# Large merchant ships in Roman times: the Spritsail legacy, Part II

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**Abstract:** Iconographic evidence and the shipwreck archaeological record seem to indicate that merchant ships dramatically increased in size and tonnage toward the end of the 2nd century BC. The experience gained from sailing replicas, such as the *Kyrenia II*, has demonstrated that ships powered by a single mainsail lacked controlled manoeuvrability and sometimes needed to resort to auxiliary power such as oars. It is argued that the development of the spritsail-*artemon* discussed previously (Davey 2015) provided the necessary means to control ships and thereby facilitated this increase in size.

## Introduction

This paper develops the discussion begun in *Buried History* 51 (Davey 2015) where it was argued that a sail called a spritsail or *artemon* was rigged at the bow of many Roman period ships from at least the 2nd century BC to assist them with directional control when sailing to windward and going about. The paper suggested that this type of sail developed from the Classical period seafaring tradition where there is literary evidence describing how the mainsail was adjusted to assist with steering the ship. The adoption of the spritsail-*artemon* had other implications for the maritime economy, one of which may be the size of merchant sailing ships. To avoid confusion with the spritsail as a mainsail, which is known from Roman times and is used today by wooden-boat enthusiasts, the term spritsail-*artemon* is used throughout.

Estimated seaborne tonnages and timetables for merchant shipping during the Roman period indicate that commerce, especially the Alexandrian-Rome grain-trade, relied on many large ships with displacements exceeding 200 tons (Pomey 1998). Indeed it has been suggested that maritime shipping volume in the Mediterranean during the Roman period was not exceeded until the 16th or 17th century (https://www.abc.se/~pa/uwa/wrekmed1.htm accessed 3-11-2016).

***Figure 1:** The Kyrenia ship hull, Kyrenia Archaeological Museum. Photo: the author*

## The shipwreck record

Parker catalogues 1259 ancient shipwreck sites in the Mediterranean and Europe (1992). Of these only a small number has been scientifically excavated and only some of these have had substantial remains of the ship's hull (Figure 1). This is not to be unexpected when the aggressive nature many shipwreck sites is considered. Timber is unlikely to remain on the seabed in rocky environments where there are strong ocean currents and, where sand or mud was the resting place, chemical and biological agents may have attacked the wood. Shipwreck sites are therefore often primarily artefact clusters.

Understandably, estimating the tonnages of wrecked ships from artefact scatters does not appear to be common practice. Ancient salvage, modern looting, the ravages of time and the possibility of multiple wrecks at the same location all complicate the situation, aside from the fact that the ship itself may not have been fully loaded at the time of its demise. The area of the artefact scatter may be quoted but even with information about the morphology and history of the site itself estimating ship tonnages would be problematic.

Some wrecks do have remnants of the hull but these are almost never complete, making the estimation of the overall hull length less than straight forward. Maritime archaeology has long undertaken the careful analysis of hull remains to discover the ships' design, boat-building traditions, represented by construction techniques and materials and the condition of the hull at the time of its

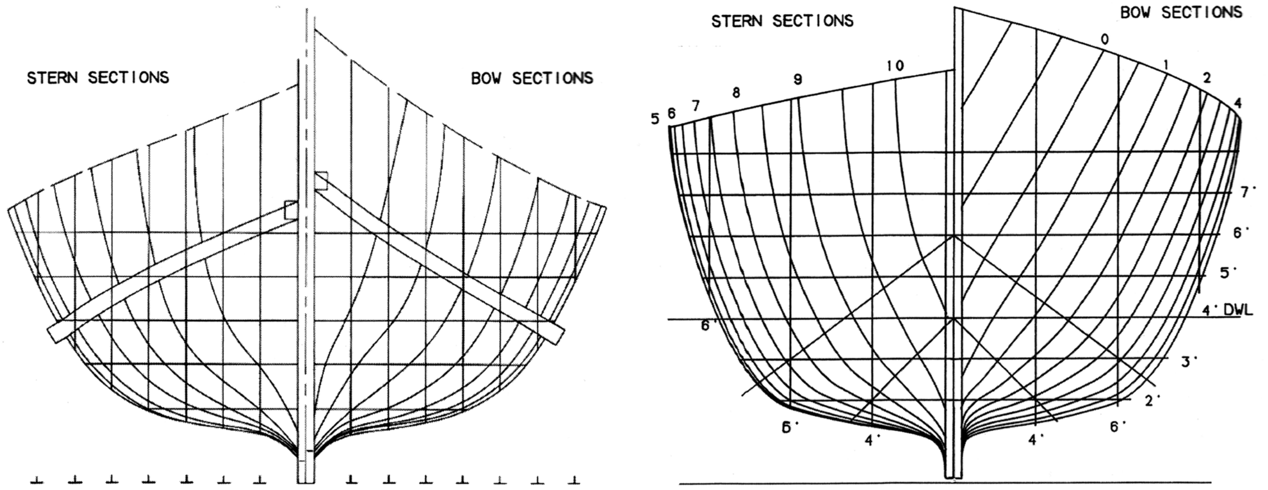


***Figure 2:*** *Two proposed reconstructed hull lines for the Ma'agan Mikhael ship, left by Rosloff – 15 tons displacement and right by Winter – 23 tons displacement (from Winters & Kahanov 2003).*

abandonment, including any repairs (Pomey *et al.* 2012; Steffy 1994). However, the next phase of working-up hull-lines and estimating displacements is yet to be undertaken comprehensively. The difficulties associated with this investigation are demonstrated by the attempts to reconstruct the lines and estimate the displacement of the Ma'agan Mikhael ship, where two different reconstructions gave tonnages of 15 and 23 (Winters & Kahanov 2003) (Figure 2). The lower figure was for a craft reconstructed with a shape not dissimilar to that of a Viking long-ship, such as the Skuldelev 3 (http://www.vikingeskibsmuseet.dk/en/visit-the-museum/exhibitions/permanent-exhibitions/skuldelev-3/ accessed 9 July 2016). Detailed discussion of the issues associated with reconstruction and tonnage estimation are included in the excavation report of the Cavalière wreck (Charlin et al. 1978: 77ff)

Parker noted that amongst Mediterranean shipwrecks that had been excavated or surveyed, ships of a size less than 75 tonnes were common from 5th century BC to the 12th century, ships of 75-200 tonnes occur during the 1st century BC to the 3rd century and larger ships were mostly in the late Republic period (1st century BC), although some marble carrying vessels dated from the late Empire period (1992: 26). He also noted that lead- and iron-stocked anchors have been found from the 3rd century BC onward (1992: 29).

Table 1 draws on the work of Pomey (2012) and Whitewright (2008) and illustrates Parker's observations. It lists nearly all merchant shipwrecks for which there is some evidence of hull length. A few issues should be borne in mind when reading the table. Shipwrecks normally bear the name of the find location. This name can be spelt differently and there can be totally different names used. The Jules Verne 7, so called because it was found in the piazza Jules Verne is, for example, sometimes called the Marseilles 4, the city where the piazza is located. As in this case, there is often more than one wreck at the location so it is important not to confuse or conflate the different wrecks. This becomes difficult when the wrecks are directly on top of one another.

Dates generally refer to the time the ship came to grief and are estimated from the finds. However, the Ma'agan Mikhael and the Kyrenia ships appear to be nearly contemporary, although they sank some ninety-years apart. It is estimated that the Kyrenia ship was about eighty-years old when it sank, while the Ma'agan Mikhael ship was quite new.

The length can refer to the water-line or overall lengths. Publications do not often make a distinction but, where they do, the overall length has been used. The estimated original length is frequently said to be very approximate (Eiseman & Ridgway 1987: 13), indeed nearly all lengths should be treated as such. Depth of water at the find location has been included as it gives an indication of the level of difficulty associated with the excavation and sometimes the method of excavation used; diving deeper than 40m is difficult and time consuming. Some wrecks such as the Lacydon and Les Sorres were discovered ashore in what may have been the environ of an ancient port. Another recent such find was reported at Antipolis (http://www.inquisitr.com/321612/proposed-parking-lot-in-french-riviera-reveals-roman-shipwreck/, accessed 8 July 2016)

The date of excavation also provides an indication of the excavation methods that may have been used and the focus of the excavation. Often the primary interest was the artefacts because shipwreck sites represent excellent time capsules and there was a need to forestall looters. Beginning with French sponsored excavations of the 1950s, interest in maritime technology has grown and more detailed attention has been devoted to hulls, anchors, chandlery, etc. Ancient hull construction varies; hulls using mortise and tenon may be an indication of a

| Name/Location | Date | Length m | Depth m | Date Excavated | Reference |
|---|---|---|---|---|---|
| Uluburun | 1316-1305 BC | 15–16 | 45-60 | 1984- 94 | (Pulak 1998) |
| Cape Gelidonya | 1200 BC | 8-9 | 27 | 1960- | (Bass 1967) |
| Point Iria | 1200 BC | 7-10 | 12-27 | 1991-4 | (Vichos 1999) |
| Mazarrón I & II | 650-600BC | 18 & 14 | | 1993-5 | (Negueruela *et al.* 1995) |
| Giglio A | 600 BC | 25 | 45-60 | 1981-6 | (Bound & Vallintine 1983) |
| Pabuç Burnu | 570 BC | 17 | 40-50 | 2002-3 | (Polzer 2010) |
| Bon Porté | 530-525 BC | 10 | 48 | 1974 | (Joncheray 1976) |
| Jules Verne 7 & 9 | 520-500 BC | 20 & 9 | - | 1993 | (Pomey 1998; 2001) |
| Grand Ribaud F | 500 BC | 20 | 60-75 | 2000-1 | (Long & Rival 2007) |
| Gela 1 | 490-480 BC | 17.4 | 5 | 1988 | (Panvini & Benini 2001) |
| Tektas Burnu | 450-425 BC | 12 | 35 | 1999-2001 | (Carlson 2003) |
| Alonissos | 425-415BC | 25 | 30 | 1991 | (Hadjidaki 1996) |
| Porticello | 400 BC | 17 | 33-37 | 1969 | (Eiseman & Ridgway) |
| Ma'agan Mikhael | 400 BC | 13.8 | 2-4 | 1985-90 | (Linder 1992; 2003) |
| Kyrenia | 306 BC | 12-15 | 33 | 1967-9 | (Steffy 1994) |
| Capistello | 300 BC. | 20 | 60-100 | 1976-8 | (Frey et al. 1978) |
| Lacydon – La Bourse | 200 BC | 23 | - | 1969-74 | (Gassend 1982) |
| Chrétienne C | 175-150 BC | 15 | | 1971-74 | (Carre 1983) |
| Les Sorres VIII | 2nd century BC | large | - | 1960s | (Izquiero 1985 & 1986) |
| Spargi | 120-100 BC | 30 | 15-16 | 1958-9 | (Pallares 1986) |
| Grand Congloué B | 100 BC | 40 | 38-44 | 1951-7 | (Benoît 1961) |
| Mahdia | 100 BC | 30 | 39 | 1908, 54-5 | (Merlin 1908) |
| Cavalière | 100 BC | 13 | 43 | 1972-5 | (Charlin et al. 1978) |
| Albenga | 100-90 BC | 30 | 40 | 1950 | (Lamboglia 1961) |
| Madrague de Giens | 75-60 BC | 40 | 20 | 1972-80 | (Tchernia et al. 1978) |
| Dramont A | 75-25 BC | 25 | 35 | 1957-60 | (Santamaria 1965) |
| Titan | 50 BC | 26 | 27-9 | 1957 | (Tailliez 1965) |
| Comacchio | 1st century BC | 21 | 3.5 silt | 1980 | (Berti 1990) |
| Grand Ribaud D | 10 BC | 18 | 19 | 1983-4 | (Hesnard et al. 1988) |
| Cap de Vol | 10 BC | 18-19 | 24 | 1978- | (Foerster 1980) |
| Port-Vendres II | 41-50 AD | large | 7 | 1972-5 | (Colls et al. 1977) |
| Diano Marina | 50 AD | 20-22 | | 1976-81 | (Gianfrotta 1990) |
| Rabiou | 50 AD | 11.3 | 30 | 2005-6 | (Joncheray & Joncheray 2005; 2006) |
| Calanque de L'Ane | 1st century AD | 20-25 | 18 | 1988- | (Ximénès & Moerman 1998) |
| Saint Gervais 3 | 150 AD | 17 | 4 | 1978 | (Liou et al. 1990; Beltrame 1996) |
| Grado | 150 AD | 13 | 15 | 1987-99 | (Beltrame & Gaddi 2005; 2007) |
| Procchio | 160-200 AD | 18 | 1-2 | 1967 | (Zecchini 1982) |
| Torre Sgarrata | 180-200 AD | 30 | 11 | 1965-7 | (Throckmorton 1969) |
| Punta Scifo A | 3rd century | 30-35 | 4-7 | 1908-9 | (Lamboglia 1974) |
| Punta Ala | 250 AD | 25 | 2 | 1980 | (Lamboglia & Pallarés 1983) |
| Giglio Porto | 300 AD | 15 | 35-40 | 1985-6 | (Rendini 1991) |
| Laurons 2 | 300 AD | 15 | 2.5 | 1978-83 | (Gassend *et al.* 1984) |
| Pointe Lequin B | 4th century | 20 | | 1970-4 | (Liou 1973; 1975) |
| Yassi Ada 2 | 4th century | 20 | 42 | 1967-74 | (Van Doornick 1976) |

***Table 1:*** *A listing of merchant shipwrecks with some estimated hull dimensions.*


***Figure 3:*** *Map of shipwrecks listed in Table 1.*

Phoenician tradition while sewn hulls may represent an Egyptian or Greek influence. Frame types vary but the universality of shell-first construction is accepted for the period under consideration. Only a few comprehensive excavation reports appear amongst the references and in a number of instances *National Geographic* remain the most useful publication.

It can be seen from Table 1 and Figure 4 that, in general, ships of up to 22m in length occur prior to the 2nd century BC but the more common length is less than 17m. From the late 2nd century BC ships of 30-40m appear in the shipwreck record. In fact about five ships of 30m length or more were wrecked at about 100BC. While this may be an accident of excavation, it may also indicate that the larger ships were being introduced more generally and were proving difficult to command. These ships displaced significant tonnages. When discussing the tonnage of the 40m long Madrague de Giens wreck Pomey and Tchernia argue that ships of up to 600 tons were not uncommon in the merchant fleet that served Rome (Pomey & Tchernia 1978).

To digress briefly, it is worth noting that a displacement of 600 tons was typical of a 6th-rated ship of the line, a frigate, in 17th-18th century navies. The largest ship in the First Fleet that came to Australia in 1788 was *HMS Sirius* of about 34m in length and 612 tons displacement (http://firstfleetfellowship.org.au/ships/eleven-ships, accessed 9 July 2016). The *Mayflower* was about 32m overall and displaced 180 tons while Captain Cook's *Endeavour* was 97 feet 8 inches (29.77m) long. Large Roman period merchant ships were clearly substantial wooden vessels by any measure.

Large boats began with the Egyptians who needed to transport obelisks, the largest of which is the 15th century BC obelisk of Thutmose III from Karnak, which is now in Rome. It is made of red granite, is 37.2 meters (122 feet) in length and weighs 455 tons. The down-river course from the quarry at Aswan reduced the need for motive power and the river context limited wave-generated stresses. Based on a relief at Deir el-Bahari, Landström suggested a reconstruction of an obelisk carrying boat that was 200 feet (61m) long, 80 feet (24.4m) wide and displaced 1,500 tons (1961: 22f).

However there are now more obelisks in Rome than Egypt and these were transported during the Roman period. Casson discussed the size of the ship used to carry the 355 ton obelisk now in front of St Peter's at the time of emperor Caligula (AD 37–41) concluding that, with associated stone work and ballast, the 'total weight aboard was 1,300 or so tons' (1971: 189). Other large ships at the time of Caligula include the two enormous Lake Nemi ships, which were 70m (230ft) long and 20m (66ft) wide, and 73m (240ft) in length and 24m (79ft) wide (Steffy 1994:70-72).

## The Literature

The shipwreck data is consistent with Casson's review of ancient literature (1971:170-3, 183-200). He argues that the capacity of Roman period merchant ships has been 'consistently and seriously underrated' (171). His main authority is the port regulations of Thasos dating from 250-200BC, which states that there were two sectors in the harbour and that no ship smaller than 3,000 talents (80 tons) could enter the first and no ship smaller than 5,000 talents (130 tons) could enter the second (*Inscriptions Graecae* XII and *Supplementum epigraphicum graecum* XVII: 417).

A large grain-carrying merchant ship called *Isis* was described by Lucian when it put into Athens in 2nd century AD. 'She was 120 cubits [55m, 180ft] in length, the ship's

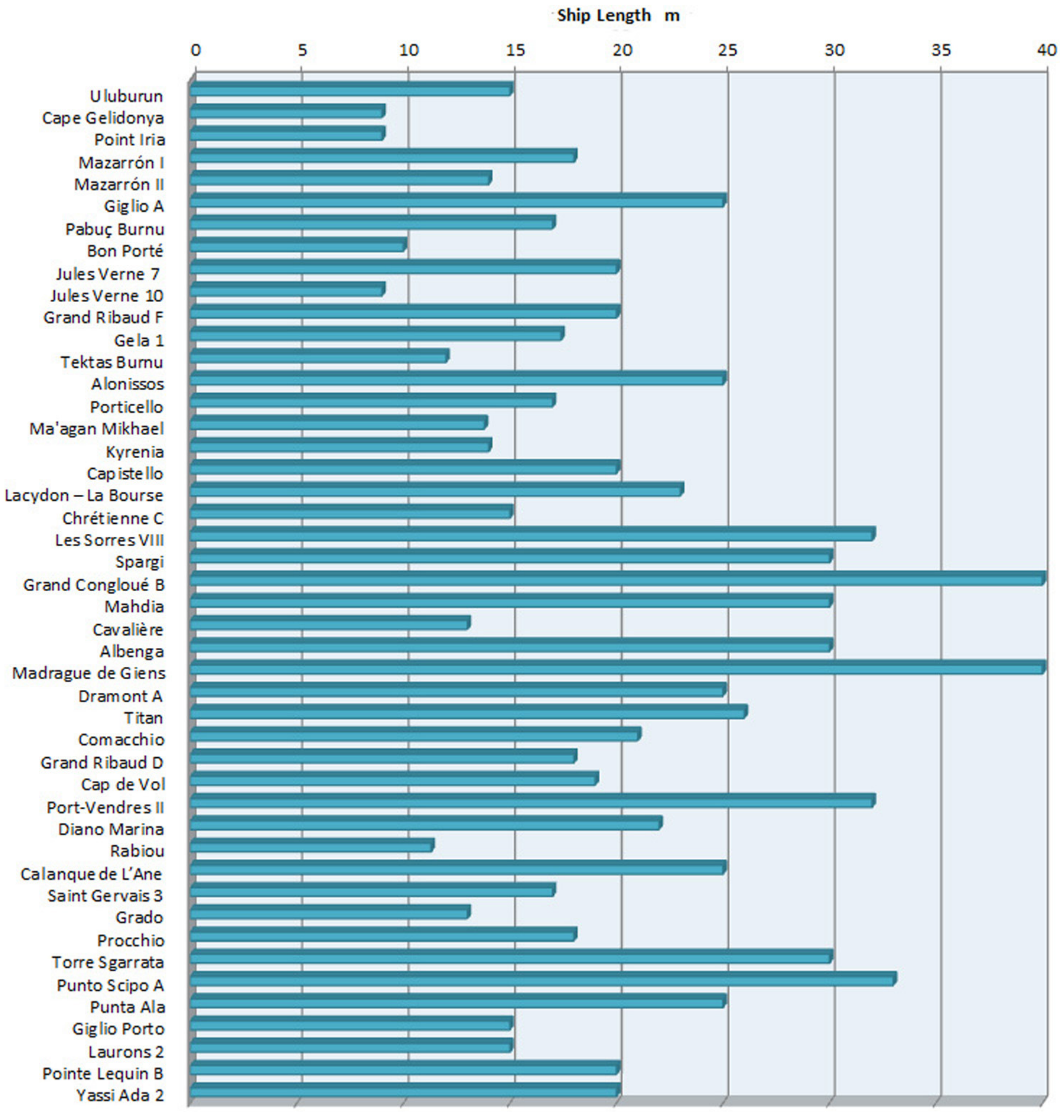


***Figure 4:*** *Bar chart of ship lengths listed in Table 1.*

carpenter said, the beam was more than a quarter of that [plus 13.75m, 45ft], and from the deck to the bottom, to the deepest point of the bilge, 29 cubits [13.25m, 43.5ft]' (Casson 1971:186). All estimates of tonnage for this vessel exceed 1,000 tons.

Casson re-translated the description of Heiro's super freighter (Athenaeus 5.206d-209d) demonstrating that large ships were known as early as the 3rd century BC (1971: 185, 191f). It had three masts and three decks and a carrying capacity estimated to be as high as 4,500 tons. Casson suggests 1,940 tons, which is still extraordinary but not impossible (1971: 186). Many scholars have dismissed the account as apocryphal but the details of construction techniques accurately reflect those known from shipwrecks of that period.

## Discussion

The iconography, literature and shipwreck data all testify to the existence of large ancient ships. It is however one thing to build a large ship and quite another to operate it successfully. Heiro's super freighter was too large to dock in many ports and so it was given to King Ptolemy and sent to Alexandria, where it may have stayed as a floating facility for entertainment or accommodation. The saga of this ship is reminiscent of Isambard Kingdom Brunel's *SS Great Eastern,* which failed its original purpose as a luxury ocean liner, was then a cable-layer and finally it became a 'tourist' attraction before being broken up 30 years after it was built. It was launched in 1858 and was by far the largest ship of the time; a larger ship would not be launched until 1898 forty years later. It was a 220m long auxiliary paddle steamer, which met with repeated 'misfortunes' and bankrupted four companies.

The *SS Great Eastern* was a mismatch of technologies and scale that could not efficiently operate in a world where the infrastructure and associated systems were insufficiently developed to support its enormous size (Emmerson 1981). Many of the applied technologies were inadequate. The paddle wheels, for example, were found to be unsuitable in the rough seas of the north Atlantic causing the ship to roll and yaw uncomfortably. Multiple screw propellers would eventually be used to propel ocean liners but this concept was in its infancy when the *SS Great Eastern* was designed. Economically sustainable technological development has to be incremental.

The increase in ship size in the Roman period would have required larger harbours, port facilities and dockyards for construction and maintenance. On board technologies also had to develop. Anchors and associated hawsers, timber heads, winching devices and mooring points needed improvement to secure large vessels with the application of manual labour. Pumping equipment would also have needed attention.

However it is the sails and rigging of such ships that needed the most attention. The use of tackle and iron fittings may have addressed some of the issues associated with the setting of large sail areas. But it was all pointless if the ship could not be controlled. Cariolou says of the *Kyrenia II* sailing trials:

> *Tacking was found to be difficult but possible. We successfully tacked twice without using oars in winds between 2-4 Beaufort. Tacking in winds above 4 Beaufort proved difficult and very dangerous for the integrity of the sail and was therefore not practised* (1997: 93).

A wind of 4 Beaufort is a moderate breeze of 10-15 knots. During its sailing trials the *Kyrenia II* broke a number of steering oars while sailing close-hauled and tacking demonstrating that significant turning forces were generated when going to windward. Ships with a single square sail and steering oars were clearly not very manoeuvrable and could be dangerous in winds exceeding a moderate breeze, especially when tacking. But the *Kyrenia II* was less than 15m long and displaced less than 30 tons and it sailed with a crew of four. Managing a 'Kyrenia-style' plus 200 ton merchant ship at sea with oars and a small crew was out of the question.

The problem of controlling a sailing vessel was discussed in Part I of this paper (Davey 2015). It pointed out that a sailing ship's direction of travel was largely determined by the set of the sails and, if the force they produced was out of balance with the dynamic force acting on the hull, the ship would be unmanageable. The forces exerted by steering oars or rudders are not significant when compared to those of the sails and hull. A ship with one sail has limited means to control the aerodynamic forces created by the sail. A second sail was the answer. The combined lateral force produced by this sail and the mainsail was more easily managed to match the hydrodynamic forces acting on the hull. If the second sail was at or ahead of the bow it could exert a significant turning moment and its size did not need to be large making it easy to trim and to facilitate the steering of the ship.

Casson believed that the origin of the foresail could be traced to the ship depicted in the 5-6th century BC Etruscan Tomba della Nave, Tarquinia, and that after a 'lack of pictures for the next half a millennium' it could be seen to have either remained 'a sail of fair size' as it was originally depicted or developed into a 'headsail... like the bowspritsail of latter ages'(1971: 240). He called both sails *artemons.* In Part I of this paper (2015: 42) it was argued that the spritsail-*artemon,* Casson's 'bowspritsail', was unrelated to the foresail because its purpose, rigging and operation were different. It was developed to assist with steering, not to provide additional power. It was rigged on an unstayed bowsprit that was secured to the hull and protruded beyond the bow so that the sail could apply a turning moment to balance the dynamic forces of the mainsail. This sail first appears in iconography and literature, where its Latin name was *artemo,* from the late 2nd century BC and there is presently no reason to suggest it had a significantly earlier origin.

The role of the spritsail-*artemon* for steering ships was described by Smith (1880: 201) and recently by Whitewright (2008: 71) but its importance has not been generally appreciated. Without it, sailing ship sizes could not exceed those which could be operated with oars. The spritsail-*artemon* facilitated the practical increase in merchant sailing ship size.

Literary and iconographic evidence seems to indicate that the spritsail-*artemon* was used from at least 100BC (Davey 2015). This coincides with shipwreck data that shows ship lengths regularly exceeding 20m from the late 2nd century BC, which in turn supports the hypothesis that large sailing merchant ships became possible with the introduction of the spritsail-*artemon* toward the end of the Roman Republic period.

However, there are some early shipwrecks with estimated lengths exceeding 20m suggesting that the picture was more complicated. Hajidaki excavated one of these, the plus 25m long 5th century BC Alonissos ship (1996). He has proposed that the Alonissos ship may have been a Κέρκουρος, which is referred to in Greek literature (Herodotus, VII 97; Arrian, Ανάβασις 'Αλεξάνδρου VI 2.4; Diodorus, XXIV 1). Casson describes this type of vessel as a merchant galley that is known to have had crews with up to 50 rowers (1971: 163ff). It was common on the Nile and the rivers of Mesopotamia, in fact Κέρκουρος derives from its Persian name. Layard's drawing of Phoenician galleys depicted in the reliefs from the Palace of Sennacherib (709-681BC) shows them to have nine oars on each side (1849). This appears to have been a common configuration.

Casson describes a variety of merchant galleys known from Greek literature, namely *akatoi, keletes, lemboi, kerkouroi, kybaiai* and *phaseloi* (1971:157-68, 1995). They were normally longer, narrower and had less free-board than sailing merchant vessels, but were wider than warships and required significant numbers of oarsmen to operate. They would have been most suited to flat water,

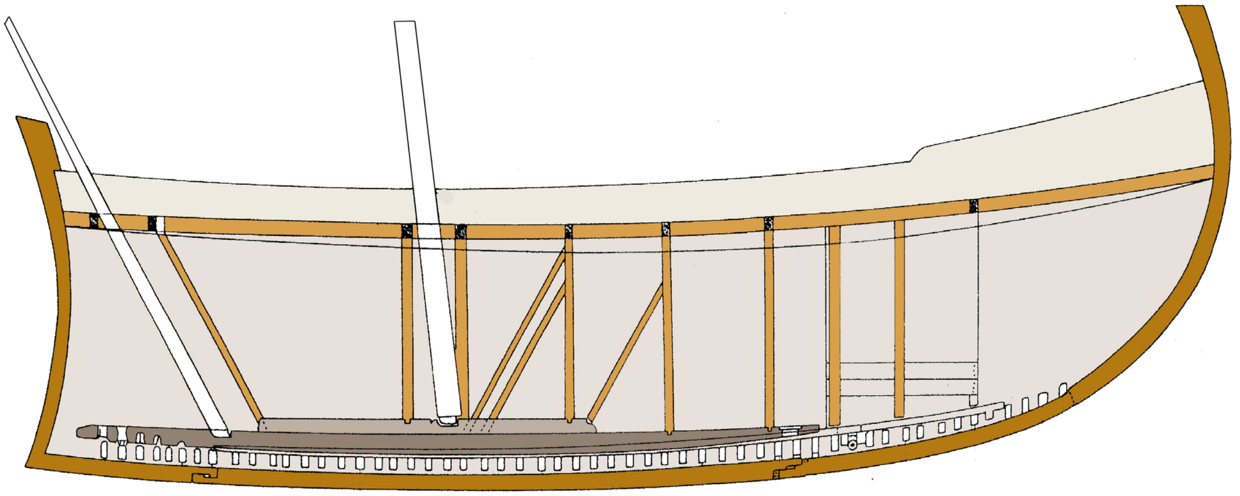

***Figure 5:*** *A reconstruction of Saint Gervais 3 wreck showing the arrangement for the main mast and the bowsprit. The bow is a cut-water design and is on the left. Developed from Beltrame (1996) and Liou & Gassend (1990).*

but were common in the Mediterranean. The shipwreck record as set out in Table 1 reveals that ships with lengths 15 – 25m did occur prior to the 2nd century BC, raising the possibility that these were merchant galleys.

Another possible merchant galley is the Marsala Punic ship 250-175BC (Parker 1992: 262ff; Frost 1981). It was estimated to be 30m long and 5m wide and the absence of cargo and a mast-step pointed to a warship, but evidence to the contrary was also significant. A ram was not found, the hull was lead sheathed and the length to width ratio of 6:1 was deemed typical of a merchant galley. A warship would be 10:1 and sailing merchant ships 3-4:1 (Casson 1995: 119).

Merchant galleys offered quick and reliable passage over short distances but were at a distinct disadvantage when undertaking long-range large-volume commodity trade such as the Alexandrian-Rome grain trade. The economics of merchant galleys and sailing ships were very different. The cost of procuring, training and maintaining a large crew made merchant galleys a high operating cost business; cargoes of such ships therefore needed to be strategically important or of high value. Merchant galleys offered certainty of passage and their predicable timetable made them the preferred means for passenger travel. They were used in the Mediterranean until the 18th century.

Prior to the introduction of the spritsail-*artemon* all sailing ships needed oars to manoeuvre from time to time. The larger the ship, the more oarsmen would have been needed. If a 25 ton vessel such as the *Kyrenia II* could be managed with four rowers, a 22m long 130 ton ship may have carried over 20 crewmen.

It would appear that the introduction of the spritsail-*artemon* to ships of 15-30m was largely a matter of economics, but the issue here is not simply that of sailing ship verses merchant galley. The spritsail-*artemon* offered more than just improved financial efficiencies, it allowed sailing merchant ships' size to exceed that of merchant galleys. Not only could hull length to width ratios be reduced to increase displacements but overall lengths could be increased. These large ships were strategic for bulk commodity trade. The need for such trade to supply Rome and the technological capability offered by the spritsail-*artemon* most probably explains the appearance of vessels exceeding 30m in length in the shipwreck record from the late 2nd century BC.

## Archaeological evidence for Spritsails

This brief review of ancient Mediterranean shipwreck data makes it appropriate to comment on the physical evidence for the spritsail-*artemon*. This sail applies a turning moment to the ship necessitating the bowsprit, to which it was attached, to be firmly secured to the hull. It was not just a matter of erecting another mast with stays because to operate effectively the spritsail-*artemon* needed an unstayed and unencumbered spar projecting ahead of the bow (Davey 2015).

Beltrame identified five wrecks where there were slots in the keelson near the bow that would secure the end of a bowsprit (1996). The shipwrecks he identified are the Saint Gervais 3 (Figure 5), Punta Ala (Livorno), Torre Santa Sabina, (Brindisi), Torre Sgarrata (Puglia) and Procchio wrecks. These ships all exceeded 17m in length and belonged to the period when the spritsail-*artemon* was common. Sprits would also have needed to be secured at the deck level, but the wrecks were not preserved to that height.

Beltrame referred to the spar as a 'foremast', however, the iconography of bowsprits shows them to have a forward rake similar to that shown in his reconstruction, Figure 5. In any case foresails rigged on stayed masts are not very common in Roman period ship images.

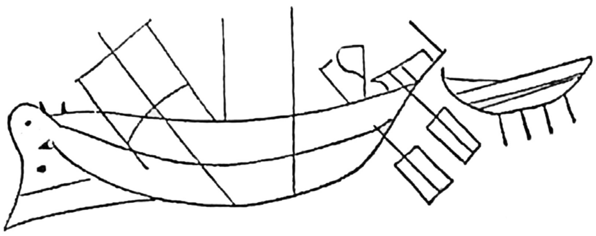

***Figure 6:*** *A graffito from the quay at Utica showing the bowsprit and spritsail. Image from Moore (1911).*

The graffito reported to be from the quay at Utica and published by Moore (1911; Basch 1987: 234) has a bowsprit sloping forward from the keel of the ship and a main mast (Figure 6). A small sail is set on the bowsprit. Moore correctly observes that the artist was probably a seaman who knew how the masts were stepped; 'a landsman would probably have made the masts end at the gunwale' (1911: 280). This evidence supports Beltrame's reconstruction (Figure 5).

Further support comes from graffito in a Roman Villa at Cucuron (Vaucluse) occupied between the first and fourth centuries (Gassend et al. 1986). It also shows the bowsprit stepped into the keel, angled forward and without stays (Figure 7). The graffito is detailed and carefully drawn probably by a seaman (Gassend et al. 1986: 30)

## Conclusion

Rome's economic power was partly the result of the significant maritime trade involving large merchant ships efficiently transporting bulk commodities. While merchant galleys were large ships, they were reliant on a large crew and were comparatively expensive to operate. It is probable that during the Classical period all sailing ships needed to carry sufficient crew members to manoeuvre the ship with oars when going to windward, avoiding hazards or entering and leaving port. When the spritsail-*artemon* was introduced, crew numbers could be reduced to those needed to operate the sails. The cost of maritime trade was also reduced and made large-scale bulk commodity trade attractive.

The spritsail-*artemon* also facilitated the growth of the sailing ship to a size that had not previously been possible and in the process offered economies of scale. These ships sometimes reached 40m in length and displaced over 600 tons, dimensions that would not again be customary until the 18th century.

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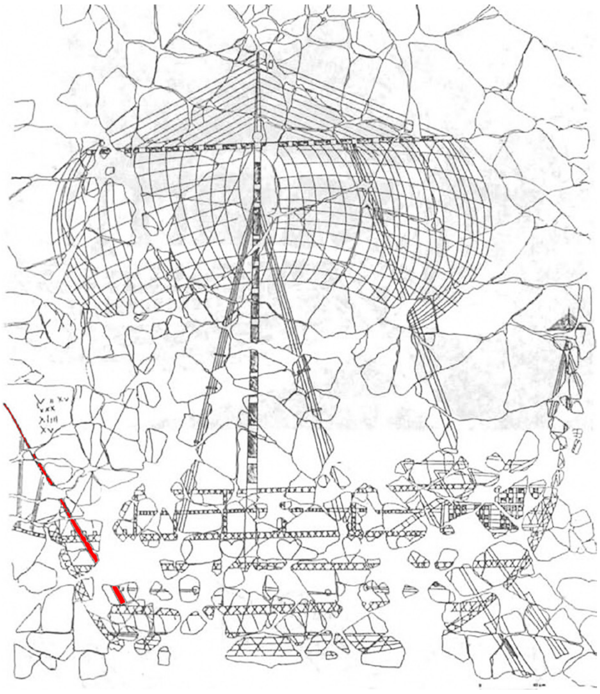

***Figure 7:*** *A graffito from a Roman villa showing a bowsprit (in red) stepped into the keel. Image after Gassend et al. (1986: Fig. 1).*

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