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RESULTS OF THE UNDERWATER SURVEY OF KAŠTELA BAY IN 2020

An underwater survey was conducted in September of 2020 on several locations in Kaštela Bay, mainly around the area of Pantan near Trogir, with the aim of assessing the potential of these locations for more detailed investigations. The limited survey gave positive results, as the collected prehistoric and Roman material pointed to a great potential of specific locations for further archaeological research.

Key words: underwater archaeology; prehistory; antiquity (Roman period); Kaštela Bay; Dalmatia; Croatia / *Ključne riječi: podvodna arheologija; prapovijest; antika (rimsko doba); Kaštelanski zaljev; Dalmacija; Hrvatska*

Introduction

The Adriatic Sea is known to be rich in sites from various archaeological periods. Attention has mostly been focused on Roman sites and shipwrecks from different periods, but research on prehistoric underwater sites has intensified recently¹. Kaštela Bay is known for its Greek and Roman, as well as Neolithic² and Paleolithic³ sites and recently, the results of a lithic analysis of Middle Paleolithic finds from the site of Kaštel Štafilić – Resnik have been published⁴.

The most recent research, the results of which we present in this paper, fits within the wider efforts of research on Paleolithic sites in the area of Kaštela and Trogir, and was preceded by the systematic excavation at Mujina pećina⁵, excavation of the open-air site at Karanušići⁶, the underwater research of the Middle Paleolithic site of Kaštel Štafilić – Resnik and as of yet unpublished analyses of Paleolithic material from the vicinity of Trogir. Recent explorations were planned as a part of the research project *Last Neandertals at the Crossroads of Central Europe and the Mediterranean* (HRZZ-IP-2019-04-6649), financed by the Croatian Science Foundation. Based on the approval of the Directorate for the Protection of Cultural Heritage, Conservation Department in Trogir, dated 9th of September of 2020, an underwater survey of the sea bottom at five locations east from the

1 Radić Rossi *et al.* 2020.

2 Brusić 1990; Brusić 2004.

3 Karavanić *et al.* 2009.

4 Karavanić, Barbir 2020.

5 Karavanić, Kamenjarin 2020.

6 Karavanić *et al.* 2016.



Map 1. Marked locations of the land positions and diving routes. Polygons of the routes are made based on the GPS data. The letter P before the number signifies the land position at which chert finds were collected and the letter Z signifies specific dives (made by M. Banda) / Karta 1. Naznačene pregledane kopnene lokacije i trase ronjenja. Poligoni trasa izrađeni su na temelju GPS podataka. Slovo P ispred broja označava kopneni položaj na kojem su prikupljeni komadi rožnjaka, dok slovo Z označava pojedini zaron (izradio M. Banda)



Fig. 1. Divers starting a dive at Pantan (Z2) (photo by M. Banda) / Sl. 1. Ulazak ronilaca u more na položaju Pantan (Z2) (snimio M. Banda)

city of Trogir and a survey of six locations on the land was conducted from the 26th to the 30th of September 2020 (**Map 1**). The position of the underwater routes was recorded by a GPS receiver fastened to a signal buoy, which was in turn pulled by one of the divers.

Methods

Method and the course of the survey

The divers generally moved parallel to each other, tied to one another by rope, with one of the divers pulling the signal buoy onto which a GPS receiver was mounted in order to record spatial data of the routes, i.e. the surveyed area. Significant finds were photographed underwater so that the time of the photograph could be correlated with the time of a specific GPS point, and thus at least roughly record the position of the find. All chert pieces resembling artefacts were collected, while sorting between artefacts and geofacts was conducted on land due to better visibility. Archaeological finds from the sea bottom were desalinated.

During the first day of the research (26th September 2020) several locations of the coastline in the vicinity of Trogir were surveyed before diving, as well as one location on the coast of Čiovo facing Trogir (**Map 1**). Fragments of chert created by natural fracturing were found on all of the locations and were collected selectively. Except for Position 6, where three potential chert artefacts were collected, no other chert artefacts were found. Fragments of Roman pottery and human bones were found at Position 5 (**Map 1: P5**). Both human bones, a distal part of the left femur and a long bone midshaft fragment, are morphologically modern and the former was radiocarbon dated. The finds and the sediment at Position 5 are the result of recent and artificial transport from an unknown location. Position 3 is composed of material recently deposited for the construction of a pier, and is thus not marked on the map, and the material (naturally or unintentionally fractured) was not collected.

From the 26th to the 30th September of 2020 a total of five dives were conducted on different locations (**Map 1, Fig. 1**). Visibility varied during different days (from 1 to 4 m at deeper locations), as did the total duration of the dives. During dives 1–3, three divers were conducting the survey, while dives 4 and 5 were conducted by two divers. During dives 3 and 4, a boat was used to reach the locations of the planned dives, which were generally in the deeper parts (during dive 5 diving depth varied between 8 and 15 m) of the Kaštela Bay.

Among the collected material, there were significantly less chert artefacts than natural fragments. During dives 2 and 3 ceramic finds (e.g. an amphorae lid) were also found.

All collected material is currently stored at the Department of Archaeology (Faculty of Humanities and Social Sciences in Zagreb), where it is subjected to desalinization. The finds will be permanently stored at the Museum of the Town of Trogir.

Sample preparation for radiocarbon dating, measurement and expression of results

One of two human bones was directly radiocarbon dated by applying Accelerator Mass Spectrometry (AMS) technique. For collagen extraction, bone sample (4 g) was mechanically cleaned, rinsed in ultrapure water (UPW) in the ultrasonic bath, then in acetone, then again in UPW. A bone was then demineralized at the room temperature by 4% HCl until the completely gelatinous/soft bone texture was reached. Next, the sample was treated by 1% NaOH solution (the base step) in order to remove the humic acids, molecules derived from the organic part of the soil that are soluble in bases. This was

followed by treatment in acidic solution (4% HCl) again to remove atmospheric CO₂ absorbed in the base. These steps are known as the A-B-A procedure. The gelatinous rest was treated in UPW acidified with HCl to pH 2–3 at 80°C for 12 hours, dissolving the collagen. The solution was hot-filtered, through glass fibre filters, removing the insoluble parts (e.g. roots, sediment, wood fragments, etc.). The filtrate was freeze-dried resulting in sponge-like collagen⁷. The collagen yield was 2.1%. Collagen was loaded in a quartz tube together with CuO and Ag-wool, sealed in the vacuum and put in the oven at 850°C to oxidize collagen to CO₂⁸.

A portion of CO₂ obtained by collagen combustion was separated for δ¹³C analysis on Isotope Ratio Mass Spectrometer (IRMS), while another portion was turned to graphite by zinc reduction with iron catalyst. The graphite was then pressed in aluminum targets for ¹⁴C/¹³C analyses on accelerator mass spectrometer⁹. The CO₂ gas and the graphite were produced at the Zagreb Radiocarbon Laboratory of the Ruđer Bošković Institute. Both IRMS and AMS analyses were done at the Center for Applied Isotope Studies (CAIS), the University of Georgia, Athens, USA.

Conventional radiocarbon age was calculated from ¹⁴C/¹³C values using Libby's half-life (5568 years) and was normalized to δ¹³C = -25 ‰. It was expressed as years BP ("Before Present" with "present" being the calendar year 1950, 0 BP = AD 1950). Calendar years expressed as cal AD were obtained from the conventional radiocarbon ages by the computer program OxCal v.4.4.4¹⁰ and using the calibration curve IntCal20¹¹.

Results

The artefacts found during the survey are described in the following section. The first part of the label is the surveyed region and the year of the survey. The middle designation of the finds between the two full stops indicates the location where it was found, and the number after the full stop is the artefact number of that location.

Lithics:

KZ20.P6.1 (**Fig. 2**) is a complete flake. It is patinated, but benthic foraminifera can be seen. The edges are damaged and rounded and the proximal part of the flake (including the platform) is heavily battered. The platform is undetermined due to damage. Length 35 mm, width 53.3 mm and thickness 11.5 mm. Mass is 21.5 g.

KZ20.P6.3 (**Fig. 2**) is a complete flake. It is patinated. More recent heavy edge damage (recognizable due to differentiation in patina). Furthermore, some of the edges are rounded. The platform is faceted. Length 30.3 mm, width 27.5 mm and thickness 7.7 mm. Mass is 7.1 g.

KZ20.P6.5 (**Fig. 2**) is a proximal fragment of a flake. It is patinated. There is small edge damage and rounding. The platform if fragmented but was possibly linear. Length 16.5 mm, width 13.4 mm, thickness 3.2 mm. Mass is 0.9 g.

KZ20.Z1.1 (**Fig. 2**) is a proximal fragment of a flake. It is patinated, but some benthic foraminifera can be seen. Edge damage is present, as is some small rounding. The platform is plain. Length 32 mm, width 26.6 mm and thickness 4 mm. Mass is 5.4 g.

KZ20.Z3.1 (**Fig. 2**) is a complete flake. It is patinated, but benthic foraminifera can

7 Sironić *et al.* 2020.

8 Sironić *et al.* 2013.

9 Krajcar Bronić *et al.* 2010; Sironić *et al.* 2013.

10 Bronk Ramsey 2009, 2021.

11 Reimer *et al.* 2020.

be seen. Some parts of the edges are damages. Platform type is plain. Length 41.4 mm, width 25 mm and thickness 6.5 mm. Mass is 8.7 g.

KZ20.Z3.2 (Fig. 2) is a right longitudinal fragment of a flake ("Siret" accidental break). It is patinated. Edge damage is present. The platform is undetermined because it is incomplete. Length 39.2 mm, width 14.5 mm and thickness 7.1 mm. Mass is 5.2 g.

KZ20.Z4.1 (Fig. 2) is a complete flake. It is patinated. There is small edge damage. The platform is faceted. Length 20 mm, width 22.2 mm and thickness 5.8 mm. Mass is 3.2 g.

KZ20.Z4.2 (Fig. 2) is a complete flake. It is patinated, but benthic foraminifera can be seen. There is edge damage. The platform is punctiform. Length 20.5 mm, width 22.9 mm and thickness 7.5 mm. Mass is 3.1 g.

KZ20.Z5.1 (Fig. 2) is a complete flake. It is patinated. There is edge damage. The platform is missing. Length 16.8 mm, width 18.4 mm and thickness 3.9 mm. Mass is 1.5 g.

An additional find from Dive 1 is ambiguous, as are several more finds from Position 6 on land.

The described lithic finds may date from the Paleolithic and / or later periods.

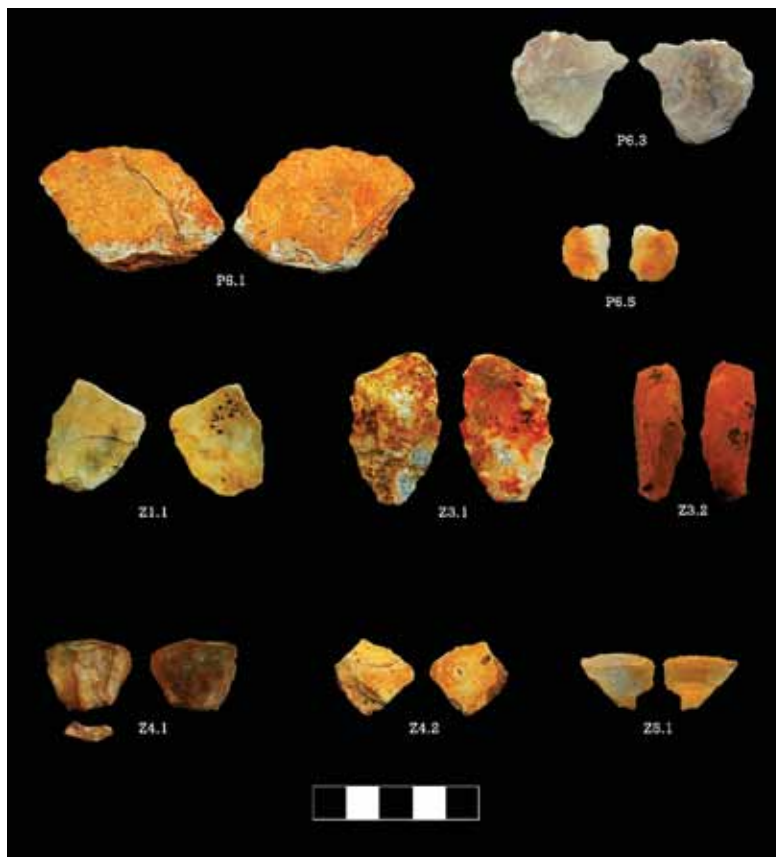


Fig. 2. Lithic artefacts found during the survey. The labels indicate the locality of the find and the find number (see the text for details). Scale is in cm (made by M. Banda) / Sl. 2. Litički artefakti pronađeni tijekom istraživanja. Oznake se odnose na mjesto i broj nalaza (detalje vidjeti u tekstu). Mjerilo je u cm (izradio M. Banda)

Pottery:

KZ20.Z2.1 (Fig. 3) is a rim fragment of a Roman plate. Can be conjoined to KZ20.Z2.2. Length (height) 36.9 mm, width 75.9 mm and thickness 5 mm. The thickness of the rim is 6.6 mm.

KZ20.Z2.2 (Fig 3) is a rim fragment of a Roman plate. Can be conjoined to KZ20.Z2.1. Length (height) 35.7 mm, width 53.7 mm and thickness 5.7 mm. The thickness of the rim is 6.9 mm.

Plate fragments can be dated between the 1st century BC and 1st century AD¹².

KZ20.Z2.3 (**Fig. 3**) is a prehistoric pot fragment with a complete handle. Length (height) 86.5 mm, width 55.3 mm and thickness 4.1 mm. The height of the handle is 71.4 mm and the thickness at the midsection is 10.6 mm.

KZ20.Z3.3 (**Fig 3**) is a complete Roman amphora lid. The diameter of the piece is 102.7 mm and the thickness 9.2 mm, while the height of the handle is 15.9 mm and its thickness 14.3 mm. It was made in a mold. It probably dates from the 1st century BC¹³. Such finds were found at the site of Siculi¹⁴.



Fig. 3. Pottery found during the survey. The labels indicate the locality of the find and the find number (see the text for details). Scale is in cm (made by M. Banda) / Sl. 3. Keramika pronađena tijekom istraživanja. Oznake se odnose na mjesto i broj nalaza (detalje vidjeti u tekstu). Mjerilo je u cm (izradio M. Banda)

Human bones:

KZ20.P5.1 is a distal part of the left femur, morphologically modern. This bone was directly dated by radiocarbon AMS to 1725 ± 20 BP, Z-7564 (A2362), $\delta^{13}\text{C} = -19.0\text{‰}$, calibrated ages ($k = 1$): cal AD 258–280 (22.0%), cal AD 330–377 (46.3%), median cal AD 342 (**Fig. 4**). Obtained calibrated median date points to the Late Roman period in Dalmatia (the middle of 4th century AD).

KZ20.P5.2 is long bone midshaft fragment, morphologically modern.

Whether the two bone fragments belonged to the same individual is impossible to say. Small fragments of Roman pottery were found at the same location (in accordance with the radiocarbon dated bone) but not collected since they were recently transported from unknown location together with sediment and human bones.

Based on the material collected the survey showed that the underwater area between Pantan and Čiovo has potential for future research, i.e. systematic surveys and collection with adequate recording of diving positions.

¹² M. Vukov, personal communication.

¹³ I. Šuta, personal communication.

¹⁴ Šuta 2011.

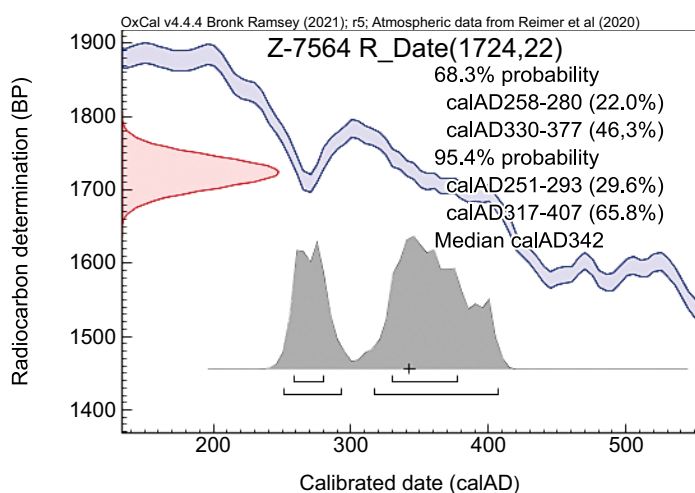


Fig. 4. Calibration of the conventional radiocarbon age for bone sample Z-7564. Software OxCal v4.4.4, calibration curve INTCAL20 / Sl. 4. Kalibracija konvencijske radiokarbonske starosti koštanog uzorka Z-7564. Software OxCal v4.4.4, kalibracijska krivulja INTCAL20

Conclusion

Given the current knowledge on the settlement of the area of Trogir and Kaštela during prehistory and the results of previous underwater research of the Kaštela Bay, an assessment of the potential of the Bay for further research was conducted, primarily for the period of the Paleolithic. Five dives were conducted with the aim of surveying the sea bottom on the selected locations, while several locations on land were surveyed before the dives. A part of the underwater locations were selected on the basis of earlier information of the presence of lithic finds (the area between Pantan and Čiovo), while a part was chosen randomly. Given the short timeframe of the research and the participation of only two or three divers, the results exceeded our expectations. Although modest, the lithic and ceramic finds indicate a great potential of the bay for further underwater research for both prehistory and later periods. This research should be conducted systematically, primarily as systematic surveys with the collection of all finds and the recording of the collection locations with GPS, and then, if required, with more detailed research or excavation of specific locations. Because of the existence of Paleolithic sites in the hinterland of Kaštela (Mujina pećina, Karanušići), underwater finds from Kaštel Štafilić – Resnik and the sporadic Paleolithic finds collected during earlier land and underwater research of the Trogir area (Lapidarij in the Museum of the Town of Trogir, Kopilica, Malo polje – Krban), further discoveries of new locations of such finds should be expected in the Bay. Such locations point to the movement of Paleolithic hunter-gatherers from the hilly hinterland towards the coastline at that time, and vice-versa, and also probably along the coast, clearly indicating that the territory which is covered by the sea today was used by Paleolithic people.

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SAŽETAK

Rezultati podvodnog pregleda Kaštelanskog zaljeva u 2020.

U rujnu 2020. obavljen je podvodni pregled više mjesta u Kaštelanskom zaljevu, napose oko područja Pantana kod Trogira, s ciljem utvrđivanja potencijala tih mjesta za detaljnija istraživanja. Ukupno je pregledano šest položaja na kopnu i provedeno šest zarona tijekom kojih su prikupljeni nalazi s morskog dna. Od litičkih nalaza pronađeno je devet artefakata te više upitnih primjeraka i prirodno razlomljenog rožnjaka. Pronađeno je i nekoliko ulomaka antičke te jedan ulomak prapovijesne keramike. Stoga je vrlo ograničen pregled dao pozitivne rezultate, odnosno prikupljen materijal iz razdoblja prapovijesti i antike upućuje na veliki potencijal pojedinih lokacija za daljnja podvodna arheološka istraživanja.

