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## **The late antique shipwreck of Debeljak, Croatia: preliminary observations on the ship structure**

Marko Uhač<sup>1</sup>, Ida Koncani Uhač<sup>2</sup>, Vincent Dumas<sup>3</sup>, Pierre Poveda<sup>3</sup>, Giulia Boetto<sup>3</sup>

1. Ministry of Culture, Department of Conservation, Pula, Croatia
2. Archaeological Museum of Istria, Pula, Croatia
3. Aix Marseille Univ, CNRS, CCJ, Aix-en-Provence, France

Debeljak is a small cove situated at the southern tip of the peninsula of Premantura in Istria. This peninsula is part of the Natural Park of Cape Kamenjak. The peninsula of Premantura constitutes the western border of the large bay of Medulin. Historical and archaeological evidence are here numerous dating from Neolithic to Early Middle Ages. The villa of Vižula is particularly well known by archaeologist. Built in during the Early Roman Empire, it was settled till the 6<sup>th</sup> century.

The cove of Debeljak is oriented east west and opens towards the cove of Medulin, and it is well protected from the western winds.

In 2015, the presence of wooden remains situated in shallow water at a depth of 4 meters, possibly dating back to antique time, was reported to Archaeological museum of Istria. The brief expertise conducted shortly after established that the remains belonged to an ancient vessel characterized by a mortise-and-tenon assembly technique for planking. Some fragments of amphorae of Late Roman type were also collected.

The next year, a preliminary documentation of the shipwreck was undertaken and, at the end, the site was secured by covering the exposed wooden parts with sand, geotextile and a metallic grid.

A sample from a plank was dated by AMS mass spectrometry between 380 and 415 AD. So the late date of the deposit was confirmed.

In October 2017 and May 2018, the shipwreck was systematically investigated by an international team directed by I. Koncani Uhač of the Archaeological museum of Istria, G.

Boetto of the Aix-Marseille University-CNRS-Centre Camille Jullian and myself for the Ministry of Culture of the Republic of Croatia. In campaigns participated 20 archaeologist and professional divers.

After the fine cleaning was completed, the shipwreck was marked for different phases of digital documentation. Samples from all the conserved wooden structures were taken for identification of the wooden species, and few planks were sectioned for dendrochronological study too.

The shipwreck lies completely broken apart and flattened on the sandy seabed. It has been preserved in a length of approximately 14,5 m and a maximum width of 7 m.

There is a gap between the northern and the southern sides spaced up to of 1.8 m at the East. In this gap, a lot of heavily damaged fragments of wood have accumulated, but any evidence of a keel was discovered till now.

A third section of the hull, probably belonging to the southern side, is situated below the two others sides, in the south-western zone.

Finally, a fragment of the keel and another piece of the hull lie approximately 2 m towards the west. This area was only briefly investigated during the last campaign.

Due to the lack of indicative elements, it is not possible to establish the position of stem and stern of the ship.

The fragment of keel corresponds to a transition piece, a post, originally connected by a hook scarf to the keel. An iron bolt secured the scarf and connected to the keel a floor-timber of which only a small fragment remains.

The planking, on average 3.4 cm thick, is edge joined by a close set of mortise-and-tenon joints. The small pegs fixing the planking are spaced on average 16 cm. Some horizontal copper nails were used to fix the oblique scarfs that are particularly numerous in the planking. Some stealers are also attested, while it was possible to identify only one wale on the displaced section of the southern side.

As the ship broke longitudinally at the level of the keel, it is difficult to study the general framing pattern and to distinguish between floor-timbers and half-frames. In any case, all the elements composing one frame are independent to the others.

Rectangular in section, on average the frames are 12.2 cm molded and 9.3 cm sided. The room-and-space measure on average 16.8 cm (between 12 and 26 cm). The frames were attached to the planking by treenails and copper nails.

The sole floor-timber identified on the southern side was connected to the keel by an iron bolt of which the traces of the concretion are well preserved.

On this floor-timber the recesses for accommodating a longitudinal internal post are also visible. It is possible that here were settled two bilge keelsons that supported the mast step.

Only few remains could be attributed to the internal ceiling and none of them was found in its original position.

The traces of woodworking are particularly well preserved, in particular the marks left by the saws used both for cutting the planking and the frame.

Some dark vertical lines probably drawn with a charred tip were observed on one side of a couple of frames of the northern side. These marks are references used by the shipwright to adjust the frame after the hull completed.

Others shipbuilder marks consists in crosses carved in the planks, in the space between the frame, and parallel carved lines to mark the position of the frame on the planking.

Finally, some lead patches attest of a repair practise. This type of repair is common between the 2<sup>nd</sup> c. and the 5<sup>th</sup> c. AD, and is attested on Pakoštane wreck.

The construction principle of the ship of Debeljak is based on a shell concept for the hull structure, and on a longitudinal strake-oriented concept for its shape, while the building process is shell first. This process is compatible with the close pattern of mortise-and-tenon joints of the planking.

While some floor-timbers are connected to the keel by bolts, this is not an indication of an active framing but rather testify of the need of cross reinforcement of the hull.

In conclusion, although recent discoveries, mainly in Dor/Tantura lagoon, indicate an early completion of the transition from shell construction to skeleton construction between the end of the 5<sup>th</sup> and the beginning of the 6<sup>th</sup> centuries at least in some parts of the Eastern Mediterranean, the ship of Debeljak could be considered as a typical example of a sailing vessel of the Roman Imperial era.

However, the achievement of the examination of the hull, the analysis of the woods employed in the construction, coupled with the study of the cargo, will surely offer new insights into the sailing routes of the Eastern Mediterranean in a crucial historical period between the end of the Roman Empire and the beginning of the influence of Byzantium in Adriatic