

# Potkamenica Cove shipwreck, island of Šolta, Croatia

Maja Kaleb

**Abstract:** The remains of a shipwreck located in the Potkamenica Cove on the island of Šolta were researched, documented and protected *in situ* in 2020, one decade after its discovery. The shipwreck is gravely devastated due to uncontrolled anchoring, but parts of the keel and one side of the ship with its belonging elements, planks and futtocks are partially preserved. The ship was built using the *shell-first* technique using the distinctive assembly method of tenon-and-mortise joinery. The sinking of the ship was dated in the 4<sup>th</sup> century by using the 14C AMS method and by the comparative analysis of movable archaeological material.

**Keywords:** Late Roman Period, Roman shipbuilding, mortise-and-tenon, Dalmatia, Croatia

## 1. Introduction

Šolta is one of the smaller islands of the Central Dalmatia region, presenting a highly indented shoreline (Fig. 1). Its administrative territory includes a number of islets and rocks. It gravitates chiefly to the city of Split, which had, and continues to have, the most significant impact on the development of the island and its inhabitants. Although we have no confirmation that the Greek polis of Olynthus colonised the island (Oreb 2012: 193) we do know that the island was referred to as Olynthus, meaning ‘unripe fig’ (Bezić 2012: 19), in the 4<sup>th</sup> c. BCE during the Greek colonisation of the Adriatic (Suić 1996: 196, 199). With the Roman incursion, and the concomitant Latinisation of toponyms, we see Šolta referred to as Solenta and by similar other names (Bezić 2012: 19–21). On the *Tabula Peutingeriana*, a cartographic itinerary showing the road network of the Roman empire, Šolta is shown as Iŷs. Solentij, i.e., *insula Solentii* (Faričić, Đuran 2012: 167). Numerous archaeological artefacts and architectural features - remains of economic and sacral character - bear witness to active life on Šolta. Along with the many traces of life on land, we also have a number of Classical Antiquity underwater archaeological sites (Vrsalović 2011: 122; Oreb 2012: 205; Bezak 2014: 570; Kaleb 2020; Kaleb 2021a: 13–14; Kaleb 2021b: 31–35) of various types (anchorage sites, loss or damage sites, and wrecks). Notable on the indented north side of Šolta is the Nečujam inlet, consisting of a number of coves: Šumpjivina, Potkamenica, Maslinica, Piškera, Supetar, Bok o’ Supetra, Tiha vala and Bok od rata.

## 2. Discovery and research

### 2.1. Discovery and survey in 2009

Potkamenica is one of the coves to the west side of the Nečujam inlet. It is characterised by shallow water and the very good protection it provides against the most perilous of winds on eastern Adriatic coast: the north-easterly *bura* and the south-easterly *jugo*. An archaeological survey was performed in 2009 following a report and the discovery of a wreck. The investigation identified an antique period ship of the late Roman empire built using the shell-first technique and described the visible elements of the wooden structure (Radić Rossi 2010: 684–686).

### 2.2. Resurvey in 2019

The part of the cove with the remains of the ship was surveyed again in 2019. It was found that the wreck had suffered significant devastation in the intervening ten-year period and that there was a large quantity of destroyed and dislocated wood in the deeper part of the cove among the Mediterranean tapeweed (*Posidonia oceanica*) growing there. As the ship’s structure was clearly threatened by a quantity of sediment insufficient to provide adequate cover, and by

the uncontrolled anchoring activity of many boaters, the decision was made to fully investigate, document, and adequately protect the wreck. The investigative work at the wreck site in Potkamenica cove in 2020 was the first systematic underwater archaeological excavation in the waters of Šolta island.



Fig. 1 Map of Croatia and Šolta Island with Potkamenica Bay (author: M. Kaleb)

### 2.3. Excavation in 2020

Following an underwater survey of the whole of the cove, our attention was focused entirely on the wreck site. It is located on the north side of Potkamenica cove, about thirty metres from the shoreline, on a gentle slope at a depth range of four to five metres. Prior to any intervention on the seabed the site area was video and photographically documented with underwater cameras for the production of a 3D model and a digital orthophoto mosaic of the condition as found. A grid with four fixed points and four 2 × 2 m metal grid sectors (trenches) was installed in order to facilitate the detailed documentation of all elements of the ship's structure. Upon completion of all preparatory work, the excavation and documentation methodology were agreed upon. It was followed by the start of archaeological excavation work which was assisted by a dredge with flexible reinforced tubes powered by a water pump. The surface layer of sediment was excavated to the level of the wooden material in order to identify the component elements. In areas where wood was not preserved the depth of the excavated layer was somewhat greater in order to ascertain if any material was present further down.

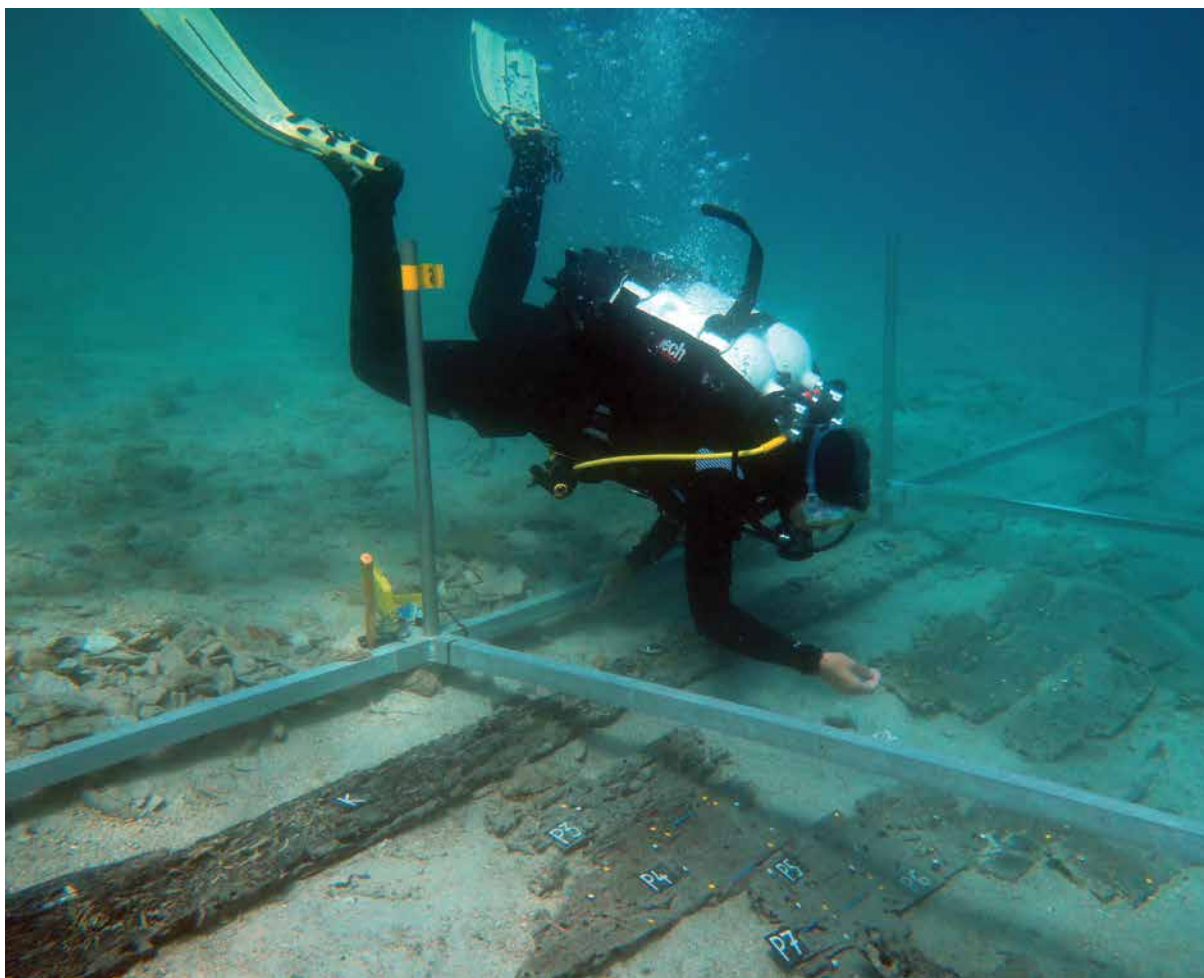


Fig. 2 Labeling of ship's structure before documenting (photo: R. Surić)

#### 2.4. Documentation

The very meagre quantity of sediment – sand and rubble – meant that the surface of the ship's structure was very quickly revealed and identified. In situ labelling of the ship's elements was initiated upon the clearing of almost the entire area of the excavated trenches. The horizontal and transverse elements of the ship were labelled (Fig. 2) with white marker on rectangular PVC labels<sup>1</sup>. The keel was designated with the letter K, with alphanumeric designators used to label the planks (P) and the frames and futtocks (F)<sup>2</sup>. Joint elements were labelled with white and yellow markers. White was used to designate the treenails used to join frames with the outside planking, and yellow to designate the pegs used to lock mortise-and-tenon joints. Butt scarfs between planks were marked with blue wire. Once all the elements were labelled, the ship's structure was photographed in detail for the production of a 3D model. A total of 500 photographic images were made, then reviewed and processed for use in the Agisoft Metashape software. The produced result is a photogrammetric 3D model and a digital orthophoto mosaic of the site (Fig. 3). Along with the digital material we also insisted on the production of technical, i.e., hand-drawn documentation. A separate plan view was drawn for each trench, later merged as a complete field drawing of the wreck. The produced drawing of the remains of the wooden structure greatly facilitated the planning of the further course of excavation work. Three profile drawings of the preserved remains of the ship were also produced ahead of the placement of markings on the ship's structure.

<sup>1</sup> The film used for the labels is also known locally as *kalander*. Besides being reasonable in terms of its cost, this material is characterised by strength and durability. Black PVC film with a thickness of 0.23 mm was used.

<sup>2</sup> As a rule, F is used to designate a frame, while Fu is used to designate a futtock, however the poor condition of preservation at this wreck hampered a confident identification of the elements and their differentiation.



Fig. 3 Orthophoto model of ship's remains (author: R. Surić)

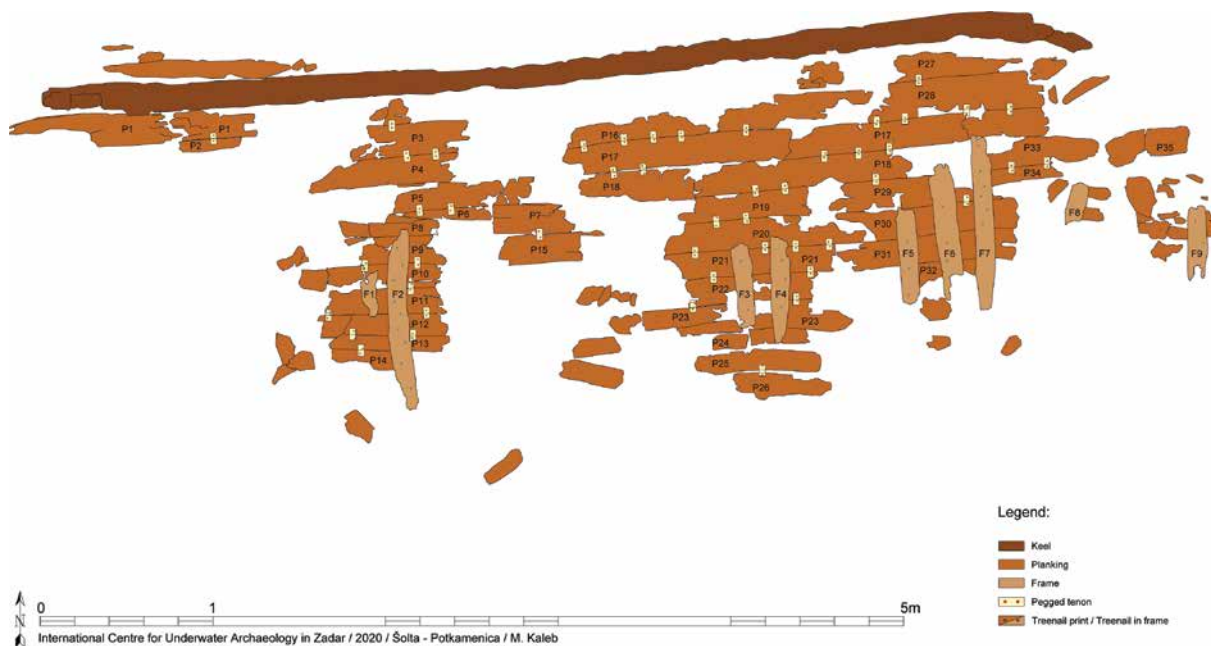


Fig. 4 Elements of wooden ship structure (drawing: M. Kaleb)

### 2.5. Remains description

The preserved part of the ship (Fig. 4) in the waters of Potkamenica cove cover a length of seven metres and width of 2.2 m. Most of the preserved remains of the outside planking and some of the futtocks were found in situ. The keel is in its proper place, but overturned. Small fragments of wood were observed around the wreck and at the bottom of a gentle slope about ten metres south from the centre of the site, but no confident determination could be made as to what part of the structural elements they were from. The very poor state of the remains of the ship's structure and the absence of some structural elements unfortunately means that no confident determination can be made as to which side of the ship has been preserved, or as to its alignment (stern and bow position).

## 3. Hull

The ship wrecked in the waters of Potkamenica cove was built using shell-first construction technique. The outside planking, consisting of planks laid edge to edge (carvel work) with mortise and tenon joints, was built after the keel and posts had been set. The ship's keel, made of oak (*Quercus sp.*), is preserved to a length of 5.9 m. The maximum preserved keel height (moulded dimension) is 18 cm, and the width (sided dimension) is 17 cm. The section is rectangular, with no visible rounding of the edges. The keel was not found in situ, rather overturned to the south with its topside lying on the garboard strake. Although it is likely that the garboard planks were joined to the keel by a system of mortise and tenon joints, as seen in the example of the Marausa wreck (Tiboni, Tusa 2016: 242) and the Monaco A wreck (Pomey, Kahanov, Reith 2012: 247), there are few material remains that might confirm this. At one end of the preserved part of the keel we see a scarf (Fig. 5), a joint used to connect two timbers or planks (Radić Rossi 2015: 445), e.g., two parts

of the keel, or the keel to the stem and/or the sternpost (Markovina, Ukalović 2010: 111). We know of a number of scarf variants (Markovina, Ukalović 2010: 111; Bernardi 1964: Figs. 15, 16, 17; Steffy 1994: 292–293), but the scarf joint most similar to the one at Potkamenica is seen on the Monaco A wreck in France (Pomey *et al.* 2012: 246, Fig. 14), with a three-part hook scarf locked with a large bolt.



Fig. 5 Keel scarf of Potkamenica shipwreck (photo: M. Kaleb)

### 3.1. Planking

The ship's planking consists of planks that are joined in rows to form strakes. We have only one partially preserved side at this wreck site, at which we have identified a possible twelve strakes. The widest plank (P28) has a width of 21.5 cm, while most of the others are about 16 cm wide. The average thickness of the planks is 3.8 cm. The longest plank (P17) measures 2.8 m. All planks subjected to xylological analysis were determined to be made of pine wood (*Pinus*), specifically black pine (*Pinus nigra*) or Scots pine (*Pinus sylvestris*), with the exception of one (P8) which is made from either Aleppo pine (*Pinus halepensis*) or stone pine (*Pinus pinea*). To the other side of the keel, towards the shoreline, we have only one very poorly preserved plank with thinned ends and degenerated form. Here and at some other zones of the wreck we see numerous perforations caused by naval shipworm (*Teredo navalis*) activity, and traces of burning.

### 3.2. Mortise and tenon joints

The planks are joined one to another with mortise and tenon joints. On the average the mortises in the planks are 6 cm wide, 6 to 8 mm thick, and 4 cm deep. A tenon averaging about 7.5 cm long and about 5 cm wide is inserted into a pair of facing mortises. The joint is locked with pegs averaging 35 mm in length gently tapered from 10 mm at one end to 8 mm at the other. All of the analysed pegs are made of black pine (*Pinus nigra*) or Scots pine (*Pinus sylvestris*). The average centre-to-centre distance between pegs is 17 cm.

### 3.3. Stability and cohesion of the ship

In the construction of this vessel the shipbuilders formed the outside planking after the keel, stem- and sternpost had been set, and then inserted the frames. Guided by the principles and methods of Classical Antiquity shipbuilding (Pomey 2004: 27–28) the primary structural elements providing stability and cohesion to the ship are the longitudinal elements, while the transverse elements (frames; floor timber, half frame, and futtock) served as reinforcement.

### 3.4. Frames and futtocks

A total of nine elements labelled F (frame) are in fact futtocks. As with the other structural elements, the state of preservation is very poor, such that assertions as to the original dimensions are uncertain at best. In all seven futtocks (F1–F7) were found in situ, while for two (F8–F9) the original position is uncertain as they are not connected with the main body of the structure. Traces of other frames and futtocks are evident as dark impressions on the preserved remains of the outside planking. We also see numerous treenails in rows set at relatively regular intervals on the inside face of the outside planking. The largest preserved futtock (F2) has a length of 1.04 m, while its maximum preserved sided and moulded dimensions are 10 cm. Five-sided and six-sided treenails with a diameter of 1.6 cm were used to attach the frames and futtocks to the planking. All the futtocks, and the treenails used to attach them, were made of oak (*Quercus sp.*).

### 3.5. Ship's fastening

Although metal nails were observed, documented and collected at the site, they were not observed in situ in the ship's structure. All of the recovered nails were made of iron. Radiographic (X-ray) images were taken of individual nails and of those in conglomerates. Most are well preserved at the core, although surrounded by a deposit of the various particles attached to the corrosion products produced by nails in seawater<sup>3</sup>.

### 3.6. Impermeability

The keel and planks are copiously coated on the inside with a black mass created from tree resin to protect the part of the ship below the waterline and to achieve the impermeability of the seams.

## 4. The result of radiocarbon dating

The xylogological analysis (Fig. 6), which determines the type of wood, was carried out by Frederic Guibal from the Mediterranean Institute of Marine and Terrestrial Biodiversity and Ecology at Aix-Marseille University (France). Two samples taken for dating using the radiocarbon method were submitted for analysis to the Laboratory of Mass Spectrometry of the Centre for Physical Sciences and Technology (FTMC) in Vilnius (Lithuania). A sample from one of the planks (P7) of the outside planking was dated, following calibration, to the period between the years 123 and 247 with a 95.4% probability. Taking into consideration the necessary period for the drying of the felled timber<sup>4</sup> and for the construction of the ship, it is likely that the ship that sank at Potkamenica set out on its maiden journey late in the 2<sup>nd</sup> or early in the 3<sup>rd</sup> c. Dating of a sample of a multifaceted treenail extracted from a futtock (F2) yielded a calibrated date with 95.4% probability from the mid-3<sup>rd</sup> to early 5<sup>th</sup> c. This result can be interpreted as indicating a repair, i.e., the replacement of worn or damaged elements with new elements, which was and remains a frequent practice in traditional wooden shipbuilding. With proper and regular maintenance, it is not unusual for ships to sail for several decades. The shipwreck in Potkamenica Cove lies just a few dozen meters from the north shore and upon excavation, it was revealed that the ship was devoid of cargo. Additionally, visible traces of burning were observed on the remains of the ship's structure, indicating a significant event in its history.

<sup>3</sup> For more detail concerning this process, see Kaleb 2021c: 51.

<sup>4</sup> Wood used for shipbuilding was dried at least two years, the time required for the moisture in the wood to evaporate. The process is done in a covered area that allows for a constant flow of air (Fréminville 1864: 345).

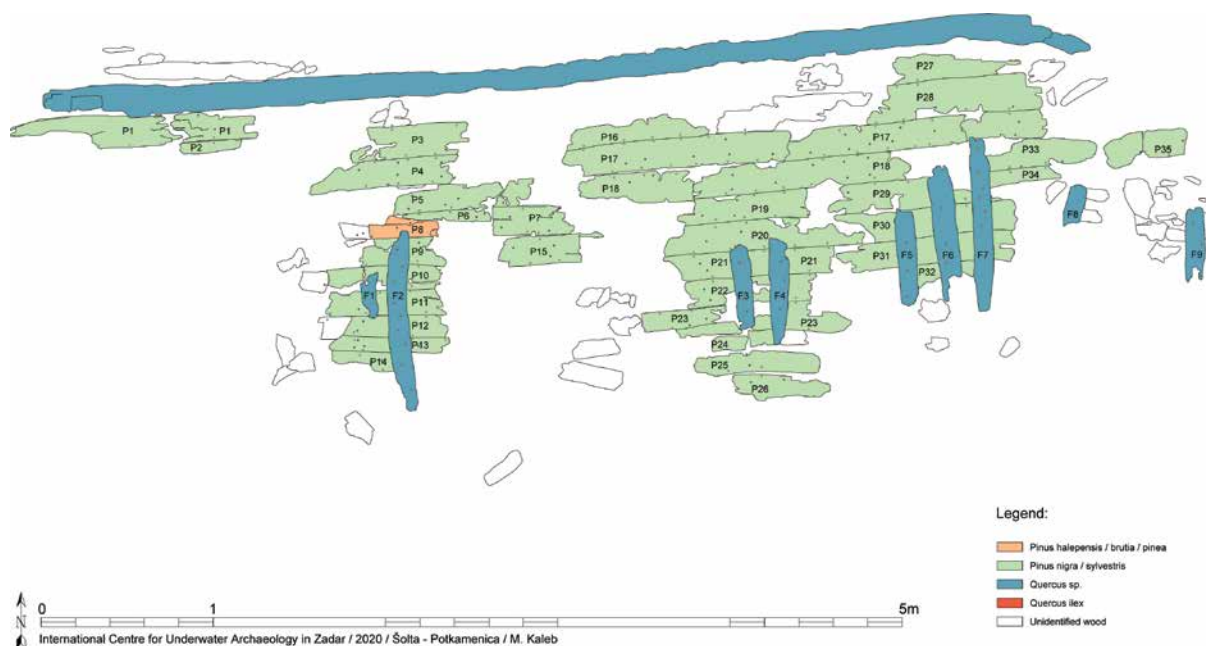


Fig. 6 Elements of wooden ship structure based on xylogological analysis (drawing: M. Kaleb)

## 5. Other finds

Numerous sherds of antique period ceramic ware were found in the course of the excavation of the wreck and the survey of its immediate vicinity. These include various ceramic forms: table and cooking ware, transport packaging, and one ceramic sinker for a fishing net. The tableware includes several sherds from jugs and bowls, while the cooking ware includes fragments of pans and pots. Among the transport ware we see several amphorae forms originating from north African workshops. Found along with the ceramic ware were a number of iron nails, several ballast stones, and one section of rope. Based on the preliminary analysis of the ceramic material and the interpretation of the radiocarbon dating, we date this wreck to the 4<sup>th</sup> c.

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