Ancient ships from the bay of Caska (Island of Pag, Croatia)

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Baltic and beyond
Change and continuity in shipbuilding

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38. Ancient Ships from the Bay of Caska (Island of Pag, Croatia)

1. Introduction

The island of Pag is one of the five biggest Croatian islands, situated in the region of Northern Dalmatia. It is an extremely elongated and narrow island, characterised by a variety of landscapes, ranging from Mediterranean marshlands to extremely hostile karst. According to the information reported by Pliny the Elder in the 1st century AD (*Nat. Hist.*: 3, 140), it seems that in Liburnian and Roman times the island was known as *Cissa*. The homonymous Liburnian *oppidum*, that named the island in ancient times, was probably situated on the hill of Košljun, at the edge of the fertile Field of Novalja, and in the immediate vicinity of the bay of Caska (Čače, 2011). Although it is still not clear which place was called *Cissa* in Roman times, it has been linguistically shown that the present day toponym "Caska" derives from *Cissa* (Vuletić, 2011), and could relate either to *Cissa* itself, or to some estate in close relation to it.

Caska is a small bay at the north-eastern end of the Gulf of Pag, with obvious traces of Roman presence on the coast and in the shallow water. The impressive walls preserved up to a height of four meters, and the numerous tiles and wooden poles that can be observed at the bottom of the shallow bay, stimulated the local imagination and the invention of the legends on a sunken city. The remains of a Roman aqueduct leading from the fresh water spring in the Field of Kolan to the bay of Caska testify to the importance of the area in the Early Roman Empire.

The bay of Caska is far distant from any seafaring route, but the fertile land, abundant marine fauna, and the sheltered position at the bottom of the gulf made it suitable for a Roman economic and/or leisure complex. Based on the preserved votive and funerary inscriptions, it could be concluded that the noble family of *Calpurnii Pisones* owned the Caska estate at the beginning of the new era (Šašel, 1963), but the subsequent passages of property and status of the settlement are not yet clear.

Visitors of the island have praised the archaeological remains in Caska and Novalja since the 16th century (Ljubić, 1877). Yet although obviously interesting and important, the site was always superficially described, but never systematically approached.

Underwater research started in 2005. Since the very beginning, it yielded some extremely interesting evidence, such as a completely preserved wooden anchor from Roman times (Radić Rossi, 2008; Čelhar, 2008). In 2009 the excavation evolved into an international interdisciplinary project which, under the name of *Cissa Antiqua*, focused on the systematic study of the ancient coastal cultural and natural landscape. Thanks to this systematic approach, the submerged harbour remains were identified, and the remains of the three vessels reused in the harbour infrastructure were discovered (Radić Rossi and Boetto, 2010; 2011; 2013; Boetto and Radić Rossi, 2012; 2014) (Fig. 1).[1]

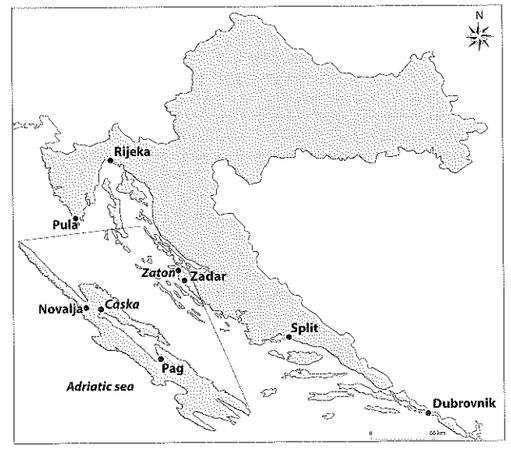

Figure 1: Caska and the island of Pag in Croatia (drawing G. Boetto)

The remains of the ancient harbour extend from east to west along the NE coast of the bay of Caska, and are buried under a very thin layer of sediment in shallow water. The harbour is situated in front of an impressive terrace wall that belongs to the remains of a monumental maritime façade related to the Roman Imperial phase of the site. In order to facilitate the representation and the description of the work in progress, the area was divided into four zones (A-D) (Fig. 2).

[1] The project *Cissa Antiqua* is supported by the Ministry of Culture of the Republic of Croatia, the Croatian Science Foundation (Project *AdriaS – Archaeology of Adriatic Shipbuilding and Seafaring*, IP-2014-09-8211), the University of Zadar and the Municipality of Novalja, the French Ministry of Foreign Affairs (MAEDI) (projects *Caska* and *Adriboats*), the Aix-Marseille University and the French National Centre for the Scientific Research (CNRS).

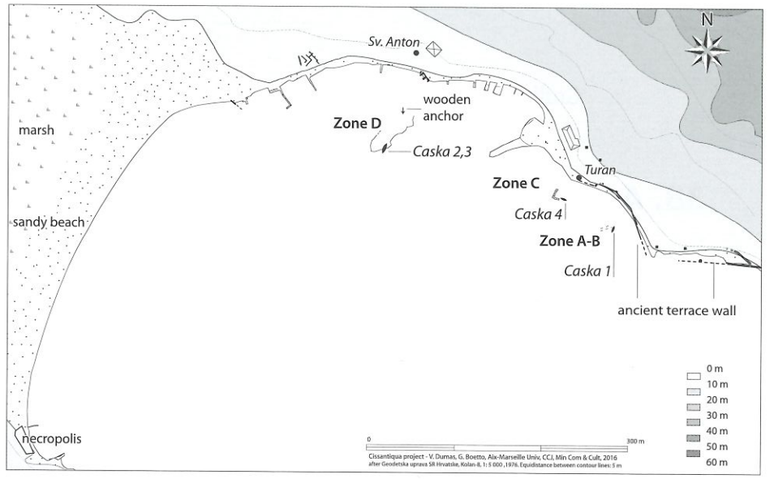

Figure 2: Site plan of the archaeological evidence in the bay of Caska (drawing: V. Dumas, G. Boetto)

The first shipwreck (Caska 1) was found in 2007 in zones A-B. This sewn boat was systematically excavated in 2009 and 2010, and research of the immediate surroundings continued through 2012. The vessel was obviously scuttled, and reused to build some pier-like wooden coastal structure, composed mainly of vertical wooden poles and raw stone material.

Zone C, situated to the west of zones A-B, was excavated in 2012, 2013 and 2016. The zone, situated in front of the tuna-watching tower (so called Turan or Tunera) built in the late 19th century, contained an impressive wooden foundation which formed the base of another operational coastal structure.[2] The foundation is composed of rectangular caissons, made of layers of horizontal logs, kept in place by vertical poles driven through rectangular openings. The caissons were filled by stones.[3]

Zone D, situated to the west of zone C, contained the southern extremity of a breakwater-like structure protecting a mooring area from the southern winds. In this zone, the remains of another ship, named Caska 2, were found and explored during the 2013–2015 research campaigns. This ship was filled with rocks and scuttled, forming the reinforcement of the fundament of the mentioned structure. The bottom of the ship was reinforced by a number of wooden planks and other wooden elements, in order to resist the load of the rocks. Excavation and analysis during the 2014 research campaign determined some of these wooden remains included pieces salvaged from a second sewn vessel, named Caska 3.

2. The shipwrecks

2.1. Caska 1

The preserved part of the sewn boat Caska 1 measures 8 m in maximum length, and 1.66 m in maximum width (Figs 3 and 4). The transverse section at the main frame has a flat frame with a rounded turn of the bilge. The keel, six strakes on each side and seven floor-timbers were found *in situ*. Several loose pieces belonging to the boat structure were also found, displaced around the shipwreck. Unfortunately, due to the lack of diagnostic elements, it is not possible to establish the orientation of the ship and differentiate between the stem and the stern. Consequently, the shape of the boat's extremities at the bow and stern of the ship cannot be determined, as only a small fragment of one end-post survived.

The keel, made of evergreen oak (*Quercus ilex* L.), is 6.55 m long. Quadrangular in section without chamfer, and with filleted inferior edges, it measures 5.7 cm sided, and 6 cm molded. It is scarfed on the extremities, in order to accommodate the stem and the sternpost. The scarfs are secured by a horizontal key (width 2.5–2.8 cm; thickness 0.8–1.1 cm) and by a vertical treenail (diameter 1–1.3 cm). The surviving end-post fragment (Nos 52–54) (Fig. 4) is made of evergreen oak, the same material as the keel.

The planking is flush-laid and carvel built (Fig. 4). All the strakes are made of beech (*Fagus sylvatica* L.), and are connected to each other by a longitudinal sewing assemblage system. The maximum width of the strakes is 16 cm. The garboards, which are composed of two planks assembled by an oblique scarf, are thicker (3.5 cm near the keel) than the other strakes (1.5–2 cm). Six other oblique scarfs connect the planks forming the western side of the boat from the second strake upwards, while no oblique scarfs are present on the eastern side. A fragment of a timber made of evergreen oak, identified as a wale, was also found disconnected from the planking at the eastern side of the hull. This piece (No. 93) (Fig. 4) is thicker (4.1 cm)

[2] The remains of a third sewn vessel (Caska 4) were discovered at the eastern edge of the structure. Similar to the others sewn vessels of Caska, it was reused in the wooden coastal structure. Since its excavation and study are just beginning, the description of this shipwreck is not included in this paper.

[3] The Russian Academy of Science (RAS) excavated in Phanagoria (Taman peninsula, Russia) a harbour structure of bigger dimensions, and dated to the late 3rd or the early 4th century AD, which resembles the structure found in Caska (see Kuznetsov and Olkhovskiy, 2014).

Figure 3: The Caska 1 shipwreck after retrieving the stone filling (photo: L. Damelet)

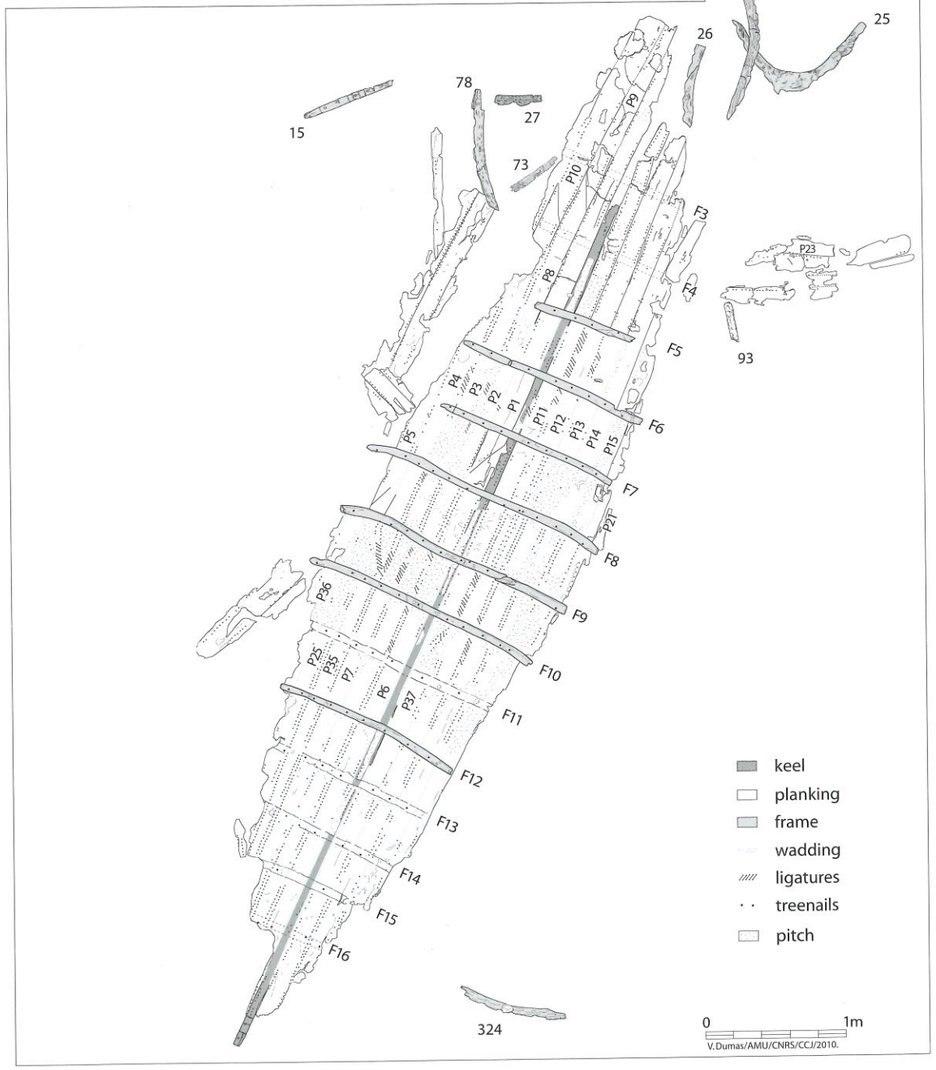

Figure 4: Plan of the Caska 1 shipwreck (drawing: V. Dumas)

Figure 5: The sewing assemblage of the planking of the Caska 1 vessel (photo: L. Damelet)

Figure 6: Notches on the thickness of a plank of Caska 1 (photo: L. Damelet)

and narrower (6 cm) than the other planks of the ship. The use of evergreen oak instead of beech is significant, as the wale strake represents a reinforcement of the boat's side.

The sewing pattern was created by simple over-edge stitches (/ / / pattern), passing through diagonal openings perpendicular to the edges of the planks (Fig. 5).[4] The stitches, made of braided vegetable fibres, pass over a wadding pad (also made of vegetable fibres) placed over the seam between the planks. Small pegs, mostly made of fir (*Abies alba* Mill.),[5] inserted into the appropriate openings, lock the sewing. The average space between the pegs, measured from centre to centre, is 2.4 cm. At the external surface of the hull the openings end in a rectangular or a lightly trapezoidal notch. In some cases the opening ends slightly towards the centre of the plank. In such a case a little groove is carved in order to lodge the stitches on the outer side of the plank. In that case the openings are more vertical than oblique (Fig. 6). No edge inserts, or coaks, were observed in the edge of the planks. However, since the hull was not fully dismantled, the potential use of edge inserts cannot be dismissed.

One repair was noted on the planking in the second eastern strake P12, between floor-timbers F7 and F9. This repair utilized the same sewing technique as the initial assembly of the original hull. Finally, an inside and outside coat of pitch sealed the hull to enhance waterproofing.

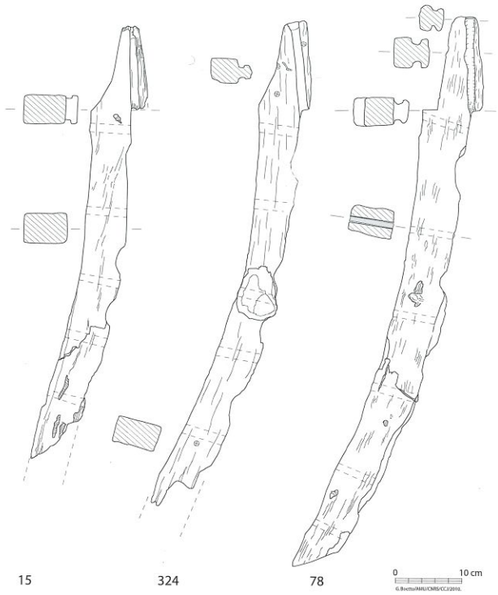

Figure 7: The three top timbers or futtocks from the Caska 1 vessel (drawing: G. Boetto)

Seven floor-timbers remained in place, and traces of an additional seven, which did not survive, were identified on the inner surface of the hull (Fig. 4). The general framing-pattern is a sequence of floor-timbers, all made of deciduous oak (*Quercus* sp.). Rectangular in section (4.5–5 cm sided; 5.5–6.5 cm moulded), they are spaced at an average distance of 39.5 cm. The frames are connected to the planking by tapered treenails (diameter 9 mm to 1.6 cm), driven from the outer side of the hull. The treenails are made of olive (*Olea europea* L.) and evergreen oak. The floor-timbers are not attached to the keel.

The lower surface of the frames is cut with a series of openings above the seams, in order to avoid crushing the wadding pad. The openings at the bottom of the frames are quadrangular in shape and oversized, having the additional function of limber holes. From the turn of the bilge and along the sides, the openings are of rounded or triangular section, and rest tightly on the wadding pad.

The most interesting pieces among the displaced frames are the three sculpted timbers made of oak (Nos 15, 78 and 324) (Fig. 7), which can be compared to similar elements on the Herculaneum boat (Italy, 1st century AD).[6] Only one (No. 78) is complete (86.5 cm in length), while the other two are broken at the lower extremity. The lateral sides of the upper extremities are provided with two carved grooves (1 cm wide and 1 cm deep), in order to house some

[4] At the extremities of the oblique scarfs, the sewing pattern could present a single cross. This crossing pattern is occasional and related to the presence of the longitudinal scarfs of the planking.

[5] Of the 26 pegs analysed, only one was made of Aleppo pine (*Pinus halepensis* Mill.). Frédéric Guibal (Mediterranean Institute of Marine and Terrestrial Biodiversity and Ecology, IMBE, Aix-en-Provence, France) and Carine Cenzon-Salvayre perform the analysis for the identification of the wood species.

[6] The shaped timbers were observed by G. Boetto directly on the boat of Herculaneum, which is on display in a small museum within the archaeological area of Herculaneum, Italy. For some preliminary information on the ship see Steffy, 1985; Ferroni and Meucci, 1989; and Bockius, 2002.

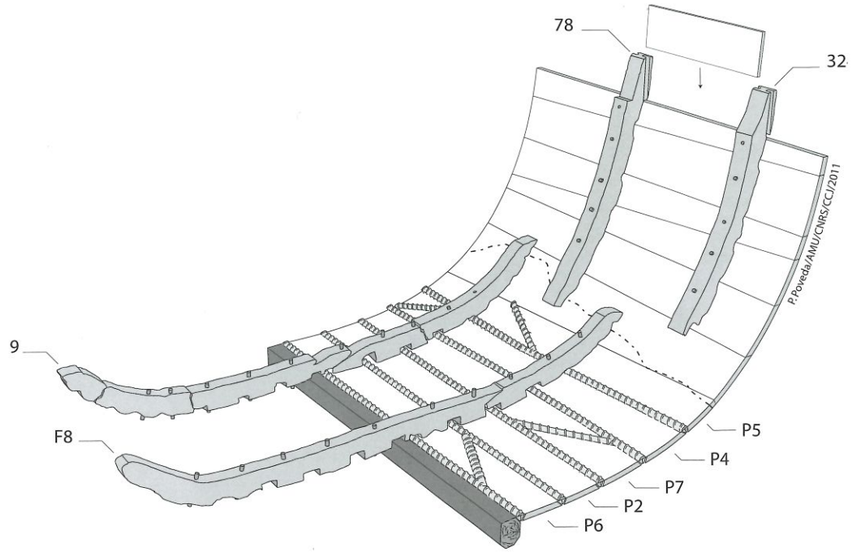

Figure 8: First axonometric view of the main section of the Caska 1 vessel (drawing: P. Poveda)

movable washboards (reconstructed width 12.5 cm). These planks would have been situated above the gunwale of the boat to keep out sea spray.

In the first reconstruction hypothesis, we consider that these timbers were intermediate top timbers, and that they were placed in the room-and-space between the floor-timbers (Fig. 8). On the other hand, as the sides of the boat are not preserved to the top, we can also imagine that these timbers were futtocks placed in the continuity of the floor-timbers. This second hypothesis implies a gunwale and a sheer line of the boat higher than that in the first case.

Four other disjointed pieces belonging to the framing have been discovered in the northern part of the trench (Fig. 4). They present all the characteristics observed on the other frames of the shipwreck, in particular the crenellated bottom and the assemblies with the planking joined by treenails.

2.2. Caska 2

The remains of the second shipwreck of Caska, Caska 2, are 13 m long and 4 m wide (Fig. 9). The ship rests on the keel, inclined to starboard (east). The transverse section at the main frame is flat, with a round turn of the bilge. The preserved structure consists of a keel, ten strakes on each side, 24 composite frames, a mast-step and at least five stringers. The ninth strake represents the lower wale, flush laid and assembled by pegged tenons. The hull was protected with a thick layer of pitch. Due to the position and the shape of the mast-step, the northern extremity of the ship was interpreted as the stem.

In the fore part of the ship there was an exceptionally preserved hearth, used for cooking on board. In the hold of the ship there were numerous loose wooden pieces, mostly planks, but also some interesting elements, such as eight thwarts, one stanchion with a forked extremity, two deadeyes, and a fragment of planking belonging to another sewn boat, similar to Caska 1 (named Caska 3). It can be assumed that most of the loose wooden elements are related to the reuse of Caska 2 in the construction of the pier-like structure, and were thrown into its hold in order to reinforce the hull before it was filled with rocks.

The axial carpentry is composed of three elements assembled by hook scarfs. The scarf between the keel and the stern transitional timber (KGS) is situated south of frame F13 while the scarf between the keel and the stem transitional timber (KGN) is situated near frame F29. As the hull has not been dismantled, the shape and characteristics of these scarfs have not been studied in detail.

The keel of rectangular section measures 8.65 m in length, and 15.5 cm in width at the main frame. The stern transitional timber (KGS) is preserved to a length of 3 m. This curved piece, 17.5 cm sided and 22 cm molded, has a triangularly shaped rabbet (height 8–9 cm, depth 3.2–4 cm). The rabbet is positioned near the upper edge of the knee. The extremities of the strakes are assembled to the stern knee by metal nails spaced 9–10 cm.[7] At a distance of 1.3 m from the conserved extremity of the knee, a small rectangular recess is carved in its upper surface (length 7 cm, width 5.4 cm, depth 5 cm). The hole is not centred, but slightly displaced towards the port side. This recess, which presents the southern edge of the ship rising towards the stern, probably housed a stanchion.[8]

[7] Only the port side of the stern knee has been studied as the extremities of the strakes were missing.

[8] It is tempting to relate this recess to the forked stanchion found between the loose wooden pieces in the infilling of the ship. Without completely rejecting this hypothesis, it is important to note that the dimensions and the shape of the tenon at the base of the forked stanchion do not exactly match the dimensions and the shape of the recess.

Figure 9: Orthophoto of the Caska 2 shipwreck at the end of the 2015 excavation campaign (T. Seguin and V. Dumas)

The stem transitional timber (KGN) is conserved to a length of 2 m. The curve is gentler than the curve of the stern transitional timber. The dimensions of the piece are 13–15 cm (max) sided, while at its northern extremity it is 13 cm sided and 17 cm moulded. The rabbet, triangular in section (4 cm x 2–2.2 cm), is carved 5 cm below the upper edge of the transitional timber.

Two planks compose the port garboard strake (P1W and P11W), while three planks constitute the starboard garboard strake (P1E, P13E and P14E). Eight strakes and a lower wale compose the rest of the planking on both the sides of the vessel.

The planking is, on average, 3.8 cm thick (2.6–4.8 cm) while the maximum width is 28.5 cm (P12W). The two lower wales (P8E and P9W) are respectively 12 cm and 14 cm wide. Only the starboard wale P8E is preserved with its original thickness (12 cm). The port wale P9W is poorly preserved and it was not possible to measure its maximal thickness.

Planks are joined with diagonal scarfs to form the strakes, and are connected to each other by a dense set of mortise-and-tenon joints. The mortises are 6.8 cm wide, 6–12 mm thick, 6.5 cm deep, and spaced on average 12 cm apart (side-to-side). The pegs are tapered (internal

diameter 95 mm, external diameter 75 mm), driven from inside of the hull and spaced on average 18 cm (centre-to-centre). The tenons, quite smaller than the mortises, are 3.4–3.5 cm wide and 5–7 mm thick. The dimensions of the mortises along the keel are bigger than the others mortises observed on the planking (width 8.2 cm, thickness 1 cm), and the mortises are closer to each other (8.8 cm on average).

Several planks (P12W, P13W, P6W and P16W on the port side; P1E and P15E on the starboard side) were repaired using patch tenons. The openings to insert these patch tenons, seen on the internal face of the planks, are rectangular and irregularly spaced (5–7 cm wide, 2–3 cm high). It is possible that some patch tenons were driven from the outer face of the planking, but there was no possibility to check that presumption. We also observed the presence of small triangular patches in strakes P5E and P6E. These repairs were probably nailed to frames F14E and F19E. In one of these repairs, the extremities of the patch are blocked on the interior by two cleats (RP and RP3).

A total of 24 frames survived, on average 8.5 cm sided and 10 cm molded, with room-and-space averaging 47 cm (ranging from 31–77 cm). The general framing pattern is of alternating floor-timbers and half-frames. However, in the central part of the hull a sequence of floor-timbers (F15, F16 F17) is present, as well as five half-frames overlapping amidships (F18W, F20E, F22W, F24E, F26W). One extremity of these half-frames crosses the keel so that the butt joints of the two half-frames projects beyond the central axis. This kind of overlapping half-frames allowed the reinforcement of the framing system. It is noteworthy that this reinforcement occurs below the mast-step timber. Moreover, a sequence of floor-timbers was noted in the aft part of the hull (F12, F13), while a sequence of half-frames was noted in its forward part (F31, F32, F33). As usual, the futtocks are not connected to the lower frames but are situated with a gap of 2–6 cm.

The limber holes, rounded in shape, are placed on both sides between the keel and the turn of the bilge, being 3.5–4.5 cm wide, and 2–5.4 cm high. The frames are connected to the planking by treenails (17 mm average internal diameter; average space centre-to-centre 12 cm). No metallic nails for the assembly between the frame and the planking have been observed. None of the visible floor-timbers were connected to the keel by nails or bolts.[9]

Several repaired frames were noted. In particular, futtocks F15W, F20bW and F25bW seem not to be original, as they broke the symmetry of the framing pattern, and are larger than the other frames. The piece RF1E, placed between F24E and F25E, reinforces the planking at the level of the oblique scarf between P12E and P20E. Moreover, some cleats of various shapes and dimensions are nailed to the planking, to reinforce some weak points (RP and RP3 on the two sides of F19E at the level of a triangular patch in the strake P6E, and RP1 at the south of F26W).

A mast-step, 6.75 m long, 15–22 cm sided and 6.8–13.5 cm molded, is positioned above the frames, from F15 to F28. A series of recesses are cut on its lower surface, to fit it precisely on the framing (depth 2–8 cm). The shape of these recesses varies. Between the frames, the lower edges of the mast-step are profiled too. The mast-hole, carved at the level of the room-and-space between the frames F21 and F22, is rectangular, 15.5 cm long, 8 cm wide, and 5 cm deep. The side forward is oblique, allowing the raising of the mast. The mast-hole is flanked on its three sides (W-N-E) by small rectangular recesses (17 cm long, 2–2.5 cm wide and deep), to house vertical planks to support the mast. Two stanchion-holes are cut at a distance of 26 cm from the mast-hole, toward the stem. These holes are quadrangular (5.7x5.1 cm and 5.6x4.7 cm), 2–2.8 cm deep, and serve to house some stanchions, connected to the support of the mast.

A few stringers belonging to the original ceiling of the ship were present on both sides of the ship. On the port side, three stringers were identified (C4/C89, C128/C257 and C97), while on the starboard side there were two identified stringers (C1/C2/C3 and C161/C182/C260/H4). The stringers are nailed to the frames. They are 19–23 cm wide, and 2.8–3.9 cm thick. The stringers C128/C257 and C161/C182/C260/H4 bear the evidence of mortise-and-tenon joints along the edges. These planks were obviously reused after the dismantling of another ship or ships.[10]

Finally, the hearth is situated above the mast-step, between frames F27 and F28 in the bow area of the ship. It is not centred along the longitudinal axis of the ship, but is oriented towards the starboard side. It is rectangular, and measures 70 cm (N-S) x 170 cm (E-W). A layer of planks was arranged in order to establish a foundation for the construction. Three planks (H1, H2/H8, and H3) crossed the mast-step and the starboard stringer (C161/C182/C260/H4) amidships, and three others (H5, H6, and H7) were placed longitudinally between F27E and F28E. Some stones were situated under these planks to wedge the structure. Above the planks, the hearth was built using bricks, tiles and a thick layer of mortar. All these elements bear the traces of fire.[11]

2.3. Caska 3

The preserved part of the third boat found in Caska, named Caska 3, is 3.25 m long, and 83 cm wide (Fig. 10). Oriented NE-SW, the boat remains nested inside the vessel Caska 2, on its starboard side, above the frames F15E to F21E. The southern extremity is transversally cut at the level of the frame F15E. The fragment of the hull of the boat Caska 3 is composed of seven strakes, three of which are stealers (P8, P9 and P10a). The keel and the frames are not preserved.

[9] This observation has to be confirmed as the mast-step has not been removed nor the floor-timbers dismantled.

[10] This practise is well attested in ancient shipbuilding for example in Naples (shipwreck Napoli A, pers. com. G. Boetto) or in Narbonne (shipwreck of Mandirac, Jézégou, *et al.* 2016, p. 37).

[11] A discussion about the position of the hearths on the ancient ship may be found in Boetto, *et al.*, 2012.

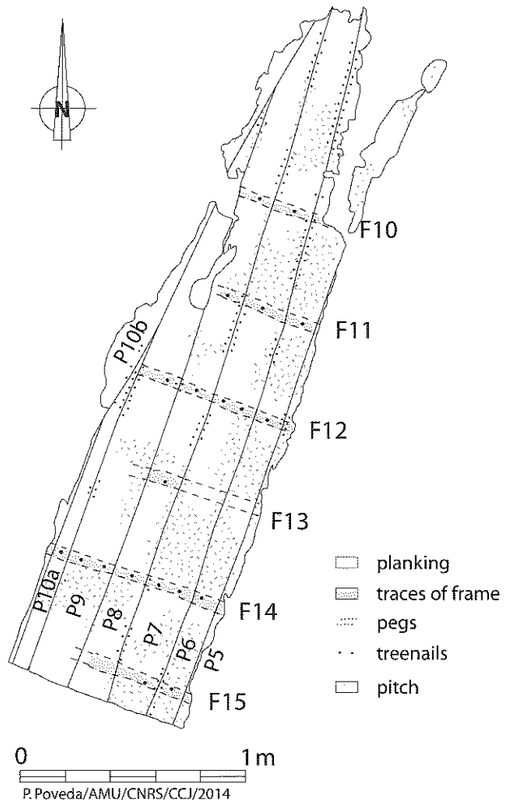

Figure 10: Plan of the Caska 3 shipwreck (drawing: P. Poveda)

The planking is flush-laid and assembled in the carvel-building technique. The maximum width is 20 cm, while the maximum thickness is 1.5 cm.[12] As in the case of Caska 1, all the strakes are made of beech (*Fagus sylvatica* L.), and are connected to each other by a longitudinal sewing system of assemblages, presenting the same characteristics observed on Caska 1 (over-edge stitches, / / / pattern). The space between the pegs blocking the sewing is 3.8 cm on average. A wadding pad and a thick layer of pitch complete the water tightness of the assemblage.

Some regular traces on the layer of pitch, as well as the rows of the treenails assuring the connection between the planking and the frames, indicate the position of six frames, which are not conserved. In spite of their absence, the traces left on the pitch indicate that the dimensions of the frames were 6.2 cm sided, and that the space between them was 39 cm. The dimensions are similar to those recorded on Caska 1.

[12] As well as Caska 1, the planking of Caska 3 suffered significant compression due to the weight of the stone infilling. So, in most cases, the recorded thickness is less than the original planking dimension.

2.4. Principles and methods of construction, propulsion and date

Concerning the principles and methods of construction (Pomey, 2004; Pomey and Rieth, 2005: pp. 29–33; Pomey, Kahanov and Rieth, 2012; 2013), all three vessels found in Caska were constructed based on a shell concept for the hull structure, and on a longitudinal strake-oriented concept for shape. The building process was shell-first.

The sewn boat Caska 1 was around 9 m long, and it was probably propelled using both oars and sail, although no trace of propulsion or steering devices have been discovered on the shipwreck. The sewn boat Caska 3 was very similar to the boat Caska 1. On the other hand, the sailing ship Caska 2, bigger than the sewn vessels (15–17 m in length), belonged to another ship type, different in both structure and shape.

Concerning the chronology of the vessels, at this stage of research, only the wood used for building the boat Caska 1 has been more precisely dated to between AD 42 and 102.[13] Based on the context of the finds, the other two vessels, Caska 2 and Caska 3, have been preliminarily dated in the 1st and the 2nd centuries AD. Samples taken for dendrochronological analysis should provide more precise dates in the future.[14]

3. Conclusion

The systematic research in the bay of Caska on the island of Pag led to a series of unexpected discoveries that changed the interpretation of the coastal and submerged archaeological remains. It provided evidence of the intense construction activities in the shallow waters, which occurred during the first centuries AD, and exploited wood as the main building material. The remarkable reuse of old ships in the form of caissons, filled with rocks, and intentionally sunk in order to reinforce the coastal structures, make this site exceptional for the Eastern Adriatic nautical archaeology studies.

The reuse of vessels in Roman harbour constructions is a well-attested practice in the Western and Central Mediterranean. At the end of the 1st century AD, in the ancient harbour of Toulon, two *horeia*-type vessels (Toulon 1 and 2) were filled with rocks, and intentionally sunk as a foundation of a jetty (Brun, 1999; Boetto, 2009). In Late Antiquity, in the harbour of Narbonne, at least one ship was intentionally sunk to restore a bank of a channel in Mandirac (Jézégou *et al.*, 2016).

In Central Dalmatia, at the site of Trstenik in Kaštel Sućurac near Split (Ruff and Radić Rossi, 2015) another mortise-and-tenon joint hull was filled with rocks and

[13] In 2012, six samples, taken at equal intervals on the growing rings on the same fragment of plank, were submitted to radiocarbon AMS dating at the *Centre de Datation par le Radiocarbone* of Lyon (France, codes Ly-9267 to Ly-9272). The results were cross-dated by F. Guibal on the Radiocarbon calibration curve by wiggle-matching in order to obtain a precise date (for the method, see Pearson, 1986: pp. 295–296; Ramsey, *et al.*, 2001: pp. 384–385).

[14] A. Ferreira Dominguez, PhD candidate Aix-Marseille University, Ecole française de Rome-Centre Camille Jullian, started the xylotomic and dendrochronological study of Caska 2 and 3 in 2016.

reused as a reinforcement of a waterfront of a Roman *villa rustica* in the near vicinity of the ancient Salona. In the north-western Adriatic, in the Veneto region, numerous parts of the sewn vessels from the Roman period were reused in embankments in river or lagoon environments (in Corte Cavanella di Loreo – Beltrame, 2000; 2002; in Motta di Cavanella d'Adige – Tiboni 2009, 2017; on the island of S. Francesco del Deserto, Capulli and Pellegrini 2010; in Padua – Beltrame 2002).

The most famous example of the intentionally sunk ship is certainly the ship of the emperor Caligula, which transported the obelisk for the Circus on the Vatican Hill (now standing in front of St. Peter's basilica) from Alexandria to Rome. Pliny (*Nat. Hist.*, 16, 201) stated that this enormous vessel carried 130,000 *modii* (800 t) of lentils as ballast. After unloading the obelisk, the ship was kept on display until the emperor Claudius decided to fill it with concrete and sink it as part of a mole of his new harbour.[15]

It is also noteworthy that the evidence from Caska further confirms the local devotion to the old shipbuilding technique of sewing into Roman times, when sewing was almost completely abandoned in the rest of the Mediterranean.[16] The ships used to build coastal structures testify to the presence of the local Liburnian population, assimilated into the Roman world, but still attached to the old customs and traditions.

Due to the space restrictions, we have intentionally omitted the discussion on the overall harbour infrastructure connected with the maritime villa property in the bay of Caska on the island of Pag. Ongoing fieldwork activities and the study of their promising results continue to provide new evidence for the interpretation of this often-misinterpreted archaeological site. These studies shed new light on the probable senatorial property of *Calpurnii Pisones*, of which the intentionally sunken ships are an integral part.

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[15] The presence of this ship and other vessels were erroneously detected in the concrete jetties of the northern mole of the Claudian harbour (Scrinari, 1979, p. 9; Testaguzza, 1970, pp. 72–73 and 91). On this issue see also Boetto, 2006, p. 838.

[16] In the shipwreck Pisa C (Pisa, Italy, 1st c. AD) a small repair by sewing was observed on planking built in the traditional mortise-and-tenon shipbuilding technique (Camilli, 2002: fig. 7). The use of internal stitching for frames is well attested in the northern part of the Western Mediterranean (from Catalonia to France) on ships built with the mortise-and-tenon technique and dated between the middle of the 3rd c. BC and the middle of the 2nd c. AD (Pomey, 2002; Marlier, 2005; 2006; Wicha, 2004; 2005; Wicha and Girard, 2006; Jézégou, 2007; Bernard, 2007–2008; Long, *et al.*, 2009; De Juan, 2013; Vivar and De Juan, 2014; Sabastia and Formentin, 2016). See Pomey, Boetto forthcoming.

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John S. Davis

39. The Problems Involved in Reconstruction of the Original Hull Shape of a 14th-Century Venetian Galley

Objective

In the context of an archaeological excavation of the 14th-century galley shipwreck found in the lagoon of Venice near the now-submerged island of San Marco in Boccalama by the *Soprintendenza per i Beni Archaeologici del Veneto* in 2001, I wished to study a hypothesis for the reconstruction of the original hull shape using the archaeological, written and iconographical sources available and record the problems to realise this objective. A half model was constructed in a scale of 1:42 which would allow for a small amount of detail while keeping the overall length under control, and this model was presented as a poster project for the ISBSA 14 in Gdańsk, Poland in September 2015.

Archaeological sources

Very few galley wrecks exist to study: in fact of two known Venetian galleys, one a *fusta* (a galley smaller than a light galley) was found in Lake Garda, Italy, and the other is the wreck of a Venetian Great Galley found at the now-submerged island of San Marco in Boccalama which has been dated to the beginning of the 14th century (Fozzati, 2002: p. 13).

The Boccalama wreck was excavated in 2001 and it appears to have been a used hull that had been cut or razed at a level of approximately halfway between the wale and the bilge, fixed in place with a series of posts, then sunk and filled with mud and sand along with another flat-bottomed boat called a *rascona* in an attempt to reinforce the island against encroachment of the lagoon. The attempt did not work and the wrecks along with the island soon disappeared into the lagoon.

The anaerobic nature of the mud preserved most of the timbers very well, much like the millions of tree trunks that were pounded into the mud to act as pillars for the overlying city of Venice, which are functioning to this day.

The team involved decided to do only a superficial examination without excavating under the hull, and using photogrammetric techniques to make a 3D photographic rendering of the hull (Fozzati, 2012: p. 12). After their work was completed the wreck was protected and allowed to be covered again by the lagoon.

Looking at the results of the excavation there are features clearly visible: the keel, floor timbers with the lower parts of the futtocks, the bottom outside planks, the keelson, the inside bilge stringers, the mast step assembly with the side supports, and many of the internal covering planks with their mortise and scarf joints clearly visible. The stem and stern posts are largely uncovered or destroyed. There are a couple of examples of parts of frames called *mezi legni*, literally half timbers or V shaped frames, which were used between the post and the choltro (see photographs in D'Agostino-Medas, 2002: pp. 68–77).

Hopefully a scientific publication will be forthcoming on the findings of the excavation team.

Written sources

In the case of Venetian galleys it is well known that technical written texts appear from the beginning of the 15th century and these must be studied to determine a database with which to compare the sources. An examination of the more readily available 14th–15th century texts permit a collection of information to create a database. The most notable manuscripts are the following: the *Libro di Navigar* (late 1300s), *The Book of Michael of Rhodes* (1435), *Ragioni antique spettanti all'arte del mare et fabriche de' vasselli* (mid- to late-1400s), *The Book of Zorzi "Trombetto" da Modone* (ca. 1440–1450).

Some of these texts have been studied by scholars and are available transcribed from the manuscript form in the original Venetian dialect of the 15th century (Bonfiglio Dosio, 1987) and two have been translated into English (Anderson, 1925 and Long *et al.*, 2009).

Examination of the texts can be difficult because some of the handwritten texts may have been difficult to read and some errors may have been carried forward in either transcription or translation. Another problem is that many words are obscure and are not known and therefore are difficult to find an accurate meaning or modern equivalent.

It was common practice in early Renaissance times to borrow and copy other texts in which you had an interest, and this led to many portions of much older texts, some

Figure 1. Half model hull shape