

The Late Hellenistic military ship of Phanagoria; New data for the reconstruction of the ship

Pierre Poveda – Giulia Boetto – Sergey V. Olkhovskiy

Abstract: The ship of Phanagoria was discovered in 2012 during the exploration of the port structures of the ancient city. The remains are nearly 16 m long and 2.7 m wide and preserved up to the caprail on port side. In 2014, a bronze casing decorated with a crescent and a five-rayed star was found 1.5 m to the west of the bow end. This bronze casing and the slender shape of the vessel have provided arguments to identify it with a military unit associated to Mithridates VI Eupator. This article presents the process carried out recently to reconstruct the original shape of the ship of Phanagoria, and discuss the results.

Keywords: Black Sea, Phanagoria, 3D model, Ship reconstruction.

Over forty years the Phanagorian expedition of the Institute of Archaeology of the Russian Academy of Sciences has been focusing its researches on the land and coastal area of the Greek city of Phanagoria. Located on the Kerch Strait separating the Black Sea and the Azov Sea (Fig. 1), the city was founded ca. 543 BCE by settlers from Teos (Asia Minor). Occupied until the Middle Ages, Phanagoria underwent a remarkable development in the first centuries BCE, and maintained, until the 4th c. CE its dominant position following the Mithridatic wars, during which Phanagoria allied with the Romans (Kuznetov, 2016: 10–19).

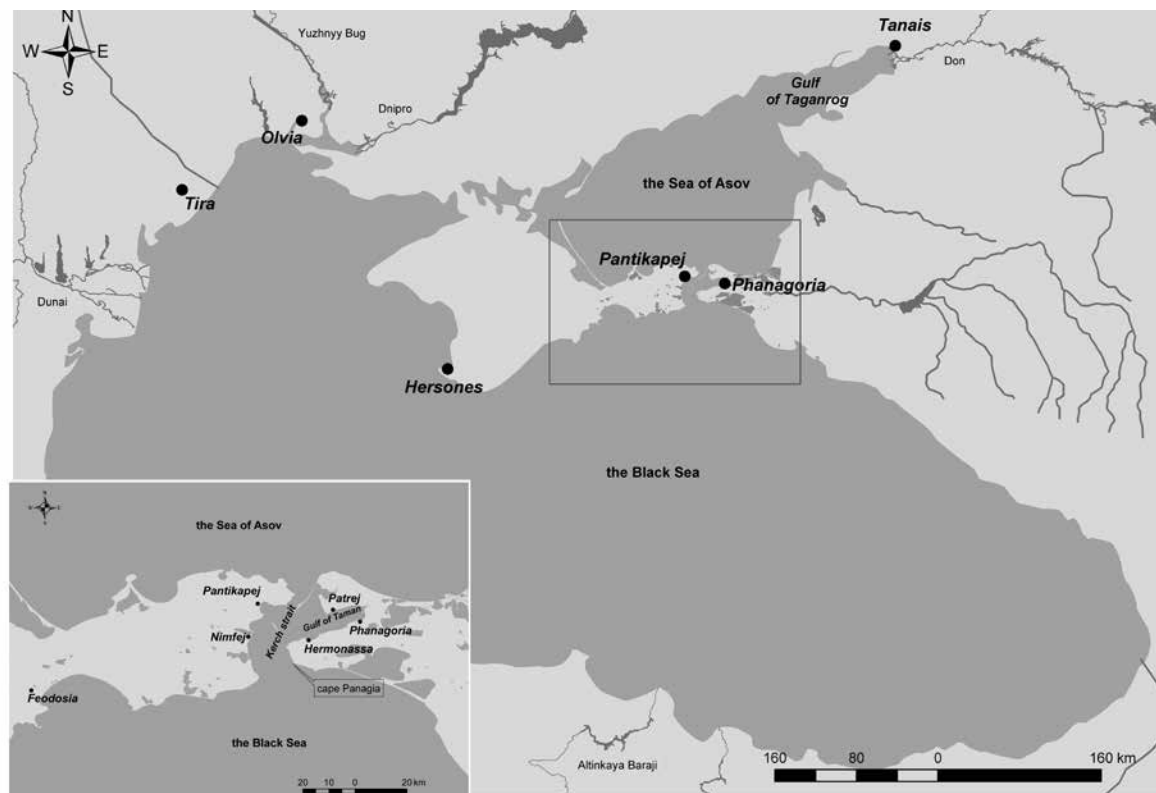


Fig. 1 The Black Sea and the Sea of Azov with localisation of Phanagoria (map: IA RAS)

From 2011 onwards, the underwater team led by Sergey Olkhovskiy has used different methods of survey on the maritime area next to the ancient city. The most informative method, considering the shallowness of the body of water in front of Phanagoria, proved to be geomagnetic survey. It allowed the localisation of part of the city's port infrastructures composed of two large berthing facilities: the eastern pier built in the 5th–4th centuries BCE (Fig. 2A) and the western pier of a latter unknown date (Fig. 2B), both built with large stone blocks. Between these two piers, a third smaller harbour structure, composed by poles, horizontal timbers, stones and reused elements from the destruction of the city in the 1st century BCE, has been discovered (Fig. 2C) (Olkhovskiy 2016: 51–54; Khotylev, Olkhovskiy 2020). In 2012, during the excavation of the massive stone embankment composing the eastern pier, the remains of a mortise-and-tenon built vessel were discovered (Fig. 2S). The bottom of the hull appeared to be covered with small stones and tile fragments, interpreted as ballast intended to improve the nautical capabilities of the ship. On top of the ballast, a Megarian bowl, a jug, some cooking pots, and two Colchian amphoras were also found and were probably used on board (Zhukovskiy *et al.* 2013; Boetto *et al.* 2022).

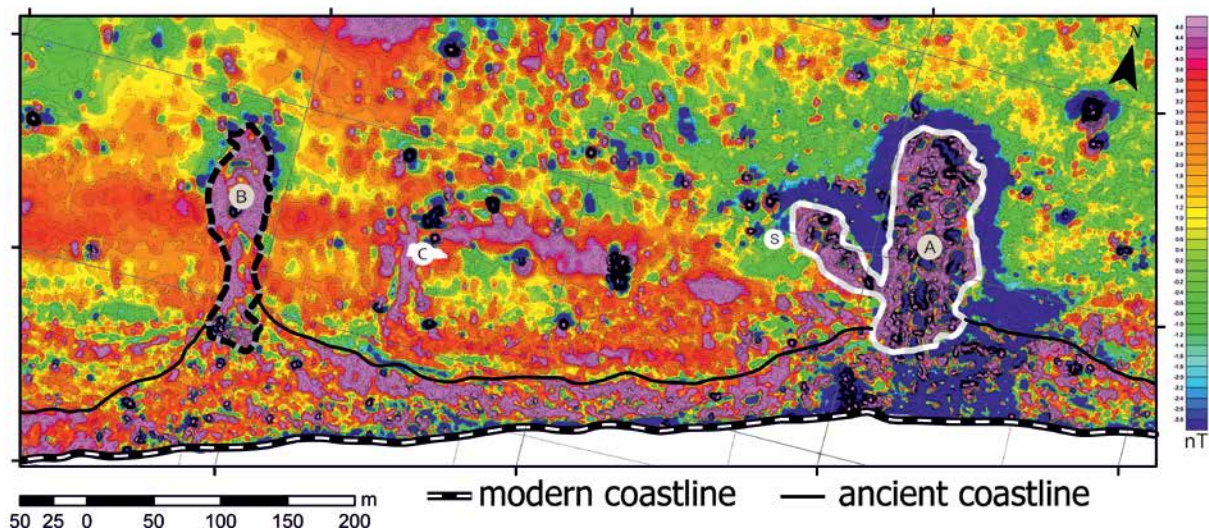


Fig. 2 Geophysical survey of the submerged zone in front of the ancient city of Phanagoria: A) eastern pier and the adjacent stone embankment (5th–4th c. BCE); B) western pier (unknown dating); C) Roman structure; S) the shipwreck (author: A. Luchnikov)

Two years later, the ballast was removed and the excavation trench was enlarged in NE direction. At a distance of 1.5 m from the end of the wreck, a bronze casing decorated with a five-rayed star and a crescent was found (Boetto *et al.* 2022). This symbol, well attested in coins minted during the Kingdom of Pontus, especially during the reign of Mithridates VI Eupator (120–63 BCE), offered important chronological information which, together with the other data collected, places the wrecking event within the first half of the 1st century BCE. The position of the bronze casing allows the location of the bow and the deduction of the sailing direction of the ship too.

In 2019, a team of the Centre Camille Jullian joined the Phanagorian expedition. The wreck was reopened, cleaned and documented, samples for xylological analyses were collected, and the ceiling and some other components were removed from the seabed.

The wreck consists of a remarkably well-preserved hull 15.82 m long and 2.40 m wide (Fig. 3A). The ship is keel-based and built shell-first in the typical Mediterranean fashion with planks assembled by a network of pegged tenons. The frame system, alternating floor-timbers and half-frames, is reinforced by paired floor-timbers, fastened to the planking by the means of clenched nails passing through treenails. The structure is strengthened by an axial internal carpentry composed of two keelsons as well as the mast-step. Two timbers, discovered not far from the bronze-casing, were interpreted as the remains of a fore-ram/*proembolion*. The wood species used for the construction are homogeneous and well adapted to the function of each ship's component. Noteworthy is a red pigment residue found on several spots on the outer hull in addition to the typical protection provided by pitch (Boetto *et al.* 2022).

Finally, the slender shape of the ship, the bronze casing decorated with a crescent and star, a symbol associated with the Kingdom of Pontus, and the remains of the fore-ram are strong arguments to identify the ship as a small Phanagorian military vessel, possibly used during the siege of the city by Mithridates VI Eupator.

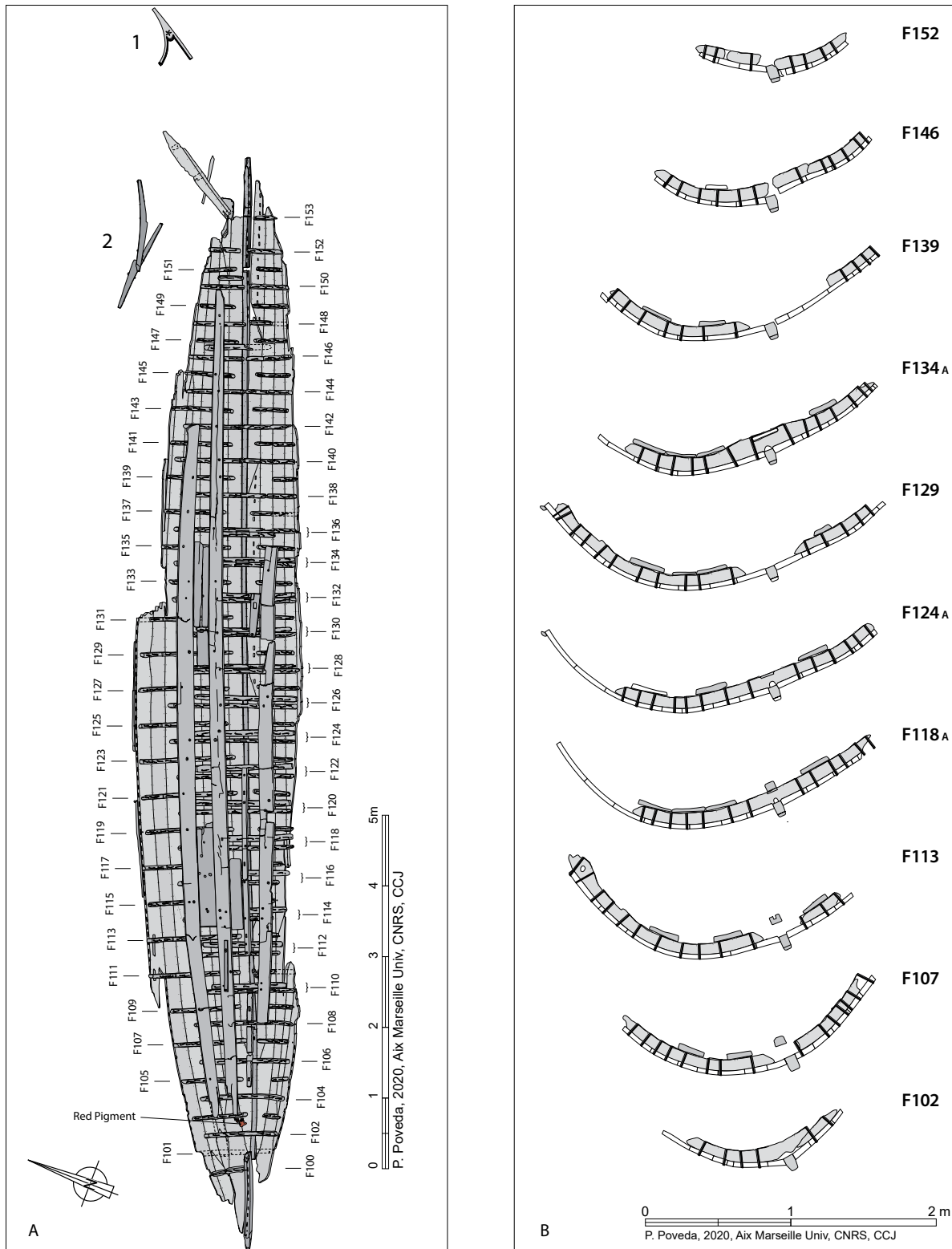


Fig. 3 Plan of the shipwreck of Phanagoria: 1) bronze casing; 2) fore-ram/*proembolion*; b) cross sections (drawing: P. Poveda, CNRS, CCJ)

1. Indications of the original shape of the ship

As the ship rested on its port side, this side was best preserved almost to the caprail (Fig. 3B). The transverse section at the main frame depicts a flat garboard with a round turn of the bilge. The longitudinal section shows a significant hog, which can be attributed to a post-depositional deformation phenomenon.

The stem, even if not preserved, had a concave profile as proved by the shape of the bronze casing. This element is 0.9 m long, 0.44 m high and weighs 15 kg. Two nails, whose holes are visible on the slightly curved arm, or cowl, attached it to the stem-post. A single nail secured the lower right arm to the keel.

A few other elements, found detached from the main hull not far from the bow, provide a considerable amount of information for the reconstruction of the original shape of the ship at the bow. These are a V-shaped floor-timber, 0.48 m wide and 0.45 m high, and two pieces made of oak (*Quercus* sp.). These two timbers are respectively 1.30 and 1.34 m long, and 55 mm thick. They are very similar in shape: a long, flat piece with a straight arm and a slightly curved arm. When placed side-by-side, the two timbers form a V-shaped structure and the individual nails match the holes in the opposite timber perfectly. It is suggested that this V-shaped structure was nailed to the outer part of the planking at the bow and capped the stem. In this configuration, this structure could be identified as a fore-ram/*proembolion*.

2. Iconographic comparison

A working hypothesis arose from the comparison between the longitudinal profile of the ship of Phanagoria and a graffito engraved in a wall of the House of Dionysus in the island of Delos Island, dated between 88 and 69 BCE when the house was abandoned after the sacking by the troops of Mithridates VI Eupator. The graffito, a ship propelled by 50 oars on each side, was identified by Captain D. Carlini as a *hekatontore* (Bash 1987: 350–351; Morel-Deledalle, Pomey 1992: 30, 45) (Fig. 4). The shape of the bow with its prominent cutwater, the blunt-faced ram, and the *proembolion*, is similar to the one that we reconstructed for the Phanagoria ship even if the dimensions and the function of the two ships are not comparable.

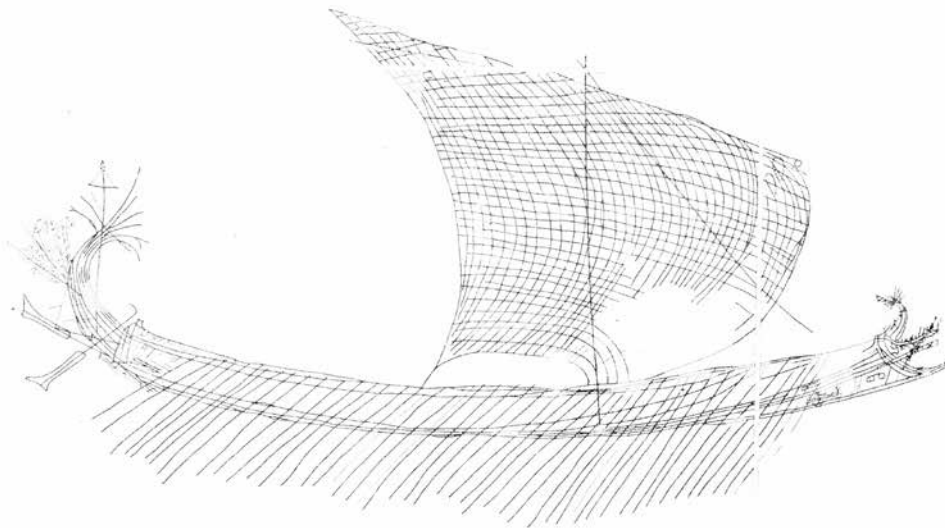


Fig. 4 Graffito of House of Dionysus (Delos, 88–69 BCE) depicting a *hekatontore* (drawing: Capitain D. Carlini, courtesy Musée national de la Marine, Paris)

Based on the shape and structure of the hull, the presence of both the bronze blunt-faced casing and the *proembolion*, we identified the Phanagoria wreck as the remains of a light sailing and rowing military ship, which must have proven to be very fast and manoeuvrable. Given its limited size, it does not fit into the category of the larger ships of the line. Instead, it must have been employed in minor war activities as a scout, or as a patrol ship. Its simple bronze casing was completely different from the three-finned rams discovered off the shore of Athlit (Israel, Hellenistic era; Casson, Steffy 1991), in Sicily at Aqualadroni near Messina (3rd c. BCE; Buccellato, Tusa 2013; Tisseyre 2014) or in the Egadi Archipelago (mid 3rd c. BCE; Tusa, Royal 2012; Tusa *et al.* 2021). We do not think it was intended to deliver a pounding blow to the enemy ships, but was placed to reinforce the cutwater.

3. The reconstruction process

Given the quantity and quality of the remains, we quickly considered the opportunity to attempt to reconstruct in 3D the original shape of the hull. It seemed to us that the port side was sufficiently well preserved in extension and that transversally its shape was relatively well preserved. However, the longitudinal profile of the wreck, with a significant hog, led us to question the appropriate method for assessing deformations and the amount of remodelling to match the original shape.

Given the high degree of accuracy of the documentation available – a complete underwater photogrammetric survey of the hull (Zhukovsky *et al.* 2013) and detailed 3D models of the recovered elements, all of which perfectly documented their shapes, revealing both deformations and cracks, as well as the exact position of each assembly element (pegs fixing tenons, nails, etc.) – we decided to reconstruct the Phanagoria ship through a hybrid scaled physical model, combining virtual and physical approaches. The use of hybrid scaled physical models is increasingly common in nautical archaeology, as recently demonstrated by the work carried out by the Norwegian Maritime Museum on the Sorenga 7 shipwreck (Falck *et al.* 2016).

In the Mediterranean, this approach is completely new and unprecedented.¹ It is worth noting that the high precision 3D documentation (i.e. the photogrammetry) and the 3D modelling of the remains, done with the software Rhinoceros, allow the construction of a physical scaled model following the ancient shell-first process, thus respecting the chronological order of placement of each element of the ship and the position of each assembly. In the case of Phanagoria, due to their good state of preservation, the frames were extracted from the 3D Rhino model of the wreck and printed. However, the modelling of the keel and the planking required a lengthy process that will be detailed in the following.

First, we modelled separately in Rhino all the elements of the wreck from the photogrammetry: the keel, the planks with their pegs for the tenons, the frames with their nails and treenails, as well as the ceiling and the keelson with their systems of assembly. Whether these elements were obtained by redrawing them or by just reworking the original mesh extracted from the photogrammetry, the goal is the same: to obtain a final 3D model of the remains in which all the elements are individualised and very accurate. The result is a complete 3D model of the remains which is not just a single mesh but composed by all the distinctive parts of the wreck.

For the planking, the idea was to obtain the developed plan of the flattened planks. To do this we used the ‘UnrollSurface’ command in the Rhinoceros 3D software, on the surfaces representing the inner faces of the planks. The position of the pegs, the position of the frames, and the position of the treenails are also marked and reported on the developed plan. These marks will be used later during the construction of the physical model to check the correct position and alignment of all the elements.

It is necessary to stress that this technique can only be applied to developable surfaces: a plank that owes its curvature partly to carving cannot be developed. Similarly, if the planks are torn, the result is a non-developable surface that prevents the use of this method. Fortunately for us, most of the strakes of the Phanagoria wreck were made from flat developable plank. Once this plan is generated, it is annotated before being printed at 1/10 scale and then glued onto cardboard from which each independent plank is cut.

For the frames, we used 3D printing, taking care to draw the holes corresponding to the assembly elements (treenails and nails) on the planking. Even if there is the possibility of having frames deformed in the transversal direction as demonstrated by previous studies (Tanner 2013: 33–34; 2020: 245–246), we estimated that the transverse shape of the port side of the Phanagoria wreck was quite undisturbed and very similar to the original.

Before beginning the reassembly of the pieces and construction of the physical model, we also had to find a technical solution that would allow a certain degree of freedom in terms of longitudinal curvature and height of the keel. This solution ensures the best possible match, i.e. all the elements fit together correctly. We designed a cradle that permitted adjustment of the height of the keel at three cross sections as well as the height of the bow and the curvature of the stern.

Mortises were carved in the thickness of the first planks and tenons inserted. The bow was temporarily held in place with a clamp. The assembly of the first five strakes, up to the turn of the bilge, did not pose any particular problems.

At this stage of the construction, the insertion of the bottom frames allowed both the cross shape of the bottom and the degree of rocker of the keel to be fixed. Indeed, it is known that increasing the keel rocker will flatten the central

¹ We have already reconstructed the shape of the highly distorted Roman ship Isola Sacra 1 following this hybrid approach, but the method used and the results are not yet published. On the ship see: Boetto *et al.* 2017; Boetto 2020: 260–265.

part of the boat, and decreasing the keel rocker closes the midship section (McKee 1978: 265–268). The height of the bow is then defined by looking for the best match between the shape of the bottom frames and the keel rocker.

The construction continued with the assembly of the successive planks and the insertion of the futtocks. To avoid unbalancing the hull, we also inserted the futtocks on the starboard side. These elements were reconstructed by symmetry to those on the port ones (Fig. 5).

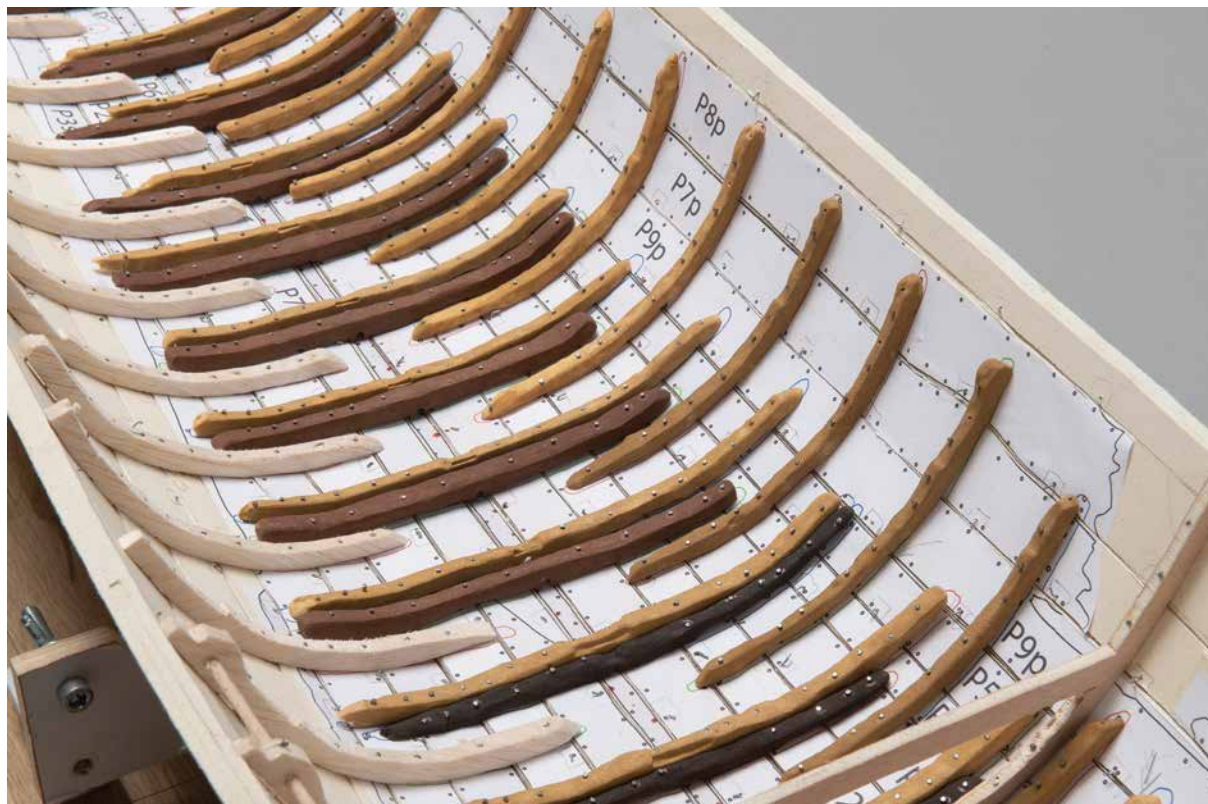


Fig. 5 Detailed view from the prow of the inside of the model. The port side is on the right of the image (photo: L. Damelet, CNRS, CCJ).

When we reached almost the level of the caprail, the hull tended to have a more and more rigid, self-supporting shape, so we could fix the bow height. The keel rocker was determined by the whole structure. Towards the bow, the keel and strakes, which had been deliberately left longer than necessary, were then cut to the correct length determined by the best fit of the bronze casing, fore-ram/*proembolion* and V-shape frame. This validated the obtained shape of the bow (Fig. 6). Once completed, the physical model was recorded using 3D scanner (Artec Leo), thus accurately recording the resulting shape.



Fig. 6 General view of the completed model (photo: L. Damelet, CNRS, CCJ)

Conclusion

The reconstruction of the original shape of the Phanagoria ship was achieved through the use of a hybrid research process combining 3D and physical modelling. This research was based on the precise study and recording of the remains of the ship, the identification of ship components, the interpretation of all the available data, and comparisons with iconography. Given the preservation of the wreck's structures particularly on the port side, the hybrid process of reconstruction allowed the shapes and dimensions of the ship to be reliably defined (Fig. 7).

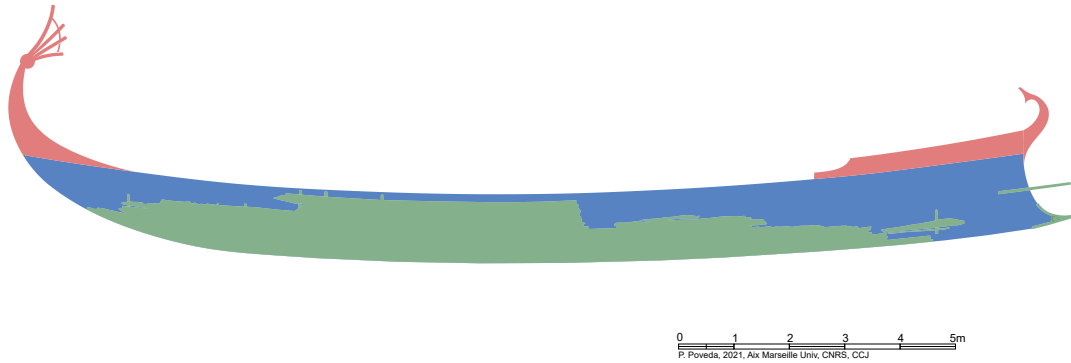


Fig. 7 Longitudinal profile of the ship highlighting the preserved part (green), and the various level of certitude of the reconstruction (blue probable reconstruction, red possible reconstruction) (drawing: P. Poveda, CCJ/CNRS)

With a length of 19.35 m and a mid-section width of 2.8 m, the length-to-breadth ratio of the ship of Phanagoria is close to 1:7, which is typical for oared long-ships, whereas merchant ships have a lower L/B ratio (1:3 to 1:4) (Fig. 8). The number of rowers could be estimated between 20 and 22, with two rowers per bench. This implies that the ship housed ten or eleven transverse beams used as rowing thwarts and supported by stanchions fitted in recesses carved in the keelson. The mortises still preserved on the keelson are spaced one meter apart and this distance corresponds almost exactly to the distance between oars (*interscalmium*) put in evidence in the archaeological records (Bockius 2012).

The next step will be the modelling of each element of the ship's structure, in particular the superstructures and the rigging and gearing. This will allow the displacement of the ship to be accurately calculated and its overall rowing and sailing performances to be studied.

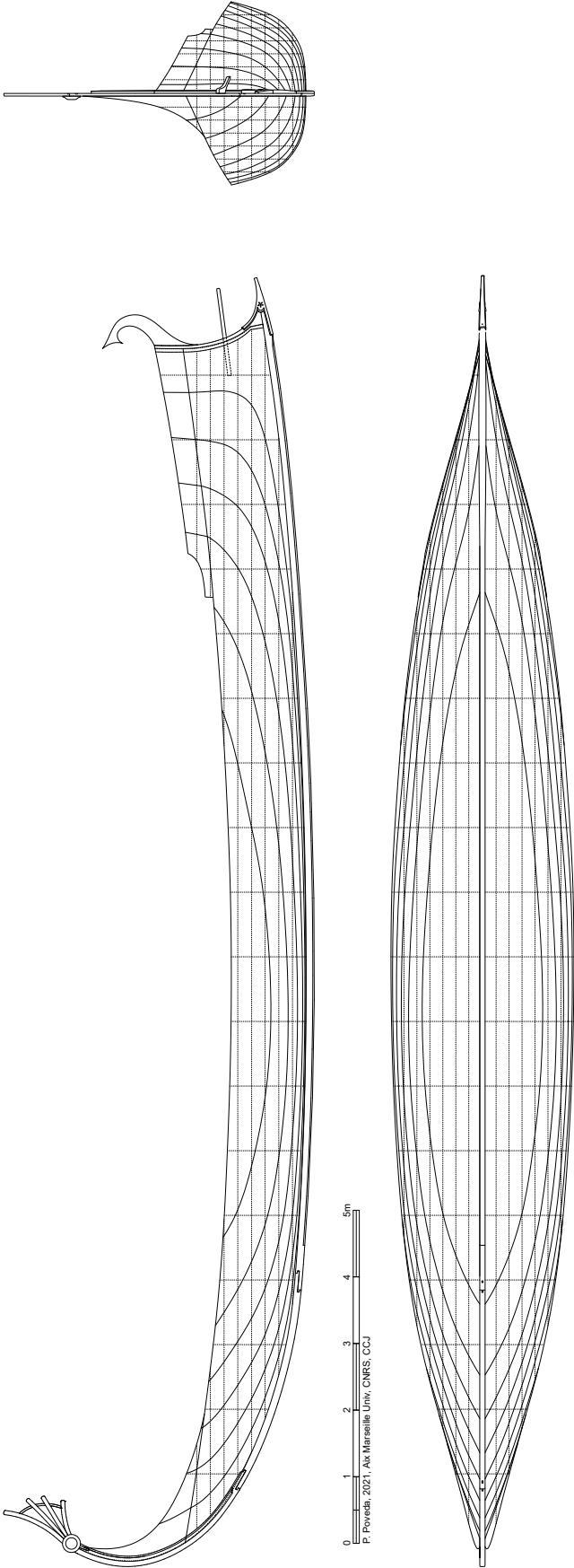


Fig. 8 Lines plan of the reconstruction (drawing: P. Poveda, CNRS, CCJ)

References

- Basch, L. 1987. *Le musée imaginaire de la marine antique*. Athens, Hellenic institute for the preservation of nautical tradition.
- Bockius, R. 2012. Uniformity or Multiplicity? On Vitruvius' *interscalmum*. In B. Rankov (ed.), *Trireme Olympias: The Final Report. Sea Trials 1992-4, Conference Papers 1998*. Oxford, Oxbow: 170–181.
- Boetto, G., Ghelli, A., Germoni, P. 2017. New Roman shipwrecks from Isola Sacra (Rome, Italy). In J. Gawronski, A. Van Holk, O. Schokkenbroek (eds), *Ship and Maritime Landscapes, Proceedings of the Thirteenth International Symposium on Boat and Ship Archaeology, Amsterdam 2012*. Eelde, Barkhuis: 260–266.
- Boetto, G. 2020. *La batellerie portuaire en Méditerranée à l'époque romaine. Le cas des bateaux à extrémité coupée*, Mémoire d'habilitation à diriger des recherches. Marseille, Université d'Aix-Marseille.
- Boetto, G., Poveda, P., Olkhovskiy, S. V. 2022. The Hellenistic Shipwreck of Phanagoria (Taman Peninsula, Black Sea, Russia): A Small Military Vessel. *The International Journal of Nautical Archaeology* 51.1: 21–45.
- Buccellato, C. A., Tusa, S. 2013. The Aqualadroni Ram recovered Near the Strait of Messina, Sicily: dimensions, timbers, iconography and historical context. *The International Journal of Nautical Archaeology* 42.1: 76–86.
- Casson, L., Steffy, J. R. 1991 (eds). *The Athlit Ram*. College Station, Texas A&M University Press.
- Falck, T., Fawsitt, S., Kerr, A. 2016. Sørønga 7: the reconstruction of a 17th century boat from Oslo harbour. *The International Journal of Nautical Archaeology* 45.2: 310–330.
- Khotylev, A., Olkhovskiy, S. 2020. Geological Studies as a Source of Data on the Maritime Trade between the Cimmerian Bosphorus and the Mediterranean in the 1st Millennium BCE. *SKYLLIS* 20: 97–107.
- Kuznetov, V. D. 2016 (ed.). *Phanagoria*. Moscow, Institute of archaeology, RAS.
- McKee, E. 1978. Reconstructing the Hull. In V. Fenwick (ed.), *The Graveney Boat*, [BAR British Series 53]. Oxford, British Archaeological Reports: 265–294.
- Morel-Deledalle, M., Pomey, P. 1992. *Récit d'une aventure : les graffiti marins de Délos*. Marseille, Musée d'histoire de Marseille: 17–23.
- Olkhovskiy, S. 2016. Underwater explorations. In V. D. Kuznetov (ed.), *Phanagoria*. Moscow, Institute of Archaeology RAS: 48–57.
- Pomey, P., Rieth, E. 2005. *L'archéologie navale*. Paris, Errance.
- Tanner, P. 2013. *Newport Ship Specialist Report: Digital Reconstruction and Analysis of the Newport Ship*. York, Archaeological Data Service.
- Tanner, P. 2020. *The Reconstruction and Analysis of Archaeological Boats and Ships*, 2 vol. PhD Dissertation. Southampton, University of Southampton.
- Tisseyre, P. 2014. Il Rostro di Messina. Il relitto di Aqualadroni C: un rostro del III sec. a. C. In A. Accardi (ed.), *Progetto Scuola-Museo. Un Mare d'aMare*, vol. 2. Palermo, Soprintendenza del Mare: 34–49.
- Tusa, S., Royal, J. 2012. The landscape of the naval battle at the Egadi Islands (241 B.C.). *Journal of Roman Archaeology* 25: 7–48.
- Tusa, S., Campbell, P., Polakowski, M., Murray, W. M., Oliveri, F., Buccellato, C. A., Fresina, A., Li Vigni, V. 2021. The Battle of the Aegates Islands, 241 BC: mapping a naval encounter, 2005-2019. In C. Prescott, A. Karivieri, P. Campbell, K. Göransson, S. Tusa (eds), *Trinacria, 'An Island Outside Time': International Archaeology in Sicily*. Oxford, Oxbow: 167–179.
- Zhukovsky, M., Kuznetsov, V., Olkhovsky, S. 2013. Photogrammetric techniques for 3-D underwater record of the antique time ship from Phanagoria. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol. XL-5/W2: 717–721.