IN THIS ISSUE: Naval technology and warfare in the Hellenistic era (323 – 31 BC)

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THE POWER OF POSEIDON

The Successors take to the sea

THEME – ROMAN BOARDING BRIDGE // PTOLEMAIC MARINES // LOOKING AT THE *LEMBOS*

SPECIALS – TRUSTED *EVOCATI* // SWORDS FOR ITALIC WARRIORS // FAKE NEWS FROM ZAMA

By Boris Dreyer

Rebuilding the past, improving knowledge

THE FRIDERICIANA ALEXANDRINA NAVIS

The effort to rebuild ancient objects at full size is a valuable means of imitating ancient living conditions – and often it turns out to be more efficient than traditional painstaking scientific research at a desk. Although the term 'experimental archaeology' is contested and considered narrowly as a 'popular activity' (with only a loose relationship to science), enterprises of this kind are far more than just an opportunity to pursue childhood dreams.

The best-reported surviving examples of ancient Roman ships were used inland on rivers, and come from Germania Magna, close to the region where researchers started to rebuild such a ship. These ancient boats were uncovered in Bavaria (Germany) at Oberstimm near Manching in the 1980s. The Romans intentionally affixed the wrecks (designated I and II) to the riverbed of a tributary of the ancient Danube. The oak of the boats and the pegs (with which the boats were affixed to the ground) can be dated dendrochronologically: wreck I was almost certainly built in AD 89 (a new date established during our work) and the wrecks were affixed to the riverbed shortly after AD 100. The Oberstimm wrecks belong to the so-called *scafae* (Vegetius 4.37.1-5) class, or fast scouting boats. In late antiquity, similar ships were called *lusoriae* (Vegetius 4.46.9). Examples were found in Mainz, built in a 'Celto-Roman' tradition. The Oberstimm *scafae* were built using Mediterranean traditional construction methods, using wood from the Danube-region.

ESTABLISHING A FRAMEWORK

To rebuild an ancient vessel means first understanding the building techniques involved. Ronald Bockius, at

The ship after launch in March 2018. It sat in the lake for about a week to allow the planks to soak up the water, expand, and thereby make the hull watertight.

the Museum of Ancient Shipping in Mainz, studied the wrecks and provided a solid basis. On this basis, we employed professionals capable of traditional ship construction – not an easy task: few today are able to apply different (traditional) crafts skills. They were supported by pupils, students and volunteers from the area.

Additionally, we profited from the experience of two reconstruction projects over the past decade. The Mainz *lusoria*, built from oak and 4000 iron nails, was twice built anew: as the 'Regina' in Regensburg in 2006, and the 'Rhenana' in Germersheim in 2013. The former was built using dimensions we now know to be inadequate. Oberstimm wreck I, sister ship to ours (wreck II) was reconstructed in Hamburg in 2008. All the ships were tested either as models in 1:5 scale in the Potsdam hydrostatic channel, or in 1:1 scale on the Danube (e.g. from Regensburg down to Budapest) with respect to their performance in long-lasting tests.

Our ship is the first full-scale copy of Oberstimm wreck II, built with the support of a wide range of scientific experts, and has new aims. We used the same types of wood (oak and pine) from the same region the Oberstimm wood originated in. The wrecks were preserved almost completely up to the gunwales, however no mast (with the exception of the mast step) and no oars were preserved. So, we had to look for comparable remains in near-contemporary findings, such as Nydam (though the ships aren't Roman) or Valkenburg. We reconstructed oars in different lengths of spruce to test the consequences for the rowers and for the width of the ship, which has to cope with narrow rivers in Germany (such as the Altmühl or Lippe). The rowers have little space, both between the benches (only about 90 cm) as well as along the benches. The result: we now have 42 oars for the 18 rowing positions at a length of 410 cm, 440 cm and 470 cm. The oars were tied to their tholepins with rope as seen in ancient iconography. This causes problems, as first tests show, with respect to the stability of the oars, as almost all ancient remains show oars with a circular cross-section.

BUILDING THE HULL

Unlike early modern ships, which are built skeleton-first, these ancient ships were constructed shell-first around a template. With the shell complete, the template is replaced with timber frames. We began the process by finding appropriate trees in the 'Reichswald' which had already a natural bend along their longitudinal axis. Consequently, we 'only' had to steam-bend the planks laterally, to make them fit the template we had constructed based on the near completely preserved wrecks.

With the backlashes (those planks which do not reach from bow to stern due to the round shape of the shell), the wale (more than twice as thick as the normal planks, which stabilize the boat in the longitudinal direction) and the gunwale (including the nine oak pins for the oars), the hull requires seven planks on both starboard and larboard. Bulwarks are added on top at bow and stern, in turn decorated with a simple *akrostolion* and *aphlaston*.

Now that the shell was done, bit by bit, the template was replaced with oak frames. They were fixed in place by about 700 oak nails, each about 25 cm long. This too, is a characteristic element of the Mediterranean building tradition which required only eighty iron nails at bow and stern. Compare that to the later *lusoria*-type, which consisted completely of oak planking fixed by 4000 iron nails! The difference in construction makes the earlier ships less than half the weight of the *lusoria* type and at only 2.2 tons, faster as well.

Additionally, after sealing the planks by caulking them with hemp and tar we reconstructed a walking deck which got – according to the *lusoriae* of Mainz – press boards. These boards can be arranged according to the size of the rowers.

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Decorative bronze reinforcement of a steering oar. It was attached to the wooden parts with no less than fourteen rivets. From the Rhone river, 3rd-1st century BC.

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1. Pupils, students, and volunteers from the area helped build the hull. Here planks are put into the steam-box to be bent to the right shape.

2. The reconstructed bilge pump, of the Dramont type, appeared to be very effective at keeping the hull dry.

3. Rudders of different shape and length were reconstructed based on contemporary evidence, and to allow experimentation under different conditions.

4. 1:10 scale models were tested in the tank of the Institute of fluid mechanics at the University of Erlangen.

5. Oars of different length were reconstructed according to contemporary evidence in order to test them with respect to handling at different depths, in narrow rivers, etc.

6. The remains of the original Oberstimm ships at the Kelten-Römer-Museum in Manching, Germany. The reconstruction is based on Oberstimm II, at left.

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NECESSARY ACCESSORIES

In wreck II Bockius believed to have found very faint indications for a bilge pump. A bilge pump in a plank boat is very plausible anyway and attested elsewhere. We started to reconstruct the Dramont pump type, in two versions, one in brass. Such a pump can be integrated into the hull, without harming the structure (as seems to have been the case in wreck II). The result is striking. The pump had a capacity of almost 90%, and can remove 16 litres of water per minute out of the bilge.

As neither a star- or larboard rudder is attested on the wreck, we had to look for contemporary instances on reliefs, mosaics and drawings. Depending on their size, the rudders consisted of one or more pieces (in our case of oak), fitted together with mortise and tenon-technique. We reconstructed two sets, one which fosters the stability (extending 118 cm below the waterline) and another with a more shallow reach of only 50cm. After all, the Romans had to cope with low water levels in small rivers, streams and lakes in Germania Magna and similar regions

Likewise the oars are bound to the tholepin with rope, matching reliefs, artefacts and ancient paintings. Traces of wear on the Oberstimm-wrecks foster this conclusion. On the almost-contemporary column of Trajan (Cichorius, table XXXIV) – as on other examples – the rowers of the biremes(!) are shown to pull with an alternating grasp, the inner hand seizing from below. This demands a high-

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er angle of the oars, which therefore have to be shorter – probably an additional argument to support the use of shorter oars, as would have been necessary in the narrow streams of Germania Magna. The placing, angle, and so forth also explain our experience in the first tests, that the rowers – unlike those in modern scull-boats – work more with their upper body and arms (always with problems of stability due to the round cross-section of the oars) and less with their legs (and feet on the stemming boards). Additionally, the oar paddles touch the water for a very short time compared with modern rowing boats.

The anchors are not preserved in Oberstimm. We built one wooden anchor (with iron fittings) and one contemporary iron anchor (of about 35 kg), based on examples in the Museum of Ancient Shipping in Mainz.

Although the oars were the main source of propulsion, it is certain that there was – attested in wreck II by a square bottomed hole in a reinforced section of the keel – a mast in the first third of the boat. It is possible that this was a towing mast – a look-out or signal mast can probably be excluded – but more likely we have to reckon with a sail. Current reconstructions count with a yard sail which is actually attested more frequently in Antiquity.

The boat has no keel in the modern sense of a downward sword or similar: therefore, the lateral area below waterline is very small. Additionally, the centre of gravity with the yard sail in the front third of the boat is very high. That means that sideways drift is difficult to avoid. The more so because the ship's sides are relatively high and easily caught by the wind. Tests with the preceding ships carrying a yard sail have borne this out.

TESTS

We tested the 1:10 copies in the hydrostatic channel, one with round- and one with concave-bow. Without sail, the round prow-version turned out to be better for open sea with higher waves, whereas the concave prow can exploit its hydrostatic advantages in inland waters. This corresponds with the tests of the 1:5 scale models in the

CARVEL-BUILT SHIPS

The Roman shipbuilders in Germania were 'imported' from the Mediterranean to the Danube region. They brought their shipbuilding traditions with them. The carvel-built shell of the Oberstimm wreck consisted of 4 cm thick planks, connected to each other edge-to-edge by mortises and 10 cm long oak-tenons, spaced every 30 cm. These springs are fixed by small oak-wood dowels, as soon as the planks were positioned to each other at an optimal angle.

Detail of Trajan's column showing the emperor himself as steersman. Note the over- and underhand grip of the rowers. →

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1. The hull planks are attached edge-to-edge with mortise and tenon joins every 30 cm.

2. One of the iron anchors based on an ancient Roman example.

3. The reconstructed ship fully painted according to Pliny the Elder's prescription of encaustic paint.

4. The Fridericiana Alexandrina Navis in its element carrying a square-rigged sail.

Potsdam channel. Average continuous speed was suggested to be 4-5 knots.

Whereas the tests with the Nydam B – model demonstrated that the potential of the clinker boat was superior (especially for open sea) to that of the Oberstimm wrecks, our ship will probably prove to be even faster than wreck I, because of the longer water line. Compared with this the *lusoria*-type, built with oak and iron, would fall far behind. Whereas a single rower in a Nydam boat has to apply about 300 kg of force (to contribute to the average speed of the entire boat), a rower on an Attic trireme has to exert 235 kg, and on the Oberstimm II and I about 220 kg, the single rower of a *lusoria* has to work 260-280 kg. In sum, the almost contemporary *lusoria*- and Nydam-boats are highly technical, designed to be fast. They do not reach the technical standard of the 200-year older Oberstimm boats, however.

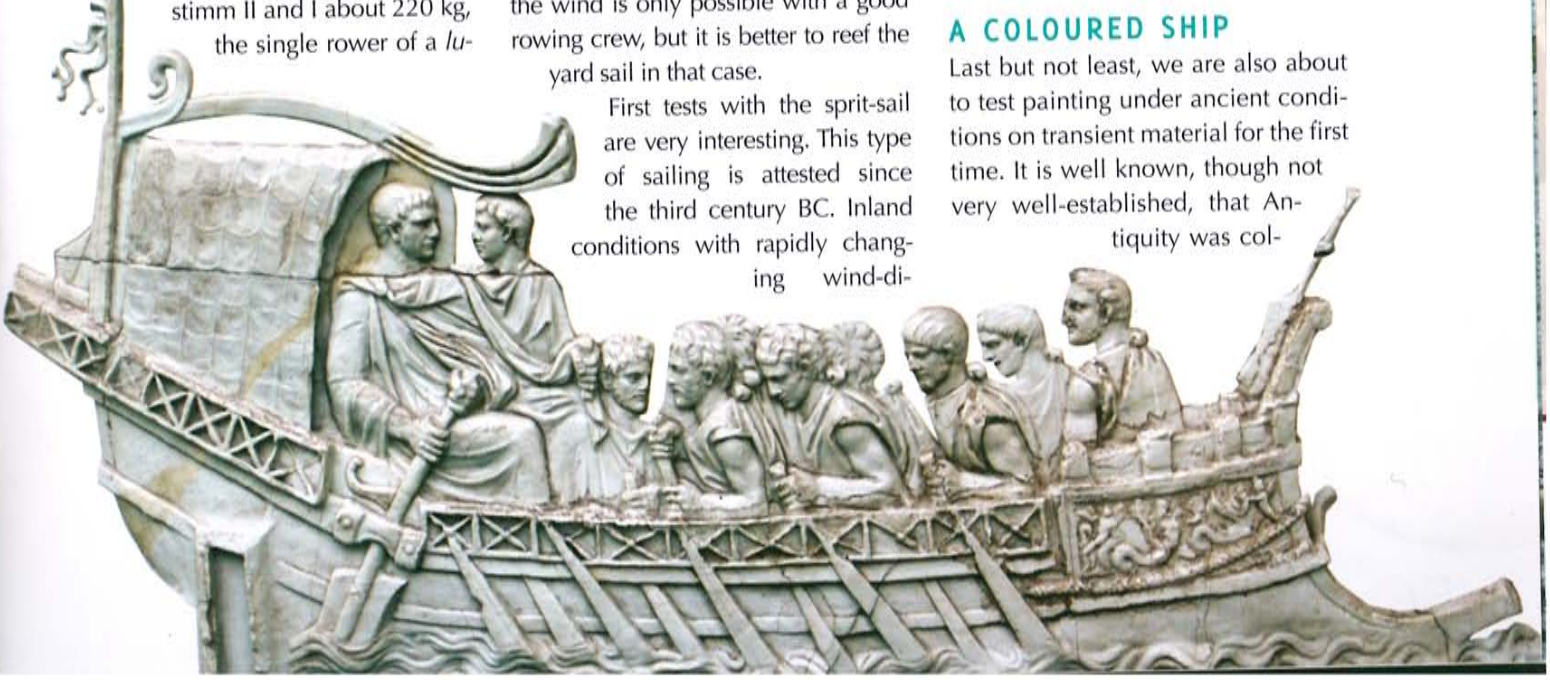
The first tests with yard sail certify – as did the tests with the 1:10 scale version – that the sideways drift is manageable with the rudder on star- and larboard (118 cm below the waterline). The boat still runs forward with almost no sideways drift in up-to-a-moderate wind (3 Bf) of 90 degrees from star- or larboard. You lose this advantage as soon as you exchange the deep rudders for the shorter version. Crossing against the wind is only possible with a good rowing crew, but it is better to reef the yard sail in that case.

First tests with the sprit-sail are very interesting. This type of sailing is attested since the third century BC. Inland conditions with rapidly changing wind-directions especially favour this kind of sail. Whereas the handling seems to be more complicated than that of the yard sail (but this may be a case of practice), and propulsion with the wind astern is reduced, the advantage is at hand: you can cross against the wind (especially with a good rowing crew) and you can even row against the wind without reefing the sail.

Additionally, we want to test our 1:10 scale models with sailing apparatus in the fluid mechanical institute of the University of Erlangen-Nürnberg first by simulating wind, which hasn't been done before, then in the wind channel.

A COLOURED SHIP

Last but not least, we are also about to test painting under ancient conditions on transient material for the first time. It is well known, though not very well-established, that Antiquity was col-



ENCAUSTING PAINT

Hot wax painting involves the application of beeswax mixed with resin and pigments to wood, canvas or some other material. Pliny the Elder states it is "in common use by way of ornament for ships of war" (*Natural History* 35.31). The mix is applied while hot and when dried was considered an effective protection from the elements: "Painting of this nature, applied to vessels, will never spoil from the action of the sun, winds, or salt water" (Idem 35.41).

oured – frankly overwhelmingly so for modern senses.

The display of colours on transient material, wood especially, and its effect is as yet almost unsubstantiated. Both ancient literature and material remains prove that ancient ship surfaces were painted either for the purpose of recognition by the crew and 'friendlies', or to impress the enemy (e.g. Philostratus, Imagines 19). Höckmann suggested that traces of painting are preserved on the Oberstimm wrecks as well, though this has not yet been proven. The final publication of the 1980s excavations has not yet appeared. Even then: the ancient paint may have faded away, with exeption of the leaded white, or could have been mis-interpreted as traces of other evidence. Traces of red paint might, for instance, have been recognized as traces of rust.

Jan Hochbruck from Cologne (www.tertiuspictor.de), a specialist in ancient painting, supported us in the first attempt to decorate a reconstructed boat with encaustic paint. Pliny's comments refer to larger warships, writing from Misenum as commander of the fleet based there, he was in an excellent position to testify. We, however, are dealing with a *scafa*, a scout-ship. According to the somewhat problematic late-Roman author Vegetius, such ships were called "painted", *picti*, in certain regions of the empire (4.37.1-5, 4.44.7, 4.46.9). The relevant passage has survived precariously, but the reconstructed text seems certain. If this is accepted, nothing has been done to test the implementation, though. Vegetius, who is not very familiar with seafaring, wrote that these ships had a camouflage coating, so that they would not be detected. Therefore, so Vegetius, 'Venetic' blue was employed for the sails, rigging and the clothing of the rowing soldiers. It is not clear whether this colour was used for the hull of the ship as well. Blue, however, was one of the most expensive colours in Antiquity, not easily available everywhere. That was certainly the case in the Danube region of Germany, with perhaps the exception of Azurite. Hence we decided use locally available colours that help disguise the ship in its natural environment, though obviously not on the same level as more modern camouflage methods would suggest.

The Ship Hall Fresco, the Porticus of the Temple of Isis in Pompeii, as well as the so-called Ulysses Mosaic from Bardo guided our paint selection. Jan Hochbruck extensively tested the mix and application of the encaustic paint, and it appears as easy as it seems at first hand: beeswax has to be warmed up, melted and mixed with resin and the natural colour in a proportion of about 1:1. We compromised on white as lead-white was not an option, and below the waterline we applied regular, pollutant-free varnish in black which looks similar to tar. The rest of the ship was painted with encaustic paint. Pliny's claims about weather resistance have appeared to be unreliable. Water does not affect it, but the paint started to melt on surfaces exposed to the sun when the environmental temperature was only 21C (approx. 70F). Probably our mix contained too much wax, but that will have to be tested further.

This particular type of paint also has implications for our tests in the water and wind-channel of the fluidmechanical Institute. The paint not only changes the weight (to a minor degree) and the protection of the wood, but also has effects on the hydrostatic behaviour (before and after polishing the wax).

LAUNCH AND FUTURE TESTS

End of March 2018 we launched the boat into water, so that the planks could draw water and the gaps, which were caulked with hemp and tar, tightened. The rigging of mast, yard and sprit were completed and the tests with oars and sails could start. After the official baptism, the ship got its maiden voyage in May. With a volunteer crew, we sailed along the Rhine-Main-Danube Canal for about 35km. Speed and other long-term tests followed over the summer which should culminate in an academic publication. AW

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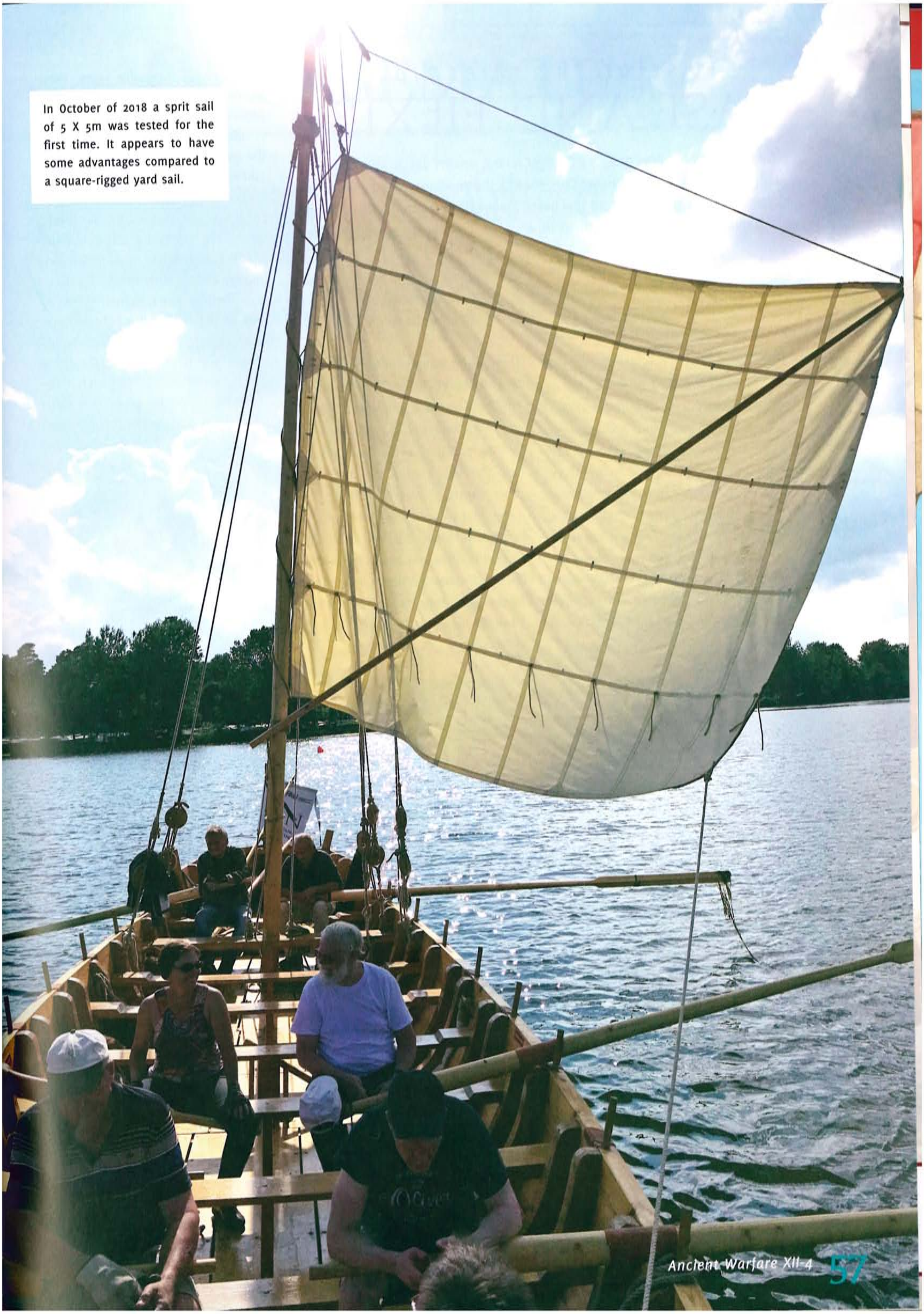
FURTHER READING

- Bockius, R., *Ruder-'Sport' im Altertum. Facetten von Wettkampf, Spiel und Spektakel* (Mainz 2013).
- Dreyer, B., 'Die Fridericiana Alexandrina Navis (F.A.N.) - Nachbau sowie wissenschaftliche Erprobung und Einordnung der Replik von Oberstimm II - Stand des Baus (Anfang Februar 2018)', in: *Skyllis* 17.1 (2018), pp. 87-96.
- Weski, T., 'The Value of Experimental Archaeology for Reconstructing Ancient Seafaring', in: L.Blue, F. Hocker, A.Englert (eds.), *Connected by the Sea. Proceedings of the 10th Symposium on Boats and Ship Archaeology Roskilde* (Oxford 2006), pp. 63 – 67.

Iron boat hook found in the cabin of the De Meern I, a Roman barge found in the Netherlands dated to the first half of the first century AD. Maritime archaeological depot of the Cultural Heritage Agency, the Netherlands.



In October of 2018 a sprit sail of 5 X 5m was tested for the first time. It appears to have some advantages compared to a square-rigged yard sail.