

Interdisciplinary Perspectives on the Sails of the Athenian Trireme

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The trireme was the most important and iconic type of warship in Classical Greece. Its superior speed, manoeuvrability and ramming power made it a formidable weapon. Modern studies of the production and function of the trireme have mainly focused on hull and oar construction and on timber, but less on the indispensable sails and rope.¹ In spite of early studies,² the gap in our understanding of ancient sails and rigging is problematic. Research on the production, function and maintenance of the sails of the trireme must build on historical, maritime, and textile studies. There are several kinds of evidence for sails and rope: archaeological, iconographical, epigraphical, and literary sources, and to these data from modern experimental archaeology must be added.

The only find of ancient sailcloth in Greece comes from Amorgos (ca 3rd century AD).³ Comparative material comes from 1st century AD Egypt, from Thebes: fragments of a torn linen sail used as mummy wrap, and Berenike: fragments of linen and cotton tabby-woven sails.⁴ Ancient iconography provides valuable information on shapes and relative size of sails, as well as on colours and rigging. Depictions, however, must be treated cautiously, due to the problem of their accuracy, as well as potential chronological developments and regional variation. The largest corpus of information on sails and rigging of the Athenian fleet is the naval inscriptions of Piraeus. They consist in annual administrative inventories (378/7–325/4 BC) listing triremes and their equipment, both present and absent. They offer significant insight into the ships' ropes and textiles, but equally on the institutional framework established by the polis for its administration and maintenance. In addition, literary sources provide data on materials and occasional insights on colours, crafts, sail terminology as well as on practical knowledge of sailing.

Nevertheless, many aspects and important information are missing but these may be complemented by modern experimental archaeology. For the trireme, the famous *Olympias* reconstruction, a full-scale replica with two sails, provides data, but research has mainly focused on the hull and oars and the *Olympias* is therefore problematic regarding sails. However, reconstructions of fully equipped Viking ships provide extensive knowledge on sails and rigging,⁵ which is valuable for theoretical and methodological reflections, despite the differences in material and chronological period.

Using the data for Viking Age sails, the cloth requirements for the sails of one trireme may be reconstructed as follows. The *Olympias* reconstruction used a main sail of 96 m² and a mast sail of 26 m². In experimental reconstructions, flax sails weigh between 500–720 g/m². A hypothetical 100 m² linen sail could thus amount to 72 kg. A hypothetical boat sail of 25 m² may have had a lower average weight of 500 g/m² amounting to 12.5 kg. In total, 84.5 kg of linen cloth. To this we must add the weight of the selvages, reinforced edges, holes for ropes etc., which would presumably all add up to a total

of ca. 100 kg of cloth. 100 kilos of linen cloth could be produced from 1,000 kg of flax stems. A tabby of 1 m² with 10 × 10 threads/cm² needs 2,000 m linen thread plus 10% for the interweaving in the fabric, thus 2,200 m or 2.2 km thread/m². For 125 m² of sailcloth, the yarn consumption equals 275 km.

If we transfer these numbers to estimates of total load time based on calculations from experimental textile archaeology,⁶ the following time is required. A spinning pace of 50 m/h would amount to 5,500 h of spinning for 275 km of thread. Experiments suggest that a sail is woven in panels of a width of ca 0.65 m; a weaver would thus weave 200 m of long panels that could be joined into a 125 m² sail and c. 5 m² additional linen cloth for edges and reinforcements. With a hypothetical weaving pace of 50 cm/day, one person would need 400 days to weave the cloth. If we convert these numbers to a model workload of 7 hours work/day, 300 days/year (a workload of 2,100 h/year), the sails of one trireme would require one person for ca 2 ½ years to spin the yarn and 1 ½ years to produce the cloth. This amounts to 4 years of textile work per trireme per person for the sails. Sails for 400 war ships would amount to ca. 1,600 years of textile work for a single person.

Notes

¹ Morrison – Coates 2000.

² Böckh 1840; Cartault 1881.

³ Alexiou et al. 2017.

⁴ Wild – Wild 2001.

⁵ Bender Jørgensen 2012; Andersen – Nørgård 2009; Andersen – Bischoff 2016.

⁶ Andersson Strand – Nosch 2015.

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