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The Hellenistic Shipwreck of Phanagoria (Taman Peninsula, Black Sea, Russia): a small military vessel

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Summary

The shipwreck was discovered in 2012 close to the shoreline of the ancient settlement of Phanagoria, Taman Peninsula, Russia. In 2014, a bronze casing decorated with a crescent and star, a symbol associated with the Kingdom of Pontus and the reign of Mithridates VI Eupator, was discovered 1.5 m to the west of the keel's extremity. In 2019, the site was re-opened to complete the study of the ship's structure. This article discusses its architecture and provides a first interpretation of the ship.

Key-words

Bronze casing, military ship, mortise-and-tenon, shell first, Pontic Kingdom

1. Introduction

For many centuries Phanagoria, a city founded by Ionian Greeks in the 6th century BCE on the South coast of the Taman Bay (Black Sea), was an important transit centre on the trade route from the Mediterranean to the Azov Sea (Fig. 1) (Kuznetov 2016). The city did not possess a comfortable natural harbour, but, undoubtedly, had a well-developed port structure.

Because of the Black Sea level's transgression, the coastal part of the city and its port were submerged and covered by seabed sediments. As a result, the remains of ancient structures are nowadays not visible (Fig. 1).

For over 20 years, the Phanagorian expedition of the Institute of Archaeology of the Russian Academy of Sciences in Moscow focused its research on this submerged area of the city, using different methods ranging from remote survey to underwater excavation.

From 2012 onwards, research was conducted on a regular basis which, among others results, permitted to identify the most effective methods in order to localise the archaeological

structures hidden under seabed deposits (Olkhovskiy forthcoming). The most informative method, considering the shallowness of the body of water in front of Phanagoria, proved to be the geomagnetic survey. It allowed the localisation of part of the city's port infrastructure composed by two large berthing facilities: the eastern pier built in the 5th-4th century BCE (Fig. 2, A) and the western pier of a latter unknown date (Fig. 2, B), both built with large stones blocks. A third smaller structure, composed by poles, horizontal timbers, stones and reused elements from the destruction of the city in the 1st century BCE, is situated between the two piers (Fig. 2, C) (Olkhovskiy 2016: 51-54; Khotylev and Olkhovskiy, 2020).

In 2012, during the excavation of the massive stone embankment near the eastern pier, the remains of ship were found (Fig. 2, S). After removing the seabed deposits covering the entire ship's structure, the ballast and a few objects used on board were found (Figs 3 and 4). This layer was documented by photogrammetry (Fig. 5) (Zhukovsky *et al.* 2013).

Two years later, the ballast was removed in order to document and study the hull remains (Figs 6 and 10a-b). During the excavation of a stone mound not far from the NE end of the ship, a bronze casing decorated with a five-rayed star and a crescent was found (Fig. 7). This finding permitted to identify the bow of the ship and the symbol to associate the ship with the Kingdom of Pontus.

In 2019, the Phanagorian expedition invited two specialists from the Centre Camille Jullian to participate the fieldwork in order to complete the documentation and study of the ship. The site was reopened, cleaned and documented, samples for xylotomic analyses were collected and the ceiling and some other components were removed from the seabed. These elements, together with some others recovered in the previous years and stored in the Phanagorian expedition center, were fully photographed, measured and documented with a portable laser scanner.

2. The shipwreck

The shipwreck is located 120 m from the modern coastline and is orientated NE/SW, the bow pointing in NE direction (Figs 2, S and 10). It lay on the slope of a stone embankment near the Eastern pier, at a depth of about 2 m from the actual sea level. The ship rested on its port side, which is better preserved than the starboard one, and was covered by 1.2 m to 1.5 m of sand and silt deposits.

2.1 Ballast and others findings

The layer of small stones, on average 80-100 mm in diameter, and fragments of tiles that covered the bottom of the shipwreck has been interpreted as ballast intended to improve the nautical capabilities of the ship. The ballast was found between the frames (from F100 to F152) and under the ceiling planks. A surface area of 2 m² of the ballast covered also the ceiling planks of the port side at the stern (Fig. 5).

The majority of the fragments belong to roof tiles produced in Sinop and in the Bosphorus area in the 4th-3rd centuries BCE. The petrological analyses performed on a selected number of stones confirm at least two different origins from Crimea and the Taman Peninsula, and from an undetermined Mediterranean region (Khotylev and Olkhovskiy 2020). They were also completely different from the bigger stones used for the construction of the eastern pier.

A Megarian bowl, a jug, some cooking wares and two Colchian amphorae probably belonging to the onboard equipment were discovered between the ballast. This material is dated to the 2nd-1st centuries BCE (Figs 5, 8b-f and 9).

In 2019, a spherical projectile made from a calcareous stone (diam. 75 mm, estimated weight 4 kg) was found under the stringer C3P and between frames F129P and 130A, thus supporting the military function of the ship (Fig. 8a). The same year, after removing the ceiling, two bronze coins were found among the ballast. The first one, minted in Panticapaeum, is dated to 175-120 BCE, the second, from Phanagoria, is dated to 200-110 BCE. Both coinages were used in Phanagoria until the middle of the 1st century BCE.

2.2 Dating and dynamic of the wrecking

The stratigraphic context and the findings place the wrecking event within the first half of the 1st century BCE. Other data are not in contradiction with this dating.

The star and the crescent of the bronze casing form a symbol connected with the Kingdom of Pontus that is well attested in coins minted from the reign of Mithridates III (220-185 BCE) to Mithridates VI Eupator (120-63 BCE) (Waddington *et al.* 1904: 8). Similarly, W. M. Murray (1991) compared symbols appearing in coins and symbols on the Athlit ram as clues for dating and establishing the provenance on the ship. The AMS radiocarbon analysis performed in 2019 on a sample from the keel near the bow offers an interval for the construction of the ship spanning from the mid-4th century BCE to the beginning of the 1st century BCE (95.4% of probability, 2 sigma).¹

¹ The analysis has been performed by the Center for Applied Isotope Studies, University of Georgia, USA. The sample code: IGAN_{AMS} 6994.

As it seemed strange that a ship that sank in the shallow waters near the city's main eastern pier was not quickly disassembled and reused, it was proposed that the ship was part of the fleet sent to Phanagoria by Mithridates VI Eupator in 63 BCE to suppress the city's uprising, an historical event related by Appian (*Historia Romana*, 12, 108). According to this hypothesis, the ship sank near the eastern pier during the conflict and was rather quickly filled with sand and silt, making its recovery difficult (Olkhovskiy 2016: 54). It is also possible that the ship of Phanagoria was intentionally abandoned because it was not operational anymore. This seems to be confirmed by the evidence of repair (see *infra*).

2.3 Description of the remains

The remains of Phanagoria's shipwreck consist in a remarkably well-preserved hull 15.82 m long and 2.40 m wide. A few other elements of the ship were discovered detached from the main hull, adding a considerable amount of information to the understanding of the ship's original architectural and functional systems (Fig.10).

As the ship rested on its port flank, this side was preserved almost until the caprail. The transverse section at the main frame (F125) depicts a flat garboard with a round turn of the bilge (Fig. 11a). The longitudinal section shows a significant hog, which can be attributed to post-depositional deformation phenomena (Fig. 11b). The stem, even if not preserved, was characterized by a concave profile as proved by the shape of the bronze casing.

The remains consist in the keel, eight strakes on the port side and five on the starboard side, 53 frames, a keelson, a mast partner, two stringers nailed to the frames on the port side and one on the starboard side, and mobile planks of the ceiling. Some detached fragments of the planking, a V-shaped floor-timber and few mobile planks of the ceiling were also discovered close to the wreck. A second keelson, placed towards the stem, and the mast-step did not survive and might have been among the rare components of the structure that were salvaged after the abandonment of the ship.

The bronze casing and two identical timbers, interpreted as part of the stem structure, were uncovered not far from the NE extremity of the keel (Fig. 10).

2.3.1 The axial carpentry

The keel (K), 12.35 m long, is not preserved on its entire length. It is made of Scots pine type² (*Pinus sylvestris* type) and scarfed toward the west to a stern transitional timber (KG) made of oak (*Quercus* sp.) thus reaching a total length of 15.44 m.

The keel is trapezoidal in section, 80 mm sided on its upper surface, 61 mm sided on its base, and 90 mm moulded (Figs 11a and 12).

The stern transitional timber is broken in two parts. The first one, 1.8 m long, is still connected to the keel by a scarf situated between the half-frames F107P and F107S. The shape and design of this scarf are unknown, as the keel and the transitional stern timber have not been dismantled and studied in detail. The assembly is secured by a vertical key rectangular in section (37x16 mm), and made of an undetermined pome fruit tree (*Rosacea maloidea*). The second part of the transitional timber is preserved on a length of 1.38 m. It is rectangular in section, 80 mm sided and 106 mm moulded, with slight chamfers at its base.

It is worth mentioning that at the preserved extremities of both the keel and the stern transitional timber, no rabbets have been observed. The planking was assembled to both these axial elements by pegged tenons, on average 53 mm wide, 6 mm thick and regularly spaced at 112 mm intervals. We observed some nails driven from outside further securing the strakes to the stern transitional timber. These nails are spaced on average 163 mm.

The absence of rabbets toward the stem is in relationship with the shape of the hull, however this characteristic is unexpected at the stern transitional timber. It is probable that rabbets to fit the strakes extremities were carved into an upper curved timber completing the stern.

Keel repair

Taking advantage of a break at the bow, two separate pieces of the keel have been raised from the seabed in 2019, for a total length of 55 cm. It was possible to observe that, at this point, the keel was doubled with a false keel, or shoe, made from beech (*Fagus sylvatica*), 61 mm sided and 25 mm moulded (Fig. 12b). This shoe was assembled to the keel with pegs, quadrangular in section (80x100 mm) and regularly spaced of 190 mm, made in an undetermined pome fruit tree. One visible peg was inserted in the lower surface of the keel without passing through the shoe. The presence of this peg is a clue for a previous shoe connected to the keel that was replaced with the actual one during the life of the ship. Significantly, this repair is located towards the bow where the keel would be subjected to wear and tear due to beaching.

² The difficulty to differentiate the wood anatomy of Scots pine (*Pinus sylvestris* L.) from that of the black pine (*Pinus nigra* Arnold) and hooked pine (*Pinus uncinata* Ramond) led Carine Cençon-Salvayre, who performed the analyses of the wood, to group the taxa under the name of ‘Scots pine type’.

2.3.2 The planking

Five strakes on the starboard side and eight on port side compose the preserved planking which is flush laid, assembled by pegged tenons and homogeneously made of Scots pine type (Figs 26 and 28).

The bottom of the hull displays an interesting feature between the frames F113 and F148. Here, the keel and the garboards are not placed at the same level, the keel being at a lower level than the adjacent garboards. The step is 14 mm deep at its maximum (Fig. 14). This characteristic correlates with the relatively small dimensions of the keel and with the bigger thickness of the garboards (between 35 mm and 47 mm, on average 42 mm) compared to the planking (between 25 mm and 40 mm, on average 32 mm).

With the exception of the starboard garboard, which shows numerous repairs (see *infra*), each strake of the ship is composed of a single plank from stem to stern or of two planks joined by a diagonal scarf. The example of the starboard garboard is particular. This strake consists in six planks.

One stealer or tapered strake (P5P) is preserved on the port side. It tapers forwards permitting to reduce the planking surface in the fore part of the hull. More likely, the fourth strakes on both sides of the ship were also stealers tapering toward the bow.

In the stern area, the second and third strakes design is peculiar and symmetrical on both sides of the ship. The second strakes (P2S and P2/11P) have a knife-shape reaching a maximum width of 275 mm (the average width of the strakes being 19,5 cm). These enlargements allow joining the second strakes to the garboards (P1/7/12S and P1P) by mean of oblique scarfs (Fig. 13). The third strakes (P3S and P3/11P) are also very large (275 mm at maximum) and present an even more elaborate shape. They are cut in such a way that it has been possible to join to them the extremities of both the fourth and fifth strakes. This planking design is unusual and could be an evidence of shipbuilding practises connected not only to a specific hull shape and a particular type of ship, but also to a regional shipbuilding tradition (see *infra*).

A rail timber (W4), 48 mm wide and 26 mm thick of Scots pine type, is nailed every 495 mm to the outer upper edge of the eighth port strake (P8P) (Fig. 15). This element increases the thickness of P8P at this point (59 mm total) and was intended to support the assembly between P8P and the ninth strake which did not survived but could be identified as a wale.

The tenon-and-mortise assembly system of the planking is very regular. On average, the mortises are 53 mm wide, 6 mm thick, and spaced 59 mm apart (side-to-side). Pegs have an internal diameter of 9 mm on average, and are spaced 112 mm apart (centre-to-centre).

Xylological analyses reveal the use of deciduous oak (*Quercus* sp.) for the tenons and of four different deciduous species for the pegs: chestnut (*Castanea* sp.), alder (*Alnus* sp.), hornbeam (*Carpinus* sp.) and a pome fruit tree (*Rosacea maloidea*).

Planking repairs

As in the keel, repairs are also attested in the planking (Fig. 13). On starboard, the garboard is composed of six planks joined by oblique scarfs. It is highly probable that three of them (P1S, P7S and P12S) belong to the original construction and were part of a unique strake in origin while the three other planks (P6S, P9S, P13S) have been repaired using patch tenons. The openings are visible on the internal surface, and measure, on average, 51x16 mm. These three repair planks are also made of Scots pine type as the rest of the planking. A single patch reinforces the junction between the keel, the original segment of the garboard P1S and the repair plank P6S. It is not excluded that other patches were used as repairs or reinforcements on the outer surface of the ship.

On the port side, two small planks (P12P and P13P) refit the aft ends of the fifth and sixth strakes. P13P is made of Macedonian pine (*Pinus peuce*), while P12P is of Scots pine type.

Finally, two planks (W2 and W3) joined by patch tenons, compose a detached piece of planking found in the fore part of the shipwreck on the port side. W2 is of Scots pine type while W3, from where the patch tenons are inserted, is made of Macedonian pine and corresponds to the repair.

2.3.3 The frames

Fifty-three frames survived, and are on average 64 mm sided and 73 mm moulded, with a room-and-space of 0.25 m (Fig. 16). The framing pattern is alternating floor-timbers, which are neither connected to the keel and extended by futtocks, and half-frames.

Fourteen floor-timbers situated in the central part of the hull, from F110 to F136, are systematically doubled by a second floor-timber that is situated towards the bow between the floor-timber and the subsequent half-frame³. One exception is F136 that is doubled with a short floor-timber placed towards the stern (Figs 16 and 17). Among these coupled floor-timbers, eight (from F112 to F126) are spaced 55 mm, and six other pairs, one on the aft part (F110) and

³ The frames (single floor-timbers, couple of floor-timbers, half-frames) are generally marked with the letter F (frame) and a number. We use the letters A (aft) or F (fore) to distinguish the two elements forming a couple of floor-timbers in relationships to their position. Similarly, we use the letters P (port) and S (starboard) to indicate the position of the half-frames or others structures (strakes, ceiling) in relationships to the keel.

five forwards the main section (F128, F130, F132, F134 and F136), are contiguous and they are not connected one another by fasteners. Five floor-timbers (F128A, F130A, F132A, F134A and F136F) are thicker than the others (maximum moulded 120 mm) while the floor-timber F102 is composed by two pieces, the port branch overlapping the starboard one.

The frames are mostly made of ash (*Fraxinus* sp.) with second floor-timbers mostly in Scots pine type. The use of other deciduous species - deciduous oak, hornbeam, elm (*Ulmus* sp.) and maple (*Acer* sp.) - is more irregular (Fig. 29).

Finally, the frames are fastened to the planking with clenched copper alloy nails, driven through treenails 14 mm in diameter and made of Scots pine type (Figs 16-18). The shank of the nails, square in cross-section (13 mm), has a reconstructed length of around 210 mm. The tips are systematically clenched towards the keel with few exceptions. At the lower end of the half-frames near the keel, the tips of the nails are clenched upwards. The same happens when recesses are carved in the frames thus preventing clenching the tips towards the keel.

The recesses for the internal axial carpentry

Along the keel, the upper surface of the floor-timbers from F110 to F146 is carved with a series of rectangular recesses to fit a mast-step and two keelsons (Fig. 17). The second floor-timber has no recesses with the exception of F136F.

In the aft part of the hull from F110 to F126 the recesses are on average 90 mm long, 10 mm wide and 10 mm deep. These dimensions correspond to those of the recesses entailed on the lower face of the keelson still preserved *in situ* (Fig. 10). In the fore part, from F138 to F146, the floor-timbers are entailed by recesses of similar dimensions as observed in the aft part of the hull, but the associated keelson didn't survive.

The five floor-timbers F128A, F130A, F132A, F134A, F136F and the short double floor-timber F136A, have bigger recesses on average: 215 mm long, 12 mm wide and 24 mm deep (Figs 18a and 22). Taking into accounts these dimensions and the specific shape of the five floor-timbers that are higher than the nearby second floor-timbers, it is probable that the mast-step was situated in this area. This position is confirmed by the use of a different wood species (hornbeam, oak and maple) for the second floor-timbers instead of Scots pine type that is the preeminent wood species used for the other similar floor-timbers (Fig. 29).

The shape of the floor-timbers and the limber holes

The bases of the floor-timbers from F110 to F138, including the second floor-timbers, display a particular shape. The feet are worked to fit perfectly into the step between the garboards and

the keel. This feature offers enough space to house central limber holes, mostly fairly rounded in shape with some examples quadrangular or triangular, and on average 50 mm wide and 40 mm high (Figs 16 and 17b).

The design of the floor-timbers of the Phanagoria shipwreck finds a comparison in two shipwrecks found in the Western Mediterranean: the Ladispoli shipwreck (Latium, end of the 1st c. BCE-beginning of the 1st c. CE, Carre 1993: figs 5 and 8) and Ovest-Giraglia 2 (Corsica, 20-30 CE, Cibecchini 2020; Cibecchini *et al.* 2017; Marlier 2020: fig. 3). These small sailing ships (60-70 t) transporting wine in large jars (*dolia*) are not comparable to the Phanagoria shipwreck since it belongs to a completely different category of ship. Nevertheless, the particular design of their floor-timbers display a similar technical solution to enhance the strength of the structural ensemble composed by the keel and the garboards. In the Phanagoria shipwreck the particular arrangement of the keel/garboards ensemble is one of the characteristics indicative of a specific architectural type.

The upper extremities of the half-frames

On the port side, the upper extremities of the half-frames feature interesting details. The tip of F111P and F113P are worked (Figs 18 and 19) and present on the top a cut to form a recess 30 mm deep. This feature is associated with a peg inserted on the lower edge of the recess, whose function is unknown. The round tips increase the height of the half-frame thus offering enough space to drill a hole for housing a cylindrical timber between the half-frames (Fig. 18d). This timber is 0.465 m long and 24 mm in diameter and functions as a cleat which was probably used to fix the rigging. The extremities of the half-frames F129P and F131P, despite their heavy deterioration, were similar to F111P and F113P.

The half-frame F115P and F117P have only the recess 30 mm deep on their upper extremities and a sort wedge of maple (*Acer sp.*), triangular in section (12 mm) (Fig. 20). As for the pegs of F111P and F113P, the purpose of such a fitting is unknown.

The worked extremities of the frames and the cylindrical cleats are similar to those observed on two small boats found in the ancient harbour of Toulon (mid 1st c. CE, Boetto forthcoming). In the Pisa C ship (1st c. CE, Camilli, Setari 2005: 46-51) the upper parts of some frames are also finely worked but their shape, conceived to reinforce the specific bulwark of Pisa C, differs from the Phanagoria one.

Finally, at the level of strake P7/10P, eight of the best-preserved port side half-frames present a recess, 14.5 mm deep (Figs 18f and 19). This recess could have been in relationship with a missing components, and this assumption is confirmed by the differences in the colour observed

in the layer of pitch covering the hull: a dark strip 0.30 m wide along strake P7/10P and dark zones on the lateral faces of half-frames (from F111P to F131P) indicate that a large plank was placed on the frames thus creating a specific anoxic environment producing a different deterioration of the pitch (Figs 18e and 19).

Frame repairs

Some repairs or reinforcements of the framing system are preserved on the port side towards the stem (Fig. 16). The timbers FR1 and FR2 are located, respectively, in the room-and-space between the floor-timbers F146 and F150, and the half-frames F147P and F151P. These timbers differ greatly in their dimensions from the rest of the floor-timbers and are made of ash (FR1) and oak (FR2) (Fig. 29).

FR2 is complete, 365 mm long, 62 mm sided and 50 mm moulded, and do not cross the keel. FR1 is broken and is 688 mm long, 73 mm sided and 85 mm moulded. The presence of fastenings on the starboard planks P12S and P2S are a clue to consider that, in origin, FR1 crossed the keel.

2.3.4 Internal longitudinal carpentry

The Phanagoria shipwreck preserved a part of its keelson, and some elements of the ceiling composed by three stringers, few mobile planks and a mast partner. Due to the presence of recesses entailed on the top of the frames along the keel, it has been possible to reconstruct the size and position of another keelson, a second mast partner and the mast-step.

The mast-step

The mast-step did not survived in the Phanagoria shipwreck, however its original position and size could be reconstructed on the basis of the recesses cut on the top of the frames. Thus, it was situated between the floor-timbers F126F and F138, slightly forward of the main cross-section, and it was at least 2.07 m long and 215 mm wide (Figs 16, 21 and 22).

The keelson

Part of the keelson is conserved at the stern (Fig. 21). Made of Scots pine type and square in section, 80 mm wide and 60 mm thick, it is composed of seven fragments for a total length of 3.8 m. On its lower face, recesses are regularly cut to fit in the notches situated on the top of the floor-timbers. To ensure its solidity, the piece is further nailed to the floor-timbers. On the

upper face, rectangular mortises (60 mm long, 25 mm wide and 21 mm deep) are carved regularly every 1.01 m, and were intended to host stanchions supporting transversal elements (beams used as thwarts). From both the surviving components and the recesses carved on the floor-timbers, it can be affirmed that the keelson was installed above the frames F104 to F126 and measured at least 5.65 m.

A similar keelson, which did not survive, was present in the fore section of the hull (Fig. 22). It was fitted on the frames from F138 to F146 and measured at least 1.52 m.

The mast-step partners

Another longitudinal timber, also made of Scots pine type, was found on the starboard side (Figs 21 and 23). The piece was nailed to the floor-timbers F130 and F132, 0.61 m long, 145 mm wide and 50 mm thick. A single rectangular mortise (80 mm long, 50 mm wide) for a stanchion was pierced forwards. Traces of nailing on the port side of the floor-timbers F130 and F132 confirm the presence of a similar piece, not yet conserved, on the port side of the mast-step. Given the shape and position of these two elements, we interpret them as mast-step partners. Their position also allows for a reconstruction of the original position of the mast.

The ceiling

The two stringers on the port side (ST1P and ST2P) and the one on the starboard side (ST1S) are of Scots pine type, 150 to 250 mm wide and 30 mm thick. They are regularly fixed to the frames by nails⁴. They possess small mortises for stanchions (Fig. 21): a square mortise (20x20 mm) is situated on ST1P and ST1S at the same level between F113 and F114, and another rectangular mortise (25x20 mm) is visible on ST1P between F148 and F149. It is probable that a similar recess was also cut on the extremity of the first starboard stringer (ST1S) that didn't survived. A small rail (72 cm long, 4 cm wide and 3 cm thick), whose function is unknown, was nailed to ST1P between F110 and F112.

Four planks (C1P-C4P) of various lengths, between 50 and 150 cm, 16 to 23 mm wide and 20 to 30 mm thick, were found between the stringers on the port side. One (C1P) is made of fir (*Abies* sp.), the three are of Scots pine type. Three other displaced ceiling planks are made of poplar (*Populus* sp.), Macedonian pine and oak.

2.4 The bow structure

⁴ These nails are probably in iron but an analysis was not undertaken.

In 2014, at a distance of 1.5 m from the fore extremity of the keel, a bronze casing was found (Fig. 10). The same year, two curious and similar timbers were also discovered not far from it (Fig. 10). Retrieved and immersed in tanks in the Scientific centre of the Phanagorian expedition, they were examined in 2019 and interpreted as part of the fore-ram or *proembolion*.

The bronze casing

A bronze casing capped the keel and the stem-post (Figs 7 and 24), and is 0.89 m long, 0.44 m high and 9-15 mm thick. This blunt-faced bronze casing weighs 15.6 kg, has a U-shaped cross-section 108 mm wide from outside, and 69 mm wide from inside which corresponds to the width of the keel. The ram tapers towards its nose, which is hollowed and square in cross-section, 44 mm on each side. Two nails, whose holes are visible on the slightly curved arm, or cowl, fixed the “ram” to the stem-post. A single nail secured the straight arm to the keel (Fig. 24b).

The bronze casing is finely decorated: all its edges have mouldings and a crescent accompanied by a five-rayed star is represented on both of its lateral faces. The star and the crescent has been associated to the reign of Mithridates VI Eupator (Olkhovskiy 2016: 54, and see *supra*).

The proembolion

The two similar oak timbers (W208 and W209) found dislocated not far from the prow are, respectively, 1.30 and 1.34 m long, 108 and 123 mm wide at their maximum and 47-55 mm thick (Figs 25). Both timbers are very similar in shape: a long and flat piece with one straight extremity, another slightly curved and in between a rabbet cut on its inner face. This rabbet, 230 mm to 450 mm deep, is cut at a slight angle of 19°.

Copper alloy nails, four on W208 and five on W209, pass through the thickness of the timbers. On one side, the heads of these nails (on average 22 mm in diameter) are inserted in recesses square or trapezoidal in shape (34x27 mm). Traces of a red pigment, similar to that observed on the planking (see *infra*), were clearly visible inside the recesses. On the opposite side, the stems of the nails or, simply, the square holes corresponding to the missing stems are visible. In the straight part of the timbers, other small square holes are visible on the inside face. This is where ended the nails driven from coming through the opposite timber.

Indeed, once the two timbers are put side-by-side, they form a sort of V-shaped structure and the various nails match perfectly the holes on the opposite timber. Consequently, the rabbet defines a space of 84 mm that would have housed a timber of a similar dimension, square in

section, standing not in vertical position but with an inclination of 19° corresponding to the slant of the rabbet.

It is suggested that this V-shaped structure was nailed to the outer part of the planking at the bow and capped the stem post (Fig. 26). In this configuration, this structure could be identified with a *proembolion* (Casson 1995: 85). The timbers were painted with a red pigment as the rest of the hull (see *infra*) and seemingly neither capped with a bronze casting or decorated as attested by the iconography (Bash 1987; Murray 1996: 214-253) or few archaeological examples (Cavazzuti 1997; Adams *et al.* 2013: 63; Zarkadas 2017) (Fig. 27).

2.5 The protection of the hull: pitch and red pigment

The planking is covered, on both sides with a yellowish layer of pitch⁵. In some areas the pitch's colour is darker, revealing the location of components that have now disappeared (Figs 18 and 28a).

A small pile of a red substance was observed inside the hull between frames F102 and F103 (Figs 10 and 28b). Traces of a similar red pigment were observed on the outside of the hull on planks P8P and W3, and on the external surfaces of the detached timbers interpreted as part of the fore-ram (Fig. 26). As this pigment was smeared on the outer surface of the hull, it can be assumed that the ship was coated with it, and that the crew had some spare material on board to eventually touch up the paint. In the Pisa C ship (1st century CE), the hull was painted in red obtained by hematite (Colombini *et al.* 2003: 659-674); for the Phanagoria ship, the paint is currently under analysis by the Kurchatov Institute in Moscow, and the results are not yet available at the time of writing this article. Anyway, it is worth noting that mines of a renowned red pigment, the *σανδαράκη* or realgar (arsenic sulphide) were situated in a mountain named Sandaracurgium, in Paphlagonia, south of Sinope (Strabo XII, 3, 40). This substance, also used as a medication although potentially poisonous (Pliny, NH, XXXIV, 55), was part of a load of pigments discovered on the Planier III shipwreck (France, 1st century CE, Tchernia, 1969: 300-303).

3. The wood species

Twelve different wood species were used in the construction of the Phanagoria ship, but two species are more often represented than the others: Scots pine type for the keel, planking, keelsons and ceiling and ash for the frames (Fig. 29).

⁵ The pitch has been sampled and analyses are in progress.

Among conifer species, Scots pine supplies one of the best woods from a mechanical resistance point of view. It is particularly flexible and due to this specific quality it was traditionally used in shipbuilding for oars and gaffs (Rival 1991: 29-30). Theophrastus (*HP*, V, 4, 4) underlined that mountain pines are particularly sensitive to the degradations made by *Teredo navalis*, while Vitruvius (*De architectura*, II, 9, 35) and Pliny the Elder (*NH*, XVI, 223) insisted on its good bending properties as well as on its durability.

Ash is generally considered as a valuable timber adapted to any type of work (Pliny the Elder, *NH*, XVI, 228). Theophrastus (*HP*, V, 7, 3) reported the use of ash, especially for the frames. Scots pine type, fir and beech are typical of mountain vegetation, while ash, elm, oak, alder, poplar and hornbeam grow in alluvial plains or riparian forests. All of those species are common in the Mediterranean and are also well attested in the Black Sea region (Grebentchikov *et al.* 1974), for example in the Mountains of Crimea and Caucasus (Douguedroit and Zimina 1987). The Macedonian pine used in the planking and in the ceiling of the ship of Phanagoria probably reveals a unique repair activity. This pine grows in mountains and subalpine forests up to 1700-2200 m, and nowadays has a very limited distribution in the Balkan area (Serbia to the north, Greece to the south, Pirin Mountains in SW Bulgaria to the east, and Albania to the west) (Vidaković 1991: 532).

It is difficult to draw conclusions from the presence of Macedonian pine in the ship: the wood may have been placed on the ship not far from where the tree has been cut. Thus suggesting that the ship was repaired very far from Phanagoria, in the west of the Black Sea, or even in the north of the Aegean Sea. Another hypothesis is that the wood of Macedonian pine may have been exported and used to repair the ship on a shipyard located much closer to the place of discovery of the shipwreck.

Anyway, the species of wood used in the shipbuilding are not in contradiction with a construction in the Black Sea region.

The homogeneity and the wood species used for both the planking and the frames are also quite remarkable. This could possibly mean that the construction of this military ship was carried out as part of a state process allowing the carpenters a good access to wood resources both in terms of quality and quantity.

4. Discussion

The construction principle used for the Phanagoria ship is based on a shell concept for the hull structure, and on a longitudinal strake-oriented concept for its hull-shape. The building process is shell-first (Pomey 1988, 1998, 2004; Pomey and Rieth 2005: 30-31; Pomey *et al.* 2012). This

is demonstrated by the close set of mortise-and-tenon joints that firmly connect the planking, thus ensuring the ship's cohesion. The frames play a secondary role in the construction.

The Phanagoria is a unique type of ship characterized by:

- A keel without rabbets associated to garboards not placed at the same level thus forming a slight internal step and a flat bottom;
- An asymmetrical profile;
- A planking flush-laid with pegged tenons, with a particular design of the second and third strakes at stern;
- A framing system composed of floor-timbers without futtocks and doubled by a second floor-timber, alternated to half-frames up to the caprail. The frames have a particular shape to fit the steps formed by the keel and garboards, and are connected to the planking, not to the keel, by clenched nails driven through treenails;
- an internal axial carpentry set directly over the frames in recesses cut on the top of the floor-timbers. The floor-timbers supporting the mast-step are higher than the rest of the framing;
- a ceiling composed by an alternation of stringers nailed to the frames and mobile planks.

One of the main particularity of this ship is the presence of pairs of floor-timbers alternated with half-frames. It is difficult to reconstruct the chronology of insertion of these floor-timbers. Taking into account that both floor-timbers are very similar, their feet are nicely shaped to fit in the space between the keel and the garboards, and the distinctive and homogeneous choice of wood, it is probable that the pairs of floor-timbers are an original feature of the ship defining a particular architectural type.

The question is to know if these characteristics are markers of a specific type of vessel of which little is known, or if they are connected to a shipbuilding tradition of the Black Sea. It might be also a combination of both, the Phanagoria being a unique type of ship showing particular regional building characteristics.

The original dimensions of the Phanagoria ship can be estimated with a certain degree of certitude around 19-20 m in length and 2.7 m at the main section. The length-to-breadth ratio is 1/7, which is much higher than the ratios observed on maritime Greco-Roman commercial vessels generally established between 1/3 and 1/4 (Pomey, Tchernia 1978: 245)⁶. This ratio,

⁶ The patrolled vessels found in Oberstimm (Germany, beginning of the 2nd century AD) and Mainz (Germany, 4th century AD) have a slender shape (Bockius 2002, 2006).

typical of oared long-ships, confirms that the Phanagoria ship is a military vessel rather than a commercial one.

The number of rowers is estimated between 20 and 22, two rowers per bench. This is based on the assumption that the ship housed ten or eleven transversal beams used as rowing thwarts and supported by stanchions fitted in recesses carved in the keelson. The mortises still conserved on the keelson are spaced one meter apart (Fig. 22) and this distance corresponds almost exactly to the distance between oars (*interscalmium*) put in evidence in the archaeological finds (Bockius 2012). Given the shape and structure of the hull, and the presence of both the bronze blunt-faced casing and the *proembolion*, we can identify the Phanagoria wreck as the remains of a light sailing and rowing naval ship, which must have proven to be very fast and manoeuvrable. Given its limited size, it doesn't 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 casing is completely different from the three-finned rams discovered off the shore of Athlit (Israel, Hellenistic era, Casson and Steffy 1991), in Sicily at Aqualadroni near Messina (3rd c. BCE, Buccelato and Tusa 2013; Tisseyre 2014) or in the Egadi Archipelago (mid 3rd c. BCE, Tusa and Royal 2012; Tusa *et al.* 2021). These rams were designed to deliver a pounding blow to the enemy ships, while the blunt-faced ram of Phanagoria is more a casing reinforcing the cutwater than a powerful weapon.

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 Delos, and dated between 88 and 69 BCE when the house was abandoned after the sacks perpetrated by the troops of Mithridates VI Eupator and by its allies, the pirates of Athenodoros (Fig. 30). The graffito, a ship propelled by 50 oars on each side, was identified by Captain D. Carlini with a *hekatontore* (Basch 1987: 350-351; Morel-Deledalle, Pomey 1992: 30, 45)⁷. 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.

5. Conclusion

The shipwreck discovered in 2012 off the ancient Greek city of Phanagoria is a remarkably well-preserved small warship dated within the first half of the 1st century BCE.

⁷ For a discussion about the pertinence of the term *hekatontore* for describing this ship, see Basch 1995: 59.

The ship was keel-based and built in the typical Mediterranean fashion with planks regularly assembled by a network of pegged tenons. The frame system, alternating floor-timbers and half-frames, was regularly reinforced by paired floor-timbers, and fastened to the planking by the means of clenched nails. The structure was strengthened by keelson made of two components apart of the mast-step. The remains reveal a nice carpentry and a choice of types of wood in relationship with the function of the ship's components.

The slender shape of the ship, the bronze casing decorated with the symbol of the Kingdom of Pontus - a crescent and a five-ray star – and the fore-ram confirms the military function of the ship.

Due to the well-preserved structure of the ship up to the caprail, the next steps of our research will be the reconstruction of the ship shape and structure in order to calculate its size and study its sailing performance.

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