Yearbook of the International Centre for Underwater Archaeology in Zadar
Godišnjak Međunarodnog centra za podvodnu arheologiju u Zadru

Submerged Heritage
Potopljena baština

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Bow of the wreck of the Coriolanus /
Pramac olupine broda Coriolanus (Foto: R. Surić)

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NEWS / NOVOSTI

Doris Kurtov dkurtov@icua.hr

Introductory course on the conservation and restoration of underwater archaeological finds

ICUA Zadar organized an Introductory Course on the Conservation and Restoration of Underwater Archaeological Finds, held from March 10 to 21, 2025. The program introduced participants to fundamental methods for handling different types of materials. Over the course, they spent several days in specialized workshops dedicated to metal, ceramics, and organic materials. The participants included Vasilija Jovanović (Montenegro), Ander Arrese (Spain), and Luise Fusco (Germany).

1. Participants of the Introductory course on the conservation and restoration of underwater archaeological finds: / Polaznici Početnog tečaja konzervacije i restaruracije podvodnih arheoloških nalaza: Luise Fusco, Ander Arrese, Vasilija Jovanović (Photo: A. Jozić)

Training in Underwater Archaeology and Digitalization of Underwater Heritage in Montenegro

ICUA Zadar organized a five-day training program on underwater archaeology and the digitalization of underwater cultural heritage, held in Ulcinj, Montenegro, from April 7 to 11, 2025. Initiated by Mr. Darko Kovačević and carried out under the auspices of

Početni tečaj konzervacije i restauracije podvodnih arheoloških nalaza

Od 10. do 21. ožujka 2025. godine MCPA Zadar proveo je tečaj konzerviranja i restauriranja podvodnih arheoloških nalaza po početničkom programu. Početni tečaj je dvotjedni tečaj tijekom kojeg se polaznici upoznaju s osnovnim metodama rada na svim materijalima i provode po nekoliko dana u svakoj od radionica (metal, keramiku, organski materijal). Polaznici tečaja bili su: Vasilija Jovanović (Crna Gora), Ander Arrese (Španjolska) i Luise Fusco (Njemačka).

2. Participants and trainers of the Ulcinj training program / Polaznici i instruktori tečaja u Ulcinju (Photo: D. Kovačević)

UNESCO and the UNITWIN Network for Underwater Archaeology, the program was supported by the Interreg IPA South Adriatic cross-border cooperation initiative as part of the broader Wrecks4All 2.0 project. The training brought together 21 participants from Montenegro and Albania, offering them the chance to strengthen their knowledge and practical skills in underwater archaeology. The curriculum combined theoretical lectures with hands-on exercises, placing particular emphasis on the use of digital technologies for documenting underwater sites.

XXX DEGUWA conference

Würzburgu in Germany was the venue from May 8 to 13, 2025 for the XXX edition of the international conference dedicated to underwater archaeology hosted by DEGUWA (Deutsche Gesellschaft zur Förderung der Unterwasserarchäologie e. V.). The ICUA Zadar representative Roko Surić participated with a poster.

3. Poster of DEGUWA conference / Poster DEGUWA konferencije (Photo: DEGUWA)

Tečaj o podvodnoj arheologiji i digitalizaciji podvodne baštini u Crnoj Gori

MCPA Zadar održao je petodnevni tečaj o podvodnoj arheologiji i digitalizaciji podvodne kulturne baštine u Ulcinju, Crna Gora od 7. do 11. travnja 2025. godine. Tečaj je organiziran na inicijativu Darka Kovačevića uz potporu UNESCO-a i UNITWIN mreže, a sufinanciran kroz Interreg IPA South Adriatic program kao dio projekta Wrecks4All 2.0. Sudjelovao je 21 polaznik iz Crne Gore i Albanije, koji su kroz predavanja i praktične vježbe usavršavali znanja, s posebnim naglaskom na digitalne tehnologije u dokumentiranju podvodnih nalazišta.

XXX. DEGUWA konferencija

Na 30. međunarodnoj konferenciji „U Posejdonovom carstvu“, koju organizira DEGUWA – Njemačko društvo za promicanje podvodne arheologije, podvodni arheolog Roko Surić sudjelovao je s poster-prezentacijom. Znanstveni skup održan je od 8. do 13. travnja 2025. godine u Würzburgu, Njemačka.

Radionica o konzervacijskoj metodi trehaloze

Od 7. do 9. svibnja 2025. godine, MCPA Zadar ugostio je ugledne stručnjake iz Japana. Kroz predavanja i praktične demonstracije podijelili su najnovije pristupe u podvodnoj arheološkoj konzervaciji, s naglaskom na metodu trehaloze. Među gostima bili su prof. Setsuo Imazu (Sveučilište Nara), prof. Kouji Ito (Sveučilište za umjetnost i dizajn Tohoku), izv. prof. Jun Kimura (Sveučilište Tokai) i gđa. Ikuno Fujii (Sveučilište Teikyo). Praktične radionice

4. Japanese expert team with ICUA and guests / Japanski tim stručnjaka sa djelatnicima MCPA i gostima - Ikuno Fujii, Setsuo Imazu, Jun Kimura, Kouji Ito (Photo: ICUA Zadar / MCPA Zadar)

Workshop on Trehalose Conservation Method and Underwater Cultural Heritage

From May 7 to 9, 2025, ICUA Zadar welcomed distinguished experts from Japan. Through lectures and practical demonstrations, they shared the latest approaches in underwater archaeological conservation, with a focus on the trehalose method. Guests included Prof. Setsuo Imazu (Nara University), Prof. Kouji Ito (Tohoku University of Art and Design), Assoc. Prof. Jun Kimura (Tokai University), and Mrs. Ikuno Fujii (Teikyo University). Hands-on workshops allowed participants to apply the techniques and deepen their understanding.

UNESCO's specialized training program

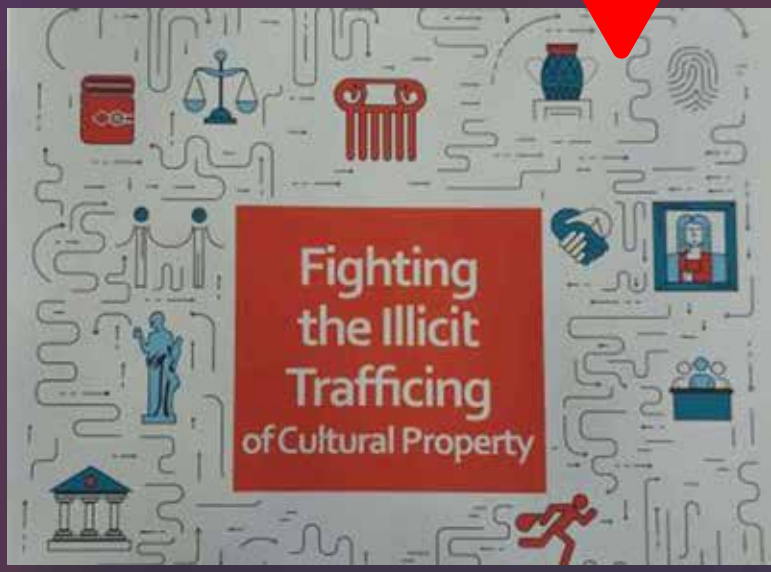
ICUA Zadar Director Mladen Pešić joined UNESCO's specialized training program, part of the EU-funded initiative, "Fighting Against the Illicit Trafficking of Cultural Property in the West" held in Mostar, May 5 to 9, 2025. The programme aimed to enhance institutional capacities for implementation of the *Specialized Training Curriculum for Police Forces in Bosnia and Herzegovina: Combatting the Illicit Trafficking of Cultural Property Using Technology* and was realized in co-operation with the Agency for Education and Professional Training (AEPTM), Ministry of Security of Bosnia and Herzegovina.

Exhibition "Veruda 1597"

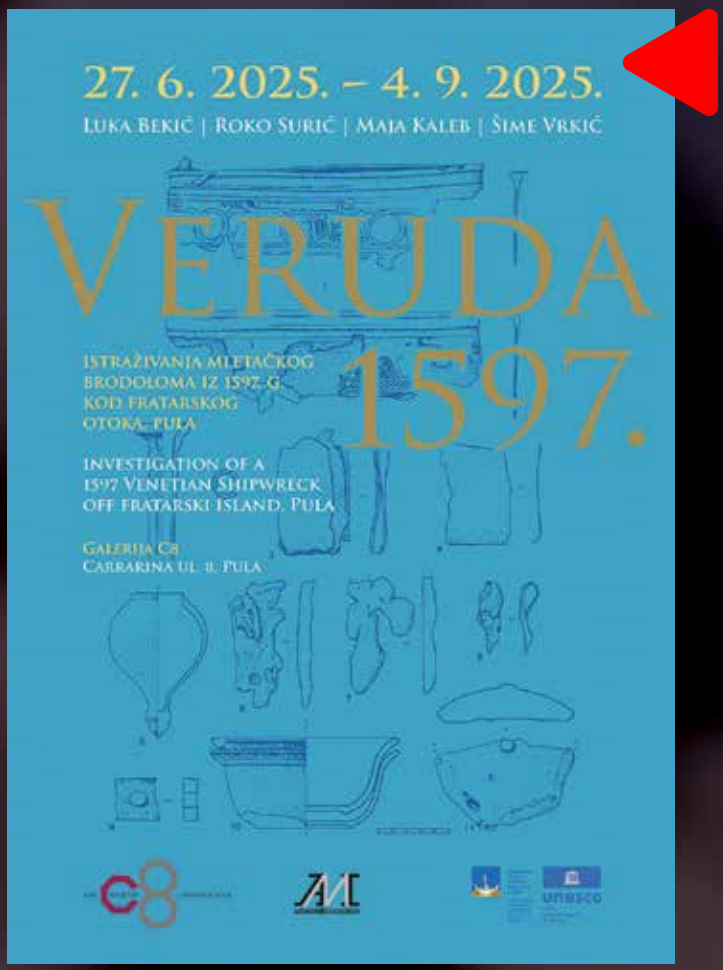
The exhibition "Veruda 1597" was inaugurated in Gallery C8 of the Archaeological Museum of Istria in Pula on June 27, 2025, and talks about the research of a Venetian shipwreck from 1597 near Fratarski Otok (Veruda). ICUA Zadar underwater archaeologists Luka Bekić, Roko Surić, Maja Kaleb and Šime Vrkić, also the authors of the

6a. Exhibition "Veruda 1597" / Izložba ,,Veruda 1597." (Photo: M. Kaleb)

omogućile su sudionicima da primijene tehnike i produbе svoje razumijevanje.



5. UNESCO's specialized training program in Mostar / UNESCO-ov specijaliziran program obuke u Mostaru (Photo: AEPIM)



6b. Exhibition "Veruda 1597" / Izložba ,,Veruda 1597." (Photo: V. Falica)

exhibition, presented various remains of a Venetian ship that was looted and sunk by the Uskoks near the island at the end of the 16th century.

6c. Exhibition “Veruda 1597” / Izložba ,,Veruda 1597.’’ (Photo: ICUA Zadar / MCPA Zadar)

Statutory Meetings & Scientific Conference, UNESCO Headquarters, Paris

From June 16 to 20, 2025, UNESCO hosted the 10th Meeting of States Parties to the 2001 Convention on the Protection of Underwater Cultural Heritage, the 16th STAB session, and the UNITWIN Network gathering, alongside a scientific conference on *Underwater Cultural Heritage and the Challenges of Climate Change*. ICUA Zadar was represented by Mladen Pešić and Doris Kurtov.

7. Meeting of UNESCO 2021 Convention in Paris / Sastnak UNESCO-ve 2001. Konvencije u Parizu (Photo: D. Kurtov)

UNESCO-ov specijaliziran program obuke

Ravnatelj MCPA Zadar sudjelovao je u specijaliziranom programu obuke u okviru EU projekta „Borba protiv ilegalne trgovine kulturnim dobrima na Zapadnom Balkanu“ u Mostaru od 5. do 9. svibnja 2025. godine. U cilju jačanja institucionalnih kapaciteta, program obuke organizirao je UNESCO u suradnji s Agencijom za školovanje i stručno usavršavanje (AEPTM) pri Ministarstvu sigurnosti Bosne i Hercegovine.

Izložba ,,Veruda 1597.’’

Izložba ,,Veruda 1597.” otvorena je u galeriji Galeriji C8 Arheološkog muzeja Istre u Puli 27. lipnja 2025. godine, a govori o istraživanju mletačkog brodoloma iz 1597. g. kod Fratarskog otoka. MCPA podvodni arheolozi Luka Bekić, Roko Surić, Maja Kaleb i Šime Vrkić, ujedno i autori izložbe, predstavili su raznovrsne ostatke mletačkog broda kojeg su krajem 16. st. kod otoka opljačkali i potopili uskoci.

Statutarni sastanci i znanstvena konferencija, sjedište UNESCO-a, Pariz

Od 16. do 20. lipnja 2025. godine UNESCO je bio domaćin 10. sastanka država stranaka Konvencije o zaštiti podvodne kulturne baštine iz 2001. godine, 16. sjednice Znanstveno-tehničkog savjetodavnog tijela (STAB) i mreže UNITWIN, uz znanstvenu konferenciju o podvodnoj kulturnoj baštini i izazovima klimatskih promjena. MCPA Zadar predstavljali su Mladen Pešić i Doris Kurtov.

2. Konferencija o očuvanju i interpretaciji pomorske baštine Hrvatske

Na 2. Konferenciji o očuvanju i interpretaciji pomorske baštine Hrvatske, održanoj 26. i 27. rujna 2025. godine u Betini, MCPA Zadar sudjelovao je s dva izlaganja: *Edukativno prezentacijski centar za podvodnu arheologiju u Zadru* (Nika Cohen) i *Condura Croatica – povijest istraživanja, značaj i konzervatorsko-restauratorski radovi* (Anita Jelić i Vladimir Kusik, Arheološki muzej Zadar – Muzej ninskih starina). Konferencija je povodom

2nd Conference on the Preservation and Interpretation of Croatia's Maritime Heritage

On 26 and 27 September 2025, the town of Betina hosted the *2nd Conference on the Preservation and Interpretation of Croatia's Maritime Heritage*, organized on the occasion of the tenth anniversary of the Betina Wooden Shipbuilding Museum. ICUA Zadar contributed with two presentations: *Education and Presentation Centre for Underwater Archaeology in Zadar* (Nika Cohen) and *Condura Croatica – History of Research, Significance and Conservation and Restoration Works* (Anita Jelić and Vladimir Kusik, Archaeological Museum Zadar – Museum of Nin Antiquities).The conference gathered experts and enthusiasts from across Croatia and, through seven sessions, showcased projects and experiences dedicated to the preservation of maritime heritage.

15th Meeting of the Section of Conservators-Restorers of the Croatian Museum Society

On 16 and 17 October 2025, the city of Pazin hosted the *15th Meeting of the Section of Conservators-Restorers of the Croatian Museum Society*. The event was organized by the State Archives in Pazin, the Ethnographic Museum of Istria, and the Pazin Town Museum. ICUA Zadar was represented by conservator-restorers Anita Jelić, Antonija Jozić, Martina Ćurković Madiraca, and Gabriela Vrdoljak Jakarić (ICUA Zadar trainee), who presented their latest projects in four posters. Notably, Martina Ćurković Madiraca received first prize for the best poster, highlighting the excellence of ICUA Zadar's contributions.

10. Participants of the 24th International Underwater Days in Kemer / Sudionici 24. međunarodnih podvodnih dana u Kemeru (Photo: TIKA, Turkey)

desete obljetnice Muzeja betinske drvene brodogradnje okupila stručnjake i entuzijaste iz cijele Hrvatske te kroz sedam sesija predstavila projekte i iskustva vezana uz očuvanje maritimne baštine.

8. Nika Cohen at the 2nd Conference on Croatia's Maritime Heritage / Nika Cohen na 2. konferenciji o pomorskoj baštini Hrvatske (Photo: A. Jelić)

15. susret Sekcije konzervatora-restauratora Hrvatskog muzejskog društva

Hrvatsko muzejsko društvo organiziralo je 15. izdanje susreta Sekcije konzervatora-restauratora, održane 16. i 17. listopada 2025. godine u Pazinu. Domaćini su bili Državni arhiv u Pazinu, Etnografski muzej Istre i Muzej grada Pazina. Konzervatorice MCPA Zadar – Antonija

9. 15th Meeting participants in Pazin / Sudionici 15. izdanja Susreta u Pazinu (Photo: N. Peko)

24th International Underwater Days in Kemer

Mladen Pešić, Director of ICUA Zadar, took part in the 24th International Underwater Days held in Kemer, Turkey, from May 15 to 18, 2025. During the event, he presented the Croatian System for the protection and management of underwater cultural heritage, recognized in 2023 by UNESCO as an example of best practice in underwater cultural heritage.

ICOM-CC WOAM in Sweden

Senior Conservator-Restorator Anita Jelić participated in the 16th Conference of the Working Group on Underwater Organic Archaeological Materials of the International Council of Museums (ICOM-CC WOAM) in Gothenburg (Sweden) from September 15 to 19, 2025. In a poster presentation entitled ''Conservation of Two Wooden Beams from a Post-Medieval Shipwreck'', she presented the results of conservation and restoration work on wooden beams from a 16th-century shipwreck.

UNESCO MONDIACULT 2025

From September 29 to October 1, 2025 UNESCO convened the *World Conference on Cultural Policies and Sustainable Development – MONDIACULT 2025* at the Barcelona International Convention Centre (Spain). The Director of ICUA Zadar, Mladen Pešić, attended this landmark gathering, which served as a global platform to promote cultural rights, foster international cooperation and solidarity, and advance inclusive, locally grounded development through culture.

12. UNESCO MONDIACULT 2025 delegates in Barcelona / Sudionici UNESCO MONDIACULT 2025. u Barceloni (Photo: UNESCO / UNESCO)

Jozić, Anita Jelić, Martina Ćurković Madiraca i Gabriela Vrdoljak Jakarić (pripravnica) – predstavile su aktualne projekte Centra kroz četiri postera, a poster Martine Ćurković Madiraca nagrađen je prvom nagradom, potvrđujući kvalitetu doprinosa MCPA Zadar.

24. međunarodni podvodni dani u Kemeru

Ravnatelj MCPA Zadar sudjelovao je od 15. do 18. svibnja 2025. godine na 24. Međunarodnim podvodnim danima u Kemeru (Turska), gdje je predstavio hrvatski Sustav zaštite i upravljanja podvodnom kulturnom baštinom prihvaćen 2023. godine kao primjer UNESCO-ve najbolje prakse u podvodnoj kulturnoj baštini.

ICOM-CC WOAM u Švedskoj

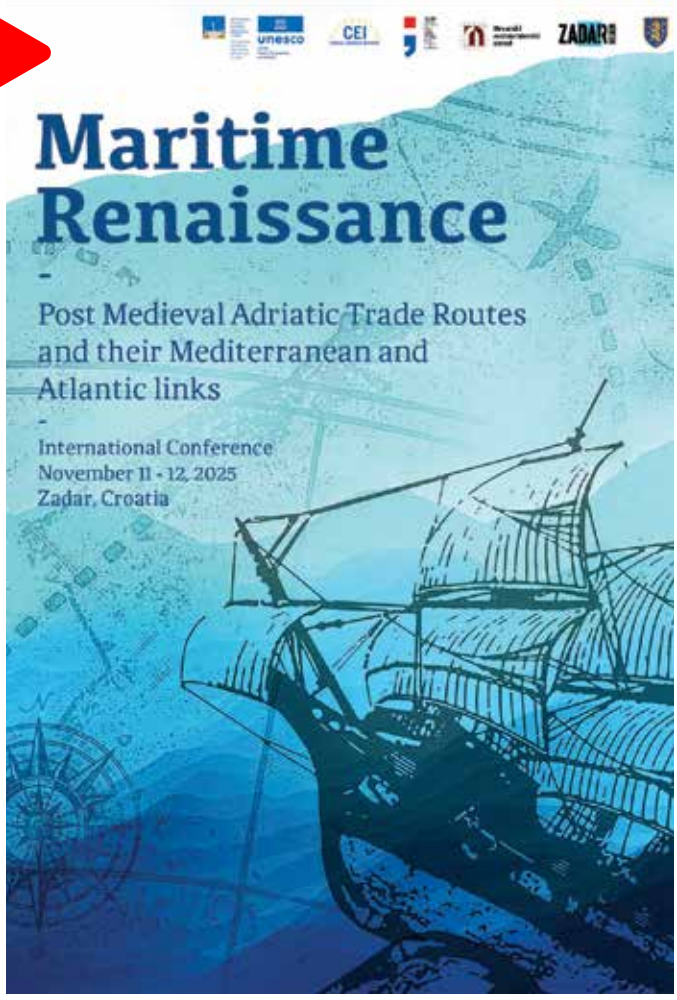
Viša konzervatorica-restauratorica Anita Jelić sudjelovala je od 15. do 19. rujna 2025. godine na 16. konferenciji Radne skupine za podvodne organske arheološke materijale Međunarodnog vijeća za muzeje (ICOM-CC WOAM) u Göteborg-u (Švedska). Posterskim izlaganjem pod naslovom *Conservation of Two Wooden Beams from a Post-Medieval Shipwreck* predstavila je rezultate konzervatorsko-restauratorskih radova na drvenim gredama iz olupine broda iz 16. stoljeća.

11. Anita Jelić at the 16th ICOM-CC WOAM conference in Sweden / Anita Jelić na 16. konferenciji COM-CC WOAM u Švedskoj (Photo: ICUA Zadar / MCPA Zadar)

UNESCO MONDIACULT 2025

UNESCO je organizirano Svjetsku konferenciju o kulturnim politikama i održivom razvoju – MONDIACULT

13a. Scientific Conference ''Maritime Renaissance'' in Zadar / Znanstvena konferencija ,,Plovidbena renesansa'' u Zadru (Photo: G. Vrdoljak Jakarić)



13b. Scientific Conference ''Maritime Renaissance'' in Zadar / Znanstvena konferencija ,,Plovidbena renesansa'' u Zadru (Photo: A. Brežanski)

2025 u Međunarodnom kongresnom centru u Barceloni u Španjolskoj od 29. rujna do 1. listopada 2025. godine. Ravnatelj MCPA Zadar, Mladen Pešić, prisustvovao je ovom značajnom skupu, koji je poslužio kao globalna platforma za promicanje kulturnih prava, poticanje međunarodne suradnje i solidarnosti te unapređenje uključivog, lokalno utemeljenog razvoja kroz kulturu.

Znanstvena konferencija *Plovidbena renesansa*

Znanstvena konferencija *Plovidbena renesansa – Trgovački putevi na Jadranu u novom vijeku i poveznice sa Sredozemljem i Atlantikom*, održana 11. i 12. studenoga 2025. godine u Edukacijsko-prezentacijskom centru za podvodnu arheologiju sv. Nikole, okupila je 19 domaćih i stranih stručnjaka koji su predstavili najnovija istraživanja podvodnih arheoloških nalaza te raspravljali o razvoju pomorske trgovine od 15. do 18. stoljeća. Posebna je pozornost bila usmjerena na međunarodne trgovačke i pomorske veze Jadrana s Mediteranom, Sjevernim morem, Baltikom i Atlantikom. Skup, otvoren za javnost, organiziran je u partnerstvu s Hrvatskim restauratorskim zavodom uz potporu Srednjoeuropske inicijative i lokalne zajednice, a završit će objavljivanjem Zbornika radova.

8. konferencija o muzejskim knjižnicama u Cartagena

Knjižničar Luka Bratović sudjelovao je on-line na 8. konferenciji o muzejskim knjižnicama u Cartageni (Španjolska) dana 20. studenoga 2025. godine, gdje je izlaganjem *Cultural Heritage and Libraries: Insights*

Scientific Conference *Maritime Renaissance*

The scientific conference *Maritime Renaissance – Post Medieval Adriatic Trade Routes and their Mediterranean and Atlantic links* held from November 11 to 12, 2025 at the Educational and Presentation Centre for Underwater Archaeology of St. Nicholas, brought together 19 domestic and foreign experts who presented the latest research on underwater archaeological finds and discussed the development of maritime trade from the 15th to the 18th centuries. Special attention was paid to the international trade and maritime connections of the Adriatic with the Mediterranean, the North Sea, the Baltic and the Atlantic. The conference, open to the public, was organized in partnership with the Croatian Conservation Institute with the support of the Central European Initiative and the local community, and will end with the publication of the Proceedings.

8th Conference on Museum Libraries in Cartagena

On November 20, 2025, librarian Luka Bratović participated online at the 8th Conference on Museum *from the Specialized Underwater Archaeology Library in Zadar, Croatia* predstavio rad Specijalizirane knjižnice za podvodnu arheologiju u Zadru.

15. Official poster of the XXVI SOMA Symposium in Cartagena / Službeni poster XXVI. SOMA kongresa u Cartageni (Photo: ARQVA, Spain / ARQUA, Španjolska)

26. XXVI. SOMA kongres

Nacionalni muzej podvodne arheologije (ARQVA) u Cartageni bio je domaćin XXVI. kongresa o mediteranskoj arheologiji (SOMA 2025), održanog od 27. do 29. studenoga 2025. godine. Trodnevni skup, posvećen temi *„Arheologija i kulturna baština na Mediteranu: izazovi i procjene upravljanja“*, ponovno je nakon prošlogodišnjeg izdanja u Zadru okupio brojne istraživače i stručnjake iz mediteranske regije radi razmjene znanja te promicanja i zaštite bogate kulturne baštine. Na skupu je ravnatelj Mladen Pešić predstavio novoobjavljeni „Zbornik radova SOMA 2024“, koji je izišao u izdanju Access Archaeopressa.

14. The official poster of the 8th Conference on Museum Libraries in Cartagena / Službeni poster 8. konferencije o muzejskim knjižnicama u Cartageni

19. dani specijalnih i visokoškolskih knjižnica u Lovranu

Knjižničar MCPA Zadar Luka Bratović sudjelovao je na konferenciji *19. dani specijalnih i visokoškolskih knjižnica* u Lovranu od 1. do 3. prosinca 2025. godine, gdje je predstavio postersko izlaganje *Harald von Petrikovits: posebna zbirka u fondu knjižnice MCPA Zadar*. Skup s temom *Sinergija i rast: knjižnice – jednake, a različite* okupio je knjižničare iz cijele Hrvatske, uz brojna izlaganja i e-postere. Konferenciju su organizirali HKD i partnerske knjižnice iz Zagreba i Rijeke.

Dani hrvatskih muzeja

Na manifestaciji Dani hrvatskih muzeja, održanoj 3. prosinca 2025. godine u Hrvatskom prirodoslovnom

Libraries in Cartagena (Spain), where he presented the work of the Specialized Underwater Archaeology Library in Zadar, Croatia with a presentation titled Cultural Heritage and Libraries: Insights from the Specialized Underwater Archaeology Library in Zadar, Croatia.

XXVI SOMA Symposium

National Museum of Underwater Archaeology (ARQVA) in Cartagena hosted the XXVI Symposium on Mediterranean Archaeology (SOMA 2025) from November 27 to 29, 2025. This three-day event explored the theme: *"Archaeology and Cultural Heritage in the Mediterranean: challenges and assessments of management."* Following last year's edition in Zadar, SOMA 2025 once again brings together researchers and professionals from across the Mediterranean to share knowledge, protect, and promote rich cultural heritage. Director Mladen Pešić participated in SOMA 2025 where he presented the newly published "SOMA 2024 Proceedings," released by Access Archaeopress.

19th Special and Academic Libraries Days conference in Lovran

ICUA librarian Luka Bratović took part in the *19th Special and Academic Libraries Days conference,* held in Lovran from 1 to 3 December 2025, where he presented a poster titled *The Legacy of Harald von Petrikovits: A Special Collection in the Library of the International Centre for Underwater Archaeology in Zadar*. The event, themed *Synergy and Growth: Libraries – Equal, Yet Different*, brought together librarians from across Croatia and featured numerous presentations and e-posters. It was organized by the Croatian Library Association in cooperation with partner libraries from Zagreb and Rijeka.

Croatian Museum Days

At the Croatian Museum Days organized on December 3, 2025, at the Croatian Museum of Natural History in Zagreb, ICUA Zadar presented two projects: *In-situ Protection of the Štuka Wreck* (Roko Surić) and *Widespread School* (Maja Kaleb). Both were shortlisted for the ICOM Croatia awards, with *Widespread School: Innovating Teaching Approaches Outside the Classroom* receiving a Special prize for Cross-Sectoral Cooperation. Funded through Erasmus+, the project promotes innovative out-of-classroom teaching methods. In April 2025, ICUA Zadar held four field workshops led by Maja Kaleb.

16. Luka Bratović at the 19th conference in Lovran / Luka Bratović na 19. konferenciji u Lovranu (Photo: ICUA Zadar / MCPA Zadar)

muzeju u Zagrebu, MCPA Zadar predstavio je projekte *In-situ zaštita olupine Štuke* (Roko Surić) i *Widespread School (*Maja Kaleb)**.** Oba su projekta bili u užem izboru za nagrade ICOM Hrvatska, a projekt *Widespread School: Innovating Teaching Approaches Outside the Classroom* osvojio je Posebno priznanje za međusektorsku suradnju. Projekt, financiran kroz Erasmus+, razvija inovativne metode učenja izvan učionice. U travnju 2025. godine MCPA Zadar organizirao je četiri radionice terenske nastave pod vodstvom Maje Kaleb.

17. Maja Kaleb at the Croatian Museum Days manifestation in 2025 / Maja kaleb na Danima hrvatskih muzeja u 2025. g. (Photo: ICUA Zadar / MCPA Zadar)

WHITHER GOES THOU, SHIP?

KAMO IDEŠ, BRODU?

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Our work at the antique period shipwreck site in Sukošan last year wound up the investigation of the surviving structure. Our plan this year envisaged uncovering the entirety of the structure and documenting it afresh and in full. The complete uncovering of the structure was necessary as it allowed for comparative analysis of numerous details; excavation work in previous seasonal campaigns had been performed in segments, uncovering only parts of the wreck. Photographic documentation and merging photographic mosaics from multiple campaigns did provide an overall picture of the ship's appearance, but the many details that required additional documentation informed our decision to undertake a complete excavation to develop an improved and integral view of all elements. The obtained data will be use in coming years to develop a model and a reconstruction of this important and fascinating antique period ship. As in previous seasons the investigation saw field director Mladen Pešić PhD head an ICUA team of Luka Bekić PhD, Roko Surić, Maja Kaleb, and Šime Vrkić PhD. They were joined by long-time associates Roman Scholz, an underwater archaeologist with Germany's Max Planck

1. Cleaning of the ship construction from the sand / Čišćenje brodske konstrukcije od pijeska (Photo: R. Scholz)

2. Entering the sea / Ulazak u more (Photo: M. Popek)

Nakon što je prošle godine istražen i posljednji dio brodske konstrukcije antičkog brodoloma u Sukošanu, ove godine je odlučeno da se cjelokupna konstrukcija otvori u cijelosti te da se još jednom kompletno dokumentira. Cjelovito otvaranje brodske konstrukcije bilo je neophodno radi brojnih detalja koji su se trebali usporediti budući da je samo iskopavanje brodske konstrukcije tijekom prošlih godina rađeno segmentirano otkrivanjem tek pojedinih dijelova broda. Iako je fotodokumentacija i spajanje fotomozaika iz različitih kampanja omogućila da dobijemo cjelovitu sliku izgleda broda, odlučeno je da se radi raznih detalja koje je trebalo dodatno dokumentirati cjelovitim otvaranjem dobije bolji uvid u sve elemente broda. Svi podatci sljedećih će nam godina služiti za izradu modela i rekonstrukcije ovog važnog i zanimljivog antičkog brodoloma. Kao i svih ovih godina, istraživanje je provođeno pod voditeljstvom dr. sc. Mladena Pešića, uz cijeli MCPA tim kojeg čine doc. dr. sc. Luka Bekić, Roko Surić, Maja Kaleb i dr. sc. Šime te naših dugogodišnjih suradnika - podvodnog arheologa Romana Scholza iz njemačkog instituta Max Planck i dr. sc. Mateusza Popeka sa Sveučilišta u Torunu iz Poljske, ovaj put potpomognutog studentima Martom Piotrowskom i Mikolajem Tanskim s istog sveučilišta. Ove nam se godine pridružio Anton Divić iz obrta NavArchos iz Hrvatske te arheologinja Kato Nees iz Belgije i Alba Ferreira Dominguez iz francuske tvrtke Ipso Facto.

3. Fine cleaning of the elements / Detaljno čišćenje elemenata (Photo: M. Popek)

Institute, and Mateusz Popek PhD of Poland's Toruń University, this time ably assisted by Toruń University students Marta Piotrowska i Mikolaj Tanski. We were also joined by Anton Divić of Croatian-based sole trader NavArchos, archaeologist Kato Nees from Belgium, and Alba Ferreira Dominguez from the French firm Ipso Facto.

The first few days were spent on removing the layer of stone and sand placed atop the geotextile used to protect the ship's structure. We removed the entire layer covering the interior of the ship before carefully removing the geotextile, followed by detailed cleaning of the wooden structure. A low wall was created by arranging

4. Detail of the marks on the ship construction / Detalj oznaka na brodu (Photo: A. Divić)

Prvih nekoliko radnih dana radilo se na čišćenju kamena i pijeska iznad sloja geotekstila koji je prekrivao brodsku konstrukciju. Skinut je sloj iz cijele unutrašnje strane broda nakon čega se pristupilo opreznom skidanju geotekstila, a nakon toga i finom čišćenju drvene konstrukcije broda. Radi zaštite od unošenja novog pijeska u procesu čišćenja brodske konstrukcije uzrokovanog morskim gibanjima, uz rub brodske konstrukcije uokolo je napravljen niži zid od složenog kamenja koje je izvađeno tijekom čišćenja broda. Isto kamenje će u konačnici poslužiti za pričvršćivanje geotekstila jednom kada se iskopavanja završe i njime će se ponovo zaštiti brodske konstrukcije.

Po završetku finog čišćenja krenulo se s označavanjem unutrašnjih elemenata broda - svih dijelova oplate, rebara, kobilice, proveza i svih drugih drvenih elemenata. Manjim pribadačama različitih boja označavali su se drveni čavli na oplati i rebrima (bijelom bojom na oplati, žutom na rebrima) i metalni čavli (zelenom bojom). Plavom žicom označene su granice između dviju platica oplate. Nakon što su svi elementi označeni, pristupilo se dokumentaciji cjelokupne brodske konstrukcije za izradu 3D modela, geodetskim snimanjima kao i bilježenju pojedinih detalja brodske konstrukcije koji će biti u narednim godinama bitni za izradu detaljnih modela i replika.

Na osnovu dobivenih informacija izrađeni su i detaljniji nacrti s elementima broda. Također je izrađen i završni ortofoto model brodske konstrukcije s vidljivim detaljima pojedinih elemenata. Utvrđeni su pojedini elementi

stones removed during the cleaning operation around the perimeter of the wooden structure to prevent marine currents from bringing new sand in during the cleaning process. These stones will be used again to hold the geotextile in place when the excavation is completed to again protect the ship's structure.

Detailed cleaning was followed by marking out the ship's internal elements: all part of the planking, the frames, the keel, the stringers, and all the other wooden elements. Small pins of various colours were used to mark the treenails of the planking and frames (white for the planking, yellow for the frames), and metal nails (green pins). Blue wire was used to indicate joints where hull planks met. Once all elements had been marked, we documented the entirety of the ship's surviving structure for the development of a 3D model, performed geodetic surveying, and recorded the individual details of the ship's structure—all of which will be critical in coming years in producing detailed models and replicas.

The data obtained was used to produce drawings in greater detail showing elements of the ship. We also developed a final orthophotographic model of the ship's structure showing details of the particular elements. We identified particular frame elements that will be critical to a future reconstruction of the ship's structure. These are floor timbers (FT) that lie on the keel, the futtocks (FU) to the north and south side, and the half frames (HF). This investigation also designated as "E" some of the ship's elements that had previously not been marked. Wood samples were once again taken from all elements since results obtained from wood analysis of samples

▶ 5. Documenting of the ship construction / Dolkumentiranje brodske konstrukcije (Photo: A. Divić)

rebara koji će biti značajni za daljnju rekonstrukciju brodske konstrukcije. Radi se o rebrima koja leže na kobilici (FT) rebrenim nastavcima sa sjeverne i južne strane (FU), rebrima koji započinju na kobilici (HF).

▶ 6. Aerial photo of the ship construction / Zračni snimak brodske konstrukcije (Photo: R. Scholz)

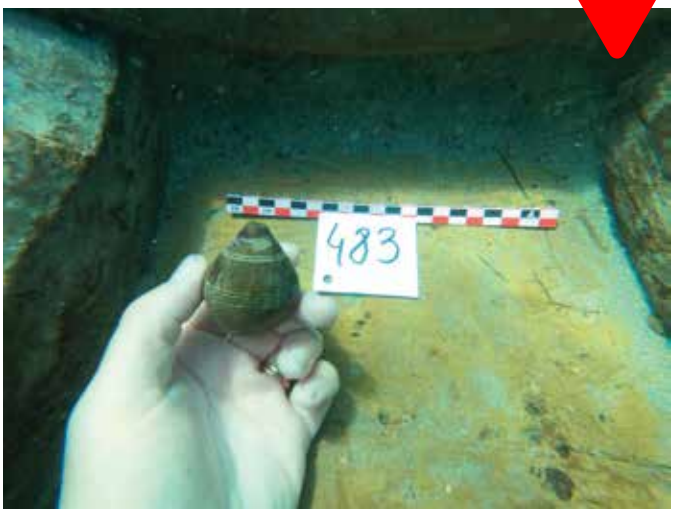
7. Elements of the clamp and filister / Elementi bočne proveze i elementa sa utorom (Photo: M. Popek)

from previous seasons were not consistent with the particular elements. In all 119 samples have been taken in the course of the investigative work. Analysis will be performed of a selection of the samples extracted in this and previous seasons. The samples will be sent to the Ipso Facto company in France, whose wood analysis specialists have participated in the investigative work at the Barbir site. A number of samples were also taken of resin from the keel and the wale.

The area of excavation was broadened in the course of this investigative campaign to an area extending beyond the ship's structure in trenches C19 and C20, parts of which were excavated last year. The scale of the work required to clean and fully investigate the ship's structure has, however, meant that again this year these trenches were not fully excavated, and work will continue in the coming year. Notwithstanding these challenges we did identify a significant number of wooden elements of the ship's structure in these trenches, which wound up here after the ship sank, likely as it broke against the antique period quay. And while we cannot in this early phase confidently identify these elements, there are indications that these may be elements of upper parts of the ship—very rare finds at underwater sites. Notable are element E38, with part of a squared hole, and element E25, part of a frame with an upper bitt, which was extracted from

Tijekom istraživanja su označeni i neki elementi unutar broda koji do sada nisu imali oznaku tako da su oni dobili oznake E. Ponovo su uzeti svi uzorci drva sa svih elemenata budući da je prošlih godina tijekom analiza vrste drva došlo do rezultata koji nisu bili konzistentni za pojedine elemente. Ukupno je uzeto 119 uzoraka tijekom istraživanja, a dio uzoraka koji su ove i prethodnih godina izvađeni će također biti analizirani. Uzorci drva biti će poslani na analizu u Francusku u tvrtku Ipso Facto koja ima stručnjake za analizu antičkog drva koji su sudjelovali na istraživanju na Barbiru. Osim tih uzoraka uzeto je i nekoliko uzoraka smole s kobilice i bokoštitnice.

Tijekom istraživanja iskop je proširen i na jednom dijelu izvan brodske konstrukcije u sondama C19 i C20 koje su dijelom bile iskopavane prošle godine. Nažalost radi opsega velikog posla na istraživanju i čišćenju brodske konstrukcije one nisu ni ove godine iskopane do kraja te će se iskop nastaviti sljedeće godine. Ipak je u tim sondama otkriven čitav niz drvenih elemenata brodske konstrukcije koji su na ovo mjesto završili nakon potonuća broda uslijed njegovog vjerojatnog razbijanja u antičku rivu. Iako je još rano da bi se definirali koji su to elementi, naznake su da se radi o elementima gornjeg dijela broda koji se iznimno rijetko nalaze na podvodnim nalazištima. Možemo izdvojiti element E38 s dijelom kvadratne rupe ili E25 koji je dio rebra s gornjom bitvom i koji je izvađen. Svi ovi elementi će nam u konačnici pomoći da nadopunimo saznanja o originalnom izgledu broda i dati smjernice u njegovoj konačnoj rekonstrukciji.



8. Wooden find with grooves found under the stringer / Drveni nalaz s utorima nađen ispod proveze (Photo: M. Kaleb)

the site. These elements will ultimately complement our understanding of the ship's original appearance and guide us in developing a final reconstruction.

As the focus of our efforts this season was on the interior of the ship only a small number of artefacts were identified. Most of these were found in trenches C19 and C20, including sherds from amphorae, coarse ware, and fine ware, lead plummets, and bronze and iron nails from the ship's structure.

Certainly the most interesting find is a wooden element of biconical form with multiple notches all over. It was found in the interior of the ship, between frames FT21 and FT22 and under stringer designated COS. Its function has not yet been ascertained, but we see that it has a deep interior recess and that, in use, it may have been set on some form of receiving end.

Completion of this investigative work has provided us with sufficient data for further work on the digital reconstruction of the ship. We look forward to this next phase in our work, which will ultimately result in a model of this antique period ship.

9. Night documentation / Noćna dokumentacija (Photo: M. Popek)

Tijekom ovogodišnjih istraživanja otkrivena je manja količina pokretnih arheoloških nalaza s obzirom da je većinu vremena istraživanje bilo koncentrirano na unutrašnji dio broda. Veći dio nalaza definiran je u sondama C19 i C20. Najveću količinu nalaza čine fragmenti amfora i grubog ili finog posuđa, olovnice te brončani i željezni čavli koji pripadaju brodskoj konstrukciji.

Svakako je najzanimljiviji nalaz drveni element bikoničnog oblika s višestrukim urezima po cijelom tijelu. Nađen je u unutrašnjosti broda, između rebara FT21 i FT22 ispod proveze oznake COS. S unutrašnje strane je šupalj te izgleda kao da je bio nataknut na nešto, ali njegova funkcija je još nepoznata.

Po završetku istraživanja prikupljeno je dovoljno podataka za daljnji rad na digitalnoj rekonstrukciji broda čime ulazimo u novu fazu i veselimo se daljnjim radovima koji će u konačnici rezultirati modelom antičkog broda.

10. Ortophoto of the final stage / Ortofotografija završnog stanja (Photo: A. Divić)

CAPE FRANINA INVESTIGATION IN ITS FIFTH YEAR

PET GODINA ISTRAŽIVANJA KOD RTA FRANINA

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1. Detail of a stopper in the ship's wooden structure / 1. Detalj čepa na drvenoj konstrukciji broda (Photo: M. Kaleb)

This year saw the fifth investigative campaign at the Cape Franina wreck site near Premantura, an effort led and managed by the International Centre for Underwater Archaeology in Zadar. This year's site team of ICUA Zadar specialists Luka Bekić PhD, Roko Surić, Maja Kaleb, and Šime Vrkić, Mladen Pešić were joined by Borna Krstulović, Tomas Kiss, Andrea Kiss, Đani Iglić, Borut Slokan, Kaia Post, Marko Hralinović, and Massimo Capulli. This archaeological investigation is funded through the Croatian ministry of culture and media, with logistical support provided by the Indie diving centre in Banjole.

This year the team of archaeologists and divers investigated what is to date the broadest area of seabed, successfully documenting a number of new trenches. The fifth season saw the archaeological component improving productivity and functionality by implementing a range of technical innovations and adaptations. One of the key such advances is the use of a mooring grid with spikes. This allows a research vessel to remain directly

Ove godine provedena je peta istraživaćka kampanja na ostacima brodoloma kod rta Franina blizu Premanture. Istraživanjima rukovodi Međunarodni centar za podvodnu arheologiju u Zadru. U istraživanju su ove godine sudjelovali stručnjaci arheolozi doc. dr. sc. Luka Bekić, Roko Surić, Maja Kaleb, Šime Vrkić, Mladen Pešić (MCPA Zadar). Ostali članovi radne ekipe su bili Borna Krstulović, Tomas Kiss, Andrea Kiss, Đani Iglić, Borut Slokan, Kaia Post, Marko Hralinović i Massimo Capulli. Istraživanja financira Ministarstvo kulture i medija RH, a logističku potporu pružio je ronilački centar Indie u Banjolama.

Ove godine je arheološka i ronilačka ekipa na nalazištu Franina istražila dosada najveću površinu i uspješno dokumentirala nekoliko novih sondi. Nakon pet godina istraživanja kod rta Franina, arheološka ekipa je uspjela podići razinu produktivnosti i svoje funkcionalnosti putem raznih tehničkih inovacija i prilagodbi. Jedno od najvažnijih je sidreno polje s klinovima, koje omogućava sidrenje broda izravno iznad nalazišta. Time se omogućava rad i prilikom ne tako povoljnih vjetrova i podiže razina sigurnosti ronilaca, koji tako mogu izroniti bliže brodu. Druge prilagodbe odnose se na ronilačku opremu i vrijeme ostanka na dnu, koje je sada standardizirano za cijelu radnu ekipu, čime se povećao broj radnih sati i sigurnost ronilaca.

Po dolasku na nalazište prvo su postavljeni konopi za sidrenje broda i obnovljene dokumentacijske fiksne točke oko nalazišta. Potom su postavljene prve sonde. S obzirom da se prošle godine zastalo s istraživanjem sonde K, ovaj puta su sonde postavljene zapadno i istočno od nje, i nazvane sonda J i L. One su imale za cilj pojasniti stanje u toj sondi i proširiti iskopani koridor. U sondi J pronađena je vrlo dobro očuvana drvena konstrukcija broda, koja se prostire na gotovo čitavu

above the site and for work to continue when winds are less favourable, improving diver safety as they can now ascend closer to the vessel. Other adaptations relate to diving equipment and the amount of time divers spend at depth, now standardised across the whole of the team, which increases working hours while improving diver safety.

The first task upon arrival was to set up anchoring cables and renew the site's documentation fixed points. This was followed by setting out the first trenches. Given that last year's campaign closed during the investigation of Trench K, this time trenches designated J and L were set out to the west and east of it. The objective was to learn more about the situation in that trench and widen the excavated corridor. Very well-preserved remains of the ship's wooden structure were identified across almost the entire length and breadth of Trench J. A significant number of artefacts were identified, including potsherds. Trench L was also entirely excavated, but revealed only a small part of the wooden structure to the west and north end. The stratum is sandy, mixed with stone and bricks. The layer of sediment here is not of the expected thickness, with an archaeologically sterile geological layer of stones appearing thirty centimetres below the seabed surface.

The excavation work was expanded to additional

2. One of the deadeyes upon recovery from the sea / Jedna od bigota nakon izvlačenja iz mora (Photo: R. Surić)

sondu. Tu je pronađeno i dosta sitnijih nalaza poput keramičkih ulomaka. Sonda L je također iskopana u cijelosti, a drvena konstrukcija je u njoj vidljiva samo na manjem dijelu, zapadno i sjeverno. Sloj je pješčani, pomiješan s kamenom i opekama. Sloj sedimenta nije debljine koju smo očekivali, te tako geološki sloj kamenja počinje već na 30 cm dubine, a ispod kojeg se ne mogu naći arheološki nalazi.

Iskopavanje je prošireno na dodatne sonde, R, U, I, T i H. Sonda R i U nalaze se istočno od sonde L i u njima nisu zabilježeni ostaci drvene konstrukcije. Međutim pronađeni su poneki sitni nalazi i željezni konglomerati. Sediment nije bio posebno dubok u ovom dijelu, brzo se nailazi na čvrsto sabijeni sloj lomljenog kamena i školjaka, koji je arheološki sterilan.

Sonda I postavljena je zapadno od istražene sonde J i njome se htjela definirati situacija oko zapadnog topa. To je obavljeno, ali sonda nije dovršena prema zapadu, pa će se to trebati nastaviti. S obzirom na nalaze bigota i konopa u sondi E, postavljena je sonda T, zapadno od nje. I u njoj je pronađeno pet bigota i više pojedinačnih nalaza. Također je na sjeveroistoku sonde T pronađeno i bolje očuvanih dijelova brodske konstrukcije, pa će biti potrebno nastaviti iskopavanje u ovom smjeru i definirati ove ostatke.

Širenje istraženog područja bilo je poduzeto i u jugoistočnom smjeru. Tako je istočno od nekadašnje sonde B otvorena sonda H, koja je u potpunosti istražena. U njoj nije bilo drvenih dijelova, a ni mnogo pojedinačnih nalaza. Na osnovu rezultata iskopavanja ovih sedam sondi, očito je da naglasak na iskopavanju mora biti prema zapadu i sjeveru.

Tijekom iskopavanja 2025. godine otkriveni su zanimljivi dijelovi konstrukcije i opreme broda. Nastavno na dosadašnja istraživanja i položaj ostataka drvene brodske konstrukcije, istražene su sonde J i I, u kojima je drvo najbolje sačuvano.

Sonda J dala je najbolje rezultate jer se drvo proteže preko gotovo cijele njezine površine. Pronađeni su dijelovi gornje oplate, rebrenih nastavaka i vanjske oplate broda, zajedno s elementima za spajanje – drvenim čavlima i metalnim klinovima. Drveni čavli gotovo su uvijek sačuvani unutar strukture drvene konstrukcije, dok se metalni klinovi pronalaze u obliku konglomerata i na mjestima gdje drvo nije sačuvano. Posebno se ističe zanimljiv detalj – čep s olovnom pločicom u obliku obruča, koji zatvara rupu (moguće namijenjenu odvodu vode).

U sondi I drvo je sačuvano samo u jugoistočnom dijelu sonde, ispod zapadnog topa. Tijekom istraživanja 2025.

trenches, designated R, U, I, T, and H. Trenches R and U are to the east of Trench L and did not yield remains of the wooden structure. What was identified were sporadic artefacts and iron conglomerates. The sediment was not particularly deep here and excavation quickly reached a firmly packed and archaeologically sterile layer of broken stone and shells.

Trench I was set to the west of Trench J and aimed to determine the situation around the west cannon. This was achieved, but work here was not completed towards the west end, and will require further excavation. Trench T was set out to the west of Trench E where a deadeye and rope from the ship's rigging had previously been recovered. Five deadeyes and a number of other finds were found in the new trench. Also found in the northeast end of Trench T were well-preserved parts of the ship's structure; identifying them will require further excavation in this direction.

The investigation area was also broadened to the southeast. Trench H was excavated and fully investigated to the east of previously dug Trench B. It yielded no wooden remains and few artefacts. What we have found in these seven trenches makes it evident that our focus in

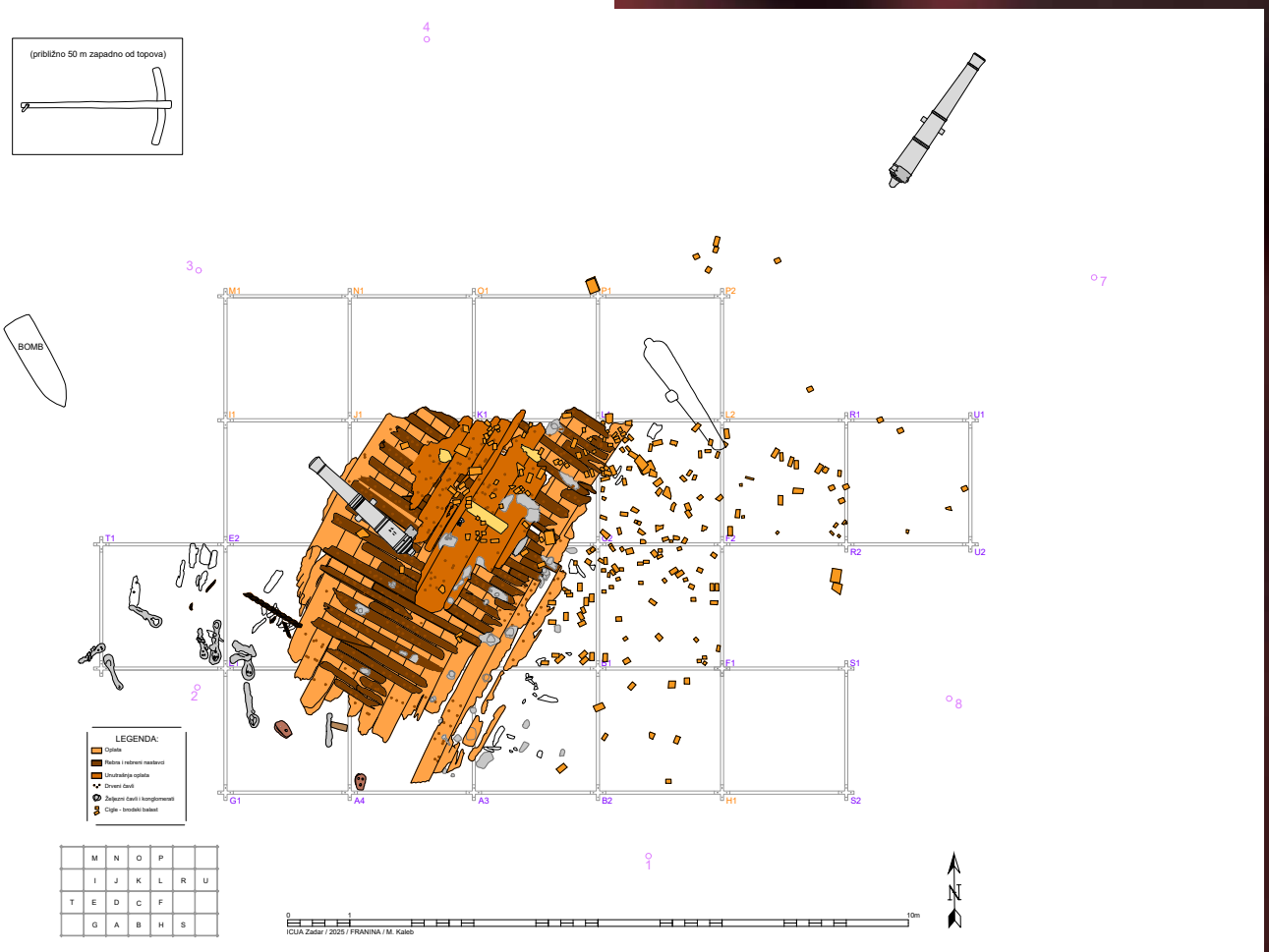
godine topovi nisu pomicani, što je znatno otežalo dokumentiranje brodske konstrukcije ispod topa.

Osim same brodske konstrukcije, pronađeni su i dijelovi brodske opreme. Posebno se ističu novi nalazi bigota. Riječ je o drvenim elementima koji se uglavnom pojavljuju u paru. Karakteriziraju ih tri rupe te utor na bočnoj strani. Ovisno o položaju, u utoru se može nalaziti konop – tada je riječ o gornjoj bigoti – ili metalna traka, u kojem je slučaju riječ o donjoj bigoti. Njihova je osnovna funkcija osiguravanje čvrstoće i stabilnosti jarbola, pri čemu se po potrebi zatežu konopi (pritezi).

Ovogodišnjim iskopavanjem pronađeno je ukupno šest bigota u dvije dimenzije. Brojnije su bigote koje se, prema svojem položaju, nalaze niže na brodu, odnosno one kod kojih se u bočnom utoru nalazi metalna traka kojom su povezane s trupom broda. Sve bigote imaju tri gotovo jednaka otvora s jasno vidljivim tragovima trošenja. Pronađene su u novootvorenoj sondi T na zapadnom dijelu nalazišta te tijekom revizijskog iskopavanja sonde E. Sve bigote nalazile su se izvan same brodske konstrukcije, u pješčanom sedimentu. Također su pronađeni i manji fragmenti konopa, što ne iznenađuje s obzirom na kontekst ostalih nalaza unutar sondi.

Istraživanja provedena 2025. godine upotpunila su sliku o ostacima drvene brodske konstrukcije i opremi broda na

3. A drawing showing the wooden elements and ship's fittings identified to date / Nacrt dosada pronađenih drvenih elemenata i opreme broda (By: M. Kaleb)



further excavation should be to the west and north.

Excavations in 2025 revealed interesting sections of the ship's structure and fittings. Continuing on the work to date and the known positions of the surviving wooden structure, we excavated Trenches J and I, where the wood has survived to the greatest degree.

Trench J yielded the best results, with surviving wood present across almost the whole of the trench. Uncovered sections include parts of the upper planking, futtocks, and outer planking, along and joining elements (treenails and metal spikes). Treenails have almost always survived within the wood, while metal spikes are identified as conglomerates at places where the wood has not survived. Especially notable is a stopper with a lead plate in the form of a hoop that plugs a hole, possibly used for water drainage.

Surviving wood identified in Trench I was limited to the southeast end of the trench, below the west cannon. The cannons were not moved in the course of work in 2025, which significantly slowed documentation of the sections of the ships structure below the cannon.

Besides the structural elements, our work also revealed some of the fittings. Especially notable are the finds of deadeyes. These wooden elements usually appear in pairs. They have a characteristic arrangement of three holes and a groove along the outside edge. We find rope at the top deadeye or a metal strap in the lower deadeye. They were part of a system that held in place and stabilised the mast, with lanyards tightened as required to tension the system.

4. The find of a brass plate, SF277, in situ / Nalaz mjedenog tanjura PN 277 *in situ* (Photo: Š. Vrkić)

This season's excavation work saw the recovery of six deadeyes in two sizes. The more numerous are the lower

lokalitetu Franina, no tek će buduće kampanje omogućiti jasniju predodžbu o dimenzijama, tipu i izgledu broda.

U ovogodišnjoj kampanji nije pronađen velik broj pojedinačnih nalaza. Najvažniji su nalazi bigota, koje su služile kao oprema broda. Uz njih, prikupljen je veći broj masivnih željeznih konglomerata, koji su u ovom trenutku neprepoznatljivi, ali će se nakon pregleda rendgenom o njima moći reći nešto više. Ostali nalazi su standardni kao i prošlih godina. Pronađene su male staklene perlice i dijelovi crvenih staklenih zdjelica. Ulomci keramike su brojni, ali su sitni.

Kao novi nalaz valjalo bi zabilježiti veliki mjedeni tanjur nepoznate namjene (PN 277) i veće drveno šilo (PN 280). Najzanimljivija je opeka koja na sebi ima urezani oblik kositrene žlice (PN 313) kakve su korištene u 16. st. Pretpostavlja se da je to postolje za kalup u kojem bi se takve žlice mogle lijevati. Svi novopronađeni nalazi su u laboratoriju MCPA u Zadru, gdje prolaze kroz proces desalinizacije.

5. Part of an astronomical compendium / Dio astronomskog kompendija (Photo: Š. Vrkić)

No najvažniji nalazi su ove godine otkriveni u konzervatorskoj radionici u Zadru. Iz željeznih konglomerata koji su prikupljeni proteklih godina i pregledani rendgenom, izvučeni su zanimljivi nalazi. Najvažniji je kolut navigacijskog uređaja s urezanim oznakama. On se nalazio duboko u masivnom željeznom konglomeratu i prije rendgenskog pregleda nije bio vidljiv. Čišćenjem se otkrio njegov oblik i oznake, a po svemu sudeći pripada nekom džepnom astronomskom kompendiju.

U sličnom konglomeratu je otkriven i jedan mletački

deadeyes, those with a metal strap encompassing the wooden body whereby they were connected to the ship's hull. All the deadeyes have three almost identical holes with clear signs of wear. They were recovered from newly excavated Trench T in the west part of the site, and in the course of re-excavation of Trench E. All were found in sandy sediment away from the body of the surviving ship's structure. Small fragments of rope were also found, which is not surprising given the context established by other finds made in the trenches.

The 2025 campaign has broadened our understanding of the wooden structure and fittings of the Franina wreck. It will require future campaigns, however, to develop a clearer picture of the ship's dimensions, type, and appearance.

This season saw few finds of individual artefacts. The most significant are the deadeyes, part of the ship's fittings. A number of massive iron conglomerates were also collected. The original form is now unrecognisable and radiographic imaging will be needed to reveal any details. Other finds include the kinds of artefacts already recovered in previous seasons, including small glass beads and fragments of small bowls of red glass. Potsherds are numerous but highly fragmented.

A new find is a large brass plate (SF277) of unknown purpose, and a large wooden handle awl (SF280). A notable find is a brick (SF313) into which a pattern has been cut of a tin spoon of the kind used in the sixteenth century. This is likely the base of a mould used to cast spoons of this type. All of the new finds are undergoing desalination at the ICUA laboratory in Zadar.

The most significant finds this year were made at the ICUA conservation workshop in Zadar. Fascinating artefacts were extracted from iron conglomerates recovered in previous seasons and examined using radiography imaging. The most notable of these is the

7. Detail of the portable long gun barrel / Detalj cijevi puške (Photo: L. Bekić)

bakreni novac. To je kovanica tipa sesino (doppio quattrino), kovana za vrijeme vladavine dužda Pasquala Cicogne (1585. – 1595.) Natpis na novcu se čita: SANCTVS M(ARCVS VENETVS), a s druge strane PAS(C CI)CONIA DUX VEN + (Palucci#19). Datacijski ovaj novac odgovara i trubama koje po urezanoj godini 1599. smještaju naš brodolom u sam kraj 16. st.

Iz konglomerata su izvučene i tri topovske kugle različitih kalibara. Jedna od njih ima četvrtastu rupu kroz koju je prolazila željezna šipka. Ta šipka povezivala ju je s drugom kuglom. Takvi dvostruki projektili su uglavnom korišteni za uništavanje neprijateljskog jedrilja.

Također je važan nalaz puške tipa arkebuza. Ona je otkrivena tako da je u prazninu unutar konglomerata željezne korozije ulivena tekuća guma, koja je po sušenju oblikovala nestali predmet. Ova arkebuza je imala cijev osmerokutnog presjeka i dužinu od oko 98 cm. Kalibar otvora cijevi je vjerojatno oko 16-17 mm, što odgovara brojnim olovnim zrnima već prije pronađenim na Franini.

6. Cannon round shot with a hole intended to take an iron connecting rod / Topovska kugla s rupom za željeznu spojnicu (Photo: L. Bekić)

U 2025. godini nastavljeno je praćenje konzervatorskog stanja dva željezna topa, zapadnog i sjevernog, koji su u prethodnim godinama zaštićeni metodom katodne zaštite uz pomoć žrtvenih aluminijskih anoda. U tu svrhu izmjereni su korozijski potencijali topova koji su za zapadni top iznosili između -0.861 i -0.866 V, a za sjeverni top između -0.787 i -0.837 V, mjereno referentnom elektrodom Ag/AgCl. Izmjereni potencijali pokazuju da katodna zaštita uspješno funkcionira već petu godinu za redom, odnosno da se topovi nalaze u stanju imunizacije bez ikakvih naznaka korozijskog djelovanja.

8. Distribution of individual finds made in this season's campaign / Raspored pojedinačnih nalaza pronađenih u ovoj kampanji (By: M. Kaleb)

ring of a navigation device with incised marks. It had been encased deep within a massive iron conglomerate and had not been visible prior to radiographic imaging. Cleaning revealed the form and markings; it was most likely part of a portable astronomical compendium.

A Venetian copper coin was found in a similar conglomerate. This was a sesino (doppio quattrino) coin, struck under the doge Pasquale Cicogna (1585–1595). The legend reads SANCTVS M(ARCVS VENETVS), and PAS(C CI)CONIA DUX VEN + to the other side (Paolucci 19). The date of this coin is consistent with the recovered trumpets, where the incised year 1599 puts this wreck at the close of the sixteenth century.

Also extracted from conglomerates were three cannonballs (round shot) of various diameters. One had a squared holed into which an iron rod was introduced. This rod would connect it to another such ball. This doubled "bar shot" was used primarily to destroy enemy sails and rigging.

Another important find was a portable long gun of the arquebus type. It was revealed by pouring liquid rubber into a cavity in a conglomerate of iron corrosion products which, when dry, revealed the form of the missing artefact. This arquebus had a barrel about 98 centimetres long with an octagonal outer cross-section. The barrel calibre

U 2025. godini zamijenjene su aluminijske anode koje su postavljene 2021. godine na zapadnom topu. Prijašnje anode težile su svaka po 4 kg, a do 2025. godine u anodnim reakcijama potrošeno je 85% njihove prvotne mase. Veća potrošnja anodnog materijala u odnosu na prvotne kalkulacije nalazi se u činjenici da je nalazište na rtu Franina pod jakim utjecajem morskih struja koje sa sobom nose veću količinu otopljenog kisika koji je glavni uzročnik ubrzane korozije. Stoga su u 2025. godini postavljene aluminijske anode veće mase, od 5 kg koje bi zapadni top morale uspješno štititi tijekom sljedećih 5 godina.

Naravno, tijekom redovitih monitoringa nalazišta, nastavit će se pratiti stanje potrošnje anoda i pravovremeno reagirati u slučaju ranije potrebe za zamjenom anodnog materijala.

Primjenom metode katodne zaštite zaustavljena je daljnja degradacija željeznih topova. Ovim eksperimentalnim projektom uspješno je povezana potreba precizne arheološke dokumentacije topova koja je bila moguća nakon uklanjanja korozivnih naslaga i inkrustacija s površine topova kao i konzervatorska potreba za trajnom zaštitom i očuvanjem izvornog izgleda novovjekovnih topova. Također, premda se u literaturi navodi da anode izrađene od aluminija ne funkcioniraju ukoliko su blago ukopane u pijesak, primjenom katodne zaštite na Franini dokazano je suprotno. Aluminijske anode povezane na topove ukopane su u pijesak i već petu godinu za redom uspješno funkcioniraju.

was likely about 16 to 17 millimetres, which is consistent with the many specimens of lead shot already recovered at the Franina site.

2025 saw continued monitoring of the state of conservation of two iron cannons, the west and north cannon, where cathodic protection was previously installed using aluminium sacrificial anodes. To this end measurements were taken of corrosion potentials, with readings for the west cannon ranging from −0.861 to −0.866 V, and for the north cannon from −0.787 to −0.837 V, as measured against an Ag/AgCl reference electrode. The measured potentials indicate that cathodic protection is functioning successfully for the fifth successive year, i.e., that the cannons are now in a state of immunity with no signs of corrosion activity.

The aluminium anodes installed at the west cannon in 2021 were replaced in 2025. The first anodes each weighed four kilograms and 85% of their initial mass had been consumed by anodic reaction by 2025. The greater rate of anode consumption versus the original calculations can be accounted for by the strong marine currents at the Cape Franina site, bringing more dissolved oxygen—the primary factor leading to accelerated corrosion. In 2025, therefore, aluminium anodes of greater mass, five kilograms, were installed, which should successfully protect the west cannon for the next five years.

Regular site monitoring will, of course, continue to observe the status of anode consumption and take timely action if there is a need for early replacement of the anode material. Implementation of cathodic protection has halted further degradation of the iron cannon. This experimental project has successfully met the requirement of precise archaeological documentation of the cannons, made possible by the removal of corrosion deposits and incrustations from their surfaces, and the conservation imperative of providing lasting protection and preserving the original appearance of these post-medieval modern cannons. Beyond that, the implementation of cathodic protection at the Franina site clearly contradicts the existing literature, which contends that aluminium anodes do not function if they are slightly buried in sand. The aluminium anodes connected to the cannons at the Franina site are buried in sand and have been functioning successfully for the fifth year in a row.

Investigative work at the Franina site was accompanied by parallel surveying of the Paltana cove in Banjole. This cove saw a continued search for the locality at which remains of rare small Spatheion 3D amphorae and *tubi fittili* type ceramic tubes were found a few years ago, for the most part in 2022. Other finds at the cove include sporadic sherds of other late period amphorae such as

Paralaleno s istraživanjem kod Franine, provodi se i pregled uvale Paltana u Banjolama. Tamo je nastavljena potraga za mjestom na kojem su se unazad nekoliko godina, uglavnom 2022. g., pronalazili ostaci rijetkih malih amfora tipa *Spatheion 3D* i cijevi *tubi fittili*. Osim tih nalaza, tu se mogu pronaći i poneki ulomci drugih kasnih amfora poput LRA 1 i tuniskih proizvoda. Pretpostavka je da se na ovom mjestu nalaze amfore koje su izbacili ribari kočari, koji negdje ispred zapadne obale Istre vuku svoje mreže preko brodoloma s tim predmetima. Mogućnost da je brodolom usred uvale Paltana je mala, ali ni to ne treba isključiti.

S obzirom da je središnji dio uvale vrlo mutan, a dno zamuljeno, teško je uočiti predmete na dnu. No ove godine uspjeli smo ponovno naići na jednu amforicu Spatheion 3D, pa smo položaj označili i uzeli mu GPS poziciju. Amforica je nađena na 6,5 metara dubine, pa će se u narednim kampanja probati ustanoviti ima li ovo nalazište ima neki veći potencijal.

Nalazište Franina i dalje pokazuje svoj istraživački potencijal i kraj istraživanja još nije na vidiku. Brojnim analizama došli smo do zaključaka da je riječ o većem brodu, vjerojatno oko 30 metara dugom. Stoga je i površina koju bi trebalo istražiti očito mnogo veća nego što se očekivalo. Mada je nalazište površinski temeljito opljačkano, netaknuti dijelovi sedimenta ipak pružaju dovoljan broj nalaza koji svjedoče o brodu i njegovom teretu. Zbog mnogih indicija, vjerujemo da je riječ o brodu koji je plovio i izvan Sredozemlja i da bi to mogao biti nizozemski brod koji je plovio na trgovačkoj ruti između Venecije, Levanta i nizozemskih luka krajem 16. st. U suradnji s kolegama iz Nizozemske započeli smo i s povijesnim i arhivskim istraživanjima kako bi bolje objasnili arheološke nalaze koje smo do sada prikupili. Istraživanja se nastavljaju naredne godine.

▶ 9. A small Spatheion 3D amphora found in the Paltana cove / Amforice Spatheion 3D skupljene na jednom mjestu u uvali Paltana (Photo: L. Bekić)

LRA 1 and Tunisian products. What seems most likely is that the amphorae found here were deposited by fishermen operating trawlers whose nets passed over a wreck with these artefacts somewhere off the west coast of Istria. The possibility that there is a wreck in Paltana cove is small, but cannot be entirely ruled out.

The water at the middle of the cove is very murky and the bottom silty, making identifying objects on the seabed challenging. We were, however, successful this year in finding one Spatheion 3D amphora, marking the findspot and taking its GPS position. This small amphora was recovered at a depth of six and a half metres, and future campaigns will aim to determine if the locality has greater archaeological potential.

The Franina site continues to demonstrate its potential and the end of our investigative work is not yet in sight. The analyses indicate that this was a large ship, likely about thirty metres from bow to stern. This means that the area to be investigated is clearly much greater than expected. Although the surface of the site has been thoroughly looted, the untouched parts of the sediment still offer a quantity of finds that are informative as to the ship itself and its cargo. There are numerous indicators that lead us to believe that this ship sailed outside Mediterranean waters; that it might have been a Dutch ship plying the commercial route between Venice, the Levant, and Dutch ports of the late sixteenth century. In collaboration with our colleagues from the Netherlands we have initiated historical and archival research that might shed more light on the archaeological finds collected to date. The investigative work will continue in the coming year.

Bibliography / Literatura:

Bekić, L. 2020. - Shipwreck with cannons at Franina cape / Brodolom s topovima kod rta Franina, *Submerged Heritage / Potopljena baština* 10, 25-31.

Bekić, L. 2021. - The systematic investigation of a wreck with cannons off the Franina cape / Sustavno istraživanje brodoloma s topovima kod rta Franina, *Submerged Heritage / Potopljena baština* 11, 13-19.

Bekić, L. 2022. - A Remarkable Discovery at the Cape Franina Wreck Site / Izvanredno otkriće pri istraživanju brodoloma kod rta Franina, *Submerged Heritage / Potopljena baština* 12, 16-23.

Bekić, L., Kaleb, M., Surić, R., Vrgoč, Z. 2022. - Ein außergewöhnlicher Fund, das Schiffswrack bei Kap Franina, *Skyllis* 22, 20-26.

Bekić, L., Kaleb, M., Surić, R., Vrgoč, Z. 2023. - 2023 Franina Wreck Site Investigation with Find of Trumpets / Istraživanja brodoloma s trubama kod Franine 2023. godine, *Submerged Heritage / Potopljena baština* 13, 19-27.

Bekić, L., Kaleb, M., Surić, R., Vrgoč, Z. 2024. - Valuable New Finds From The Franina Cape Wreck Investigation / Novi vrijedni nalazi pri istraživanju brodoloma kod rta Franina, *Submerged Heritage / Potopljena baština* 14, 13-24.

10. Some of the members of the 2025 Franina investigative team, from the left: / Dio radne ekipe Franina 2025, s lijeva: Luka Bekić, Roko Surić, Tomas Kiss, Šime Vrkić, Marko Hranilović, Andrea Kiss, Maja Kaleb, Borut Slokan, Massimo Capulli, Robert Lehotkai, and Lucrezia Maghet (Photo: E. Kamerla)

THE NGOMENI SHIPWRECK

AJALI YA MELI YA VASCO DA GAMA ENEO LA NGOMENI, MALINDI, KENYA

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1. Location / Eneo (Google Maps)

Starting with Vasco da Gama's voyage to India, in 1497-1499, Carreira da India was a maritime trade route between Portugal, the Indian Subcontinent, and Asia in general, a major development in the history of world commerce, and a fast, large capacity and regular connection between two worlds previously connected only by travelers, circumventing by the sea the many political barriers between them. During the reign of king Manuel I (1495-1521) this maritime trade route linked Europe and Asia with goods, men and the ideas they carried.

The discovery of a 16th-century Portuguese shipwreck in Ngomeni, near Malindi, Kenya, on the Swahili coast, triggered the study of the Portuguese ships that sailed in the India Route. It is possible that the ship found at Ngomeni could be the *São Jorge*, from Vasco da Gama's third armada, lost in 1524 en route to India, and likely one of the earliest examples of a Portuguese galleon, a type of warship introduced by the Portuguese state from 1518 onwards (Pissarra 2012; 2016). Two shipwrecks occurred in this area, making the identification difficult, at least for the time being. The first was the ship *São Jorge*, from the third Armada of Vasco da Gama, lost on its way to India, in 1524, and the second was the nau *Santa Maria da Graça*, lost in the same area in 1544.

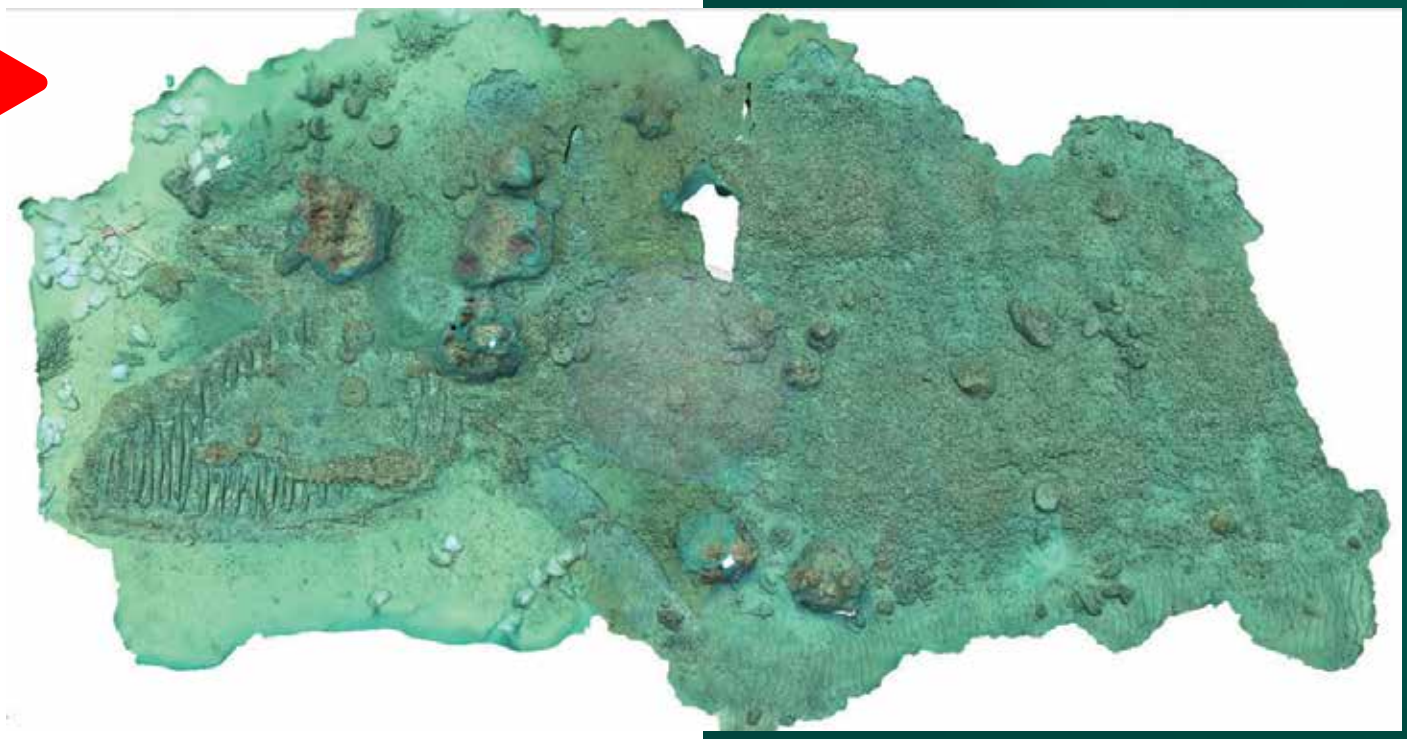
Muhtasari

Mojawapo ya Meli za enzi ya Vasco da Gama ni ile ya Ngomeni iliyozama karibu na pwani ya Malindi, nchini Kenya, eneo ya Ras Ngomeni kwenye kina cha kati ya mita 5 hadi 7. Meli hii ilitangazwa kwa makumbusho ya kittaifa ya Kenya, Malindi na wavuvi wa Ngomeni mwaka wa 2007. Huenda meli hiyo baada ya kuzama iliendelea kuokolewa tangu kupotea kwake, na hakika iliendelea kuporwa. Watafiti walianzisha mradi wa akiolojia wa jamii huko Ras Ngomeni, na waliwafunza wakazi kazi kadhaa na kwa sasa wanachimba eneo hilo kwa nia ya kuunda kituo cha makumbusho na tafsiri ili kuwaleta wageni Ras Ngomeni, kuunda ajira na kukuza uchumi wa eneo hilo huku wakiunda kituo cha kujifunzia kuhusu meli iliyozama na hadithi yake katika muktadha wa hadithi ya Pwani ya Swahili.

Utangulizi

Kuanzia na safari ya Vasco da Gama kwenda India, mnamo 1497-1499, Carreira da India ilikuwa njia ya biashara ya baharini kati ya Ureno, Bara Ndogo la India, na Asia kwa ujumla, maendeleo makubwa katika historia ya biashara ya dunia, na uwezo mkubwa na muunganisho wa haraka, mkubwa na wa kawaida kati ya bara mbili ambazo

2. Ras Ngomeni / Ras Ngomeni Ras Ngomeni (Photo: S. Kellersohn)



3. Plan of the hull exposed / Muundo wa sehemu ya chini ya meli ulio wazi (By: B. Frabetti)

The nau or galleon *São Jorge*, under captain Fernando de Monroy, was part of the third Armada of Vasco da Gama, which encompassed 15 ships and carried around 3000 men. It was charged with ambitious and important tasks. *São Jorge* was lost on the shallows of Malindi, probably the area that is now Ngomeni, about 30 Km from Malindi (Bita 2018). It's cargo included 139 galley oars. The nau *Santa Maria da Graça*, was lost while sailing to India in the Armada of Fernão Peres de Andrade, which was composed of five ships, with Fernão Peres de Andrade in the nau *Espera*, Luiz de Calatayud in the nau *Santo Espírito*, Jácome Tristão in *São Filipe*, in a second attempt, after being forced to abort and return to Lisbon in the previous year, Simão Peres de Andrade in *Burgalesa*, and Simão de Melo in *Graça*, which was lost at Baía Formosa, five leagues from Malindi, a description that coincides with the Ngomeni area. Both the cargo and the people were salved.

4. The Ngomeni shipwreck / Mabaki ya meli ya Ngomeni (Photo: S. Kellersohn)

hapo awali ziliunganishwa na wasafiri pekee, wakiepuka vizuizi vingi vya kisiasa kati yao kando ya bahari. Wakati wa utawala wa mfalme Manuel I (1495-1521) njia hii ya biashara ya baharini iliunganisha Ulaya na Asia kwa bidhaa, watu na mawazo mapya.

5. Aspect of the shipwreck / Muonekano wa mabaki ya meli (Photo: S. Kellersohn)

6. Cleaning the shipwreck / Kusafisha mabaki ya meli (Photo: S. Kellersohn)

The Ngomeni ship ran ashore in front of a small creek and the village of Ras Ngomeni. The coast is not densely inhabited and the site is not frequently visited. The coast around the shipwreck is a fossil coral reef. Protected by a mangrove, this section of the coast has nevertheless changed fast in the last century, and it is likely that its present configuration is different from the landscape Portuguese seamen encountered 500 years ago.

It is difficult to interpret the documental evidence pertaining to location of these shipwrecks. After 1498 Portuguese ships visited the Swahili coast, both to trade and replenish their stores. These contacts were vital to the *Carreira da India*, the round voyage between Lisbon and the Indian subcontinent. The ships lost along this coast form an

7. Cinnabar / Mdalasini (Photo: C. Bita)

Ugunduzi wa meli ya Ureno ya karne ya 16 huko Ngomeni, karibu na mji wa Malindi, Kenya, kwenye pwani ya Swahili, ndio uliosababisha utafiti wa meli za Ureno zilizosafiri katika njia ya India. Inawezekana kwamba meli hii ya Ngomeni ikawa ndio ile ya São Jorge, ambayo ilikuwa majawapo ya meli ziliokuwa kwenye msfara wa tatu wa Vasco da Gama, iliopotea mwaka wa 1524 njiani kuelekea India, na pengine mojawapo ya mifano ya mwanzo ya meli za Kireno, aina ya meli za kivita zilizoletwa na serikali ya Ureno kuanzia mwaka wa 1518 na kuendelea (Pissarra 2012; 2016). Meli mbili za Kireno zilipotelea katika eneo hili, na hii imefanya utambuzi kuwa mgumu, angalau kwa wakati huu. Ya kwanza ilikuwa meli ya São Jorge, kutoka kwa msafara wa tatu wa safari ya Vasco da Gama, iliyopotea njiani kuelekea India, mwaka wa 1524, na ya pili ilikuwa nau Santa Maria da Graça, iliyopotea katika eneo hilo hilo mwaka wa 1544.

Meli ya São Jorge, chini ya nahodha Fernando de Monroy, ilikuwa mojawapo ya meli kwenye msafara wa tatu wa Vasco da Gama, ambao ulijumuisha meli 15 na kubeba takriban wanaume 3000. Ilikabidhiwa majukumu makubwa na muhimu. São Jorge ilipotea kwenye kina kifupi cha Malindi, pengine kwenye eneo ambalo sasa ni Ngomeni, kama kilomita 30 kutoka mji wa Malindi (Bita 2018). Mizigo yake ilijumuisha makasia 139 ya meli. Nau Santa Maria da Graça, nayo ilipotea wakati meli kuelekea India katika msafara wa Fernão Peres de Andrade, ambao ulikuwa na meli tano, na Fernão Peres de Andrade katika nau Espera, Luiz de Calatayud katika nau Santo Espírito, Jácome Tristão akiwa katika São Filipe kwenye jaribio la

8. Millstones / Mawe ya kusagia (Photo: F. Castro)

archive with important information about the chain of operations that made these voyages possible.

The Swahili coast encompasses a significant portion of the Mozambican coast, starting around Sofala, all the coast of Tanzania, and most of the Kenyan coast, all the to Malindi and Lamu, near the border with today's Somalia. Populated by skilled merchants and sailors, this portion of the western shore of the Indian Ocean has been known for its cosmopolitan culture and rich trade. When the Portuguese arrived in the Indian Ocean, in March 1498, Vasco da Gama established relations with the Sultan of Malindi and had a pilar erected on its coast, which is still standing.

Malindi is an old city situated at the mouth of the Sabaki River, in Kenya, situated around 120 Km north of Mombasa. Emerging as an important Swahili city from the 15th century onwards, it became a central harbor in the 11th century, attracting merchants from Somalia, Egypt, the Arabian Peninsula, Persian and Indian came to engage in trade.

9. Small ceramic basin / Bakuli ndogo ya kauri (Photo: C. Bita)

10. Ivory / Pembe za ndovu (Photo: C. Bita)

pili, baada ya kulazimishwa kurudi Ureno mwaka wa jana yake. Simão Peres de Andrade huko Burgalesa, na Simão de Melo ndani ya Graça, ambayo ilipotea huko Baía Formosa, takribani kilomita kadhaa kutoka Mji wa Malindi, maelezo ambayo yanalingana na eneo la Ngomeni. Mizigo na watu wote waliokolewa.

Meli ya Ngomeni ilisukumwa ufukweni mbele ya kijito kidogo na kijiji cha Ras Ngomeni. Pwani yenyewe haina watu wengi na eneo la meli hii haitembelewi mara kwa mara. Pwani karibu na ajali ya meli ni mwamba wa matumbawe. Ikiwa imelindwa na mikoko, sehemu hii ya pwani imebadilika haraka katika karne iliyopita, na kuna uwezekano kwamba muundo wake wa sasa ni tofauti na mandhari ambayo mabaharia wa Ureno walikutana nayo miaka 500 iliyopita.

Sio rahisi kutafsiri ushahidi kwenye nakala zinzoosika na sehemu zilipopotea hizi meli. Baada yam waka wa 1498 meli za kireno zilitembelea bahari ya Africa mashariki kwa biashara na pia kupakia bidhaa zao za matumizi. Uhusiano huu ulikuwa muhimu kwa *Carreira da India*, ule mzunguko kati ya Lisbon and the bara Hindi. Meli zilizopotea katika bahari hii ni maktaba muhimu yenye habari muhimu kuhusu utengamano na shughuli ziliowezesha usafiri.

Ukanda wa Bahari ya Africa mashariki au Swahili inaunganisha sehemu muhimu za bahari ya nchi ya Msumbiji kuanzia mji wa Sofala, pwani yote ya Tanzania na Kenya, kupita Malindi na Lamu hadi mpakani wa Kenya na Somalia. Ukanda huu unahishi watu shupavu kwa biashara za kimataifa na ubaharia. Pwani hii tangu jadi imefahamika kuwa ya mchanganyiko wa mila za watu kutoka bara tofauti, na utajiri wa biashara. Wakati Wareno walipofika nahari ya Hindi Mwezi wa tatu 1498, Vasco da Gama alijenga uhusiano na Sultani wa Malindi na akajenga mnara katika eneo hili, mnara ambao bado ungaliko unasimama.

The ship condition was assessed in March 2024 (Castro et al. 2024), and an exploratory field season was planned for the following November, and carried out from the 2nd to the 23rd of that month. A total of 232 dives, or nearly 306 underwater hours were spent cleaning, tagging, trenching, and recording the site, which consists of a ballast mound oriented roughly NE-SW and covering an area of about 40 x 20 m. The ballast pile, formed by round stones with diameters between 10 and 25 cm, is lodged between four large boulders, and is rich in maritime fauna. Three of the boulders form a triangle, and a fourth is placed to the west of the first three. This site is a fishing spot and there are several large stone anchors apparent. There are also some millstones, and historical evidence pointing to the trade of millstones between Portugal and India. In November 2025 we resumed the work on the site and spend another three weeks excavating the site 254 dives and about 300 underwater hours of work. It is still impossible to say where we are excavating on the ship's hull, as no diagnostic features, such as the keel and keelson were exposed so far.

11. Copper ingot / Ingoti ya shaba (Photo: C. Bita)

12. Rigging block / Roda ya meli (Photo: C. Bita)

The Ngomeni shipwreck inspired us thus to revisit existing data on the ships of this period, and to focus our research on the technological advances of the first half of the 16th century, particularly the design of better, safer, more powerful, and faster ships, such as the naus, galleons, and war caravels, in Portuguese *caravelas de armada*.

The artefact collection recovered so far in the excavation of the Ngomeni ship suggests an early 16th-century shipwreck (Casimiro et al. forthcoming). Ivory and copper ingots with the Fugger mark were found at Ngomeni (de Flamingh et al. 2020). Although a complete analysis of the artefact collection is not ready yet, the artifacts are consistent with those found in other contemporary Portuguese shipwrecks, such as *Bom Jesus* (1533) wrecked off the coast of Namibia (Knabe and Noli, 2012), *São João* (1552) and *São Bento* (1554), both lost against the coast of South Africa or the Seychelles (Boudeuse Cay) Portuguese shipwreck, probably the *Santo Antonio*

Malindi ni mji mkongwe wa zamani uliopo karibu na mto mkuu wa Sabaki nchini Kenya, takribani kilomita 120 Km kaskazini mwa mji wa Mombasa. Mji wa Malindi uliibuka kuwa jiji kubwa na muhimu kwenye ukanda wa bahari ya afrika mashariki kuanzia karne ya 15 na kuendelea mbele. Ulikuwa bandari ya muhimu karne ya 11 na ikitembelewa na wanabiashra wa kimataifa kutoka Somalia, Misri, Uarabuni na bara Hindi, wakifika Malindi kufanya biashara.

Hali ya meli hii ya Ngomeni chini ya maji ilichunguzwa mnamo Machi 2024 (Castro et al. 2024), na msimu wa uchunguzi mkuu ulipangwa na kufanywa kuanzia tarehe 2 hadi 23 November. Jumla ya hatua za kupiga mbizi 232, au karibu masaa 306 chini ya maji zilitumika kusafisha, kuweka alama, kuchimba, na kurekodi eneo hilo la meli, ambalo lina vifusi vya mawe ya farumu sehemu ya kuelekea NE-SW na kufunika eneo la takriban mita 40 x 20. Rundo la farumu, la mawe ya mviringo yenye kipenyo kati ya sentimita 10 na 25, liko kati ya mawe manne makubwa, na lina wanyama wengi wa baharini. Mawe matatu kati ya hayo yamejipanga kwenye pembetatu, na ya nne iko magharibi mwa hayo matatu. Eneo hili hutumika na wenyeji wa Ras kuvulia samaki na kuna nanga kadhaa kubwa za mawe zinazoonekana. Pia kuna baadhi ya mawe ya kusagia, na ushahidi wa kihistoria unaoelekeza kwenye biashara ya mawe ya kusagia kati ya Ureno na India. Mnamo Novemba 2025 tulianza tena kazi kwenye eneo hilo na kutumia wiki zingine tatu tukichimba eneo hilo kwa kupiga mbizi 254 na takriban saa 300 za kazi chini ya maji. Hadi kwa sasa ni vigumu kueleza ni sehemu gani yah ii meli tunakochimba, kwani hakuna vipengele vya uchunguzi, kama vile keel na keelson vilivyogunduliwa hadi sasa.

Meli ya Ngomeni ilitutia moyo kutokana na nakala zilizopo kuhusu meli za kipindi hiki, na kuzingatia utafiti wetu kuhusu maendeleo ya kiteknolojia ya nusu ya kwanza ya karne ya 16, hasa muundo wa meli bora, salama zaidi, zenye nguvu zaidi, na zenye kasi zaidi, kama vile meli za naus, galleons, na misafara ya vita, katika caravelas de armada ya Kireno.

of 1589.

As galleons were not around until 1518, the possibility of this shipwreck being *São Jorge* makes it a potentially interesting discovery. Galleons were warships designed in Portugal initially for the Indian Ocean service, and built in Portugal and Portuguese shipyards in India, from 1518 onwards. The galleon *São Jorge* is also referred in the chronicles and state papers as a *nau*, a general word for large sailing ships, but it can be that it was one of the earliest galleons, and we have no plans nor descriptions to guide us through an hypothetical reconstruction. The Ngomeni ship is an extraordinary find, with enormous potential for the study of 16th-century Portuguese ships, whether it was the galleon *São Jorge* or the nau *Santa Maria da Graça*.

13. Porcelain shard from the reigns of the emperors Hongzhi (1488-1505) or Zhengde (1506-1521) / Kipande cha kauri kutoka enzi za watawala wa Uchina wa Hongzhi (1488–1505) au Zhengde (1506–1521) (Photo: C. Bita)

The excavation of this site is the responsibility of National Museums of Kenya, co-directed by Caesar Bita and Filipe Castro, and funded by National Museums of Kenya, the Sines Municipal Council, and Mr. Gary Philbrick, an American benefactor who is also part of the team.

Most of the fieldwork is the responsibility of the residents of Ngomeni, whom we consider to be the owners and best custodians of the shipwreck and the bay where it lies. This project is theirs and developed for them. As a community archaeology project, carried out by the residents and framed by us and the National Museums of Kenya. An interpretation center is planned for the site, as well as a dedicated room at the Malindi Museum, located next to the monument to Vasco da Gama and the other navigators that visited the Malindi coast.

Through this shipwreck, the history of Portugal becomes part of the history of Kenya, and one of the goals of this project is to bring the story of Vasco da Gama and the Portuguese expansion to the local population. To this end, we have already held several conferences at the Malindi Museum, which is serving as the first stop for the recovered artifacts. The conservation of the artifacts is the responsibility of the Mombasa conservation laboratory, whose expertise is internationally recognized, notably through the treatment of the collection of the Portuguese ship *Santo António de Taná*, excavated in Mombasa by the Institute of Nautical Archaeology in the 1970s. With the sponsorship of the Sines City Council, the birthplace of Vasco da Gama, we intend to develop a set of digital models that will allow us to improve our understanding of

Mkusanyiko wa vitu vya kale vilivyopatikana hadi sasa katika uchimbaji wa meli hii ya Ngomeni unaonyesha kwamba hii meli ya mapema ya karne ya 16 iliyovunjika (Casimiro et al. inakuja). Vipande vya pembe za ndovu na shaba vyenye alama ya Fugger vilipatikana Ngomeni (Bita, 2018; de Flamingh et al. 2020). Ingawa uchambuzi kamili wa mkusanyiko wa vitu vya kale zilizopatikana haujakamilika bado, vitu hivyo vinaendana na vile vilivyopatikana katika meli zingine za Ureno kama vile Bom Jesus (1533) zilizopotea karibu na pwani ya Namibia (Knabe na Noli, 2012), São João (1552) na São Bento (1554), zote zilipotea kwenye pwani ya Afrika Kusini au meli ya Ureno ya Shelisheli (Boudeuse Cay), labda Santo Antonio ya 1589.

Kwa kuwa meli za kivita hazikuwepo hadi 1518, uwezekano wa meli hii ya kivita kuwa São Jorge unaifanya iwe ugunduzi unaoweza kuvutia. Meli za kivita za Galleon zilikuwa meli za kivita zilizoundwa Ureno awali kwa ajili ya huduma ya Bahari ya Hindi, na zilijengwa katika viwanja vya meli nchini Ureno na nchini India, kuanzia 1518 na kuendelea. Galeon ya São Jorge pia inajulikana katika historia ya serikali ya Ureno kama nau, neno la jumla la meli kubwa za meli, lakini inaweza kuwa kwamba ilikuwa moja ya meli za mapema zaidi, na hatuna maelezo ya kutuongoza kupitia ujenzi wa meli hizi. Meli ya Ngomeni ni ugunduzi wa ajabu, na ina uwezo mkubwa sana wa kusoma meli za Ureno za karne ya 16, iwe ni meli ya São Jorge au Santa Maria da Graça.

14. Celadon shard / Kipande cha kauri ya kichina ya kijani au seladoni (Photo: C. Bita)

the ships of the Portuguese Discoveries and voyages.
The study of Portuguese ships and their histories is important for the history of Europe and the world, and the media coverage of this project outside Portugal has already generated interest from the German television network ZDF and the Franco-German television network ARTE, which are producing a documentary about the life of Vasco da Gama and the shipwreck of Ngomeni. If it is possible to identify Ngomeni's ship as Vasco da Gama's galleon *São Jorge*, the interest of this site will be even greater, as a physical artifact of the navigator's life.

Bibliography

Bita, C. 2018. - The Ngomeni shipwreck: Its discovery and what it tells us about the 16th century transoceanic trade, *Kenya Past and Present* 45, 33-44.

Casimiro, T., Detry, C., Pinheiro, H., Nunes, R., Teixeira, H., Neto, N. (In press) - Uma cozinha na Rua Nova da Trindade em meados do século XVI, in *Actas do III Encontro do Centro de Arqueologia de Lisboa*. Lisbon: CAL.

Castro, F., Bita, C., Pissarra, J. Frabetti, B. 2024. - The Ngomeni Shipwreck and Portuguese India Route Ships, *Journal of Maritime Archaeology* 20(1), 1-27.

de Flamingh, A., Coutu, A., Sealy, J., Chirikure, S., Bastos, A., Libanda-Mubusisi, N., Malhi, R., Roca, A. 2020. - Sourcing Elephant Ivory from a 16th Century Portuguese Shipwreck, *Current Biology* 31(3), 621-628.

Knabe, W., Noli, D. 2012. - *Die Versunkenen Schatze der Bom Jesus*. Berlin: Nicolai.

Pissarra, J. 2012. - Navios Orientais, in Domingues, F. (ed.) Navios, *Marinheiros e Arte de Navegar*, 1500-1668, 125-136. Lisboa: Academia de Marinha.

Pissarra, J. 2016. - Portugal e o desenvolvimento das marinhas oceânicas: o galeão português. 1518-1550. Unpublished PhD dissertation, University of Lisbon.

15. Penico / Chombo cha kijisaidia haja ndogo (Photo: C. Bita)

Uchimbaji wa eneo hili la meli hii ya Ngomeni ni jukumu la Makumbusho ya Kitaifa Kenya, (National Museums of Kenya) yanayoongozwa kwa ushirikiano na Caesar Bita na Filipe Castro. Uchimbaji unfadhiliwa na Makumbusho ya Kitaifa ya Kenya, Baraza la Manispaa la Sines, na Bwana Gary Philbrick, mfadhili wa Marekani ambaye pia ni mzmiaji na mmoja katika ya timu inayochimba meli hii. Kazi nyingi za uifadhi ni jukumu la wakazi wa Ngomeni, ambao tunawatambua kuwa wamiliki na walinzi bora wa meli hii ya Ngomeni. Mradi huu ni wao na umetengenezwa kwa ajili yao. Kama mradi wa akiolojia wa jamii, unaofanywa na wakazi na kuandaliwa na sisi na Makumbusho ya Kitaifa ya Kenya. Kituo cha tafsiri kimepangwa kwa ajili ya eneo hilo, pamoja na chumba maalum katika Jumba la Makumbusho la Malindi, lililoko karibu na mnara wa Vasco da Gama na mabaharia wengine waliotembelea pwani ya Malindi.

Kupitia meli hii iliyozama, historia ya Ureno inakuwa sehemu ya historia ya Kenya, na moja ya malengo ya mradi huu ni kuleta hadithi ya Vasco da Gama na upanuzi wa Ureno kwa wakazi wa eneo hilo. Kwa lengo hili, tayari tumefanya mikutano kadhaa katika Jumba la Makumbusho la Malindi, ambalo linatumika kama kituo cha kwanza cha mabaki yaliyopatikana kwa meli hii. Uhifadhi wa mabaki haya ni jukumu la maabara ya uhifadhi ya Mombasa, ambayo utaalamu wake unatambuliwa kimataifa, haswa kupitia usindikaji wa mkusanyiko wa meli ya Ureno Santo António de Taná, iliyochimbwa Mombasa na Taasisi ya Akiolojia ya Baharini (institute of Nautical Archaeology) katika miaka ya 1970. Kwa ufadhili wa Halmashauri ya Jiji la Sines, mahali pa kuzaliwa kwa Vasco da Gama, tunakusudia kutengeneza seti ya mifumo ya kidijitali ambayo itaturuhusu kuboresha uelewa wetu wa meli za Ugunduzi na safari za Ureno.

Utafiti wa meli za Ureno na historia zao ni muhimu kwa historia ya Ulaya na dunia, na habari za mradi huu nje ya Ureno tayari zimeibua shauku kutoka kwa mtandao wa televisheni ya Ujerumani ZDF na mtandao wa televisheni ya Ufaransa na Ujerumani ARTE, ambao wanaandaa makala kuhusu maisha ya Vasco da Gama na kuzama kwa meli ya Ngomeni. Ikiwa inawezekana kutambua meli ya Ngomeni kama meli ya Vasco da Gama iitwayo São Jorge, shauku ya tovuti hii itakuwa kubwa zaidi, kama kitu halisi cha maisha ya baharia.

MISSING ROMAN PERIOD WRECK OFF SVETI IVAN ISLAND NEAR ROVINJ

NESTALI RIMSKI BRODOLOM KOD OTOKA SVETI IVAN BLIZU ROVINJA

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An archaeological team of the International Centre for Underwater Archaeology in Zadar and of the Bavarian Society for Underwater Archaeology (BGfU) from Germany launched a search this year for a missing Roman period wreck off Sveti Ivan Island near Rovinj. The site was identified by archaeologists in 2011 when local divers led an ICUA team to a position known as *Ciglice* ("Small Bricks"). Bricks are scattered on the seabed here in quantity, along with amphorae sherds that divers have been removing in great numbers for decades. Initial surveying of the terrain found that this was a proper late antique period wreck with a cargo of amphorae and fine north African sigillata ware. The site lies to the northwest of the island, at depths of five to ten metres. The initial dives at the site recovered a dozen special finds, parts of amphorae, small sigillata vessels, and even parts of a ship's lead plating. Although extensively looted we have chosen this site as one of those at which we will attempt to determine the degree to which traces of a wreck have survived.

Investigation of the site was scheduled for this season and a small team was set up with the task of systematically surveying the entire submerged slope of the island in search of finds that might provide insight as to the ship's origin, its cargo, and when it sank. Participating in the underwater investigation were ICUA specialists Luka Bekić PhD, Maja Kaleb, and Šime Vrkić PhD, joined by Max Fiederling PhD, Michael Heinzlmeier, and Philip Tanzer of the BGfU. Also on the team was archaeology student Deni Demetlika. Logistical support—diving cylinder refilling and equipment storage—was provided by the Rovinj Sub diving centre.

Most of the surface finds were recorded on the rocky slope from depths of five to ten metres, which informed our decision to set out a grid of large four-by-four-metre trenches. These were marked out with iron spikes and cords to improve diver orientation. The rocky seabed

Ove godine je arheološka ekipa Međunarodnog centra za podvodnu arheologiju u Zadru i Bavarskog društva za podvodnu arheologiju (BGfU) krenula u potragu za nestalim rimskim brodolomom kod otoka Sv. Ivan blizu Rovinja. Ovo nalazište je arheološki otkriveno tek 2011. g. kada su arheološku ekipu MCPA lokalni ronioci odveli na poziciju koju su zvali „ciglice". Ova pozicija je tako nazivana jer su ovdje na dnu razbacane brojne opeke, ali i ulomci amfora, koje su ronioci masovno odnosili desetljećima. Već pri prvim pregledima terena uočeno je da je tu riječ o pravom kasnoantičkom brodolomu s teretom amfora i fine sjevernoafričke sigilate. Nalazište je na sjeverozapadnoj strani otoka, na dubini od 5 do 10 metara. Prilikom prvih ronjenja na ovom mjestu smo prikupili desetak posebnih nalaza, dijelova amfora, sigilatnih posudica pa čak i dijelove olovne oplate broda. Stoga je ovo, mada gotovo u potpunosti opljačkano nalazište, određeno kao jedna od točaka gdje će se pokušati ustanoviti koliko još ima preostalih tragova brodoloma.

Istraživanje brodoloma došlo je na red ove godine, pa je okupljena manja ekipa koja je imala za zadatak sustavno pretražiti čitavu padinu otoka u potrazi za arheološkim nalazima koji bi mogli dati odgovore o tome odakle je ovaj brod došao, što je prevozio i kada je potonuo. U podvodnim istraživanjima su sudjelovali djelatnici MCPA doc. dr. sc. Luka Bekić, Maja Kaleb i dr. sc. Šime Vrkić, a iz BGfU dr. sc. Max Fiederling, Michael Heinzlmeier i Philip Tanzer. Ekipi se pridružio i student arheologije Deni Demetlika. Logističku podršku punjenja ronilačkih boca i skladištenja opreme pružio je ronilački centar Rovinj Sub.

S obzirom da je najviše površinskih nalaza zabilježeno na kamenitoj padini od dubine pet metara do dubine od deset metara, odlučeno je da će se postaviti mreža većih sondi stranica 4 x 4 metra. Oni su iskolčeni s željeznim šipkama i konopima za bolju orijentaciju ronilaca. S obzirom na kamenito dno, šipke nisu uvijek mogle biti postavljene

here meant that we were not always able to set out spikes at the ideal spot, resulting in a degree of deviation in the appearance of the grid. This did not, however, unfavourable impact our ability to accurately record the position of individual special finds, measured in each of the trenches. The non-diagnostic sherds from the bodies of amphorae collected along with the special finds were counted, photographed, and weighed before being returned to the seabed.

1. Searching the grid area on the rocky slope / Pretraživanje mrežišta na kamenoj padini (Photo: M. Fiederling)

Documentation of the investigation field was two-fold. Analogue measurements were taken of all fixed points outside the field and of the fixed points of the investigation grid. The whole of the investigation field was also photographically imaged for the development of a model and orthophotograph that will form a site plan. Surface buoys were used to calibrate the field in the GPS system. Individual special finds were calibrated to the grid to develop a distribution map. Manual examination of the investigation field on the slope was followed by water pump-powered eductor excavation of three two-by-two-metre trenches on the sandy seabed below the slope. Some artefacts were recovered from these trenches, but it is evident that most artefacts remain on the rocky slope and have not been washed down to the sandy bottom.

The investigation yielded only 25 special finds. Typologically significant amphorae sherds were particularly rare, as most of the recovered sherds are from the body of amphorae and not typologically relevant. This clearly indicates the extent of looting at this site. That the ship was obviously carrying a cargo of amphorae is evident from the total sherd count. Two massive amphora spikes and three upper parts with handles were found. These correspond to the Africana IIC type (SF14, SF36,

na idealnim mjestima pa je došlo do otklona u izgledu mreže. No to nije utjecalo na točnost pozicija pojedinih posebnih nalaza, koji su umjereni u svakoj sondi. Osim posebnih nalaza, prikupljani su i nedijagnostički ulomci trbuha amfora, koji su nakon brojanja, fotografiranja i vaganja vraćeni na morsko dno.

Dokumentacija polja istraživanja obavljena je dvojako. Analogno su izmjerene sve fiksne točke van polja kao i fiksne oznake mrežišta istraživanja. Ujedno je cijelo polje istraživanja fotografirano za izradu modela i ortofotografije u svrhu izrade nacrta nalazišta. Spomenuto polje je putem površinskih bova uspješno umjereno u GPS sustav. Svi pojedinačni posebni nalazi su umjereni u mrežištu za izradu karte rasprostiranja. Nakon što se ručno pregledalo polje pretraživanja na padini, na pješčanom dnu ispod padine iskopane su tri sonde veličine 2 x 2 metra, uz pomoć vodene pumpe i mamuta. U tim sondama pronađeno je nekoliko nalaza, ali očito je da se većina nalaza zadržala na kamenitoj padini i da erozijom nisu legli na pješčano dno.

Tijekom istraživanja pronađeno je samo 25 posebnih nalaza. Posebno rijetki su tipološki značajniji nalazi amfora, a većina pronađenih ulomaka su dijelovi trbuha amfora koji nisu tipološki relevantni. To je jasan pokazatelj opsega pljačke ovog nalazišta. No brod je svakako prevozio teret amfora, što se može zaključiti

2. Sherd from a small Near Eastern amphora / Ulomak manje bliskoistočne amfore (Photo: L. Bekić)

SF41), dated to the fourth and early fifth centuries. A smaller globular amphora with a ribbed shoulder is attributable to Near Eastern production (SF15).

We also recovered a number of other potsherds. Most were from sigillata plates and platters with impressed designs. The most notable is a plate with a design in relief of a man, by all appearance a depiction related to the Mithraic cult. The figure—wearing a short tunic and a cloak—holds a long staff, likely a torch. In the Mithraic iconography torches were held by the *dadophoroi* Cautes and Cautopates. These plates are of the Hayes 53A type, dating from 350 to 430 CE, possibly later. The only other such finds were found at the Babuljaš-Pakoštane and Duboka-Hvar sites.

3. A plate with a man depicted in relief / Tanjur s reljefnim prikazom čovjeka (Photo: L. Bekić)

Besides the fine ceramic ware, finds included large mortars and coarse pottery, late antique cooking pots, and other forms, including bowls. An unusual ceramic weight (SF23) made of a massive brick has grooves where a cord was tied. Detailed analysis of all the recovered artefacts will follow desalination and cleaning at the ICUA conservation laboratory in Zadar.

As always, when divers report a find, we examined other positions with the aim of identifying possible new wreck sites. Following on a report from Zoran "Zoki" Čurčić of the KPA Rovinj diving club we visited a position between Sveti Ivan Island and Sturag Island, where he observed a pile of bricks at a depth of twelve metres. At the position we observed a large pile, covering a ten-by-five metre area. The bricks are stacked in orderly fashion, indicating a vessel with a cargo of bricks. Capsizing or jettisoning would not have left a neatly arranged pile on the seabed. This dive did not identify any other signs of a ship or other finds. A sample was taken of the bricks, and the site was video and photographically documented. The bricks are likely of nineteenth century date.

The dive team also visited the find of a post-medieval refuse dump to the west of Sveta Katarina Island. A visit

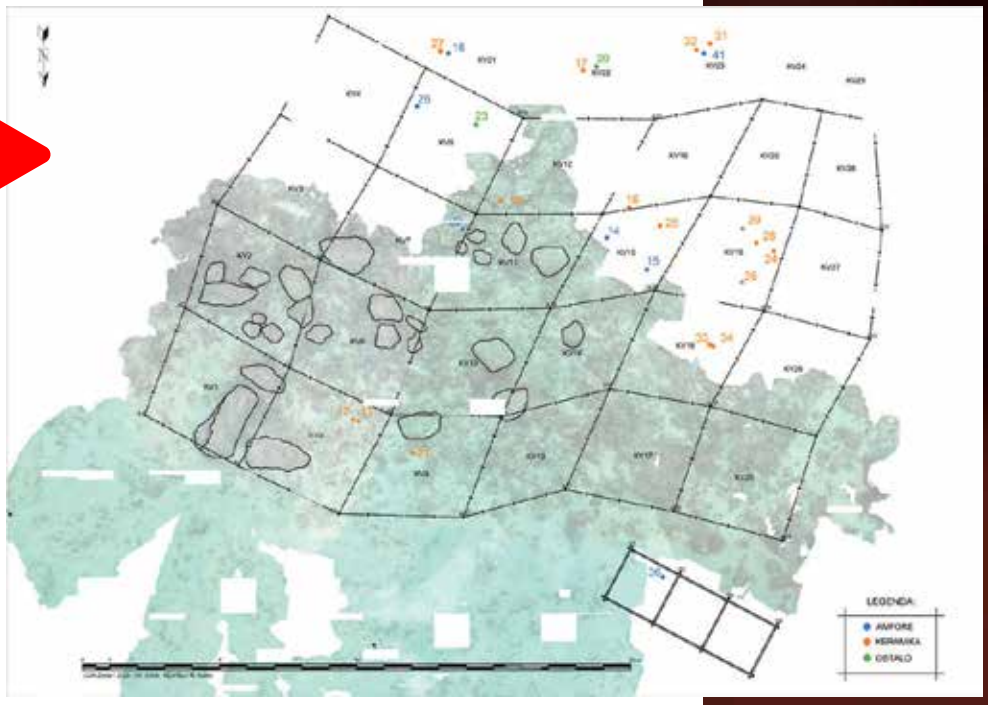
po ukupnom broju ulomaka. Pronađena su dva masivna šiljka amfore i tri gornja dijela s ručkama. Amfore bi odgovarale tipu Africana IIC (PN 14, 36, 41) koji se datira u 4. i početak 5. st. Ujedno je nađena i manja globularna amfora s narebrenim ramenom, koja bi se mogla pripisati bliskoistočnoj produkciji (PN 15).

Osim amfora pronađeno je više ulomaka različitih keramičkih posuda. Uglavnom su to sigilatni tanjuti i pladnjevi s utisnutim ukrasima. Najvažniji nalaz ovih istraživanja je tanjur s reljefnim prikazom čovjeka, koji po svojem izgledu spada u prikaze vezane uz Mitrin kult. Naime, osim kratke tunike i plašta, čovjek u ruci drži dugi štap, vjerojatno baklju. Takve baklje su u Mitrajskim prikazima držali Kauta i Kautopata, bakljonoše. Ovakvi tanjuri klasificiraju se kao tip Hayes 53 A i datiraju od 350. do 430. g., a možda i kasnije. Kod nas su pronađeni samo na nalazištima Babuljaš - Pakoštane i Duboka - Hvar.

Osim fine keramike, zabilježeni su i nalazi većih tarionika i grube keramike, kasnoantičkih lonaca za kuhanje i drugih oblika poput zdjela. Pronađen je i neobičan keramički uteg (PN 23), izrađen od masivne opeke, koji na sebi ima utore za vezanje konopa. Detaljna analiza svih nalaza obaviti će se nakon provedene desalinizacije i čišćenja u konzervatorskom laboratoriju MCPA u Zadru.

Kao i svake godine, ovisno o dojavama ronioca, pregledavali smo i druge pozicije kako bi ušli u trag potencijalnim brodolomima. Prema dojavi ronioca KPA Rovinj, Zorana Čurčića Zokija, otišli smo na poziciju između otoka Svetog Ivana i Sturaga, gdje je na dubini od 12 metara zamijetio hrpu opeka. Po dolasku na poziciju uočili smo da je na dnu velika hrpa opeka, 10 x 5 metara površine. Opeke su uredno posložene što ukazuje da je ovdje potonuo brod koji je prevozio teret opeka. Da je riječ o prevrtanju ili izbacivanju, opeke ne bi bile uredno složene na dnu. No, nikakvih tragova broda ili nekog drugih nalaza nismo pronašli prilikom tog ronjenja. Uzeli smo uzorak opeke i napravili video i fotodokumentaciju ovog nalazišta. Opeke vjerojatno datiraju u 19. st.

Osim toga, ronioci su posjetili nalazište novovjekovnog stovarišta otpada na zapadu otoka Sv. Katarina. Također su po dojavi školjkara ronioca otišli na rt Muntrav (Montauro) provjeriti dojavu o nekoliko amfora koje vire iz pijeska, ali ta dojava nije potvrđena uviđajem.



4. Site drawing showing the distribution of finds / Nacrt nalazišta s rasporedom nalaza (By: P. Tanzer, M. Kaleb)

was also made to the Muntrav (Montauro) cape based on a shellfish diver report of a number of amphorae poking out of the sandy bottom but our survey of the locality did not confirm the report.

An advanced underwater archaeology course was staged in the autumn of 2025 in the frame of our investigation of the underwater archaeological site off Sveti Ivan Island. This is one of a series of specialised courses ICUA has offered for over a decade now, originally launched in collaboration with UNESCO to provide systematic education for underwater archaeologists, and to promote the implementation of international standards in underwater cultural heritage protection.

The two-week programme was staged in Rovinj and on-site, with course activities based out of the KPA Rovinj diving club, and logistical support provided by the Rovinj Sub diving centre. The participants took part in actual fieldwork at a late antique wreck site, with a combination of theoretical lectures and an intensive hands-on component, including methodology training, site documentation, and manual excavation of archaeological finds.

Taking part in the course were Ernest Rappel (Germany), Jordan Hanson (Ireland), Maider Galparsoro Aierbe (Spain), and Agata Karan (Croatia). Collaborating in the course programme were members of the BGfU and outside associates, continuing a long tradition of ICUA-organised international education programmes aimed at providing specialist training for archaeologists in the investigation and preservation of underwater cultural heritage.

U sklopu istraživanja podvodnog arheološkog nalazišta kod otočića sv. Ivan, tijekom jeseni 2025. godine održan je Napredni tečaj podvodne arheologije. Riječ je o jednom u nizu specijaliziranih tečajeva koje MCPA provodi već više od desetljeća, a koji su izvorno pokrenuti u suradnji s UNESCO-om s ciljem sustavne edukacije arheologa za rad u podmorju i primjenu međunarodnih standarda u zaštiti podvodne kulturne baštine.

Dvotjedni program provodio se u Rovinju i na samom nalazištu, dok je baza za održavanje tečaja bio KPA Rovinj–CAS Rovigno, uz logističku potporu ronilačkog centra Rovinj Sub. Polaznici su sudjelovali u stvarnom terenskom radu na kasnoantičkom brodolomu kroz kombinaciju teorijske nastave i intenzivnog praktičnog dijela, koji je obuhvaćao metodološke vježbe, dokumentiranje nalazišta i ručno iskopavanje arheoloških nalaza.

Na tečaju su sudjelovali Ernest Rappel (Njemačka), Jordan Hanson (Irska), Maider Galparsoro Aierbe (Španjolska) i Agata Karan (Hrvatska). Tečaj je proveden u suradnji s članovima Bayerische Gesellschaft für Unterwasserarchäologie (BGfU) te vanjskim stručnjacima, nastavljajući dugogodišnju tradiciju MCPA u organizaciji međunarodnih edukacijskih programa usmjerenih na stručno osposobljavanje arheologa za istraživanje i očuvanje podvodne kulturne baštine.

Istraživanjem rimskog brodoloma kod Svetog Ivana, završavamo radove na svim važnijim brodolomima Rovinjštine. Ovo nalazište će vjerojatno biti u potpunosti istraženo kroz još jednu ili dvije kampanje. Od neistraženih brodoloma ostaje samo novovjekovni brodolom s crjepovima kod otoka Samera i rimski brodolom na većoj dubini prema Barbarigi, koji je pronađen prošle godine. Nadamo se da će se u budućim pretraživanjima rovinjskog područja pronaći još poneki brodolom koji bi vrijedilo istražiti. Indicije za to postoje, ali je potrebno naći nekog ronioca koji zna točniju poziciju tog nalazišta. Do tada će se završiti istraživanje brodoloma kod Svetog Ivana, koji mada temeljito opljačkan, ipak daje dovoljno podataka za znanstvenu analizu.

5. A pile of bricks, possibly a wreck site between the Sveti Ivan and Sturag islands / Hrpa opeka, brodolom između otoka Sv. Ivana i Sturaga (Photo: L. Bekić)

Investigation of the Sveti Ivan Island wreck site rounds out our work investigating major shipwrecks in the Rovinj area. This site will likely be fully investigated over the course of one or two more campaigns. Wrecks yet to be investigated are the post-medieval wreck with a cargo of roof tiles off Samer island, and the Roman period wreck identified last year at greater depth in the Barbariga area. We hope that future exploration of the Rovinj area will identify as yet unknown wrecks that warrant investigation. There are indications that such sites may exist, but that will depend on finding a diver able to pinpoint the location. Investigation of the Sveti Ivan Island wreck site—thoroughly looted but still providing sufficient data for analysis—will be completed in the meantime.

Bibliography / Literatura

Bekić, L. 2020. - Investigation at Sestrica Island and the Rovinj Area in 2020 / Istraživanja na otoku Sestrica I u okolici Rovinja 2020. godine, *Submerged Heritage / Potopljena baština* 10, 46-50.

Bekić, L. 2021. - Underwater Investigation in Rovinj in 2021 / Podvodna istraživanja u Rovinju tijekom 2021. godine, *Submerged Heritage / Potopljena baština* 11, 45-50.

Bekić, L. 2022. - Roman Wreck Investigation at Sestrica Island off Rovinj Wraps Up / Završetak istraživanja rimskog brodoloma kod rovinjskih otoka Sestrice, *Submerged Heritage / Potopljena baština* 12, 43-49.

Bekić, L. 2023. - *Rimski brodolom kod otoka Velika Sestrica / A Roman Shipwreck off Velika Sestrica Island* (Istraživačke studije iz podvodne arheologije 5 / Studies in Underwater Archaeology 5). Zadar: Međunarodni centar za podvodnu arheologiju u Zadru.

Bekić, L. 2023. - Underwater Archaeologists in Rovinj / Podvodni arheolozi u Rovinju, *Submerged Heritage / Potopljena baština* 13, 40-46.

Bekić, L. 2024. - New Find of a Roman Period Wreck with Amphorae to the South of Rovinj / Novi nalaz ostataka rimskog brodoloma s amforama južno od Rovinja, *Submerged Heritage / Potopljena baština* 14, 56-60.

6. Part of the Rovinj 2025 team and participants of the international underwater archaeology course, from the left: / Dio radne ekipe Rovinj 2025 i polaznici međunarodnog tečaja podvodne arheologije, s lijeva: Deni Demetlika, Jordan Hanson, Šime Vrkić, Agata Karan, Maja Kaleb, Maider Galparsoro Aierbe, Luka Bekić, Michael Heinzlmeier, Phillipp Tanzer, Ernest Rappel, and Max Fiederling (Photo: F. Kaffola)

SCANNING THE SEABED OFF DUGI OTOK ISLAND

SKENIRANJE PODMORJA DUGOG OTOKA

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Underwater archaeologists have identified sites off Dugi otok Island on multiple occasions over recent years, with most of these sites recorded in the area up to forty metres depth.[1] These are depths accessible to diver surveys and are located in the immediate vicinity of the island's shores. In 2023 ICUA specialists received reports of site locations in areas further off the island, where depths exceed forty metres. These locations are recorded on the maps fishermen use, primarily when trawling. We know that bottom trawling nets, designed to run across the seabed to make their catch, also irreparably devastate any cultural heritage they come across. Trawl fishers often also "catch" a variety of archaeological artefacts. The typical practice when drawing bottom trawl nets is to record on maps locations of interest to fishermen. These are usually rocky outcrops, concentrations of rocks, and wrecks around which greater numbers of fish usually congregate. Archaeologists are rarely able to access information concerning these areas of rock rising above the sandy bottom as fishermen are in no hurry to share what is for them valuable information. In 2023, however, ICUA gained access to one such map covering the area to the west of Dugi otok Island within Croatian territorial waters up to the twelve nautical mile boundary from the island's coastal baseline.

ICUA Zadar does not possess the equipment necessary to scan and survey finds at these depths, and we turned to the Centre for Underwater Archaeology in Bulgaria's Sozopol as it does have the equipment needed to pursue this project. Our colleagues from Bulgaria arrived with the equipment essential for scanning the deep areas slated for surveying this season, including sophisticated multibeam, side-scan sonar, and submersible ROV equipment. Most critically we were joined by an experienced Bulgarian team consisting of Kalin Lyubenkov Dimitrov, Kiril Gligorov Velkovsky, Viktor Vasilev Dimitrov, and Zhelyazko Dimitrov Zhelyazkov. The survey took place from 20 to 29 August of 2025. The archaeological investigation was led by field director Mladen Pešić and his deputy Roko Surić.

1 Pešić 2015, 24–28; Uglešić & Parica 2013, 147–149.

1. Prepping the winch for the side-scan sonar / Pripreme vinča za side scan sonar (Photo: M. Pešić)

Podvodna nalazišta Dugog otoka evidentirana su u nekoliko navrata tijekom prošlih godina od strane podvodnih arheologa, no većina tih nalaza zabilježena je u području do 40 metara dubine.[1] To su dubine koje su dostupne roniocima za pregled i nalaze se u neposrednoj blizini otoka. Tijekom 2023. godine djelatnici MCPA dobili su informacije o postojanju pojedinih nalazišta na područjima koja se nalaze na dubinama većim od 40 metara i dosta su udaljena od obale. Navedene lokacije zabilježene su na kartama koje su ribari koristili tijekom svojih ribarskih aktivnosti, najčešće prilikom kočarenja. Poznato je da kočarske mreže koje su dizajnirane tako da stružu morsko dno i prikupljaju ribu, ujedno i nepovratno uništavaju i kulturnu baštinu koja se tamo nalazi. Ribari tijekom ribarenja često u kočama „uhvate" i razne arheološke nalaze. Običaj je da se prilikom povlačenja takvih pridnenih mreža na kartama bilježe lokacije koje su ribarima zanimljive, najčešće nekakvi podvodni brakovi, nakupine kamena ili brodolomi oko kojih se najčešće skupljaju veće količine ribe. Arheolozi vrlo teško dolaze

2. The side-scan sonar is ready for descent / Side scan sonar spreman za spuštanje (Photo: M. Pešić)

Frane Sorić of Preko provided use of his boat, co-piloted by captain Ljubo Markulin.

Much of the preparatory work took place in the port of Gaženica, where two days were spent mounting the seabed scanning equipment on the boat.

The most complex process involved mounting a winch weighing in excess of six hundred kilograms and required to lower and raise the side-scan sonar device. A mobile crane was used to lift the winch onto the boat for mounting on the boat's rail. We also mounted a multibeam device used to develop a precise map providing us with a topographic picture of the seabed. An additional generator was also mounted to provide the electrical power needed to operate the winch. Before heading out to Dugi otok Island our test of the equipment in the Zadar Channel confirmed that it was fully operational and ready for our investigative work.

The investigative concept was to use the side-scan sonar in parallel with the multibeam; they yield differing but compatible results, together providing a much better picture of the seabed for our subsequent analysis. Our survey of the terrain utilised a multibeam resolution covering an area of about 160 metres (eighty metres to each side of the boat), while the side-scan sonar was set to cover about 280 metres of surface area; a hundred metres to each side of the boat in high resolution and a further approximately forty metres to each side in somewhat lower resolution. We also used an underwater robot, a Chasing model ROV, to survey a number of promising locations. Only a small number of locations were thus closely examined given that this season's

do tih informacije tzv. „zadiva" zato jer ribari čuvaju te podatke za sebe, no tijekom 2023. godine upravo jedna takva karta koja pokriva područje zapadnog dijela Dugog otoka na području teritorijalnog mora Republike Hrvatske do granice od 12 nautičkih milja od krajnje granice obale otoka je došla je u MCPA Zadar.

S obzirom da MCPA Zadar ne posjeduje opremu s kojom bi se mogli skenirati i pregledati nalazi na tolikim dubinama odlučeno je da će se u projekt uključiti bugarski Centar za podvodnu arheologiju iz Sozopola koji posjeduje opremu s kojom se projekt može provesti. Bugarski kolege donijele su opremu koja je bila neophodna za dubinsko skeniranje područja koje se odlučilo ove godine pregledavati, a radi se o sofisticiranoj opremi kao što je multibeam, sidescan sonar i podvodni ROV. Najvažnije je što je uz opremu na istraživanju uključen i iskusni bugarski tim Kalin Lyubenkov Dimitrov, Kiril Gligorov Velkovsky, Viktor Vasilev Dimitrov, Zhelyazko Dimitrov Zhelyazkov. Pregled je obavljen u periodu 20. do 29. kolovoza 2025. Arheološka istraživanja vodio je dr. sc. Mladen Pešić, a zamjenik voditelja bio je Roko Surić. Prilikom istraživanje koristila se brodica u vlasništvu Frane Sorića iz Preka, uz kojeg je brod vozio i kapetan Ljubo Markulin. Velik dio pripremnih radova odvijao se u luci Gaženica gdje se oprema 2 dana montirala na brod koji je korišten za skeniranje podmorja.

Najkompleksniji proces je montiranje vinča teškog preko 600 kila koji je služio za dizanje i spuštanje Side Scan Sonara. Vinč se montirao uz pomoć kamion dizalice koja ga je digla u brod nakon čega je dodatno fiksiran za ogradu broda. Također je montiran i multibeam uređaj koji će služiti za preciznu izradu karte to jest pružit će nam sliku reljefa morskog dna. Na brodu je i montiran dodatni agregat kao izvor struje koji će poslužiti za pokretanje

3. Kiril and Viktor prepare the ROV / Kiril i Viktor pripremaju ROV-a (Photo: M. Pešić)

4. Scanning results were monitored here / Kutak za praćenje rezultata skeniranja (Photo: M. Pešić)

investigative work is focused on scanning the greatest possible area to obtain the greatest possible quantity of data for analysis over the coming years.

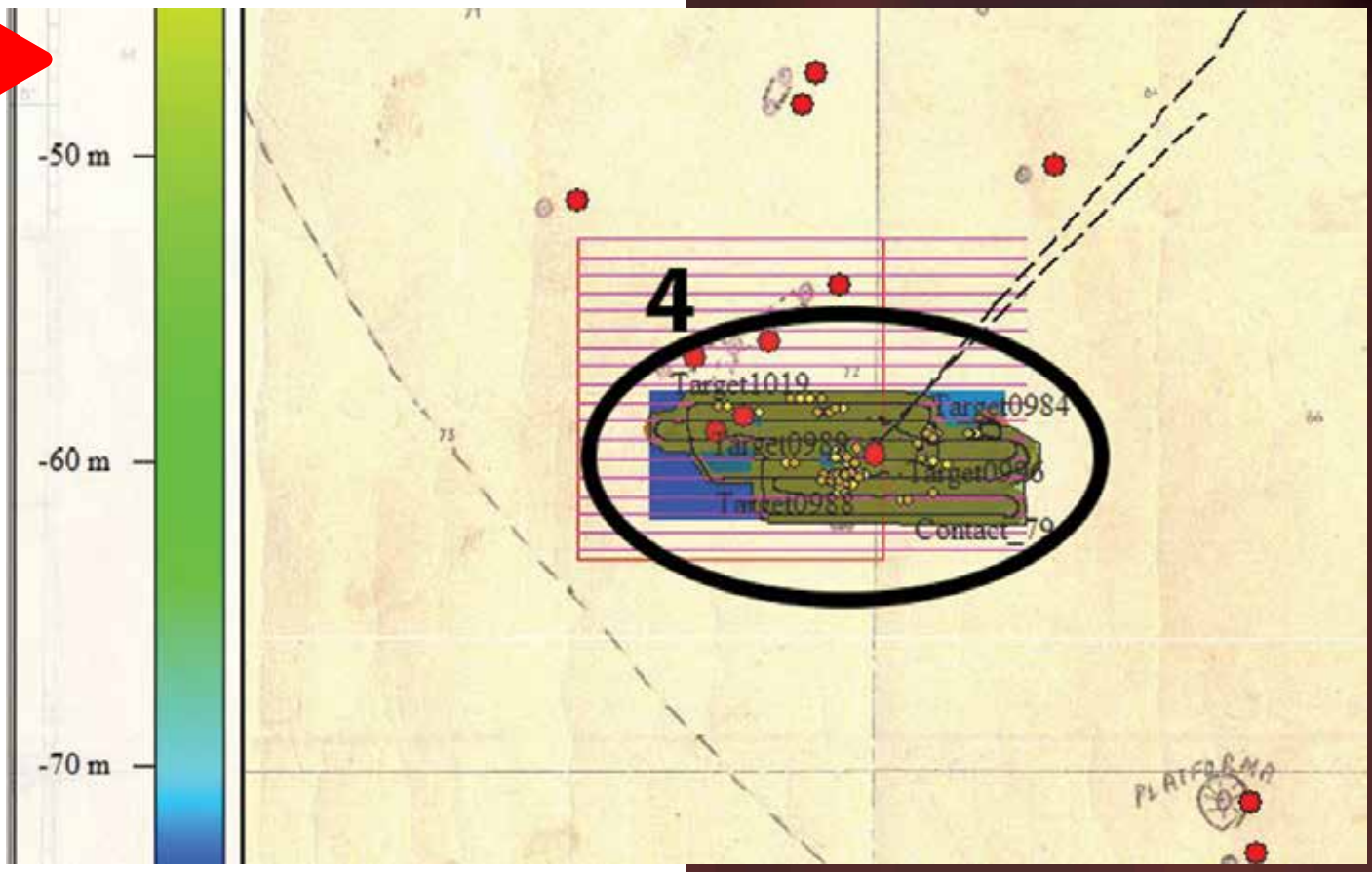
Scanning was performed of multiple areas over seven days. Each zone was marked out with parallel lines spaced 250 metres apart. This aimed to capture the entire area as dictated by the scope of the side-scan sonar. The ideal boat speed during operation was from 3.5 to 4.5 knots, with greater and lower speed also providing a means of

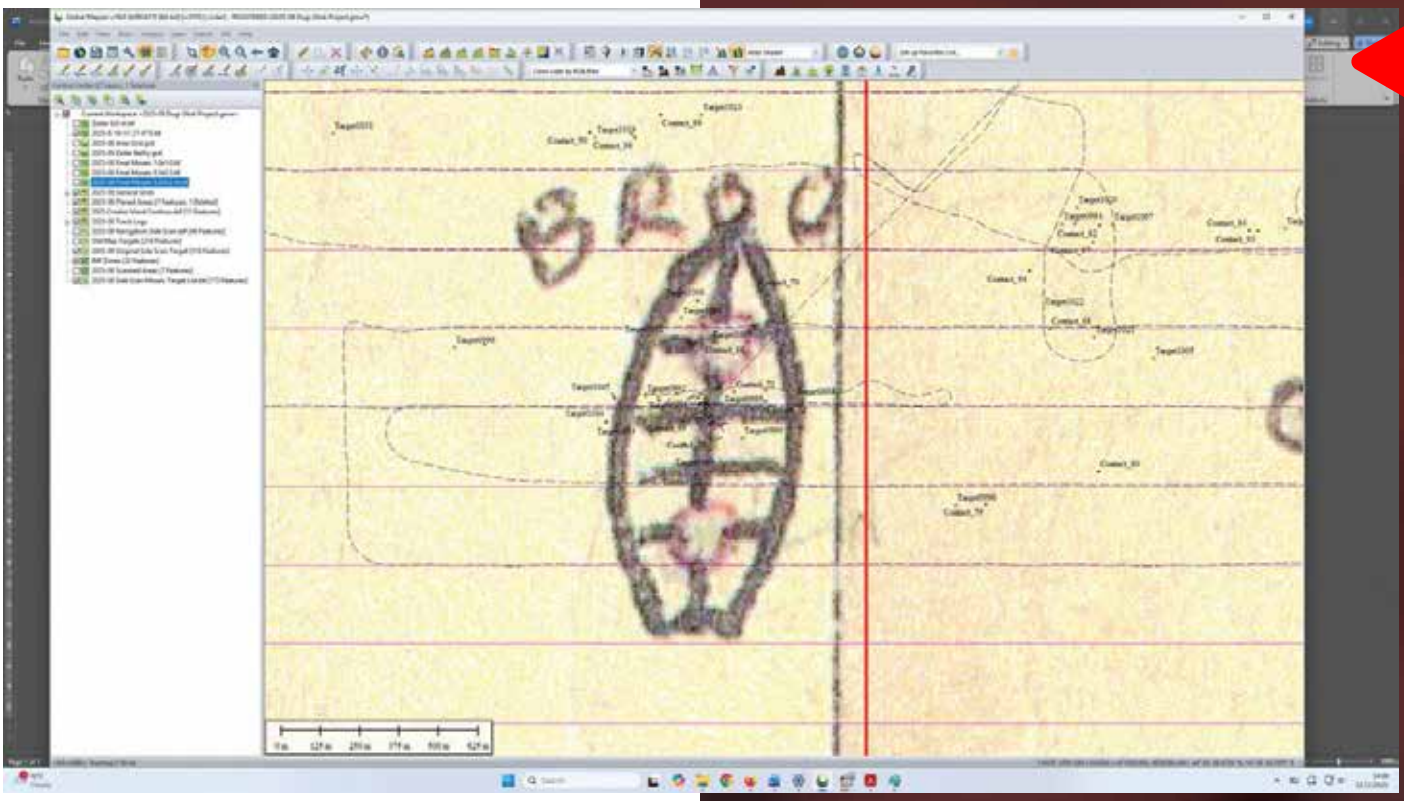
vinča. Prije odlaska na Dugi otok oprema je testirana u zadarskom kanalu te je zaključeno da je funkcionalna i da se može krenuti na istraživanje.

Ideja istraživanja bila je da se paralelno koriste Side Scan Sonara i multibeam koji imaju različite rezultate, a međusobno su kompatibilni i daju puno bolju sliku morskog dna koja se kasnije treba analizirati. Tijekom pregleda terena koristila se rezolucija multibeama koja pokriva površinu od oko 160 metara (80 m sa svake strane broda), dok je side scan sonar bio postavljen da pokriva oko 280 metara površine; sa svake strane broda 100 metara u visokoj razlučivosti i oko 40 metara u nešto slabijoj razlučivosti. Osim toga koristio se i podvodni robot, ROV model Chasing, s kojim se proveo pregled nekoliko zanimljivih lokacija. Pregledan je samo manji broj lokacija iz razloga što je ovogodišnje istraživanje bilo koncentrirano na skeniranje što većeg područja da bi se dobilo što više podataka koji se mogu pregledavati i narednih godina.

Skeniranje se provodilo kroz sedam dana na različitim područjima. Svako pojedino područje bi se označilo kao mreža paralelno postavljenih linija udaljenih međusobno 250 metara. Razlog tome je da se prilikom skeniranja pokrije kompletna površina koju obuhvaća side scan sonar. Idealna brzina kretanja broda je 3,5 do 4,5 čvorova, s tim da se smanjivanjem i povećanjem brzine dodatno može regulirati udaljenost uređaja od dna. Skeniranje se provodilo paralelno na niskoj frekvenciji od 400Hz i na visokoj frekvenciji od 900Hz. Za pregled dobivenih rezultata koristio se program Global Mapper.

5. Map of the scanned areas / Karta skeniranih područja (By: K. Velkovsky, M. Pešić)





6. The BROD position on the map / Pozicija BROD na karti (Photo: M. Pešić)

regulating the height of the device above the seabed. Scanning was performed in parallel at a low frequency of 400Hz and a high frequency of 900Hz. Global Mapper software was used to review the results.

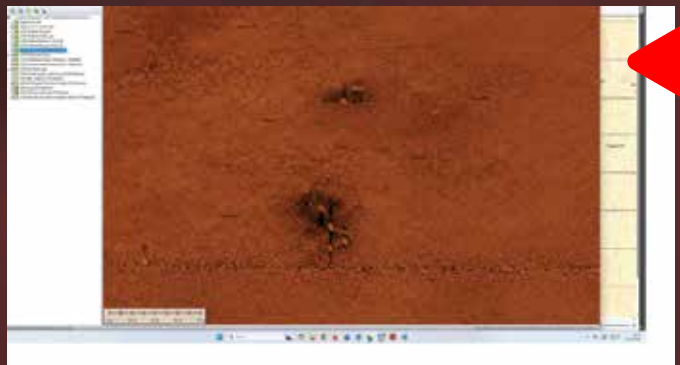
The scanning operation acquired a number of promising targets that will be analysed further; the most interesting position, however, is indicated on the mapped terrain as BROD ["SHIP"]. The scan itself and the subsequent ROV survey identified a metal wreck. There are two concentrations of metal remains, evidently parts of a ship that broke apart over a broad area when it sank. The wreck lies at a depth of 77 metres. The area was scanned several times to precisely determine the object's location and appearance, followed by a ROV descent to the seabed to image the sunken remains. What is possibly a container or tank was identified to the north side, while the main concentration of the ship's remains are to the south side. Much of the wreck is covered by nets and net cordage, some of which rise several metres above the seabed. This survey was unable to precisely establish a date, but it is possibly a twentieth century wreck.

Some of the promising positions, which give all the appearance of a wreck with amphorae, were found by ROV imaging to be no more than clusters of rock resembling such a wreck.

In the project's first season applying non-destructive methods for our survey of the seabed off Dugi otok Island proved to be a challenging but promising endeavour. This

Iako je tijelom skeniranja otkriven niz različitih meta koje se tek trebaju pregledati, najzanimljivija je bila pozicija koja je na kartama označena kao BROD. Prilikom skeniranja i prilikom naknadnog pregleda ROV-om dewfiniralo se da se radi o ostatcima metalne olupine. Radi se o dvije nakupine metala, očigledno ostatci broda koji se uslijed potapanja raspao na većem području. Nalaze se na dubini od 77 metara. Područje je skenirano više puta da bi se točno odredila lokacija i izgled objekta nakon čega je na dno spušten ROV koji je i snimio potopljene ostatke. Definirano je da se na sjevernoj strani nalazi odvojeni objekt nalik na spremnik ili tank, dok se glavna koncentracija ostataka brod nalazi na južnoj strani. Dobar dio olupine prekriven je mrežama i konopima od mreža od kojih se neki uzdižu i nekoliko metara iznad dna. Na osnovu ovog pregleda nije se moglo točno ustanoviti datacija broda, ali moguće je da on pripada periodu 20. stoljeća.

7. Results of side-scan sonar imaging of the BROD position / Rezultat skeniranja pozicije BROD na side scan sonaru (Photo: M. Pešić)



8. Remains of the metal wreck / Ostatci metalnog brodoloma (Photo: V. Dimitrov)

is an open sea area, largely uncharted in archaeological terms, and the existing data on submerged cultural heritage is modest indeed. We collected abundant data from the area surveyed with side-scan sonar and multibeam devices. Over the coming period the obtained data will be analysed in detail, informing our conclusions as to possible targets that warrant more detailed examination.

Plans are in place to continue our collaboration with the Centre for Underwater Archaeology in Bulgaria's Sozopol in the coming year, aimed at further survey scanning that will cover other areas to the north side of Dugi otok Island and at examining some of the promising targets identified this year.

9. Remains of the wreck covered with nets and cordage / Ostatci brodoloma prekriveni mrežama i konopima (Photo: V. Dimitrov)

Nažalost, na nekim pozicijama koje su potencijalno izgledale kao brodolomi s amforama, snimkom ROV-om ustanovljeno je da se radi samo o nakupini stijena koje svojim oblikom podsjećaju na brodolom s amforama.

Pregled podmorja Dugog otoka nedestruktivnim metodama se prve godine se pokazalo kao izazovan, ali zanimljiv projekt budući da je područje otvorenog mora relativno nepoznato arheolozima i podatci o potopljenoj kulturnoj baštini su vrlo oskudni. Prikupljeno je mnogo materijala sa skeniranog područja koje se pregledavalo paralelno Side scan sonarom i multibeamom. Kroz naredni period će se dobivene informacije detaljno analizirati nakon čega će se dobiti zaključak o potencijalnim metama koje je potrebno detaljnije pregledati.

Suradnja s bugarskim Centrom iz Sozopola se planira i sljedeće godine kada će se nastaviti skeniranje drugih područja na sjevernoj strani dugog otoka, a ujedno će se i pregledati neke od meta koje su skenirane ove godine.

Bibliography / Literatura:

Pešić, M. 2015. - New developments in the archaeological survey of Zadar County waters / Nove zanimljivosti s rekognosciranja podmorja Zadarske županije, *Submerged Heritage / Potopljena baština* 5, 24-28.

Uglešić, A., Parica, M. 2013. - Antička, srednjovjekovna i ranonovovjekovna arheološka baština Velog Rata, in Faričić, J. (ed.) *Veli Rat*, 147-159. Zadar: Sveučilište u Zadru.

THE UNDERWATER CULTURAL LANDSCAPES OF MONTENEGRO PROJECT: DIGITAL DOCUMENTATION TECHNIQUES FOR IN-SITU PRESERVATION

PODVODNI KULTURNI PREDJELI CRNE GORE: SAVREMENE DOKUMENTACIJSKE TEHNIKE ZA IN-SITU OČUVANJE

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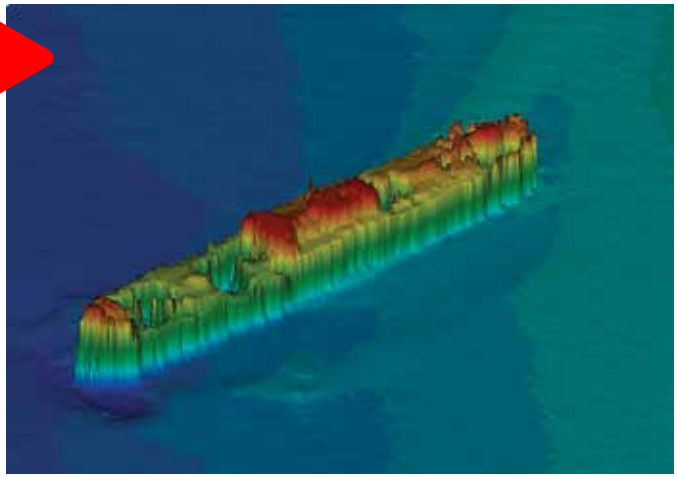
Montenegro's Adriatic coast contains underwater cultural sites that remain incompletely documented, rendering this heritage "invisible" to decision-makers and limiting its legal protection against human and environmental threats.[1] To address this gap, the "Underwater Cultural Landscapes of Montenegro" project was initiated by the Center of Archaeology, IIMS, the University of Montenegro in cooperation with the Institute of Hydrometeorology and Seismology's Sector for Hydrography and Oceanography. Building upon technical capacities from prior EU co-funded initiatives and extending foundational surveys, the project employs a multidisciplinary approach and advanced technology to generate high-resolution digital datasets. This aimed to support state institutions in establishing legal protection and monitoring systems, to align with EU directive on Maritime Spatial Planning and UNESCO recommendations.[2] Operational execution relied on an inter-institutional framework, where hydrographers Luka Ćalić and Radovan Kandić, under Director Dušica Brnović, led acoustic data acquisition, while maritime archaeologists Darko Kovačević, and Filip Popović, conducted targeted photogrammetry, archaeological interpretation, and GIS integration. Adhering to the UNESCO 2001 Convention, the project utilizes contactless documentation methods to prioritize *in-situ* preservation, ensure accurate digital documentation and creation of integrated GIS inventory of underwater cultural assets.[3]

1 MacKintosh, 2019; Royal 2015; Gačević 2012.
2 Barianaki, Kyvelou, Ierapetritis, 2023; Government of Montenegro, 2025, 99-100.
3 Guérin, 2025.

Podmorje Crne Gore krije lokalitete podvodne kulturne baštine iz različitih perioda jadranske istorije koji su zbog nedovoljne dokumentovanosti ostali „nevidljivi" donosiocima odluka i bez pravne zaštite.[1] Centar za arheologiju IIMS-a Univerziteta Crne Gore, u saradnji sa Sektorom za hidrografiju i okeanografiju Zavoda za hidrometeorologiju i seizmologiju, pokrenuo je projekat „Podvodni kulturni predjeli Crne Gore" sa ciljem da podigne svijest o neophodnosti očuvanja podvodne kulturne baštine i premosti jaz nedovoljne dokumentovanosti lokaliteta. Oslanjajući se na kapacitete razvijene kroz ranije EU kofinansirane inicijative i nadograđujući se na prethodna istraživanja, projekat primjenjuje multidisciplinarni pristup i savremene tehnologije u cilju generisanja visokorezolucijske digitalne dokumentacije. Jedan od ciljeva projekta je da se institucijama pruži podrška i stvori dokumentacijska osnova za uspostavljanje pravne zaštite, kao i inkluzija podvodne kulturne baštine u implementaciju EU Direktive o pomorskom prostornom planiranju i zadovoljavanje preporuka UNESCO-a.[2] Operativna realizacija zasnivala se na međuinstitucionalnom okviru, u kojem su hidrografi Luka Ćalić i Radovan Kandić, pod rukovodstvom direktorice Dušice Brnović, predvodili prikupljanje podataka akustičnim sonarima, dok su pomorski arheolozi Darko Kovačević i Filip Popović sprovodili fotogrametrijsko dokumentovanje, arheološku interpretaciju i GIS integraciju. U skladu sa UNESCO Konvencijom iz 2001. godine, projekat primjenjuje beskontaktne metode dokumentovanja dajući prioritet in-



1. World War Two shipwreck Maria Pompeii sunk off the coast of Platamuni in 1942 / Brodolom iz Drugog svjetskog rata Maria Pompeii, potonuo u blizini obale Platamunija 1942. godine (By: ZHMSCG, UCG)

The technical core of the "Underwater Cultural Landscapes of Montenegro" project rests on a remote sensing strategy that integrates acoustic and optical remote sensing methods, designed to maximize data fidelity through a methodology tailored to the specific environmental and structural requirements of various submerged sites.[4] The primary phase of data acquisition utilized acoustic sensors deployed from the research vessel *Sejong*, operated by the Institute of Hydrometeorology and Seismology of Montenegro. Depending on the depth and complexity of the target, documentation was strategically partitioned. Specific shipwreck sites were documented using the NORBIT iWBMS Multi-Beam Echo Sounder (MBES), which delivered ultra-high-density 3D bathymetric data to geometrically define large structures, while other sites were mapped using the Edgetech 4125 Side Scan Sonar. The Edgetech 4125, utilizing dual-frequency CHIRP technology, was instrumental for sites requiring high-frequency, 2D acoustic imagery, allowing the team to resolve scattered debris fields that geometric bathymetry might obscure.[5] For sites requiring the higher level of detail, the methodology shifted to visual documentation where divers executed targeted photogrammetry. In the final integration phase, these data streams were synthesized into operational datasets: raw acoustic data from MBES and Side Scan surveys was processed into clean 3D point clouds, digital terrain models (DTMs) and ortophotos, while the photographic datasets were processed via Structure-from-Motion (SfM) algorithms to generate photo-realistic 3D mesh models and high-resolution orthomosaics.[6] These outputs transcend simple visualization, providing digital archive that allows researchers to perform precise measurements, assess structural degradation, and set the base to monitor site

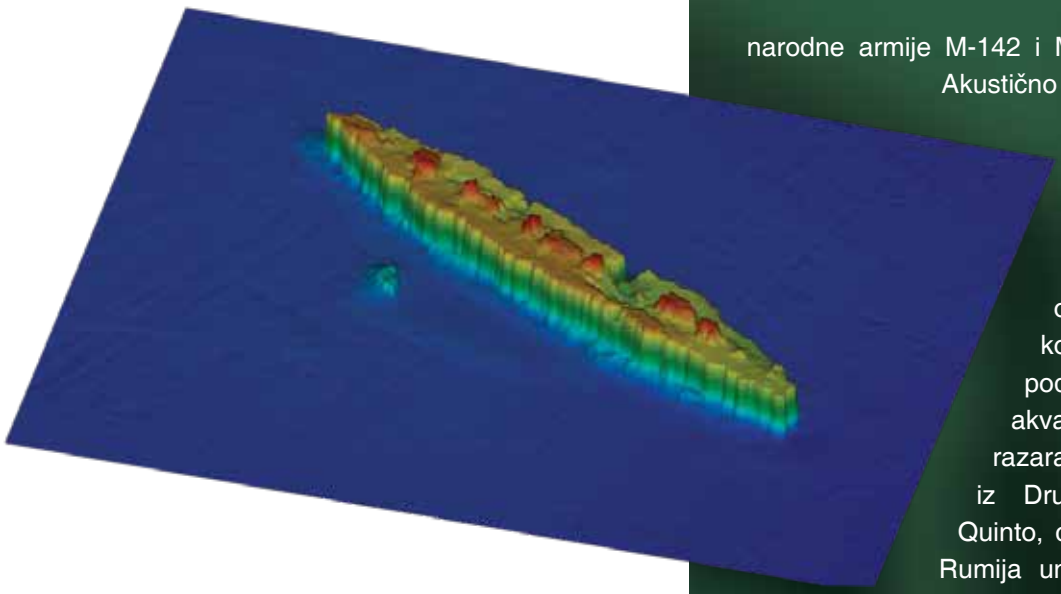
4 Papatheodorou *et al.*, 2011, 103-104.
5 Papatheodorou *et al.*, 2011, 103.
6 Calantropio, Chiabrando, 2024.

situ očuvanju, kako bi se obezbijedila precizna digitalna dokumentacija i formirao integrisani GIS inventar podvodnih kulturnih dobara.[3]

Tehničko jezgro projekta „Podvodni kulturni predjeli Crne Gore" zasniva se na strategiji koja integriše akustične i optičke metode daljinske detekcije, osmišljene da maksimizuju kvalitet podataka kroz metodologiju prilagođenu specifičnim ekološkim i strukturnim karakteristikama različitih lokaliteta podvodne kulturne baštine.[4] Primarna faza prikupljanja podataka koristila je akustične senzore postavljene na istraživačko plovilo *Sejong*, kojim upravlja Zavod za hidrometeorologiju i seizmologiju Crne Gore. U zavisnosti od dubine, razmjere i složenosti lokaliteta, dokumentovanje je strateški segmentirano. Pojedinačni brodolomi dokumentovani su korišćenjem NORBIT iWBMS višesnopnog ehosondera (MBES), koji je obezbijedio 3D batimetrijsku dokumentaciju za geometrijsko definisanje velikih struktura, dok su drugi lokaliteti mapirani pomoću bočnog sonara Edgetech 4125. Edgetech 4125, sa dvofrekventnom CHIRP tehnologijom, bio je ključan za lokalitete koji zahtijevaju 2D akustične snimke, omogućavajući dokumentovanje rasutih ostataka koje geometrijska batimetrija može zanemariti.[5] Za lokalitete koji zahtijevaju najviši nivo detalja, primenjivan je metod podvodne fotogrametrije. U završnoj fazi integracije, ovi različiti tipovi podataka objedinjeni su u operativne skupove: akustični podaci iz MBES i bočnosonarskih snimanja obrađeni su u čiste 3D oblake tačaka, digitalne modele terena (DTM) i ortofoto prikaze, dok su fotogrmetrijski setovi podataka obrađeni putem Structure-from-Motion (SfM) algoritama radi generisanja fotorealističnih 3D modela i ortomozaika.[6] Ovi rezultati prevazilaze vizuelizaciju, stvarajući bazu podataka koja omogućava precizna mjerenja, procjenu strukturne degradacije i uspostavljanje osnove za dugoročni monitoring promjena na lokalitetima bez potrebe za fizičkom intervencijom.[7]

Nadovezujući se na osnovna daljinska istraživanja koja je RPM Nautical Foundation sprovodila u periodu 2009–2014, a koja su obuhvatila priobalnu zonu do dubina od oko 100 metara duž skoro polovine obalne linije i identifikovala lokalitete od helenističkog do modernog perioda, projekat „Podvodni kulturni pejzaži" imao je za cilj da popuni preostale dokumentacione praznine evidentiranjem gotovo svih poznatih lokaliteta duž čitave obale.[8] Višeslojna metodologija projekta selektivno je primijenjena na raznovrsnu pomorsku baštinu.

Visokorezolucijski NORBIT MBES sistem korišćen je za precizno batimetrijsko definisanje širokog spektra potopljenih objekata, uključujući brodolome iz Drugog svjetskog rata Maria Pompei (Slika 1), Carlota i Oreste, motorno-jedrilicu Littorio i minolovce Jugoslovenske



2. Austro Hungarian protected cruisers SMS Zenta sunk during the Battle of Antivari, 16 August 1914 / Austrougarska zaštićena krstarica SMS Zenta, potonula tokom Bitke kod Antivarija, 16. avgusta 1914. godine (By: ZHMSCH, UCG)

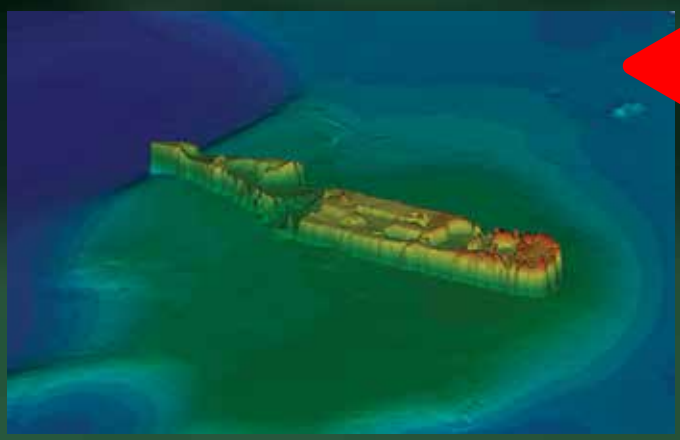
changes over time without the need for physical intervention.[7]

Building upon the foundational remote sensing campaigns conducted by the RPM Nautical Foundation between 2009 and 2014, which surveyed almost the half of the coastal zone to depths of approximately 100 meters and identified various sites from the Hellenistic to modern periods, the "Underwater Cultural Landscapes" project sought to bridge remaining documentation gaps by recording nearly all known sites along the whole coastline.[8] The project's multi-tiered methodology was applied selectively across these diverse maritime assets.

The high-resolution NORBIT Multi-Beam Echo Sounder (MBES) system was deployed to provide precise bathymetric site definitions for a wide array of submerged structures, including the World War Two shipwrecks Maria Pompei (Figure 1.), Carlota, Oreste, the moto-sailning boat Littorio and the Yugoslavian People's Army minesweepers M-142 and M-143 in the vicinity of Budva. This acoustic mapping further extended to the Austro-Hungarian cruiser SMS Zenta off the coast of Petrovac which was first time documented through this project (Figure 2), the possible Junkers 88 airplane remains near Čanj, and the diverse maritime heritage of the Bar aquatorium, encompassing the French destroyer Dague, Second World War shipwreck SS Quinto, the Montenegrin royal yacht Rumija within the harbor of Bar (Figure 3), and an unidentified shipwreck containing cannons and shipboard equipment of French origin. To complement these datasets, the Edgetech 4125 Side

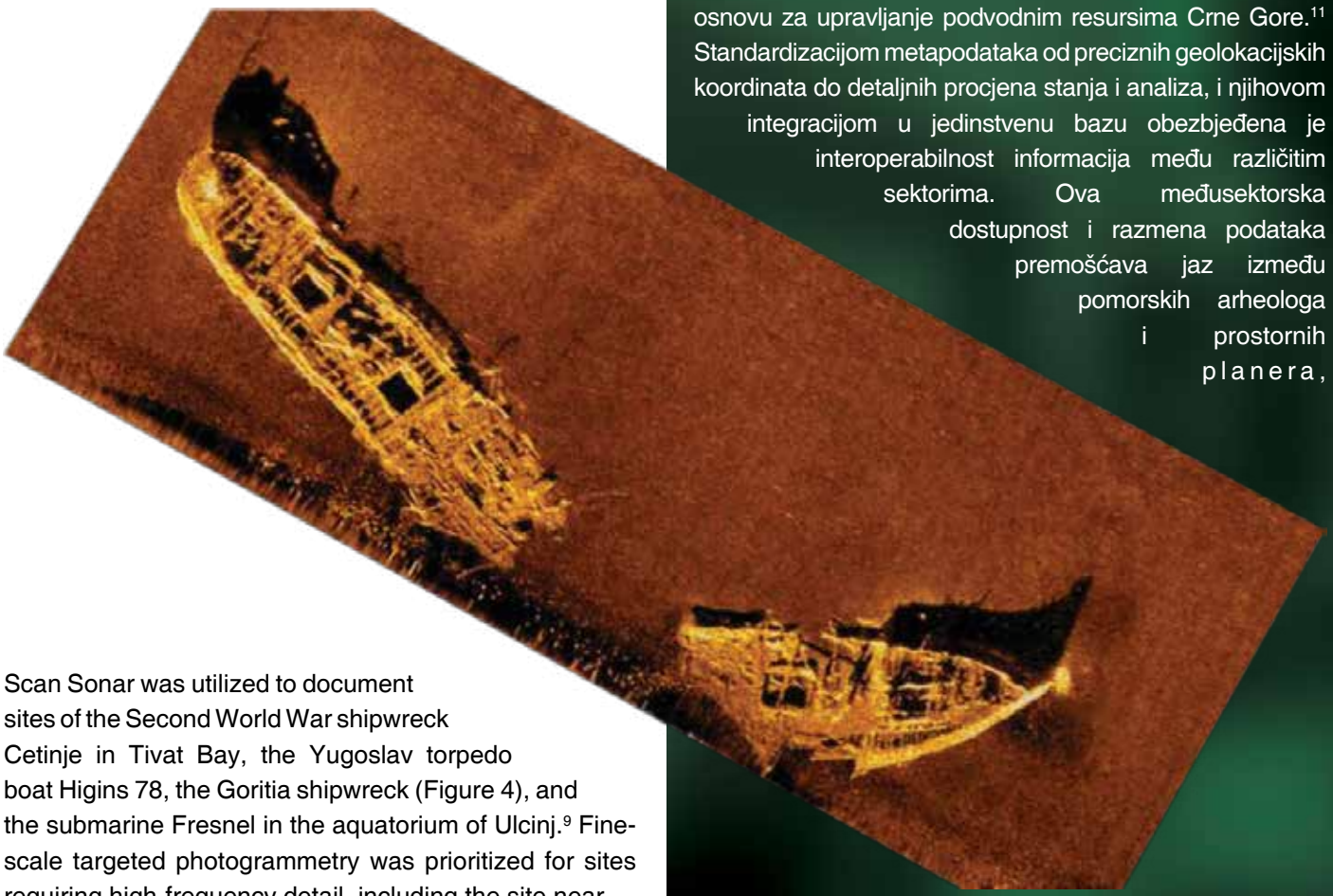
7 Calantropio, Chiabrando, 2024; Papatheodorou *et al*., 2011, 103-104.
8 Royal, 2018; Royal, 2015.

narodne armije M-142 i M-143 na području Budve. Akustično mapiranje prošireno je i na austrougarsku krstaricu SMS Zenta kod Petrovca (Slika 2), koja je prvi put dokumentovana kroz ovaj projekat, potencijalne ostatke aviona Junkers 88 kod Čanja, kao i raznovrsnu podvodnu baštinu barskog akvatorijuma, uključujući razarač Dague, brodolom iz Drugog svjetskog rata SS Quinto, crnogorsku kraljevsku jahtu Rumija unutar luke Bar (Slika 3) i neidentifikovani brodolom sa topovima i brodskom opremom francuskog porijekla nedaleko od Volujice. Bočni sonar Edgetech 4125 korišćen je za dokumentovanje parobroda Cetinje brodoloma iz Drugog svjetskog rata u Tivatskom zalivu, jugoslovenskog torpednog čamca Higins 78, parobroda Goritia (Slika 4) i podmornice Fresnel brodoloma iz Prvog svijetskog rata u akvatorijumu Ulcinja.[9] Fotogrametrija je korišćena za lokalitete koji zahtijevaju visok nivo detalja, uključujući lokalitet kod Dobreča sa imbreks crijepovima (Slika 5), parobrod Tihany iz Prvog svjetskog rata, torpedni čamac Golešnica 91 iz 20. vijeka, partorlni brod PBR512 koji je bio u sastavu Jugoslovenske ratne mornarice (Slika 6), ostatke aviona Supermarine Spitfire IX Trop u priobalju Herceg Novog, kao i brodolom iz Drugog svjetskog rata Oreste kod Budve i razarač Dague iz Prvog svjetskog rata kod Luke Bar.[10]



3. Remains of the Royal yacht "Rumija" gifted to Prince Nicholas I of Montenegro by Turkish Sultan Abdul Hamid II, sunk by Austria-Hungary in March 1915 in the Port of Bar / Ostaci kraljevske jahte Rumija, poklonjene knjazu Nikoli I Crnogorskom od strane turskog sultana Abdul Hamida II, potopljene od strane Austro-Ugarske u martu 1915. godine u luci Bar (By ZHMSCG, UCG)

Nakon prikupljanja, podataci su objedinjeni u centralizovanu GIS bazu podataka, koja predstavlja



Scan Sonar was utilized to document sites of the Second World War shipwreck Cetinje in Tivat Bay, the Yugoslav torpedo boat Higins 78, the Goritia shipwreck (Figure 4), and the submarine Fresnel in the aquatorium of Ulcinj.[9] Fine-scale targeted photogrammetry was prioritized for sites requiring high-frequency detail, including the site near

Dobreč comprised of *imbrex* tiles (Figure 5), the World War I steamer Tihany, the mid-20th-century torpedo boat Golešnica 91, patrol boat PBR 512 of Yugoslav People's Army (Figure 6) and the remains of a Supermarine Spitfire IX Trop airplane in the littoral of Herceg Novi, as well as the significant Second World War shipwrecks Oreste near Budva and the World War I wreck of French destroyer Dague near the Port of Bar.[10]

The project went beyond mere data collection by consolidating all survey outputs into a centralized Geographic Information System (GIS) database, creating a comprehensive digital inventory that serves as the baseline for the management of Montenegro's underwater resources.[11] By transforming isolated datasets into a coherent inventory and standardizing metadata, ranging from precise geolocation coordinates to comprehensive condition assessments and analysis, the database ensures that information remains interoperable across various state sectors. This cross-sectoral integration is bridging the historical disconnect between maritime archaeologists and state planners by rectifying the previous "invisibility" of these sites in broad development strategies. Now, institutions involved in the chain of cultural heritage protection, along with spatial planning authorities, can access a unified layer of spatial data,

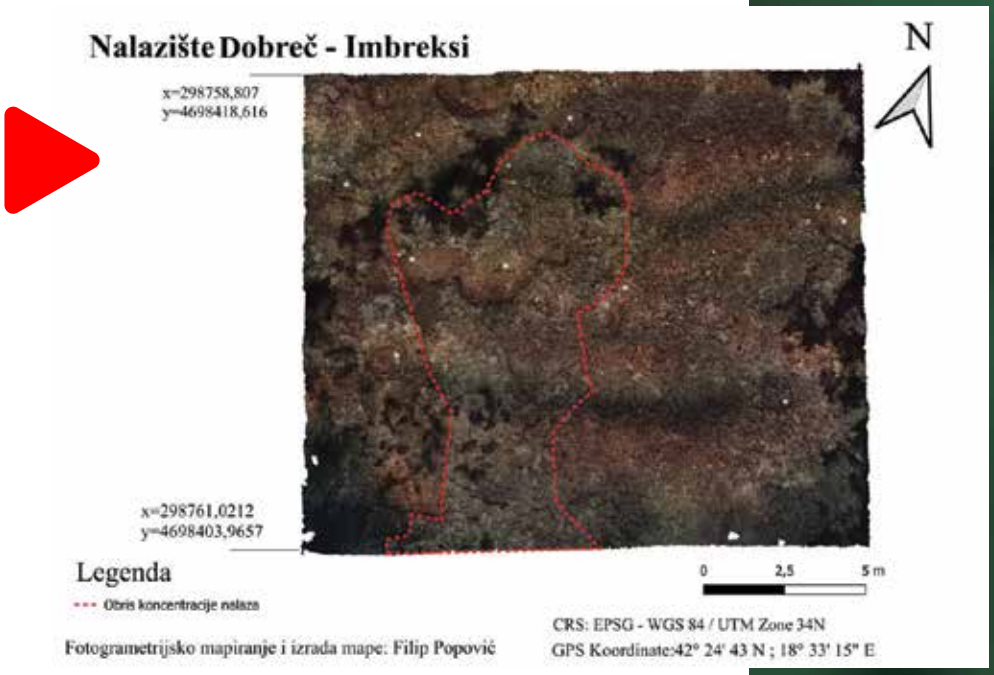
9 Gačević, 2012
10 Gačević, 2012.
11 Figueiredo, Bernardes, 2010

osnovu za upravljanje podvodnim resursima Crne Gore.[11] Standardizacijom metapodataka od preciznih geolokacijskih koordinata do detaljnih procjena stanja i analiza, i njihovom integracijom u jedinstvenu bazu obezbjeđena je interoperabilnost informacija među različitim sektorima. Ova međusektorska dostupnost i razmena podataka premošćava jaz između pomorskih arheologa i prostornih planera,

▶ 4. The steamship "Goritia" mixed cargo steamship of the Austrian "Lloyd" sunk in the vicinity of Ulcinj / Parobrod Goritia, mješoviti teretni parobrod austrijskog „Lloyda", potonuo u blizini Ulcinja (By: ZHMSCG, UCG)

ispravljajući prethodnu „nevidljivost" ovih lokaliteta u širim razvojnim strategijama. Institucije uključene u lanac zaštite kulturne baštine, kao i organi prostornog planiranja, sada imaju pristup jedinstvenom sloju prostornih podataka, što omogućava Upravi za zaštitu kulturnih dobara da definiše pravnu zaštitu, dok planerima omogućava sagledavanje zona kulturne baštine i njenih konflikata sa drugim konkurentnim pomorskim interesima.[12] GIS baza funkcioniše kao aktivni alat upravljanja koji olakšava donošenje odluka i osigurava da se podvodna kulturna baština prepozna kao kulturno dobro unutar administrativnog i pravnog okvira Crne Gore.[13]

Projekat „Podvodni kulturni predjeli Crne Gore"je doprineo izradi Prostornog plana Crne Gore do 2040. godine, obezbjeđujući podatake potrebne za podizanje statusa potopljene baštine u nacionalnoj planskoj hijerarhiji.[14] Unošenjem preciznih georeferenciranih koordinata i digitalne dokumentacije u državni planski okvir, projekat je stvorio osnovu da se podvodna kulturna baština uzme u obzir tokom implementacije EU Direktive o pomorskom prostornom planiranju (2014/89/EU). Kako Crna Gora usklađuje svoje pomorske politike sa EU standardima,



5. The plan of the site near the Dobreč cape comprised of imbrex tiles / Plan lokaliteta u blizini rta Dobreč, koji čine imbreks crijepovi (By: Filip Popovic, UCG)

enabling the Authority for Protection of Cultural Properties to define precise legal boundaries and terms of protection, while allowing planners to view heritage zones alongside competing maritime interests.[12] Consequently, the GIS database functions not just as a static archive, but as an active governance tool that facilitates informed decision-making and ensures that underwater cultural landscapes are recognized as tangible assets within Montenegro's administrative and legal framework.[13]

The inventory developed through the "Underwater Cultural Landscapes of Montenegro" project has contributed to the Spatial Plan of Montenegro until 2040, providing the evidence-based dataset required to elevate submerged heritage within the national planning hierarchy.[14] By embedding precise georeferenced coordinates and digital documentation into the state's planning framework, the project is preparing the necessary ground for the UCH to be took into account during the implementation of the European Union's Maritime Spatial Planning (MSP) Directive (2014/89/EU). As Montenegro aligns its maritime policies with EU standards, the project's GIS database provides a "clash-detection" mechanism to manage overlaps between cultural heritage and other maritime industries, such as tourism development, energy infrastructure (submarine cables), and commercial fishing.[15]

baza podataka pruža doprinos upravljanju preklapanjima između kulturne baštine i drugih pomorskih djelatnosti, poput turističkog razvoja, energetske infrastrukture (podmorski kablovi) i komercijalnog ribarstva.[15]

Pored uticaja na politike, rezultati projekta dostavljeni su svim institucionalnim akterima u lancu podvodne kulturne baštine radi jačanja institucionalnih kapaciteta, dok je zajednička izložba sa Pomorskim muzejem Crne Gore u Kotoru doprinijela podizanju javne svijesti o ovim „skrivenim" dobrima (Slika 7). Konačno, ovaj digitalni arhiv predstavlja trajnu osnovu za praćenje degradacije lokaliteta i uticaja klimatskih promjena, kao i ključni preduslov za održivo upravljanje i pravnu zaštitu podvodne kulturne baštine.

12 Firth, 2018, 30-31
13 Spreafico *et al.*, 2024.
14 Government of Montenegro, 2025, 99-100.
15 Firth, 2018, 30-31.

Bibliography / Bibliografija:

Barianaki, I., Kyvelou, S., Ierapetritis, D. 2023. - How to incorporate cultural values and heritage in maritime spatial planning (MSP): a systematic overview, *Preprints* 2023.

Calantropio, A., Chiabrando, F. 2024. - Underwater Cultural Heritage Documentation Using Photogrammetry, *Journal of Marine Science and Engineering* 13(3), 413.

Figueiredo, A., Bernardes, I. 2010. - The importance of GIS in underwater archaeology, in *UISPP Conference Proceedings* (Archaeopress, volume 5, 2010).

Fith, A. 2018 - *Managing shipwrecks*. Fjodr Limited for Honor Frost Foundation.

Gačević, D. 2012. - *Podmorje Crne Gore*. Herceg Novi: Matica crnogorska.

Government of Montenegro, Ministry of Spatial Planning, Urbanism and State Property. 2025. - *Spatial Plan of Montenegro up to* 2040. Podgorica.

Guérin, U. 2025. - Preserving the heritage of the deep: addressing the current challenges of underwater cultural heritage, in UNESCO Secretariat of the 2001 Convention on Protection of the Underwater Cultural Heritage PH Magazine (115).

6. Patrol Boat of Yugoslavian People's Army PBR 512 sunk within the Zanjice Bay / Patrolni čamac Jugoslovenske narodne armije PBR 512, potonuo u uvali Žanjice (Photo: Center of Archaeology, UCG)

Beyond policy, the project results were fed to the all institutional stakeholders in the underwater cultural heritage value chain to strengthen institutional capacity, while a collaborative exhibition with the Maritime Museum of Montenegro in Kotor raised public awareness of these "hidden" assets (Figure 7). Ultimately, this digital archive serves as a permanent baseline for monitoring site degradation and climate change impacts and essential prerequisite for the sustainable management and legal protection of underwater cultural heritage.

7. Underwater Cultural Landscapes of Montenegro, an open air exhibition in front of Maritime Museum of Montenegro / Podvodni kulturni pejzaži Crne Gore, izložba na otvorenom prostoru ispred Pomorskog muzeja Crne Gore (Photo: MMM, UCG)

MacKintosh, R. 2019. - Capacity in Maritime Archaeology: A Framework for Analysis, *Journal of Maritime Archaeology* 14(3), 391-408.

Papatheodorou, G., Geraga, M., Chalari, A., Christodoulou, D., Iatrou, M., Fakiris, E., Kordella, S., Prevenios, M. Ferentinos, G. 2011. - Remote sensing for underwater archaeology: case studies from Greece and the Eastern Mediterranean, *Bulletin of the Geological Society of Greece* XLIV, 100-115.

Royal, J. 2015. - Maritime evidence for overseas trade along the Ilyrian coast: the eastern Mediterranean connections, in Demesticha, S. (ed.) *Per terram, per mare: Seaborne trade and the distribution of Roman amphorae in the Mediterranean*, 199-218. Uppsala: Åströms.

Royal, J. 2018 - *The Ilyrian Coastal Exploration Program (2010-2014): The Roman and Late-Roman finds*, independently published.

Spreafico, A., Colucci, E., Chiabrando, F., Auriemma, R. 2024. - A review of existing sources for the design of an archaeological underwater cultural heritage database of the Puglia Region (Italy), *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XLVIII(4), 445-452.

FASCINATING FINDS FROM SVETI ANTE STRAIT NEAR ŠIBENIK

ZANIMLJIVI NALAZI IZ KANALA SV. ANTE KOD ŠIBENIKA

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While implementing measures aimed at protecting Croatia's fan mussel population diver Đani Iglić of Bibinje observed a number a large sherds of Roman period amphorae off Cape Šenišna in the area immediately facing the Sveti Ante Strait Visitor Centre, notifying the International Centre for Underwater Archaeology in Zadar of his discovery. It was evident from the submitted photographs that this was not an everyday find and that it warranted inspection and, if possible, recovery. The findspot falls within the area administered by the Nature of Šibenik-Knin County public institution. ICUA Zadar contacted the institution's management to arrange the details of underwater surveying. We planned a limited duration activity to collect artefacts, establish the findspot characteristics, and ascertain the broader site context and potential. With this in mind we planned dives both at the findspot and along the opposite shore to establish a possible pattern in the broader area. Taking part were ICUA Zadar specialists Luka Bekić PhD, Maja Kaleb, Roko Surić, and Šime Vrkić PhD, joined by technical diver Đani Iglić. The investigative work covered three days. The initial survey of the terrain was done on 27 May 2025, the second on 5 June, and the third on 25 September.

The first day of our survey, in May of 2025, we headed out in the waters facing the visitor centre at the Sveti Ante Strait. Our team of underwater archaeologists began their dive to the west of Cape Šenišna, working in two groups. The first group documented and collected finds at depths of about twenty metres, while the second group descended to thirty metres to seek any remaining finds. Visibility was limited but satisfactory. The terrain is made up of loose broken stone and drops relatively abruptly to a sandy bottom at thirty metres depth. Both groups saw successful dives at this position, collecting nine large amphorae sherds, most from neck and upper body sections.

Povodom provođenja mjera zaštite plemenite periske, ronilac Đani Iglić iz Bibinja primijetio je kod rta Šenišna, odmah ispred Posjetiteljskog centra Sv. Ante, nekoliko većih komada rimskih amfora i o tome obavijestio Međunarodni centar za podvodnu arheologiju u Zadru. S obzirom na dostavljene fotografije, bilo je jasno da su nalazi nesvakidašnji i da bi bilo potrebno obaviti uviđaj i prema mogućnosti prikupiti neke od nalaza. Djelatnici MCPA Zadar su stupili u kontakt s upravom Javne ustanove Priroda Šibensko – kninske županije, na čijem su prostoru nađeni spomenuti nalazi i dogovorena je suradnja oko obavljanja podvodnih pregleda. Isplanirana je jedna kratka i vremenski ograničena akcija, u kojoj bi se nalazi prikupili, ustanovio karakter nalazišta i pokušalo prepoznati širi kontekst i potencijal ove pozicije. Stoga je odlučeno roniti na poziciji nalaza, ali i pregledati nasuprotnu obalu kako bi se ustanovio možebitni obrazac na širem prostoru. U istraživanju su sudjelovali doc. dr. sc. Luka Bekić, Maja Kaleb, Roko Surić, dr. sc. Šime Vrkić (MCPA Zadar) i tehnički ronilac Đani Iglić. Istraživanje je provedeno u tri radna dana. Prvi pregled terena obavljen

1. Divers at the point of entry into the sea facing the Sveti Ante Strait Visitor Centre / Ronioci na mjestu ulaza u more, ispred Posjetiteljskog centra Sv. Ante (Photo: Š. Vrkić)

2. One of the amphorae on the seabed off Cape Šenišna / Jedna od amfora na dnu ispred rta Šenišna (Photo: R. Surić)

A third group was set up to survey the east end of Cape Šenišna and Minerska (Tratica) Cove. The survey off Minerska Cove did not yield archaeological finds of any significance, with only sporadic amphorae sherds found in the deeper water facing the cove, in the strait.

Plans were developed following our survey of the south side of the Sveti Ante Strait to survey the coves to the other side with the aim of determining if the same types of localities, possible anchorage sites, are present there. We selected Čapljena Cove and Sičenica Cove, two inlets that appear most promising in this regard. Their positions and configurations make them favourable as Roman period anchorage sites, and we expected to find a situation analogous to that on the south side. This survey was performed in June of 2025.

Our first group of divers surveyed the whole of Čapljena Cove and found sporadic artefacts attributable to the post-medieval period. These are jugs and bowls largely of north Italian maiolica sgraffito ware and other related

3. A diver at Čapljena Cove with a post-medieval bowl / Ronilac u uvali Čapljena s novojekovnom zdjelom (Photo: R. Surić)

je 27. svibnja 2025.g., a drugi pregled 5. lipnja. Treći terenski pregled obavljen je 25. rujna 2025. g.

Prvog dana pregleda, u svibnju 2025. g. akcija je započela ispred Posjetiteljskog centra u kanalu Sv. Ante. Podvodni arheolozi su se spustili u more zapadno od rta Šenišna, te su se podijelili u dvije skupine. Prva skupina je dokumentirala i prikupila nalaze na oko 20 m dubine, dok se druga skupina spustila do 30 m dubine gdje su tražili preostale nalaze. Vidljivost je bila ograničena, ali zadovoljavajuća. Teren je sipki razlomljeni kamen i razmjerno se naglo spušta prema 30 metara gdje se nalazi pješčano dno. Obje skupine su izronile uspješno i na toj poziciji je prikupljeno 9 većih dijelova amfora, uglavnom grla i gornjih dijelova.

Nakon toga, formirana je treća skupina, koja je trebala pregledati istočni dio rta Šenišna i uvalu Minerska (Tratica). Prilikom pregleda uvale Minerska nisu pronađeni značajniji arheološki nalazi, mada se na dubljem dijelu ispred uvale, u kanalu, mogu pronaći sporadični ulomci amfora.

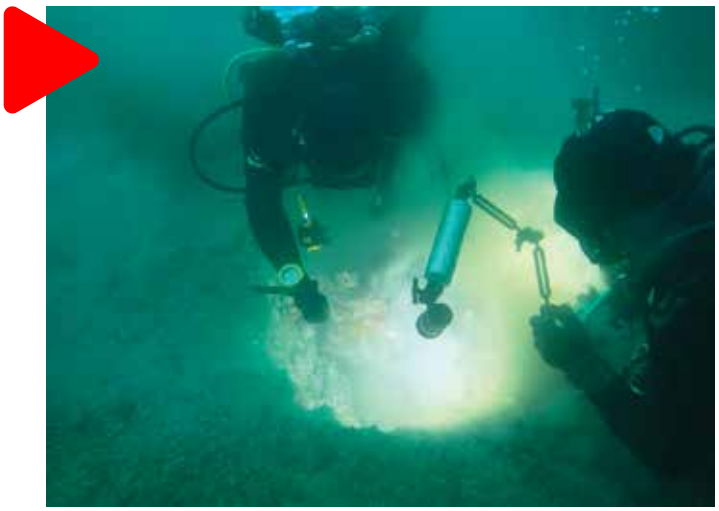
Nakon pregleda južne strane kanala Sv. Ante, planiran je pregled nasuprotnih uvala, kako bi se ustanovilo da li se isti karakter nalazišta, potencijalno sidrište, može očekivati i tamo. Izabrane su dvije uvale s najviše potencijala, uvala Čapljena i uvala Sičenica. One po svom položaju i konfiguraciji čine povoljni prostor za sidrenje brodova u rimsko doba, te se očekivala analogna situacija kao na južnoj strani. Taj pregled obavljen je u lipnju 2025. g.

Prva skupina ronioca pregledala je cjelokupnu uvalu Čapljena i pronašla je sporadične nalaze koji se mogu pripisati novovjekovnom razdoblju. To su vrčevi i zdjele koji uglavnom pripadaju sjevernotalijanskoj graviranoj majolici, ali i drugim srodnim nalazima. Svi ti nalazi mogu se datirati od 16. do 18. st. Iznenađujuće je malo bilo nalaza iz rimskog razdoblja, jedno grlo amfora tipa Forlimpopoli i još tek nekoliko manjih ulomaka drugih amfora. Ovo ukazuje da uvala Čapljena u rimsko doba nije bila od veće važnosti.

Sljedeća skupina ronioca trebala je pregledati uvalu Sičenica, koja se i danas koristi kao komunalna lučica i sidrište za jahte. Pregledan je dio komunalne lučice, kao i sidrište u sredini uvale. U ovom slučaju novovjekovni nalazi su gotovo potpuno izostali, ali je pronađeno nešto više rimskih ostataka. Na dubinama od oko 20 pa do 10 metara, prema sjevernom dijelu uvale i uzvisini Štrika pronađeni su raštrkani ulomci amfora, uglavnom trbusi i donji dijelovi, bez gornjih dijelova, što ukazuje na kontinuiranu pljačku. Zanimljivo je da sve amfore pripadaju osnovnom tipu amfora, Dressel 6A, koja se odlikuje širim trakastim obodom grla i izduženijim šiljkom

artefacts. These are all finds attributable to the sixteenth to eighteenth century period. The number of Roman period finds was surprising small; a neck sherd from a Forlimpopoli amphora, and a few small sherds from other amphora forms. This indicates that Čapljena Cove was not frequented during the Roman period.

The second group of divers was tasked with surveying Sičenica Cove, currently a small municipal harbour and yacht anchorage. A part of the harbour and the anchorage area in the middle of the cove were surveyed. Here we found an almost complete absence of post-medieval artefacts, but did identify a somewhat greater number of Roman era remains. Scattered sherds, largely from the body and lower body of amphorae, absent upper parts, were found at depths ranging from twenty to ten metres towards the north end of the cove facing the higher ground at the Štrika location, all pointing to long term looting. It is noteworthy that all of these amphorae are of the basic type, the Dressel 6A, characterised by a broad strap-like rim and an elongated spike at the base. This suggests that this locality was of particular importance over a brief period of the Roman administration of the first century. Given the degree of looting we cannot know whether the finds here are evidence of a single episode or of



4. Excavation of amphorae sherds at about thirty metres depth off Cape Šenišna / Iskopavanje dijela amfore na oko 30 m dubine kod rta Šenišna (Photo: Š. Vrkić)

continuous anchorage activity in the first century. What is clear, however, is that the survey of this cove did not yield the same results as seen at Šenišna Cape, which leads to our conviction that the Šenišna site was a position of some importance in the Roman period. Amphorae sherds were not collected from Sičenica Cove.

Given the results up to that point we opted to repeat the survey of the Cape Šenišna area, but with a wider scope. This survey was performed in September of 2025. The survey was envisaged as first covering the

na dnu. To pokazuje da je ovo mjesto bilo od posebne važnosti u neko kraće vrijeme rimske uprave u prvom stoljeću. Jesu li nalazi na ovoj poziciji trag jednokratnog događaja ili kontinuiranog sidrenja u doba 1. st. nije moguće utvrditi, s obzirom na stupanj pljačke nalaza. Ipak, pregled ove uvale nije polučio iste rezultate kao na rtu Šenišna, što nas je uvjerilo kako se tamo radilo o značajnijem položaju u rimsko doba. Ulomci amfora iz uvale Sičenica nisu prikupljani.

S obzirom na dotadašnje rezultate, odlučeno je ponoviti pregled prostora kod rta Šenišna, ali sa širim opsegom. Taj pregled proveden je u rujnu 2025. g. Podvodni pregled je koncipiran na način da se prvo pretraživalo dublje podmorje, na dubinama preko 30 metara, a kasnije plići dio prema uvali Škar, uglavnom na 20 metara, ali i manje. Pregledom dubljeg dijela, ponovno su pronađene amfore, ovaj puta skoro čitava amfora tipa Dressel 2-4. Osim na tom dijelu, i na plićim dijelovima zapadne strane rta Šenišna, pronađeno je nekoliko koncentracija amfora koje se mogu datirati u različita razdoblja.

Pronađeno je i jedno veliko admiralsko sidro koje leži na otprilike 20 m dubine. Tijelo sidra je dužine preko tri metra, a prečka je duga oko dva metra, što znači da je služilo za brod većih dimenzija. Točna datacija sidra u ovom trenutku nije moguća, ali vjerojatno potječe iz 19.

5. A lower part of a Dressel 6A amphora from the north end of Sičenica Cove / Donji dio amfore Dressel 6A na sjeveru uvale Sičenica (Photo: M. Kaleb)

area at depths in excess of thirty metres, and later the shallower waters towards Škar Cove, most at a depth of twenty metres, some at lesser depths. Amphorae were again found during the survey of the deeper area, this time an almost intact amphora of the Dressel 2-4 type. Several concentrations of amphorae attributable to various periods were identified in other areas, and in the shallower areas of the west side of Cape Šenišna.

A large admiralty pattern anchor was found lying at a depth of about twenty metres. The shank measures over three metres, and the stock about two, meaning that it was used on a large ship. An exact date cannot yet be determined, but it is likely attributable to the nineteenth century. In all, this dive recovered five amphorae sherds, three from the upper and two from the lower parts.

These finds in the depths off Cape Šenišna point to a multi-century period across which Roman period ships anchored here. Another notable detail is that our survey of the shallower water along the shore found small amphorae sherds encrusted to the rock near the shore. That these finds were made in the area near the shore tells us that this activity was not limited merely to sporadic anchoring during navigation, rather it points to some more significant Roman era onshore activity. It is too early to speculate as to what that might have been, but it is possible that there was a *villa rustica* or some other onshore economic activity such as a saltworks. It would be useful to compare the results of these investigations with field reconnaissance onshore to establish the broader context of these finds.

The significant artefacts here are the amphorae sherds collected off Cape Šenišna. In all, fourteen large pieces were recovered, most neck and spike sherds, of a diversity that gives us a chronological and typological range. The preliminary typological identification is based on visual inspection of the amphorae sherds, while final analysis will include examination of the fabric, i.e., the material composition and texture of the ceramic body.

The earliest amphorae are of the early Lamboglia II type, dated to the second century BCE and manufactured in the north of Italy. There are other similar sherds from the Cape Šenišna site. These are followed chronologically by sherds

st. Sveukupno je tijekom tog zarona izronjeno pet dijelova amfora, tri gornja i dva donja dijela.

6. An admiralty pattern anchor off Cape Šenišna / Admiralsko sidro pred rtom Šenišna (Photo: Đ. Iglić)

Ovi nalazi u dubinama pred rtom Šenišna ukazuju na dugotrajno, višestoljetno sidrenje rimskih brodova na ovom mjestu. Također je vrlo zanimljiv bio i pregled plićeg dijela uz obalu, gdje su ustanovljeni manji ulomci amfora koji su inkrustrirani uz obalne stijene. Činjenica da su ti nalazi uz samo obalu, ukazuje nam da ovdje nije bila riječ samo o sporadičnom sidrenju tijekom plovidbe, nego je i na obali bilo neke značajnije rimske aktivnosti. Za sada nije moguće ustanoviti o čemu je riječ, ali moguće da je na obali postojala neka *villa rustica* ili drugi gospodarski objekti, poput solana il slično. Rezultate ovih istraživanja bilo bi korisno usporediti s terenskim rekognosciranjima na priobalnim kopnenim dijelovima kako bi se ustanovi širi kontekst ovih nalaza.

7. Dressel 2-4 Tyrrhenian amphora, 1st c. BCE to 1st c. CE / Amfora tipa Dressel 2-4 Tirrenica, datacija 1. st. pr. Kr. do 1. st. (Photo: Š. Vrkić)

Od pokretnih nalaza, najvažnije su amfore prikupljene pred rtom Šenišna. Sveukupno je izvađeno 14 većih ulomaka, uglavnom grla i šiljaka, koje svojom raznolikošću pokazuju datacijski i tipološki spektar nalaza. Napravljena su preliminarna tipološka određenja sukladno vizualnom pregledu, dok će se konačna analiza napraviti nakon provjere fakture amfora.

from Dressel 2-4 Adriatica amphorae of the first century BCE to first century CE, originating from the eastern shores of Italy. One is of the Dressel 2-4 Tyrrhenian type, of the same date range, but produced in workshops along the Tyrrhenian Sea. The upper part of its handle is slightly broader.

Two neck sherds were recovered from Forlimpopoli amphorae of the mid-first to mid-third century, originating from Forli in Italy. A sherd was recovered attributable to the Almagro 50 type of the third to fourth century, and another to the closely related Almagro 51C type of the fourth to mid-fifth century. These types originate from Lusitania. One of the recovered amphora sherds may be attributable to the Kapitän I type of the late second to fourth century, differentiated, however, by a grooved handle.

A number of north African amphorae were found. Two are necks sherds; of the mid-third to early fifth century Africana IID type, and of the third century Africana IIB type, both from what is now Tunisia. An amphora spike sherd is of the Africana IIIC/Keay XXV type of the late fourth to first half of the fifth century, also of north African origin. The most recent amphora is of the Late Roman I type of the fifth to seventh century period, from what was once the province of Cilicia.

A number of post-medieval artefacts were recovered. These include a sixteenth century *alla porcellana* plate, and a bowl and jug, both with engraved decoration and both of the sixteenth to seventeenth century period. All are of north Italian origin. The most recent find is of a chamber pot, dated to the period up to the eighteenth century, also from the north of Italy.

8. An amphora, likely of the Almagro 50 form, 3rd to 4th c. CE / Amfora, vjerojatno tip Almagro 50, datacija 3. do 4 .st. (Photo: Š. Vrkić)

9. Africana IID type amphora, mid-3rd to early 5th c. CE / Amfora tipa Africana IID, datacija sredina 3. do početka 5. st. (Photo: Š. Vrkić)

Najranija amfora pripada tipu rane Lamboglie II, koja se datira 2. st. pr. Kr., a porijeklo je sjeverna Italija. Sličnih ulomaka ima još kod rta Šenišna. Nakon njih datacijski dolaze dijelovi amfora tipa Dressel 2-4 Adriatica, s datacijom od 1.st. pr. Kr do 1. st., a porijeklo im je istočna obala Italije. Jedna pripada sličnom tipu Dressel 2-4 Tirrenica, s istom datacijom, ali iz radionica na Tirenskom moru. Ova ima malo širi gornji dio ručki.

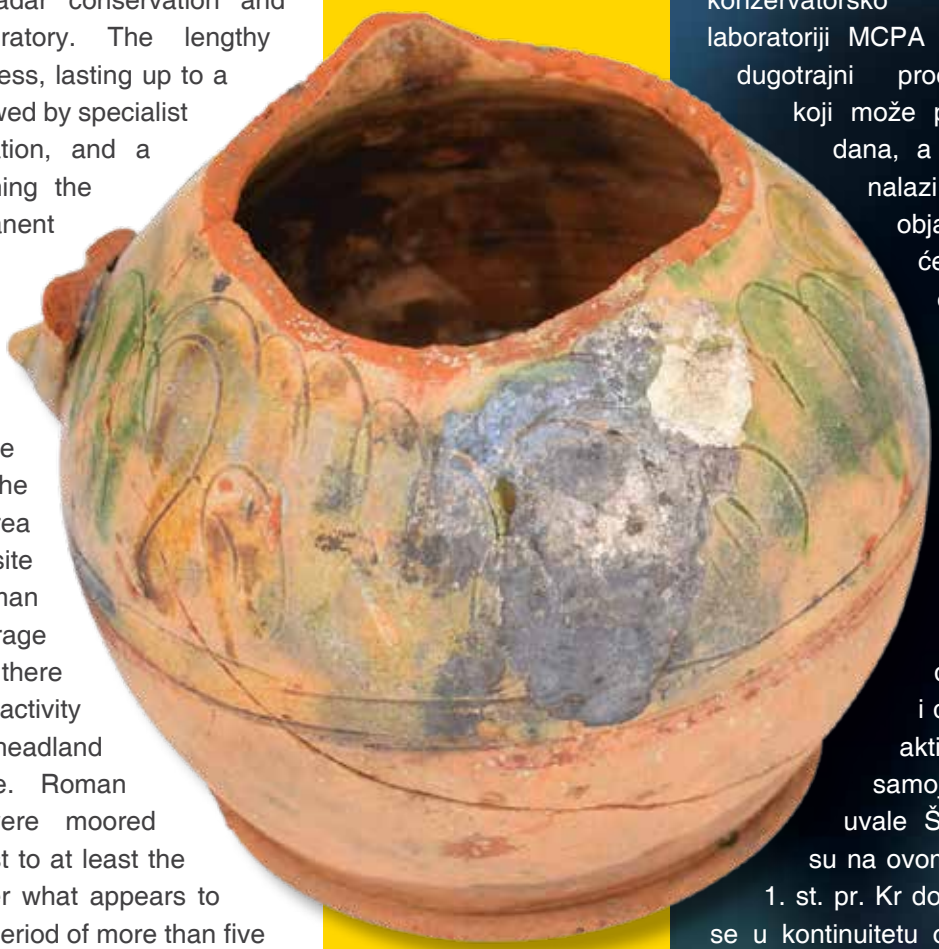
Nadalje, pronađena su dva grla amfora tipa Forlimpopoli, s datacijom od sredine 1. st. do sredine 3 st. Porijeklo im je Forli, Italija. Jedan primjerak amfore mogao bi se pripisati tipu Almagro 50 koji se datira od 3. do 4. st., a drugi bliskom tipu Almagro 51C, datacije od 4. do sredine 5. st.. Porijeklo ovih tipova je Luzitanija. Jedan dio amfore možda se može pripisati tipu Kapitan I, s datacijom od kraja 2. do 4. st., samo što ovaj ima drugačiju ručku s utorom.

Pronađeno je i više amfora sjevernoafričkog porijekla. Jedna grlo amfore tipa Africana IID, datacija od sredine 3. do početka 5. st., zatim grlo amfore Africana IIB, s datacijom u 3. st., obje porijeklom iz današnjeg Tunisa. Nađen je i jedan šiljak amfore tipa Africana IIIC - Keay XXV, s datacijom na kraj 4. st. ili prvu polovica 5. st., također porijeklom iz sjeverne Afrike. Najmlađa je amfora tipa Late Roman I, s datacijom od 5. do 7. st. i porijeklom u nekadašnjoj pokrajini Kilikija.

Pronađeno je i nekoliko novovjekovnih nalaza. To su tanjur *alla porcellana* iz 16. st., zdjela i vrč s graviranim ukrasom koji se datiraju od 16. do 17. st. Svi imaju porijeklo iz sjeverne Italije. Najmlađi nalaz je noćna posuda, koja se može datirati sve do 18. st., također iz sjeverne Italije.

All of the recovered artefacts are now at the ICUA Zadar conservation and restoration laboratory. The lengthy desalination process, lasting up to a year, will be followed by specialist analysis, publication, and a decision concerning the place of permanent storage.

This limited duration archaeological reconnaissance has shown that the Cape Šenišna area was a long-term site of frequent Roman era anchorage activity, and that there was also onshore activity between this headland and Škar Cove. Roman period ships were moored here from the first to at least the sixth century over what appears to be an unbroken period of more than five centuries. For some reason this position was more favourable or of greater interest than similar positions to the other side of the Sveti Ante Strait, although we have not identified traces of landing or port structures.



10. A jug with engraved decoration, 16th to 17th c. CE / Vrč s graviranim ukrasom, datacija 16. do 17. st. (Photo: Š. Vrkić)

The Cape Šenišna site presents a wealth of amphorae sherds, possibly on account of the significant depth and the fact that the area had long been an access-denied military zone. We are hopeful that what remains to be found will not be looted as the result of local development of the tourism industry.

The investigative potential here is not limited to the underwater site, as the archaeological scope may well extend to a possible onshore site. The collected artefacts will be analysed in terms of typology, but also in terms of what they tell us about Roman era maritime trade in the Šibenik area.

Svi pokretni nalazi su trenutno u konzervatorsko restauratorskoj laboratoriji MCPA Zadar. Predstoji im dugotrajni proces desalinizacije, koji može potrajati oko godinu dana, a nakon čega će se nalazi stručno obraditi i objaviti. Nakon toga, biti će donesena odluka o mjestu stalne pohrane.

Ovo vremenski ograničeno arheološko rekognosciranje, pokazalo je da se kod rta Šenišna u rimsko doba često i dugotrajno sidrilo, ali i da se neka određena aktivnost odvijala i na samoj obali, između rta i uvale Škar. Rimski brodovi su na ovom mjestu pristajali od 1. st. pr. Kr do najmanje 6. st., čini se u kontinuitetu od preko pet stotina godina. Iz nekog razloga, ovaj položaj je bio povoljniji ili zanimljiviji od sličnih položaja s druge strane kanala Sv. Ante, mada nisu pronađeni ostaci pristaništa ili lučkih objekata.

Nalazište kod rta Šenišna bogato je brojnim ulomcima amfora, a razlog tomu može biti značajnija dubina, ali i nekadašnja nepristupačnost, jer je ovdje dugi niz godina bila vojna zona sa zabranom pristupa. Za nadati se da preostali nalazi ipak neće biti opljačkani razvojem turizma na ovom području.

Potencijal istraživanja ove pozicije postoji ne samo kao podvodnog nalazišta, nego i kao potencijalnog kopnenog, za sada nepoznatog nalazišta. Prikupljeni nalazi biti će analizirani kao tipološki artefakti, ali i kao prilog istraživanja pomorske trgovine rimskog doba na šibenskom području.

INSPECTING AND MONITORING PROTECTED SITES IN THE WATERS OFF ISTRA COUNTY

PREGLED I KONTROLA STANJA ZAŠTIĆENIH PODVODNIH NALAZIŠTA U ISTRI

Roko Surić rsuric@icua.hr

Notwithstanding legal and physical protections, the underwater archaeological sites in Croatia's Adriatic waters remain exposed to various threats, whether from human activity such as unauthorised diving, anchoring, and fishing, or from natural degradation processes. This constant pressure demands systematic and multiannual monitoring of their condition.

As part of this effort the International Centre for Underwater Archaeology in Zadar performed underwater archaeological inspections of some of the protected sites in Istra County early in March of 2025 as part of the protected underwater cultural heritage inspection and monitoring programme funded through the Croatian culture and media ministry.

Four sites were covered by this year's programme activity: the Roman period wreck with amphorae at the Buje shallows near Umag, the Franina wreck near Premantura, the Veruda site and the associated Seline strait near Pula, and the metal wreck of the English warship HMS *Coriolanus* near Novigrad.

One of the best-known protected sites off the coast of Istra County is a Roman period wreck with a cargo of amphorae at the Buje shallows near Umag, now protected by a metal cage. The cage is intended to prevent devastation of the site, in particular damage that could be caused by diving and accidental damage resulting from anchoring and fishing.

This year's visual inspection was performed without entering the protective cage and did not observe traces of recent devastation. Fragmented amphorae were observed inside the cage, while outside the cage we did not observe archaeological artefacts. The cage is in relatively good condition, with minor gaps at some joints caused by the separation of elements, not yet compromising the protective function. A thick layer of

Unatoč pravnoj i fizičkoj zaštiti, podvodna arheološka nalazišta na hrvatskom dijelu Jadrana i dalje su izložena raznim oblicima ugroze, bilo kroz ljudske aktivnosti poput neovlaštenih ronjenja, sidrenja i ribolova, bilo kroz prirodne procese propadanja. Upravo zbog takvog stalnog pritiska nužno je provoditi sustavan i višegodišnji monitoring njihova stanja.

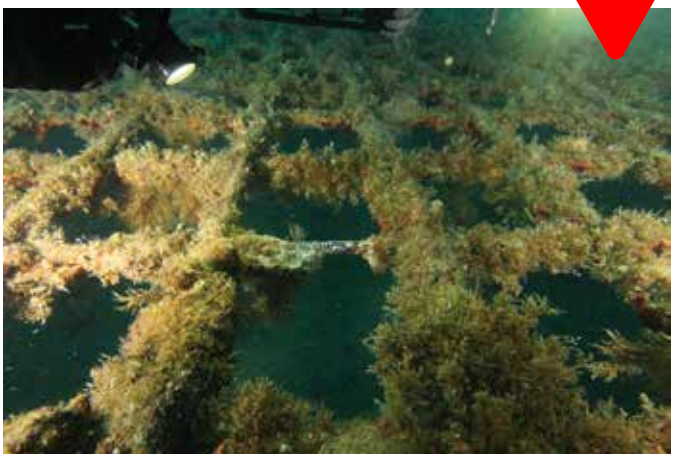
U tom je kontekstu Međunarodni centar za podvodnu arheologiju u Zadru početkom ožujka 2025. godine proveo podvodni arheološki pregled dijela zaštićenih nalazišta u vodama Istre u sklopu programa *Pregled i monitoring zaštićenih podvodnih nalazišta na Jadranu*, koji se provodi uz potporu Ministarstva kulture i medija Republike Hrvatske.

Ovogodišnjim programom obuhvaćena su četiri nalazišta: rimski brodolom s amforama na pličini Buje pored Umaga, brodolom Franina u blizini Premanture, nalazište Veruda s pripadajućim kanalom Selina kod Pule te metalna olupina engleskog ratnog broda *HMS Coriolanus* u blizini Novigrada.

▶ 1. Remains of the antique period wreck near the Buje shallows / Ostaci antičkog brodoloma pored pliči Buje (Foto: R. Surić)

marine fouling was removed locally to check the condition of the metal, and it was found that the structure beneath the growth is solid and in good condition.

Remains of fishing tackle were observed at multiple points on the cage, indicative of intensive fishing activity in the immediate vicinity of the site and further vindicating the installation of the protective structure.



2. Inspecting the condition of the metal of the protective cage / Pregled stanja metala na zaštitnom mrežištu (Foto: R. Surić)

The archaeological site of a sunken ship off Veruda island was fully investigated in the course of previous campaigns, with the remains then protected with a geotextile and ballast stone covering. Monitoring and inspection is performed on a regular basis as this site remains under threat due to the relatively shallow location, the proximity of the shoreline, and frequent anchoring.

Our visual inspection this season did not observe changes that would indicate site devastation. Our attention was especially focused on the broader Seline strait area between Veruda island and Cape Selina, which had an important role in the past in coastal navigation and anchoring.

Examination of the seabed in the strait recorded many archaeological finds, largely of the post-medieval period (fifteenth to nineteenth century) and sporadic antique period finds. This concentration of finds confirms long and intensive maritime activity in this area.

The early seventeenth century Franina

3. Remains of fishing tackle on the metal cage / Ostaci ribolovnih alata po metalnom mrežištu (Foto: R. Surić)

Jedno od najpoznatijih zaštićenih nalazišta u istarskim vodama je rimski brodolom s teretom amfora na pličini Buje pored Umaga, koji je dodatno zaštićen metalnim mrežištem, tzv. kavezom. Svrha ove konstrukcije je sprječavanje devastacije nalazišta, osobito one uzrokovane ronilačkim aktivnostima, ali i zaštita od slučajnih oštećenja nastalih sidrenjem ili ribolovom.

Ovogodišnjim vizualnim pregledom, provedenim bez ulaska unutar zaštitnog mrežišta, nisu uočeni tragovi nedavnih devastacija. Uočene su fragmentirane amfore unutar kaveza, dok izvan zaštitne konstrukcije nisu zabilježeni arheološki nalazi. Zaštitno mrežište nalazi se u relativno dobrom stanju, iako su na pojedinim spojevima vidljivi manji razmaci nastali odvajanjem elemenata, no oni trenutačno ne ugrožavaju njegovu zaštitnu funkciju. Debeli sloj morskog obraštaja uklonjen je lokalno kako bi se provjerilo stanje metala, pri čemu je ustanovljeno da je konstrukcija ispod vegetacije čvrsta i dobro očuvana.

4. A post-medieval glazed jug found during the survey of the Seline strait / Novovjekovni glazirani vrč pronađen pregledom kanala Selina (Foto. M. Kaleb)

Na više mjesta na mrežištu zabilježeni su ostaci ribolovnih alata, što svjedoči o intenzivnim ribarskim aktivnostima u neposrednoj blizini nalazišta i dodatno potvrđuje opravdanost postavljanja zaštitne konstrukcije.

Arheološko nalazište potopljenog broda kod otočića Veruda u potpunosti je istraženo u ranijim kampanjama, nakon čega su njegovi ostaci zaštićeni geotekstilom i balastnim kamenjem. Zbog relativno male dubine, blizine obale i čestog sidrenja, nalazište je i dalje potencijalno ugroženo, zbog čega se

site, designated Z-69 in Croatia's register of cultural property, has seen a multi-year campaign of systematic archaeological investigation and protection. The completion of the investigative campaign saw the remains of the wreck protected with a cover of sand, geotextile, and stones in an effort to mitigate natural and human factors.

Our inspection this year did not observe surface changes at the site. A particular aspect of the monitoring pertains to the cathodic protection of two iron cannons at the site. Aluminium anodes, consumed in favour of the cannons and thus protecting them from corrosion, were inspected, and corrosion potentials were measured at multiple points. The readings indicate that the cathodic protection system is exceptionally effective, further justifying the in-situ protection of these metal finds, otherwise highly susceptible to deterioration.

▶ 5. Visual examination of the site off Cape Franina / Vizualni pregled nalazišta u podmorju rta Franina (Foto: R. Surić)

provode redoviti kontrolni pregledi.

Ovogodišnjim vizualnim pregledom nisu uočene promjene koje bi upućivale na devastaciju nalazišta. Posebna je pažnja pritom posvećena i širem prostoru kanala Selina, smještenog između otočića Veruda i rta Selina, koji je u prošlosti imao važnu ulogu u priobalnoj plovidbi i sidrenju.

Pregledom morskog dna u kanalu zabilježeni su brojni arheološki nalazi, uglavnom iz novovjekovnog razdoblja (15.–19. st.), uz sporadične nalaze iz antičkog razdoblja. Takva koncentracija nalaza potvrđuje dugotrajnu i intenzivnu pomorsku aktivnost na ovom prostoru.

Na nalazištu Franina, koje se datira u početak 17. stoljeća i upisano je u Registar kulturnih dobara pod oznakom Z-69, već se niz godina provode sustavna arheološka istraživanja i mjere zaštite. Nakon završetka istraživačkih kampanja, ostaci brodoloma prekriveni su pijeskom, geotekstilom i kamenjem kako bi se smanjio utjecaj prirodnih i ljudskih čimbenika.

Ovogodišnjim pregledom nisu uočene promjene na

▶ 6. Measuring corrosion potential of the west cannon / Mjerenje korozijskog potencijala na zapadnom topu (Foto: R. Surić)

7. Bow of the wreck of the Coriolanus / Pramac olupine broda Coriolanus (Foto: R. Surić)

This year's monitoring programme also saw an inspection of the metal wreck of the English warship HMS *Coriolanus*, which sank near Novigrad in 1945 and is now protected cultural property listed under code Z-20. The wreck lies at a depth of about 27 metres, and its location was confirmed using sonar detection.

The inspection found that the site was not marked by a buoy as required, possibly because it was deliberately removed out of season, or was damaged by fishing activity. Our visual inspection found a well-preserved and imposing ship's hull, with lush marine organism growth. Our inspection was performed outside the

površini nalazišta. Poseban dio monitoringa odnosi se na katodnu zaštitu dvaju željeznih topova koji se nalaze na lokalitetu. Aluminijske anode, koje se troše umjesto željeza i time štite topove od korozije, pregledane su i izmjeren je korozijski potencijal na više točaka. Rezultati mjerenja pokazali su da sustav katodne zaštite djeluje izuzetno učinkovito, čime je potvrđena opravdanost *in situ* zaštite ovih osjetljivih metalnih nalaza.

U sklopu programa monitoringa ove je godine pregledana i metalna olupina engleskog ratnog broda *HMS Coriolanus*, potonulog 1945. godine u blizini Novigrada, a danas zaštićenog kulturnog dobra pod oznakom Z-20. Nalazište se nalazi na dubini od oko 27 metara, a njegova lokacija potvrđena je sonarom.

Prilikom pregleda utvrđeno je da nalazište nije obilježeno propisanom plutačom, što može biti posljedica namjernog uklanjanja izvan sezone ili oštećenja uzrokovanog ribarskim aktivnostima. Vizualnim pregledom uočen je dobro očuvan i impozantan trup broda, s bogatim obraštajem morskih organizama. Pregled je obavljen s vanjske strane olupine, bez ulaska u unutrašnjost.

Na središnjem dijelu broda vidljiva su znatna oštećenja, najvjerojatnije nastala uslijed eksplozije mine koja je

8. A naval gun near the ship's bow / Top na pramcu broda (Foto: R. Surić)

wreck and no entrance into the hull was effected.

Significant damage is evident at the midpoint of the ship, most likely caused by the explosion of the mine that sank the ship back in 1945. Remains of fishing nets and cords were observed at multiple points on the wreck. This indicates intensive fishing in the area of this protected cultural property and underscores the always possible threat of damage. The two guns near the ship's bow are standout details and are the visually most attractive element of this wreck.

The 2025 campaign in the frame of the Inspection and Monitoring of Protected Underwater Sites in the Adriatic Sea programme saw detailed visual inspection of the condition of some of the key protected sites in the waters off Istra County. Our inspection found no major devastation or alarming changes at these sites. Our documented findings establish an important basis for future comparative analysis and long-term monitoring, and the results of the inspection confirm the importance of the continuous presence of the profession in the field. Systematic monitoring translates into timely detection of potential threats and facilitates the planning of protective measures, thus ensuring the long-term preservation of the valuable underwater cultural heritage of Croatia's Adriatic waters.

1945. godine potopila brod. Na više mjesta na olupini uočeni su ostaci ribolovnih mreža i konopa. Takvi nalazi upućuju na intenzivan ribolov u području zaštićenog kulturnog dobra i potencijalnu opasnost od daljnjih oštećenja. Posebno se ističu dva topa na pramčanom dijelu broda, koji predstavljaju najatraktivniji vizualni element olupine.

Provedbom programa *Pregled i monitoring zaštićenih podvodnih nalazišta na Jadranu* u 2025. godini izvršen je detaljan vizualni pregled stanja dijela najvažnijih zaštićenih nalazišta u vodama Istre. Na temelju pregleda nisu uočene veće devastacije ni alarmantne promjene stanja. Prikupljena dokumentacija predstavlja važnu osnovu za buduće usporedbe i dugoročni monitoring, a rezultati pregleda potvrđuju važnost kontinuirane prisutnosti struke na terenu. Sustavni nadzor omogućuje pravovremeno uočavanje potencijalnih ugroza i planiranje mjera zaštite, čime se dugoročno osigurava očuvanje vrijedne podvodne kulturne baštine hrvatskog Jadrana.

Bibliography / Literatura:

Surić, R. 2021. - Inspecting and Monitoring Croatia's Protected Underwater Sites / Pregled i monitoring zaštićenih podvodnih nalazišta u Hrvatskoj, *Submerged Heritage / Potopljena baština* 11, 20-24.

Surić, R. 2023. - Inspecting the Condition of Three Protected Adriatic Underwater Sites / Pregled stanja triju zaštićenih podvodnih nalazišta na Jadranu, *Submerged Heritage / Potopljena baština* 13, 15-18.

Surić, R. 2024. - Monitoring the conditions of selected Adriatic underwater sites / Kontrola stanja važnih podvodnih nalazišta na Jadranu, *Submerged Heritage / Potopljena baština* 14, 61-64.

▶ 9. Remains of fishing equipment on the wreck / Ostaci ribolovnih alata po olupini broda (Foto: R. Surić)

GAME CHANGER – WHEN UNDERWATER ARCHAEOLOGISTS HAVE THEIR OWN MBES

ZMIENIAJĄC ZASADY GRY - KIEDY ARCHEOLODZY PODWODNI POSIADAJĄ WŁASNY MBES

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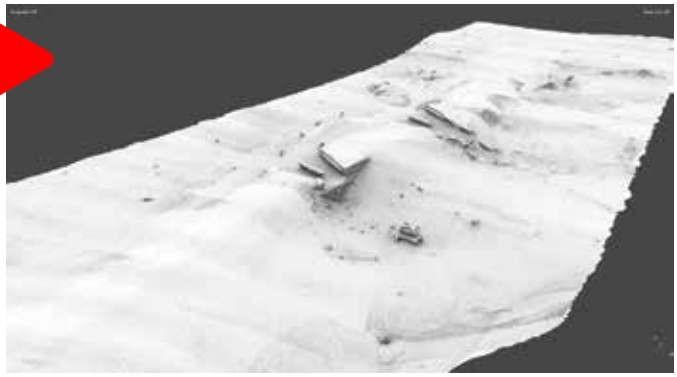


1. 3D model of the submerged XIX century mill / 1. 3D model of the submerged XIX century mill (Photo: M. Popek)

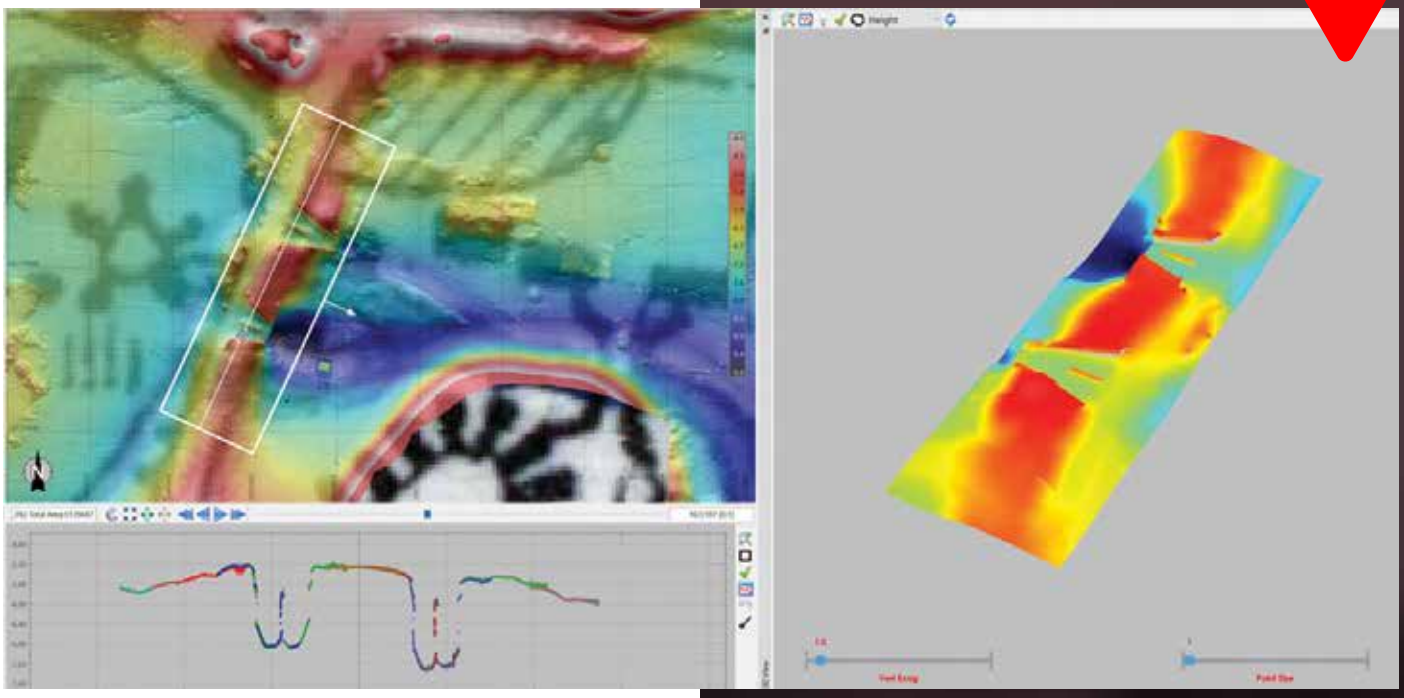
The Centre for Underwater Archaeology at Nicolaus Copernicus University in Toruń has just taken a step that changes the rules of the game in Polish and possibly European underwater archaeology. Acquiring its own multibeam echosounder (MBES) is not merely another piece of equipment; it is a strategic investment. It marks a point where we cease to be just recipients of ready-made data from external contractors and become fully active hosts of the entire process: from the initial acoustic pulse sent from a vessel to the final 3D model of a wreck or archaeological site displayed on a computer screen.

A traditional echo sounder emits a single sound pulse downward and measures depth based on the echo returned from the bottom. In contrast, a multibeam echosounder is much more sophisticated: instead of a single beam, it emits a wide range of beams that spread out beneath the vessel's hull. Each beam bounces off the seafloor or an object on the seabed, then returns to the transducer, which measures the return time and the angle at which the signal was received. This data

Centrum Archeologii Podwodnej UMK w Toruniu zrobiło właśnie krok, który zmienia zasady gry w polskiej i być może europejskiej archeologii podwodnej. Zakup własnej sondy wielowiązkowej (MBES – *multibeam echosounder*) nie jest tylko kolejną pozycją na liście sprzętu. To moment, w którym przestajemy być wyłącznie odbiorcami gotowych danych od firm zewnętrznych, a stajemy się pełnoprawnymi gospodarzami całego procesu: od pierwszego impulsu akustycznego wysłanego z jednostki pływającej, aż po finalny model 3D wraku czy stanowiska na ekranie komputera.

Klasyczna echosonda wysyła pojedynczy impuls dźwiękowy w dół i na tej podstawie mierzy głębokość. Sonda wielowiązkowa robi coś znacznie bardziej zaawansowanego: zamiast jednej wiązki wysyła cały wachlarz wiązek, rozkładających się pod kadłubem łodzi. Każda z nich odbija się od dna lub obiektu na dnie, wraca do przetwornika, a system mierzy czas powrotu oraz kąt, pod jakim sygnał został zarejestrowany. Z tych informacji obliczana jest głębokość w wielu punktach jednocześnie.
W praktyce oznacza to, że podczas jednego przejścia łodzi nad stanowiskiem otrzymujemy gęstą chmurę punktów pomiarowych, która pozwala odtworzyć ukształtowanie dna w trzech wymiarach. Na takich modelach widać nie tylko duże formy, ale też drobne detale: sylwetki wraków, zarysy konstrukcji, ślady dawnych umocnień czy subtelne zagłębienia powstałe w wyniku prac wykopaliskowych.

Do tej pory standardem było zamawianie pomiarów u firm specjalizujących się w hydrografii. Dostawaliśmy wtedy gotowy produkt: mapy batymetryczne, przekroje,



2. Remains of the mill and archival map with localizaction of remains / Pozostałości młyna oraz mapa archiwalna z zaznaczonymi lokalizacjami pozostałości (Photo: M. Popek)

allows for the calculation of depth at multiple points simultaneously.

In practice, this means that during a single pass of the boat over the site, we collect a dense cloud of measurement points, enabling us to reconstruct the shape of the seabed in three dimensions. These models not only reveal large forms but also intricate details, such as wreck silhouettes, outlines of structures, traces of old fortifications, or subtle depressions caused by excavation work.

Until now, it was standard practice to order surveys from companies specialising in hydrography. We would then receive a finished product, including bathymetric maps, cross-sections, and seabed models. As archaeologists, we used these studies, but had limited influence on how they were initially prepared. The measurement methodology, data density, noise filtering techniques, and choice of processing algorithms were decided by the contractor. Our team's experience has shown that the needs of underwater archaeologists often differ from those of typical hydrographers.

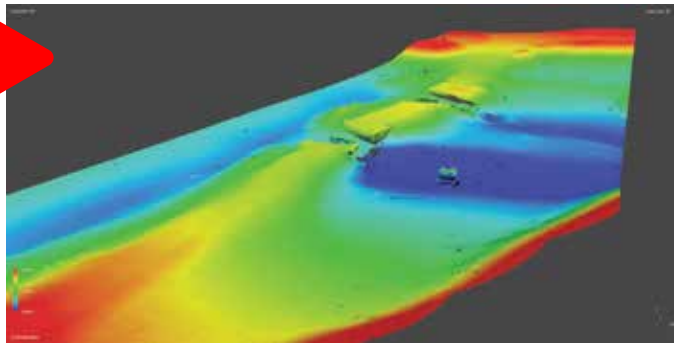
Having our own multibeam echosounder completely changes this balance. We control how densely we scan an area, how to plan the measurement lines in relation to the wreck or structure, and how to set the system parameters based on depth and other factors. The data collection process becomes an integral part of the research plan, rather than merely an external service that is accepted or rejected.

modele dna. Jako archeolodzy korzystaliśmy z tych opracowań, ale mieliśmy ograniczony wpływ na to, jak dokładnie zostały przygotowane. Metodyka pomiaru, gęstość danych, sposób filtracji szumów i wybór algorytmów przetwarzania były po stronie wykonawcy. Doświadczenia naszego zespołu pokazały, że potrzeby archeologów podwodnych często różnią się od standardu pracy hydrografów.

Posiadanie własnej sondy wielowiązkowej całkowicie zmienia tę relację. To my decydujemy, jak gęsto chcemy skanować dany obszar, jak poprowadzić linie pomiarowe względem wraku czy konstrukcji, jak dostosować parametry systemu do głębokości czy innych czynników. Proces pozyskiwania danych staje się integralną częścią strategii badawczej, a nie zewnętrzną usługą, którą można jedynie zaakceptować lub odrzucić.

Jedna z największych zalet posiadania MBES polega na tym, że o jakości końcowego modelu dna decydujemy już w terenie, a nie dopiero przy komputerze. W czasie skanowania możemy na bieżąco sprawdzać, czy uzyskana chmura punktów jest wystarczająco gęsta, czy nie pojawiają się niepokojące „dziury" w danych, czy obiekt jest czytelny w takim ujęciu, jakie przyjęliśmy.

Jeżeli coś budzi wątpliwości, możemy od razu wrócić nad dany sektor, zmienić kierunek prowadzenia linii pomiarowej, zagęścić sieć profili lub zmodyfikować parametry pracy sondy. Dzięki temu nie jesteśmy skazani na sytuację, w której dopiero w laboratorium orientujemy się, że czegoś brakuje albo że pewne partie stanowiska archeologicznego zostały zobrazowane zbyt pobieżnie. Taka elastyczność jest kluczowa



3. Point cloud of the old mill construction / Chmura punktów konstrukcji starego młyna (Photo: M. Popek)

One of the main benefits of using MBES is that we can assess the quality of the final bottom model in the field, rather than relying solely on computer-generated results. During scanning, we can continuously evaluate whether the point cloud is sufficiently dense, identify any problematic 'holes' in the data, and confirm that the object is clearly represented in the chosen approach.

If something raises doubts, we can immediately return to the designated area, change the direction of the measurement line, increase the density of the profile network, or adjust the survey parameters. This way, we avoid only discovering in the laboratory that something is missing or that certain parts of the archaeological site have been imaged too superficially. Such flexibility is especially crucial for complex objects with intricate geometry or in challenging hydrological conditions.

When we previously used external contractors, we typically received data in a processed form: as ready-made models, maps, or rasters. Now, we have access to a complete set of raw measurements. It's like receiving RAW files from a professional camera instead of a low-resolution photo.

Access to raw data lets us decide how detailed a model we wish to build, which filters to apply, and how to handle noise or individual outliers. Equally important, the same data can be processed multiple times, testing different approaches and revisited years later when new analytical tools emerge.

Raw data from MBES can be transferred directly to photogrammetric software. This enables us to combine precise bottom geometry with photogrammetric models to produce integrated 3D representations of sites. This hybrid – a geometric skeleton from the probe and textures from photographs – results in a model that is both highly accurate in measurements and visually very clear. It also facilitates capturing a broader context.

Modern underwater archaeology is becoming less and less based on a single type of data. Seabed models, zwłaszcza przy obiektach złożonych, o skomplikowanej geometrii czy w trudnych warunkach hydrologicznych.

Kiedy korzystaliśmy z usług zewnętrznych, najczęściej otrzymywaliśmy dane w formie już przetworzonej: jako gotowe modele, mapy czy rastry. Teraz dysponujemy pełnym zestawem surowych pomiarów. To tak, jakby zamiast zdjęcia w niskiej rozdzielczości otrzymać komplet plików RAW z profesjonalnego aparatu.

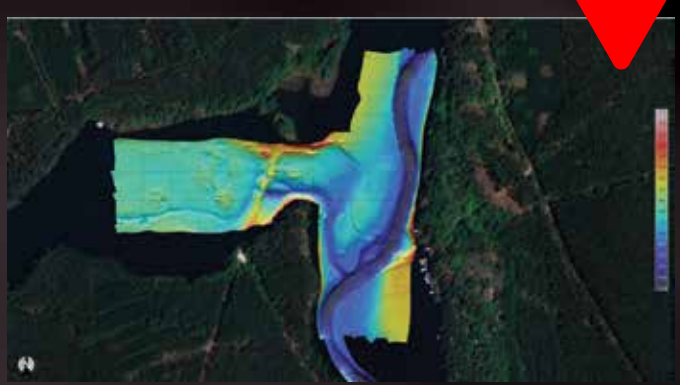
Dostęp do surowych danych pozwala nam samodzielnie decydować, jak bardzo szczegółowy model chcemy zbudować, jakie filtry zastosować, jak potraktować szumy czy pojedyncze punkty odstające. Co równie ważne, te same dane można przetwarzać wielokrotnie, testując różne podejścia i wracając do nich po latach, gdy pojawią się nowe narzędzia analityczne.

Surowe dane z MBES mogą być przenoszone bezpośrednio do oprogramowania fotogrametrycznego. Dzięki temu możemy łączyć dokładną geometrię dna z modelami fotogrametrycznymi, tworząc zintegrowane modele 3D stanowisk. Taka hybryda – szkielet geometryczny z sondy i tekstura ze zdjęć – daje efekt, który jest jednocześnie bardzo precyzyjny pomiarowo i niezwykle czytelny wizualnie. Pozwala też na uchwycenie szerokiego kontekstu.

Współczesna archeologia podwodna coraz rzadziej opiera się na jednym typie danych. Modele dna, chmury punktów, zdjęcia, plany stanowisk, informacje historyczne i wyniki analiz środowiskowych spotykają się dziś w środowiskach GIS, które pozwalają oglądać i analizować stanowisko jak wielowarstwową mapę.

Dzięki MBES możemy precyzyjnie georeferować modele fotogrametryczne oraz archiwalne plany czyli osadzać je w konkretnych współrzędnych geograficznych. Model wraku przestaje być jedynie „ładnym obiektem 3D", a staje się elementem większej układanki: wiemy, gdzie dokładnie leży, pod jakim kątem jest zanurzony,

4. Paleochannel of river, submerged roads and ramains of the mill / Paleokanał rzeki, zalane drogi i pozostałości młyna (Photo: M. Popek)



5. Archaeological training area grid / Grid obszaru szkoleń archeologicznych (Photo: M. Popek)

point clouds, photographs, site plans, historical information, and environmental analysis results are now integrated within GIS environments, enabling sites to be viewed and analysed as multi-layered maps.

Thanks to MBES, we can accurately georeference photogrammetric models and archival plans, allowing us to embed them within specific geographical coordinates. The wreck model is no longer just a 'nice 3D object', but becomes part of a larger puzzle: we know precisely where it lies, its angle of submersion, and how it relates to the modern coastline or other relics in the area. The integration of data from MBES, photogrammetry, and GIS enables us to monitor changes over time, compare research seasons, and develop comprehensive scenarios for preserving underwater heritage.

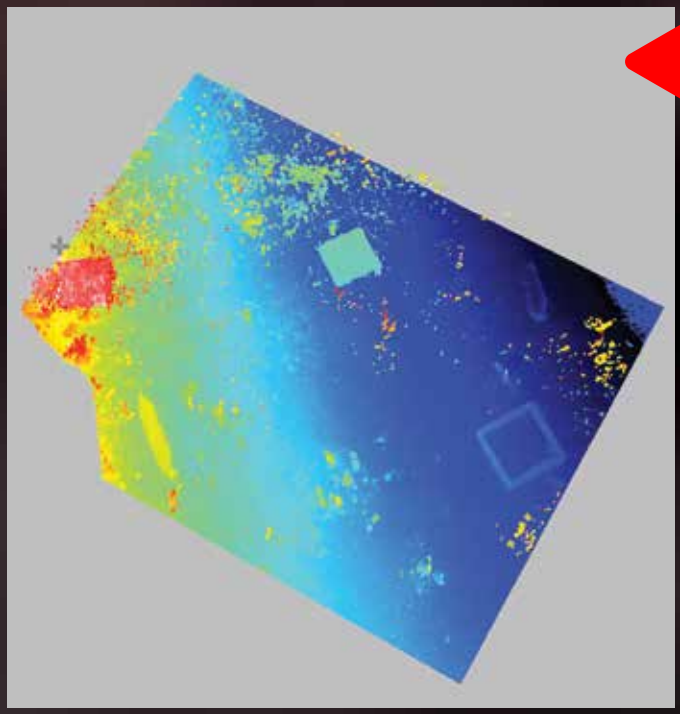
Our own multibeam echosounder opens up new perspectives for conducting long-term underwater excavations. We can regularly scan the same site and observe how its relief changes with each stage of exploration. In practice, this means that we can position archaeological excavations with great accuracy and then verify how their range and depth translate into changes in the topography of the bottom.

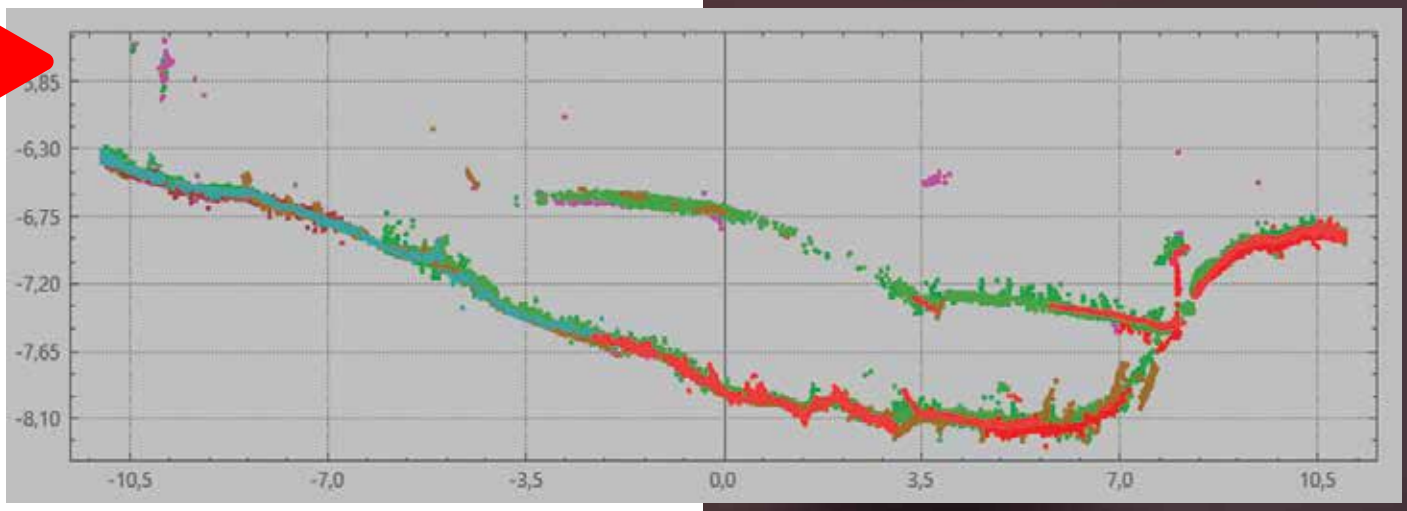
Such repeated surveys allow us to document the impact of our activities on the site, assess the risk of erosion or silting, and respond more quickly when new threats arise. It is not only a documentation tool, but also an essential element of responsible heritage management, which, by definition, is exposed to currents, waves, vessel traffic, and human interference.

jak ma się do współczesnej linii brzegowej czy do innych reliktów w okolicy. Zintegrowanie danych z MBES, fotogrametrii i GIS daje możliwość śledzenia zmian w czasie, porównywania sezonów badań oraz budowania kompleksowych scenariuszy ochrony dziedzictwa podwodnego.

Własna sonda wielowiązkowa otwiera przed nami nową perspektywę w prowadzeniu długotrwałych wykopalisk podwodnych. Możemy regularnie skanować to samo

▶ 6. Archaeological training area point cloud / Chmura punktów obszaru szkoleń archeologicznych (Photo: M. Popek)





7. Medieval bridge trench cross section / Przekrój poprzeczny wykopu średniowiecznego mostu (Photo: M. Popek)

Purchasing MBES is undoubtedly a significant expense, but considering it from the perspective of several or a dozen years, it is also a source of savings. Instead of outsourcing surveys to external contractors each time, we can conduct them ourselves when needed, for both large projects and smaller surveys, as well as student projects.

Equally important is the fact that we invest in developing our team's skills. Archaeologists, equipment operators and GIS specialists learn how to plan survey missions, operate probes, control data quality and perform advanced processing of results. These skills remain within the institution, strengthening its independence and opening the way to even more ambitious projects in the future.

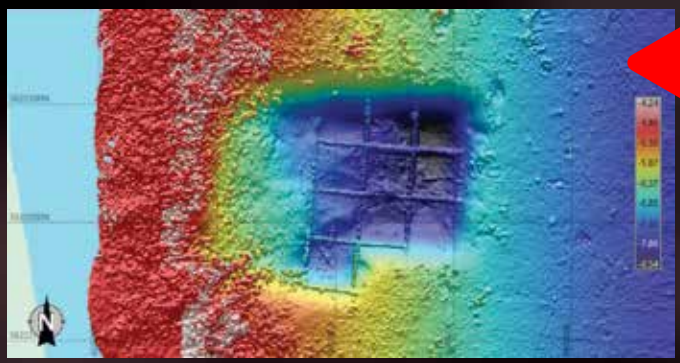
The most significant change lies in something very simple: for the first time, we have complete control over how data is collected, processed and archived. We set the quality standards, decide which data is published, which is stored for future research, and which can be considered working data.

Such data independence has a significant scientific impact. It enables the development of long-term monitoring programmes, the creation of comparable measurement series, and the advancement of proprietary analysis methods. MBES is becoming not only a measuring device, but also a tool around which an entire research environment can be built.

The purchase of a multibeam echosounder by the Centre for Underwater Archaeology at Nicolaus Copernicus University in Toruń is a crucial step in the development of our centre, but we also view it as an opportunity for the entire community involved in underwater heritage in Poland and Europe. With modern equipment and a

stanowisko i obserwować, jak zmienia się jego rzeźba wraz z kolejnymi etapami eksploracji. W praktyce oznacza to, że jesteśmy w stanie bardzo dokładnie pozycjonować wykopy archeologiczne, a następnie sprawdzać, jak ich zasięg i głębokość przekładają się na zmiany w ukształtowaniu dna.

Takie powtarzalne pomiary pozwalają dokumentować wpływ naszych działań na stanowisko, oceniać ryzyko erozji lub zasypywania i szybciej reagować, gdy pojawiają się nowe zagrożenia. To nie tylko narzędzie dokumentacyjne, lecz także element odpowiedzialnego zarządzania dziedzictwem, które z definicji jest narażone na działanie prądów, falowania, ruchu jednostek pływających czy ingerencję człowieka.



8. Medieval bridge trench grid / Grid wykopu średniowiecznego mostu (Photo: M. Popek)

Zakup MBES to bez wątpienia duży wydatek, ale patrząc w perspektywie kilku czy kilkunastu lat, jest to również źródło oszczędności. Zamiast za każdym razem zlecać pomiary zewnętrznym firmom, możemy wykonywać je samodzielnie wtedy, gdy są potrzebne – zarówno w ramach dużych przedsięwzięć, jak i mniejszych sondaży czy projektów studenckich.

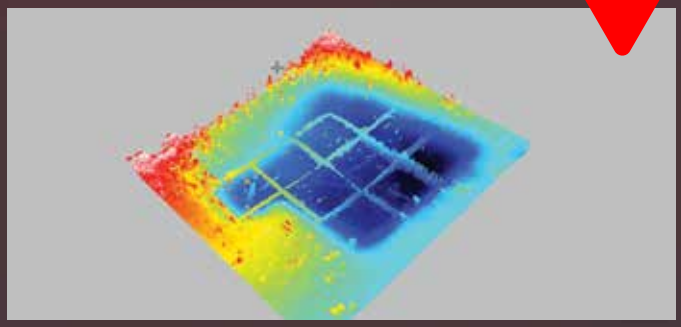
Nie mniej ważne jest to, że inwestujemy w rozwój kompetencji zespołu. Archeolodzy, operatorzy sprzętu i specjaliści od GIS uczą się planowania misji pomiarowych, obsługi sondy, kontroli jakości danych

9. Medieval bridge trench point cloud / Chmura punktów wykopu średniowiecznego mostu (Photo: M. Popek)

team trained to operate it, we are open to cooperation with other institutions, including universities, museums, conservation services, and partners from abroad.

We want MBES to be not only 'our' tool, but also part of a broader research infrastructure that various centres can use. We are ready to join forces, share our experience and work together to create new standards for the documentation and protection of underwater cultural heritage.

11. Team during survey / Zespół podczas badań (Photo: M. Popek)



10. Georeferencing of the old trench in Lednica Lake / Georeferiwabue starego wykopu w jeziorze Lednica (Photo: M. Popek)

oraz zaawansowanej obróbki wyników. Te umiejętności zostają w instytucji, wzmacniając jej niezależność i otwierając drogę do jeszcze ambitniejszych projektów w przyszłości.

Największa zmiana kryje się może w czymś bardzo prostym: po raz pierwszy mamy pełną kontrolę nad tym, jak dane są pozyskiwane, przetwarzane i archiwizowane. To my ustalamy standardy jakości, decydujemy o tym, które dane trafiają do publikacji, które są przechowywane na potrzeby przyszłych badań, a które można uznać za materiał roboczy.

Taka suwerenność danych ma ogromne znaczenie naukowe. Pozwala budować długoterminowe programy monitoringu, tworzyć porównywalne serie pomiarowe i rozwijać własne metody analizy. MBES staje się nie tylko urządzeniem pomiarowym, lecz także narzędziem, wokół którego można budować całe środowisko badawcze.

Zakup sondy wielowiązkowej przez Centrum Archeologii Podwodnej UMK w Toruniu to ważny krok w rozwoju naszego ośrodka, ale widzimy go również jako szansę dla całego środowiska zajmującego się dziedzictwem podwodnym w Polsce i Europie. Dysponując nowoczesnym sprzętem i zespołem przygotowanym do jego obsługi, jesteśmy otwarci na współpracę z innymi instytucjami: uczelniami, muzeami, służbami konserwatorskimi i partnerami z zagranicy.

Chcemy, aby MBES nie był jedynie „naszym" narzędziem, ale stał się elementem szerszej infrastruktury badawczej, z której mogą korzystać różne ośrodki. Jesteśmy gotowi łączyć siły, dzielić się doświadczeniem i wspólnie tworzyć nowe standardy dokumentacji oraz ochrony podwodnego dziedzictwa kulturowego.

NEW PREMISES—NEW OPPORTUNITIES: ICUA ZADAR EDUCATION AND PRESENTATION CENTRE FOR UNDERWATER ARCHAEOLOGY ST. NICHOLAS WORKSHOPS

NOVI PROSTORI – NOVE MOGUĆNOSTI: EDUKATIVNO-PREZENTACIJSKE RADIONICE U MCPA ZADAR

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Renovation of the buildings that once housed Zadar's St Nicholas convent, completed in 2024, was a key step in the further development of the International Centre for Underwater Archaeology in Zadar (ICUA). Acquiring permanent premises for visitor activities has created new opportunities to raise public awareness of underwater cultural heritage. The Eduacation and Presentation Centre for Underwater Archaeology St. Nicholas is now a place where specialists, pupils, students, and the broader public come together, and where underwater archaeology is presented in a clear and accessible manner.

2025 saw the first workshops at these premises for groups of different ages and interests. Fifteen workshops brought together some 350 participants from across the country. The programme is funded through Croatia's Ministry of Culture and Media, with staff from almost all ICUA departments taking part in the preparation and staging. This collaborative effort has seen workshops covering various aspects of our work; from archaeology and documentation to heritage conservation and presentation.

The workshops aim to raise public awareness of underwater archaeology and to encourage interest in the preservation of underwater cultural heritage. The focus is on hands-on work and active participation. The people who take part can acquaint themselves with basic methods employed in the investigation, documentation, and preservation of archaeological finds in marine environments.

▶ 1. Archaeology students use the literature to identify artefact comparanda as part of the Zadar Reads event / Studenti arheologije traže analogije predmeta u literaturi povodom manifestacije Zadar čita (Photo: M. Ivić Miljković)

Obnova kompleksa bivšeg samostana sv. Nikole u Zadru, dovršena 2024. godine, bila je važan korak u daljnjem razvoju Međunarodnog centra za podvodnu arheologiju u Zadru (MCPA). Dobivanjem stalnog prostora za rad s posjetiteljima otvorile su se nove mogućnosti za približavanje podvodne kulturne baštine široj javnosti. Edukativno-prezentacijski centar sv. Nikola tako je postao mjesto susreta stručnjaka, učenika, studenata i građana, ali i prostor u kojem se podvodna arheologija može predstaviti na jednostavan i razumljiv način.

Tijekom 2025. godine u novom prostoru počele su se po

2. A demonstration of wheel-thrown pottery making / Demonstracija izrade posuda na lončarskom kolu (Photo: N. Cohen)

The year began with ICUA taking part in the nationwide Museum Night event, which also servedas a public presentation of the new premises. Two thematic workshops were staged for all ages. Visitors painted ceramic tiles with maritime motifs and repurposed used fishing nets by creating bracelets. These activities were supplemented by discussion of the protection of marine environments, in particular the issue of discarded fishing gear.

A workshop was staged in the spring for archaeology students in the frame of the Zadar Reads event. Students were introduced to archaeological material and consulted specialist literature kept at the ICUA library to learn the skill of identifying comparanda (analogous artefacts) and interpreting recovered artefacts. Our particular focus was on the importance of reading, source analysis, and properly citing the literature used.

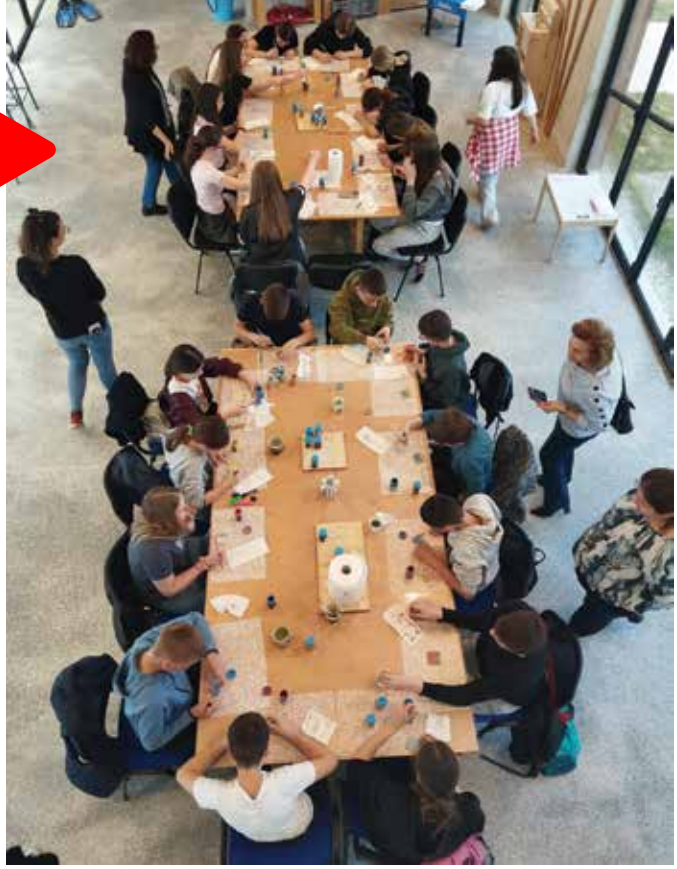
In March and April of 2025 second grade pupils attending Bartul Kašić Elementary School took part in two creative workshops staged at the pavilion of our Education and Presentation centre where they had a hands-on opportunity to learn about forming and decorating objects made of clay. At the first gathering the pupils created objects utilising a variety of techniques. These were then dried and fired to give them their final solidity and form. The second workshop focused on painting and decorating, which imparted personality and final appearance to these objects. The work developed patience, precision, and imagination, and the capacity to collaborate and exchange ideas. This form of practical learning has been shown to

prvi put održavati radionice namijenjene različitim dobnim i interesnim skupinama. Ukupno je održano petnaest radionica na kojima je sudjelovalo oko 350 polaznika iz Hrvatske. Program je financiran sredstvima Ministarstva kulture i medija Republike Hrvatske, a u njegovoj pripremi i provedbi sudjelovali su djelatnici gotovo svih odjela MCPA Zadar. Takva suradnja omogućila je da radionice obuhvate razne aspekte rada, od arheologije i dokumentacije do konzervacije i prezentacije baštine.

Radionice su osmišljene s ciljem da podvodnu arheologiju približe javnosti i potaknu interes za očuvanje podvodne kulturne baštine. Naglasak je stavljen na praktičan rad i aktivno sudjelovanje. Kroz predavanja, radionice i kreativne zadatke sudionici su mogli upoznati osnovne metode istraživanja, dokumentiranja i očuvanja nalaza iz mora.

Već početkom godine MCPA se uključio u nacionalnu manifestaciju Noć muzeja, što je ujedno bila i prilika da se novi prostor predstavi široj publici. Održane su dvije tematske radionice za sve uzraste. Posjetitelji su oslikavali keramičke pločice s motivima mora i izrađivali narukvice od recikliranih ribarskih mreža. Kroz takve aktivnosti razgovaralo se i o zaštiti morskog okoliša, posebno o problemu napuštenih ribarskih alata.

3. German terms related to the marine environment are easy to learn through play / Njemačke pojmove vezane za podmorje lako je naučiti uz igru (Photo: M. Ivić Miljković)



4. Painting is more fun in groups / Oslikavanje je zabavnije u grupi (Photo: N. Cohen)

be a valuable and encouraging experience for all who took part.

An important part of our work is our collaboration with elementary schools in Zadar in the frame of the Erasmus+ Widespread School: Innovating Teaching Approaches Outside the Classroom programme, implemented through the City of Zadar departments for EU funds and for training and education. This programme is conceived as a merger of various subject areas and out-of-classroom hands-on learning. This form of school instruction has been shown to be very valuable as it provides pupils with direct contact with heritage and often stimulates a deeper sense of curiosity. Activities associated with foreign languages, mathematics, biology, environment, society, geography, history, and the arts are leveraged as ways whereby pupils learn about the underwater world and how archaeologists work. Activities included developing geometric models, reading topographic maps, recognising underwater sites, and painting ceramic tiles. Pupils also had an opportunity to see diving equipment, archaeological finds, and to learn more about the natural processes that impact the safeguarding of ships and objects in a marine environment.

A presentation on the profession of an underwater archaeologist was held at the Radost kindergarten, adapted for preschool children. Oral presentation, play, and demonstration were used to introduce children to the basic parts of diving equipment, while photographs and videos of underwater sites allowed them to see actual archaeological artefacts. The children were especially

U proljeće je održana radionica za studente arheologije u sklopu manifestacije Zadar čita. Studenti su se upoznali s arheološkim materijalom i koristili stručnu literaturu iz specijalne knjižnice MCPA kako bi naučili prepoznavati analogije i tumačiti pronađene predmete. Poseban naglasak bio je na važnosti čitanja, analizi izvora te ispravnom citiranju korištene literature.

Tijekom ožujka i travnja 2025. godine učenici 2. razreda Osnovne škole Bartula Kašića sudjelovali su u dvjema kreativnim radionicama u prostoru paviljona edukativno-prezentacijskog centra za podvodnu arheologiju sv. Nikola, gdje su kroz praktičan rad upoznali svijet oblikovanja i ukrašavanja predmeta od gline. Na prvom susretu izrađivali su vlastite predmete različitim tehnikama, koji su nakon sušenja i pečenja dobili svoju čvrstoću i formu. Druga radionica bila je posvećena oslikavanju i ukrašavanju, čime su predmeti dobili osobni pečat i završni izgled. Kroz rad su razvijali strpljenje, preciznost i maštu, ali i učili surađivati i razmjenjivati ideje. Ovakav oblik praktičnog učenja pokazao se kao vrijedno i poticajno iskustvo za sve sudionike.

Važan dio programa činila je suradnja sa zadarskim osnovnim školama kroz projekt terenske nastave u okviru Erasmus + programa „Widespread School; Innovating Teaching Approaches Outside the Classroom“ kojeg provodi Upravni odjel za EU fondove i Upravni odjel za odgoj i školstvo Grada Zadra. Program je bio zamišljen kao spoj različitih predmeta i praktičnog učenja izvan učionice. Ovakav oblik nastave pokazao se vrlo vrijednim jer učenicima omogućuje neposredan kontakt s baštinom i često potakne dodatnu znatiželju. Učenici su kroz aktivnosti povezane sa stranim jezicima, matematikom, biologijom, prirodom i društvom, zemljopisom, povijesti i likovnom kulturom upoznavali podvodni svijet i način rada arheologa. Između ostalog, izrađivali su geometrijske modele, promatrali topografske karte, prepoznavali podmorske lokalitete i oslikavali keramičke pločice. U isto vrijeme mogli su vidjeti ronilačku opremu, arheološke nalaze i saznati više o prirodnim procesima koji utječu na očuvanje brodova i predmeta u moru.

U dječjem vrtiću Radost održano je predstavljanje zanimanja podvodnog arheologa, prilagođeno djeci predškolske dobi. Kroz priču, igru i demonstraciju djeca su upoznala osnovne dijelove ronilačke opreme, pogledala fotografije i video snimke podvodnih nalazišta te imala priliku vidjeti stvarne arheološke predmete. Posebno ih je razveselila mogućnost da, uz nadzor, isprobaju disanje na regulator spojen na bocu sa zrakom. Suradnja s vrtićem nastavljena je i kroz radionicu bojanja glinenih pločica s reljefnim logotipom MCPA, koja je održana u paviljonu edukativno-prezentacijskog centra sv. Nikola. Prije kreativnog dijela djeca su razgledala stalni postav

5. The kids were eager to try breathing through a regulator while wearing a diving mask / Sva djeca željela su pokušati disati na regulator noseći masku (Photo: M. Ivić Miljković)

delighted by the opportunity to breathe through a regulator connected to a scuba cylinder, all, of course, under expert supervision. Our work with the kindergarten also included a painting workshop featuring clay tiles with an embossed ICUA logo, staged at the pavilion of our Education and Presentation centre. The creative segment was preceded by a tour of our permanent exhibition to acquaint the children with artefacts recovered at underwater sites. The painted tiles were glazed and magnets were attached to create a take-home souvenir.

Our education programmes were not targeted only at children and youth. In September and October, we staged workshops for residents of the St. Francis residential care home. Participants shaped and painted clay objects, developing motor skills, concentration, and providing time in collective creative work. Their creations were exhibited on World Mental Health Day, which gave the program further social value.

The year closed in a collaboration with the Zadar School of Applied Arts and Design. Workshops saw pupils make holiday decorations and other ornamental objects from clay. They participated in all phases of work; pouring liquid clay into moulds, working the casts, and painting the fired pieces. This acquainted them with the different phases of ceramic production and developed their understanding of the technological procedures. Unique pieces were created, demonstrating a combination of creativity and practical knowledge. Throughout the year working with

6. A tour of the permanent exhibition at the former St Nicholas church building is integral to our workshops / Obilazak stalog postava u bivšoj crkvi sv. Nikola sastavni je dio radionica (Photo: N. Cohen)

i upoznala se s predmetima pronađenima na podvodnim nalazištima. Oslikane pločice kasnije su glazirane i pretvorene u magnete koje su djeca ponijela kući kao uspomenu.

Edukativni programi nisu bili namijenjeni samo djeci i mladima. Tijekom rujna i listopada održane su radionice za korisnike Doma za odrasle osobe sv. Frane. Sudionici su oblikovali i oslikavali glinene predmete, pri čemu su razvijali motoričke vještine i koncentraciju, ali i provodili vrijeme u zajedničkom kreativnom radu. Njihovi radovi bili su izloženi povodom Svjetskog dana mentalnog zdravlja, što je programu dalo i dodatnu društvenu vrijednost.

Kraj godine obilježen je suradnjom sa Školom primijenjene umjetnosti i dizajna Zadar. Za učenike su organizirane radionice izrade blagdanskih ukrasa i dekorativnih predmeta od gline. Sudjelovali su u svim fazama rada – od lijevanja tekuće gline u kalupe, preko obrade, do oslikavanja već pečenih oblika. Na taj su način upoznali različite faze izrade keramike i bolje razumjeli tehnološke postupke. Nastali su unikatni radovi koji su spojili kreativnost i praktično znanje. Rad s glinom kroz godinu se pokazao kao jedan od najučinkovitijih načina povezivanja edukacije i kreativnosti. Kroz izradu predmeta sudionici su mogli bolje razumjeti kako su nastajali keramički nalazi koje danas pronalazimo na arheološkim lokalitetima. Takvo iskustvo često ostavlja jači dojam nego samo promatranje gotovih predmeta.

Kroz sve ove aktivnosti edukativno-prezentacijski centar sv. Nikola postupno se profilira kao živ i otvoren prostor u kojem se podvodna arheologija predstavlja na pristupačan način. U radionicama su sudjelovale različite dobne skupine, od djece predškolske dobi do studenata i starijih osoba, a svatko je mogao pronaći nešto što mu je blisko.

7. The painted objects ready for exhibition / Obojani predmeti spremni su za izložbu (Photo: N. Cohen)

clay was shown to be one of the most effective ways of bringing together learning and creativity. Creating objects gave participants a much more tangible understanding of how pottery recovered at archaeological sites was created. This is often much more impactful to our comprehension than simply observing a finished object.

Through these activities the Education and Presentation Centre for Underwater Archaeology st. Nicholas is gradually developing its presence as a vibrant and open space at which underwater archaeology is showcased in an accessible manner. Participants represented all age groups from preschoolers and students to the elderly, and everyone had an opportunity to find something special to them.

The 2025 workshops demonstrated how important education is to heritage preservation. Awareness of the value of underwater sites is not the product only of scientific investigation, it is also developed through continued interaction with the general public, which is why workshops of this kind play an important role in the nexus between specialists and society at large.

The education and presentation workshops staged in 2025 mark the dawn of a new phase in ICUA activity. Here underwater archaeology expands beyond the strict scope of specialist work and is rendered more approachable and comprehensible to broader society. In the long term this approach builds a sense of responsibility towards the sea and past maritime activity, and raises awareness of the fact that underwater cultural heritage is a common good worth discovering and safeguarding.

Radionice provedene tijekom 2025. godine pokazale su koliko je edukacija važna za očuvanje baštine. Svijest o vrijednosti podmorskih nalazišta ne stvara se samo kroz znanstvena istraživanja, nego i kroz kontinuiran rad s javnošću. Upravo zato ovakve radionice imaju važnu ulogu kao poveznica između stručnjaka i zajednice.

Edukativno-prezentacijske radionice održane tijekom 2025. godine mogu se promatrati kao početak jedne nove faze djelovanja Centra. Podvodna arheologija ovdje izlazi iz okvira isključivo stručnog rada i postaje bliža i razumljivija široj publici. Dugoročno, takav pristup pomaže u stvaranju osjećaja odgovornosti prema moru i njegovoj prošlosti te jača svijest o tome da je podvodna kulturna baština zajedničko nasljeđe koje treba upoznati i čuvati.

8. Zadar School of Applied Arts and Design pupils meticulously paint Christmas decorations / Učenice Školom primijenjene umjetnosti i dizajna Zadar pedantno oslikavaju Božićne ukrase (Photo: N. Cohen)

CONSERVATION OF ARCHAEOLOGICAL WATERLOGGED WOOD FROM A SUNKEN SHIP AT AN ANCHORAGE NEAR VERUDA ISLET

KONZERVACIJA MOKROG ARHEOLOŠKOG DRVA S POTOPLJENOG BRODA NA SIDRIŠTU KOD OTOČIĆA VERUDE

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Archaeologists of the International Centre for Underwater Archaeology in Zadar have conducted systematic underwater archaeological investigations over several years of a north Adriatic shipwreck at an anchorage site near Veruda Islet. The site, in relatively shallow water, drew significant attention from specialists and scientists as it may provide insights into shipbuilding practices, trade networks, and the material culture of the Adriatic in the Renaissance period. The investigation leveraged archaeological methods including stratigraphic recording, photogrammetric documentation, and in situ conservation practices, in line with international standards in the protection of underwater archaeological heritage.[1]

Combined analysis of recovered artefacts—including ceramics, metal objects, wooden structural elements, and other material remains—with radiocarbon dating (14C)[2] of fragments of the ship's wooden planking, has provided us a clearer picture of the ship's activity in the second half of the sixteenth century. This date chronologically locates the ship to a period that saw intense commercial activity, growing maritime tensions between the European powers, and the expansion of Mediterranean trade routes.[3]

Detailed documentation of the wreck and associated artefacts was followed by in situ preservation of the

1 Scholz 2021, 27–38, 201–204.
2 Radiocarbon dating (14C) was performed by Tomasz Goslar of the Radiocarbon laboratory in Poznań, Poland.
3 Bekić 2021, 167–176.

Tijekom više godina, arheolozi iz Međunarodnog centra za podvodnu arheologiju u Zadru sustavno su provodili podvodna arheološka istraživanja olupine broda na sidrištu u blizini otočića Verude, u sjevernom Jadranu. Ovo nalazište, koje se nalazi na relativno maloj dubini, privuklo je značajnu pažnju stručne i znanstvene zajednice zbog svog potencijala da pruži uvid u brodograditeljske prakse, trgovačke mreže i materijalnu kulturu renesansnog razdoblja na području Jadrana. Istraživanja su provedena arheološkim metodama uključujući stratigrafsko bilježenje, fotogrametrijsku dokumentaciju i *in situ* konzervatorske prakse, u skladu s međunarodnim standardima za zaštitu podvodne kulturne baštine.[1]

Kombinacijom analize pronađenih nalaza kao što su keramika, metalni predmeti, drveni konstruktivni elementi i drugi materijalni ostaci s radiokarbonskim datiranjem (14C)[2] fragmenta drvene brodske oplate, utvrđena je aktivnost broda tijekom druge polovice 16. stoljeća. Takvo datiranje smješta brod u razdoblje pomorske povijesti obilježeno intenzivnim trgovačkim aktivnostima, rastućim pomorskim napetostima među europskim silama i širenjem mediteranskih trgovačkih ruta.[3]

Nakon detaljne dokumentacije olupine i pripadajućih nalaza, donesena je odluka o očuvanju ostataka trupa broda *in situ*, primarno kako bi se smanjio rizik od oštećenja i osigurala dugoročna zaštita u izvornom podvodnom kontekstu. Ipak, odabrani nalazi izvađeni su

1. Beam before (a) and after (b) mechanical cleaning/ Greda prije (a) i nakon (b) mehaničkog čišćenja (Photo: M. Šimičić, M. Bačić)

surviving remains of the ship's hull. The decision to keep the wreck in place was informed first and foremost by a desire to mitigate any risk of damage and to ensure long-term protection in the original marine context. A selected group of artefacts was, however, recovered for conservation, investigation, and possible museum presentation. One of these is a section of a wooden beam[4] identified as a structural element of the ship, likely part of a longitudinal member or a frame, notable for its state of preservation and unusual changes to the surface. The beam is rectangular in section, 80 cm long, 10 cm wide, and 5.5 cm thick, and has seven round holes, each between two and three centimetres across.

Initial examination showed typical deposits associated with long-term exposure to a marine environment, including calcified layers and marine organisms (shells, wormholes, pinholes, etc.). Mechanical cleaning included removal of surface biological and mineral deposits giving a clearer view of the wood's condition. Removal of surface deposits revealed distinct large areas of orange to brown colour. These stains were interpreted as iron corrosion products, specifically iron oxides and hydroxides[5], indicating that metal fasteners were once fixed to or embedded in the beam. Traces of corrosion were most pronounced around the regularly spaced round holes, which likely held iron elements or fasteners, now entirely degraded by corrosion processes. Traces of scorching were observed on one side, possibly a sign of exposure to fire at sea or when the ship sank.

Residual iron corrosion products are of concern with regard to the chemical stability of this wooden artefact. Iron ions and their corrosion products are known to catalyse acidification and oxidative deterioration in archaeological waterlogged wood, leading to severe long-term degradation.[6] This informed our decision to precede conservation treatment with desalination, supplemented

4 Analysis of the beam identified the wood as oak. Wood species analysis was performed by Michèle Dinies of the German Archaeological Institute (DAI) in Berlin.
5 Jozić 2014, 47–59.
6 Hocker 2018, 105.

radi konzervacije, istraživanja i moguće muzejske prezentacije. Među njima, drvena greda,[4] prepoznata kao strukturni element broda, vjerojatno dio uzdužnice ili rebara, istaknula se zbog svojeg stanja očuvanosti i neuobičajenih površinskih promjena. Greda je pravokutnog oblika, duljine 80 cm, širine 10 cm i debljine 5,5 cm, te sadrži sedam kružnih otvora svaki promjera između 2 i 3 cm.

Pri početnom pregledu, greda je pokazivala tipične naslage povezane s dugotrajnom utjecajem morskog okoliša, uključujući kalcificirane slojeve i morske organizme (školjke, crvotočine, rupice itd.). U sklopu mehaničkog čišćenja uklonjene su površinske biološke i mineralne naslage, čime je omogućen jasniji uvid u stanje drva. Nakon uklanjanja površinskih naslaga posebno su postale upadljive velike površine obojene narančasto-smeđim tonovima (Slika 1b). Te su mrlje protumačene kao produkti korozije željeza, konkretno željezni oksidi i hidroksidi,[5] što ukazuje na to da su nekoć u gredu bili učvršćeni ili ugrađeni metalni spojni elementi. Tragovi korozije bili su posebno izraženi oko pravilno raspoređenih kružnih otvora, za koje se pretpostavlja da su služili kao ležišta za željezne elemente ili spojnice, danas potpuno degradirane uslijed korozijskih procesa. Dodatno, na jednoj strani grede uočeni su tragovi paljenja, što upućuje na moguću izloženost vatri bilo tijekom plovidbe, bilo kao dio samog brodoloma.

Prisutnost ostataka željezne korozije izazvala je zabrinutost za kemijsku stabilnost drvenog nalaza. Naime, poznato je da željezni ioni i njihovi produkti mogu katalizirati zakiseljavanje i oksidativno propadanje kod mokrog arheološkog drva, što dugoročno može dovesti do njegove potpune degradacije.[6] S obzirom na to, prije nastavka bilo kakvih konzervatorskih zahvata, pored desalinizacije, odlučeno je provesti i predobradu usmjerenu na uklanjanje željeznih spojeva radi smanjenja koncentracije otopljenih soli koje mogu pospješiti korozijske i degradacijske procese.

Desalinizacija je provedena postupno, periodičnom izmjenom demineralizirane vode, s ciljem difuzijskog uklanjanja topljivih soli iz strukture drva. Posebna se

2. Extraction of iron ions using coatings / Ekstrakcija željeznih iona pomoću obloga (Photo: A. Jelić)

by pre-treatment stage aimed at removing iron compounds and reducing the concentration of dissolved salts that can accelerate corrosion and degradation processes.

Desalination was performed gradually, with periodic replacement of the demineralised water aimed at achieving the gradual diffusion and removal of soluble salts from the wood. Special attention was paid to reducing the concentration of chloride ions, which can significantly destabilise the wood's chemical stability. This procedure preceded preparation of the artefact for further stabilisation and conservation treatment.

A limited supply of chemicals significantly impacted the scope and reach of our conservation strategy from this point. These limitations were not related only to the availability of chemical compounds, they also informed key decisions regarding the materials and methods used. A practical and targeted approach to wood treatment was thus applied. A localised iron removal procedure was carried out, using a 2 % aqueous solution of disodium ethylenediaminetetraacetic acid (2Na-EDTA) and oxalic acid.[7] As immersing the beam in a large quantity of prepared solution was not an option, it was applied with pads directly to the affected surfaces (Figure 2), aimed at a controlled removal of iron ions from the structure of the wood. The use of pads was considered the most effective method given the limited resources available.

Microscopic analysis was performed using scanning electron microscopy (SEM) in combination with energy-dispersive X-ray spectroscopy (EDS) to verify the effectiveness of the pre-treatment and to determine the elemental composition of the treated wood.[8] This technique enabled high-resolution imaging and mapping of elements on the wood surface. The results confirmed the dominance of carbon and oxygen, consistent with organic material, while calcium, magnesium and sulphur were present in small amounts, most likely the result of mineral infiltration from seawater. Critically, iron was recorded only in trace amounts, confirming the success of the chemical removal of corrosion products.

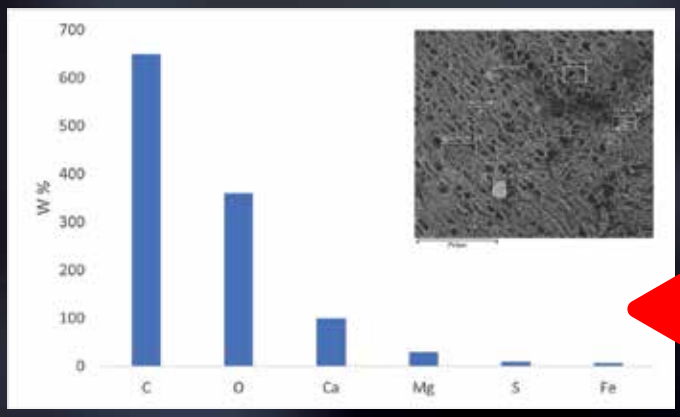
7 Unger et al. 2001, 502.
8 SEM-EDS analysis was performed by ArcheoLab, a sole trader for technical analysis based in Pula.

pažnja posvetila smanjenju koncentracije kloridnih iona, koji mogu značajno destabilizirati kemijsku ravnotežu unutar drva. Ovaj postupak predhodio je pripremi artefakata za daljnju stabilizaciju i konzervatorsku obradu. Međutim, ograničene količine kemikalija znatno su utjecale na opseg i dubinu daljnje konzervatorske strategije. Ta ograničenja nisu bila vezana samo na dostupnost kemijskih sredstava, već su oblikovala i ključne odluke o korištenim materijalima i metodama. Kao odgovor na uvjete, primijenjen je praktičan i ciljani pristup tretiranja drva. Proveden je lokalizirani postupak uklanjanje željeznih spojeva, koristeći 2%-tnu vodenu otopinu dinatrijeve soli etilendiamintetraoctene kiseline (2Na-EDTA) i oksalne kiseline.[7] Otopina je nanošena u obliku obloga izravno na zahvaćene površine (Slika 2), što je omogućilo kontrolirano uklanjanje željeznih iona iz strukture drva unatoč nemogućnosti uranjanja grede u veće količine pripremljene otopine. Metoda korištenja obloga odabrana je radi učinkovitosti i ograničenosti resursa.

Kako bi se potvrdila učinkovitost predobrade i utvrdio elementni sastav tretiranog drva, provedena je mikroskopska analiza korištenjem skenirajuće elektronske mikroskopije (SEM) u kombinaciji s energijsko-disperzivnom rendgenskom spektroskopijom (EDS).[8] Ova tehnika omogućila je visoko rezolucijsko snimanje i mapiranje elemenata na površini drva. Rezultati su potvrdili dominaciju ugljika i kisika, što je u skladu s organskim materijalom, dok su kalcij, magnezij i sumpor bili prisutni u manjim količinama, najvjerojatnije kao posljedica mineralne infiltracije iz morske vode. Ključno željezo je zabilježeno tek u tragovima, što ukazuje na uspješnost kemijskog uklanjanja korozijskih produkata (Slika 3).

Nakon desalinizacije i faze predobrade, provedena je stabilizacija drva pomoću polietilen glikola (PEG), polimera široko primjenjivanog u konzervaciji mokrog arheološkog drva. PEG djeluje tako da zamjenjuje vodu u staničnoj strukturi, čime se sprječava skupljanje

3. Results of SEM-EDS analysis / Rezultati SEM-EDS analize (Photo: A. Jelić)



Desalination and pre-treatment were followed by stabilisation using polyethylene glycol (PEG), a polymer widely used in the conservation of archaeological waterlogged wood. PEG acts by replacing water in the cellular structure, thereby preventing shrinkage and cell wall collapse during drying.[9] In ideal conditions conservation would involve a sequence of PEGs of varying molecular weights over an extended period to achieve optimal absorption and stabilisation. Limited access to material, however, meant that only the previously used PEG 4000, a high molecular weight polymer, was available.

The suitability of PEG 4000 was confirmed by infrared spectroscopy, liquid chromatography, and thermal analysis (thermogravimetric analysis and differential scanning calorimetry)[10], but there was a degree of uncertainty on account of the years held in storage. Notwithstanding the possible risk of uneven absorption and surface supersaturation, the decision was made to proceed with the available material.

Impregnation began with a 10 % PEG solution, increased by 10 % per month up to a final concentration of 70 %. A gradual increase strategy reduces osmotic stress and improves polymer penetration into the wood. The impregnation phase lasted approximately seven months with occasional process control.

The beam was air-dried following impregnation, kept under layers of plastic film removed on a daily basis to ensure gradual evaporation. Relative air humidity was maintained at around 65 % during the initial phase of drying, later reduced to between 50 and 55 %, while the temperature was kept constant at around 20 °C. This slow and strictly controlled drying significantly reduced the risk

9 Hoffmann 2013, 25–36.
10 Analysis of the previously utilised PEG was performed by Khôi Tran of ARC-Nucléart, Grenoble, France.

i kolaps staničnih stijenki tijekom sušenja.[9] U idealnim uvjetima, konzervacija bi uključivala primjenu niza PEG-ova različitih molekulskih masa kroz dulje vremensko razdoblje kako bi se postigla optimalna apsorpcija i stabilizacija. Međutim, zbog ograničene dostupnosti materijala, raspolagalo se isključivo ranije korištenim PEG-om 4000, polimerom visoke molekulske mase.

Njegova ispravnost potvrđena je infracrvenom spektroskopijom, tekućinskom kromatografijom i toplinskim analizama (termogravimetrijskom analizom i diferencijalnom pretražnom kalorimetrijom),[10] no zbog višegodišnjeg skladištenja zadržana je određena razina nesigurnosti. Unatoč mogućem riziku neujednačene apsorpcije i površinske prezasićenosti, odlučeno je nastaviti s dostupnim materijalom.

Postupak impregnacije započeo je otopinom PEG-a koncentracije 10%, koja se zatim povećavala za 10% mjesečno, sve do konačnih 70%. Postupno podizanje koncentracije smanjilo je osmotski stres i omogućilo bolje prodiranje polimera u drvenu strukturu. Faza impregnacije trajala je približno sedam mjeseci uz povremenu kontrolu procesa.

Nakon završetka impregnacije greda je sušena na zraku, ispod slojeva plastične folije koji su svakodnevno uklanjani kako bi se omogućilo postupno isparavanje. U početnoj fazi sušenja relativna vlažnost zraka održavala se na oko 65%, a u kasnijoj ona je snižena na između 50 i 55%, dok je temperatura bila konstantno oko 20 °C. Ovakav spor i strogo kontroliran proces sušenja značajno je smanjio rizik naglog stezanja i razvoja većih pukotina. Nakon sušenja, višak PEG-a uklonjen je s površine drva vrućim zrakom, upijajućim papirom i malom količinom etanola (Slika 5).

Unatoč činjenici da je korišten već upotrijebljeni PEG 4000, konačni rezultati pokazali su se iznenađujuće dobrima. Formiranje veće pukotine tijekom procesa impregnacije izazvalo je zabrinutost, no tijekom sušenja pukotina je ostala stabilna, kao i sama greda. Uočene su tek manje površinske pukotine, bez znakova savijanja, raslojavanja ili strukturnog slabljenja. Premda nešto tamnije boje i veće mase zbog zadržanog polimera, greda je zadržala stabilnost i cjelovitost. Ovi rezultati ukazuju da su, unatoč ograničenjima materijala i postupka, ključni ciljevi konzervacije mokrog arheološkog drva, dimenzijska stabilnost i dugoročno očuvanje, uspješno postignuti.

Konzervacija grede iz olupine broda pronađenog na sidrištu kod otočića Verude jasno ilustrira izazove,

4. Removing the beam from the PEG process / Vađenje grede iz PEG postupka (Photo: A. Jozić)

5. Removal of excess PEG from the wood surface / Uklanjanje viška PEG-a s površine drva (Photo: A. Jozić)

of abrupt shrinkage and the development of large cracks. Hot air, absorbent paper and a small amount of ethanol were used to remove excess PEG from the surface of the wood once drying had been completed.

The final result was surprisingly good when considering that previously used PEG 4000 was employed. The formation of a large crack during the impregnation process was a source of concern, but it remained stable during drying, as did the whole of the beam. We observed only minor surface cracking, with no signs of warping, delamination, or weakening of the structure (Figures 6a and 6b). Although somewhat darker and heavier due to the retained polymer, the beam retained its stability and integrity. These results indicate that, despite the material and process limitations, the key objectives of archaeological waterlogged wood conservation—dimensional stability and long-term preservation—were achieved.

6. Beam after conservation and restoration works / Greda nakon konzervatorsko-restauratorskih radova (Photo: A. Jelić)

The conservation of a beam from a wreck found at an anchorage site near Veruda Islet clearly illustrates the challenges faced and ingenuity required in conservation work. The successful stabilisation of this artefact, achieved through a combination of targeted chemical treatment, careful planning, and adaptable methods, demonstrates that quality results are possible even when resources are limited. The preserved wooden element represents not only a valuable source of historical information, but also an educational example of effective, resource-conscious conservation practices.

ali i domišljatost potrebnu u području konzervatorske znanosti. Uspješna stabilizacija ovog nalaza, ostvarena kroz kombinaciju ciljane kemijske obrade, pažljivog planiranja i prilagodljivih metoda, pokazuje da su kvalitetni rezultati mogući čak i u uvjetima ograničenih resursa. Nadalje, očuvani drveni element danas ne predstavljaju samo vrijedan izvor povijesnih informacija, već i edukativni primjer učinkovite, resursno svjesne konzervatorske prakse.

Bibliography / Literatura:

Bekić, L. 2021. - Povijesni kontekst arheoloških nalaza kod Verude, in Bekić, L. (ed.) *Potopljeni brod na sidrištu kod Verude*, 167-176. Zadar: Međunarodni centar za podvodnu arheologiju u Zadru.

Hocker, E. 2018. - *Preserving Vasa*. London: Archetype Publications.

Hoffman, P. 2013. - *Conservation of Archaeological Ships and Boats*. London: Archetype Publications

Jozić, A. 2014. - The Conservation and Restoration of Metal Finds, in Bekić, L. (ed.) *Conservation of Underwater Archaeological Finds - Manual*, 47-59. Zadar: Međunarodni centar za podvodnu arheologiju u Zadru.

Scholz, R. 2021. - Metodologija iskopavanja i dokumentiranja, in Bekić, L. (ed.) *Potopljeni brod na sidrištu kod Verude*, 27-38. Zadar: Međunarodni centar za podvodnu arheologiju u Zadru.

Scholz, R. 2021. - In situ zaštita nalazišta i nadzor, in Bekić, L. (ed.) *Potopljeni brod na sidrištu kod Verude*, 201-204. Zadar: Međunarodni centar za podvodnu arheologiju u Zadru.

Unger, A., Schniewind, A.P., Unger, W. 2001. - *Conservation of Wood Artefacts, A Handbook*. Berlin, Heidelberg, New York: Springer.

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