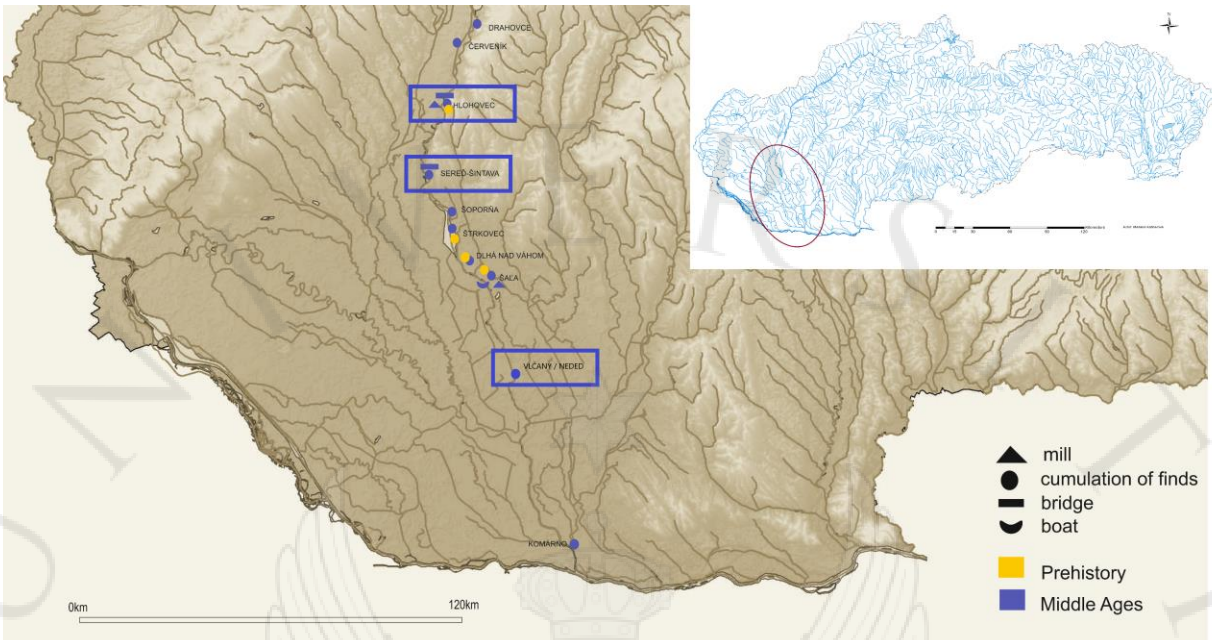

Fig. 1 – Map of important archaeological sites on the lower reach of the Váh River (elaborated by: M. Kaštierová, K. Daňová, M. Daňová, J. Stehlíková)

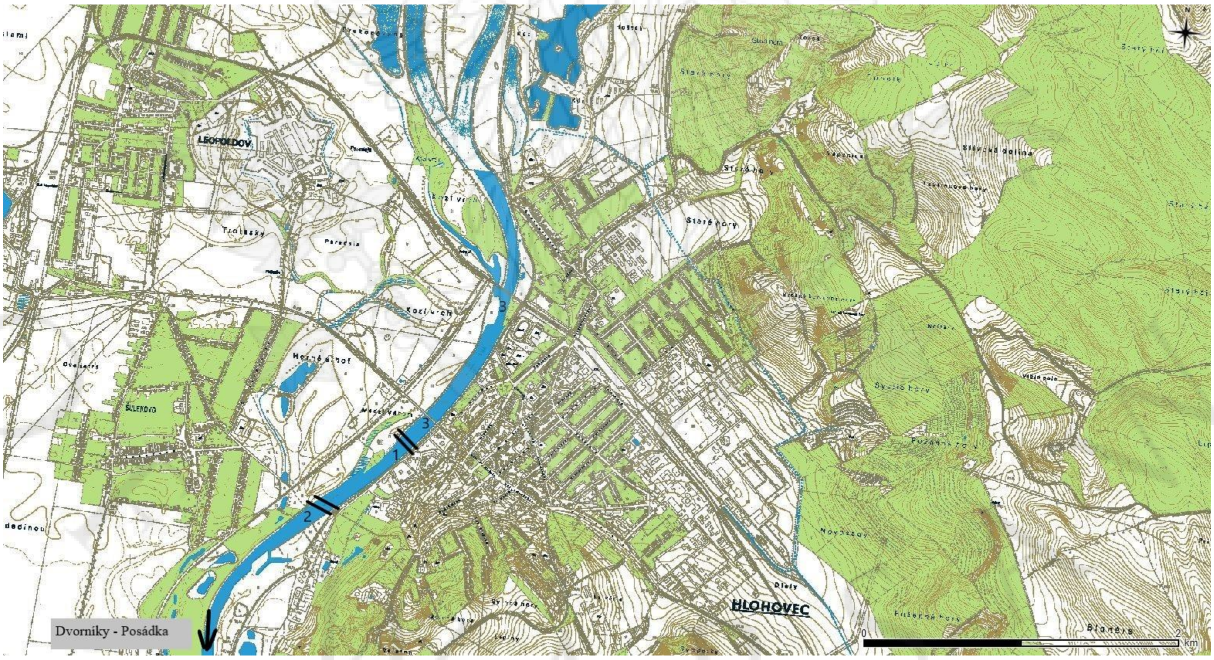

Fig. 2 – Bridges in Hlohovec (1 – medieval (?) bridge remains, 2 – bridge from the 18th century, 3 – present-day bridges); scale 1:10 000 (elaborated by: K. Daňová, M. Daňová)

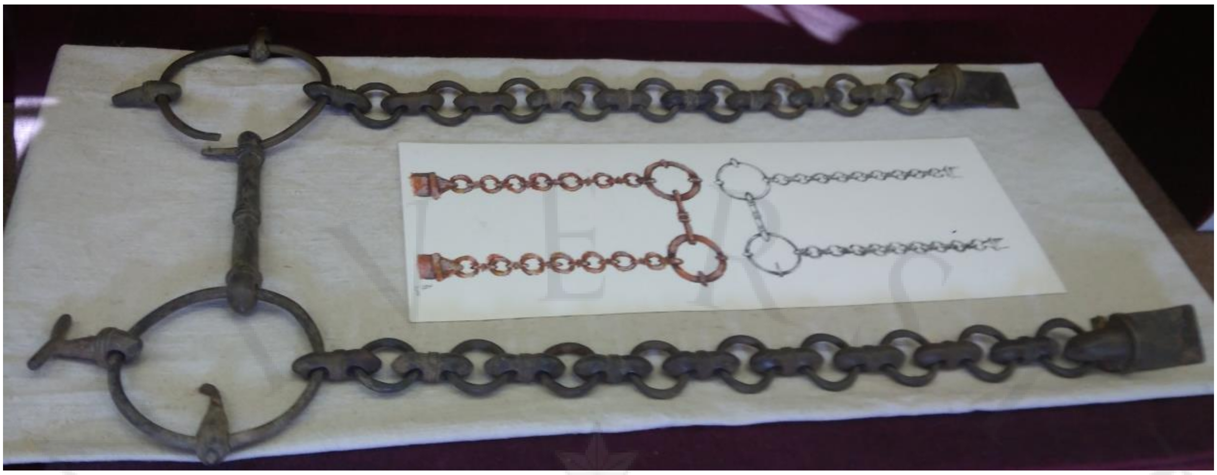

Fig. 3 – Snaffle from the Roman Period, found at Hlohovec, in the location Dvorníky–Posádka, directly from the Váh riverbed (photo by: K. Daňová)

Fig. 4 – Remains of the medieval (?) bridge, in service until the 18th century A.D. (photo by: K. Daňová)

Fig. 5 – Wooden piles and structures along the banks of the Váh River, area of the eighteenth-century bridge (photo by: K. Daňová, M. Cheben [Institute of Archaeology, Slovak Academy of Sciences])

Fig. 6 – Piles with iron forged reinforcement on the bank of the Váh River (photo by: K. Daňová)

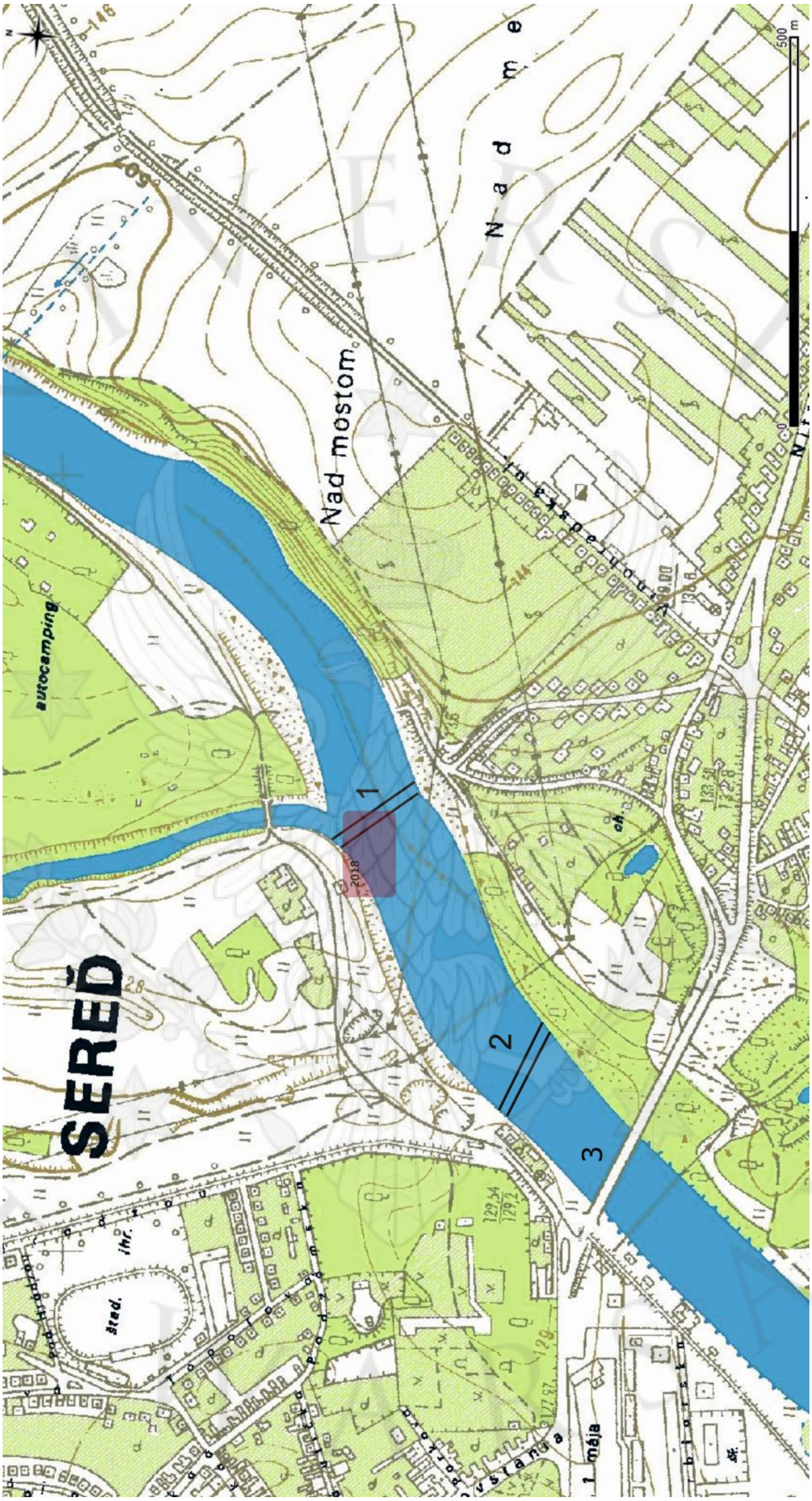

Fig. 7 – Bridges in Sereď (1 – bridge from the 19th century, 2 – medieval bridge remains (?), 3 – present-day bridge, in red– area studied in 2018); scale 1:10 000 (elaborated by: K. Daňová)

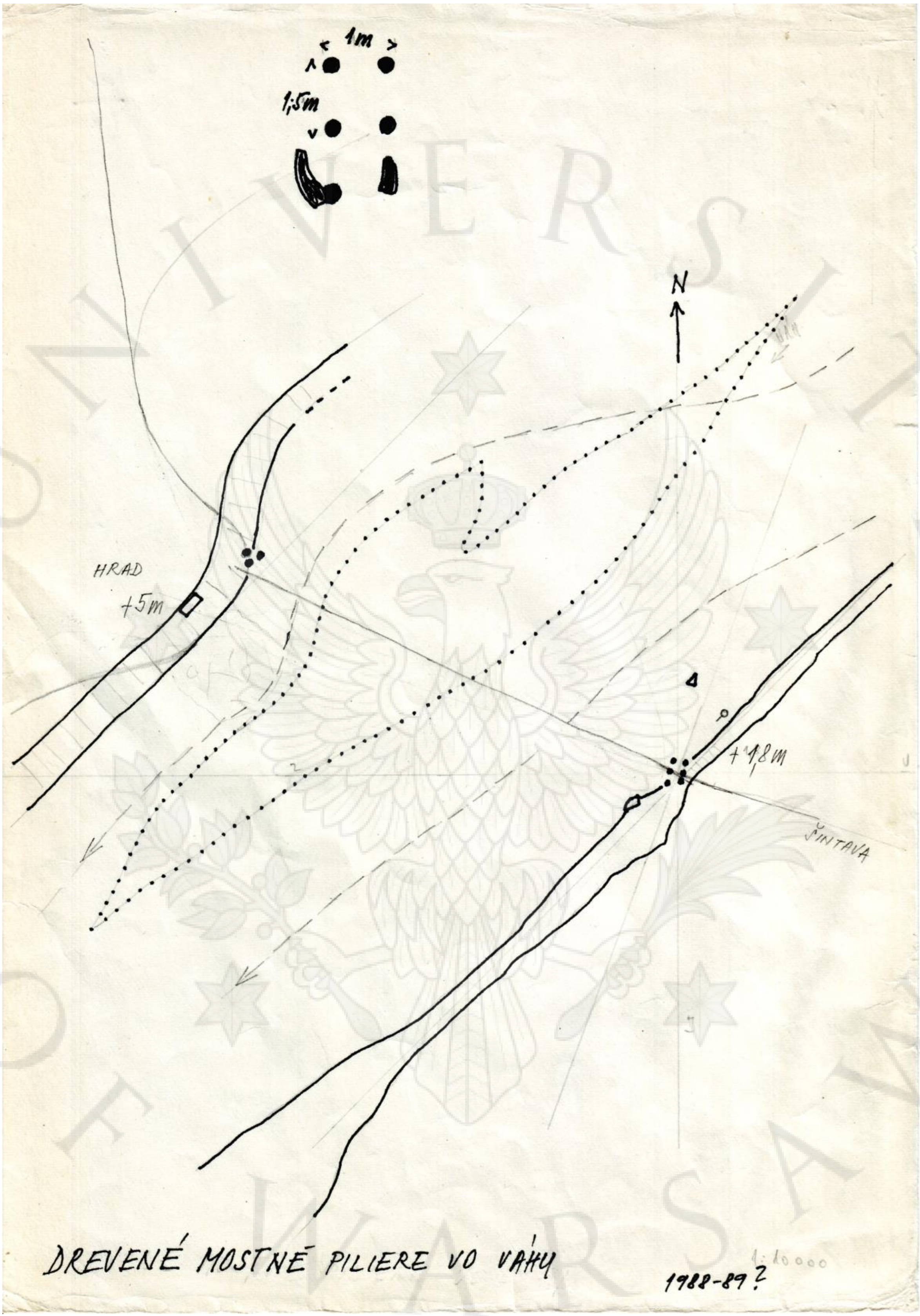

Fig. 8 – Documentation of the bridge construction (no. 2) by former museum workers; not visible today (elaborated by: P. Ištok)

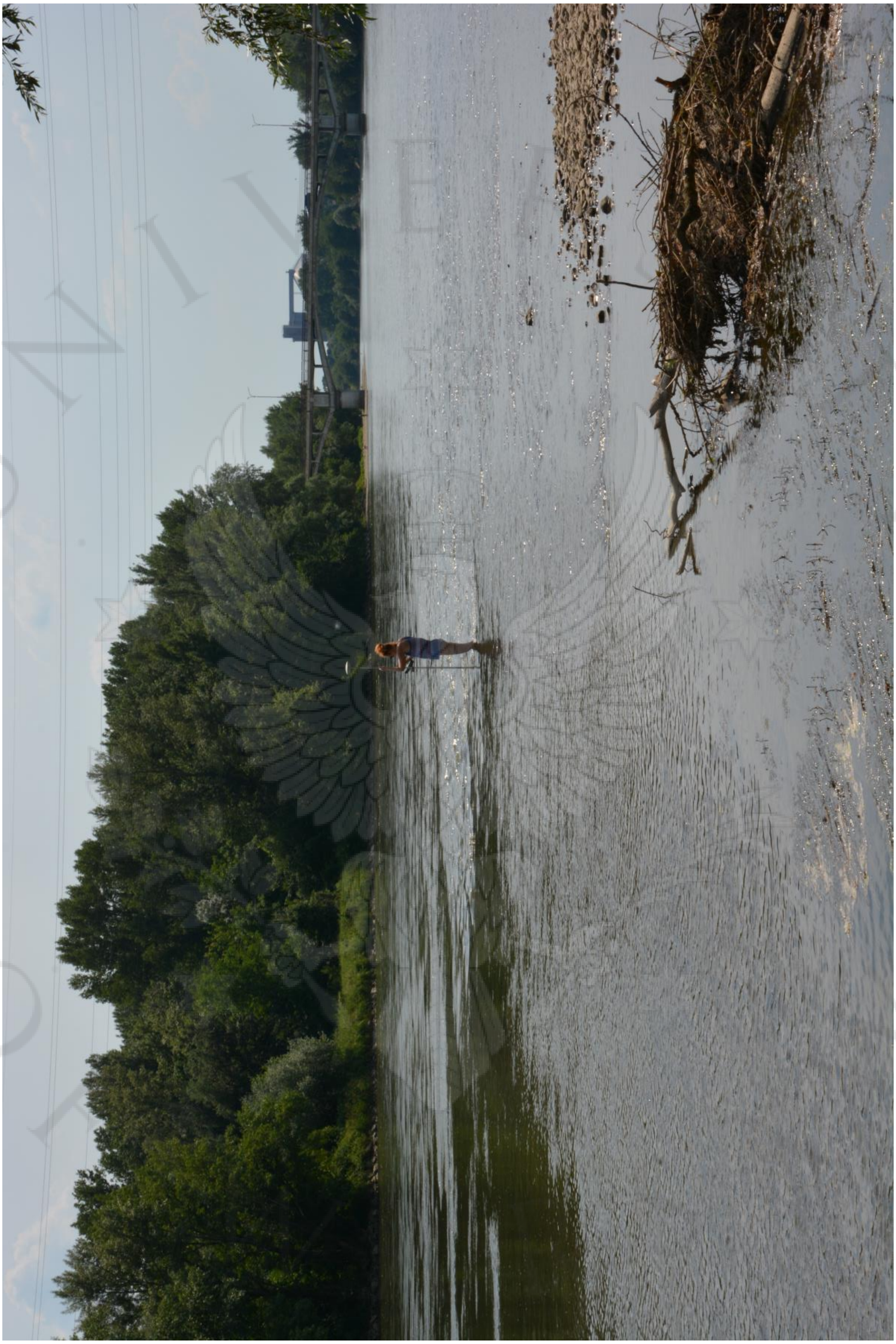

Fig. 9 – Documentation of the wooden remains of the bridge (no. 1) and water regulation system; summer 2018 (photo by: K. Daňova)

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Axes from Lake Lubanowo (Pomerania, Poland) and Their Possible Function on the Background of Watery Finds of the Roman Period and Middle Ages

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Abstract:

In the small lake at Lubanowo (Pomerania, Poland) numerous interesting items have been discovered, both by chance and during regular surveys. Apart from weapons and tools dated to the Roman period some medieval specimens have also been found here, i.a. axes. Together with the Roman period axes and adzes they create a collection of specimens which may be treated as carpenters' utensils. But is that interpretation correct? The paper discusses possible answers to the question of the plausible function of the items but also analyses the phenomenon of similar finds from lakes dated to the Roman period and Middle Ages. The Roman period ones are interpreted in the same way as north European parallels, i.e. as sacrificial deposits; further sites of the same character with finds of axes from the territory of Poland are mentioned, i.e. Krępsk (Pomerania, Poland), Piła (Greater Poland), Żarnowiec (Pomerania, linked plausibly with the Wielbark culture), and Łężany (Warmia, Poland; the Bogaczewo culture). Much bigger scope of possible explanations is discussed in case of items from the Middle Ages. Chosen parallels from Pomerania and Greater Poland are taken into account, including elaborate dispute referring to weapons from Ostrów Lednicki (Greater Poland). The latter have been treated, i.a., as the losses connected with building of the bridges or with the battle which had hypothetically taken place on both bridges; however, the article underlines certain sacral acts to explain finds from Lake Lednica but also certain other medieval watery finds of tools and weapons. The position of the Lubanowo finds allows falsifying some of original interpretations and in conclusion it is assumed that most probably the said axes from Lake Lubanowo had been deposited sacrificially.

Keywords:

axe, adze, Lubanowo, Roman period, Middle Ages, sacrifice, weapon, underwater archaeology

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In the small lake at Lubanowo (Banie comm., ex-*Liebenow* in West Pomerania, NW Poland) numerous interesting items have been discovered, both by chance and during regular surveys. From 2014 until 2018 the team of scholars and students from the Institute of Archaeology, University of Warsaw, featuring the Institute of Archaeology and Ethnology, Polish Academy of Sciences, has conducted underwater survey in the former *Herrn-See* in Lubanowo (Nowakiewicz 2016: 17–20; Brzóska and Kontny 2016). During underwater research weapons, potsherds, tools, and horse harness elements (including chain reins) have been found (Kontny *et al.* 2016a). They are dated mainly to the Roman period but also to the Middle Ages (Kontny *et al.* 2016b). Some of the Roman period items bear traces of ritual destruction (Kontny 2016: 286). The parallels to Roman period weapons may be indicated in the Przeworsk culture and, to some extent, also in Scandinavia (the ones from the younger Roman period).

Among the items dated to the Roman period there is the Oder-Elbe-type axe (Kontny *et al.* 2016a: 133; **Fig. 1:1**), typical of the Younger and Late Roman period (Kieferling 1994: 339, fig. 4),[1] which has been discovered by unprofessional explorers. Such form is characteristic for the interfluve of the Elbe and Oder Rivers, i.e. Elbian cultural circle, Luboszyce culture, and the Bohemian Basin (Kieferling 1994: fig. 4) but their distribution should be broadened into the Jutland Peninsula (Kontny *et al.* 2016b: 245–246) and Pomerania (Kontny *et al.* 2016b: 244–245; Kontny 2019: 84–85, fig. 15:3).[2] Another axe (**Fig. 1:2**) may be attributed to Żarnowiec type (Kontny *et al.* 2016b: 132–133) and dated similarly to the aforementioned one, although they are proved already in the B_{2b} phase. Such scarce forms appear in the entire territory of Poland, but close parallels may be found in adjoining area of the West Balt circle, southern Scandinavia, and even as far as the Pontic zone (Kieferling 1994: 341–343, fig. 6; Kontny *et al.* 2016b: 246–247). One may also add to the list a few adzes (**Fig. 1:3–7**), three of them quite small (below 10 cm in length) and asymmetric, with rectangular cross sections of sockets (Kontny *et al.* 2016a: 142–143; 2016b: 257–259). Two were slightly bigger; one of them had a circular sleeve (Kontny *et al.* 2016a: 141–142). Both forms have Roman period parallels, e.g. for the larger items – the specimen from possible sacrificial bog find from Żarnowiec (Pomerania, Poland; Kontny 2006: 150, figs. 1:E, 2–3) – and for the smaller – numerous Roman period finds from the West Balt circle, but documented also i.a. in northern Europe

[1] Adopting the classification of the Luboszyce culture axes, it should be classified as type A according to Grzegorz Domański (1979: 51) or type 2 after Walter Matthes (1931: 43, pl. 27). Such slender forms possess triangular projections, i.e. indistinct lugs just beneath the eye and asymmetrical blade, frequently with slightly distinct beard and barely pronounced butt.
[2] See also the Pomeranian find from Lake Krępsko, described further.

(Kontny 2016: 38–41, fig. 2) and Dębczyno group (Pomerania) in the younger Roman period (Kokowski 2006: 133, figs. 1, 3:b).

During the regular survey, a few specimens dated to the Middle Ages have also been found in Lubanowo; among them the early medieval axe of type 5, variant IB.5.4 according to Kotowicz (**Fig. 2:1**), i.e. a local form typical in particular of northern Poland and used primarily in the 10th and 11th century (2018: 88–89, pl. VII:5). Additionally, two stamped late medieval axes along with their wooden hafts have been surfaced (**Fig. 2:2–3**); these ones should be assigned to the popular type IX according to Głosek and dated to the wide time span from the late 13th until 16th century (1996: 40–43, 80, pl. XVII– XXIII; see also remarks of Piotr Kotowicz who noticed the thirteenth-century roots of the aforementioned types, *cf.* early medieval types IIB.7.3 and IIIB.7.3 [Kotowicz 2018: 121–122]). The hafts were made of branches: the first of them of diffuse-porous wood (maybe birch) and the second of black oak.[3] Medieval items were generally spotted at the larger depths (ca. 2–4 m) than the Roman period ones (up to 2 m), which may be a result of changes of the lakeshore outline (**Fig. 3**).[4] Axes from the Roman Iron Age unfortunately come from accidental finds, so one may only generally place them in the north-western and western part of the reservoir, in the area of a stony lakebed or close to the north-eastern shore.

Together with the Roman period axes and adzes the collection consists of ten specimens, which may be treated as carpenters' utensils. To answer the question, one has to analyse the size and form of each axe. For the Roman period items there are no well-established traits which allow distinguishing weapons from tools in a definite way; one may rather assume that most frequently the considered items are multifunctional, however, with the predominant military function (Kontny 2018: 80–85). Such studies of early medieval items have been done lately by Piotr Kotowicz (2013: 78–81; 2018: 155–165), who has linked the smallest forms (below 10 cm in length, weighting less than 100 g, frequently having short hafts, up to 40 cm) with specialized carpenters' tools. He ascribed the biggest and heaviest ones (over 500 g) to the same functional group; the specimens with asymmetrical blades in top view (distinguished and sharpened one-sidedly) have

[3] The analysis was done by Ph.D. habil. Paweł Kozakiewicz from the Warsaw University of Life Sciences (Polish: *Szkoła Główna Gospodarstwa Wiejskiego w Warszawie*) to whom I would like to express my gratefulness.
[4] One cannot be sure how significant were the alterations of the lake area without further studies, however, examples from other lakes show that it cannot be neglected; in case of Lake Żółte in West Pomerania prominent surface elevation differed the Early Middle Ages from the late Atlantic stage, counting ca. 3 m, and the medieval water level was close to the contemporaneous one (*vide*: Chudziak *et al.* 2014: 60–64, fig. 3.30). As far as the lakeshore is concerned, it might have been situated even several dozen metres outside from today's shoreline. Naturally, to prove it one would need to carry detailed palaeoenvironmental analyses. However, it seems impossible that the surface was significantly lower, so the deposited items were originally located in the water.

also been attributed therein. Kotowicz has quoted the idea that one of the elements which may indicate the function of an object is the angular cross-section of an eye hole preventing from twisting the haft while performing repeatable cuts. These criteria do not have to be adequate for the Roman period axes. The ones from Lubanowo weight respectively 119 g and 227 g. If one takes into consideration the fact that haft from these times had length from 60 to 90 cm, i.e. their range was comparable to the one of the swords (Kontny 2018: 80–81, fig. 12), it could be assumed that they generally served as weapons, which were also used for woodworking, but only occasionally; the more so that they were found mostly in the weapon graves (*cf.* Domański 1979: 51–52; Bemmann 2007: 76–77; Kontny 2018: 81, 83). The adzes were used in the household instead and are rarely found in the lakes/bogs.[5] The axes were spotted (but rather rarely) in Scandinavian sacrificial bog sites (e.g. Nørbach 2009: 261), where household tools were unique,[6] i.e. the places in which weapons (most probably won on the invaders) were deposited, sometimes in their masses, sometimes only in selected number. They have been dedicated to the gods of war and frequently destroyed (to make them harmless to the living?); maybe their aim was also to commemorate the victors. It is believed that they were thrown from the lakeshore or drowned with the use of boats.[7] Only a few bog/lake sites of the same character are known so far to the south of the Baltic Sea, and axes were found there too.[8] In Żarnowiec, known from archive sources (*cf.* Kontny 2006), both an axe (similar to the symmetrical one from Lubanowo) and adze (comparable to the bigger one from Lubanowo) have been documented; the site may be assigned to the Wielbark culture (**Fig. 4:1–2**). But this is not the only bog site in Pomerania where weapons, including axes, have been discovered. Deducing from an archive source (a letter of Georg A. Crüger to Wilhelm Schwartz (1875), after: Kaczmarek 1998: 341) one may assume that another Wielbark culture bog site has been situated in Piła (Greater Poland, ex-*Schneidemühl*); the axe, probably of Elbe-Oder type[9] has been located there (**Fig. 4:3**; Kontny 2019: 84, fig. 15:3). Subsequent axe (**Fig. 4:4**) was pulled out of the waters of Lake Krępsko in Krajeńskie Lakeland (Pomerania), close to the peninsula at Krępsk,

[5]Apart from Lubanowo and Żarnowiec one may mention only a single find from Nętno, site 38, which was located ca. 50 m from the bridge remains (Chudziak *et al.* 2016: 152, fig. 157 160:i). Taking into account the accompanying specimens, one may assume it can be dated to the Middle Ages.

[6] With the exception of Vimose (Christensen 2005), where numerous agricultural and handicraft utensils were excavated; possibly they may be linked in their significant part with the Balts participating in raids aimed at southern Scandinavia (Kontny 2017: 34–40).

[7] There are also other explanations of the weapon finds, i.a. that the items dealt with are the local arms or arms seized by indigenous warriors during military expeditions, but these ideas do not seem convincing enough. For the discussion concerning the interpretation of bog sites *vide*: e.g. Ilkjær 2003: 60–63; Rau 2016; Kontny 2019: 13–14.

[8] Except for the bog site at Wólka (Masuria, Poland), ex-*Wolka-See* (Kontny 2015).

[9] The drawing of the find is sketchy but shows the shape well enough (the letter of Georg A. Crüger to Wilhelm Schwartz [26th January 1875], after: Kaczmarek 1998: 341).

during the archaeological survey executed by the scholars from the Nicolaus Copernicus University in Toruń (Chudziak *et al.* 2016: 72, fig. 56:c). It has been found next to two spearheads (one of them most probably dated to the turn of the early and younger Roman period) and an early medieval sword (Chudziak *et al.* 2016: 72–75, fig. 56:a–b, 57).[10] The axe has erroneously been linked with the Middle Ages (Chudziak *et al.* 2016: 72, 75) whereas it is a typical Roman period form (Oder-Elbe type).[11] Cultural affiliation is not utterly clear: it may be linked with the Wielbark culture, as in case of spearheads (the settlement of that cultural unit – Krępsk, site 13 – has been registered at the opposite side of the lake (ca. 500 m north-west as the crow flies – *vide*: Chudziak *et al.* 2016: fig. 51).[12] However, the area was abandoned by the peoples of the Wielbark culture at the beginning of the younger Roman period, and a new phenomenon, i.e. Dębczyno group, appeared at the turn of C_{1a} and C_{1b} subphases (Machajewski 1992: 165); therefore one cannot exclude the connection with the latter – taking into account quite long chronology of the type, embracing the whole younger and late Roman period.[13]

There are further bog sites with weapons from Pomerania which may be dated to the proto-historical period, but they are known exclusively from imprecise mentions, not including their exact character, content, completeness, and chronology.[14] Only in case of wetland depots of iron items (carpenters', blacksmiths', and agricultural tools as well as axes) from Czarnkowo, i.e. ex-*Zarnekow* (file *Czarnkowo*, archive of H.-J. Eggers, National Museum in Szczecin)[15] as well as Stare Dłusko in Lubusz Land (Rembecki 2019) one may assume their dating to the turn of the early and younger Roman period. Single pre-Roman, Roman, and Migration Period weapons are known also from the Noteć River, in southern Pomerania (Makiewicz 1992).

[10] At least one of spearheads (Chudziak *et al.* 2016: fig. 56:a), though resembling early medieval specimens should rather be attributed to Kaczanowski XV type, known from B_{2b} phase until C_{1b}, but most popular in C_{1a} (*vide*: Kaczanowski 1995: 23, pl. XII:3); its pseudo-medieval form may be suggested by a non precise drawing ignoring the socket with facets and profiled blade (*vide*: Chudziak *et al.* 2016: fig. 232). Classification of the Przeworsk culture shafted weapons' heads (to which one may attribute the spearheads) is adequate here, as in case of the Wielbark culture the armament types of the Przeworsk culture prevailed in the early Roman period until C_{1a} subphase (Kontny 2019: 89–90).
[11] See the specimens from Lubanowo and Piła. Theoretically, one may try to link it with variant IB.3.27 (Kotowicz 2018: 69) but while compared to the Elbe-Oder-type items with lower widenings at the shaft-hole (Kieferling 1994: fig. 4), the Roman period origin seems more probable.
[12] Another phenomenon typical of the Wielbark culture comes from Krępsk, i.e. the cemetery with stone circular constructions (Kokowski 2012).
[13] There is another Roman period axe, found in Lake Lednica (*vide*: Kotowicz 2014: 224, no. 73, with further literature); however, it should be attributed to the Przeworsk culture.
[14] Dargikowo, ex-*Darkow* (Pomerania, Poland) – skull, amber ornaments, glass beads, and iron spearheads acquired during peat digging (Lissauer 1887: 162; Blume 1912: 179; Mączyńska 2000: 277); Starzyn, ex-*Altes Vorwerk b. Sellin* (Pomerania, Poland) – bronze cauldron, blue bead of a Roman origin, and oaken 'spearheads' (Leube 1971: 101; Mączyńska 2000: 279).
[15] I would like to thank Krzysztof Kowalski and Bartłomiej Rogalski, Ph.D. from the museum for the above data.

Another Roman period specimen (**Fig. 4:5**) was found in Lake Legińskie in north-eastern Poland in the Bogaczewo culture Leginy, site 11 (Warmia, Poland) nearby the island with traces of habitation lasting from the Bronze Age and Early Iron Age, through pre-Roman and Roman period until the Middle Ages.[16] It has been attributed to type II.1.1 according to Kontny (2018: 85), discovered ca. 25 m from the lakeshore and picked up by colleagues from Toruń during the underwater survey (Chudziak *et al.* 2016: 100–102, fig. 75, 76:a). The only accompanying element was another axe (Chudziak *et al.* 2011: 102, fig. 76:b), but this time late medieval one, i.e. type IX according to Głosek (1996). The team of underwater archaeologists from the Institute of Archaeology, University of Warsaw has surveyed the area to the west and north-west of the island very thoroughly with metal detectors during courses of underwater archaeology in the 2010s. Unfortunately, no corresponding items have been found, despite the fact that the lakebed is quite consistent and hard there, so – if present – they should be traceable; one may also exclude the presence of any bridge remains.

But there are bridges known from the proto-historical period, specifically among the Celts, with the most famous La Tène site where the bridges over the Thielle River entering Lake Neuchâtel (Romandy, Switzerland) have been located (**Fig. 5**). They served not exclusively as a trackway, but also as a sacrificial place where weapons had been hanged and thrown in the waters from the 3rd century B.C. with the peak in sacrificial use ca. 200 B.C. (e.g. Vouga 1923; Betschard 2007). The axes and adzes (sawing knifes as well) are also known from here, but the former weighted almost 1 kg each, too heavy for military purposes, so most probably they served as tools lost during construction works.[17] In Pomerania there are the bridges known from the Early Iron Age, e.g. the Lusatian culture wooden remains from Nętno, site 38 (Pomerania, Poland) south-west of the island on Lake Gągnowskie in Drawsko Lakeland (**Fig. 6**), dated to the 7th century B.C. or Hallstatt C period (Rembisz 2009a: 102–104; Chudziak *et al.* 2011: 134–136, figs 108, 112, 113; Chudziak *et al.* 2016: 147–149, figs 151, 158, 159). Here also an early medieval construction, parallel to the former one, has been spotted. In both cases not only axes but also precious weapons have been found, like Hallstatt period iron sword with copper alloy cross-guard, together with bronze personal ornaments, clay pots, and antler axe from the first site (Rembisz 2009a: figs 3–12) and decorated medieval spearhead next to agricultural tools,

[16] Results of the excavations carried by the Institute of Archaeology, University of Warsaw and 'Dajna' Foundation – personal communication with Magdalena Nowakowska (Institute of Archaeology, University of Warsaw) and Agnieszka Jaremek ('Dajna').

[17] I had an opportunity to study the axes from the La Tène culture collected in the *Museum für Vor- und Frühgeschichte* in Berlin.

pottery, and horseshoe from the latter (Chudziak *et al.* 2011: figs 109–111). As refers to the Early Iron Age finds they are treated as ritual deposits aimed to provide favour of protective deities and ancestors; feminine jewellery suggests that female gods have been worshiped there, and sword may be interpreted as a contribution of an individual warrior, a kind of 'substitute offering', replacing grave furnishing in case of cremation, or a visual element of *rites de passage* (Blajer 1992: 103–104; Rembisz 2009a: 109–110). Such phenomenon was especially popular in the Late Bronze Age in Pomerania, with momentous role of weapons which diminished in the Early Iron Age (Rembisz 2009b: 19–20).[18] But is that also the case of medieval axes?

The axes may be theoretically connected with construction work losses just like in case of the eleventh–twelfth-century bridge in Bobięcino on Lake Bobięcińskie Wielkie (**Fig. 7**; Chudziak *et al.* 2011: 43–52, figs 23–25)[19] and Świeszyno in Lake Głębokie with a single small axe (Chudziak *et al.* 2011: 218–222, fig. 194, 195), both in Bytów Lakeland in West Pomerania, but also Lubniewice on Lake Lubiąż in Łagowskie Lakeland (part of Lubuskie Lakeland), site 9 (Chudziak *et al.* 2016: 81–95, figs 69–80)[20] and site 10 (Chudziak *et al.* 2016: 96–113, figs 90–100)[21] as well as Mikorzyn, site 17 on Lake Mikorzyńskie, Kujawskie Lakeland (Chudziak *et al.* 2016: 133–144, figs 138–146).[22] Nevertheless, such obvious 'functional' explanation may not always be adequate.

A non-Pomeranian lake site from Lake Lednica in Greater Poland should also be discussed here, where in the vicinity of one of the islands, Ostrów Lednicki (with the stronghold – a seat of Polish rulers of the late 10th–early 11th century) an assemblage of items, dominated by weapons, has been revealed. Almost 170 axes have been found in that body of water,

[18] For interpretations of Bronze Age and Iron Age deposits *vide*: Kontny 2019: 8–14, with further literature.

[19] Axes are the most numerous category of finds there, including 16 items; they have been found together with a fishing lures and clay pots. One may reasonably consider that they were lost during the building or repairing process of the wooden constructions, which had been lasting for at least 150 years, so the axe drowned every ten years on average seems probable. Moreover, the losses could have been even rarer, as a few specimens have been found far from the bridge construction (Chudziak *et al.* 2011: fig. 22), which not only changes the proportion but also means that some of the axes cannot be explained in the aforementioned manner.

[20] The bridge existed as early as second half of the 8th century, but most probably it was used even in the late medieval times. In the close vicinity there were found i.a. nine axes, an iron dusack, crossbow trigger, sword, stirrup, six horse bits, 10 knives, three sickles, two keys, some clay vessels, and animal bones. Some axes, a dusack, stirrup and pewter jug, crossbow element, and Gothic key link the construction with the Late Middle Ages.

[21] I.a. seven axes, five spearheads, a battle knife, bucket bow, knives, a spur, bits, a clay fishing sinker, quern stone, and numerous clay pots; the bridge existed here in the 11th century, but one of the axes is definitely late medieval; another, dated to the Early Middle Ages, was discovered several metres from the bridge remains.

[22] Two axes are known from the site, as well as a spearhead, sickle, spur, sword, three bolt heads, clay vessels, and a skeleton of a horse. Late medieval chronology of the finds is proven by the analyses of the wood samples taken from the bridge constructions.

with the great majority dated to the Early Middle Ages (Tokarski 2000: 78–84, 92–95, pl. I–V; Kotowicz and Sankiewicz 2013; Kotowicz 2013; Głosek 2014: 81–90, pl. II–V). Greater part of the collection has been detected in the vicinity of two bridges, leading from the ruler's seat (with the palace, church, and stronghold): the eastern one directed to Gniezno and western to Poznań; the bridges existed for quite short period, i.e. ca. 70 years, from 963/4 until 1038 A.D. (Wilke 2000: 64–66; 2014a: 64–65). The finds have been explained by accidental dropping during building/repairing of the bridge (in reference to tools) but generally they are connected with the battle (Kola, Wilke 2000: 56–57; Tokarski 2000: 89; Sankiewicz 2013: 28; Wilke 2014b: 111–113; 2018: 73–76) which probably took place in 1038 or 1039 A.D. during the military raid of Bretislaus I, the Prince of Bohemia (**Fig. 8**). It is assumed that the attackers clashed with defenders on both bridges, forfeiting their military equipment. Additionally, there are two skeletons of adult males aged 25–30 buried in medieval layers of the sediments, close to the bridge – possible victims of the encounter (Wrzesińska 2014). Such hypothesis is deeply rooted in medieval archaeology, however, there are also particular doubts as to its consistency,[23] e.g. a small number of human remains makes such hypothesis uncertain (one should rather assume dozens of bodies especially if considers quite heavy infantry as the most plausible clashing unit; the burden of knights' equipment should descend them quickly); naturally, it may be a matter of state of research but still the number seems definitely too tiny.[24] Great number of the axes also makes one wonder: they are ca. three times more frequent than spearheads (*cf.* Tokarski 2000: 78, 84; Głosek 2014: 81; Wilke 2014b: 98), i.e. the most popular weapon in the Middle Ages (*vide*: Nadolski 1954: 51–52; Nowakowski 2005; 72–75).[25] It cannot be accounted for construction losses, especially if compared with the bridge from Lake Bobięcińskie Wielkie. However, it may be assumed that smaller underrepresentation of spearheads results from them having floated together with shafts (heads were not heavy enough to outweigh the buoyancy of wooden shafts), thus later

[23] One of the first having expressed that this widely accepted explanation may not be that certain was Leszek P. Słupecki who, pondering over the large number of weapons being discovered there, proposed that some part of them (including axes) could have been deposited into water as sacrifices (Słupecki 2006: 67–68). Such possibility is taken into account by Piotr Kotowicz, too (Kotowicz 2018: 172–173). One cannot omit Jacek Wrzesiński, M.A., from the Museum of the First Piasts (*Muzeum Pierwszych Piastów*) in Lednica, who has presented his doubts in the lecture *Bitwa na mostach lednickich – militaria Ostrowa Lednickiego* (*Battle on the Lednica's Bridges – Militaria of Ostrów Lednicki*) delivered during the 23rd Archaeological Festival in Biskupin (*Festyn Archeologiczny w Biskupinie*), on the 24th of September 2017.

[24] The animal bones found close to the bridge are generally post-consumption ones. Only the horses' skeletons excavated in the area of one of the bridgeheads may be connected with the military aspect of the site: most probably being warhorses; nonetheless, one cannot ascertain whether they were victims of a battle or a ritual (*vide*: Makowiecki, Makowiecka 2014: 266–268).

[25] Proportions may be different (with appreciation of swords) for the other areas, e.g. Scandinavia, but still the variation should not be that big (*vide*: Wilke 2014b: 95, 97).

on it was easy to collect them, whereas axes have sunk immediately. The shields' shortage might derive from the same reason. Another challenge lays in a fact that numerous militaria, including axes (**Fig. 9**), have been found far from the brides; inasmuch in the part east to the island they have been encountered close to the bridge, in the western the appeared in the elongated, several-dozen-metre-wide zone, reaching over 150 m to the south and north from the bridgehead; additionally, there is a small area with militaria adjoining to Ostrów Lednicki from the south (Wilke 2014b: fig. 14). Axes have appeared in all abovementioned parts (Sankiewicz 2013: fig. 4).

Some scholars try to explain weapons' position distant from the western bridge by the fact that the battle could have been waged on the ice cover or the rafts and boats might have been used, possibly during landing of invading troops in various parts of the island (Kola and Wilke 2000: 57; Wilke 2006: 446–448; 2014b: 113; 2018: 76–77). The first possibility seems unreasonable here as in such case one should expect no skeletons in the lake and the same should refer to the more valuable weapons: this is even easier to collect the spoils of war from the icy battlefield than from 'normal' one, i.e. a grassland. Another explanation does not seem trustful too: the logboats are the only watercrafts known from the lake, some of them possibly from the times when bridges have existed (Ossowski 2014). Waldemar Ossowski has observed that some were made of poplar and lime, i.e. light, locally accessible wood, and presumes that the traces of the logistic operation, having included preparation of the logboats fleet for the attacking forces, could be visible there (Ossowski 2014: 253–254). However, in the author's opinion unstable logboats with curved bottoms (the flattened ones are typical of the later times – *vide*: Ossowski 2014: 252, 254) were the means of transport or fishing and did not serve the military purpose. Too shaky even to stand inside, they seem very dangerous to transport fully equipped attackers not to mention their engagement in fighting. Even if troops were light armoured, they would need a space for long spears and shields and with the vessel's width of 40–90 cm (Ossowski 2014: 252) it seems rather improbable. Moreover, such craft would require propulsion, so the place for paddlers should be provided as well. All in all, it seems hardly imaginable that such boats were used for transport of more than scouts, although the opposite opinions are acknowledged by the author of the hereby paper (*vide*: Ossowski 2014: 253, 257). Possible use of rafts, although proven for the fifteenth- and sixteenth- century Switzerland (Wilke 2018: 77, fig. 19), is excluded too, as – driven by a pole – they were useless in deep waters of Lake Lednica (Ossowski 2014: 254). Additionally, the distance between certain weapons and the western shore of the island seems too big (even over 50 m) to be in a range of an axe's or spear's throw, considering the imaginable defenders' counterattack.

If the concept of a battle situated on both bridges was right, one should probably assume an abrupt attack, not including landing forces; information concerning medieval encounters situated on bridges have been collected by Gerard Wilke (2006: 451–453). Otherwise, i.e. in the situation including the visible preparation for landing, the defenders would surely destroy the bridgeheads to prevent the easiest way of an assault.[26]

Some of military equipment found far from the bridges cannot be explained by a battlefield concept, also because of some additional contextual elements, i.e. the ring-mail without its 'human content' (Kola 2014; Sankiewicz 2018a: 142–143; 2018b: 222, Cat. No. 1); it seems hardly imaginable that it has not been worn by the landing troops. In this matter it is worth recollecting the story about the Pomeranian raid of Bolesław II the Generous and his knights presented by Gallus Anonymous; some of them drowned while crossing a river because of the ring-mails and arms burden, which has resulted in eliminating armour from the Polish armament (*Cronica et gesta...*, after 2003: I, 25). It seems to be just a curiosity without significance for the real weaponry. The concept that the ring-mail from the vicinity of Ostrów Lednicki has been quickly removed and dropped right after a warrior has fallen into the water (Wilke 2006: 448) seems purely theoretical as one cannot dispose of heavy armour (ca. 10 kg) in a very dense surrounding without any help and in time short enough to avoid drowning.

One should also remark that in the elongated zone adjoining to the island from the west not only weapons, but also household and agricultural tools have been discovered (Radka 2014: 153). As far as the author is concerned, it should not be treated as garbage (Wilke 2006: 449), as the assemblage included a great number of iron tools, which might have been re-used (forged once again). Therefore, the interpretation opted for in hereby paper is the sacrificial one, at least of that part of the site.[27] It is sometimes assumed that the sacrificial deposits preceded the official Christianization of Poland (Słupecki 2006: 68) which may be proven by the fact that singular axes from Lake Lednica are dated generally to the 9th–10th century

[26] Although traces of burnt wooden logs have been found at the bridgeheads, they rather seem to suggest an aborted activity; they may as well be a result of a battle or retreat. Another proof for the fire on the bridge are the partly burnt hafts of certain axes (Wilke 2014b: 113), which would let one link at least part of militaria directly with a battle. However, this must not be so obvious, as there are no mentions concerning scorched hafts in further detailed studies (*vide*: Stępnik 2013; Kotowicz 2013: 74–78) and the burnt fragments were not visible after the conservation process (personal communication: Piotr Kotowicz, Ph.D., to whom the author is grateful for the information). One should mention that decomposition of the waterlogged wood may result in burnt-like surfaces having actually nothing to do with fire treatment (*vide*: Ossowski 1999: 57).

[27] It seems not utterly clear whether it was a place of an encounter or rather/also offerings, but further studies are essential to solve the problem, including elaboration of the plan showing the detailed distribution of artefacts.

(Kotowicz 2018: 172). However, the phenomenon must not be narrowed to pre-Christian times. Surely, not all warriors living in Ostrów Lednicki have been deeply devout Christians and even then traditional rites, i.e. watery offerings, probably survived, at least partially.[28] Long-lasting pagan ceremonial activity associated with water, mentioned several times in the written sources (*vide*: e.g. Wilke 2018: 73, 75, with further literature; Słupecki 2006: 67), is confirmed by complaints of priests as late as in the 14th and 15th century (Bylina 2009: 96, 116, here collection of adequate mentions taken from written sources). These practices have survived in folklore, often changing over time into Christian customs (e.g. divination on the St. John's Eve and Refreshment Sunday).

One should pay attention also to another phenomenon observed in Lake Lednica: there are a few weapons (**Fig. 10**, *cf.* **Fig. 9**) from the Late Medieval Period (axes and a sword) found far from both bridges and close to them (Sankiewicz 2013: fig. 4; Kotowicz and Sankiewicz 2013: 130, 172, 198, 224, 234, 238, 254, pl. XIV:2, XXXV:2, XLVIII:2, LXI:2, LXVI:1, LXVIII:2, LXXVI:2; Pudło and Żabiński 2011: 30–31, pl. IX). They are linked with the 7th settlement layer in Ostrów Lednicki stronghold and the existence of the manor situated on the small hill-fort on Ledniczka Island, i.e. the late 14th and early 15th century (Kotowicz 2013: 82; therein further literature). It probably means that the pagan rituals have been cultivated here, although on a small scale. The most astounding is the fact that some axes have sunk close to the ruins of the bridges. Dendrochronological studies have proven that the constructions have not been rebuilt after the Bretislaus' calamity (Krąpiec 2000). One may assume that their ruins had still been recognizable in the late 14th century and the offerings situated here make one ponder over the possibility that even earlier the bridges had served their sacrificial purpose (*vide*: fn. 27)! Great number of weapons and preference for the axes may be explained by multiple episodes resulting in weapons casting, but – taking into account all abovementioned coincidences – not necessarily as military activities but ritual ones as well.

The fact that ritual activity connected with water basins has taken place in medieval Pomerania was proven very well by the finds from Żółte on Lake Zarańskie in Drawskie Lakeland, where axes were one of the most popular sacrificed items, definitely outnumbering spearheads. They have been discovered in line with a stronghold and adjacent settlement situated on the peninsula (**Fig. 11**) – in the shallow bay – as well as around the small island

[28] Gerard Wilke believes that it cannot be true in case of the ruler's seat (*sedes principales*), due to the close proximity of the representatives of the Christian state and religious elites (2018: 46); however, it seems that the pagan rites have survived in case of at least vast numbers of soldiers (i.a. mercenaries), even if covered with Christian patina. Moreover, the rites might not have been performed overtly, as in a provocative way. See also remarks of Arkadiusz Michalak (2015: 300) and the whole paper, although dealing specifically with swords.

next to the aforementioned peninsula (Kaźmierczak 2014: 243–251, fig. 6.117); one has to underline that the water level during the times of medieval sacrificial activity (late 9th–11th/12thcentury – *vide*: Chudziak, Kaźmierczak 2014: 25) was slightly higher that it is today (Chudziak *et al.* 2014: 62–64, fig. 3.30–31).

There are also other contexts for medieval axes found in lakes.[29] In case of finds close to quey's construction (**Fig. 12**), one may think of inadvertent losses resulting from construction works or normal activity situated on the piers like possibly in case of Niedźwiedź, site 5 on Lake Steklińskie (Steklin, Dobrzyńskie Lakeland), where seven axes, a spear (together with a shaft), half--scythe, sickle, bronze bowl, bone skate, and pottery (Chudziak *et al.* 2011: 141–147, figs 116–120) have been discovered close to the wooden constructions; another example is Pszczew, site 2 on Lake Miejskie (officially: Kochele, traditionally: Pszczewskie) in Lubuskie Lakeland with early medieval swords, a spur, dagger, half-scythe, punch, bowl, quern stone, fishing lures, antler fragments, and pottery (Chudziak *et al.* 2011: 178–185, figs 149–154). In a similar way one may explain finds stretched along the lake shore and adjoining to the reed bed in the vicinity of medieval strongholds or settlements, e.g. Łoniewo, site 1 on Lake Łoniewskie (called also Osiecznica) in Krzywińskie Lakeland (Chudziak *et al.* 2011: 107–115, figs 83–89) – apart from axes and spearheads also the knives, iron keys, buckets mounts, an agricultural tool, bone skate, clay weight, pottery, and antler pieces have been documented here – or Raduń, site 16 on Lake Raduń in Choszczeńskie Lakeland – with an iron strike-a-light, axe, knife, two sickles, and a potsherd (Chudziak *et al.* 2011: 193–195, figs 193–194). Similar interpretation may be applied in case of Bnin, site 1 on Lake Bnińskie in Greater Poland where a bone skate, spearhead, early medieval axe, quern stone, medieval pottery, and a bronze socketed axe (dated to Early Iron Age) have been found (Chudziak *et al.* 2011: 37–42, figs 13–15), and maybe also Danków, site 9 on Lake Wielgie in Myśliborskie Lakeland (Chudziak *et al.* 2011: 60–64, figs 35–36) with, i.a. three late medieval axes, a spearhead, two iron padlocks, a pot-shaped tile, and clay vessels. On some occasions the discussed items have been found among wooden remains of former stronghold walls or shore reinforcements, as in case of Gwieździn, site 54 on Lake Szczytno in Krajeńskie Lakeland – two axes (early and late medieval), a sickle, and potsherds from the Early Middle Ages (Chudziak *et al.* 2011: 69–73, figs 43–47). However, even then one should theoretically consider the possible sacrificial purpose of certain finds, especially in case of the discoveries in significant distance from the lakeshore. Some categories of items are understandable as casual losses, i.e. bows of buckets and clay pots (connected with water

[29] Chosen examples come mostly from Pomerania but also Greater Poland.

drawing), as well as clay sinkers, and fishing lures (fishing) or broken elements impossible to repair (quern stones or small metal elements). But in case of well-preserved weapons and agricultural tools (scythes and sickles mostly) as well as keys/padlocks, one should speculate why these particular categories of items appear here repeatedly and whether they might bear any ritual meaning. Over-representation of axes generates the reflection too.[30] One can assume that at least some finds may be interpreted as sacrificial ones, linked probably with the military sphere (maybe associated with the warfare[31]) and agricultural one (fertility rituals?).[32] But also keys have a vast potential symbolic meaning, connected with the opening and closing, so, therefore, with controlling, sheltering, and giving. They were symbols of ancient chthonic deities, an attribute of Greek goddess Hekate (controlling of magic or the nature) or Celtic Epona (opening the door to the netherworld); in Roman world the key was given to ladies of the house with wishes of fortunate childbirth; it used to be also a symbol of the power over household, known in the Merovingian period etc. The same symbolism refers to the padlocks (Czarnecka 2010: 20–26). One may also consider the bridal offerings (women's ornaments found in bogs are interpreted in that way – Bluijienė 2010: 156–157). The phenomenon definitely requires further studies. Moreover, the riverine finds of medieval axes have been reported as well, and these are usually numerous.[33] Their original context is difficult to reconstruct precisely.[34]

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[30] One should consider also utensils lost while preparing ice holes. There are different tools useable here and an axe is one of them. Though it seems to be a very rare accident to lose the axe as its butt is much wider than the blade so it jams in the break of ice cover. Afterwards it is not the case of ice picks which one may frequently find in lakes: obviously the modern ones but possibly they occurred also in medieval times. One should consider, e.g. the find from Ostrowite Trzemeszeńskie, site 13 on Lake Ostrowickie in Gnieźnieńskie Lakeland (Chudziak *et al.* 2011: 168, fig. 135:h), interpreted as a late medieval javelin head or missile inspired by Frankish forms (*ango*); the latter possibility is improbable as such forms quit as early as the 6th century (Siegmund 1996: 702–703) and elements dated this way are lacking at the site; moreover, they are unknown from the territory of Poland until now.

[31] Such idea was suggested for the Roman and Migration periods as well as the medieval bog offerings of weapons from Neman-Daugava interfluve area (Bluijienė 2010: 144–156, table 1) and medieval axes from Prussian territory (Nowakiewicz 2017: 96). One should remember symbolic value of medieval weapon depositions in waters as expressed in the Arthurian legends, i.a. Excalibur given to Arthur by the Lady of the Lake and brought back to the lake, or Excalibur's scabbard which was said to have powers of its own sheltering its bearer, stolen from Arthur by his half-sister Morgan and thrown into a lake, never to be found again (Bradley 1990: 1–4).

[32] Taking into account the character of offerings left in and close to waters it is assumed that sickles and half-scythes might have performed alternative social functions as apotropaic devices deposited to advert demonic influence thanks or votive offerings symbolizing the fruits of the earth and abundant harvest; tools' effectiveness was to be strengthened by the material (iron), sharp blade, and crescent shape (*vide*: Chudziak 2005: 201–202, 213–214, 218). There is also a tantalizing symbolic connection of sickles with the military sphere, i.e. it served as a weapon or tool during military expeditions, e.g. to acquire the fodder for warhorses (Janowski and Kurasiński 2010: 91–92; here also different interpretations of such finds from funerary contexts like denominators of the position or anti--vampire treatment – Janowski, Kurasiński 2010: 90–94). It may be valid also for the earlier times, i.e. La Tène Period sacrificial bog site at Llynn Cerrig Bach (Cae Ifan Farm, Anglesey, Wales; Fox 1946: fig. 65, 144).

[33] In case of Pomerania, these are mainly finds from the rivers bordering the country, i.e. Odra and Noteć (Kotowicz 2014: 83, 84, 168, 169). For weapon deposits in liminal zones *vide*: Kontny 2019: 9–11.

[34] These are sets composed of axes exclusively.

Watery finds of medieval axes are dated mostly to the 11th century (basing on the catalogue by Piotr Kotowicz – Kotowicz 2014). Could this issue be correlated with the military crisis and cultic activity resulting from the warlike tendencies comparable to the Roman period votive deposits in northern Europe? Internal problems and military activities of Poland in the 11th century resulted in the independence of Pomerania. This created a field for the undisturbed implementation of the pagan beliefs. The manifestation of them sustained a sense of political separateness and inner unity. However, those are also the times of internal struggles resulting from consolidation attempts (Piskorski 2002: 49). Contact with the Christian world has transformed some pagan practices. This fact may result from the intensification of iconic deposits. Pomeranians' attachment to pre-Christian beliefs has been confirmed by the missionary operation of St. Otto of Bamberg in the early 12th century (*Dialogus de Vita Ottonis Episcopi Babenbergensis*, after: Bojar-Fijałkowski 1986). Symbolic value of axes is known from the Bronze Age in the Nordic cultural circle, specifically their connection with lunar sphere and divine twins – rescuers of sailors, protectors of travellers, helpers in battle, healers of illness, master musicians and dancers (Kristiansen 2013: 85–87). But myths of various nations lets one attribute them to thunder gods and also pay attention to their link with *rites de passage* (also childbearing and weddings) and apotropaic power – in the Slavonic and Balt milieu they were put under beds or cradles, edge upwards, or situated outside houses during tempests – to secure a sleeping person against demons or to drive away storms (Moszyński 1934: 310). They were used also in rituals aimed at securing the fertility of plants and animals (Pełka 1987: 56, 58). Sometimes they were situated under the bench on which the coffin rested as a mean of protection against the deceased and another connection with burial ceremonies is waving an axe which was meant to clean the room in which the dead body had lain to get rid of the death itself and evil spirits too (Kotowicz 2018: 171, with further literature). One may be sure that they had their symbolic meaning also in the Middle Ages, as the axes-amulets or items of possible ritual purpose inferred from their decoration (Kotowicz 2018: 171–172). Additionally, it was the attribute of certain saints but also executioners and symbol of authority, power, war, martyrdom etc.; it was frequently used in coat of arms as well (Wyrwa 2013: 13–18, 20–22).

Summing up, it is assumed that the axes deposited in Lake Lubanowo have been the offerings. There is no place for queys in at least a few spots where they have been found: great boulders densely covering the bottom in the western part of the lake exclude such possibility. If one was to assume that the items sank haphazardly in connection with household activities, how could the fact that some of them have been found more than 20 m from the lakeshore be explained? Air-hole losses should rather be rejected as well. Moreover, there are also further Roman period artefacts (mostly weapons and horse harness) and medieval specimens (i.a. spearheads, padlocks' keys, and horseshoes) found here. All in all, the lake in Lubanowo seems to attract the attention of weapons' keepers both in the Roman period and medieval times, but also in 20th century, as the post-war battlegrounds in the region (i.a. battles of Banie, while failed German armoured offensive *Sonnewelde* in February 1945) were cleansed of junk and the place in which it was drowned was… Lake Lubanowo. *Genius loci*?

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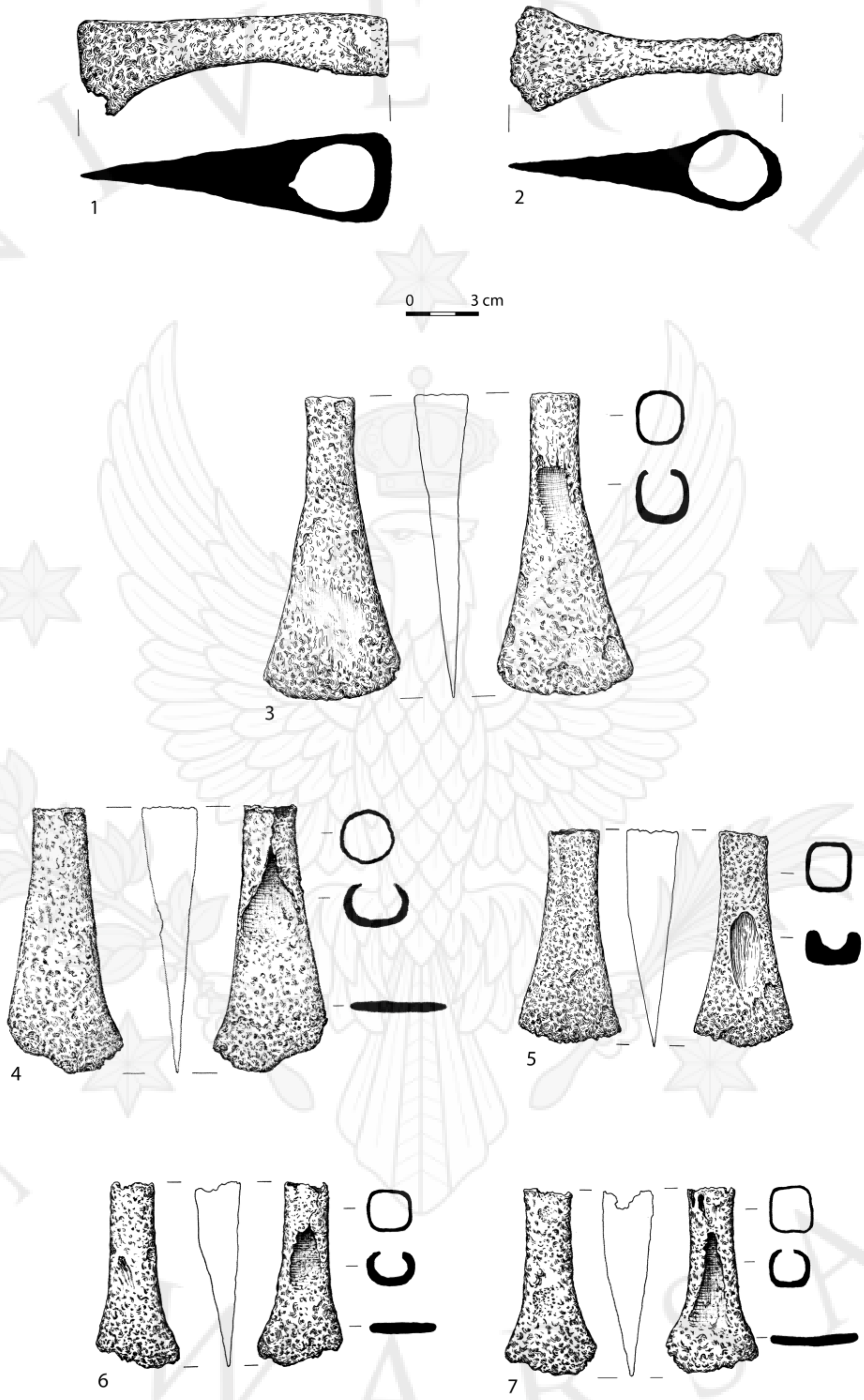

Fig. 1 – Roman period axe heads (1–2) and adzes (3–7) from Lubanowo Lake (after: Kontny *et al.* 2016a)

Fig. 2 – Early (1) and late medieval (2–3) axes from Lubanowo Lake (1 – photo by: J. Strobin; 2–3 – photo by: M. Osiadacz; 2a – photo by: T. Nowakiewicz; 3a – photo by: B. Kontny)

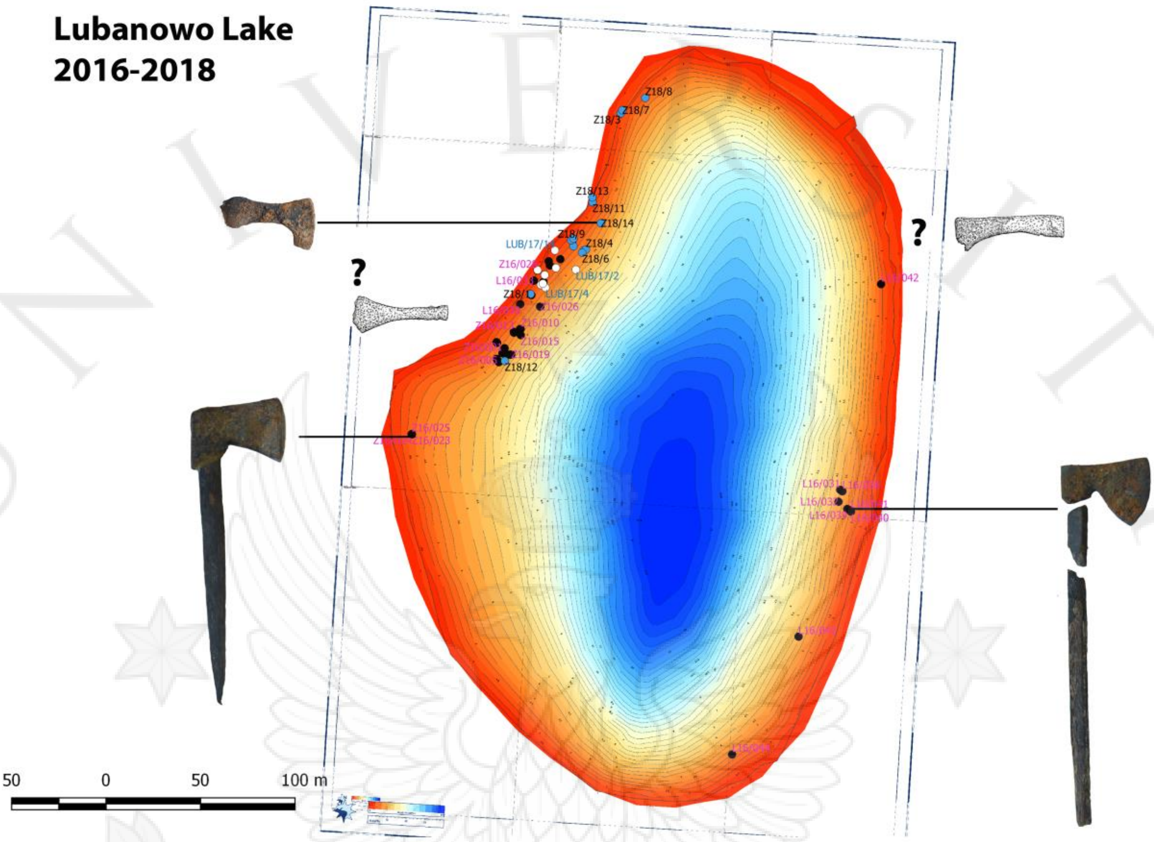

Fig. 3 – Bathymetric plan of the Lake Lubanowo with marked findings of relics (years 2016–2016; with inventory nos), including axes (elaborated by: P. Prejs, B. Kontny)

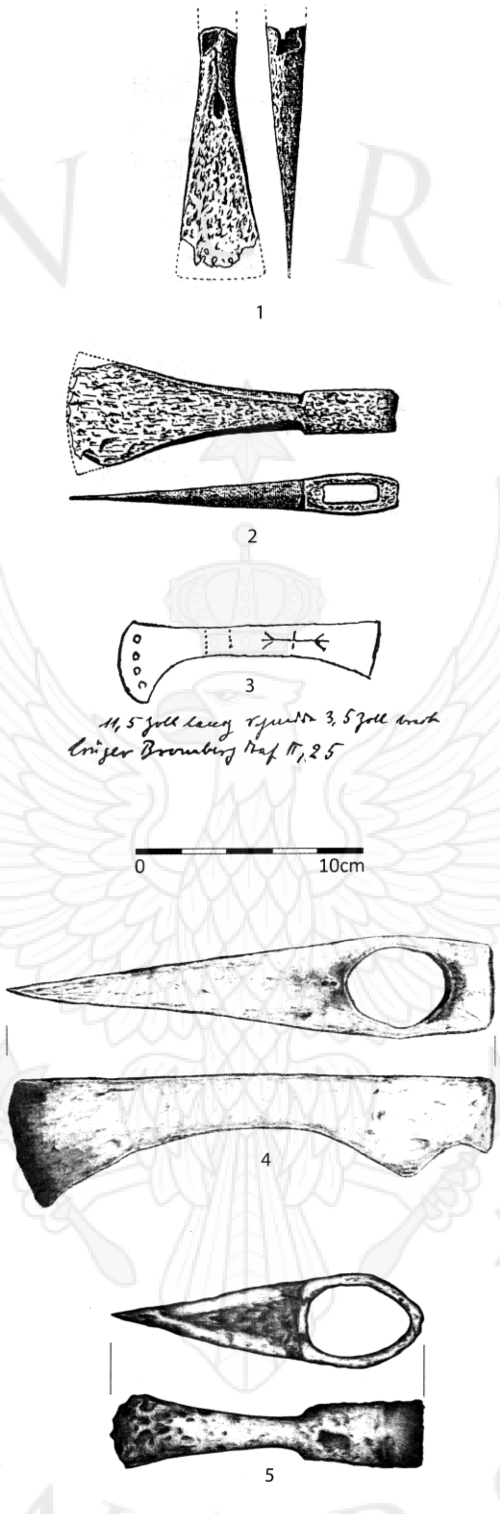

Fig. 4 – Roman period adze and axe heads from bogs/lakes in Poland,
1–2 – Żarnowiec (after: La Baume 1940), 3 – Piła (after: Kontny 2019),
4 – Krępsk (according to Chudziak *et al.* 2016), 5 – Leginy (after: Chudziak *et al.* 2011)

Fig. 5 – Reconstruction of sacrificial place at La Tène by André Houot (after: *La Tène…* 2009)

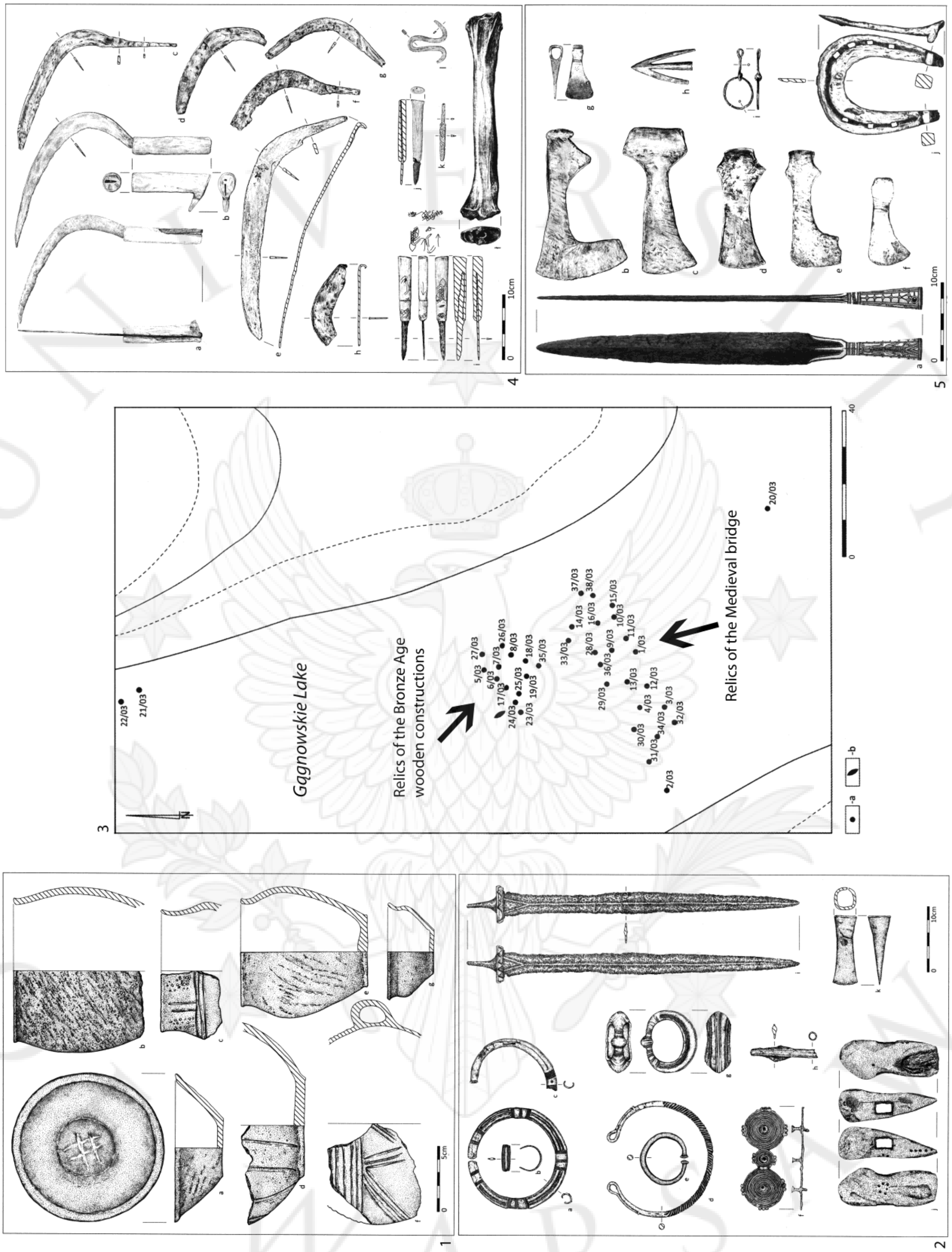

Fig. 6 – Nętno, site 38. Location of archaeological objects excavated during exploration in 2003 (3) and Early Iron Age (1–2) or medieval (4–5) finds. 3a: historic objects, b – dugout boat (after: Chudziak *et al.* 2011)

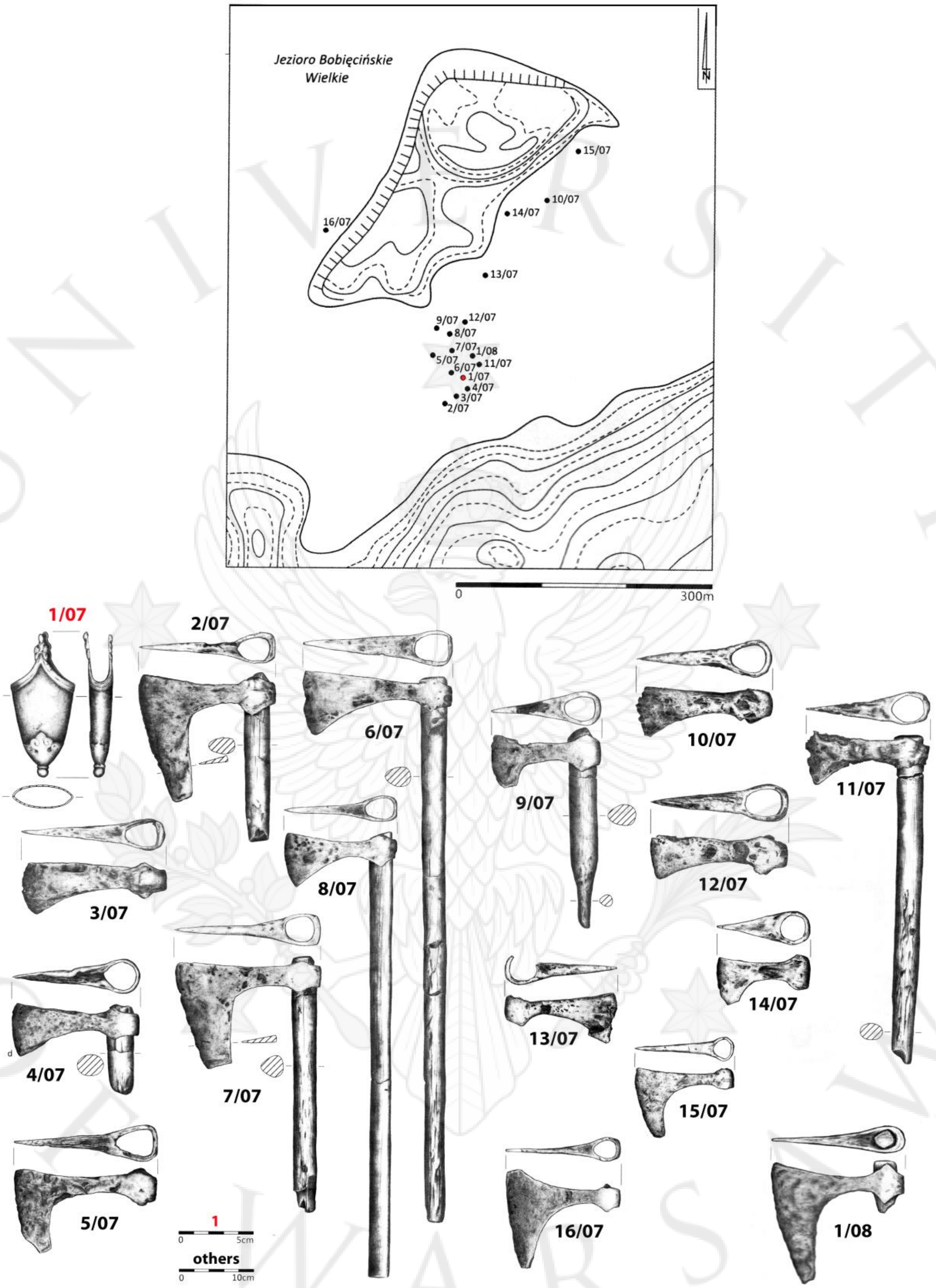

Fig. 7 – Bobięcino, site 3 and selection of the finds excavated during exploration in 2007 with inventory nos (elaborated by: B. Kontny, after: Chudziak *et al.* 2011)

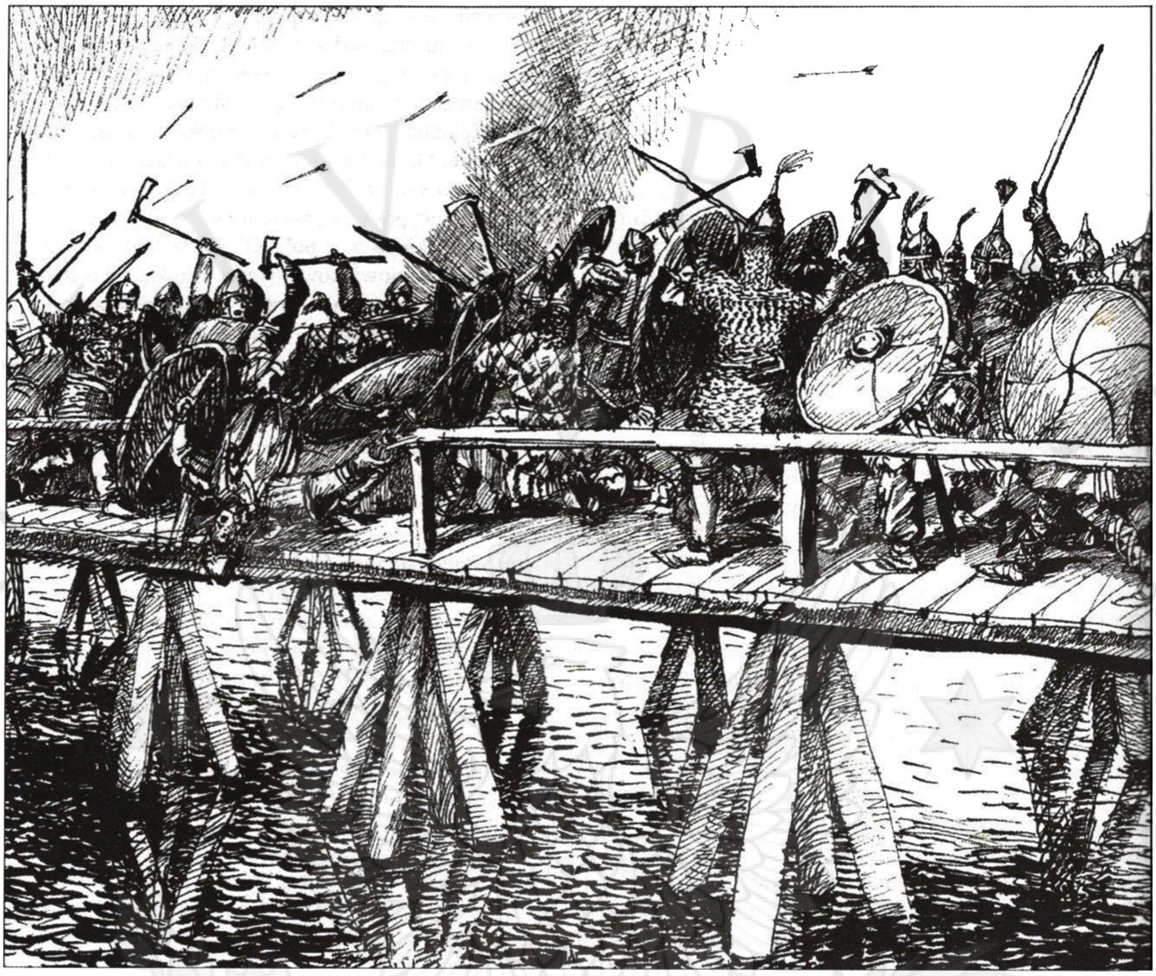

Fig. 8 – Present representation of the fights on the Ostrów Lednicki bridge in 1038
by A. Zaręba (after: Wilke 2014b)

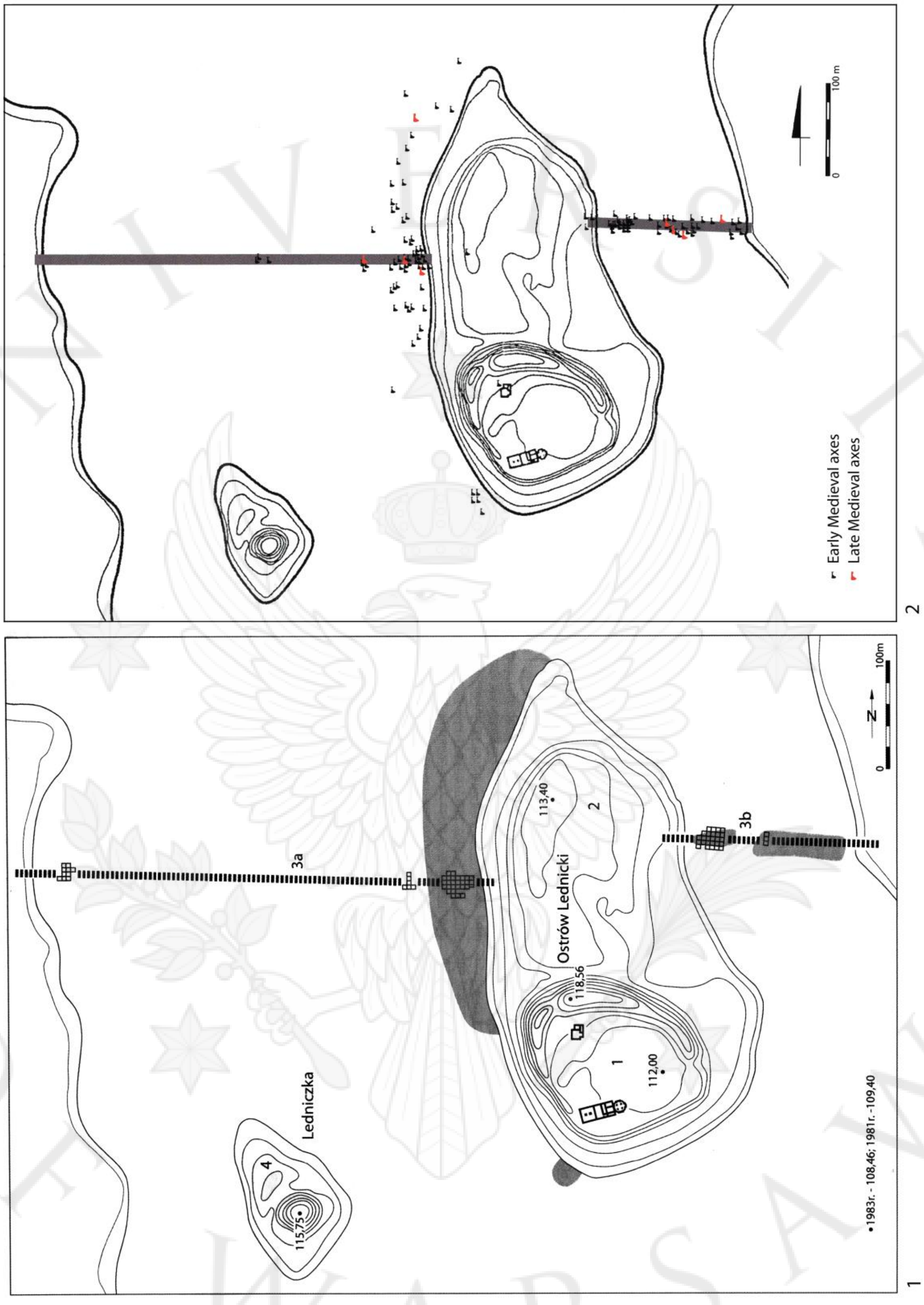

Fig. 9 – Distribution of militaria in the vicinity of Ostrów Lednicki. 1 – bridges with sectors of excavating military accessories at the bottom of the lake marked in grey colour (1 – stronghold – the residence of the First Piasts, 2 – borough settlement, 3a – „Poznań bridge", 3b – „Gniezno bridge", 4 – Ledniczka – mote-and-bailey conical fortress; according to Wilke 2014b), 2 – the location of the axes (after: Sankiewicz 2013)

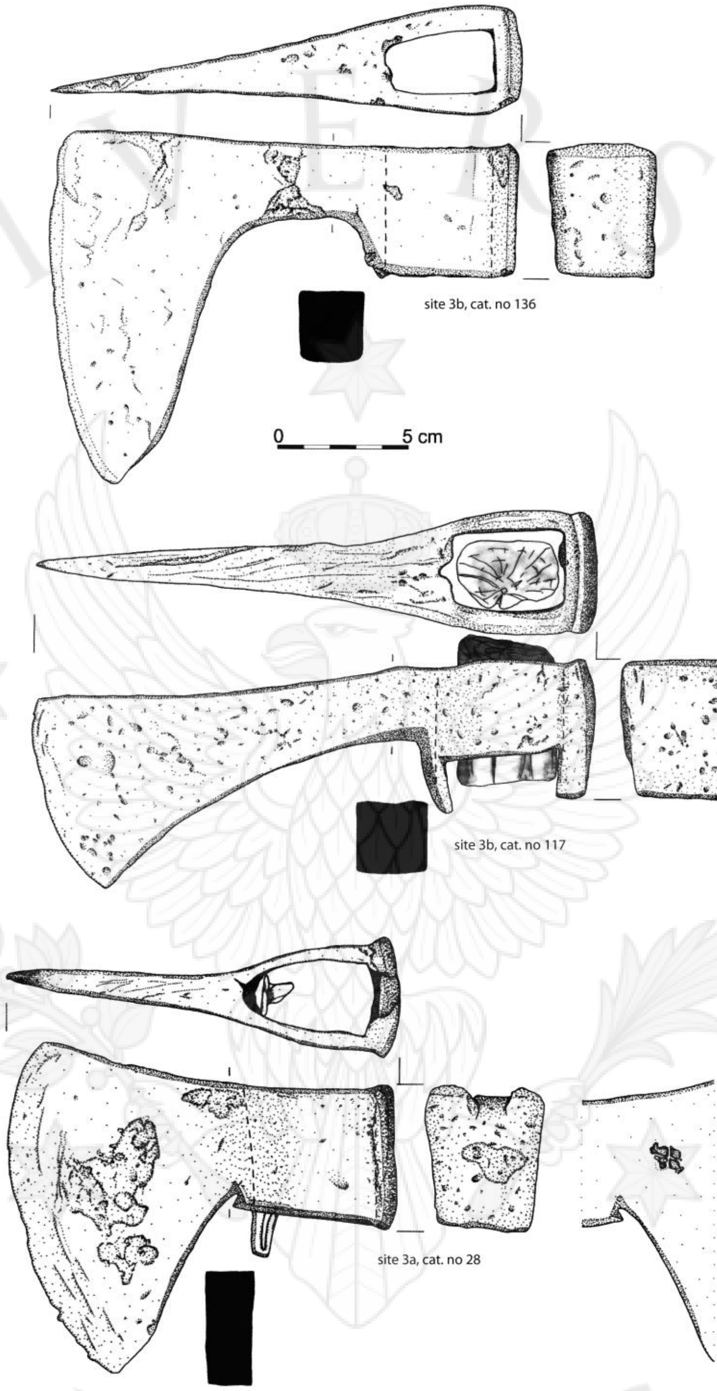

Fig. 10 – Selection of the late medieval axe-heads found nearby the remains the bridges at Ostrów Lednicki (after: Kotowicz, Sankiewicz 2013)

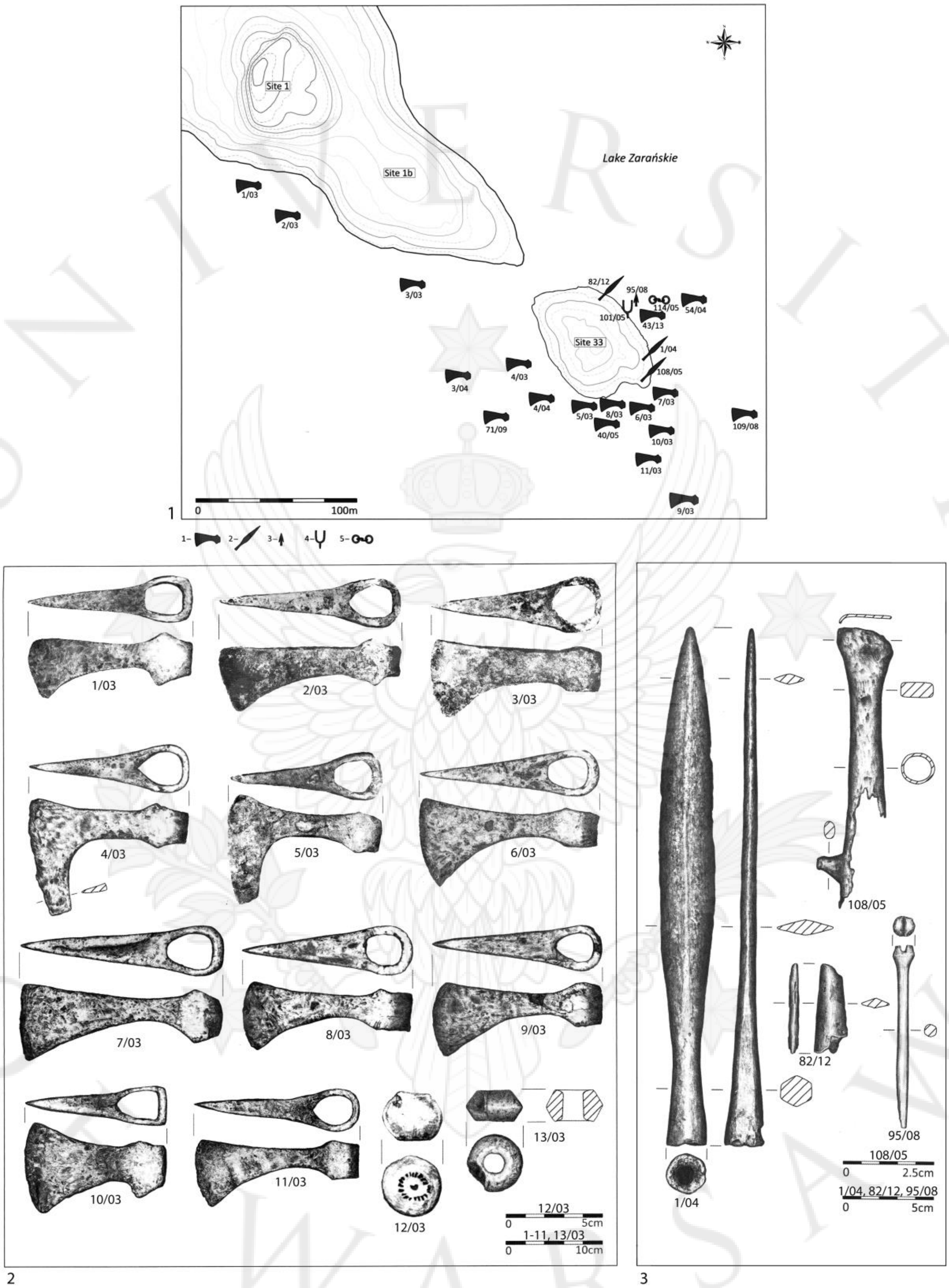

Fig. 11 – Żółte, Lake Zarańskie. 1 – location of weapon and horse tack finds (1 – axe-heads, 2 – spearheads, 3 – arrow, 4 – spur, 5 – bit), 2–3 – selection of the finds with inventory nos. (after: Chudziak *et al.* 2014)

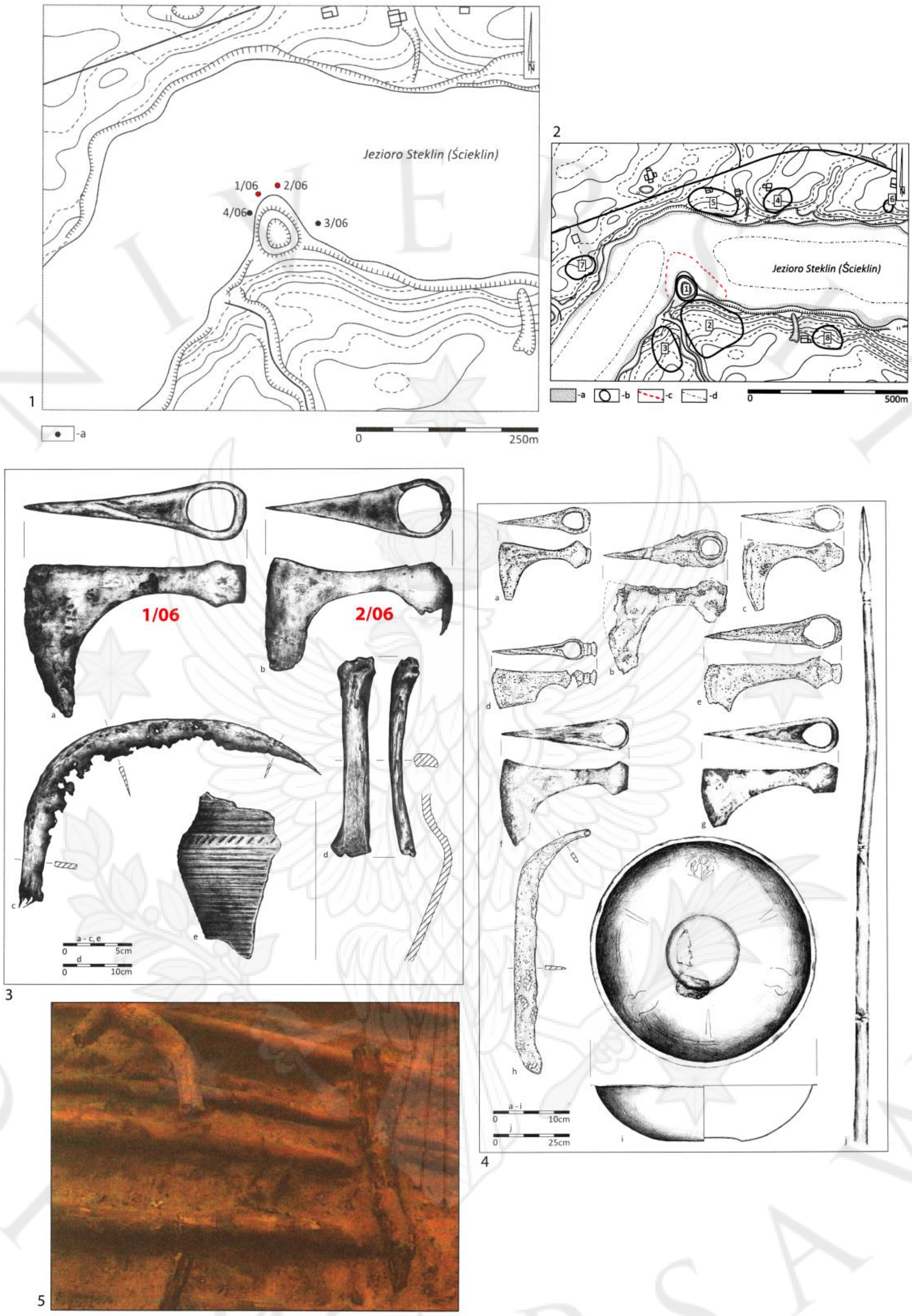

Fig. 12 – Niedźwiedź, Lake Steklin, site 5. 1 – location of items excavated during exploration in 2006, 2 – archaeological sites (1 – early medieval stronghold, 2 – settlement unit of Pomeranian culture and medieval settlement, 3 – medieval settlement unit, 4 – settlement unit of Pomeranian and Wielbark cultures, 5 – settlement unit of Trzciniec culture? and Early Middle Ages, 6 – settlement traces of Pomeranian culture, 7 – settlement signs of Lusatian culture and late medieval settlement unit, 8 – medieval settlement unit; a – range of reed bed, b – dry land archaeological site, c – range of appearance of historic material, d – range of underwater penetration), 3–4 – selection of archaeological finds, 5 – wooden construction excavated in underwater trench in 2001 (after: Chudziak *et al.* 2011)

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Shipwreck from Czersk. Excavation of the Large Vistula River Vessel from Medieval Times

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Abstract:

During the summer of 2018, remains of a wooden vessel were excavated and extracted near Czersk (Masovian Voivodeship, Poland). The recovered shipwreck is an example of the largest sailing vessel type used on the Vistula River in the pre-industrial era.

This paper shows the results of the recovery operation conducted by the State Archaeological Museum in Warsaw in cooperation with the Archcom company and the University of Gdańsk. Methods used during the documentation process allowed recording of the shipwreck site and timbers in a full 3D form. Thus, it was possible to refine the current knowledge about the ship itself and inland shipbuilding on the Vistula River. Furthermore, it is possible to reconstruct the original vessel's appearance, both in digital and physical form.

Keywords:

shipwreck, medieval shipbuilding, Vistula River, inland transport, documentation methods, Computer Vision Photogrammetry, 3D scanning

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Introduction

The archaeological investigations conducted so far show that large river crafts intended for navigation on the Oder and the Vistula Rivers started to be built and used in the 13th century A.D. The largest of them was *szkuta*, originally used on the Vistula for transporting grain. This type of vessel was a workhorse for carrying bulk commodities to Gdańsk until the late 18th century A.D. (Smolarek 1985: 174–177). However, until recently this kind of craft had been known only from written and iconographic sources. Luckily, in the summer of 2009 the first wreck of *szkuta*, dated to the medieval period, was successfully investigated in the old riverbed of the Vistula near Czersk, in Masovian Voivodeship.

The wreck was situated inside a small pond, which was in the past part of the riverbed (**Fig. 1**). The first archaeological research included the uncovering of the entire structure and the preparation of detailed *in situ* documentation. The hull had its original form preserved in 60%, with almost intact aft section (**Fig. 2**). The dendrochronological analysis revealed that the timbers used for the construction came from trees cut between 1478 and 1481 A.D. (Ossowski 2010: 107). The vessel was in use for almost 60 years before it was probably scuttled along the shoreline of the river. Having based on the field documentation, the first attempt to reconstruct the appearance of the ship has been made (Ossowski 2010: 108; Żrodowski 2010: 213–217). The total length of the vessel was estimated at up to 30 m with the original width of about 7–8 m.

After excavations, the rest of the hull was partially covered with sand and sunk again at its original location. It was meant to be fully recovered and documented in the next field season.

Preparation for Recovery

The fact of discovering the first large Vistula River vessel attracted the attention of the Regional Council of Masovian Voivodeship. Immediately after the first information came to light, the analyses of the possibilities for the ship's unearthing and its further exhibiting have begun. The State Archaeological Museum in Warsaw declared its willingness to undertake this task in cooperation with the National Maritime Museum in Gdańsk. Nevertheless, the recovery was limited at that time by the lack of appropriate conservation facility. None of the laboratories existing in Poland was able to handle conservation of such long shipwreck timbers. This forced the researchers to change both their priorities and the project schedule.

At that time the State Archaeological Museum in Warsaw proposed to build a new facility within the area of the Storage and Research Centre for Archaeological Finds, located in Rybno near Sochaczew (Masovian Voivodeship, Poland). With the financial support of the Masovian Regional Council, in the years 2011–2013 the old storage warehouses in Rybno were designated for future conservation laboratory of waterlogged archaeological wood. However, such large-scale work required major changes in the old facility's infrastructure. Besides, the whole storage house was located within the historical complex of the 19th century Rybno Manor, which caused some difficulties with construction works. The adaptation of the old warehouses was undertaken in 2012–2013. The conservation--restoration infrastructure was designed by Ph.D. habil. Małgorzata Grupa from the Nicolaus Copernicus University in Toruń (Grupa 2013). Having based on her concept, the facility was equipped with large tanks for storing and impregnation of waterlogged archaeological wood. Inside the main building a specially designed six-metre-long freeze-drying chamber has been built, where the conservation process of the wreck elements could have been finalized. Additionally, the building was equipped with a crane with lifting capacity of 1600 kg that was to carry the heaviest elements (**Fig. 3**).

During the first half of 2018, the facility was ready to receive the first elements. In August 2018 the Masovian Voivodeship Heritage Office approved the research programme for the wreck recovery and its conservation (Borkowski *et al.* 2018) and gave the State Archaeological Museum the green light for its excavation. All archaeological works were conducted under the supervision of Ph.D. Wojciech Borkowski and M.A. Witold Migal from the Museum. The recovery operation and documentation process were carried by the *Archcom* company, specializing in the excavation of historical shipwrecks. The scientific consultation of the project was entrusted to Ph.D. habil. Waldemar Ossowski – a Professor from the University of Gdańsk. The whole operation was financed by the State Archaeological Museum with the support of the Regional Council of Masovian Voivodeship.

Recovery Operation, 2018

Although the fieldwork of 2009 provided substantive data of the site, it was clear that the upcoming recovery operation required different approach in methods and logistics; few problems needed to be solved before the first shovel was to hit the ground.

One of the biggest issues was the limited space. Due to the agreement with the owners of the area, none of the undertaken actions should affect their apple orchard. It meant that the total area of archaeological works was limited to 2000 m^2, including 600 m^2 pond, where the wreck was situated. This required careful distribution of recovered sediment around the wreck as well as the deployment of the rest of the archaeological infrastructure (**Fig. 4**).

The second problem was the constant need for pond draining. As part of the old riverbed, the whole area was heavily affected by groundwater. Thus, constant pumping water out of the pond was required to keep its level at the minimum. Furthermore, the water had to be transported to a distance that would not have a negative impact on the nearby countryside. To minimize the problems, the whole operation had to be started when the water level of the pond was the lowest, which basically meant dry and hot period of the high summer season. In consequence, it led to another issue: the shipwreck had to be extracted as fast as possible to minimize the time of timbers exposition to the sun heat and their further deterioration.

The recovery operation was scheduled for the end of August and took 16 days. It was conducted by the team of five archaeologists from *Archcom* company with the assistance of four workers deployed by the State Archaeological Museum. Firefighters from the local volunteer units of Wojciechowice and Góra Kalwaria (Masovian Voivodeship, Poland) have helped with the pond drainage.

At the first stage, the pond was completely drained with the use of three motor pumps and kept at the lowest level for the whole excavation. The water was pumped out to the safe distance of 120 m from the site to an old drainage canal connected to Czersk Lake. Then, sand was manually removed from the shipwreck's structure. Due to the weather conditions, the wreck was constantly poured with fresh water to slow down the drying process.

The condition of the shipwreck corresponded to the state during previous works on site in 2009 (**Fig. 5**). The most deteriorated portion was its starboard side. Part of the midship section was missing and the remaining elements were heavily damaged, possibly by pond dredging. In the best state of preservation was the aft, originally covered by the thick layer of sand. On its port side, the elements of the structure were preserved up to the gunwale. However, a section of pine gunwale has fallen from its original location and had to be extracted from the site as first. The most deteriorated part was the forward section, where the structure of the upper parts was damaged or missing.

Site Documentation

The limited time frames for the recovery operation required time-saving methods of site documentation. The obvious choice was, therefore, the photogrammetry that allowed to generate good quality and precise site plans and thus to locate each timber from the original structure. Over the last decade, Computer Vision Photogrammetry was successfully tested on various archaeological sites and, in recent years, became a standard tool in the documentation of shipwrecks (Bednarz and Różycki 2017; van Damme 2015; Jones 2005; Yamafune 2016; Yamafune *et al.* 2017).

Prior to the documentation, each timber was labelled with coloured cattle ear tags with a pre-printed number sequence from 001 to 200. The labels were fastened with copper roofing nails. All tagged timbers were registered in the database with the information regarding their location and relation to adjacent wreck structures.

The recording process was based on aerial photography. All pictures were taken by the remotely controlled drone equipped with a digital camera with a twenty-megapixel sensor. The use of a drone speeded the whole recording process and prevented the contamination of timbers by stepping onto the cleaned surface of the shipwreck. For the project purposes, the site documentation was divided into three stages. During the first one, all *in situ* structures, including framing system and side planking, were recorded. The second phase included the documentation of the bottom of the hull with dissembled upper parts. It revealed all edge to edge connections between bottom planks and gave more information about the fasteners. The last phase was focused on recording the area after extraction of the timbers, where the other additional structures and objects were uncovered (**Fig. 6**). Each stage required 900–1600 photos with the resolution of 3992 × 2242 pixels.

Before the processing, all photos were first enhanced in *Adobe Lightroom®* for balance. The datasets were then imported to *Agisoft Photoscan®* where the photos were aligned to create 3D point clouds and finally generate 3D meshes with applied textures. All models were scaled with the use of 1 × 1 m cross-scale that was placed close to the recorded wreck's structures. All measurements were processed subsequently in the software. For the final corrections, additional ground control points were used. They were placed in various locations of the site. Coordinates of these points have been taken using the GPS-receiver: *Spectra Precision GNSS S60*, and converted to WGS-84 coordinate system.

The final output included three 3D models of each stage of shipwreck's disassembly, georeferenced, with enough quality to distinguish all the necessary construction details and features of all original timbers. All three layers were then integrated as flat orthogonal pictures and used to create a precise site plan (**Fig. 7**).

Timbers Extraction

The extraction was carried with the use of thirty-metre-long crane. The limited space on the archaeological site forced the researchers to access each shipwreck section from the single position of the crane. Prior to the lifting, each timber had to be detached.

However, the disassembly of the structure revealed another problem, i.e. the condition of the wreck itself. Its location within the pond in the low-oxygen environment created favourable conditions for wood preservation. Most of the timbers, originally covered by the thick layer of wet sand, survived almost intact, with just small traces of deterioration. Therefore, each iron rivet or treenail had to be dismantled and removed manually with care necessary to preserve fragile wooden material.

The lifting operation was combined with transport and divided into two phases. During the first one all framing elements and side planking were extracted directly to the truck. Most of the shipwreck parts were transferred in one piece. However, to fit on the truck, elements longer than 11 m had to be cut in half. In the second phase the whole bottom planking and the aft piece were extracted. All elements were transported over 100 km to the conservation facility in Rybno, where further documentation process has taken place.

Digital Recording of Timbers

In the foreword to his book, Richard Steffy says that wooden boats and ships are the most marvellous structures ever built by humankind (Steffy 1994: IX). With no doubt, none of other human-made crafts relies in such a strong way on the three-dimensional form, which defines its basic characteristics and capabilities. If the three-dimensional shape plays the main role in the ship's construction, one should also try to use a spatial approach in its recording and analysing. The idea of digital three-dimensional studies of shipwreck structures has developed within the past few years, mostly due to improvement of computer techniques. The software environment is becoming much more accessible and friendlier for users not related to the architectural and engineering industry. The recording of *Newport Ship* (Jones 2005; Jones *et al.* 2013) or *Copper Wreck* (Żrodowski 2014) clearly showed that 3D scanning of individual timbers can deliver more detailed information about ship construction and help in the analysis and reconstruction of its original shape.

The documentation of the Czersk shipwreck was mostly based on the experience from archaeological excavations of two shipwreck sites related to the 1715 A.D. Swedish ship-barrier located in the entrance to Bay of Greifswald in North-Eastern Germany (Auer *et al.* 2017: 18–25). The recording process has been started by cleaning each timber from sediments and original waterproofing paint. Simultaneously, first interpretations and a general description were noted on timber sheets. Basically, the timber sheets delivered information about features that could vanish through the cleaning process (e.g. waterproofing materials, damaged and broken parts, repairs) and were used for the final description of the timber.

Cleaned elements were scanned with the *Artec Eva*® hand scanner (**Fig. 8**). The device, based on the structured light scanning technology, captures in high resolution the object's geometry and texture with all its features. The main advantages are no limit of the size of the scanned objects and small time-consumption needed for processing the data. In comparison with the Computer Vision Photogrammetry, a complete model can be processed even five times faster. Each object required two scans of both sides. The processing was performed with the use of *Artec Studio*® software, that enabled to merge into a single solid mesh both scanned surfaces.

Generated 3D models were further elaborated in the so-called annotation process. With the use of *Rhinoceros*® 3D software, each feature visible on the scanned timber was highlighted by the 3D contour applied directly on the meshed model. The contours were grouped into individual layers that represented different kinds of features, like fasteners, tool marks, wood science etc. (**Fig. 9**). The annotation process allowed recording a variety of complex timber details in a rapid and accurate way. For the paper prints of documentation, 3D models were put within flat layouts with generated technical viewports of each their face and cross-section (**Fig. 10**). The annotation was accompanied with the timber description, where complex information about the element, including data from paper timber sheets, was written on the timber description.

The collected data, including scans, annotated models, timber descriptions, and detail photo shots of structure features have been used to create a Timber Catalogue, considered to be a basic element of the recoding process (Castro *et al.* 2018: 61–62). Its compilation delivered a good foundation for further complex and complete analysis of the vessel construction.

The Project's Future

The complete documentation process does not fulfil all project objectives. A detailed 3D documentation of elements gives an opportunity for digital reconstruction with all missing or heavy damaged parts. This kind of reconstruction can provide more precise information about the ship's capacity, performance, propulsion, and overall appearance.

Simultaneously with the post-excavation works the conservation process has started. The presence of oversized elements requires enlargement of the facility, especially water tanks and a freeze--drying chamber where eleven-metre-long elements are to be kept. Another, much bigger warehouse for the timbers storage is planned to be built in 2019. Based on the programme calculation, the whole conservation process should be finished in eight years.

Detailed digital documentation allows replicating the missing elements and fitting them within the original wreck structures. According to modern principles of monument restoration, it is permissible to restore historical or archaeological objects to their original form and condition. From the very beginning of the project its goal was not only to save the wreck, but also organise an exhibition about Vistula boatbuilding traditions where the restored Czersk vessel would be the main attraction.

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Fig. 1 – The location of the shipwreck (elaborated by: M. Grabowski)

Fig. 2 – Preserved remains of the vessel excavated in 2009 (photo by: W. Ossowski)

Fig. 3 – Conservation facility in Rybno, near Sochaczew (photo by: W. Borkowski)

Fig. 4 – Aerial photography of the shipwreck site in 2018 (photo by: P. Stencel)

Fig. 5 – Uncovered wreck structures during the field works in 2018 with visible construction of the aft (photo by: M. Grabowski)

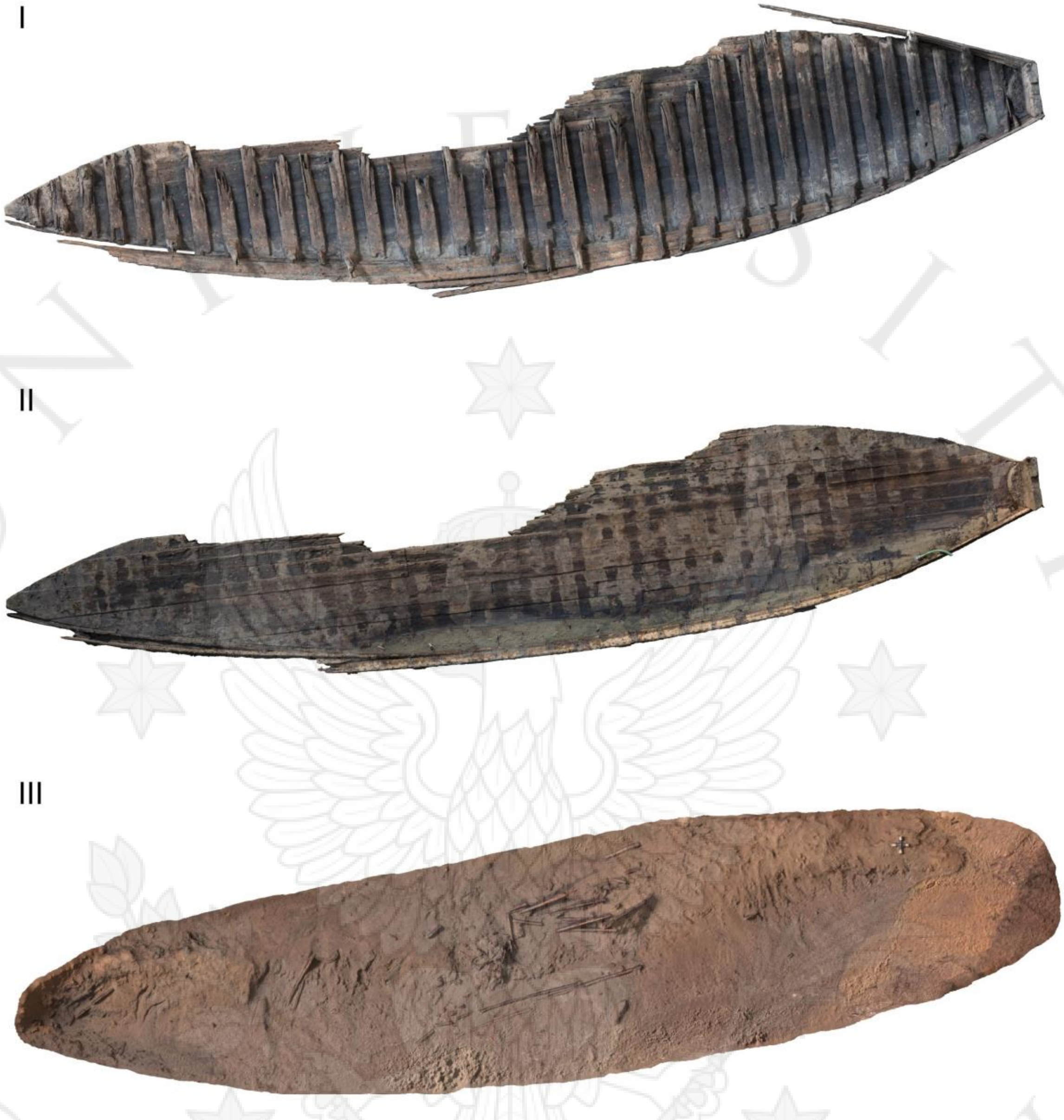

Fig. 6 – Orthogonal site documentation based on the Computer Vision Photogrammetry: I – *in situ* with all timbers attached, II – with disassembled frame stations and side planking, III – structures underneath the wreck (elaborated by: P. Stencel)

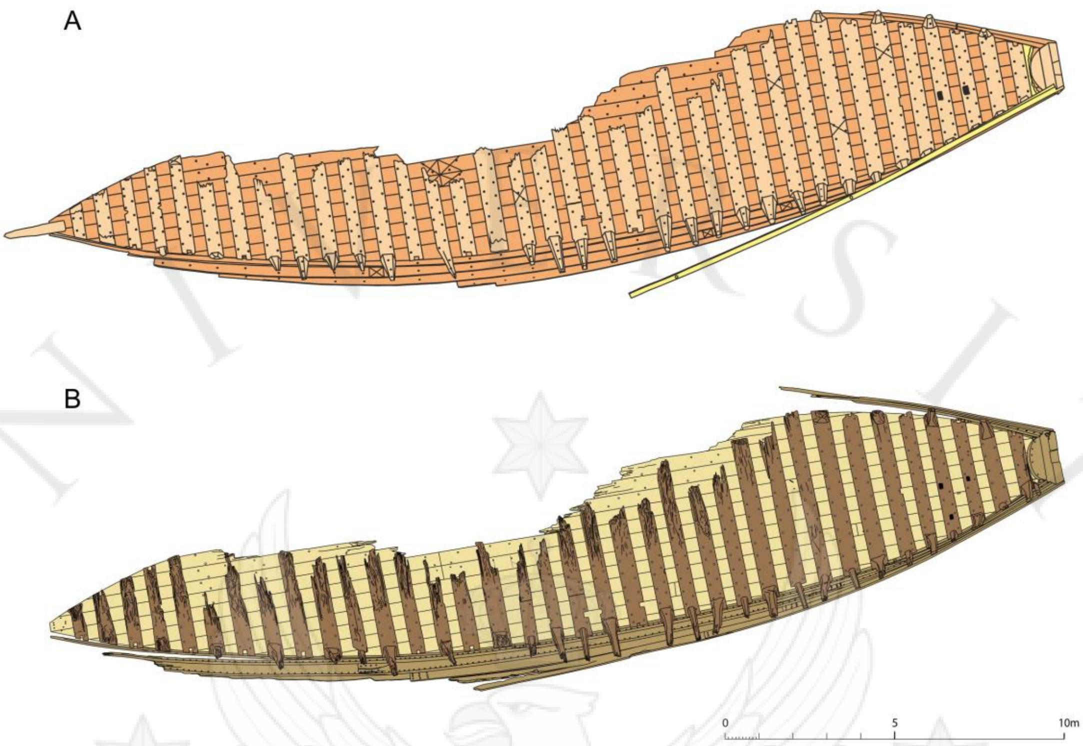

Fig. 7 – Comparison of the original site plan from 2009 [A] and site plan based on the Computer Vision Photogrammetry [B] (elaborated by: M. Grabowski, W. Ossowski)

Fig. 8 – Timber recording with the use of 3D hand scanner (photo by: M. Grabowski)

Fig. 9 – Processing of scanned timber in *Rhinocerros*® 3D software; visible features are 3D contoured and grouped in particular layers (photo by: M. Grabowski)

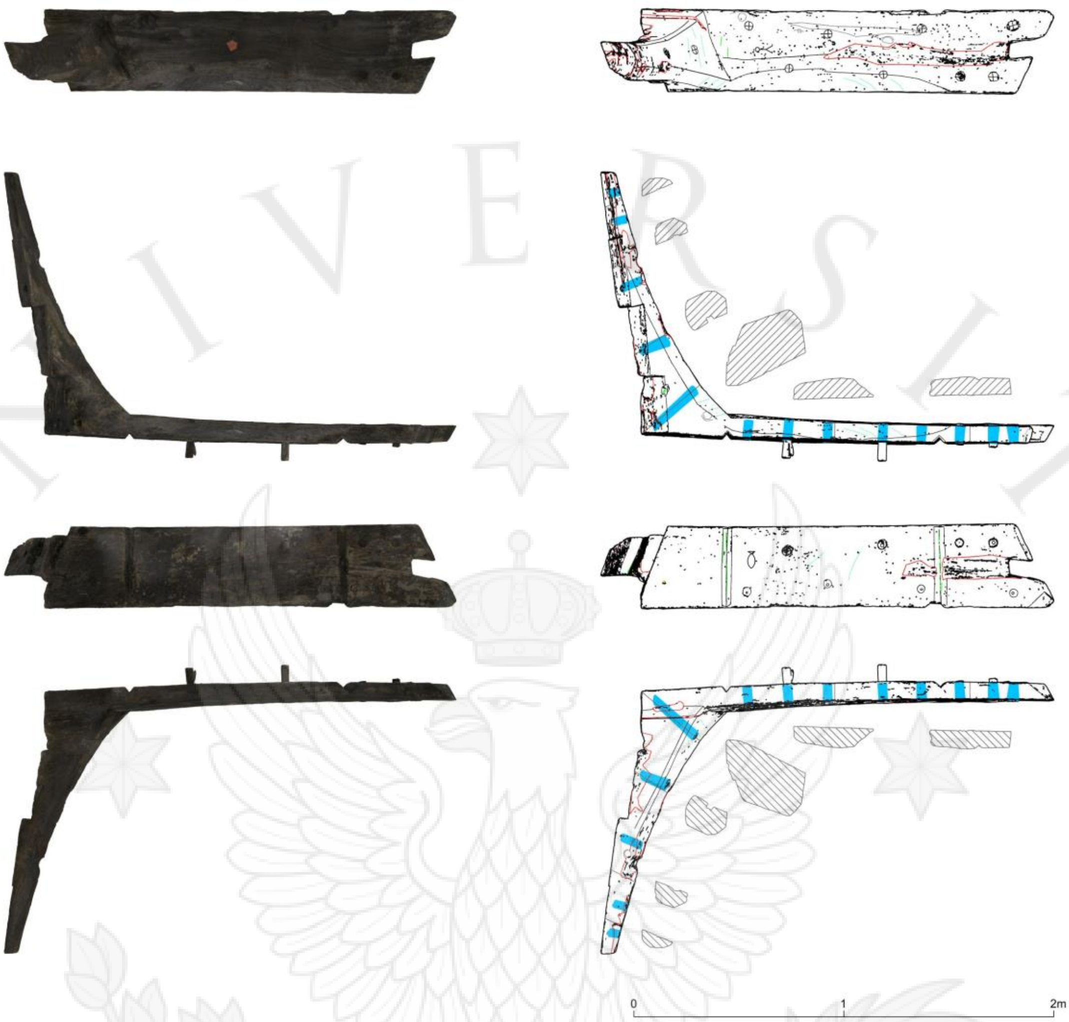

Fig. 10 – Scanned timber with original texture and its computer generated technical drawing with annotations (elaborated by: P. Kucharczyk)

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Underwater Relic of the Battle of the Oder River – Wreck of a Frontal Semi-Pontoon from the Soviet N2P Pontoon-Bridge Park

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Abstract:

On the right bank of the Oder River, over a dozen kilometres downstream of Kostrzyn nad Odrą (Lubusz Land, Poland), lies the 'Porzecze' Landscape-Nature Protected Complex (West Pomerania, Poland). It encompasses floodplains, marshes, meadows, riparian forests, and sandy dunes inhabited by rare species of plants and animals. At the beginning of the previous decade the divers penetrating one of the local oxbow lakes had discovered a wreck of a flat-bottomed, iron vessel, about five metres long. The find had been interpreted as a German cargo boat from the first half of the 20th century and had not attracted any major attention of neither museum curators nor scientists.

In 2016 scholars and students from the University of Szczecin (West Pomerania, Poland), together with a diving expert from the NUREK–TECHNIKA Company have thoroughly reinvestigated the wreck, taking side-scan sonar images and measurements. It has become possible to correctly identify the wreck as a frontal semi-pontoon of the Soviet N2P heavy pontoon-bridge park (Russian: тяжёлый понтонный парк Н2П*). It was a mobile set of military engineering equipment designed for construction of ferries and floating bridges, introduced to the Red Army service in 1932. The watercraft has sunk or has been sunken during the fights along the Oder River, clashes between the Red Army and the armed forces of Nazi Germany in winter and spring of 1945. The wreckis preserved in a good condition (hull framing is complete, and the plating has negligible losses), though all removable parts are missing.*

The wreck, now examined and documented, is currently the only known specimen of this type of a semi--pontoon in Poland. It remains an interesting, yet hardly accessible element of cultural heritage of the Oder Valley, enriching natural assets of the 'Porzecze' Landscape-Nature Protected Complex.

Keywords:

ethnology, underwater archaeology, ethnoarchaeology, wreck, Second World War, Red Army, military engineering, pontoon-bridge park, Oder River, West Pomerania

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Introduction

At the beginning of 1945 at the Eastern Front of the Second World War the Red Army accompanied by the Polish Army troops stationed along the Vistula River preparing to strike the final blow upon the armed forces of Nazi Germany. On the 12th of January the units of the 1st Belorussian Front and the 1st Ukrainian Front have moved from their positions toward west, beginning the gigantic offensive military operation which was recorded by history as the Vistula–Oder Offensive (Rydłowski and Safjan 1960: 7; Kazakov 1974: 10–14). In the plans of the Soviet General Headquarters, a key issue was the march toward the Third Reich capital city of Berlin (Brandenburg, Germany). The Oder River was the last large aquatic obstacle on which the Germans could arrange the line of defence to stop the attack (Tieke 2015: 58).

In the early morning of the 31st of January 1945 the selected armoured-motorized squad of the Soviet 5th Shock Army arrived, low on fuel, at the riverside of the Oder, over a dozen kilometres north of Küstrin (Neumark, Germany; after 1945 Kostrzyn nad Odrą, Lubusz Land, Poland). The Red Army troops have passed the frozen river over the ice (leaving all tanks and most of the artillery on the right bank) and captured the village of Kienitz (Brandenburg, Germany) by surprise, forming a bridgehead situated barely 69 km from the centre of Berlin. The military and propaganda importance of this feat should be stressed by the fact that the deputy of the supreme leader Joseph Stalin and a commander of the 1st Belorussian Front – Marshal Georgy Zhukov himself – – has extensively described it in his war memoirs (Zhukov 1985: 322–324).

Though some researchers dispute the details regarding the circumstances of capturing Kienitz described there, it is certain that on the last day of Januray the village was under Russian control, and hard fights erupted over the bridgehead (Bokov 1979: 80; Le Tissier 1996: 34–36; Beevor 2002: 69). A week later, the ice cover on the Oder began to crack, significantly hindering the Red Army's deployment of forces, armament, and supplies to the western bank of the river (Antonow 1980: 304–305). It was not until the ice floe has drifted down the river, have the Soviest sappers constructed the floating bridge with the load-bearing capacity of 16 tons near Kienitz.[1] Both the presented events as well as later struggles along this section of the front during the Battle of Berlin are quite accurately described in the memoirs of the participants and scientific publications of military historians (Worobjow *et al.* 1971: 132; Sawicki [ed.] 1977: 290–293; Bokow 1977: 310–313; Kohlase 1993: 47–48; Toczewski 2010: 154–156; Tieke 2015: 86). However, after that bloody fighting another kind of souvenir remained, almost totally unknown until the recent time.

[1] The bridge is visible on a map showing sectors of action of Soviet 47th Army and 3rd Shock Army on the 16th of April 1945, in the beginning of Battle of Berlin (Le Tissier 1996: 165, Map 19).

It is a wreck of watercraft which has sunken during the military operations in one of the oxbows at the eastern side of the Oder River. This article aims to present the history of this discovery, its (re)interpretation and identification.[2] The results of the following are elaborated in the text:

- ethnological research (structured qualitative interviews and informal conversations) as well as museum, library, archive, and the Internet queries, accomplished by ethnologist Piotr Maliński in the time period of 2015–2018;[3]
- fieldwork using side-scan sonar and diving reconnaissance, executed in July 2016 by the authors of this paper;
- accurate measurements of the wreck performed in August 2016, where archaeology students from the University of Szczecin (Magdalena Drozd and Kamila Skowrońska) participated under the supervision of Piotr Maliński.

The use of ethnological methodology and ethnological research techniques to localize an object of archaeological heritage, in order to perform its prospection and complete the documentation, can be regarded as an action in the scope of ethnoarchaeology – or even 'underwater ethnoarchaeology', considering the location of the wreck (being underwater). The concept of 'underwater ethnoarchaeology' (which may seem controversial at first glance) is more fully explained in another text, which has been published in this volume (Maliński, forthcoming).

Apart from the results of the interdisciplinary field research this article contains as well the detailed technical data of the described watercraft, along with several practical remarks that could prove useful considering the recovery of the wreck in the future.

The Discovery and Verification of the Find

After the end of the Second World War the Oder became a border river between Poland and Germany. At the end of the 20th century the Polish authorities paid special attention to the area placed on the east bank of the river near Kienitz, because of its natural and landscape assets. Indeed, the landscape there is extraordinarily diversified, unusual for the surroundings of the Oder. On the floodplains, among the oxbows, vast marshes, meadows, and riparian forests, there are sand dunes, highest in the entire valley of the river (**Fig. 1**).

[2] It is a revised, completed, and edited version of a text that has been recently published in Polish (Maliński *et al.* 2018).
[3] Among others, as part of the project *Ethnoarchaeology of the Lower Oder. Preliminary Research of the Wrecks in the Selected Sections of the River*, funded by the National Science Centre, Poland (grant no. 2018/02/X/HS3/00475) and carried by the University of Szczecin, Poland. The text dedicated to the project has been published in this volume (Maliński, forthcoming).

It is overgrown by shrubs and both deciduous and evergreen tree stands, in which atypical, decumbent forms of trees can be spotted. Many endangered and protected plants can be found in the area, which is also inhabited by some rare animal species. In 1992 the area was covered by wildlife protection, forming the 'Porzecze' Landscape-Nature Protected Complex[4] (West Pomerania, Poland), spanning 142 ha in total area (Jermaczek *et al.* 1999: 57; Chara 2012: 9).

First mentions regarding the wreck stranded in the area of the 'Porzecze' Complex have reached Piotr Maliński in 2015. At this time the ethnological qualitative research on fluvial cultural heritage of West Pomerania has been conducted. During the structured interviews and informal conversations the data regarding ships and boats that had sunk in the Oder River and its distributaries has been gathered.[5] The information about 'the wreck from Porzecze' has been brought independently by three individuals, who have encountered the sunken watercraft during recreational diving in the period of 2001–2009.[6] The divers suspected that it might have been a wreck of a German transport boat, used in the pre-war period. During interviews and conversations with Piotr Maliński, the informants used phrases like 'steel boat', 'tub boat', 'cargo boat', and 'small barge'.[7] They stressed that it is 'without cargo', 'entirely empty'[8], which indirectly indicated their conviction that the vessel has been designed to transport cargo. The divers, however, found traces of evidence suggesting that the boat has been sunken during war operations: an artillery shell case has been discovered inside the wreck, as well as the irregular cavities in the hull, which were interpreted as bullet holes. The discoverers claim that the news about the wreck has been relayed to the nearest museum, the local institution governing the water resource management, as well as the regional heritage protection services. The underwater discovery, however, did not arouse any interest.

Willing to verify the gathered verbal information regarding the wreck, Piotr Maliński decided to perform a more detailed field investigation using non-invasive methods. They have come to fruition in 2016 thanks to the favourable attitude of both the administrator of the area

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[4] The name of the Complex is derived from a small village named Porzecze (West Pomerania, Poland; until 1945: Hälse, Neumark, Germany) located nearby (Dittmann 1996: 281).

[5] The interview schedule has been applied, which listed the wording and sequencing of questions about wrecks. The questions referred to location of sunken watercrafts, as well as respondents' convictions of their types and provenience. However, not all informants agreed to be interviewed, some of them preferred rather less formal talks.

[6] First of them was a person with professional connections to inland navigation on the Oder River, who withheld its identity, explaining that he does not seek publicity. The second informant was Mirosław Wójcik, the founder and director of the Regional Museum (Polish: *Muzeum Regionalne*) in Kierzków (West Pomerania, Poland; Maliński 2017b: 29–32). The third person was a historian and archaeologist Aleksander Ostasz, director of the Museum of Polish Arms (Polish: *Muzeum Oręża Polskiego*) in Kołobrzeg (West Pomerania, Poland), an active and accomplished researcher of underwater archaeological heritage of West Pomerania (Maliński 2017a: 71–72).

[7] Polish: '*stalowa łódź*', '*krypa*', '*łódź towarowa*', and '*mała barka*'.

[8] Polish: '*bez ładunku*', '*całkiem pusta*'.

and the local authorities for protection of cultural heritage, which have issued permissions to carry the fieldwork in the area of 'Porzecze' Landscape-Nature Protected Complex (where restricted laws regarding wildlife conservation are in effect).[9] To perform the research, Piotr Maliński invited the co-authors of this text: a commercial diver Sławomir Radaszewski, and an archaeologist Przemysław Krajewski, experienced in research at underwater archaeological sites (Maliński, Krajewski *et al.* 2016; Maliński 2017a: 72). The team included two aforementioned students of archaeology, who had earlier participated in underwater reconnaissance and research as members of the Scientific Club 'Floating Research Station' at the University of Szczecin, Poland (Maliński 2016).

The assorted team has performed fieldwork using side-scan sonar, thanks to which the wreck has been found resting at a small depth (0.6–1.3 m) in an oxbow of the Oder River (**Fig. 2**). Analysing the sonar images and basic measurements has allowed Piotr Maliński to identify the type of a sunken watercraft. It happened to be a frontal semi-pontoon, an element of N2P pontoon-bridge park, produced in USSR in the 1930s. During further works, the geographical coordinates of the wreck have been determined and more detailed measurements have been taken, which served to develop the drawing documentation.

Technical Data and Structure of the Watercraft

The N2P heavy pontoon-bridge park (Russian: *тяжёлый понтонный парк Н2П*) has been designed by a team of military engineers: I.G. Popov, S.V. Zavackij, B.N. Korčemkin, N.A. Trenke, and A.I. Ugličiničev.[10] It was a mobile set of engineering equipment destined to organize landing, ferry, and bridge crossings. Ferries and floating bridges constructed from its elements had load-bearing capacity from 16 to 60 tons. N2P parks have been first deployed as an equipment of Red Army pontoon-bridge battalions in 1932. It seems that until 1942 they were the only pontoon-bridge parks in the world allowing constructing ferries and bridges with load-bearing capacity reaching 60 tons (Veremeev 2017).

Every N2P park consisted of 48 steel semi-pontoons (16 frontal and 32 middle ones) as well as bridge spans and supports, access ramps, auxiliary equipment, and engines: either outboard

[9] The authors are very thankful for the chief forester Cezary Augustyniak (State Forests – National Forest Holding 'Nadleśnictwo Dębno') for issuing the permit for fieldwork and for detailed information regarding law in force in the area of 'Porzecze' Complex. The authors also wish to thank the Head of the West Pomeranian Voivodeship Heritage Office, Ewa Stanecka, for quick and free permission to search for the wreck.

[10] Unfortunately, the known sources mention the names of only one of the constructors, Sergej Vladimirovič Zavackij (Čistjakov 2017).

motors, type SZ-20 or MW-72, or BMK-70 motor boats. The entire park used to be transported on 86 specially adapted ZiS-5 trucks (Veremeev 2017).

The mentioned semi-pontoons could have been connected serially (by two or three) in sets, called single pontoons and one-and-a-half-pontoons (Hovratovič 1950: 191–192; Viničenko 1999: 37).[11] Those pontoons were connected to each other in parallel (by two, three or six) using a bridge span, to construct a ferry or a section of floating bridge. The load--bearing capacity of the ferry or bridge segment depended on the number of semi-pontoons used for its construction. Besides the above purposes, single pontoons and one-and-a-half--pontoons were also used as standalone vessels functioning as landing boats (**Fig. 3**).

The frontal semi-pontoon from N2P heavy pontoon-bridge park was a steel vessel with a welded framing construction, being flat-bottomed, with an ovoid bow (containing small bow half-decks) and a stern with a vertical transom (**Fig. 4**). Its dimensions were 5.30 × 2.20 × 1.05 m (length overall × width × height). It had a nominal weight of 950 kg and a load-bearing capacity of 6.1 tons. The framing of the semi-pontoon consisted of six frames, three panting stringers, four side stringers, two pillars, and a deck-beam, connected by several reinforcements and bends (horizontal and vertical). Almost entire hull plating have been constructed of one to one-and-a--half-millimetre-thick steel plate sheets, except connections between boards and bottom plating, where two-and-a-half-millimetre-thick plate was used. On the bow half-decks there were two vertical sockets for embedding the cathead with lifting capacity of 400 kg. Between the half--decks, a manual driven anchor winch was mounted. The anchor rope was placed on the bitts welded to pillars. The railing stringers had series of vertical holes for fastening railing poles, rowlocks, and horizontal structural elements of ferries and bridges (Hovratovič 1950: 191–192).

The semi-pontoon was also equipped with five oars (the crew consisted of four oarsmen and a helmsman-motorman) and wooden gratings arranged on the bottom. At the stern ends of panting stringers, at the bottom edge of the transom, there were two fastenings enabling to connect the watercraft with other N2P park semi-pontoons.

Condition of the Wreck

As mentioned earlier, the semi-pontoon is stuck on a small depth, dependent on actual water level in the oxbow. In favourable conditions it can be even seen below the surface

[11] However, Polish soldiers called single pontoon colloquially '*dwojak'* (literally: 'double') and one-and-a-half--pontoon '*trojak'* (literally: 'triple') (Sowiński and Tyszyński 1949: 73; Dideńko 1978: 99).

of the water (**Fig. 5**). The wreck orientation is 85°, so that its bow is pointed eastward. The hull of the semi-pontoon rests submerged in the bottom sediments at the depth of ca. 0.3 m, tilted toward the starboard and trimmed to the stern. The tilt and trim are caused by wreck being located on the slope of the bottom that piles eastward, forming shallow (**Fig. 6**).

The measurements performed have shown that the tilt and trim angles are higher on the stern side of the watercraft (both being 7°) than on the bow (where tilt is 3° and trim 5°). The differences in degree values indicate that the hull structure is slightly distorted. In spite of this, the hull is preserved in relatively good condition: the framing is complete, and the plating of the boards and the bow side has only minor losses. All preserved elements are covered by a layer of oxides. The corrosion has especially strained the thin plating, which has now little mechanical durability. The right half-deck has been completely destroyed, and the left one has been damaged (**Fig. 7**).

All the removable equipment of the half-pontoon is missing, including the anchor, anchor line, the cathead, capstan, railing poles, rowlocks, oars, and gratings. During the diving reconnaissance on the bottom of the basin, near the bow of the wreck, Sławomir Radaszewski has found only a fragment of the arm of a steel anchor (of Admiralty Pattern) along with its bill and fluke (**Fig. 8**).[12] The reconnaissance has also demonstrated that the hull of the semi-pontoon is entangled in fishing strings and ropes with double hooks, and artificial fishing baits (lures, rippers etc.). The area where the wreck is submerged is overgrown by yellow water-lily (*Nuphar lutea*).

Summary

The type and purpose of the watercraft unambiguously indicate that its presence on the bottom of the basin is linked to the battles alongside the Oder River, which were fought between the Red Army and Nazi Germany forces in winter and spring of 1945. Basing on collected data, it cannot be ascertained if the found semi-pontoon was functioning in the landing, ferry or bridge crossing of the river. It can be only assumed that it has been sunken because of the enemy fire, which left marks visible as irregular holes in board plating. It is possible that the crew had tried to direct the sinking vessel and either reach the eastern bank of the Oder (then turgid and widely distributed over the floodplains) or embed it on the shallows. The broken fragment of the anchor found near the bow of the wreck can

[12] After completing the drawings and photographic documentation, the artefact has been deposited in the exact place where it was found.

indicate that an attempt has been made to surface the wreck, with the use of anchor equipment from the other vessels, or to haul it through the bottom to the shore. Anyway, to ascertain the date, circumstances, and causes of sinking of the semi-pontoon, further research would be needed, especially querying the Russian military archives. It can be hypothesized that the analysis of German sources could also yield interesting results.[13]

The 'wreck from Porzecze' seems to be a valuable discovery, because currently it is the only known specimen of N2P bridge park semi-pontoon in Poland. In the collections of Polish museums only the elements of modernized version of this park (designated N2P-41) can be found,[14] which was used by the Polish Armed Forces during and after the Second World War (Malczewski and Polkowski 1970: 107–108; Herrmann 2006: 52). The semi-pontoons of the N2P-41 park differ from their N2P counterparts by the shape of the bow and type of stern mountings, as well as slightly in dimensions (**Fig. 9**).[15]

Considering the unique character of the wreck and its historical and scientific value it has been decided to withhold its exact location to protect it from devastation or theft. In West Pomerania certain groups can be encountered, called '*mafia wydobywcza*' (literally: 'excavation mafia'), that illegally explore underwater archaeological heritage and excavate the artefacts for commercial purposes.[16] In order not to facilitate their criminal activity, this text does not include any map. The coordinates of the find were only provided within a report handed over to the West Pomeranian Voivodeship Heritage Office and to the State Forests – – National Forest Holding 'Nadleśnictwo Dębno' (Maliński, Radaszewski *et al.* 2016). Additionally, actions were taken to determine the possible ways and costs of recovery of the semi-pontoon and hand it to the museum. For now, however, the wreck remains underwater – as an interesting, though hardly accessible element of cultural heritage of the Oder Valley, diversifying and enriching the numerous natural assets of 'Porzecze' Landscape-Nature Protected Complex.

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[13] Valuable information could possibly be found in a book containing memories of inhabitants of Kienitz, from the period of battles of the Oder bridgehead in 1945 (Rambusch 2010). Unfortunately, despite long searching, the publication could not be found in any of the Polish libraries or private collections.

[14] Specimens of frontal semi-pontoons of N2P-41 park are exhibited in the Museum of Engineering and Chemical Defence Troops (Polish: *Muzeum Wojsk Inżynieryjnych i Chemicznych*) in Wrocław (Lower Silesia, Poland) – a division of Land Forces Museum (Polish: *Muzeum Wojsk Lądowych*) in Bydgoszcz (Kuyavia, Poland), and in the Museum of 1st Polish Army Memorabilia and History of Mieszkowice Land (Polish: *Muzeum Pamiątek 1. Armii Wojska Polskiego oraz Dziejów Ziemi Mieszkowickiej*) in Mieszkowice (West Pomerania, Poland) – a division in Gozdowice (West Pomerania, Poland).

[15] Differences between the structure and dimensions of semi-pontoons from both parks are explained in detail in Soviet military instruction manual (Tamakulova [ed.] 1945: 41–53).

[16] Information collected by Piotr Maliński during ethnological research in 2018.

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Fig. 1 – 'Porzecze' Landscape-Nature Protected Complex from the bird's eye view. Sand dunes in the foreground, oxbows, marshlands, and the Oder River in the background. Beyond the river, to the left, village of Kienitz is visible (photo by: P. Maliński)

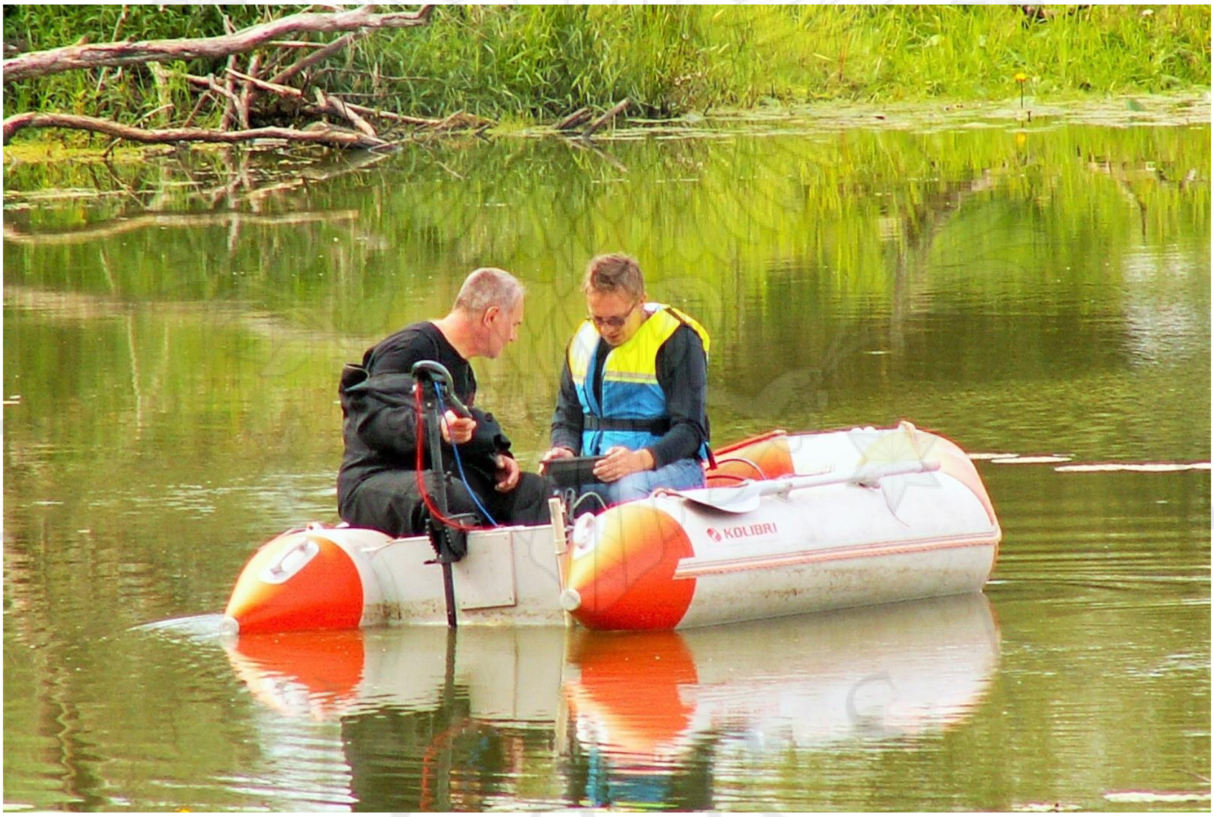

Fig. 2 – Sławomir Radaszewski (to the left) and Piotr Maliński during search for the wreck (photo by: P. Krajewski)

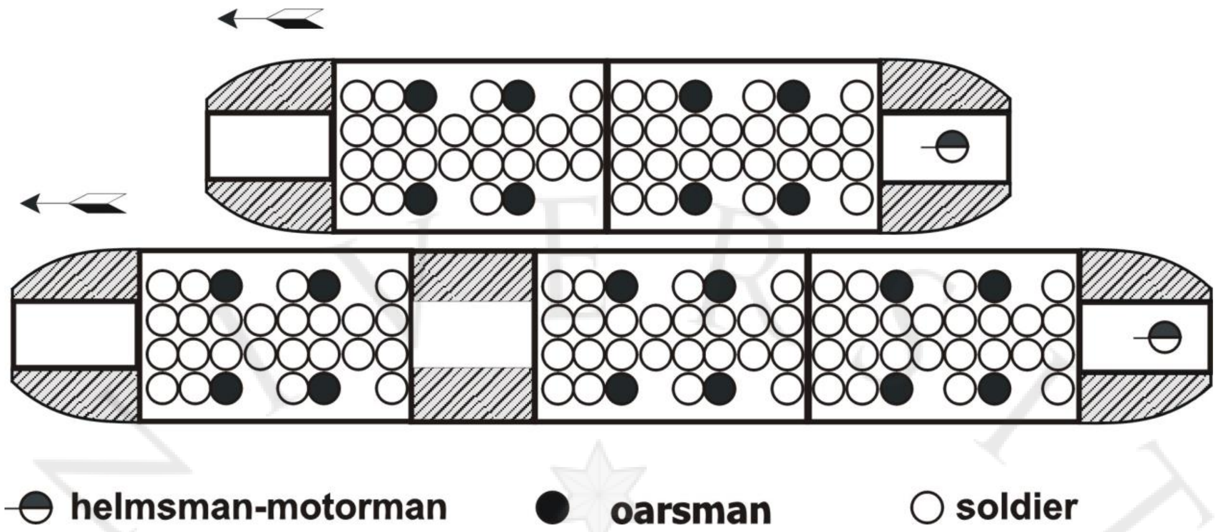

Fig. 3 – Schematic plan of placement of the crew and passengers (soldiers) in single pontoon (top) and one-and-a-half-pontoon (bottom) from N2P park (elaborated by: S. Radaszewski, basing on Hovratovič 1950: 192, Fig. 148v, translated and completed by P. Maliński)

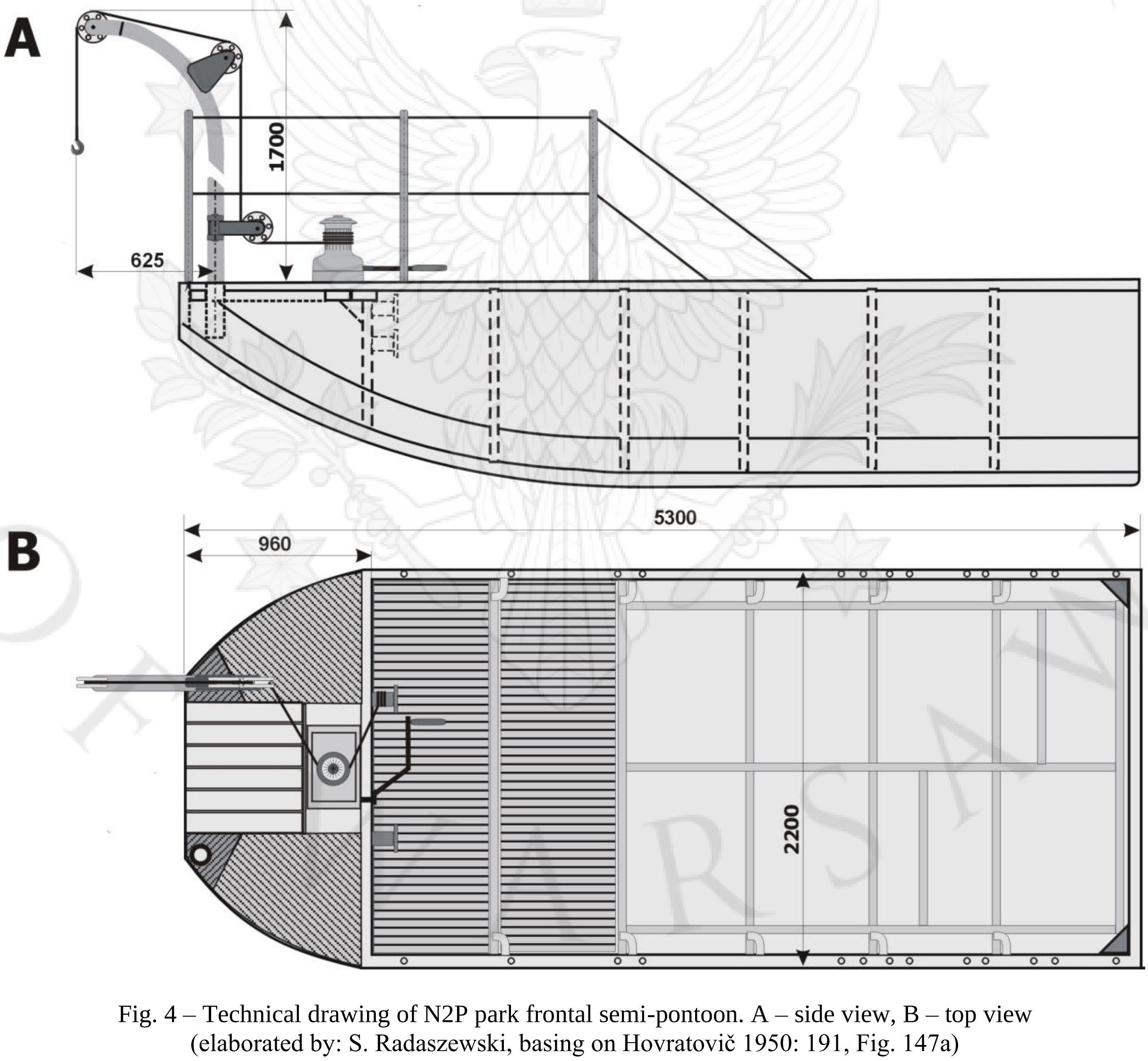

Fig. 4 – Technical drawing of N2P park frontal semi-pontoon. A – side view, B – top view (elaborated by: S. Radaszewski, basing on Hovratovič 1950: 191, Fig. 147a)

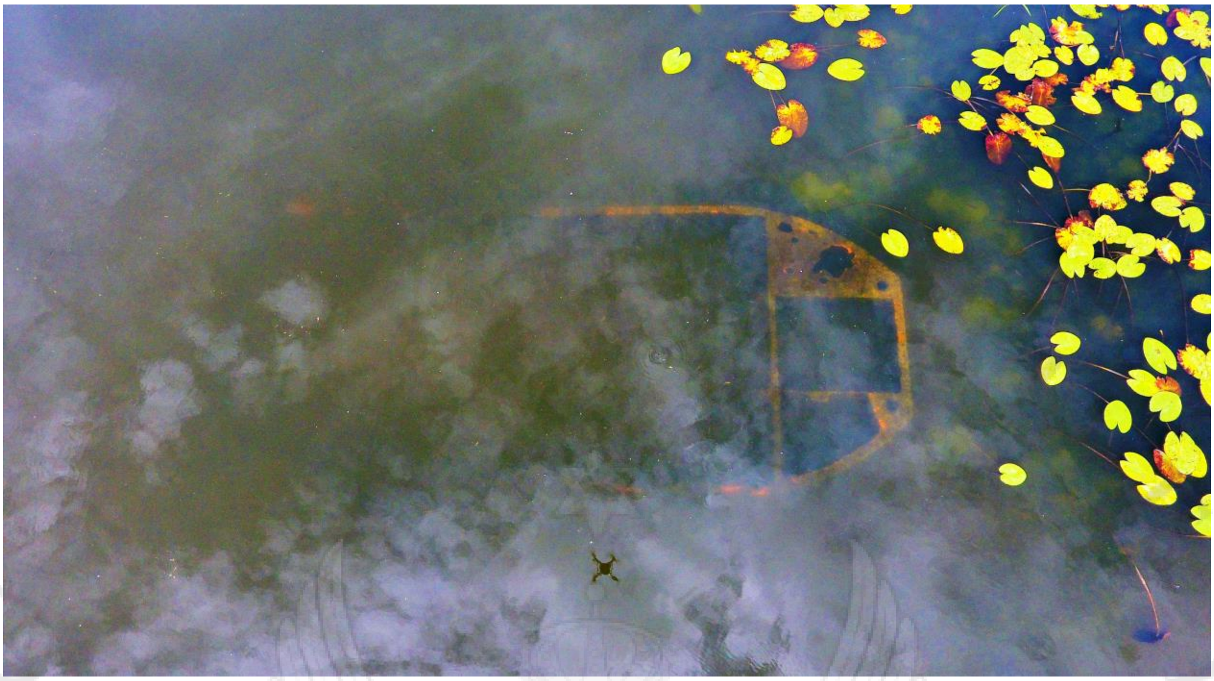

Fig. 5 – Bow section of the wreck visible underwater beneath the leaves of yellow water-lily (*Nuphar lutea*) (photo by: P. Maliński)

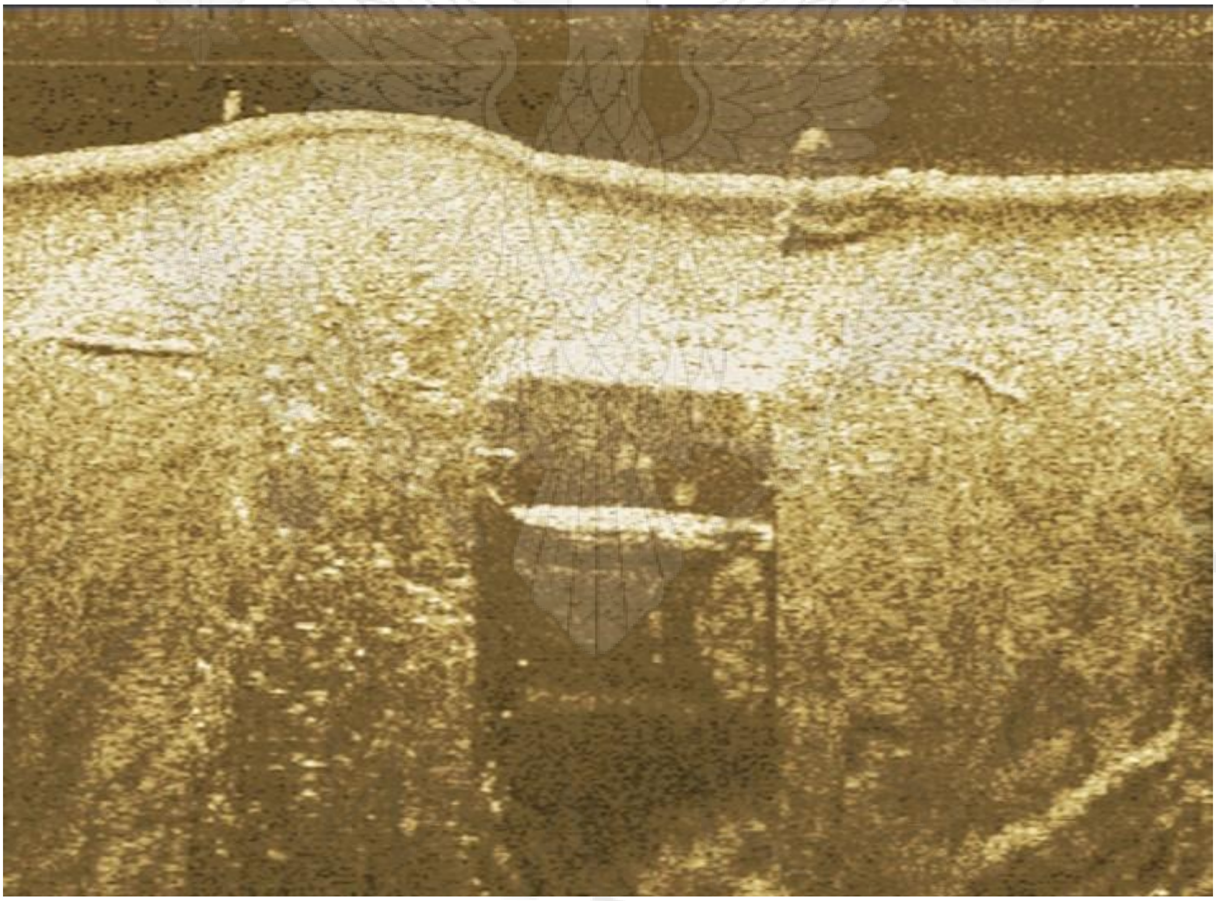

Fig. 6 – The wreck as seen on side-scan sonar image (image by: P. Maliński)

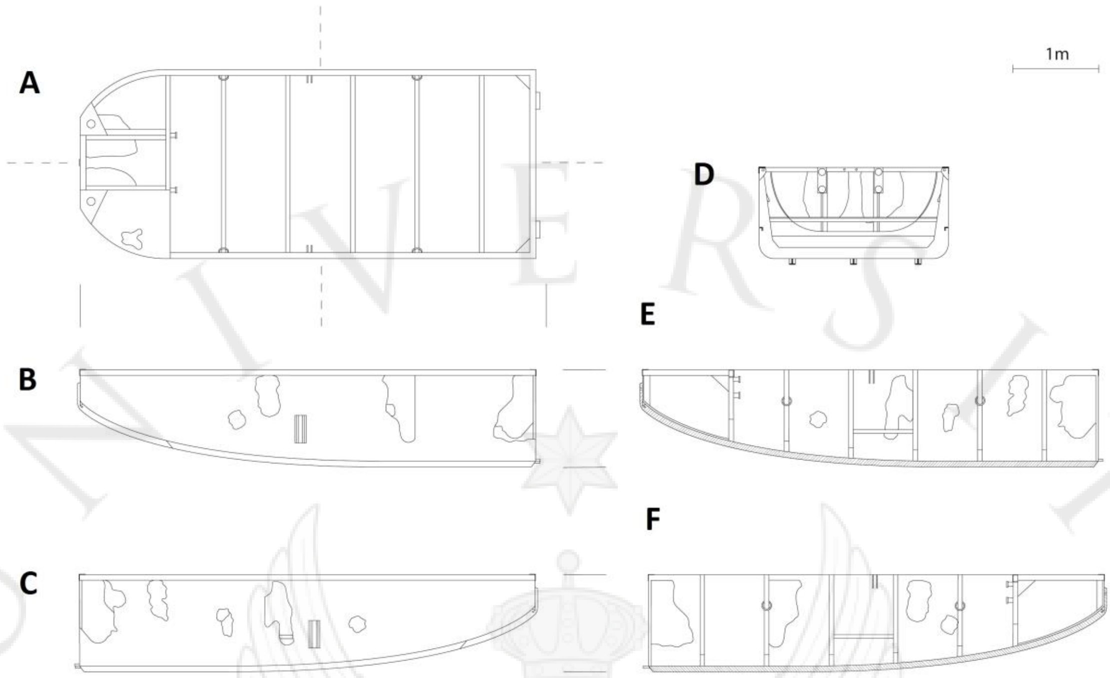

Fig. 7 – Drawing of the wreck based on measurements and archival photographs of frontal semi-pontoons of N2P park; A – top view, B – port side view, C – starboard side view,
D – transverse section (viewed from the stern), E – longitudinal section (viewed from port),
F – longitudinal section (viewed from the starboard) (elaborated by: M. Drozd)

Fig. 8 – A fragment of anchor found near the bow of the wreck (elaborated by: M. Drozd)

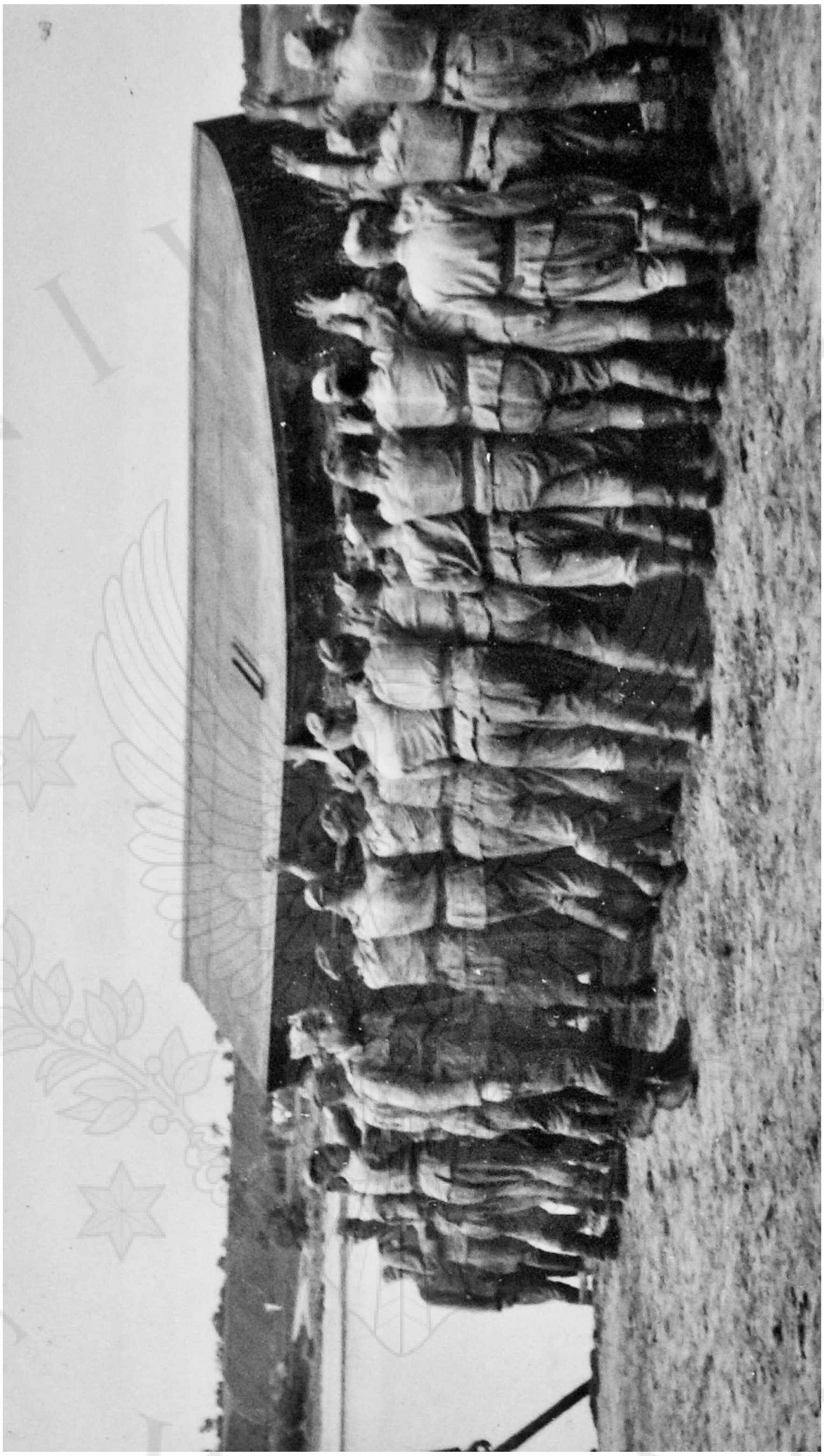

Fig. 9 – Soldiers of the Polish Armed Forces during military exercise, flipping the N2P-41 park frontal semi-pontoon to the board; as seen, its hull has the same width from the bow to the stern, unlike N2P park frontal semi-pontoon, in which hull is narrower toward the bow.
Photograph made in 1949 at the Vistula River, place and author unknown;
archival photograph from collection of the Museum of Engineering and Chemical Defence Troops (*Muzeum Wojsk Inżynieryjnych i Chemicznych*) in Wrocław (Lower Silesia, Poland) – a division of Land Forces Museum (*Muzeum Wojsk Lądowych*) in Bydgoszcz (Kuyavia, Poland),
signed 27/12, inv. no. 2116/05 (reproduction by: P. Maliński)

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The Lower Oder: 'Gardens Full of Wrecks'. First Results of Ethnoarchaeological Research

Piotr Maliński*

Abstract:

The project Underwater Ethnoarchaeology of the Lower Oder. Preliminary Research of Shipwrecks in the Selected Sections of the River is funded by the National Science Centre, Poland (grant no. 2018/02/X/HS3/00475) and carried by the University of Szczecin (West Pomerania, Poland) in the time period of 2018–2019. It assumes application of information gathered during ethnological fieldwork for the use of underwater archaeology.

During structured interviews with representatives of social groups related by occupation or hobby to the Lower Oder (e.g. seamen, fishermen, divers, anglers, sailors etc.) the data concerning any known wrecks is being gathered – along with the broad context: spatial (localization, position, orientation) and socio-cultural (toponymy, beliefs, convictions of types and provenience of sunken watercrafts). On this basis sections of the river were selected, with the highest number of located wreck sites. These areas were prospected with the use of side-scan sonar and an unmanned aerial vehicle (UAV). The next stage of research (for now yet unaccomplished) is the elaboration of bathymetric maps. The spatial analysis of the data gathered this way will be used to designate areas for underwater archaeological research. It will consist of making the photographic and video documentation during diving reconnaissance, and then descriptive and graphic documentation of selected wreck sites.

The results of the ethnological fieldwork allowed determining not only the areas where wrecks are located, but also their socio-cultural context – how they are functioning in the consciousness of people residing by the Lower Oder. On the other hand, the results of archaeological fieldwork will enable to verify the accuracy of convictions and beliefs regarding shipwrecks, and also determine the scope and methods of further research upon discovered underwater archaeological sites.

Keywords:

ethnology, underwater archaeology, ethnoarchaeology, underwater archaeological heritage, wreck sites, survey, side-scan sonar, UAV, Lower Oder River, West Pomerania

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Introduction

The Oder belongs to the largest rivers in the drainage basin of the Baltic Sea; in terms of river basin area it ranks third (after the Neva and Vistula). Its sources are placed among the Odra Highlands in eastern Czech Republic, from where through Moravian Gate it flows onto the territory of Poland. Through Upper and Lower Silesia it reaches the Lubusz Land, where it becomes a border river between Poland and Germany. Even further, in the West Pomerania, it flows into Szczecin Lagoon, having travelled over 850 km. Its transboundary nature is a reason to call it 'a river of three nations' (**Fig. 1**).[1] The Oder Valley is not only an ecological corridor connecting different geographical regions and their ecosystems, but also an important transportation, mercantile, and tourist route along the meridian (Jankowski and Świerkosz [eds] 1995; Jirásek 2007; Marszałek 2003; 2007; Zawadka 2007). As Karl Schlögel has written, "*Oder is like an encyclopaedia. Between Moravian Gate and Szczecin Lagoon one can see almost everything that the world of Central Europe has to offer*"[2] (Rada 2009: 7).

In the lower course of the river, its valley creates a unique natural and cultural landscape. The Lower Oder splits there into two branches: the East and West Oder (**Fig. 2**). Between them multiple riverbeds exist, partially separated from the main ones, repeatedly merging and separating within the bottom of the valley (Migoń 1995: 36). This region, called Międzyodrze (literary: 'area between the Oders'), encompasses fluviogenic peat bogs and wetlands, intersected by a web of canals and oxbows (Leszczyńska 2009). At the beginning of 20th century it has been encircled by levees and a system of hydrotechnical devices has been built, forming three polders for agricultural use. After the Second World War the land underwent re-naturalization and now several dozens of river islands of Międzyodrze are a wildlife habitat where in 1993 a Landscape Park 'Lower Oder Valley' has been established (Jasnowska [ed.] 2002; **Fig. 3**).

The eastern branch of the Lower Oder (known as the Regalica) near Szczecin (West Pomerania, Poland) flows into transitory deltaic Lake Dąbie (Szczecin, Poland) with a surface area of 56 km^2. The West Oder flows through the downtown of Szczecin, where it becomes a part of the Szczecin–Świnoujście fairway, connecting seaports and shipyard industry centres located in both cities. Within the fairway, the river constitutes officially

[1] The Poles, on the other hand, call the Oder the 'princess of Polish rivers', unlike the longer Vistula River, which bears a symbolic name of the 'queen'.
[2] "*Die Oder ist wie eine Enzyklopädie. Zwischen Mährischer Pforte und Oderhaff bekommt man fast alles zu sehen, was die Welt Mitteleuropas zu bieten hat*" (trad. M. Maliński).

an area of internal sea waters. Below Lake Dąbie, both branches of the Lower Oder merge and flow further north (under the name Domiąża), passing by the seaport in Police (West Pomerania, Poland), to diverge again (into the Wąski and Szeroki Nurt) and flow into Szczecin Lagoon. This coastal lagoon is connected to the Baltic Sea by three straits (the Peene, Świna, and Dziwna), located between islands Usedom (Polish: Uznam) and Wolin and the mainland. As it can be seen, the river mouth system of the Oder is extensive and quite complex (Kowalewska-Kalkowska 2012: 17–21).

Oder 1945: 'the River of Blood' and the Graveyard of Ships

At the end of the Second World War, the Lower Oder has played a significant role in plans of the Third Reich territorial defence. Along the river, the forces of Nazi Germany have established a defensive frontier, at which they intended to stop the offensive of the Red Army (accompanied by Polish Army troops) at the Eastern Front. Colonel-General Alfred Jodl, chief of the operation staff of the *Oberkommando der Wehrmacht*, has allegedly said that "(…) *the outcome of the Battle of Berlin will be decided at the Oder*"[3] (Lakowski 1995). It is where the forces of the 1st and 2nd Belorussian Front have taken their positions, and on the 16th of April 1945 started the Berlin Strategic Offensive Operation (Worobjow *et al.* 1971; Le Tissier 1996). It led to capturing the capital of Nazi Germany and its unconditional surrender. Extremely fierce and bloody battles along the Oder have resulted in tens of thousands of casualties. Therefore, in Polish literature, the Oder has been dubbed 'a river of blood' or 'a river of death' (Mechło and Mechło 2004: 76; Maliński 2017a).

The military operations have caused the Oder's bridges, ports, and shipyards to crumble into ruin, and at the bottom of the river an unimaginable number of sunken watercrafts, military and civilian vehicles, along with different kinds of equipment, armament, and accessories of fighting armies has rested. In an official report of Polish authorities from 1945 it has been stated that 933 wrecks of ships and barges have been located in the Oder; it seems that this estimation does not include wrecks of smaller boats, cars, tanks, planes etc. (Januszewski *et al.* 2001: 97). Most of them have rested in waters of the Lower Oder.

For example, the fleet that found its resting place in Port of Szczecin includes the seagoing ships,[4] floating docks, and crane vessels, icebreakers, tugboats, cutters, barges as well

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[3] "(…) *Die Schlacht um Berlin an der Oder entschieden wird*" (trad. M. Maliński).

[4] Among them was the steamship *Artushof*, hit by incendiary bombs, which cargo still arouses interests of the researchers. After the war, 38 massive graphite rods were salvaged from its cargo holds, which –

as U-boats (Müller and Kramer 1994; Müller 1996: 72–73). In the mouth of the Regalica, near Lake Dąbie, the Germans have sunken the unfinished aircraft carrier *Graf Zeppelin* – – the only launched vessel of this type in the Third Reich – the steamship *Marienburg*, and a ferry (Breyer 1989; Benken 2013; Maliński 2017b: 70–71). A significantly more serious wreck barrier has been created on the East Oder, consisting of four seagoing ships, two barges, a suction dredger, and several smaller vessels, which have rested under a damaged bridge at highway Berlin–Königsberg (former East Prussia, contemporary Kaliningrad, Kaliningrad Oblast', Russia). This barricade, as it can be assumed from its German name (*Hafensperre*), was meant to block the access to the Port of Szczecin (Steinweg 1954: 104; Dinklage and Witthöft 2001: 271).

It is near the mentioned highway where the Red Army has crossed the East Oder, Międzyodrze, and the West Oder in the second half of April 1945. According to General Pavel Ivanovič Batov, the commander of the 65th Army, 15 landing crossings and 11 ferry crossings have been organized there, and 10 floating bridges have been constructed (Batow 1963: 473–515; 1966: 60). The German documents state that the artillery fire has allegedly sunk 107 landing and sapper boats in this region (Murawski 2017: 327, 405).

More than a dozen of wrecks, including the plane ones, have also rested at the bottom of Lake Dąbie. On the coast of the lake a German town of Altdamm (currently Dąbie, a city district of Szczecin) has been situated. After the war, the town has been governed by the Polish military commandant, Lieutenant Marian Wieczorek, who had been constantly writing down his memoirs in the time of his service. He later published them under a significant title *Ogrody pełne wraków* (literally: '*Gardens Full of Wrecks*', Wieczorek 1985). The title can be successfully related to the entire valley of Lower Oder in 1945.

Exploration of the Underwater Cultural Heritage of the Lower Oder

Cleansing the Oder of the wrecks has lasted for many years after the war. A lot of ships have been salvaged, though some have been repaired and were deployed under the Polish civil ensign.[5] However, a large number of wrecks still rest at the bottom of the river. Some of them

– as Leszek Adamczewski (2009: 240–244, 251–257) claims – could have been originally intended to build one of Nazi Germany's nuclear reactors.

[5] For example, a German steamship *Ruhr* which obstructed the current of the East Oder upstream Gryfino in West Pomerania, Poland (Steinweg 1954: 142; Dinklage and Witthöft 2001: 338); renamed as *Ustka*, it has become the first Polish merchant ship that reached Spitsbergen (Svalbard archipelago, Norway), transporting

have become a subject of interdisciplinary research, in which the author of this text participated – as an ethnologist – in the years 2015–2016. Among others, during ethnological qualitative research (structured interviews and informal conversations with the respondents) oral information about the location and provenience of the sunken watercrafts has been gathered. On its basis, a few wrecks have been located in the Oder and its branches, and three of them have been investigated by archaeologists, identified, and then documented (**Fig. 4**). The mentioned wrecks included a nineteenth-century flat-bottomed fishing boat (Maliński, Filipowiak *et al.* 2016) and two elements of Soviet pontoon-bridge parks (NLP and N2P types)[6] sunk during the Battle of Oder in 1945 (Maliński, Krajewski *et al.* 2016; Maliński *et al.* 2018; Maliński *et al.*, forthcoming).

During the aforementioned research, it has come to light that the representatives of social groups related by their occupation or hobby to the Lower Oder (e.g. seamen and officers of inland navigation, fishermen, divers, anglers, sailors etc.) possess surprisingly abundant knowledge of the river depths and the form of its bottom. This underwater space has three aspects:

- natural (because of the plants and animals living in it);
- social (due to people exploiting it and being occasionally present in it);
- cultural (because the products of material culture can be found there).

Moreover, some regions and places are connected to popular convictions that have arisen on the basis of experience of their users, as well as beliefs based on the oral tradition (Maliński 2018: 54).

The experiences mentioned above have encouraged the author to prepare a research project dedicated to perception of the underwater space of the Lower Oder and the objects of material cultural heritage present in it. Considering the depths of the river as a sphere of cultural landscape, the author has figured that it remains not only the least accessible zone of the Lower Oder Valley, but also the least known in the scientific sense. It could be stated that distinctive elements of this underwater cultural landscape are the wrecks themselves, and some of them should also become archaeological sites, protected by Polish law. Recognition of the potential of the resources of fluvial archaeological heritage has become a main objective of the project *Underwater Ethnoarchaeology of the Lower Oder. Preliminary Research of Wrecks in the Selected Sections of the River*. The project is carried by the University of Szczecin

there in 1957 the scientists of Polish Academy of Sciences, along with materials to build Polish Polar Station Hornsund (Maliński 2017b: 71).

[6] One of these wrecks is described in another text, which has been published in this volume (Maliński *et al.*, forthcoming).

and funded by the National Science Centre, Poland (grant No. 2018/02/X/HS3/00475) as a part of the MINIATURA 2 call (Maliński 2018: 56).

Research Method and Fieldwork Techniques

The project assumes the use of ethnological fieldwork techniques (interviews and observations) to locate underwater archaeological sites, in order to prospect and document them. Can it be called ethnoarchaeology? The Polish ethnological dictionary (*Słownik etnologiczny*) notes that in the period of shaping of the contemporary ethnoarchaeology, at the break of fifth and sixth decade of the 20th century, it was "(…) *initially understood as a method of gathering information through ethnographical fieldwork for the use of archaeology*"[7] (Posern-Zieliński 1987: 83). During the realization of this project, the same research process is applied. It can be then considered ‘ethnoarchaeological’ – with a caveat that it is a return to the earlier, a bit ‘archaic’ concept of ethnoarchaeology, which through the recent half of a century has significantly developed and gained new connotations and a broader meaning (David and Kramer 2001). Because the research applies to the underwater archaeological heritage, a term ‘underwater ethnoarchaeology’ has been included in the title of the project, and it could lend the name to the research method. It may obviously seem controversial to some theorists, but it must have appealed to the scientists rating the grant proposal, if the funding for the project has been accepted.

Anyway, the ethnological qualitative research began in October 2018 with structured interviews, during which spatial (location, position, orientation) and socio-cultural (toponymy, beliefs, convictions of types and provenience of sunken watercrafts) data regarding the wrecks and their context was acquired from the respondents. On this basis, sections of the Lower Oder have been selected, in which most wreck sites are supposed to be found (Maliński 2018: 54–55). The next stage of research works, currently in progress, is the prospection of these basins with hydroacoustic method. For this purpose, a kayak equipped with multifunction chartplotter with side-scan sonar[8] is being used (**Fig. 5**). The sonar images allow verifying the gathered information, if only the wrecks actually rest in the indicated places. What is interesting, in several cases the location of completely submerged wrecks was possible thanks to aerial photos made

[7] "(…) *pojmowana początkowo jako metoda zbierania informacji przez etnograficzne badania terenowe na użytek archeologii*" (trad. M. Maliński).
[8] LOWRANCE HDS7 GEN2 Touch.

by unmanned aerial vehicle, a UAV[9] (Cheng 2016: 160–161), despite the relatively low transparency of water in the Lower Oder (**Fig. 6**).

Here appears another methodological question, concerning creation of sonar images and aerial photographs: should it be categorized as a technique of ethnological or archaeological fieldwork? For the ethnologist, observing wrecks on the screen of sonar or a tablet connected to a UAV controller is – *nomen omen* – an observation (so a basic fieldwork technique used in ethnology). Archaeologists, however, would probably recognize such technique as remote sensing – – in its 'active' (sonar) and 'passive' (UAV) form. It seems that this problem deserves a deeper methodological reflection in the future, but at the present stage the most important concept is the statement that both techniques are effective for the location of the wrecks in the Lower Oder.

In case of discovering the wrecks, the project anticipates the next stage of research (for now yet unaccomplished): basing on measurements registered by sonar bathymetric maps of the respective river sections are to be elaborated. Spatial analysis of the data from bathymetric maps will be used to designate the areas of underwater archaeological research. It will consist of making the photographic and video documentation during diving reconnaissance, and then descriptive and graphic documentation of selected wrecks. All underwater actions will be performed as a commercial service by a professional company, and the diving team is to include an archaeologist with adequate experience and qualifications.

The results of the ethnological research described above will not only allow determining the places and areas where sunken boats and ships rest, but also recognizing their socio-cultural context – how they function in the awareness and memory of denizens of the Lower Oder area. On the other hand, the results of archaeological research will allow verifying the accuracy of the convictions and beliefs concerning the wrecks, as well as determining the scope and methodology for further research upon the discovered underwater archaeological sites (Maliński 2018: 55).

It is worth emphasizing that there is neither library nor internet query among research tasks of the project. In fact, the author has already completed them before the project began. Although the source value of materials collected in this way seems to be significant, most of them refer to wrecks, which have been already raised. Nevertheless, the queries provided plenty of general, contextual, and comparative information which has been helpful during further research (and also useful for writing this text).

[9] A quadcopter DJI Phantom 4.

As to the archive query, it was not originally included in the project, too. However, when the task began several scientists independently of each other advised the author to use the potential of archive historical sources concerning wrecks of the Lower Odra. The author followed this right advice and decided to conduct such a query independently of the project's implementation. It occurred to be an interesting idea and the results obtained so far are very promising; however, collected archive data about wrecks should be verified in the field.[10]

First Results of the Project

Although the project has not been completed yet (neither the bathymetric maps were elaborated, nor diving reconnaissance was implemented) the first results were achieved. Basing on the data gathered partially during the structured interviews[11] and also on those acquired earlier (before the project began), several places on the Lower Oder have been selected, where the wrecks were supposed to be located. Most of them have been positively verified using side-scan sonar (or a UAV). On the taken sonar images – aside from underwater fauna, flora, and bottom sediment formation – also numerous objects resting there and diverse types of wrecks and wreck sites can be observed. It is worth noting that the quality of images sometimes allows the preliminary identification of the type of the sunken watercraft. Among them are, for example: fishing boats, passenger cars, smaller and larger river barges (with or without cargo) as well as other, for now unidentified vessels (**Fig. 7–11**). On some sonar images damage of the hulls can be seen, e.g. larger and smaller holes in the plating. On the basis of gathered data the dimensions of the wrecks can be estimated – the largest is 35 m long.

Among the other sunken objects and items, numerous car tyres can be observed (**Fig. 7**). Their presence at the bottom of the river is a phenomenon deserving closer attention.[12] On the margin, it is worth noting that car tyres seem to be a category of artefacts quite attractive for scientific analysis. That is because every one of them is a potential written source,

[10] The author would particularly like to thank Michał Grabowski, Institute of Archaeology and Ethnology, University of Gdańsk (Pomerania, Poland) for tips on relevant resources of the State Archive in Szczecin (Polish: *Archiwum Państwowe w Szczecinie*).
[11] With interview schedule consisting of 10 open questions.
[12] During the interviews performed so far information has been gathered stating that the tyres have been reused on barges as broadside fenders. As respondents claim, the chains on which the tyres were hang have deteriorated during exploitation. Motion of the hull on the water caused tearing on the links of the chain. The weight of the tyre finally broke the most severed link and the improvised fender sank in the river. This hypothesis, at first glance quite plausible, does not explain the matter of displacement of the tyres, particularly the causes of their marked concentration in some locations. What may be interesting is that these locations are not nearby any basins attended by barges.

containing very precise information regarding time and place of its origin.[13] However, the number of tyres resting at the bottom of the Oder (so far several dozen have been found) entices to apply the quantitative methods, e.g. statistical analysis, to analyze this category of finds.

As for the wrecks, it has to be noted that within the fieldwork area there are also those that partially protrude over the surface of the water; therefore no sonar is needed for their location. However, for their photographic documentation a UAV proves very useful **(Fig. 12)**. For the researcher, especially the vertical aerial photographs of these wrecks seem convenient. Such pictures can be quickly and easily taken, and their informative potential is comparable to that of the graphical documentation (top view projection), which requires long and labour--consuming measurements (**Fig. 13**).

The best known and largest wreck of this type in Western Pomerania is undoubtedly the so-called *Concrete Ship* (*Betonowiec*), that protrudes out of the water near the north coast of Lake Dąbie (**Fig. 14**). It is a reinforced concrete hull of the unfinished German steam freighter, about hundred-metre-long, built at the end of the Second World War at the shipyard in Rügenwalde (after 1945 Darłowo, West Pomerania, Poland). In that period, Nazi Germany experienced the shortage of both steel and means of marine transport – as a result, ships with hulls of reinforced concrete have entered mass production (Finsterwalder 1966; Maliński 2019). One of them was *Betonowiec*, now a characteristic element of cultural landscape of the Lower Oder Valley (Maliński 2017b: 71). Rich social context of this wreck deserves special attention – it is a well-known tourist attraction and a frequent gathering place of sailors. On the wreck itself the concerts are organized, as are trainings of water rescue services. There has even been a project proposal, so far not undertaken, of rebuilding the wreck to form the marina. At least for these reasons, the *Concrete Ship* of Lake Dąbie deserves a dedicated scientific description, which would gladly be undertaken by the author in the near future.

Expected Results and Long-Term Objective of the Project

After the end of the fieldwork phase and the compilation of its results the answers to several significant research questions could be acquired:

- what role do the wrecks play in the underwater cultural landscape of the examined sections of the Lower Oder?

[13] Of course, assuming that the inscriptions made by the manufacturer were not damaged during the exploitation of the tyre or as a result of post-deposition processes. It should be expected that the marks of exploitation will allow determining if the tyre was reused as a broadside fender or not.

- what is their number, size, state of preservation and displacement in the geographical space?
- do the convictions and beliefs of local people regarding the sunken watercrafts overlap with the actual situation?
- what is the cultural significance of the investigated wrecks for the regional heritage of West Pomerania and the national heritage of Poland?
- what scope and methodology should the further research of the found wreck sites have?

Measurable final effects of the project will be the map and catalogue of wreck sites of the Lower Oder.[14] They will be passed to the West Pomeranian Voivodeship Heritage Office, along with the attached proposal to acknowledge some of them as underwater archaeological sites. The method of setting the limit of proposed archaeological sites will be consulted with archaeologists and specialists from the West Pomeranian Voivodeship Heritage Office.

In addition, more detailed scientific descriptions of wrecks at the selected sections of the river will be compiled. They are supposed to be published, but providing all gathered information to the public is not recommended. It applies specifically to the accurate geographical coordinates of the wrecks. There is a justified fear that such data could be exploited by illegal explorers of underwater archaeological sites, which is not uncommon in West Pomerania. As it seems, they are organized groups of people, with their own professional diving and exploratory equipment, who obtain artefacts for their own private collections or to sell them to sometimes foreign collectors (Święch 2014: 32–33). Though it is very difficult to estimate the losses and damages to the archaeological heritage caused by the activity of those groups, their colloquial name used in West Pomerania has a disturbing tone: '*mafia wydobywcza*' (literally: 'excavation mafia'). Another problem is posed by companies raising or buying steel wrecks to sell them as scrap metal (**Fig. 13**). In the last years at least two vessels of undoubtedly significant historical value have been simply cut and sold as scrap metal in Szczecin.[15]

Publishing data regarding location of wreck sites in the Lower Oder is linked to yet another potential danger. It cannot be excluded that some of the wrecks found (especially those

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[14] The catalogue will contain basic descriptive information about each wreck (location, position, orientation, depth, condition, preliminary identification of the type, presumably chronology, etc.) and its sonar image or aerial picture. In case of wrecks investigated by divers, there will be also drawings (black and white, in three casts, scale 1:100) and underwater photographs.

[15] These were: a steam-powered suction dredger *Mamut* and a barge – both of them from the beginning of the 20th century (Słomiński 2009; Jaszczyński 2011).

sunken during the Second World War) still contain dangerous cargo: weapons, ammunition, explosives or inflammable materials (Święch 2016: 154). Eventual attempts to excavate such 'underwater memorabilia from the past' can end with a tragic disaster.

Summarizing, not only wrecks should be protected from the danger of illegal explorers, but also the illegal explorers should be protected from the dangers which are still to be found inside the wrecks. The easiest way of such protection is simply not disclosing the geographical coordinates of the particular wreck sites to the public.

At the end it is worth presenting the long-term goal of the aforementioned research. It is the formulation of another, international and complex research project, encompassing all the wrecks in the entire lower course of the Oder – from the mouth of the Warta River to the Szczecin Lagoon (Maliński 2018: 55). It needs to be stressed that the requirement of formulation of such a project is specified in the regulations of MINIATURA 2 call, under which the National Science Centre, Poland has granted assets to the University of Szczecin, for the research presented in this text. The call is addressed "(…) *to researchers having the PhD scientific degree, who plan to apply for funding the future research projects in calls of the National Science Centre, and its basic purpose is financial support of research activity that serves the preparation of a future research project*"[16] (Janeczek 2018: 1). Because the author will attempt to continue the interdisciplinary research of the underwater cultural heritage of the Lower Oder, he would hereby like to invite to cooperation all the researchers interested in discovering the mysteries of the West Pomeranian 'gardens full of wrecks'.

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Fig. 1 – The Oder – 'a river of three nations' – on the map of central Europe. The research area is marked with a red rectangle (elaborated by P. Maliński on the basis of *Europa mapa wektorowa*, freepic.com [online, accessed: 15/07/2019], designed by Freepik, Public Domain https://pl.freepik.com/darmowe-wektory/europa-mapa-wektorowa_333750.htm)

Fig. 2 – Satellite imaging of a fragment of the Lower Oder mouth system. Visible are: Międzyodrze, Lake Dąbie, and agglomeration of Szczecin – capital of West Pomerania. *Miedzyodrze – satellite view*, NASA, commons.wikimedia.org (online, accessed: 10/02/2019), by the original uploader Pa3Widzi at Polish Wikipedia. NASA, https://zulu.ssc.nasa.gov/mrsid/ (transferred from pl.wikipedia to Commons), Public Domain, https://commons.wikimedia.org/w/index.php?curid=6261219

Fig. 3 – A bird's eye view of Międzyodrze. To the left, West Oder and a highway bridge, near which the Red Army crossed the river in the spring of 1945. On the horizon, Szczecin and Lake Dąbie are visible (photo by: P. Maliński)

Fig. 4 – Wojciech Filipowiak (Institute of Archaeology and Ethnology, Polish Academy of Science) taking photographical documentation of the wreck of a fishing boat on the bank of the Domiąża River near the village of Kamieniska (West Pomerania, Poland; photo by: P. Maliński)

Fig. 5 – Underwater prospection with the use of kayak equipped with side-scan sonar (photo by: P. Maliński)

Fig. 6 – The aerial photograph with two visible wrecks of barges in the side branch of the West Oder: one protruding from the surface of water, the other completely submerged

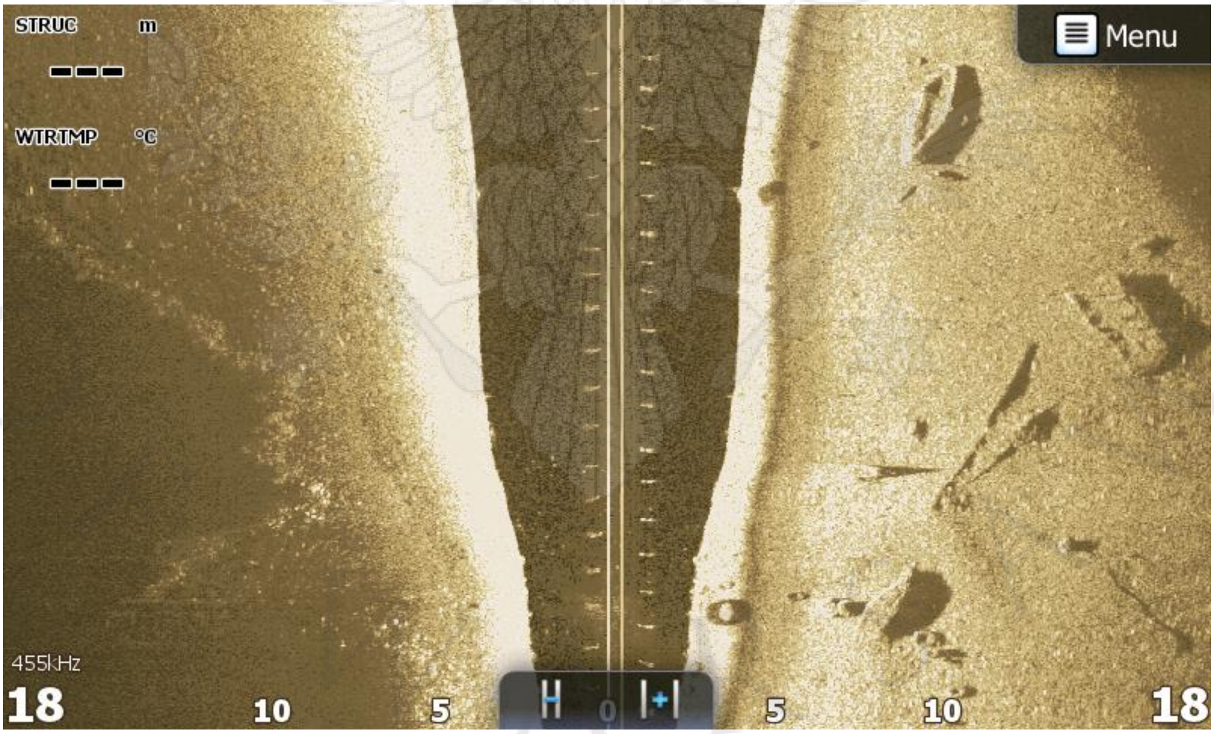

Fig. 7 – The sonar image reveals a wreck site on the bottom of side branch of East Oder. Small round objects visible on the image are car tyres (image by: P. Maliński)

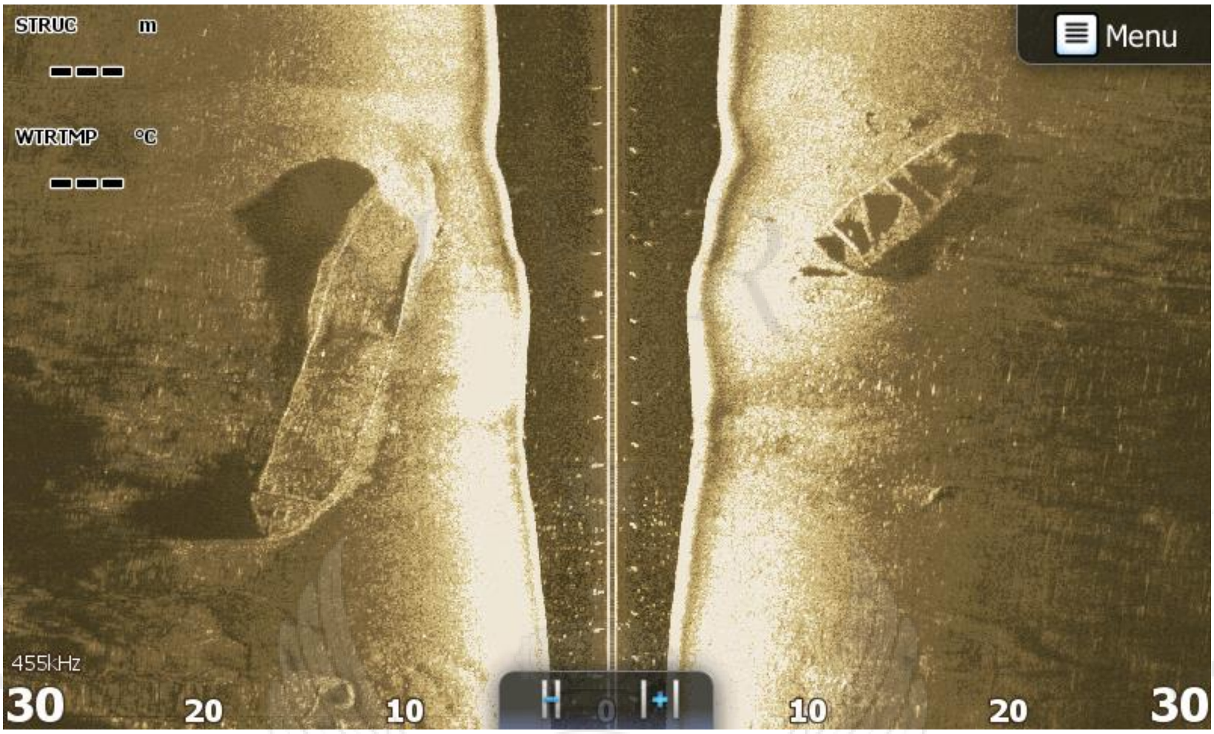

Fig. 8 – Fragment of the wreck site on the West Oder (two of all six wrecks on site visible);
on the wreck to the left open deck hatch can be seen, on the wreck to the right – five bulkhead partitions
(one being damaged, which might have caused the vessel to sink; image by: P. Maliński)

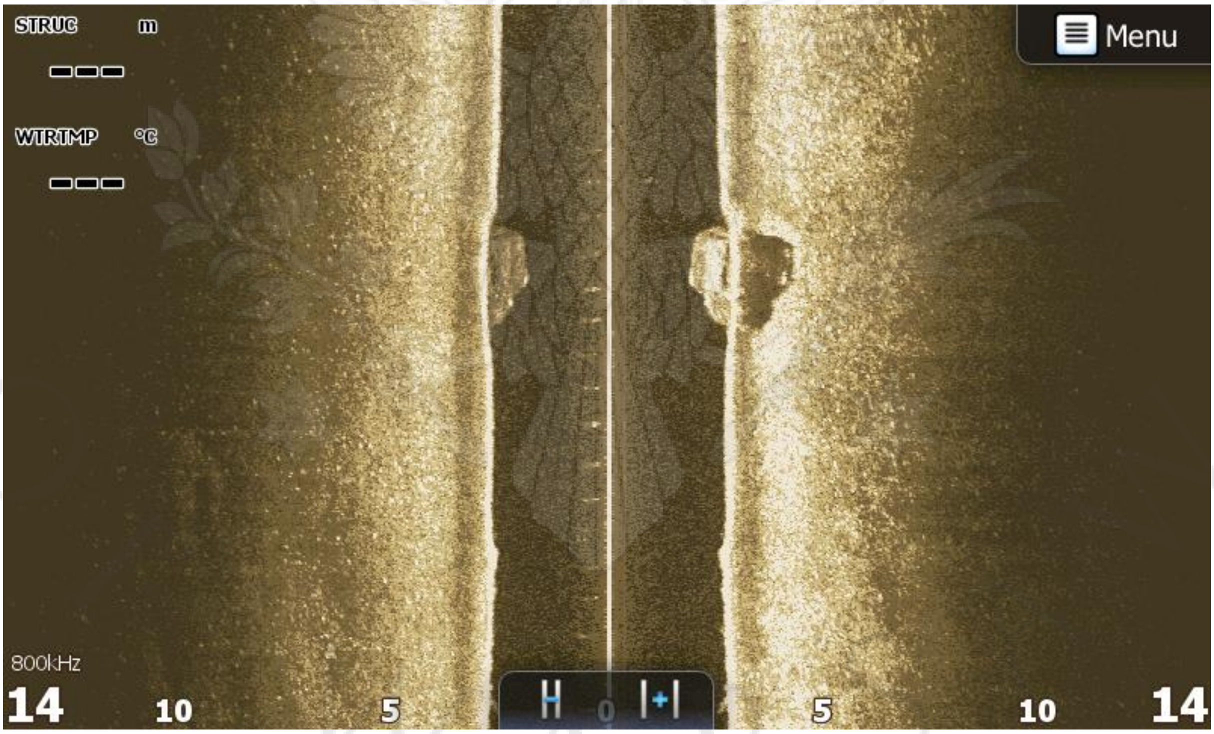

Fig. 9 – A wreck of passenger car (probably Polski Fiat 126p) at the bottom of the East Oder
(image by: P. Maliński)

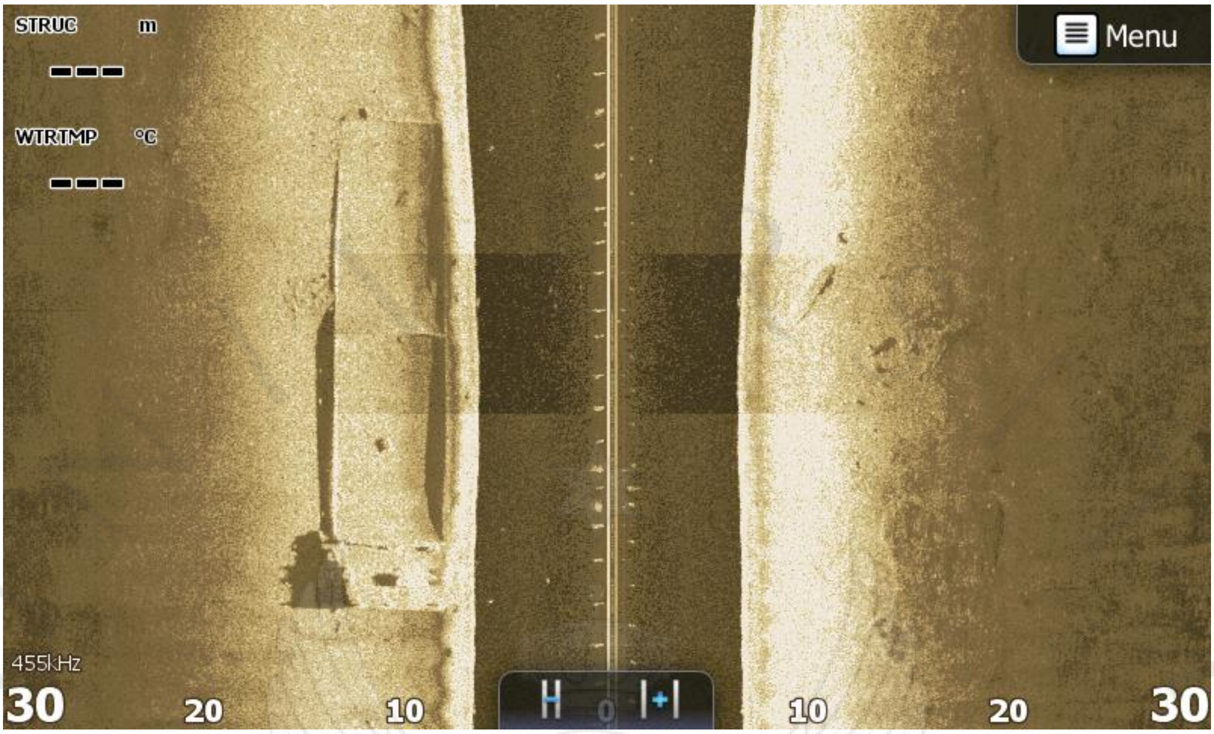

Fig. 10 – A distinctive element of underwater cultural landscape of the Lower Oder – a wreck of the 35-metre-long river barge (probably BP-400 type).
On the bow deck an anchor windlass is visible (image by: P. Maliński)

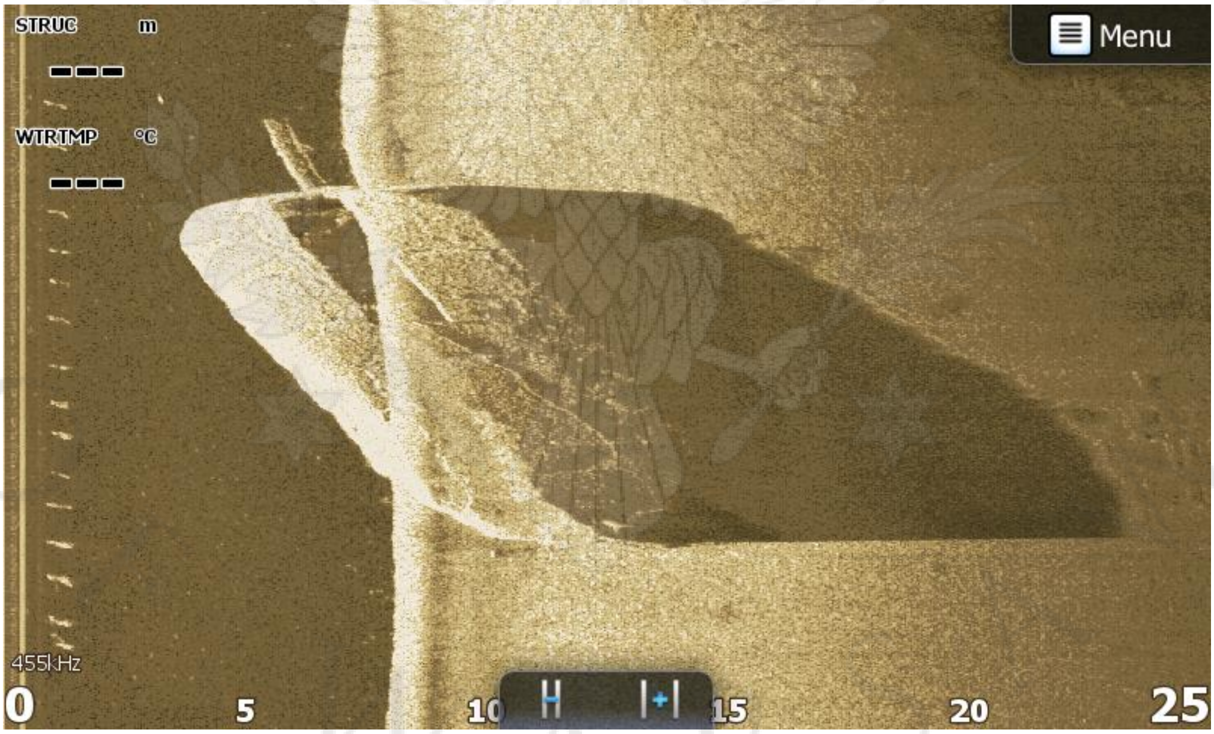

Fig. 11 – A wreck of unidentified watercraft found in the East Oder (image by: P. Maliński)

Fig. 12 – A shipwreck stranded on a shore of Lake Dąbie near the village of Lubczyna (photo by: P. Maliński)

Fig. 13 – Vertical aerial photograph of the wreck of a pontoon (partially cut for scrap metal) in side channel of the West Oder (photo by: P. Maliński)

Fig. 14 – Reinforced concrete hull of an unfinished steam freighter, embedded on the bottom of Lake Dąbie. In the background, visible are the buildings of Skolwin, city district of Szczecin (photo by: P. Maliński)

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The Most Recent Five Years of Underwater Research in the Department of Underwater Archaeology at Nicolaus Copernicus University in Toruń

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Abstract:

The article describes the last five years of research activities of the Department of Underwater Archaeology at Nicolaus Copernicus University, Toruń, Poland. Over this period the Department has made a big progress in the application of new technologies in scientific research. The first significant change took place in the period 2013/2014, when non-invasive technologies such as GPR, sub-bottom profiler, and side-scan sonar were used. Underwater excavations at the Lake Lednica archaeological site (Greater Poland, Poland) started as early as in the 1970's of the 20th century. In the years 2015–2018 new technologies were adopted for research in the lake. Moreover, spectacular discoveries were made, including a new bridge on the island of Ledniczka (Greater Poland, Poland). At the same time, a large logboat was documented (photogrammetry) and risen from the lake. Also, new methods of documentation and research (multibeam sonar, sub-bottom profiler) were implemented at the site. In 2018, after almost a thirty-year-long break, the Department of Underwater Archaeology returned to research on the medieval harbour in Puck Bay (Pomerania, Poland). The activity was connected with a new project: Virtual Arch – Visualise to Valorize. For Better Utilization of Hidden Archaeological Heritage in Central Europe. *The main goal of this project is to create 3D visualisation of the medieval harbour.*

Keywords:

underwater archaeology, Nicolaus Copernicus University (UMK), Lake Lednica, Puck, medieval harbour, medieval bridge

The beginnings of underwater archaeology at the Nicolaus Copernicus University in Toruń can be seen in 1975 when an underwater scientific and research team was set at the Institute of Archaeology and Ethnography. In 1976, archaeology students were trained for underwater

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research (Kola and Wilke 1980: 96). The first underwater archaeologists from Toruń gained their experience during the research of George Bass from the Institute of Nautical Archaeology, carried in Turkey, among other locations, at the site of Yassi Ada (Wilke 1985). In Poland, however, archaeologists from Toruń have been involved in the work of the Central Maritime Museum on the 'Miedziowiec' wreck (Kola and Wilke 1983). After seven years of research, in 1982, the Laboratory of Underwater Archaeology was created and headed by Gerard Wilke, Ph.D. In 1985, the Laboratory was redesignated as the Department of Underwater Archaeology (Chudziakowa 2002: 67–72).

The basic research topic of the Department of Underwater Archaeology was the early medieval bridges of the West Slavs. In addition to many bridges having been found and examined, the most comprehensive studies were carried on the remains of the bridge in Lake Bobięcińskie Wielkie (Pomerania, Poland) in the years 1976–1982 (Kola and Wilke 1985; Szulta 2008; Wilke 1983), and from 1982 to the present day on two bridge crossings leading to Ostrów Lednicki Island (Greater Poland, Poland; Kola 2000; 2014; Kola and Wilke 2000; Kola *et al.* 2016; **Fig. 1**). From the mid-1980's to the first decade of the 21st century regular research and verifications of lake dwellings and lake-side dwellings was also conducted (Gackowski 1993a; 1993b; 2017; Pydyn 2010; Wilke 1988; 1991). At the beginning of the 1990's, the Department of Underwater Archaeology conducted research of the early medieval port in Puck (Pomerania, Poland; Szulta 1993; 1995; 2002a; 2006; **Fig. 2**). Outside the Polish borders, underwater archaeology teams from Nicolaus Copernicus University carried the projects in the ancient city of *Olbia* (Mykolaiv Oblast') in Ukraine (Pydyn 2008; Szulta 2002b), and in the port of Zaton (Dalmatia) in Croatia (Pydyn and Gluščević 2011).

The year 2013 was a breakthrough time for the Department of Underwater Archaeology. It was in that year that a project called: *Non-destructive Comprehensive Recognition of Archaeological Resources of the Bottoms of Lakes and Coastal Zones in Selected Reservoirs of the Iławskie Lake District* was carried, and it was continued under the name: *Recognition of Archaeological Resources of Lakes and the Coastal Zone of the Iławskie Lake District* in 2014 (Pydyn 2016: 79).

During these two projects, the Department team decided to introduce into the prospection technologies that had not been used in inland waters until then. This approach has given exceptionally good results in the lakes where archaeological sites have not yet been discovered.

In the 2013 season 12 lakes from the region of Warmia (Poland) were surveyed: Jeziorak, Łabędź, Trupel, Łodygowo, Młynek, Bartężek, Ruda Woda, Iliński Mały, Klasztorne, Kocioł, Silm, and Mózgowskie (Gulbińskie); in most of them new sites have been located or archival sites have been verified (Pydyn 2013; 2016). Several non-invasive prospection methods have been used during this project. The first of these was a single beam sonar scan with simple side scan sonar (Lowrance HDS 5 Gen), which has been used to create bathymetric maps and search for objects protruding from the bottom. Another method used was the sub-bottom profiler, the purpose of which was to register the archaeological layers of the bottom sediments. The last method applied was based on the use of ground-penetrating radar, which had been expected to detect archaeological structures under the lakebed.

Of the dozen archaeological sites surveyed, four were the most interesting in the 2013 season. The first of them was a bridge on Lake Jeziorak, leading from the island of Wielka Żuława, to the north (**Fig. 3**). During the prospection, the Department of Underwater Archaeology team has located there relics of the bridge crossing and a very large collection of artefacts (Popek *et al*. 2013). This crossing is marked on a map dated back to 1620 (Szczepański 2013: 247). The bridge, dated dendrochronologically, was determined to be from the latter part of the 13th century. A collection of artefacts from the site of the crossing is dated broadly, from the Early Middle Ages to the beginning of the 20th century (Popek *et al.* 2013). The second extremely interesting site is located on the isthmus connecting Lake Jeziorak with Lake Płaskie. At this point, guided by archaeological intuition (on the ground there are no reported traces of archaeological sites) the Department of Underwater Archaeology team has located two bridges and a dugout. The first of the crossings dates back to the middle of the 11th century and the second's chronology was established broadly: between the end of the 8th and the mid-tenth century. In addition, near the older crossing at its northern abutment, prehistoric material appeared over a vast area. Fragments of pottery from the Early Bronze Age and pieces related to the so-called West Balts Barrows Culture from the Early Iron Age have been found there, as well as two antler axes, one of which has been radiocarbon dated with a probability of 95.4% to the period between 1421–267 B.C. (Pydyn 2016; **Fig. 4**).

There is another very interesting site in Lake Klasztorne. This lake is located to the west of the lakes discussed earlier. Researched in the 1990s, two clusters of piles in the bay of the lake were interpreted as a lake dwelling or remains of bridges dated to the Neolithic. In 2013 the research team decided to verify this site. A dozen or so new objects have been found, including an extremely interesting T-shaped axe, radiocarbon dated with a probability of 90.8% between the years 4064 and 3964 B. C. New research results suggest that these objects may be remnants of a fish trap construction (Kofel *et al.* 2014; Pydyn 2016). The last exceptionally interesting site researched in the 2013 season was two bridge crossings leading to the island of Kurhany on Lake Łodygowo (**Fig. 5**). Although the site was known in the 19th century, there was not enough archaeological documentation. The bridges date from the beginning of the 12th and the beginning of the 14th century. Although they run from other directions, they converge at one point on the island where the gate to the stronghold had been most likely located. The huge number of animal bones was discovered in shallow waters that surround the island. In addition to the significant quantity of pottery, large number of metal objects has been found there (Pydyn 2016; Pydyn *et al.* 2017).

In the 2014 season Lake Iławskie, Lake Mózgowskie (Gulbińskie), Grażymowskie lakes (Eastern and Western), and Lake Gil Wielki (Warmia, Poland) were surveyed. Among them the most surprising was Lake Gil Wielki. In the shallows in the middle of the lake and on nearby peninsulas bone material and prehistoric ceramics have been found. Carbon deposits inside ceramic vessels have been dated using the radiocarbon method. The earliest dated find comes from the middle of the 4th millennium B.C., and the most recent from the latter part of the 2nd millennium B.C. Archaeozoological analyses suggest that the majority of bone remains belong to wild animals. All this suggests that the team is dealing with a multi-phase coastal prehistoric site, with an important phase attributed to the Corded Ware Culture horizon (Pydyn 2016).

From 2013 to 2018 underwater research at Ostrów Lednicki has been conducted every year. The years 2013–2014 have been devoted to continuing the exploration of the western bridgehead of the so-called Poznań Bridge in order to determine its construction details. However, the following years brought very different and interesting findings. In the 2015 season a unique object identified as a fishing trap was found at the abutment of the Poznań Bridge (Gręzak *et al*. 2018; **Fig. 6**). Owing to their very delicate construction, such objects are extremely rare, and finding them *in situ* is exceptional. Thanks to a very precise and delicate exploration, archaeologists managed to document the object at the place of its finding and extract from it several hundred fish bones and three domestic animal bones, probably bait located inside the trap. The high research value of the find led to the decision to extract it and pass to the Museum of the First Piasts in Lednica (Polish: *Muzeum Pierwszych Piastów na Lednicy*). The operation required exceptional delicacy and precision, but it was possible to extract the object. Currently, it is in the Museum of the First Piasts conservation-restoration department and will be exhibited at this facility in the future (Pydyn *et al.* 2018). In 2016, during an underwater archaeological excavation of Lake Lednica, an eleven-metre-long dugout from the Early Middle Ages was excavated. The boat was found in 1989 during the exploration of the eastern part of the Poznań Bridge. In 2016 at the request of the newly emerging Polish History Museum in Warsaw, the Department of Underwater Archaeology team performed an operation to raise the object. The operation was extremely difficult because of the lime wood of which the boat was made (**Fig. 7**). This material made the object very delicate and even a slight pressure on the surface might have caused irreversible damage. Therefore, it was decided to extract the object in seven parts in accordance with its natural cracks. The operation proceeded smoothly, and the object is currently located at the Laboratory of Documentation and Conservation of the Institute of Archaeology, Nicolaus Copernicus University in Toruń; in the future it will become part of the exhibitions of the Polish History Museum in Warsaw (Radka 2017; Pydyn and Radka 2017).

The year 2017 was a breakthrough in the research of Lake Lednica. In this year, the project entitled: *The Cradle of the Piasts – Archaeological Underwater Prospections in the Area of Lake Lednickie* was implemented. As part of this project, prospections were conducted around the lake, but non-invasive scanning of the water basin itself was also carried. To create an accurate bathymetric map of the selected area a multi-beam (Sea-Bat 7125) probe has been used which made it possible to cover 100% of the lakebed. In addition, a sub-bottom profiler Innomar SES 2000 Medium has been applied, showing the exact location of all objects below the sediments. Finally, the selected area was scanned with a caesium magnetometer (G858 and G882) which has indicated non-metal objects on and under the lakebed. These tasks were carried by the Maritime Institute in Gdańsk. Thanks to this, almost 500 locations that could be of archaeological value were obtained. Only a small number of these readings have been checked, but this contributed to the discovery of not only loose finds, but also a completely new archaeological structure (**Fig. 8**). This new object was a bridge leading from the mainland to the island of Ledniczka. A year later, in 2018, it was decided to excavate a small part of this bridge, which brought some very interesting results (**Fig. 9**). Archaeological remains acquired during the research can be dated mostly to the 13th century. However, both dendrochronological and radiocarbon dating methods indicate two separate results: the 13th and 10th century. Therefore, it can be assumed that two bridges of different chronology had been located here (Pydyn *et al.* 2018).

The third research issue on which the team of the Department of Underwater Archaeology has focused is the reconstruction of the medieval port in Puck (Pomerania, Poland). These activities are carried as part of the project *Virtual Arch – Visualise to Valorize. For Better Utilization of Hidden Archaeological Heritage in Central Europe*. This project is a part of the Interreg Central Europe framework and will be carried in the period of 2017–2020. The aim of this project is to create an application for mobile devices that will make it possible to 'explore' the virtual reconstruction of the port. One of the activities leading to this aim was the collection of the archival documentation of research conducted in this site from the 1980s to 2014 (Szulta 2002a), and its digitalization. The next action was the creation of an accurate bathymetric map of the area of the harbour under investigation with the use of multibeam sonar. These tasks were carried in collaboration with the Maritime Institute in Gdańsk. Next, photogrammetry of the wooden structures appearing there has been made in selected areas, which will serve as a basis for three-dimensional reconstruction (**Fig. 10**). Taking advantage of the opportunity, scans have been made using a completely new so-called parametric sub-bottom profiler, provided by the Innomar company, which allows not only the production of profiles but also three-dimensional visualization of the tested sediments. This gave unexpected results in the form of detailed plans of old excavation trenches already invisible on the surface and a great number of new archaeological objects. As a part of these activities, evidence of the very dynamic destruction of archaeological layers at this site by the activity of the sea has also been gathered; this situation requires the fastest possible archaeological intervention and rescue research.

The most recent five years have been a very dynamic period in the activities of the Department of Underwater Archaeology, Institute of Archaeology, Nicolaus Copernicus University in Toruń. During this period, the team has moved from traditional drawing documentation and search performed by divers to prospection with non-invasive approach to documentation using geodetic methods and photogrammetry, which has pushed the Department's methodology into the 21st century and made it possible to compete with the leading European centres. This period has also been very abundant in archaeological discoveries. The team has located several dozen new sites in the Iławskie Lake District, several of which have been exceptionally spectacular. Even the research of Lake Lednica, which has been conducted for so many years and which has not foreshadowed any novelties, has brought unique findings of fishing traps and a new bridge crossings. It has also been decided to return to the subject of the port in Puck, which somehow has been forgotten by researchers, and is one of the most interesting underwater archaeological sites in Poland. However, this is only the beginning of a new path in the future of the Department. For the coming years, it is planned to constantly develop and test new technologies, expand research interests towards the underwater cultural landscape, and make new cooperation agreements with leading world centres of underwater archaeology.

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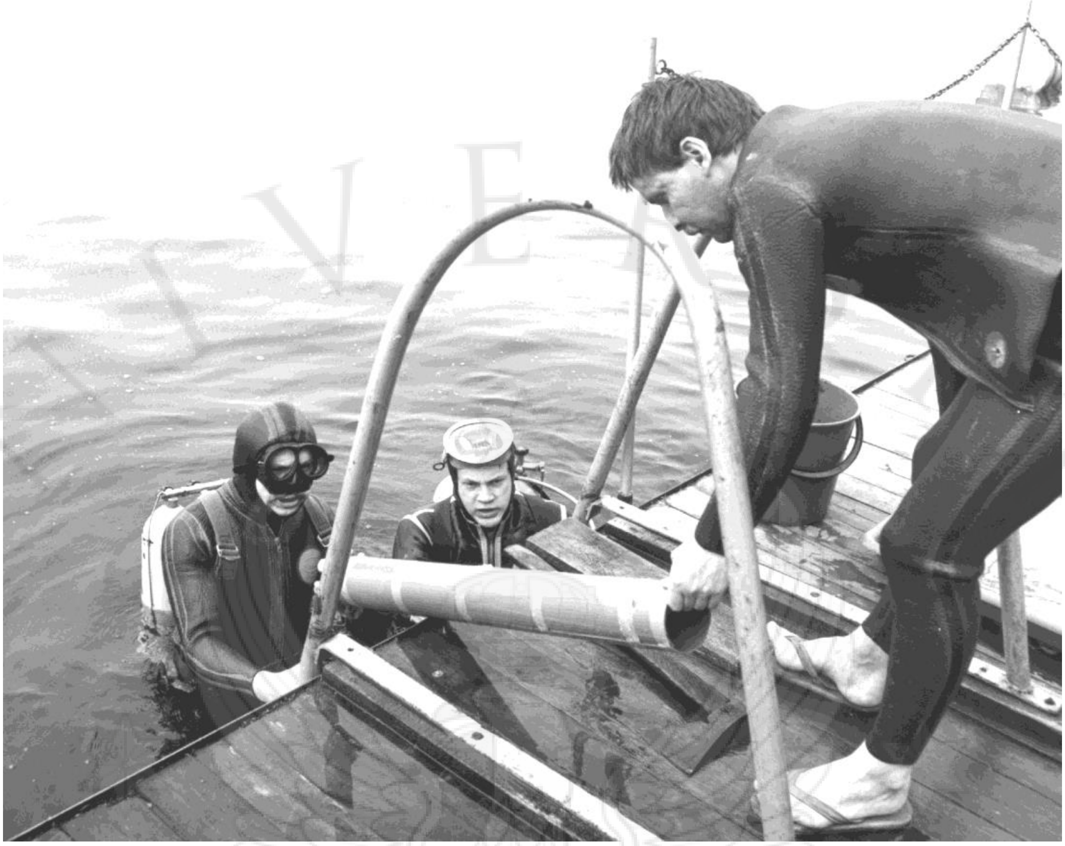

Fig. 1 – Underwater archaeological excavations in Lake Lednica in the 1980s
(Archives of the Department of Underwater Archaeology, UMK)

Fig. 2 – Underwater archaeological excavations in the Puck Bay in 1991
(Archives of the Department of Underwater Archaeology, UMK)

Fig. 3 – Documentation of the remains of the bridge at Lake Jeziorak – the Island of Wielka Żuława (photo by: A. Pydyn)

Fig. 4 – Archaeologist Rafał Solecki with the Bronze Age axe (photo by: D. Kofel)

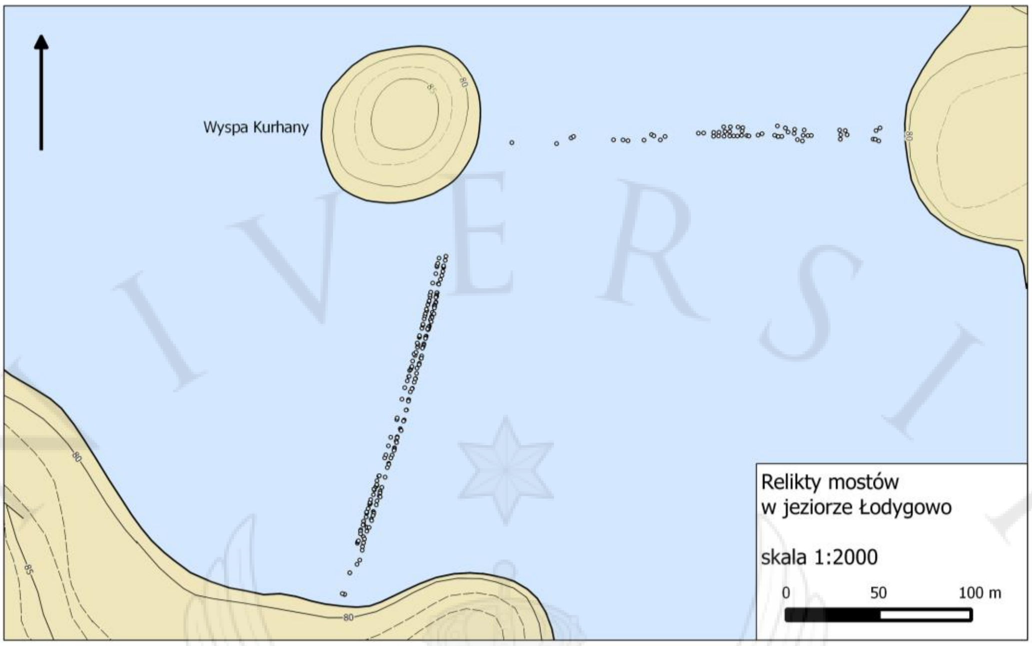

Fig. 5 – Plan of medieval bridges in Lake Łodygowo (elaborated by: P. Stencel)

Fig. 6 – Ortophotomosaic of a fish trap from Lake Lednica (elaborated by: P. Stencel)

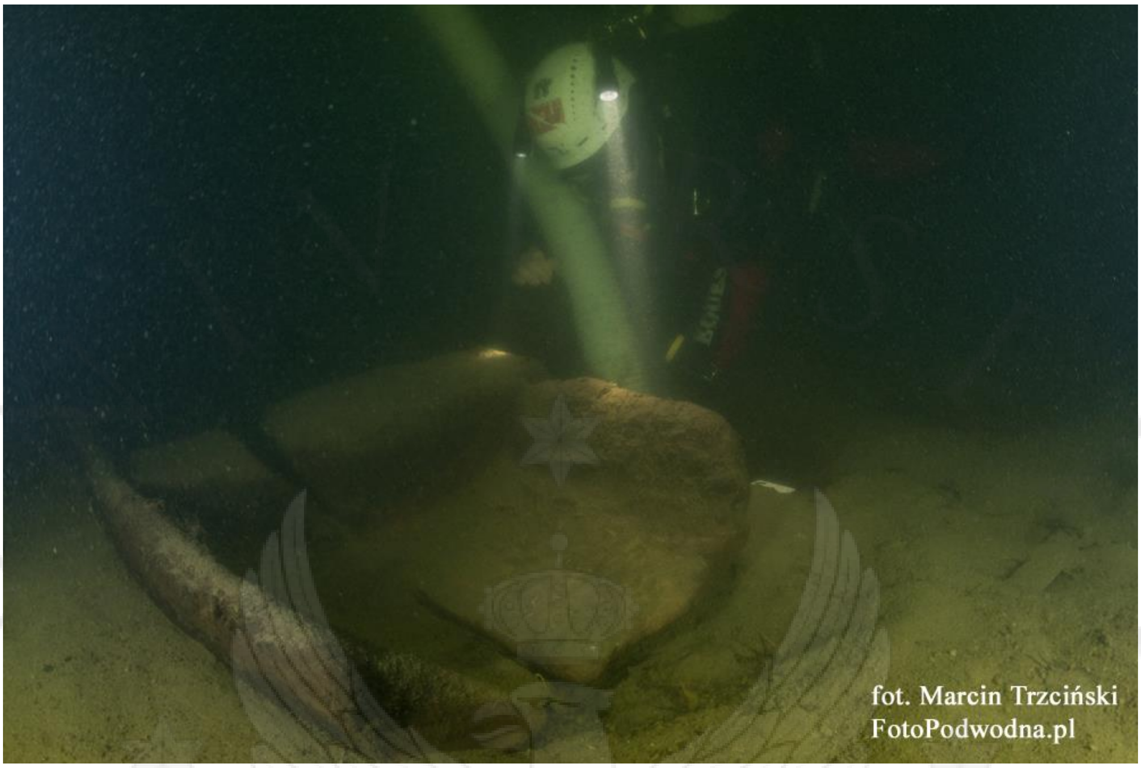

Fig. 7 – Large logboat from Lednica Lake (photo by: M. Trzciński)

Fig. 8 – Diver with a medieval axe in Lake Lednica (photo by: M. Popek)

Fig. 9 – 3D model of trenches with remains of the medieval bridge on the island of Ledniczka, Lake Lednica (elaborated by: P. Stencel)

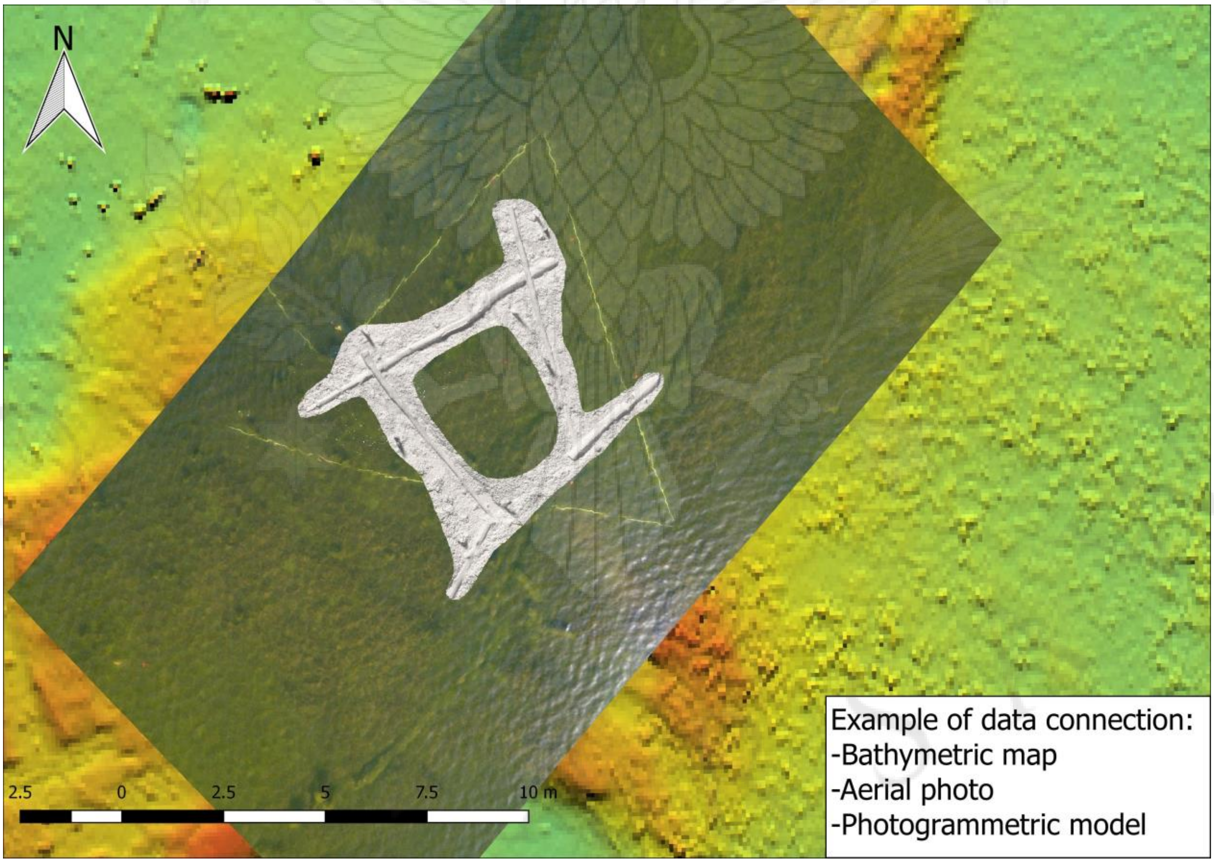

Fig. 10 – An example of different data connection – bathymetry, aerial photo and a photogrammetry model at the Puck Bay (elaborated by: P. Stencel, M. Popek)

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Site Rybno I – Lake Grid Dwelling on Lake Piłakno and its Micro-Region. Research Proposal

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Abstract:

The lake grid dwelling Rybno I, Lake Piłakno (Mrągowskie Lakeland, Poland), first recognized in the 1920s, was a kind of a training site for Polish underwater archaeology in the 1960s; its milestone role in the field, complemented by the fact that it was never thoroughly studied and published, has led to the idea of introducing a project aiming at the comprehensive research of the settlement and its location. The work plan joins the research of the data acquired during previous fieldwork at the site itself and the surroundings of the lake with the innovative approach possible due to the access to modern but already proven equipment and methods.

Keywords:

grid dwelling, lake settlement, early Iron Age, West Balt Barrow Culture, Piłakno, Rybno

Introduction

In March 2019 a new research project within the scope of underwater archaeology has been inaugurated at the University of Warsaw. It has been granted funding from the National Science Centre, Poland[1] and is scheduled for the following 36 months. Its main objective is a comprehensive research of the submerged residues of the lake grid dwelling Rybno I, Lake Piłakno (Mrągowskie Lakeland, Masurian Lake District, north-eastern Poland). The project is centred on the site representing a very particular type of the early Iron Age settlement, traditionally defined as 'defensive', one of the distinctive features of the so-called West Balt Barrow Culture[2].

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[1] *Lake Grid Dwelling in Rybno, Piłakno Lake (Warmian-Masurian Voivodeship). New Ideas for Interpretation of the Lake Dwelling Phenomenon* (grant no. 2018/29/N/HS3/02949, PRELUDIUM 15 call).

[2] Also: West Baltic Barrow Culture.

The presence of the unique artificially constructed 'islands', intentionally located in the shallow lake bays, is unquestionably worth attention. The previous researchers have agreed to call this type of settlement 'grid dwellings' (e.g. Kola [ed.] 2000), as they were built by placing a wooden 'grid' at the bottom of a shallow bay, near the shore, enforcing it with soil, weighing down with stones, and then covering it with the platform, as a base for buildings. Rather small dimensions (estimated 5–6 super-structures) might be the evidence for atomization of the groups of the West Balt Barrow Culture, and maybe also for the inner hostilities, which might have been the impulse for building defensive settlements (e.g. Okulicz 1970: 72, 75; see also the chapter on the micro--region of Lake Piłakno). According to Jacek Gackowski, the closest analogy for this type of architecture seems to be the dwellings at the Belarusian Polesia (Gackowski 2000: 48–50, 63).

History of Research

Rybno has been known to scholars already before the Second World War, first noticed by a local forest-man, who has discovered some artefacts and reported it to *Prussia-Museum* in Königsberg. In 1933 Karl O. Rossius confirmed the location of the Piłakno *Pfahlbau* (for a long time sites of this kind were mistaken for palafittes) and mentioned the recovered artefacts: five round-bottomed vessels, a quern, and 'fishing-net weight' (Rossius 1933: 87). After the war, following the preliminary verification of the rather shallow site (1952, published: Antoniewicz 1955; 1959, published: Dąbrowski 1962) a joint team of archaeologists from the Polish Academy of Sciences and State Archaeological Museum in Warsaw has completed two seasons of fieldwork: in 1961 and 1962 (published: Odoj 1961; Bukowski *et al*. 1964; Bukowski *et al*. 1965; Bukowski 1965). Włodzimierz Antoniewicz, who led the first survey, has acquired two ceramic vessels collected by the discoverer of the site, Fryderyk Kulik, and stored in the forestry office. The lake shore pointed by Kulik was completely covered with reed, which made the actual investigation of the site impossible (Antoniewicz 1955: 355–356). In 1959 the team of divers has recovered *"plates, big--bellied and ovoid pots, cups, dishes, ladles, miniature vessels"* and other ceramic and stone (querns, grinders, polishers) artefacts (Dąbrowski 1962: 185–186). In 1961 the shore was still covered with reed, which was the first obstacle to overcome by the group of researchers, supported by sport divers. The site was located ca. 60 m from the shore, at a depth of 0.8–2 m (Bukowski *et al.* 1964: 72). The excavated sector was divided into 1 m^2 (the systematic underwater documentation was included in excavation schedule for the first time in the history of Polish underwater archaeology); the artefacts were located within. No stratification was observed, so the layers were distinguished arbitrally. As far as documentation is concerned, drawn plans were prepared both underwater and from the surface; the underwater photography was also included. It is worth noting that the works under the surface were generally performed by four sport divers, supervised from the surface by archaeologists using goggles and snorkels (**Fig. 1**). The site was explored with an airlift (which was said to be ineffective) and than a water jet (strong water current; **Fig. 2;** Bukowski *et al.* 1964: 75). The researchers have discovered the layer of charcoal, which is an important matter to investigate in the current project (Mileszczyk 2018). Discoveries from the first season include: thirteen complete or nearly complete ceramic vessels, multiple pottery fragments, animal bones, stone artefacts (e.g. a quern), and a casting mould in three pieces, as well as multiple fragments of the wooden structure, including a piece interpreted as a sill or lintel (Bukowski *et al.* 1964: 80–86). In 1962 the new trench was connected to the former one; the work has continued in the first dig and then moved to the latter, but only the first strata has been researched; further efforts consisted in surveying the area to determine the stretch of the site. The divers used hookah surface-supplied system, where the air is delivered from the tank via single hose. The water jets were still used, but this time fixed on the iron rail. The team continued taking photographs both *in situ* and on the surface (Bukowski *et al.* 1965: 99–101). The results of the exploration were similar to previous year's – stone paving, burnt wooden elements (some of them interpreted as the residues of the residential-utility building) with traces of tools, pugging pieces, few pales, and mixed artefacts, including a fully preserver round-bottom vessel from the first trench and what was described as a 'ceramic spoon'. In the lakebed survey the divers have discovered some further pottery shards, querns and grinders, as well as what is described as the residues of hearths (Bukowski *et al.* 1965: 102, 105–108). The area of the site was finally approximated for 0.5 ha (Bukowski 1965: 117). The samples for pollen analyses were obtained both in 1961 and 1962 field season, from the lakebed in area of the settlement, nearby alder forest, peat bog, and the cultural layer under the construction beams. The results of the analyses were published; they did not appear to be helpful in many interpretations, apart from the general view on when the crop cultivation in the area has begun (ca. 2500 B.C.) and that the area has been successively de-forested, with a peak corresponding with the functioning of the lake settlement, which may be the proof of the increased role the agriculture has played. It was inferred that to catch the climate changes the research requires additional data and verification in the 'next research seasons'. Single sample from the top cultural layers was presented for the radiocarbon analyses, and the date 230+/–120 B.C. was established (Bukowski *et al.* 1964: 78–79; 1965: 109–111). The interpretation of the charcoal layer was that the platform has burnt, and that the water level must have been at least a metre lower than in present, as the strata of burnt material occurs one metre below the surface (Bukowski *et al.* 1964: 80). In 1991 a group of young scholars from Nicolaus Copernicus University in Toruń began further verification of the site. Six most remote pales have been documented on the site plan with a traditional and the only available method: angular intersection. Applying the same method, the bathymetric plan has been elaborated and then, basing on the acquired data (clusters of artefacts, wooden elements, and the shape of the lakebed) the hypothetical frame of the artificial island has been established, being in disagreement with the results of the previous research. The team has collected the fragments of pottery, artefacts of antler, and a quern (Łapo and Ossowski 1995: 47–50). In 2000, as a matter of further research, seven samples were obtained for the dendrochronological analyses, only two of which occurred to be of oak. Unfortunately, it was impossible to get any conclusive results. Single radiocarbon analyses yielded 2370+/-40 BP (Krąpiec 2000: 74, 77). Due to the systematic development of the tree-ring database, an attempt to establish more precise chronology for the site is necessary. In some regions abundant in bog and lake sites the occupation of the area can nowadays be followed with a great (even calendrical) precision.

Lake Piłakno Micro-Region

Mrągowskie Lakeland covers the middle part of the Masurian Lake District, creating a particular kind of a hummock with culminations over 200 m a.s.l., towering over Olsztyńskie Lakeland at the west and the region called Kraina Wielkich Jezior Mazurskich (‘Land of Great Masurian Lakes’) at the east. A boarder of the moraine range of the Mrągowskie Lakeland stretches in between Stare Kiejkuty (east from Szczytno) and Ruciane-Nida, which matches the range of the moraines from the so-called Poznańska phase of the Weichselian glaciation (for the area of Poland called ‘northern-Polish’), in some places represented by large clusters of boulders (e.g. the moraine by Wojnowo, by Ruciane-Nida). In the area of Lake Piłakno the moraines of the Pomorska phase of the Weichselian are present, having the parallel-wise pattern, and their relative heights reach 60 m. Next range of moraines leads through Sorkwity and Mrągowo, constituting the highlands embracing the niche of Lake Piłakno. Finally, at Mrągowskie Lakeland there are seven more or less parallel glacial troughs, and in one of them a ribbon lake called Piłakno is located (Kondracki 1972: 168–170). Rich land relief, numerous watercourses and reservoirs conducted the creation of small, clearly separated settlement units, creating so-called ‘niches’ (*cf.* Nowakowski 1983: 316). One of such niches is the micro-region of Lake Piłakno, in the waters of which Rybno I is located.

The term ‘micro-region’ in the hereby paper is considered an area inhabited by a social group of the ‘lowest level’ (Okulicz J. 1983: 209), constituting a settlement community, consisting of an “*extended family or a kinship group*”[3] (Okulicz J. 1968: 39). It has been initially presumed that for the centres of micro-regions one should acknowledge the cemeteries (*cf.* Okulicz J. 1968: 39).

Obviously, without the written sources it is not possible to say what level of importance the cemetery had for the community; was it only the place of final rest, or also the centre of ritual activities? Either way, even as ‘only’ a resting place of the ancestors the cemetery must have born some kind of significance for the local community. It has been an indication and one of the causes for the bond joining such a group; even if the people have been changing the location of settlements, they moved nearby. Such an approach is suggested by the hitherto studies on the pre- and proto-historic settlement patterns (*cf.* e.g. Godłowski 1960: 55–75; Okulicz J. 1983: 207–209; Czarnecka 1990: 7–12). This thesis has to be verified by the hereby project.

The basis for the analyses cannot focus only on the research of the lake dwelling in Rybno, but also the part it played in the whole micro-region and the relations with the sites located nearby the ribbon of Lake Piłakno, with the special attention paid to cemeteries. One of the closest is the burial mound site Rybno II, studied initially in the second half of the 19th century (Hennig 1878: 480–498), and then in 1962 by Władysława Ziemlińska-Odojowa (1962: 818–820; 1981: 259–311); another one is the burial site Sorkwity III located in the close proximity (Hoffmann 1992: 327–332). The settlement grid around Lake Piłakno is complemented by the early Iron Age upland settlement in Maradki, surveyed in 1970 by Jerzy and Łucja Okulicz along with Ewa Gąssowska (Gąssowska and Okulicz Ł. 1970: 641–642; 1975: 319–326). The comparative analyses of the artefacts may answer multiple questions connected first and foremost with the relative chronology of the Rybno I settlement in this particular micro-region, as well as the structure and probable social stratification of the group having once inhabited the surroundings of the lake. It is important to establish in what relation the lake dwelling was with other sites and what the chronological interrelations in the area might be pointed; particularly: which of them have been functioning simultaneously. It can also be the premise for confirmation if the same group has used more than one settlementin the same time. To establish the range of the micro-region may not be the easiest task, although it can be assumed

[3] „*(Składająca się z) rodu lub grupy rodów*” (trad. M. Mileszczyk).

that a location of the site has been determined by the easy communication with the burial ground. It can be hypothesized that the inhabitants of the particular settlement have been using the closest cemetery.

Research Objectives and Implementation of the Project

The important result of the project is to be a monograph the lake dwelling in Rybno. This topic waited for the complete study for a long time (up till now the site was published only in the form of reports, Odoj 1961; Bukowski *et al*. 1964; Bukowski *et al*. 1965; Bukowski 1965; Łapo and Ossowski 1995: 47–50). What is more, most of the reports were printed before the most significant studies on West Balt Barrow Culture were announced (Antoniewicz 1964; Okulicz Ł. 1970; 1976; Hoffmann 1999; 2000). During the preliminary studies the working hypothesis has been elaborated, concerning the connection between the lake grid dwellings of the West Balt Barrow Culture and the early metallurgy, which is responsible for the concept of investigation of the idea behind the lake grid dwellings in south-eastern Baltic zone (Mileszczyk 2016a: 138; 2018). Apart from the new typological analyses of the artefacts recovered by the previous researchers, which is mostly completed by now (Mileszczyk 2016a; 2016b), non-invasive hydroacustic research, meticulous excavation of the relics, as well as the paleoecological analyses are planned, the purpose of which is the thorough depiction of Rybno settlement in the early Iron Age.

It is planned to implement the project with a wide range of methods, starting from (1) extended archive query, through (2) core-boring and analyses of the paleoecological samples (pollen and micro carbon residues), (3) elaboration of the model of terrain and orthoimage, (4) non-invasive hydro-acoustic survey aiming at bathymetry, (5) systematic underwater prospection, (6) traditional or underwater documentation of the residues of the lake dwelling (drawing and photography), (7) dendrochronological and radiocarbon dating, and (8) elaboration and dissemination of data. Proposed methods and technologies are to be innovative, but already proven in the fieldwork (side sonar, aerial photography, underwater metal detectors, LIDAR, photogrammetry etc.).

The extensive query in the archives and collections of Prussia-Museum, nowadays stored in Berlin (in the Museum for Pre- and Early History[4]), and the regional institutions of Warmia, Masuria, and northern Podlachia will allow summarizing the previous research and completing the renewed study on the artefacts recovered from Lake Piłakno during the 1961–1962 campaign

[4] German: *Museum für Vor- und Frühgeschichte.*

(stored in Museum of Warmia and Masuria in Olsztyn[5]). First of all, the archive query is necessary to complete the knowledge of the pre-war episode connected with Lake Piłakno exploration (Rossius 1933: 87). The discoveries were then deposited in *Prussia-Museum*, what was already confirmed – in the collection of Museum in Olsztyn there is an artefact no. 1131/69, complemented with the information that it was gained in 1945 from the collections of Prussia Museum. What is more, during the research in the Museum of Warmia and Masuria the archive of photographs has been discovered, mostly unpublished pictures from the 1961–1962 campaign[6] (**Fig. 1, 2**), but also the ones showing the round--bottom vessels labelled '*Ribben*' presented on the shelf, with the note "*reproduction from the archives of Prussia-Museum*" (catalogue no. 7138, 7139). The meticulous studies of the archives will enable to complement the information concerning the first research episode concerning the lake dwellings from Warmia and Masuria, contributing e.g. to the re-discovery of some sites due to finding out their location.

The pollen and micro-carbon analyses are the basis for an attempt of reconstruction of the early Iron Age paleoenvironment of the micro-region (how the lake has functioned in the cultural landscape of the early Iron Age, including e.g. the vegetation surrounding the lake, its water level etc., as well as establishing site's precise chronology). First and foremost, the samples for the paleoenvironment analyses have to be acquired both by coring the lakebed and from the cultural layers of the site. Effectiveness and rationality of the environmental analyses was indicated in numerous publications (e.g. Tobolski 1995; Filbrandt-Czaja 2000; Kupryjanowicz *et al.* 2013; Cywa *et al.* 2014; Menotti 2004; Fredengen 2002). This allows tracing the development of anthropopressure in the area of the research site as well as its impact on the water ecosystems, connected with cultural eutrophication; the past lake-level fluctuations might also be reconstructed. Micro-carbon analysis will allow e.g. looking into the layer of burning which is confirmed at the site by the previous expeditions. The chronology of the cores will be established with the method of radiocarbon dating (Mileszczyk 2018).

Proven modern methods for acquiring and synthesizing fieldwork data (hydroacustics, equipment for underwater photography, software) will be used to develop a bathymetric plan of the site and full underwater documentation, including photogrammetry or photomosaic. During the actual fieldwork the first phase is to acquire the data for the bathymetric plan (side sonar, Total Station). The second

[5] Polish: *Muzeum Warmii i Mazur w Olsztynie*.

[6] We wish to express our gratitude to Professor Mirosław J. Hoffmann Director Piotr Żuchowski (both Museum of Warmia and Masuria in Olsztyn) for the permissions to publish the archive photographs from the Museum's collections.

phase consists of the excavation, performed according to the well-established methodology and heritage office instructions. After the exploration, the accurate documentation will be elaborated, depending on the underwater conditions, mostly visibility (Mileszczyk 2018).

Independently from the underwater and hydroacustic research the model of the terrain and orthoimage are to be prepared. The data from LIDAR (used successfully in archaeology) will allow surveying the area concerning any new sites near the coastline and map it, which is especially useful in the hardly accessible areas. Application of further modern equipment to elaborate the orthoimage and the LIDAR data will facilitate the observation of the site from above – completely new perspective for the site, necessary in modern archaeological research (Mileszczyk 2018).

The last dendrochronological analyses were inconclusive; thus, it is important to make an attempt of establishing its chronology once again. Because of the development of the database for dendrochronology, attempts to establish the chronology of the site will be taken, thus the wood samples will be surfaced (Mileszczyk 2018).

The means of modern underwater research, including the use of metal detectors, are presumably the aid to answer the question about the lack of the metal objects at the site. The pollen, micro--fossil, and micro-carbon will also contribute to the latter, giving also the invaluable data on the past environment depiction. Establishing site's chronology, acquired both by dating the samples for pollen analyses and wood, will allow summarising the location of this particular lake dwelling in the broader horizon of this phenomenon, but also in the Piłakno lake micro-region. The side sonar scan, underwater photomosaic/photogrammetry, and the model of the lake micro-region are supposed to lead to the satisfactory results as far as the data for the reconstruction is concerned: hardly any data from previous excavations on the 'Polish' lake settlements might give the insight into the actual construction of such dwelling (apart maybe from some profiles provided by the 'dry' sites of this kind, e.g. Gackowski 1995). The objective of the hereby project is also recovering as much data as possible in this matter, which is to be a prominent start of the long further research leading into the possible reconstructions (Mileszczyk 2018).

Final Remarks

The issue of south-eastern Baltic region lake dwellings have to be included in the comparative study of the settlements built on water and marshes all over the world in different epochs. The proposed research, in all the aforementioned aspects, should lead to verification of the interpretation of function and origins of this kind of architecture in this particular area, including the hypothetical connection of the lake grid dwellings with the early metallurgy. It is to be enhanced with the attempt of reconstruction of the ecosystem and the anthropogenic impact in the micro-region in the discussed period. It is presumed that the acquired results will be completing the state of research included in the published materials concerning this site and the issue from the larger point of view. The competent interpretation will be a significant step in the process of reconstruction of the full context of the idea for building on water. Last but not least: it is to contribute to the field of underwater archaeology; due to meticulous case study the methods and tools for this kind of fieldwork could be refined.

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Fig. 1 – Archaeologist supervising the works of sport divers
(photo by: R. Odoj 1961; from the collection of Museum of Warmia and Masuria in Olsztyn)

Fig. 2 – Test of the equipment
(photo by: J. Dąbrowski 1961; from the collection of Museum of Warmia and Masuria in Olsztyn)

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The State and Prospects of Archaeological Underwater Research as a Part of the Project *Vistula Underwater Heritage of Warsaw and the Surrounding Area. Recognition of Underwater Archaeological Sites as a Part of AZP[1] Research*

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Abstract:

In this season a new project will be launched, which is a continuation and complement to earlier research activities undertaken on the Vistula waters in different years. A group of experienced divers and archaeologists received funding for the non-invasive prospection of a selected section of the Vistula River. The main aim is the detailed observation of the riverbed in the selected area by using high frequency side scan sonar. The project is planned to be completed by the end of this year.

Keywords:

underwater archaeology, Vistula River, side scan sonar, recognition, non-invasive prospection

Introduction and Background

Underwater investigations on the Warsaw section of the Vistula River have been already carried for several years. Following the interest a team of archaeologists and divers under the auspices of the Association of Archaeologists of Tomorrow (Polish: *Stowarzyszenie*

[1] AZP in an intialism for Polish *Archeologiczne Zdjęcie Polski*, an initiative realized throughout Poland since 1978, including searching for, registering, and georeferencing archaeological sites. The main goal of the project is to obtain information needed for scientific and conservation purposes, related to the protection of heritage. The search for archaeological sites is mainly conducted using the field prospection in spring and autumn. In addition, information from archive studies and interviews with residents of a given area are used.

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Archeologów Jutra) has submitted a project to the National Heritage Board of Poland (Polish: *Narodowy Instytut Dziedzictwa*) and at the beginning of the year received funding within the program *Protection of Archaeological Heritage – Edition 2019* (Polish: *Ochrona zabytków archeologicznych 2019*). The project *Vistula Underwater Heritage of Warsaw and the Surrounding Area. Recognition of Underwater Archaeological Sites as a Part of AZP Research*[2] provides for the recognition and inventory of archaeological sites located in the waters of the Vistula River from the Żerański Canal in Warsaw (520 km of the river) to Jabłonna Commune (533 km of the river; Legionowo County, Masovian Voivodeship) with a total area of about 4.8 km^2 (**Fig. 1**).

The first regular research in Warsaw section of the Vistula waters was carried in 2011–2015, and its aim was to find marble ornaments and other decorations of Warsaw palaces, transported on ships during the Swedish Deluge (Kowalski and Wagner 2016; Kowalski 2015a; Kowalski 2015c). These pioneering studies brought a huge amount of architectural, military, and boatbuilding findings, which in recent years have become the subject of scientific studies (Kowalski 2015b, Kowalski 2014) and popular science publications (Kowalski 2013; Jamkowski and Kowalski 2018).

In 2012, due to the low water level (Kowalski *et al.* 2013: 24), at the point of Bednarska Street in Warsaw, archaeological inventory works were realized around the piles protruding above the river level – relics of old bridges. In 2015 hydrological conditions allowed the continuation of work by the team of the Association of Archaeologists of Tomorrow, experienced in underwater research, and their result was an inventory of 180 pales. The following year non-invasive archaeological work was implemented using high frequency side sonar by the same team. The research covered the section of the river between the Gdański Bridge and Karowa Street and in the vicinity of Wilanów (district of Warsaw), where a single pile was noticed giving the basis for the inference. A total of about 53 ha of the riverbed in the centre of Warsaw and about 5 ha in Wilanów (Brzóska and Prejs 2018: 188–189) were investigated. As a result, 166 new piles were discovered between the Gdański Bridge and the Świętokrzyski Bridge. There were 59 of them at the point of Bednarska and Karowa Streets, and 11 were located directly by the Gdański Bridge. The most interesting discovery was 96 pales located at Mostowa/Boleść Street, which are probably a part of the oldest bridge in Warsaw built in 1573–1603 (Brzóska and Prejs 2018: 184–185, Chwaścicki 1997: 14).

[2] Application number 2208/19 financed from the funds of the Minister of Culture and National Heritage.

Barge wreck (W10), 12–metres-long and 2.5-metres-wide, lying on the left bank of the river at the point of the Old Town, is another important discovery worth mentioning (Sadurski 2018: 176–178). Inventory and underwater research works from 2015–2016 were financed by the Bureau of the Culture of the City of Warsaw (Polish: *Biuro Stołecznego Konserwatora Zabytków*)[3]. In 2017 funding from the same source was given to another project, *Archaeological Research of the Warsaw Vistula River Shipwrecks* (Polish: *Archeologiczne badania wraków statków wiślanych*), which is a continuation of work from previous years, aimed at identifying previously discovered wrecks. The effect was the documentation of the three wrecks marked as W1, W2, and W10. For units marked as W1 and W2, dated to 1877 and 1521 respectively, it was possible using dendrochronological analysis of wood samples obtained from both wrecks (Sadurski 2018: 173, 175), while the wreck W10 occurred to be an example of a 20th-century steel barge (Sadurski 2018: 176).

<u>*About the Project*</u>

The fieldwork prospection method with the use of high frequency (1200 khz) side sonar will be implemented in the planned research (**Fig. 2**). It is necessary to emphasize the constant development of sonar devices, which translates into better imaging of the bottom than it was a few years ago. The progress in the field of technology allows seeing more details of objects and facilitates their interpretation. An equally high frequency of work was previously available only in towed sonars, however, in the hereby project a transom transducer will be used, that gives the possibility of investigating very shallow waters, and is limited only by the immersion of the research boat and engine. An additional difficulty is the variable level of the river causing the necessity to adjust floating to its rhythm, lower and higher water levels. There is a need for continuous monitoring of the riverbed due to erosion and accumulation of bottom sediments, which contribute to covering or revealing objects at the riverbed.

The chosen area will be divided into strips, so that sonar observation ranges overlap each other, achieving the maximum degree of site inspection. The entire process will be registered directly with GPS/GLONASS with the recording of paths. Recorded GPS tracks as well

[3] Initially as part of the project *Interdisciplinary Studies of the Vistula River* led by Hubert Kowalski, Ph.D.

as sonar images will be mutually correlated with each other and placed on plans in the GIS system. Next, a detailed analysis and interpretation of the sonographic map of the bottom will be elaborated in terms of reflective horizons of anthropogenic character. In selected places, which will be recognized as traces connected with human activity, diving will be carried. Their main goal will be to confirm the anomalies observed on the sonar image, determine the type of object and its preliminary dating. On this basis, a list of archaeological sites will be registered and AZP reporting sheets will be prepared. The planned research area runs through four areas of AZP programme: 55–65, 55–66, 53–65, 53–64, for which underwater non-invasive prospection will be a valuable supplement. The team of archaeologists and divers involved in the project has a vast experience necessary to implement the project (*cf.* Kontny, Brzóska, Prejs 2018; Kontny, Brzóska, Bucholc *et al.* 2018). The results of the works are to be included in the further studies.

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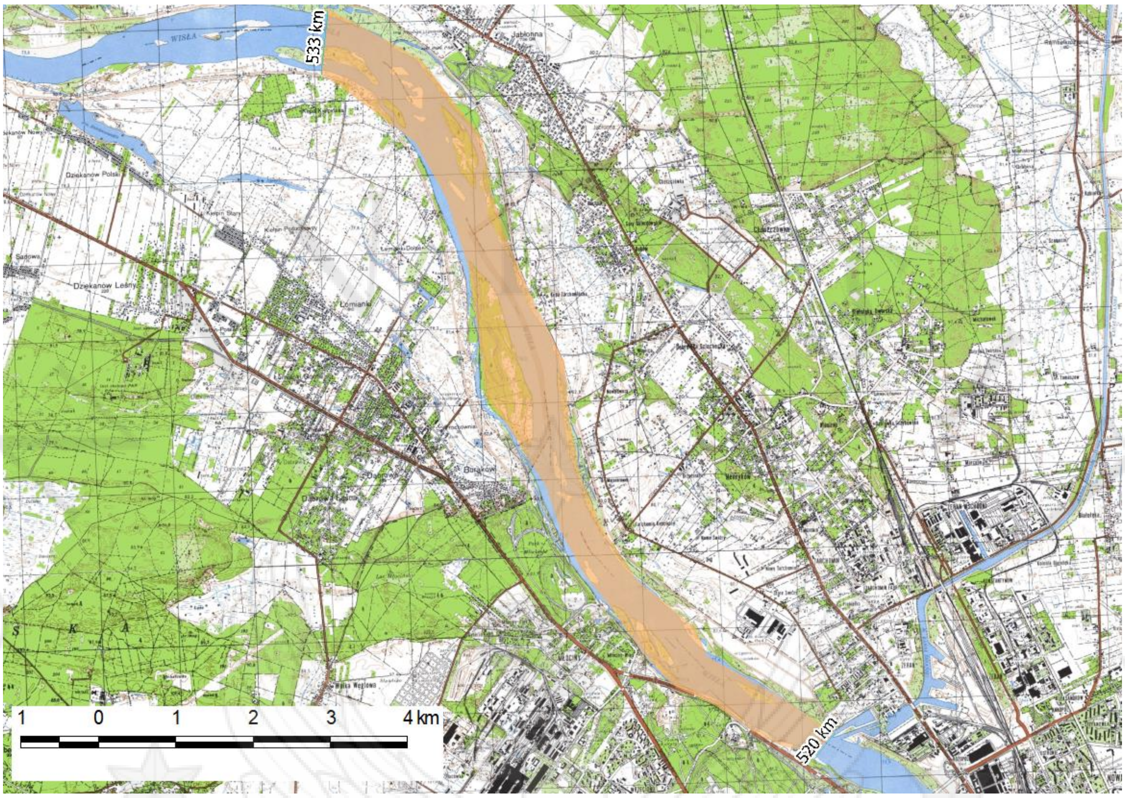

Fig. 1 – A map on which the research area of the Vistula River is marked with colour (elaborated by: P. Prejs)

Fig. 2 – Members of the project team (photo by: R. Małys)

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