UNIVERSITY OF SOUTHAMPTON

FACULTY OF LAW, ARTS & SOCIAL SCIENCES

School of Humanities

Maritime Technological Change in the Ancient Mediterranean: The invention of the lateen sail

Two Volumes, Volume Two

by

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5.1 Appendix One - Maritime archaeological finds

The most complete dataset regarding the archaeological record of the ships and boats of the ancient Mediterranean is that compiled by Parker (1992). The aim of the following appendix is to provide a catalogue of the archaeological remains which are relevant to the current study. Broadly speaking, such remains mostly comprise the direct remains of rigging components from shipwrecks, including the remains of masts and mast-steps. Also included are rigging components excavated from terrestrial contexts, usually port-sites, where the rigging component probably had a maritime origin.

Sites are listed in alphabetical order with an ID number prefixed by the letter 'S'. References to sites in the main text follow this convention, so reference to *Site 001 – Agde D*, would read S001. The location of the site is given, followed by the assigned date and a description of the main characteristics. In the case of shipwrecks, details such as cargo, possible origin and wood species used for construction are included if they are published. In such cases only the basic details have been included. Following the site description is a description of the identifiable rigging components recovered during the survey or excavation of the site. As many details as possible are included, likewise drawings or plans are included where available. Regrettably, time constraints have precluded the inclusion of any rigging components recovered during the recent discovery and excavation of a large number of ship remains in Istanbul. Likewise only limited information is currently available on any rigging components originating from the site of Olbia in Sardinia. Parker's catalogue has provided the main source for this, in association with published reports, when accessible. The literature associated with a site and the reference to its entry in Parker's database (if applicable) is included at the end of each entry. Sites which have been excavated and published since 1992 obviously do not have an associated number in Parker's database.

Notes:
The abbreviation Dr. has been used in place of Dressel when relating amphora form, e.g. Dr. 2-4 when referring to Dressel 2-4.
Certain French nautical terms have been used due to the lack of a suitable English equivalent. These are indicated in italics throughout, e.g. *carlingots*.
Wood types are referred to by their Latin title for consistency, where the species has not been identified the genus is given alone. A translation from the Latin is given in Appendix Two.

Site 001: Agde D

Location: Southern France

Date: 1st Century BC

Vessel description: A relatively well-preserved wreck dating to the 1st century BC carrying a cargo of several hundred Dr. 1c amphoras. Surviving shipboard pottery included sherds of Campanian A and C black-gloss ware. The surviving parts of the hull indicate that the vessel was built with mortice and tenon construction with frames made from *Quercus* and planking from *Abies*, tenons and treenails were also made from *Quercus*. The exterior of the hull was lead sheathed.

Rigging remains: A single sheaved Roman style block measuring 198mm long by 115mm at the widest point. No thickness was recorded.

Associated Literature: (Carre 1983: 19; Joncheray 1975: 103-4; Liou 1973: 578 & fig. 10; Parker 1992: No. 11).

Site 002: Berenike

Location: Egypt, Eastern Desert

Date: c. 275 BC - early 6th century AD

Site description: Important port site situated behind the large promontory of Ras Banas at the southern end of the Egyptian Red Sea coast. The port was the sister port to Myos Hormos in facilitating trade between the Mediterranean and the Indian Ocean during antiquity. It was occupied from the Ptolemaic period and experienced a period of decline during the 2nd and 3rd centuries AD before a renaissance in the late 4th century. The site was finally abandoned during the early 6th century AD.

Rigging remains: The remains of sail fragments and brail rings have been excavated from the port of Berenike on the Egyptian Red Sea coast. The sail fragments, characterised by the remains of reinforcement strips come from two rubbish deposits dated to the 1st century AD and the late 4th/ early 5th century AD. The majority of these reinforcement strips are made from cotton, which is of Indian, rather than Mediterranean origin. The examples found suggest that the sails were reinforced with both horizontal and vertical webbing strips. A number of brail rings, manufactured from wood and horn have also been found in association with sail fragments in the deposit dating to the 1st century AD. The publication of more information on the brail rings is awaited.

Associated Literature: (Wild 2002; Wild & Wild 2001).

Site 003: Black Sea (Wreck D)

Location: Black Sea, 25km north of Sinope.

Date: 5th century AD

Vessel description: Well-preserved remains of a shipwreck lying below the anoxic layer in the Black Sea at a depth of c.320m. The vessel stands upright on the seafloor and appears to be buried in sediment roughly to the level of the deck. The mast of the vessel remains upright in-situ. The remains of the vessel indicate that it was 12-14m in length. A variety of timbers demarcate the outline of the vessel by protruding through the sediment. This has allowed the identification of what is possible the sternpost, rudder support, timberheads and a series of four stanchions located aft of the mast.

Rigging remains: Wreck D represents the best preserved example of an in-situ ancient mast, albeit in an inaccessible location. The mast stands 11m clear of the deck of the vessel and is free of any fittings. A piece of rope remains coiled around the top of the mast, which also has a cavity in its tip. The absence of any sheaves or other fittings suggests that a masthead of some sort may have been fitted to this cavity. Towards its foot, the mast is supported by a mast-partner to which it is secured with a pair of large treenails. A number of long pieces of timber lie along the deck of the vessel which may be the remains of its yard. The surveyors of the wreck have suggested that the mast is canted forwards, although they admit that there is no way of telling if this is intentional or as a result of the vessels sinking and subsequent impact in the bottom, 320m below. They suggest that the forward rake of the mast and absence of fittings on the mast may indicate that the vessel was rigged with a lateen sail.

Associated Literature: (Ballard *et al* 2001; Ward & Ballard 2004).

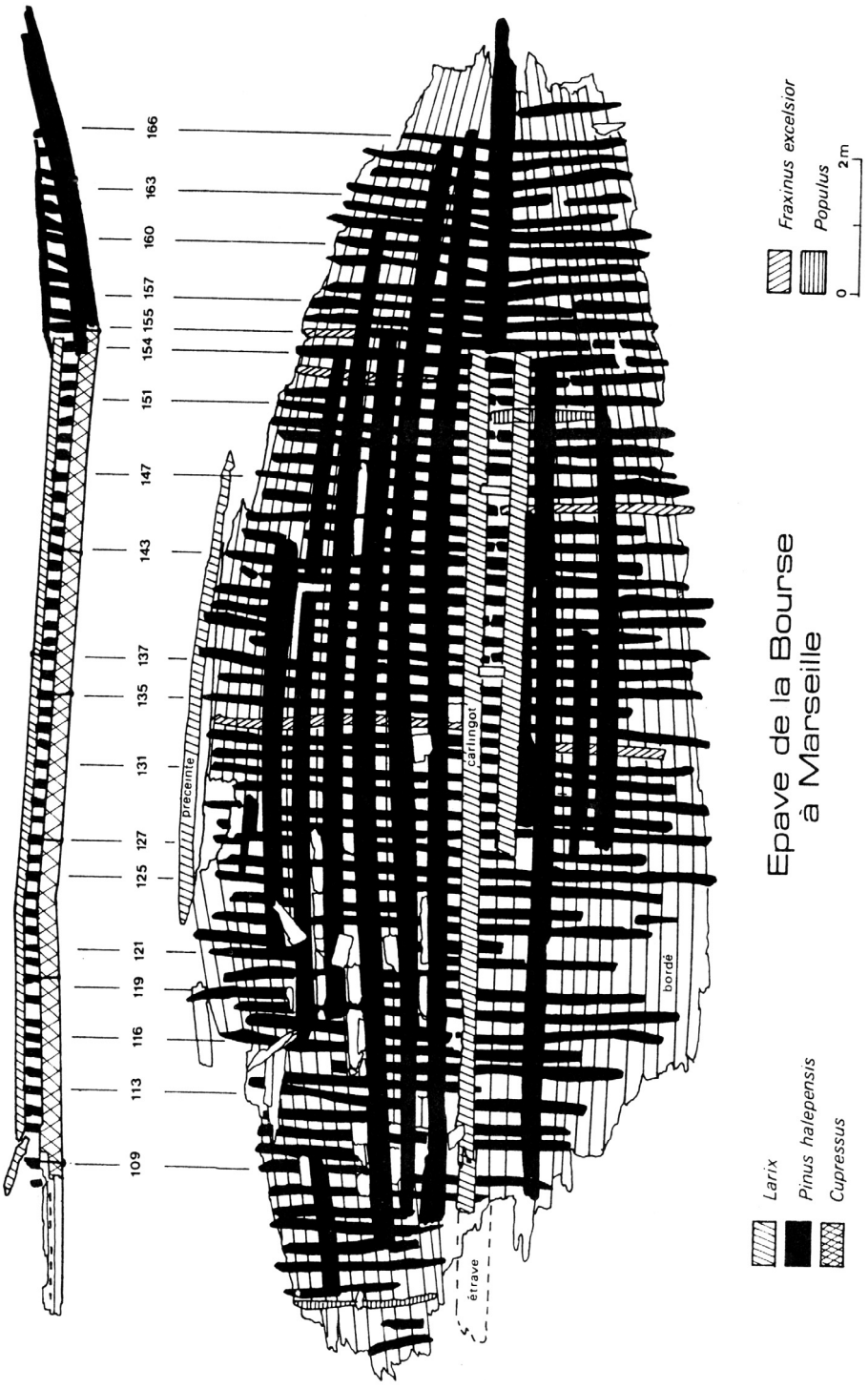
Site 004: Bourse, La

Location: Marseille, Southern France

Date: Late 2nd century AD

Vessel description: Substantial remains of a well preserved Roman ship. The vessel is estimated to have been 23m in length with a beam of 9m. The extant remains measured 20m by 7m. The tonnage of the vessel is estimated at between 115-140 tonnes, probably the latter. A pair of *carlingots* survive although the mast-step does not. The keel was made from *Cupressus sempervirens*, the keelson from *Pinus pinea* and the *carlingots* from *Larix deciduas*. The majority of the framing elements as well as the stern-post were made from *Pinus halapensis* with a small amount of *Fraxinus excelsior* and *Populus.* The garboard strakes were made from *Pinus halapensis* while the remaining strakes were made from a mixture of *Larix decidua* and *Pinus halapensis*. Treenails and tenons were made from *Cupressus sempervirens* and *Olea*. The exterior of the hull was pitched. The ship was built with an alternating procedure in which groups of planks were fastened to treenails to a successively extending framework of floors, half

floors and futtocks. The primary floors were attached to the keel by copper bolts. The jointing and angle of the stern-post suggest that the vessel had a concave bow. The vessel probably drew about 1.2m unladen and seems to have been designed for work along the coast.
Associated Literature: (Gassend 1982; Parker 1992: No. 668; Rival 1991: 245-265).



Plan and profile of the Bourse shipwreck showing the principle wood species used in the construction of the structural elements of the hull (Rival 1991: Fig. 82).

Site 005: Caesarea Maritima (Straton's Tower)

Location: Israel

Date: Mid 1st century AD

Rigging remains: Ten lead rings discovered in sand next to the shipwreck. The rings range in diameter from 55/56mm to 31/37mm. None of the rings exhibit any lugs, splits or holes, it is possible that they may have been tied directly to the sail around the body of the ring. Their cross-sectional shape ranges from circular to rectangular.

Associated Literature: (Fitzgerald 1994: 169; Parker 1992: No. 1115).

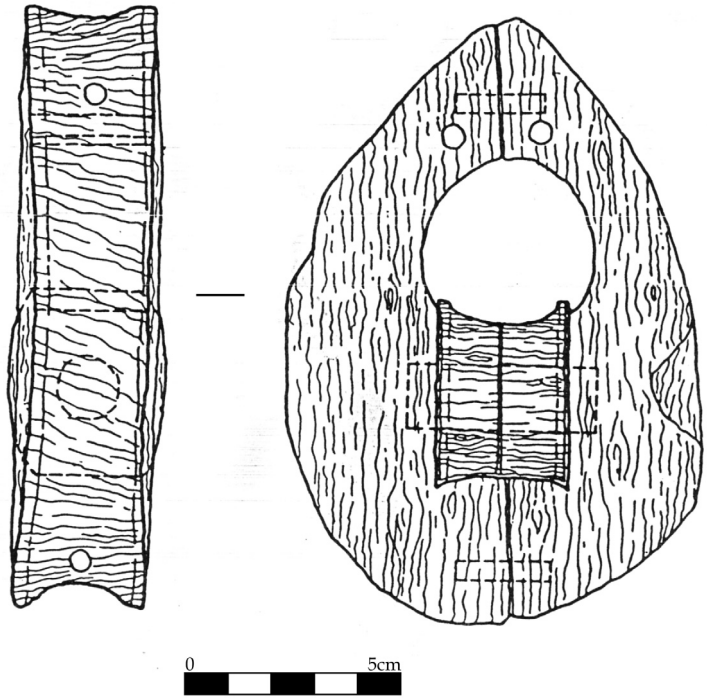
Site 006: Caesarea Maritima

Location: Israel

Date: Late 1st century BC/early 1st century AD

Rigging remains: Single sheaved Roman block 130mm x 90mm x 30mm. The sheave is recorded as having a diameter of 40mm. The seizing holes measured 6mm in diameter and the groove for the outer strop was c. 20mm across. The shell (body) of the sheave is made from *Buxus* and the sheave is made from *Quercus alliprinus*. The upper dowel used to hold the two halves of the block together was made from *Fagus silvatica*.

Associated Literature: (Oleson 1983; 1994: 104, fig 33 & pl 22; Parker 1992: No. 1115).



Mediterranean style sheave block from Caesarea Maritima (Oleson 1983: Fig. 3).

Site 007: Cap del Vol

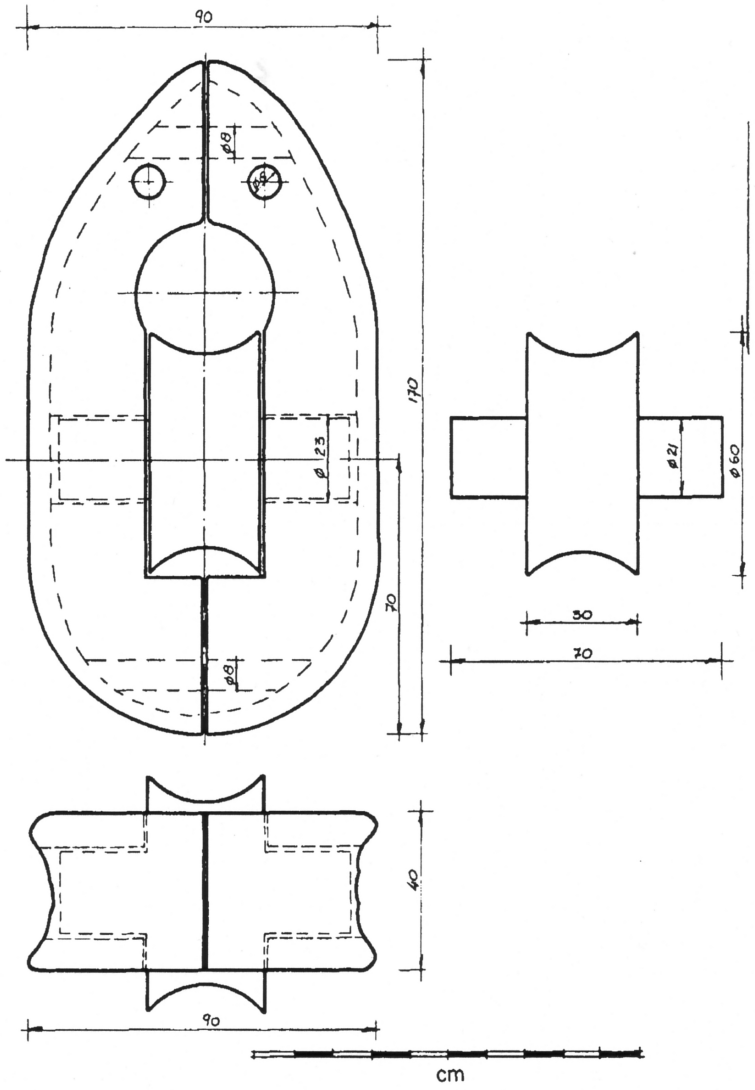
Location: Gerona, Spain

Date: c. 10 BC - AD 5

Vessel description: Remains of one end of a flat-bottomed vessel 18-19m in length, it is not clear which end but the stern is more likely. The vessel had a heavily worn keel suggesting regular beaching. The frames were fastened to the planking by nails as well as treenails. The main cargo was of Pascual 1 amphora in keeping with the local nature of the vessel.

Rigging remains: Two wooden pulley blocks of Mediterranean style were found during the excavations, one on either side of the ship. The published pulley is made from *Quercus ilex* and measures 170mm in length by 90mm wide. The sheave has a diameter of 60mm and could have carried rope up to 30mm in diameter. The exterior rope strop could not have been more than 40mm diameter.

Associated Literature: (Foerster 1980; Oleson 1983; Parker 1992: No. 186).



Mediterranean style sheave block from the Cap del Vol shipwreck (Foerster 1980: Fig. 5).

Site 008: Calanque de L'Ane

Location: Southern France

Date: Late 1st century AD

Vessel description: Shell-first, mortice and tenon built vessel of particularly robust construction carrying a cargo of tiles. The preserved remains measured 13.4m in length and 6m wide and included both *Pinus halapensis* and *Pinus sylvestre*. The original vessel is estimated to have been 20-25m in length. The mast-step and keelson were preserved and a coin of Domitian was found in the mast-step recess. The keelson rested on two longitudinal timbers (*carlingots*) and was preserved for 9m. Two lateral timbers (1.2m x 0.3m x 0.32m) provide further support for the mast-step. Both have circular mortices cut into their upper surface to receive a stanchion. The long keelson and carlingots are characteristic of Mediterranean shipwrecks of this period, the lateral mast-sisters are known only on wrecks from late-antiquity (see **Dor 2001/1** and **Tantura F**).

Rigging remains: Rigging remains were sparse and consisted of a sailmaking needle, a rigging bitt and a pulley fragment. More pulley axles were found on the starboard side of the vessel. The form of the pulleys is unclear from the published reports.

Associated Literature: (Parker 1992: No. 158; Ximénès & Moerman 1998).

Site 009: Catalans, Les

Location: Marseille, Southern France

Date: mid 4th century AD.

Vessel description: No remains of the ship structure have been found. The cargo consisted of Almagro 51a, Dr. 23 and Beltrán 72 amphora. One Almagro 51a amphora contained the remains of mackerel.

Rigging remains: A pulley block made from a single piece of wood with a disc sheave was found on the site. The block measured 350mm in length with a thickness of 75mm. The disc sheave was 110mm in diameter with a thickness of 23mm. The block was rigged via a suspension hole at one end which was 40mm in diameter.

Associated Literature: (Carre 1983: 39; Parker 1992: No. 280)

Site 010: Ciotat A

Location: Southern France

Date: c. 200-140 BC

Vessel description: Well-preserved wreck with a main cargo of Graeco-Italic amphoras (Will type E). Other finds included Campanian A black-gloss pottery.

Rigging remains: Disc sheave, 110mm in diameter by 21mm thick.

Associated Literature: (Carre 1983: Pl. xiv; Parker 1992: No. 312).

Site 011: Cavalière

Location: Southern France

Date: c. 100 BC

Vessel description: Well preserved flat-bottomed vessel with a length of about 13m and a tonnage of c. 20 tons. The vessel retained a well-preserved mast-step, which was located ⅓ of the vessels length from the bow and set into a keelson 7.5m in length. The keelson rested directly onto the frames rather than on a pair of *carlingots* as with later wrecks. The hull was built shell-first from *Pinus heldreichii* with treenails of *Abies alba* and tenons of *Quercus ilex*. The cargo was mixed and indicated that the vessel was engaged in tramping from port to port. Excavated remains indicate possible stops in North Africa, Campania, Spain and possibly Liguria.

Rigging remains: A single disc sheave with a diameter of 115mm and a thickness of 15mm and a wooden brail ring 45mm in diameter.

Associated Literature: (Charlin*, et al.* 1978: 57-60 & fig. 33; Parker 1992: No. 282).

Site 012: Chrétienne C

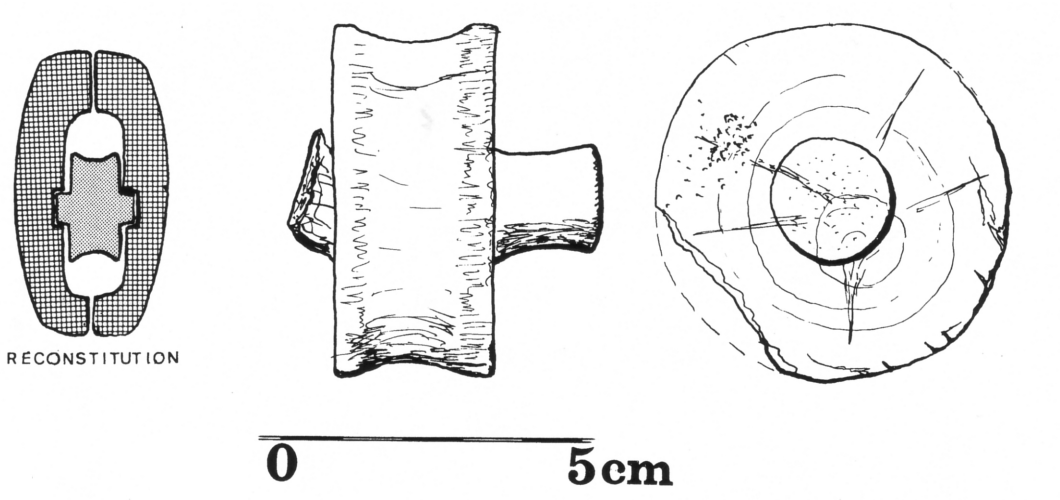
Location: Southern France

Date: c. 175-150 BC

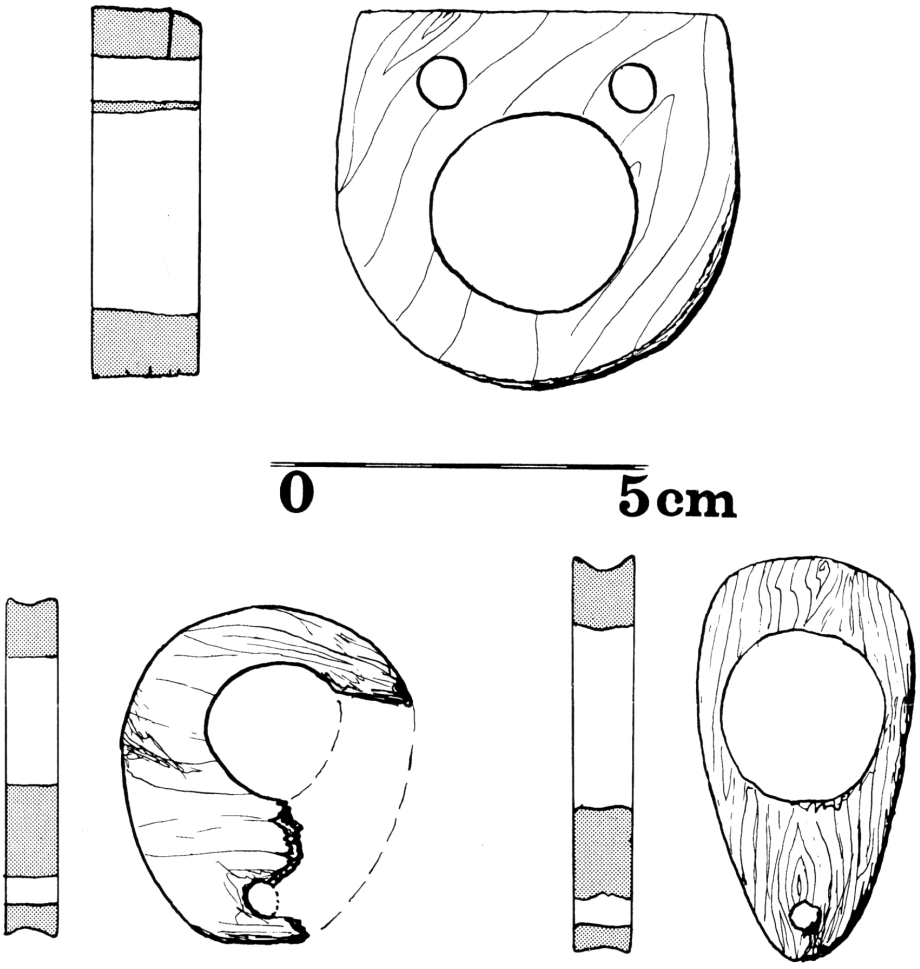
Vessel Description: Shell-first, mortice and tenon built ship, estimated to have been 15m in length and carrying 13-15 tonnes of cargo. The mast was stepped ⅓ of the length of the vessel from the bow. The cargo included Graeco-Italic amphora (Will type D) carrying Campanian wine. This, along with Italian Black-gloss pottery probably indicates that the vessel was involved in the wine trade between Italy and southern Gaul.

Rigging remains: A cylindrical sheave belonging to a Mediterranean style block was found on the wreck. The well-preserved sheave measured 58mm in diameter with a thickness of 26mm. Three heart blocks were also found. All three were flat pieces of wood, pierced with one large hole and either one or two smaller holes, presumably for seizing. Parker describes them as small deadeyes, however, their size might mean they are a distinct form of brail ring, or another type of fairlead used elsewhere on the ship. Similar items excavated from the Laurons 2 and Madrague de Giens wrecks were identified as eyelets for rope ends, while those from Kyrenia, Laurons 3 and Fournon, which are larger are interpreted as deadeyes.

Associated Literature: (Carre 1983: Pl. III,2; Joncheray 1975; Parker 1992: No. 304).



Cylindrical sheave from the Chrétienne C shipwreck (Joncheray 1975: Fig. 50.1).



Heart blocks from the Chrétienne C shipwreck (Joncheray 1975: Fig. 50.3-5).

Site 013: Comacchio

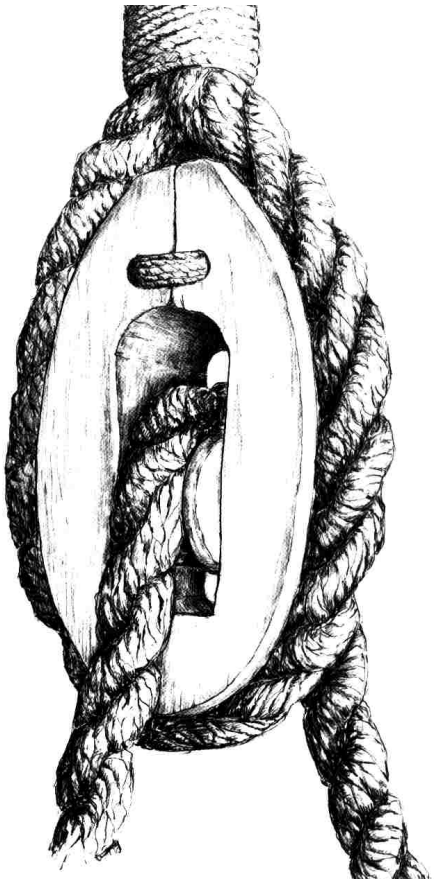
Location: Po Delta, Italy.

Date: Late 1st century BC

Vessel description: Well-preserved flat-bottomed wreck measuring 21m long by 5.6m wide, estimated to have been 25m long when complete and carrying 130 tons of cargo. The hull is significant because the construction is mixed between sewn construction in the lower half of the hull and mortice and tenon for the upper planking. The frames were also sewn to the planking. The planking was of *Ulmus* while the framing elements were made from *Quercus*. The vessel lacked a fully-developed keel and instead had a keel-plank, probably indicating use in riverine/coastal environments. The cargo consisted of 102 lead ingots, probably of Spanish origin. Also carried were four different forms of transport amphora: local Dr. 6, Dr. 2-4 from the eastern Mediterranean, Chian and one-handled Panella 36. A cargo of boxwood logs was also carried and there may also have been a consignment of coarse pottery. The ship was probably involved in the *cabotage* of this widely sourced cargo up the River Po.

Rigging Remains: Typical single sheaved Roman block, no dimensions given although a good illustrative drawing of the main features of such a block was made which is included here.

Associated Literature: (Berti; 1990; Parker 1992: No. 1206).



Artistic impression of the Mediterranean style sheave block excavated from the Comacchio shipwreck (Berti, Navis I Database).

Site 014: Diano Marina

Location: Italy

Date: Mid 1st century AD

Vessel description: Well preserved *Dolia* wreck, estimated to have been 20-22m in length. The centre of the ship contained fourteen large dolia arranged in three rows. The ship also carried at least 1000 Dr. 2-4 amphoras from Tarraconensis. Both the amphora and the dolia would have contained wine. The stamps on the dolia associate them with the Pirani of Minturnae who are known from other dolia to have dealt in Italian wine (see **Grand Ribaud D**). By the middle of the 1st century AD they were clearly dealing in Spanish wine as well, a pattern suggested from the remains of other dolia wrecks. The mast-step of the vessel also survived and was located ⅓ of the length of the ship from the bow. The remains of the hull, which was constructed using the classical mortice and tenon technique, indicate that extra beams were inserted inside the vessel in order to retain the dolia.

Associated Literature: (Gianfrotta 1990; Marlier & Sibella 2002; Pallarés 1996; Parker 1992: No. 364)

Site 015: Dor

Location: Israel

Date: Late Roman/Byzantine

Rigging remains: Various rigging elements found during excavations at the site include a deadeye from Dor F and eight brail rings from the south-east main bay. The deadeye measures 175mm x 92mm x 41mm. It is pierced with two holes both measuring 25mm each and a single vertical hole 26mm x 27mm. The outside edge of the deadeye is grooved to take a rope c. 23mm in diameter. The brail rings measure between 60-65mm in diameter and are each pierced with two holes through the body of the ring. They appear to have been deliberately broken.

Associated Literature: (Kingsley 2004b: 48; Kingsley & Raveh 1996: 55, 67-8, fig 47, pl 49 & pl 70).

Site 016: Dor 2001/1

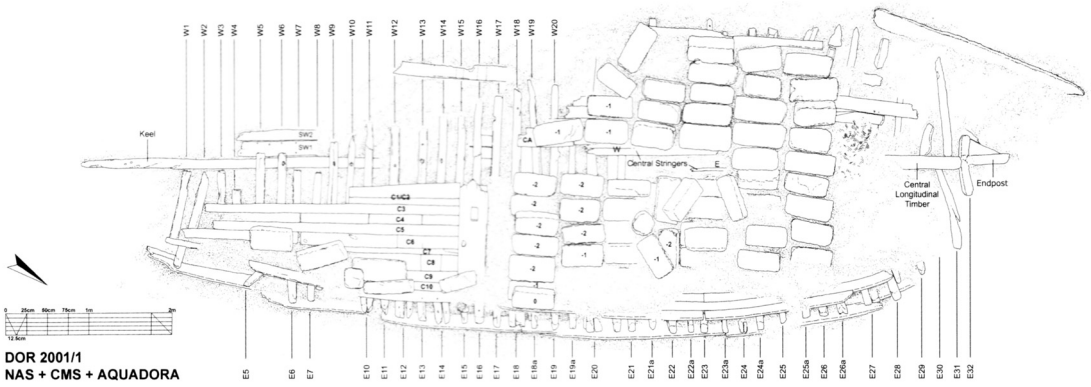
Location: Dor anchorage, Israel

Date: Late 5th/early 6th century AD

Vessel description: The wreck of a Byzantine coaster carrying a cargo of local building stone. The vessel is built entirely frame-first, along with the contemporary shipwreck of Tantura A it is the earliest frame first built vessel so far discovered in the Mediterranean. The vessel was preserved to a length of 11.5m by 4.5m in width. The original ship is estimated to have been c. 16m long by 5m wide. The hull amidships was almost completely flat-bottomed. Although the mast-step timber did not survive, one of the mast-sisters which provided the mast-step with lateral support did, a pair of *carlingots* also survived. A complete mast-step and mast-sister

arrangement was excavated on the **Tantura F** shipwreck which shared other constructional similarities with Dor 2001/1. The excavators suggest that Dor 2001/1's complete mast-step system would have been similar to the one found on **Tantura F**. This suggests the use of a relatively short mast-step timber mounted amidships on a pair of *carlingots* and given lateral support by a pair of mast-sisters.

A range of different wood species were used in the construction of the ship. The keel, mast-step sister, *carlingots* and hull planking were made from *Cupressus sempervirens*. Frames were made from *Fagus orientalis*, *Pinus brutia*, *Quercus cerris*, *Tamarix*, *Ulmus campestris* and *Ziziphus spina christi*. The surviving endpost was made from *Ulmus campestris* and the ceiling planks from *Pinus brutia*. The origin of all the wood species was western Turkey, except for the *Tamarix* and *Ziziphus spina christi* which were local to the wreck site
Associated Literature: (Barkai & Kahanov 2007; Mor & Kahanov 2006).



Overview plan of the Dor 2001/1 shipwreck (Mor & Kahanov 2006: Fig. 1).

Site 017: Dramont E

Location: Southern France

Date: Mid 5th century AD

Vessel description: Classical double-ended vessel of around 16m in length and a cargo capacity of around 40 tons. The hull of the vessel was well preserved and was constructed in the classical Mediterranean tradition with fully pegged mortice and tenon jointing. The mast step, located in the forward half of the hull also survived as did the foot of the mast. The mast-step cavity was cut into a long keelson (over 6m in length) which in turn rested upon a pair of *carlingots*. This arrangement, like the general construction of the hull is typical of Mediterranean shipping from the 1st century AD onwards. Planking was of *Pinus halapensis* and *Pinus pinea*. The keel was made from *Pinus pinea* while the stern post and *carlingots* were of *Pinus halapensis*. The keelson was made from *Larix deciduas* while the frames were made from a mixture of *Pinus halapensis*, *Pinus maritima* and *Juglans regia*. The surviving foot of the mast indicates that it

was made from *Albies*. Tenons and treenails were made from *Quercus ilex* and pegged with *Olea*.

The cargo of the vessel consisted mainly of large cylindrical amphorae (probably Keay type 35) the content of which were primarily fish oil and salted fish. In between these were stowed Keay type 25, also of a Tunisian form and several hundred plates of African Red Slip ware. The cargo indicates that the ship's voyage originated in North Africa, maybe on the Tunisian coast. The dating of the wreck suggests that trade between North Africa and Europe did not diminish as a result of the Vandal invasion of North Africa.
Associated Literature: (Parker 1992: No. 375; Santamaria 1996).

Site 018: Edfu
Location: Egypt, Nile
Date: 1st century BC
Rigging remains: Sail remains comprising part of a mummy wrapping found at Edfu on the Nile. The sail is made from linen manufactured according to Egyptian practices and so is assumed to be relatively local in origin. The sailcloth is reinforced with horizontal and vertical webbing strips. At one point of intersection a wooden brail ring was attached.
Associated Literature: (Black 1996; Rougé 1987; Wild & Wild 2001).

Site 019: Fournon
Location: Southern France
Date: Roman
Rigging remains: An oval heart block measuring 210mm x 75mm x 42mm with a large central hole 45mm x 25mm. Two smaller holes for seizing are located at one end which measure 5mm in diameter. A toggle was also excavated which measured 150mm in length with a maximum diameter of 45mm.
Associated Literature: (Carre 1983: 132 & Pl. xlvii2)

Site 020: Grado
Location: Italy, Northern Adriatic
Date: Mid 2nd century AD
Vessel description: The preserved remains of the vessel measured 13.1m in length by 6.1m wide. The vessel was built shell-first using mortice and tenon joinery. The mast-step and keelson survive and are located centrally in the vessel, the keelson is 7.5m long and rests on a pair of *carlingots* in keeping with other Mediterranean shipwrecks. The keel was made of *Ulmus* and the planking was of *Pinus*, apart from four planks made from *Larix*. The stem and stern posts and *carlingots* were also made from *Pinus* and the keelson was made from *Abies*. All

of the frames were made from either *Pinus pinea* or *Pinus halapensis*, apart from one (possible replaced) which was made from *Fagus*. Tenons were made from *Quercus ilex* and *Olea*, which was also used for the treenails. The cargo consisted of four types of amphora; Afr.1, Afr. 2a, Kapitan 1 and Tripolitanian, as well as a large quantity of glass. The vessel seems to have been built along the north Adriatic coast where it seems to have been engaged in short-haul trade and been repaired several times during its working life.

Rigging remains (deadeyes): Five deadeyes were excavated which, despite coming from a single period site exhibited a large degree of variation in size and form. The largest deadeye (no number) measured 147x92x26mm and was pierced with 3 shroud holes c. 25mm in diameter and two seizing holes to secure the rope strop. The shroud holes were arranged in a triangular formation with two holes set above/below the single hole. Another example (2156) measured 145x105x35mm and was pierced with two shroud holes (c. 25mm) and two seizing holes. The final type of deadeye found at Grado measured 116x78x20mm and was pierced with two shroud holes (c. 25mm) and a single seizing hole.

Rigging remains (Blocks): Four blocks were also excavated from the wreck which exhibit a range of different forms. A single sheave, Roman style block (2142) was excavated which measured 110x75x26mm. As well as this, multiple sheave blocks were excavated which have more in common with blocks in use on modern traditional wooden vessels. Their main characteristic is a flat, disc shaped sheave rather than the cylindrical form seen in a Roman style block. A double and triple sheave block were also excavated. No dimensions were given in the report. Also excavated was a six sheaved block in which three of the sheaves were set at right angles to the other three.

Rigging remains (general): As well as the more recognisable rigging elements described above, the site at Grado also contained other less common items. These included a number of toggles, mobile rigging ‘bitts’ and a belaying pin. The toggles ranged in size from 217mm long by 38mm diameter to 90mm long with a diameter of 30mm. They are interpreted as being used to join two ropes together by passing one rope around the centre of the toggle, which was then passed through an eyelet on the second rope. They could also be used to attach ropes to the corners of sails in the same manner. Three wooden bitts were also excavated from the site. Such items were generally attached permanently to the side of the vessel in order for ropes, both rigging and mooring, to be made off. In the case of the Grado wreck a mobile bitt was also found. The bitts from Grado range in size from 1190x100x85mm and 1035x95mm for the two stationary bitts and 750mm for the mobile bitt. The end of one of the stationary bitts had been sculpted into the shape of a woman. The belaying pin was found under the starboard side of the prow and measured 187mm in length.

Associated Literature: (Beltrame & Gaddi 2005; Beltrame & Gaddi 2007).

Site 021: Grand Congloué A & B

Location: Southern France

Date: 210-70 BC

Rigging remains: Excavation of the two wrecks of different dates on this site led to the recovery of around 100 brail rings of various sizes. Of these 80 were of a similar diameter (c. 80mm) and had no lugs or piercing for attachment. Another group of rings which ranged from 90-120mm in diameter were all provided with a lug through which either one or two holes were pierced. One ring is unusually large, with a diameter of 240mm, it seems likely that this ring may have served another purpose. Taken as a whole the brail rings are present in three different forms; flattened on two faces, flat on one face and rounded on another and rounded on both faces. Some of the rings have been pulled in line with the lug and are stretched in this direction. This maybe as a result of tension on the brailing line stretching the ring.

Associated Literature: (Benoit 1961: 178-9, fig 94 & pl 30; Parker 1992: No. 472 & 473).

Site 022: Grand Ribaud D

Location: Southern France

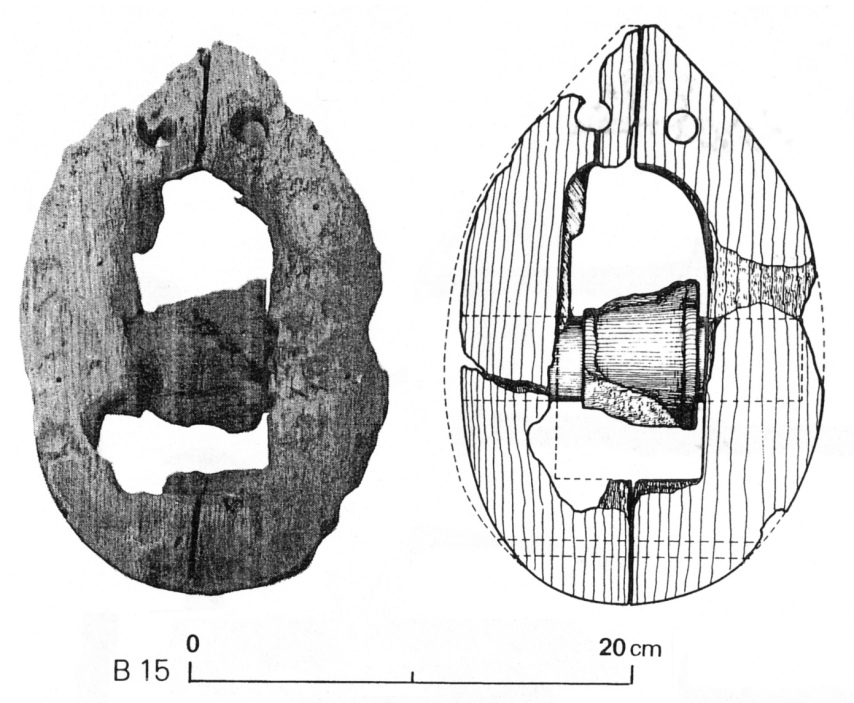
Date: 10-1 BC

Vessel description: The remains of a *Dolia* wreck, c. 18m in length and a capacity of 45-50 tons carried eleven large dolia. The stamps on the dolia indicate a link with Minturnae in southern Italy. There were also c. 200 Dr. 2-4 amphora originating in the Naples area. A further consignment of 26 Dr. 2-4 amphora originated in the Adriatic regions of Italy. The final voyage of the vessel seems to have been from the Bay of Naples area, possible with a previous stop in the Adriatic. Analysis of the shipboard pottery which was recovered indicated that the vessel had a crew of six, identifiable from their graffiti on Arretine plates and cups. This included *Pap(us)*, *Ma[…]* and/or *Mar(ius)* and *Sex.R[…]*, a further crewmember simply marked their cup with a square symbol.

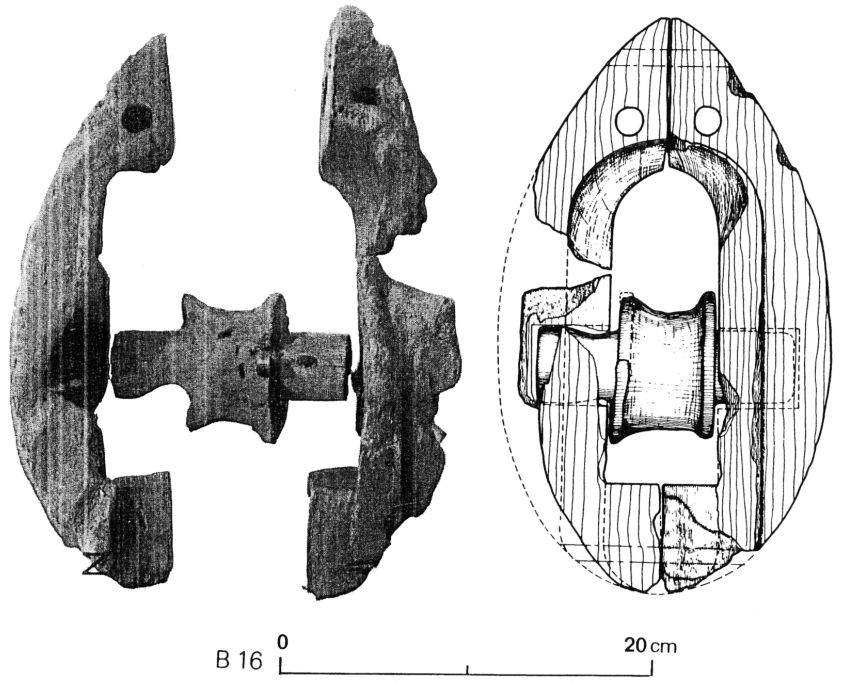
Rigging remains: Two Roman style single-sheave blocks were excavated, both were made using distinctive cylindrical sheaves with a two part body. B.15 measured 26.5 x 17.1 x 6.7cm, the diameter of the sheave was 6cm and was designed to carry rope 40mm in diameter. B.16 measured 31.3 x 18 x 9.3cm, the sheave diameter was 8cm and it could have accommodated rope 4cm in diameter. The shells of both blocks were strengthened by small mortices and tenons being used to join them together. Another, very different single-sheave block was also excavated from the wreck. This block (B.17) had a flat disc-sheave and is relatively large, measuring 44.9 x 18.8 x 13.8 cm, the sheave itself had a diameter of 17cm and a width of 4.5cm. All three blocks were found close together in the same area of the wreck. The remains of two wooden brail rings were also excavated; B.19 had an external diameter of 6cm and an

internal diameter of 3.3 it was 1.1cm wide. B.20 measured 7 x 3.4 x 1.3 cm for the same measurements respectively.

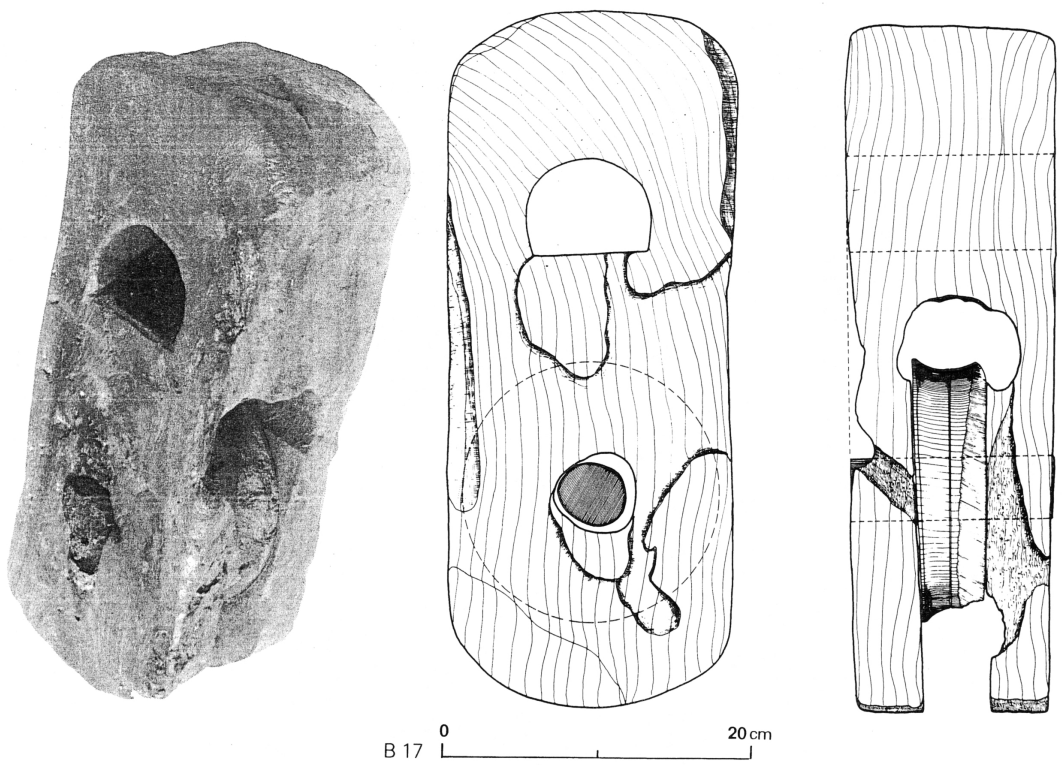
Associated Literature: (Hesnard*, et al.* 1988: 105-126; Parker 1992: No. 477).



Sheave block B15 from the Grand Ribaud D shipwreck (Hesnard, *et al* 1988: Fig.XLIV).



Sheave block B16 from the Grand Ribaud D shipwreck (Hesnard, *et al* 1988: Fig.XLIV).



Disc sheave block B17 from the Grand Ribaud D shipwreck (Hesnard, *et al* 1988: Fig.XLIV).

Site 023: Grau du Roi

Location: Port-Carmagues, Southern France

Date: Roman

Rigging remains: Deadeyes pierced with three main holes and two seizing holes, 130mm and 140mm in length.

Associated Literature: (Granier 1965: 291 & fig 51)

Site 024: Kyrenia

Location: Northern Cyprus

Date: 310-300 BC

Vessel description: Well documented wreck of a small merchant ship, 13.6m long x 4.4m wide. The vessels mast-step was preserved which was located ⅓ of the length of the vessel from the bow. There was some evidence that the mast may previously have been stepped further forward. The mast-step was made from a single short piece of wood 1.15m in length which was rabbeted underneath to fit over the floor timbers. The hull was constructed shell-first using edge joined planking secured with mortice and tenon joints. The majority of the planking was of *Pinus halapensis* with tenons of *Quercus cerris*. Although the hull was sheathed in lead when the vessel was excavated, analysis indicates that this was added during repairs to the hull at some point in the life of the ship, rather then being part of the original building process. The vessel was reconstructed with a concave bow based on the remaining evidence. The cargo of the vessel

was mixed and included 400 amphoras, the majority from Rhodes, as well as c. 10,000 almonds which seem to have been carried in sacks. Analysis of the shipboard pottery indicates that the ship had a crew of four.

Rigging remains: Excavation of the vessel uncovered a rigging block and 171 brail rings. The brail rings recovered during the excavation comprise two distinct types. 131 of the rings measure 59-67mm and have two holes for attachment punched through the body of the ring. The second group of 40 rings measure 65-72mm and have a rectangular lug on one side where two holes are located. The rigging block was a typical Mediterranean style, single sheave block, made from *Fagus* or *Morus nigra*. It measured 260mm x 105mm x 60mm, the sheave had a diameter of 75mm and a thickness of 40mm. Several heart blocks were also found which were interpreted as deadeyes and used as such in the reconstruction of the Kyrenia II and Kyrenia Liberty replicas.

Associated Literature: (L. Swiny – pers.comm.) (Katzev & Katzev 1989; Parker 1992: No. 563; Steffy 1985; 1994: 42-59; Swiny & Katzev 1973).

Heart blocks serving as deadeyes in the Kyrenia Liberty replica, (J.Whitewright).

Site 025: Laurons 1

Location: L'Anse des Laurons, Southern France.

Date: 3rd-4th centuries AD.

Vessel description: Abandoned vessel with no cargo whose remains extended for 13.1m in length by 4m in width. The ship was constructed with a keel of *Quercus*, planking of *Pinus* and treenails and tenons of *Quercus ilex*. The stern of the vessel is indicated by the presence of a cavity for the ships pump. The mast-step did not survive but a pair of *carlingots* did, the longest of which survived to a length of 7m. Their presence suggests that the mast-step consisted of a long keelson.

Associated Literature: (Parker 1992: No. 577; Ximénès & Moerman 1987: 171-174).

Site 026: Laurons 2

Location: L'Anse des Laurons, Southern France.

Date: c. AD 175-200

Vessel description: The wreck of a very well-preserved and fully excavated merchant ship. The ship has been reconstructed as being 15m in length with a beam of 5m and a hold depth of 1.3m. The vessel was double-ended with nearly symmetrical stem and stern posts. The keel and part of both posts survived intact. The mast-step of the vessel survived in-situ and was located 1/3 of the ships length from the bow. The keelson survived to a length of 5.2m but measured 7.75m originally. It was situated upon two *carlingots* which measured 7.9m in length. Most of the cargo, as well as the pump seems to have been salvaged in antiquity.

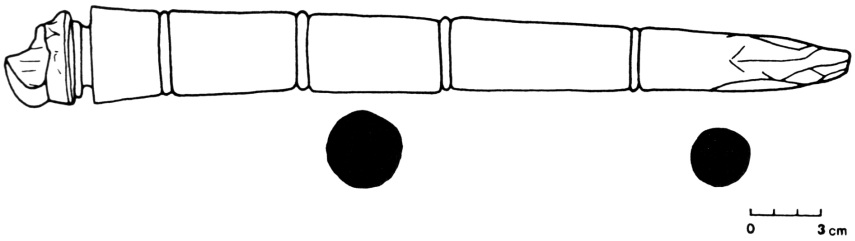
Rigging remains (Blocks): Three single sheave blocks with disc sheaves were excavated from the vessel. All were made from a single piece of wood and were almost rectangular in form with a suspension hole in one end, rather than a rope strop around the outside of the pulley. The smallest block was 195mm x 65mm with a sheave 55mm in diameter and 17mm thick. The suspension hole measured 20mm. A second block measured 243mm x 64mm with a sheave 64mm in diameter and 20mm thick. The third block measured 235mm x 85mm x 45mm with a sheave 80mm in diameter and 20mm thick. The suspension hole measured 32mm is diameter. One of the blocks was made from *Juglans*, with a *Buxus* axle for the sheave.

Rigging remains (Deadeyes): Fourteen deadeyes were recovered during the excavation of the Laurons 2 wreck, including 12 complete ones. Several of these were grouped on the port-side of the vessel, outside the hull, just aft of the mast-step. This seems likely to have been the position they were in when the vessel sank and is consistent with the use of deadeyes in the shrouds of the vessel, providing lateral support to the mast. Eight of the deadeyes are pierced with two holes and six of them have three holes. All of the deadeyes are of a comparable size; 115mm x 90mm x 30mm. Four deadeyes were analysed for their wood species, three were made of *Juglans* and one of *Fagus*. A heart block was also recovered from the wreck. The excavators

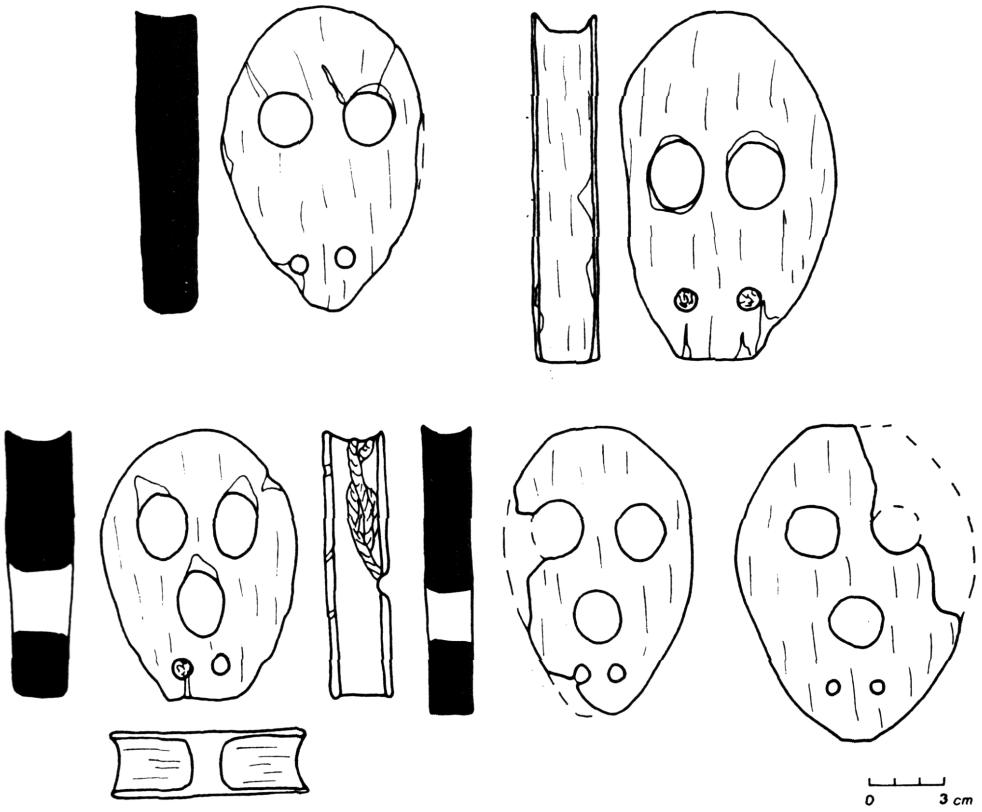
concluded that it served as an eyelet rather than a deadeye. This seems logical given the presence of so many recognisable deadeyes in the remains of the wreck.

Rigging remains (General): The remains of seven toggles were excavated from the anchorage at Laurons, one of which is described as specifically coming from Laurons 2 and which was made from *Rhamnus cathartica*. As well as toggles a variety of rigging bitts were also recovered. One of these measured 195mm in length with an average diameter of 17mm. A second bitt was 232mm in length with a diameter of 35mm. The larger of the bitts is from Laurons 2 and was found under the port side of the hull towards the stern, this has been interpreted as a mooring bitt.

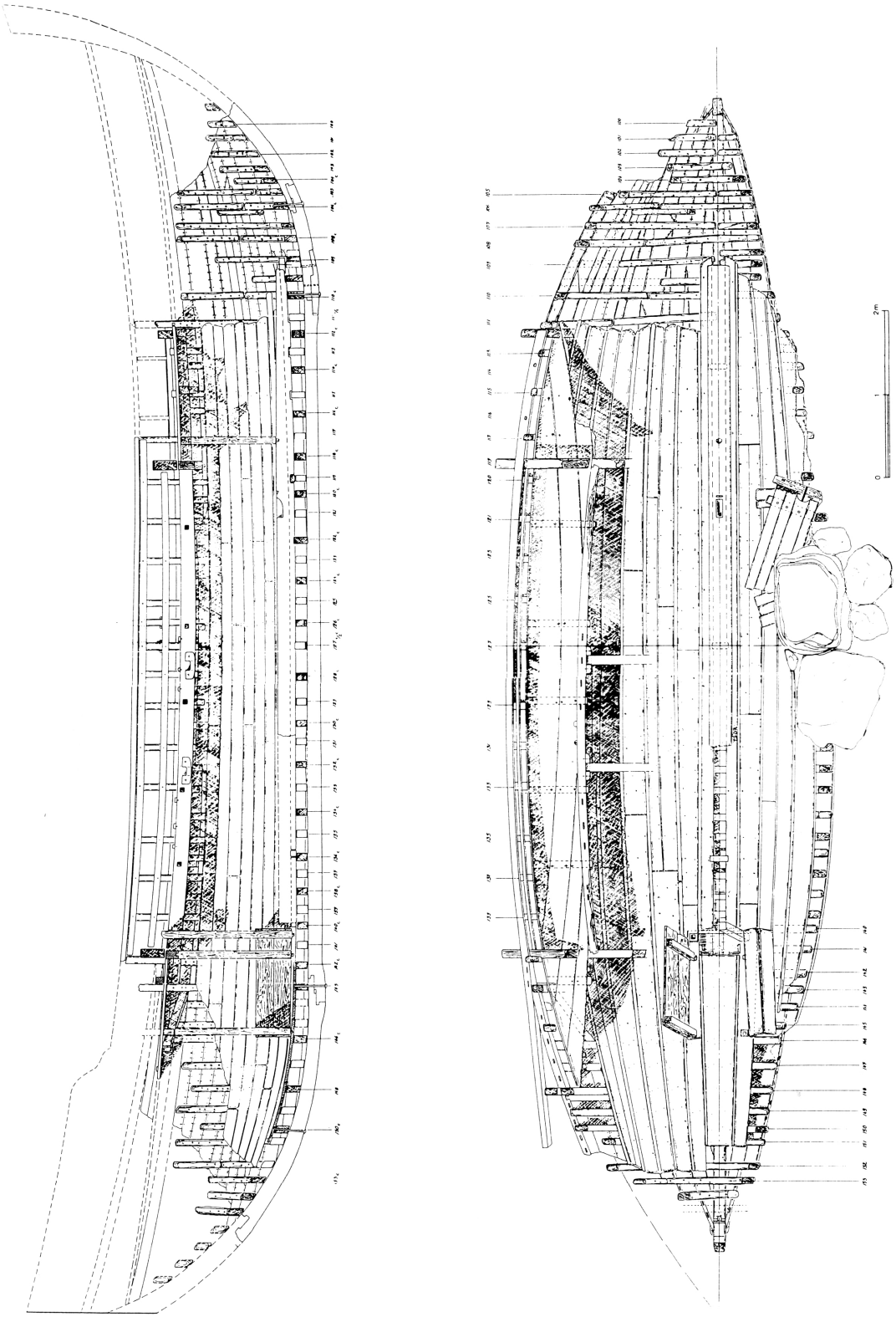
Associated Literature: (Carre 1983: 35-37; Gassend*, et al.* 1984; Parker 1992: No. 578; Ximénès & Moerman 1990).



Bitt from the Laurons 2 shipwreck (Ximénès & Moerman 1990: Fig. 6).



Deadeyes excavated from the Laurons 2 shipwreck (Ximénès & Moerman 1990: Fig. 2).



Plan and side elevation of the Laurons 2 shipwreck illustrating the relatively high level of preservation of hull remains found at the site (Gassend *et al* 1984: Fig. 19 & 21).

Site 027: Laurons 3

Location: L'Anse des Laurons, Southern France.

Date: 3rd century AD

Vessel description: Partially excavated wreck preserved to 9.67m in length by 4.5m in width and ballasted with stone blocks which remained in-situ. The keelson was made from pine and survived to a length of 4.5m. The mast-step, cut into the upper face of the keelson seems to have been located amidships, although the published illustrations are a little ambiguous. The keelson was mounted on a pair of *carlingots* which were made from cypress and which protruded for 1.2m aft of the keelson where an oval pump cavity was cut into them. The planking was made from pine.

Rigging remains: A single heart block was recovered which has been interpreted as a deadeye, rather than an eyelet, due to its size.

Associated Literature: (Parker 1992: No. 579; Ximénès & Moerman 1987: 174-178; 1990: 9).

Site 028: Laurons 4

Location: L'Anse des Laurons, Southern France.

Date: AD 310-340

Vessel description: The preserved remains of the wreck measure 9.3m in length by 2.55m in width. The wreck was mostly destroyed by fire, but was dated via coins found on board. The keel and keelson were made from *Pinus*, the latter was preserved for four metres and had a mast-step cut into one end and another smaller cavity, probably for a stanchion, 2.55m aft of this. The mast-step was probably located in the forward half of the vessel. The keelson rested upon a pair of *carlingots*, made from *Ulmus* and were conserved for 3.8m. The planking was also from *Pinus* and the framing was made from *Ulmus*.

Associated Literature: (Ximénès & Moerman 1987: 178-179).

Site 029: Madrague de Giens

Location: Southern France

Date: 70-50 BC

Vessel Description: Remains of the largest ancient Mediterranean shipwreck so far excavated. The original vessel measured 40m in length, 9m in width and had a hold 4.5m deep and could carry about 400 tons of cargo. The vessel was built shell-first with a double layer of mortice and tenon edge-joined planks. Unlike vessels such as Dramont E and Laurons 2, the Madrague de Giens ship had an asymmetrical hull with a concave stem and a distinctive angular joint between keel and end-post. Iconographic examples of this hull shape can be seen in V10, V12 and V23 in Appendix Three. The external layer of planking was made from *Abies* and the inner layer from *Ulmus* and *Pinus nigra*. The majority of the tenons used for fastening were made from evergreen oak. The keel and stem-post were made of elm, the stern-post of oak and the

keelson of *Quercus ilex*. Frames were made from *Ulmus*, *Juglans*, *Quercus ilex* and *Fraxinus*. The majority of the cargo consisted of 6-7,000 amphoras, mostly Dr. 1b from Canneto and San Anastasia in Southern Latium, which contained wine. A fourth series of amphora was loaded on top of the main cargo. The rest of the cargo consisted of several hundred pieces of black-gloss pottery as well as hundred of coarseware plates, lids, jars and pitchers. This additional cargo was all packed in boxes and stowed on top of the main amphora cargo.

Rigging remains (Brail rings): Lead and wooden brail rings were excavated from the Madrague de Giens shipwreck. The lead rings fall into two main groups. 17 are between 60-70mm in diameter and are 6-9mm in thickness. A further 16 are 80-85mm in diameter and are 8-10mm in thickness. A single ring is 90mm in diameter and 12mm thick, another single ring is 100mm in diameter. The two excavated wooden rings were 50mm in diameter, 15mm thick and had two attachment holes which were 5mm in diameter.

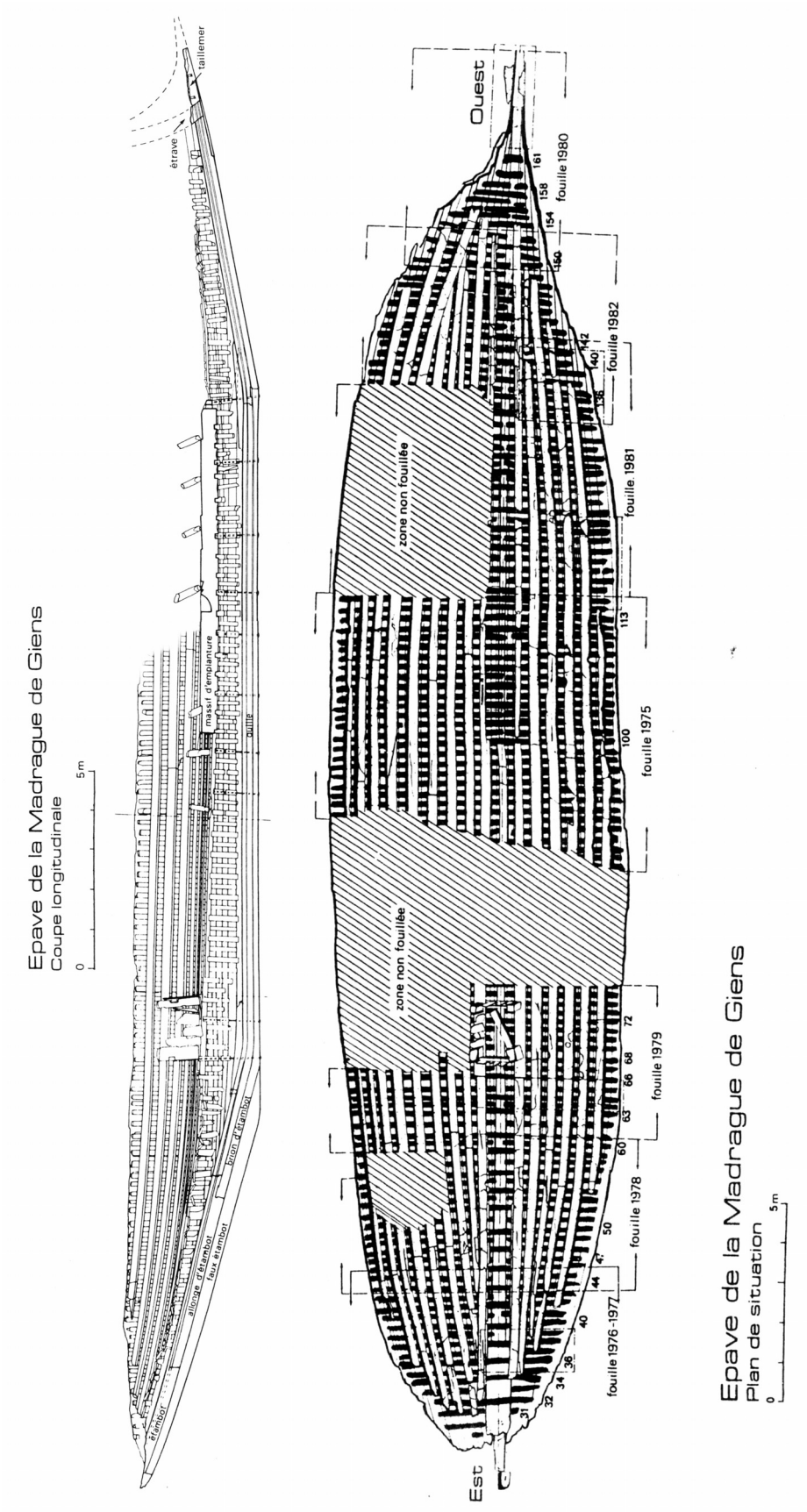
Rigging remains (Blocks): The remains of nine Mediterranean style blocks were excavated from the shipwreck, in addition two cylindrical sheaves were excavated with no associated block. Three disc sheaves were also excavated.

No.	Description	Length	Width	Thick	Sheave Ø	Sheave Th.
1	Med style block	290mm	125mm	65mm	100mm	-
2	Med style block	390mm	160mm	37mm	-	-
3	Med style block	280mm	160mm	55mm	-	-
4	Med style block	285mm	170mm	50mm	63-70mm	-
5	Cylinder sheave	-	-	-	80mm	50mm
6	Cylinder sheave	-	-	-	70mm	40mm
7	Disc Sheave	-	-	-	340mm	65mm
8	Disc Sheave	-	-	-	60mm	35mm
9	Disc Sheave	-	-	-	90mm	55mm

Dimensions of blocks and sheaves from the Madrague de Giens shipwreck.

Rigging remains (General): Eleven ovoid heart blocks were excavated from the stern of the vessel, all of which had a large primary hole and a small seizing hole near the pointed end. All were grooved around the exterior to facilitate a rope strop. The heart blocks have been reconstructed into two sizes. The first measure 160mm x 90mm 19mm, the central hole has a diameter of 43mm while the seizing hole is 15mm. The second group are smaller and measure 110mm x 80mm x 15mm. A single toggle was also excavated which measured 190mm in length, with a diameter of 36-45mm.

Associated Literature: (Carre 1983: 20-26, 49-50, 83, 94, 131 & 154; Liou & Pomey 1985; Parker 1992: No. 616; Pomey 1997: 180; Rival 1991: 148-244; Tchernia & Pomey 1978).



Longitudinal profile of the Madrague de Giens shipwreck, the angular transition between keel and stem/stern post is clearly visible. (Rival 1991: Fig 24, 68 & 70).

Site 030: Marmara, Sea of

Location: Sea of Marmara

Date: Late 4th/early 3rd century BC

Rigging remains: Mediterranean style single sheave block recovered from the looted and dredged remains of merchant ship. The amphora scatter of the wreck seems to indicate a vessel of similar size to the Kyrenia ship (Pulak pers.comm.). The sheave block is of typical Mediterranean form and construction. It is made from two halves with a cylindrical sheave in between them. The shells are pierced by two small holes at the upper end for seizing line to run through.

Associated Literature: (Pulak 1985: 3).

Site 031: Marsala (Punic Ship)

Location: Sicily

Date: 250-175 BC

Vessel description: Wreck of an oared galley excavated off Western Sicily. The wreck is notable for the considerable quantity of cordage, all made from esparto grass which was excavated.

Associated Literature: (Parker 1992: No. 263).

Site 032: Marseille

Location: Southern France

Date: 5th century BC – 5th century AD

Site Description: Rescue excavation in the heart of the old town of Marseille at Palais de la Bourse and Place Jules Verne have revealed extensive elements of the Greek and Roman waterfront as well as a range of shipwrecks, including that of **La Bourse (S004)**. several archaic Greek sewn vessels and the remains of a Roman harbour dredger.

Rigging remains: A range of rigging components were excavated from Roman contexts in the waterfront area, these included a range of deadeyes, Mediterranean blocks, cylindrical sheaves, disc sheaves and toggles. Personal inspection of these artefacts confirms their similarity to those from other areas of the Mediterranean.

Associated Literature: (P. Pomey & M-B. Carre, Pers.Comm.; Hesnard *et al* 1999: 62-65).

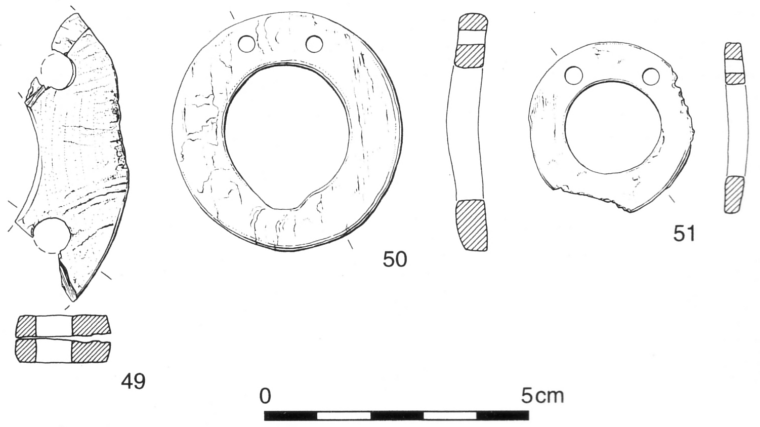
Site 033: Mons Claudianus

Location: Egypt, Eastern Desert

Date: Early 2nd century AD

Rigging remains: Three horn brail rings were excavated from the Imperial quarries at Mons Claudianus in the Egyptian Eastern Desert. Similar examples have been found from other contemporary sites in the area, including the ports of Berenike and Myos Hormos on the Red Sea coast. Two of the rings are virtually complete and measure 44mm and 31mm in diameter

with a thickness of 5mm each. A third is incomplete. All of the rings have been pierced with two holes, punched directly through the body of the ring. The incomplete ring has wear marks by the attachment holes consistent with those made by attachment and use on the face of a sail. Associated Literature: (Hamilton-Dyer 2001: 360 & fig. 11.4).



Horn brail rings from the site of Mons Claudianus, Egypt (Hamilton-Dyer 2001: Fig. 11.4).

Site 034: Myos Hormos

Location: Red Sea, Egypt.

Date: 1st century BC – 3rd century AD

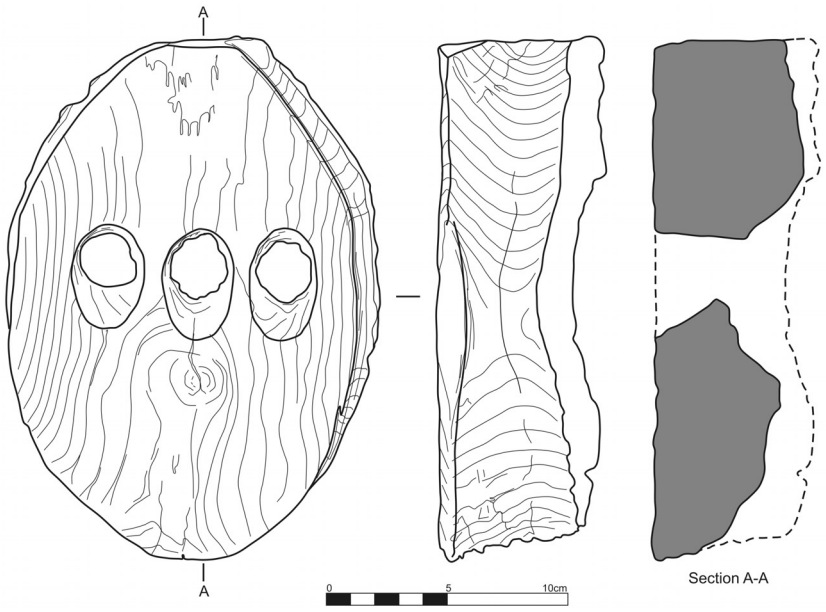
Site description: The ancient port of Myos Hormos is situated about 8km north of the modern town of al-Quseir on the Egyptian Red Sea coast, 500km south of Suez. The Roman town occupied a position on a coral platform between the sea and the lagoon (now silted) which formed the ancient harbour. The site is mentioned in the 1st century AD *Periplus Maris Erthyraei* as a major port for trade with the east. Strabo (2.5.12) noted that 120 ships sailed annually from Myos Hormos to India. The Roman occupation of the site lasted from the 1st century BC until the late 3rd century AD.

Rigging remains (Brail rings): Brail rings were by far the most numerous class of maritime artefact surviving from *Myos Hormos*. They were excavated during every field season, principally from the Roman *sebakhs* (rubbish dumps) which are scattered across the site, and encompass the full Roman chronology of the site (1st century BC – 3rd century AD). The 169 brail rings excavated can be classified into two groups, based on the material from which they are made. 118 of them were made from cattle horn and the remaining 51 were made from wood. The use of these two types of materials is consistent with finds of brail rings from Berenike, which were also made from wood and horn. Of the eight brail rings analysed for wood species, five were made from blackwood (*dalbergia sp.*), a species of tree found in East Africa and

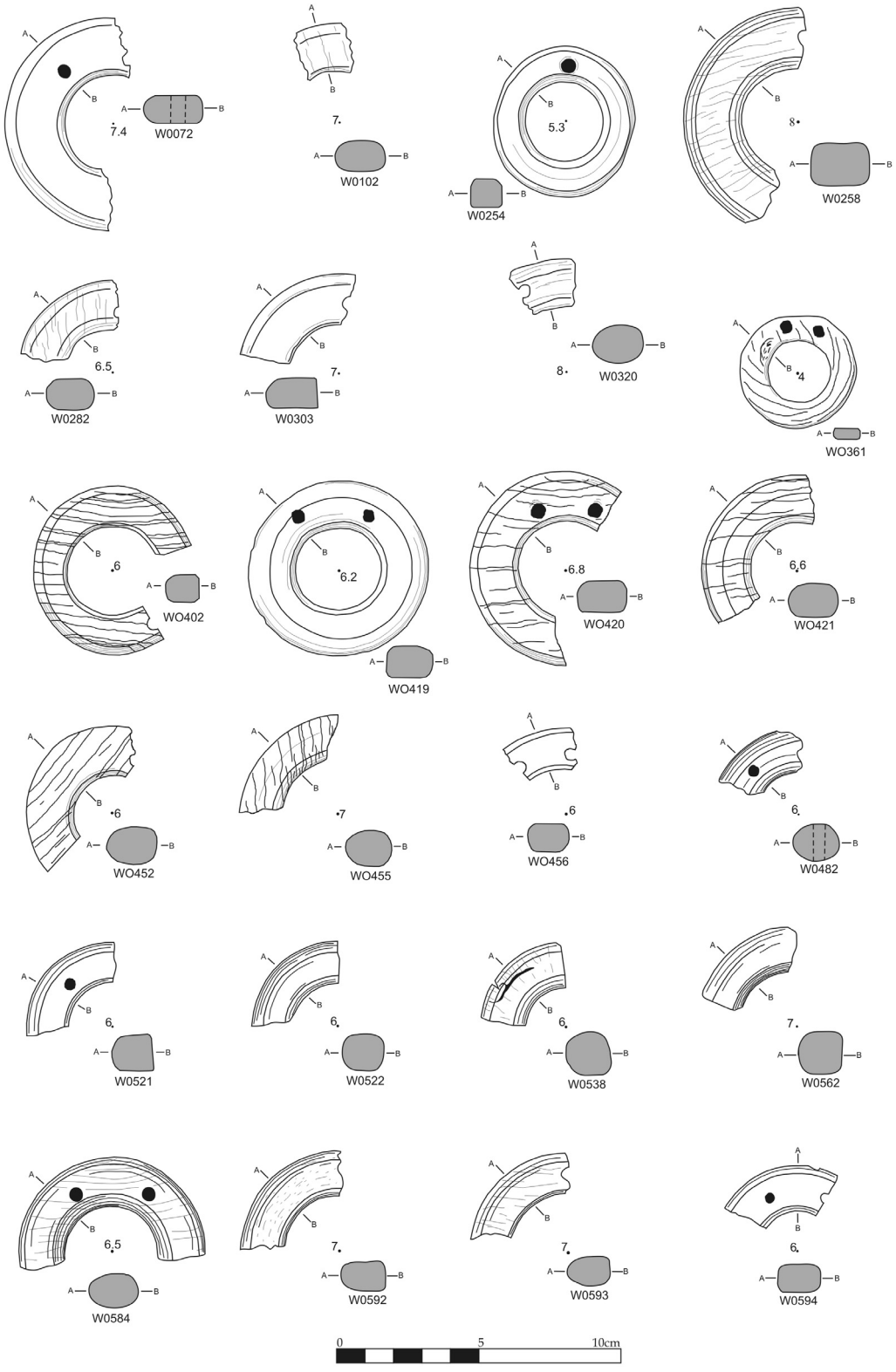
India, not the Mediterranean. Two brail rings were made of *Tamarix* and the final one was made of *Olea*.

Although superficially similar there are differences between individual rings which should be noted. The most obvious of these is the large difference in size from ring to ring, this ranges across all brail rings from 37mm to 95mm in diameter. Even in the small sample illustrated here it is possible to see both the differences in size and the differences in the cross-sections recorded through the rings. These range from almost circular (wo482), to oval (wo584) to square or rectangular (wo258). The majority of the brail rings are pierced with two holes directly through the body of the ring, although some have been pierced with a single hole. These holes would have provided the point at which the brail rings was attached to its sail, as evidenced by the brail ring still attached to the fragment of sail cloth discussed below. Although there is a large difference in the external diameter of the brail rings, there is relatively little difference in the size of the attachment holes. These range from 4-7mm and the largest brail rings has an attachment hole only 1mm bigger than that of the smallest ring.

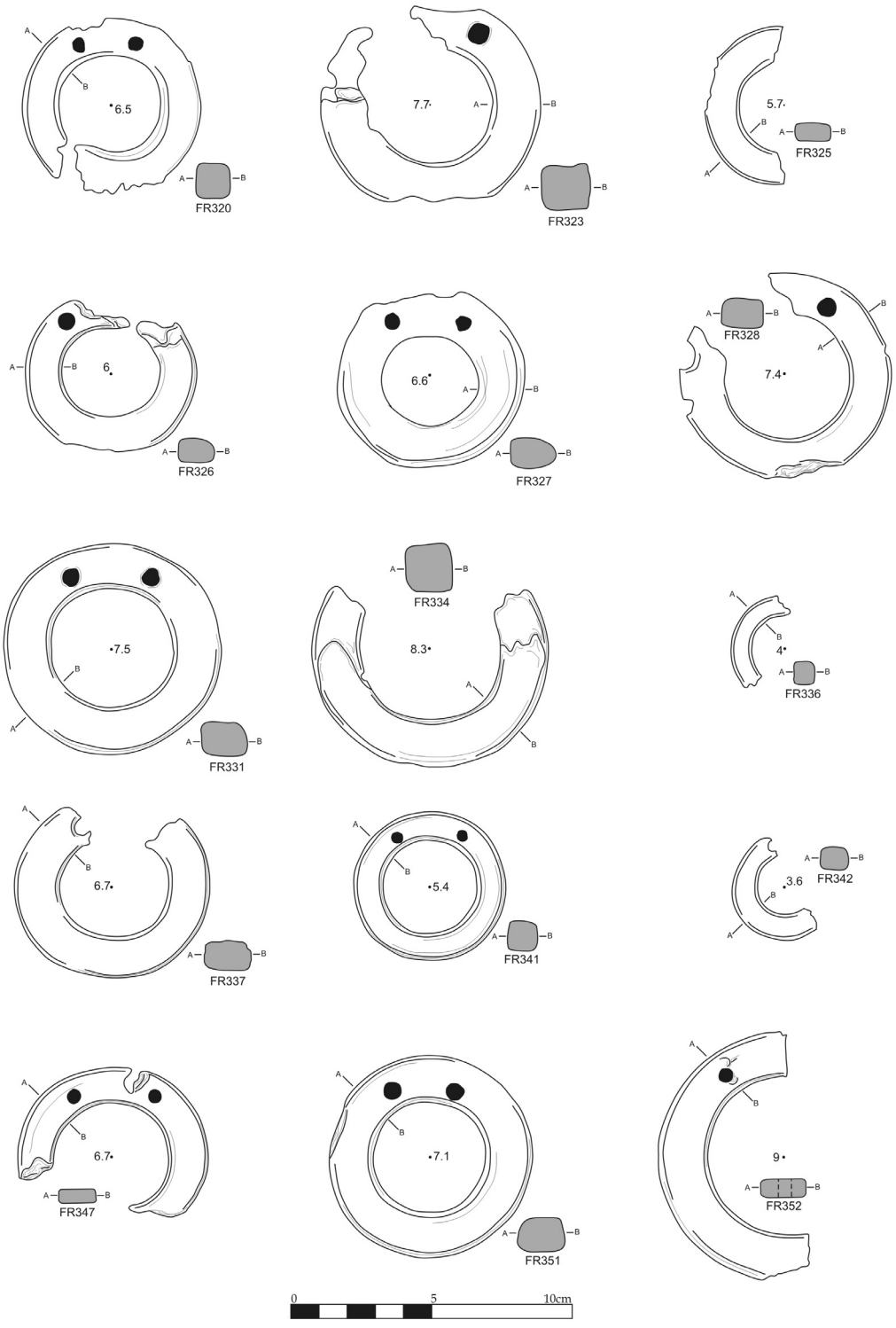
Rigging remains (Deadeye): A deadeye was excavated from a small building on the east side of central peninsular of the site dating to the mid/late 2nd century. The deadeye consisted of an oval shaped tablet of wood, pierced by three holes set alongside one another in the centre of the block. It measured 214 mm long, 144 mm wide and was 55 mm thick although the reverse side had been heavily degraded. The outside edge had been grooved in order to take a rope strop which could have been up to 28 mm in diameter. The three central holes could have carried ropes of up to 25mm in diameter. The deadeye was made from *Dalbergia*.



Deadeye from the Red Sea port of Myos Hormos (J.Whitewright).



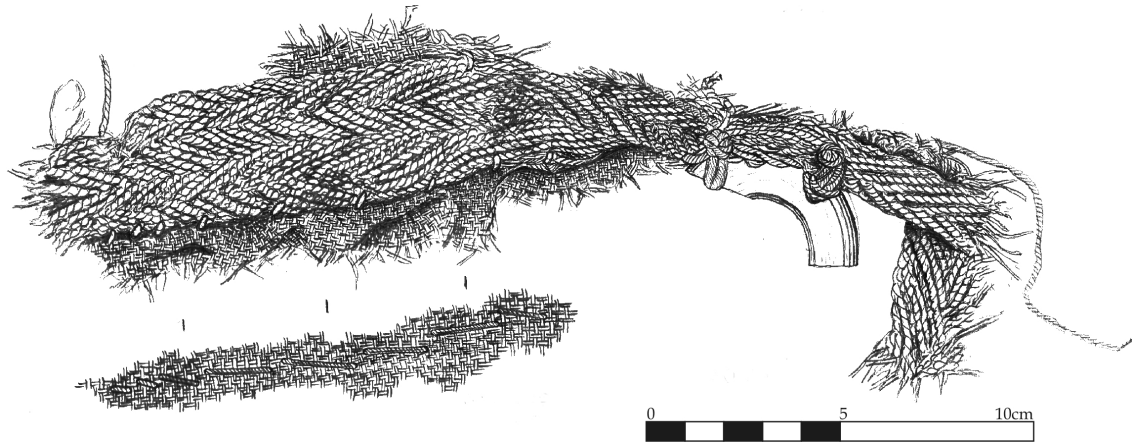
A sample of wooden brail rings from the Red Sea port of Myos Hormos (J.Whitewright).



A sample of horn brail rings from the Red Sea port of Myos Hormos (J.Whitewright).

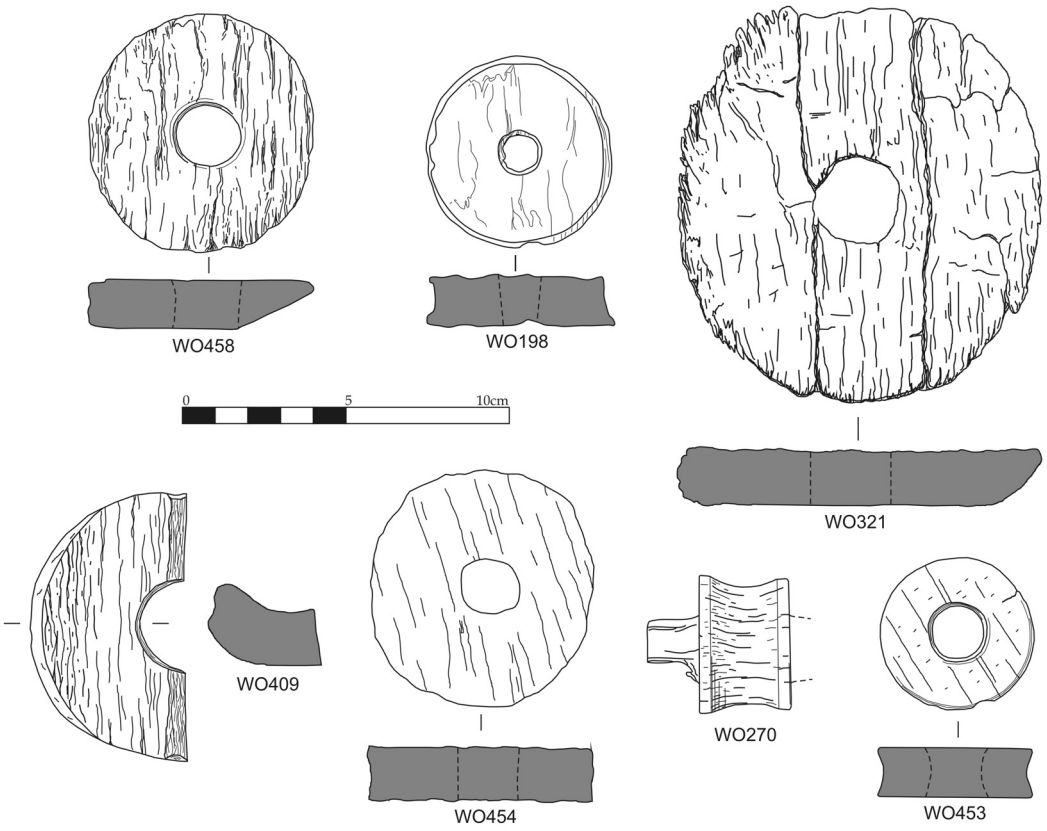
Rigging remains (Sailcloth): A small fragment of Roman sail, dating to the late 1st or early 2nd century AD was excavated from a Roman *sebakh*. It was possible to distinguish the sail fragment from other pieces of textile found at the site because of the remains of a wooden brail ring which was still attached. Sewn to the sailcloth was a reinforcement strip of heavier material

and it was to this that the brail ring was attached. The brail ring measured 50mm in diameter and its orientation (assumed to be with the holes uppermost) confirmed that the reinforcement strip ran horizontally across the face of the sail, with no vertical webbing strips. Discovery of this fragment (T331) also enabled the identification of other pieces of reinforcement webbing and fragments of sail. One of these strips (T27) measured 1.32 m in length, the brail rings were no longer in place but remains of the twine used to attach them were, two sets of attachments spaced 81 cm apart were found and these corresponded to the holes on the brail ring still attached to T331. The webbing strip (T27) also runs along the length of a vertical seam joining two different pieces of cotton sail together. In this example there is no evidence for the presence of any horizontal webbing strips. In total 69 textile fragments were excavated which probably had a maritime function. 61 were pieces of webbing strip and four were sail fragments. As with the contemporary site of Berenike to the south, the sail fragments from Myos Hormos also seem to be made from cotton manufactured in India.



Fragment of cotton sailcloth, horizontal reinforcement strip and attached wooden brail ring from the Red Sea port of Myos Hormos (J.Whitewright).

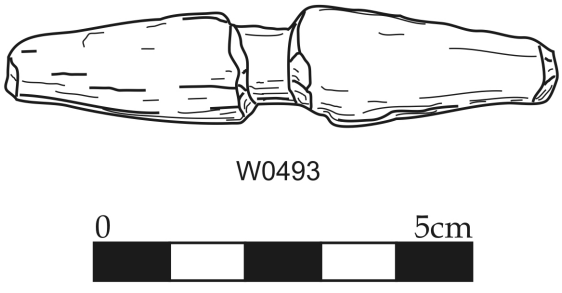
Rigging remains (Sheaves): Excavations at Myos Hormos also unearthed seven sheaves from different rigging blocks. The sheaves all date to the second half of the 2nd century AD with the exception of *wo198* which is 1st century AD in date. The finds consisted of the sheaves only, no shells or axles were found at all during the excavation of the site. Six of the sheaves were flat, circular discs of wood and ranged in size from 46 mm to 81 mm in diameter. Their outer edge, where not decayed was grooved to carry the associated rope, while their thickness, and so the diameter of the rope they could carry, was very consistent at between 14-16 mm. One of the disc sheaves was made of *Tectona grandis* and another was made of *Dalbergia*. The seventh sheave, *wo270*, although damaged was cylindrical and of the type associated with Mediterranean style sheave blocks. It is the only evidence of the use of this type of block at the site.



Wooden sheaves from the Red Sea port of Myos Hormos (J.Whitewright).

Rigging remains (General): A single toggle was excavated from a Roman deposit in trench 8a dating to the late 2nd/early 3rd century AD. The toggle was 73mm in length with a circular cross-section 16mm in diameter at the widest point, tapering to 7mm at the ends. The central notch which would have carried the rope eye was 11mm in diameter and 6-8mm wide. Large quantities of cordage were also excavated from the site, however this included very few diagnostic pieces. A variety of material was used in the manufacture of the cordage used at the site including animal hair, bast, cane, grass, palm and reed. However, it is generally impossible to state which materials were used in specifically maritime contexts

Associated Literature: (Handley 2003; Peacock & Blue 2006; Whitewright 2007b).



Wooden toggle from the Red Sea port of Myos Hormos (J.Whitewright).

Site 035: Nin (Enona)

Location: Croatia

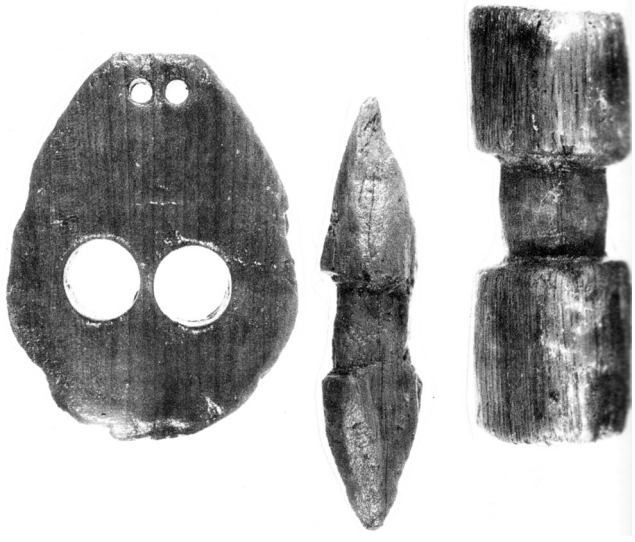
Date: Late 1st century AD

Vessel description: Two vessels, 7-8m in length and constructed using sewn, edge-joined planking were excavated from Roman harbour deposits at the site on Enona, modern day Nin.

Rigging remains: Three Mediterranean style blocks, a deadeye and two toggles were recovered during the excavation. No measurements are provided, or a scale in the published photographs (below). The size of the boats suggests that all the rigging components associated with them must have been relatively small. The deadeye in this instance comprised two holes for the shrouds and two smaller holes for the seizing. One of the toggles had pointed ends and the other had flat ends.

Associated Literature: (Brusic & Domjan 1985; Parker 1992: No. 1248-9).

Mediterranean blocks from the site of Nin (Enona), Croatia (Brusic & Domjan 1985: Fig. 6.8).



Deadeye and toggles from the site of Nin (Enona), Croatia (Brusic & Domjan 1985: Fig. 6.9).

Site 036: Ognina A

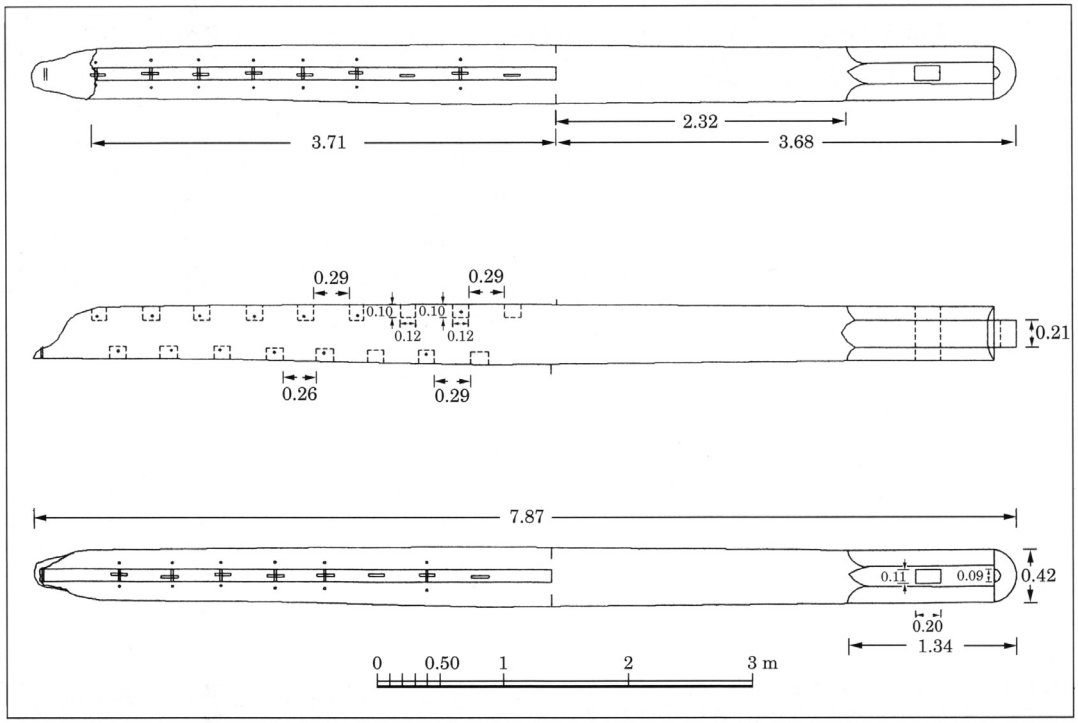
Location: Sicily, near Syracuse

Date: AD 215-230

Vessel description: A substantial amphora wreck scattered on a rocky seafloor. The luxurious fittings of the ship, including a mosaic floor and marble pillars have led to the controversial interpretation of the vessel as a pleasure yacht.

Rigging remains: Four bronze disc sheaves were recovered from the site. Two of the sheaves measured 170mm in diameter while the remaining two had diameters of 150mm and 140mm.

Associated Literature: (Gargallo 1972: pl 12; Parker 1992: No. 755).



Lower portion of mast from the Roman port of Olbia (Riccardi 2002: Fig. 3).

Site 037: Olbia

Location: Sardinia

Date: 1st century AD

Rigging remains (Mast): Remains of the bottom of a ships mast, measuring 7.87m in length. The base of the mast has a curved tenon which projects for 180mm and which would have located the mast in the mast step. One metre above this the mast is octagonal in form with a rectangular section cut through it. The remaining mast is circular in section although flat planes have been cut on either side. These planes are cut into by a series of large mortices which may have been intended to take the mast partners. The mast has been calculated to have been about 12-15m in height and belonged to a ship of between 30-35m in length.

Rigging remains (General): A variety of other rigging components were also excavated from the Roman harbour at Ostia. These included a disc sheave, a deadeye and a Mediterranean sheave block with two sheaves. The latter artefact is the only double Mediterranean sheave block so far published.
Associated Literature: (Riccardi 2001; 2002).

Site 038: Pisa (Roman harbour)
Location: Pisa San Rossore 2, Pisa, Italy
Date: Roman Imperial
Rigging remains: Excavation at the site of San Rossore in Pisa uncovered the remains of one of the Roman riverfronts of the city. Work is still ongoing, both in excavation and analysis, published data is therefore still preliminary. As well as the remains of sixteen ships of different types, dates and sizes, pieces of ships equipment, termed *ships' tackle* by the excavators was also recovered. These included a Mediterranean style sheave block and needles associated with sailmaking and rigging. The sheave block was complete and measured 140mm in length by 60mm in width, no thickness was given. The block was similar in form to the example found at Caesarea Maritima. At the moment of excavation the block still retained its outer strop.

Nine needles were also excavated different areas of the harbour. These were made of bronze or iron and were pierced with either a single (1) or double eyelet (5), the remaining three were fragmented. Double-eyed needles are associated with maritime activity such as sailmaking or net mending. Separate artefacts, resembling modern net menders were also found at the site. The single-eyed needle was made of bronze and measured 94mm in length and had a round section. The double-eyed needles varied from 105mm to 222mm in length and were all square in section with a flattened end where the eyelets were situated. Four of the double-eyed needles were curved while the remaining one, also the largest, was straight.
Associated Literature: (Bigagli 2000; Bruni 2000).

Site 039: Port-Vendres I
Location: Southern France
Date: c. AD 400
Vessel description: A fully excavated well-preserved Late-Roman wreck which contained a variety of rigging elements. The vessel itself was 18-20m long with a beam of c. 8m, it is estimated to have carried around 70-75 tons of cargo while drawing about 2.2m of water. The vessel was built shell-first using mortice and tenon edge-joined planking and had a symmetrical double ended form. The mast-step, located in the forward half of the hull is cut into a keelson, preserved to 7.5m in length, which rests upon a pair of *carlingots*. The *carlingots* extend aft of the keelson where an oval cavity for the ships pump is cut into them. The hull was made

predominantly from *Pinus halapensis* with the exception of the garboard strake on the starboard side (*Cupressus*), one frame (*Quercus ilex*) and another single strake (*Olea*), of the sampled material. The tenons and treenails were made from *Olea*. The cargo consisted mainly of Almagro 50 and 51c amphora, the majority of which contained pilchards

Rigging remains: A variety of different types of blocks were recovered during the excavation of the shipwreck. A block with a single disc sheave measured 150mm x 70mm x 54mm, the sheave had a diameter of 50mm and a thickness of 15mm. A unique triple block was also found. This consisted of a two disc sheaves, 42mm and 44mm in diameter set alongside each other. Above/below them was a larger disc sheave, 70mm in diameter and 17mm thick, set at a 90˚. The total size of the block was 260mm in length and 120mm wide. The final block was also multi-sheaved with five disc sheaves and four disc sheaves set at 90˚ to each other. A suspension hole is above the row of five sheaves and is 64mm in diameter. The five sheaves have their axles in line with the suspension hole and measure 142mm in diameter by 18mm thick. The row of four sheaves beneath is set at 90˚ and have a diameter of 132mm and a thickness of 18mm. A single toggle was also recovered from the wreck which measured 153mm in length, with a maximum diameter of 30mm.

Associated Literature: (Carre 1983: 40-45; Liou 1974; 1975: 572-3; Parker 1992: No. 874; Rival 1991: 267-296).

Site 040: Port Vendres II

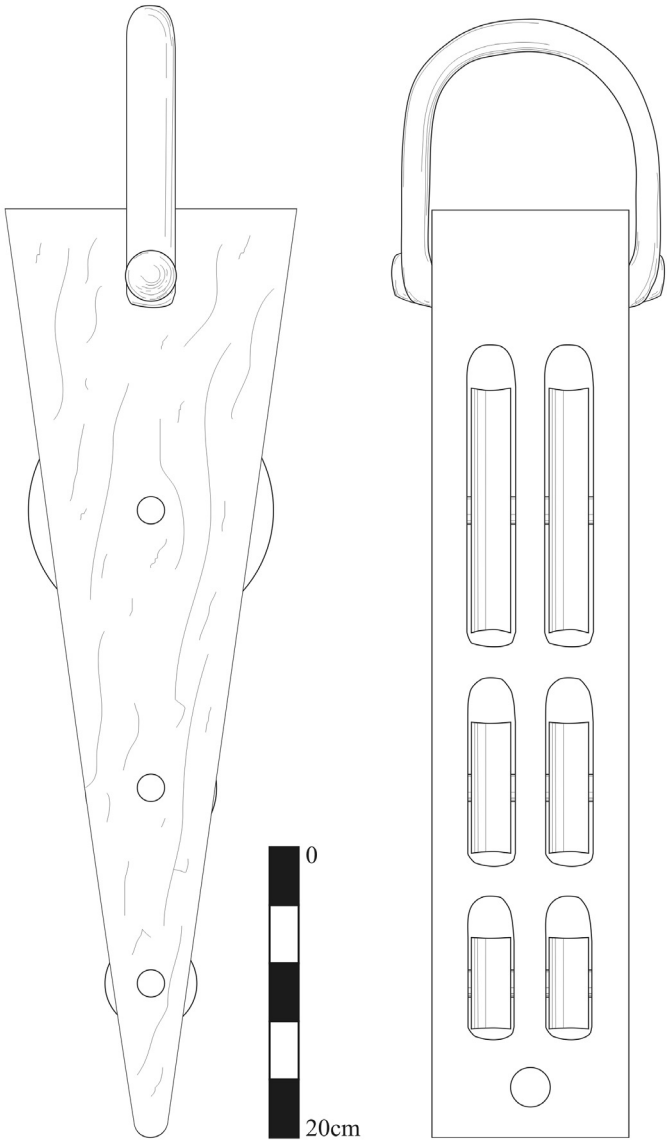
Location: Southern France

Date: c. AD 42-48

Vessel description: Claudian wreck, dated via the stamp on the cargo of tin ingots. As well as the tin, the cargo consisted of three types of amphora; Dr. 20, Dr. 28 & Haltern 70. The names of eleven different shippers can be made out on the amphora establishing that they came from Baetica. Five different olive oil producing estates are named on the Dr. 20 amphora.

Rigging remains: A triangular multi-sheaved block was recovered during the excavation which is shown on the 1977 interim site plan. It consists of a large single piece of wood, triangular in shape which houses six sheaves, set in pairs, of diminishing sizes towards the tip. A large iron loop is attached through the block at the widest end of the triangle. The total size of the block is 640mm in length with a thickness of 135mm. The largest pair of sheaves (nearest the base of the triangle) are 168mm in diameter, the middle pair 90mm in diameter and the smallest pair 63mm in diameter. All the sheaves have a standard thickness of 27mm. There is a circular hole at the point of the triangle which runs perpendicular to the sheave axis.

Associated Literature: (Carre 1983: 41 & Pl. x; Colls*, et al.* 1977; Parker 1992: 875).



Reconstruction of the multi-sheave block excavated from Port-Vendres 2 shipwreck, based on the measurements given by Carre (1983: 41).

Site 041: Rabiou

Location: Saint-Tropez, Southern France

Date: c. AD 50

Vessel description: The remains of a shell-first, mortice and tenon, edge-joined ship was excavated over a number of seasons. The keel was preserved to a length of 11.3m and the ship was notable for its robust framing. The mast-step survived which was cut into the forward end of the keelson which was mounted on a pair of *carlingots*, It seems likely that the mast-step was located in the forward ½ of the hull. Although the excavators cite similarities between the construction of the ship and earlier Hellenistic rather than Imperial traditions, the keelson and

carlingot relationship is consistent with Mediterranean shipping from this period onwards. The ship carried a principal cargo of Dr. 2-4 amphoras as well as Dr. 9 amphoras. The presence in the latter of fish sauce remains indicates a departure point for the voyage in Iberia.
Rigging remains: Two small cylindrical sheaves were recovered from the port side of the wreck, measuring 52mm and 36mm in diameter.
Associated Literature: (Joncheray & Joncheray 2005a; 2006a; Joncheray & Joncheray 2005b; 2006b; Parker 1992: No. 1009)

Site 042:Ravenna

Location: Ravenna, Italy
Date: 5th century AD
Vessel description: Late Roman wreck uncovered during building work with preserved dimensions of 7.22m long by 2.75m wide. A large section of the stern of the vessel was destroyed during discovery by a mechanical excavator. The wreck is dated to the 5th century AD by artefacts found in the hull, which included African cups, a glass bottle and oil lamps. The sediments overlying the wreck illustrate the change from coastal environment to fresh water stream or lagoon. Preliminary observations suggest that use of *Quercus* for the keel and frames, *Abies* for the planking (external and ceiling) and *Pinus* for the keelson. The mast-step is cut directly into the keelson in the forward half of the hull. The keelson itself rests directly on the frames and was notched on the underside. The construction details of the hull suggest that it was made using 'mixed' construction. Mortice and tenon joints were used up to the level of the knees. The mortices were spaced 80cm apart and the tenons were loose and unpegged. It has been suggested that they were simply used to hold the planks in place while they were secured. The side planks were nailed to the frames by iron nails and treenails and the hull was coated in pitch. In reconstruction, the hull has a flat-bottom and sharp entry and exit. It was probably intended for sea and shallow water in keeping with the coast around Ravenna.
Associated Literature: (Medas 2003)

Site 043: Saint Gervais 2

Location: Southern France
Date: c. AD 600-625
Vessel description: Frame-first vessel with a hull suited to deep sea navigation, with a capacity of about 41-49 tons. Its estimated dimensions were 15-18m in length with a beam of 6m. The vessel was built using frame-first construction with only minimal edge-jointing at the ends of the vessel. Part of the keelson survived which rested upon a pair of *carlingots*. The remains of the ships pump also survived which was well preserved. Parker reports that a wooden brail-ring was excavated, however inspection of this artefact reveals that it is a wooden ring from the ships pump which was situated immediately aft of the keelson. The principal cargo of the vessel was

probably corn. Shipboard items and pottery are of eastern Mediterranean origin and indicate that the commerce the ship was engaged in was conducted by merchants from the eastern Mediterranean.
Associated Literature: (Carre & Jézégou 1984; Jézégou 1989; Parker 1992: No. 1001).

Site 044: Saint Gervais 3

Location: Southern France
Date: AD 149-154
Vessel description: The hull of this merchant vessel was preserved to an extent of 17m long by 6m wide, this included the steps for an *artemon*/foremast and a main-mast. The main cargo of the vessel was salvaged in antiquity but seems to have consisted of Dr. 20 and Beltrán 2B amphoras from southern Spain. Pear-shaped amphoras from Gaul were also excavated. Stamps and inscriptions on the Dr. 20 amphora indicate that they were carrying olive oil from near Astigi. The cargo is representative of the produce of several estates, loaded aboard by several different merchants. The Dr. 20 amphoras lack the control mark generally placed on amphoras being imported to Rome, the combination of this and the presence of Gaulish amphora containing wine have led to the suggestion that the vessel stopped in Southern France to pick up the latter and was ultimately heading for the lower Rhone.
Associated Literature: (Beltrame 1996; Liou & Gassend 1990; Parker 1992: No. 1002).

Site 045: Serçe Limani

Location: SW Turkey
Date: 11th Century, c. 1025
Vessel description: Remains of a modest sized merchant ship, c. 15.5m in length, wrecked in the anchorage of Serçe Limani. Cargo comprised mainly of glass cullet and intact glassware and red-ware vessels. The excavation of the site revealed the remnant of the vessel's hull and investigation concluded that the ship had been built entirely frame-first.
Rigging remains: As well as the cargo and personal items of the crew, the remains of several items of the vessels rig also survived, mainly blocks and sheaves. The most significant piece was a triple sheaved block (rg1) measuring 350mm in length, a maximum preserved width of 169mm and a maximum preserved thickness of 103mm. A single hole (49mm x 26mm) pierces the width of the block at the same end as ropes would have passed around the sheaves. One complete (38mm diameter) and one partial hole pass through the thickness of the block at the other end, their orientation suggest three such holes would have existed originally. The best preserved sheave slot has a length of 153mm and a width of 26mm, the width of the partially preserved slot is identical. Two sheaves (rg6 & rg10) were found in place, the best preserved sheave rg6, measured: diameter 88mm, mid thickness diameter 78mm, thickness 26mm, pinhole diameter 28mm. Block rg1 was probably made of elm while the sheaves were made from

boxwood. Block rg1 was found in the bow of the vessel, its form corresponds with the blocks from lateen/settee halyard systems (chapter 2.2) and so it has been interpreted as part of the halyard system for the foremast. The presence of a sheave, much larger than those from rg1, found in the stern of the vessel suggests the presence of a larger halyard block to serve the mainmast.

Associated Literature: (Bass*, et al.* 2004; Mathews 2004; Parker 1992: No. 1070).

Fig. 11-4. RG 1 and RG 1 reconstructed, Scale: 1:3

Block RG1, probably the upper block from the foremast halyard system of the Serçe Limani shipwreck. The date of the wreck and the rigging remains found suggest that the vessel was rigged with a lateen sail (Mathews 2004: Fig. 11-4).

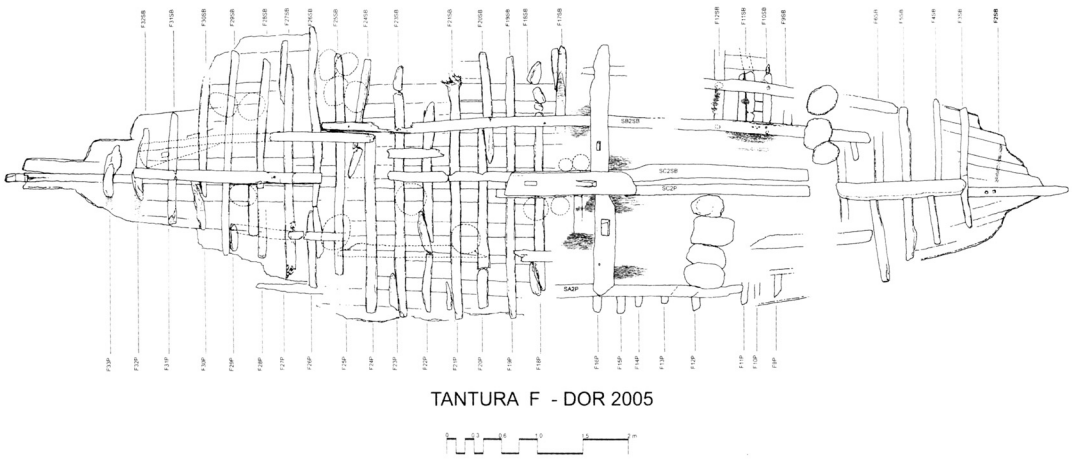
Site 046: Tantura F

Location: Israel

Date: early 8th century AD

Vessel description: Tantura F is one of the few shipwrecks in the Mediterranean from the early Islamic period and represents the remains of a completely frame-first built ship. The preserved remains cover an area 12m x 3.5m. The vessel was flat-bottomed amidships and shares many constructional features with the **Dor 2001/1** shipwreck. This included a central longitudinal timber laid on top of the framing along the centreline of the vessel at either end, but not incorporating the mast-step in the manner of a keelson. The keel was made from at least two pieces of wood (*Pinus brutia* and *Pinus nigra*) scarfed together. Frames were made from *Tamarix* and *Pinus brutia*, while the planking central longitudinal timbers and mast-step assemblage were all made from *Pinus brutia*. The complete mast-step system of the vessel was preserved. This consisted of a relatively short mast-step timber measuring 1.45m x 0.26m x 0.2m which was mounted on a pair of *carlingots*. The mast-step timber was given lateral support at the aft end by a pair of mast-sisters which butted against it at the point where the mast would have been stepped in a sloping notch. A second notch was cut in the mast-step timber towards its forward end. The whole mast-step system was located amidships of the vessel.

Associated Literature: (Barkai & Kahanov 2007)



Overview plan of the Tantura F shipwreck (Barkai and Kahanov 2007: Fig. 2).

Site 047: Tradeliére

Location: Near Cannes, Southern France

Date: 20-10 BC

Vessel description: A shell-first, mortice and tenon edge-joined ship which was lead sheathed carried a very mixed cargo. 300-400 amphoras made up around two-thirds of the cargo and were of a variety of types; Dr. 2-4, Dr. 6 and Rhodian. Around fifty of the Dr. 2-4 amphoras contained dates. The remaining cargo consisted of tens of thousands of hazelnuts, originally packed in sacks, pottery in the form of Pompeian Red plates and glass cups. The pottery and glass seem to have been packed in wooden crates.

Rigging remains: A cylindrical sheave from a Mediterranean style block. The sheave had a maximum diameter of 50mm and a thickness of 40mm, the diameter of its axle was 30mm.

Associated Literature: (Carre 1983: 18; Joncheray 1975: 103; Parker 1992: No 1174).

Site 048: Yassi Ada

Location: Yassi Ada, SW Turkey

Date: 4th century AD & 7th century AD

Vessel description: The remains of two antique shipwrecks were excavated by INA in the 1970's. The most extensively excavated shipwreck dated to the 7th century AD (c. AD 625), while an earlier, and less well-documented shipwreck dated to the 4th century AD. The principal interest in the site is the contrasting methods of construction employed in building each of the two vessels. The 4th century shipwreck utilised the recognised shell-first, edge-joined, mortice and tenon construction characteristic of antique Mediterranean shipping, although with mortice and tenons spaced more widely apart than in earlier shipwrecks. In contrast to this, the 7th century wreck employed a different method of construction which has been described as 'mixed' employing elements from of both shell-first and frame first traditions. Mortice and tenon jointing was used, but at widely spaced intervals and without the use of locking pegs in the mortices. The 7th century wreck also preserved an extensive set of carpenters/shipwright tools. A steelyard bearing the name 'Georgiou Presbyterou Nauklerou' which probably belonged to the owner/skipper of the vessel was also found. The principal cargo of the vessel was around 900 amphoras, probably containing wine.

Associated Literature: (Bass & van Doorninck 1971; Bass & van Doorninck 1982; van Doorninck 1976).

5.2 Appendix Two: Wood species used in Mediterranean ship construction and rigging components

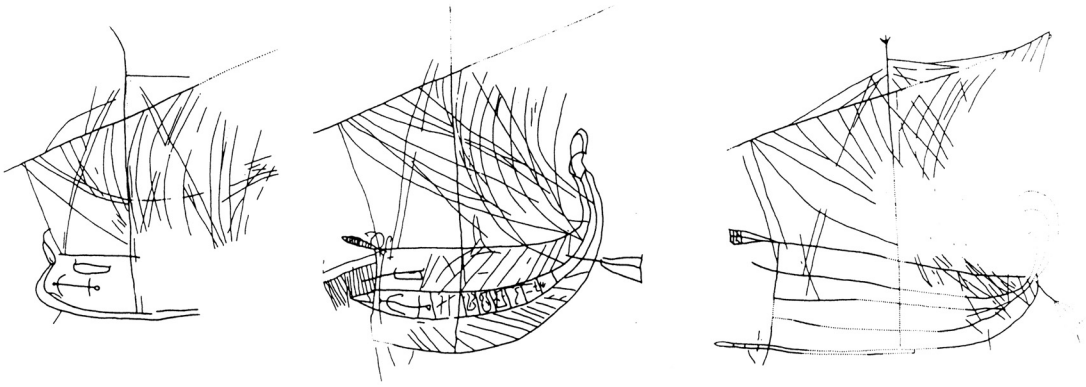
Abies alba	- Silver Fir
Buxus	- Boxwood
Cupressus sempervirens	- Mediterranean Cypress
Dalbergia	- Blackwood
Fagus silvatica	- Beech
Fagus orientalis	- Oriental Beech
Fraxinus excelsior	- Common or European Ash
Larix decidua	- European Larch
Juglans regia	- Common Walnut
Morus nigra	- Black Mulberry
Olea	- Olive
Pinus brutia	- Turkish Pine
Pinus halapensis	- Aleppo Pine
Pinus heldreichii	- Bosnian Pine
Pinus maritima	- Marine Pine
Pinus nigra	- Black Pine
Pinus pinea	- Umbrella Pine or Stone Pine
Pinus sylvestre	- Scots Pine
Populus	- Poplar
Quercus alliprinus	- Common Oak
Quercus ilex	- Evergreen Oak or Holm Oak
Quercus cerris	- Turkey Oak
Rhamnus cathartica	- Common Buckthorn
Tamarix	- Tamarisk
Tectona grandis	- Indian Teak
Ulmus campestris	- Common Elm
Ziziphus spina christi	- Christ's Thorn

5.3 Appendix Three: Iconographic depictions of sailing vessels referred to in the text

The following catalogue of ship imagery should not be considered as a definitive collection of iconographic evidence. The work of Basch (1987) currently represents the most complete resource for maritime iconography in the ancient world. The examples included below represent those most relevant to the current investigation. Vessels are referred to in text by reference to their ID number, so the first example in the catalogue, Vessel 01, would simply be referred to as V01. Numbering runs continuously throughout the whole catalogue. The catalogue is grouped according to geographical origin into depictions from the Mediterranean and those from the Indian Ocean. Within these groups depictions are grouped according to rig-type. All groups are ordered chronologically, vessels for which there is definitive dating evidence are placed ahead of those with more general dates.

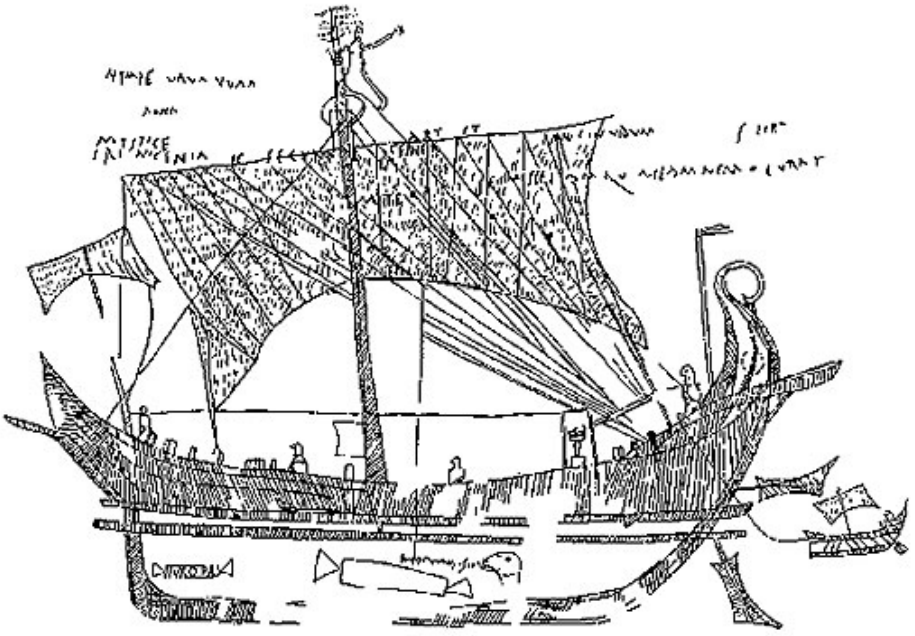
5.3.1 The Mediterranean square-sail

Vessel 01



Period/Date: Early 1st century BC
Medium: Graffito
Origin: Delos
Description: Three ship graffitos from Delos which show square-sail vessels with inclined yards. The ships are sailing from right to left and have yards and sails which are obviously tilted. All the vessels are shown with brails, indicative of the Mediterranean square-sail rig. Forestay and backstays are also shown as well as braces and lifts on the right-hand vessels. The inclined nature of the yard on these and other depictions have led to its interpretation as a form of 'proto-lateen' sail (Basch 1997: 216-9; 2001: 63-4). In reality such an arrangement of yard and sail is to be expected when a square-sail is set close-hauled. This can be witnessed in replica square-sail vessels from Roskilde (Denmark) and Kyrenia (Cyprus).
Related literature: (Basch 1997: Fig. 10.; 2001: Fig. 7).

Vessel 02



Period/Date: 1st century BC

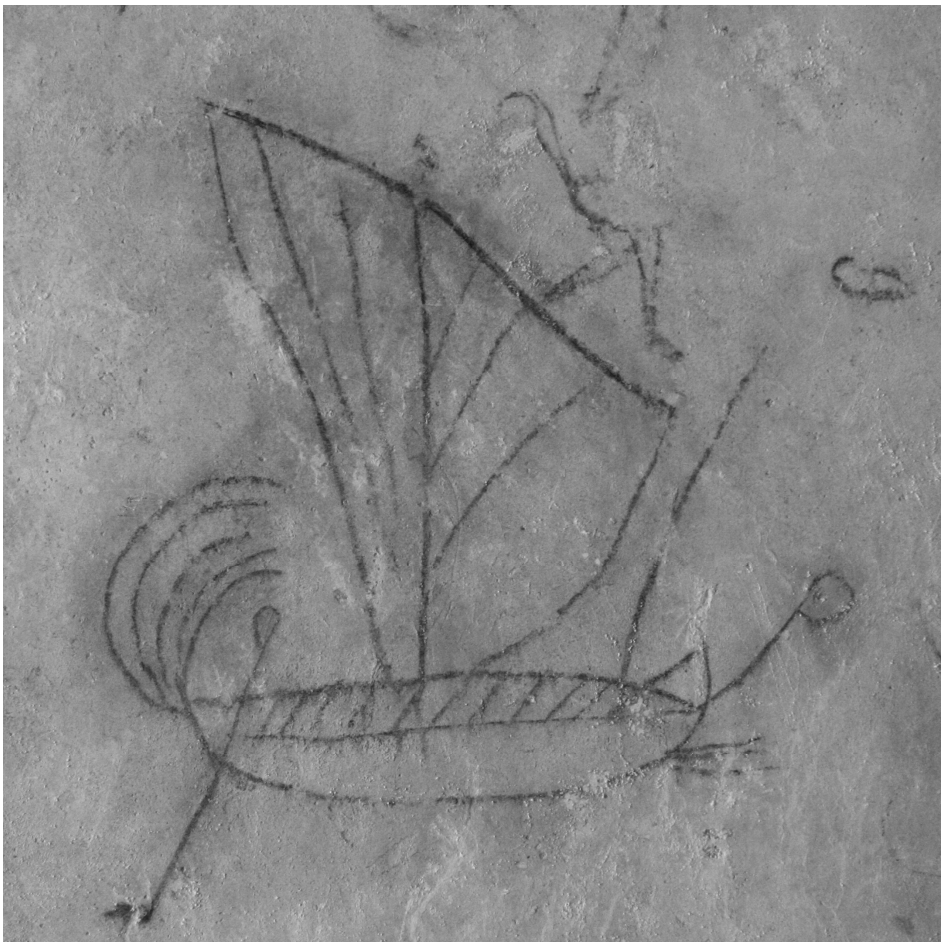
Medium: Graffito

Origin: Pompeii, Italy

Description: Depicted on the north wall of the *peristyle* of a house at Pompeii (Reg.1 Ins.15 no.3), the ship is named Europa. As well as being a rare example of a named vessel, the graffito is also a detailed depiction of a Roman Cargo vessel. Europa is shown towing a smaller vessel behind. Europa is depicted with a main mast and artemon, both of which are rigged with a square-sail. A forestay and backstay are both depicted as well as a double halyard. Thirteen brail lines are shown running up the face of the sail before returning to deck toward the stern of the vessel, where they are made off to bar. A possible brace is depicted at the forward end of the yard. One sheet of the artemon is also shown. The vessel towed astern is rigged with a single mast and square-sail. No other details are visible.

Related Literature: (Bass 1974: 72; Benoit 1961: fig. 73; Jashemski 1974).

Vessel 03



Period/Date: 270 BC – 14 AD

Medium: Graffito

Origin: Anfouchy, Alexandria

Description: Graffito drawn on the wall of *hypogea* No. 2 at Anfouchy in Alexandria. The *hypogea* itself is dated to the 3rd century BC and Basch has identified the ram of the vessel as being of a 'triple branch' type which is not represented after the reign of Augustus (Basch 1989: 328). The vessel is shown with a single mast. The yard of the vessel is inclined downwards toward the bow, a series of lines running from the yard to the base of the mast probably represent brailing lines. It is possible that the inclination of the yard is to avoid a bird which is to the right of the mast, although Basch thinks otherwise (*ibid*: 329). The other significant feature of the vessel is the long spar protruding from the bow. No sail is shown on this spar and Basch has interpreted it as being to receive the bowlines of the mainsail. Parallels are shown on vessel 013 and 033. The angle of the yard may be caused by it being set along the centre of the vessel and hauled down in the bows.

Related Literature: (Basch 1989).

Vessel 04

Period/Date: AD 50

Medium: Relief, Tombstone.

Origin: Pompeii

Description: A relief on the tombstone of Naevoleia Tyche, a shipper from Pompeii. The vessel has a main-mast rigged with a square-sail. A spar is visible, set in the bows of the vessel, however it is bare with nothing to suggest that it carried an artemon. It could possibly have served to secure a bowline if one was used (c.f. vessels 032 & 033). The halyard system of the vessel is depicted and consists of a large block just above the sides of the vessel, the upper end of the halyard runs to the masthead which is topped with a squarish object possibly to facilitate securing lines and standing rigging. The vessel is shown with two shrouds on the port side. A forestay is depicted running to a bracket or block set into the bows of the ship. The yard is shown as two lengths of timber fished together. The sail is fitted with brails and the sail is partially brailed up with ten brailing lines. These are controlled by a crewman standing just forward of the helmsman. Two crew are on the yard to furl/unfurl the sail while two more are depicted climbing the forestay and halyard. It is unclear if they are ascending or descending. The hull projection in the bow of the vessel shows a remarkable similarity to the bow structure of **V06**.

Related literature: (Basch 1987: 457-61; Beltrame & Gaddi 2005: 81; Casson 1991: pl. 41; 1995: xxv & fig. 151).

Vessel 05

Period/Date: AD 50-70

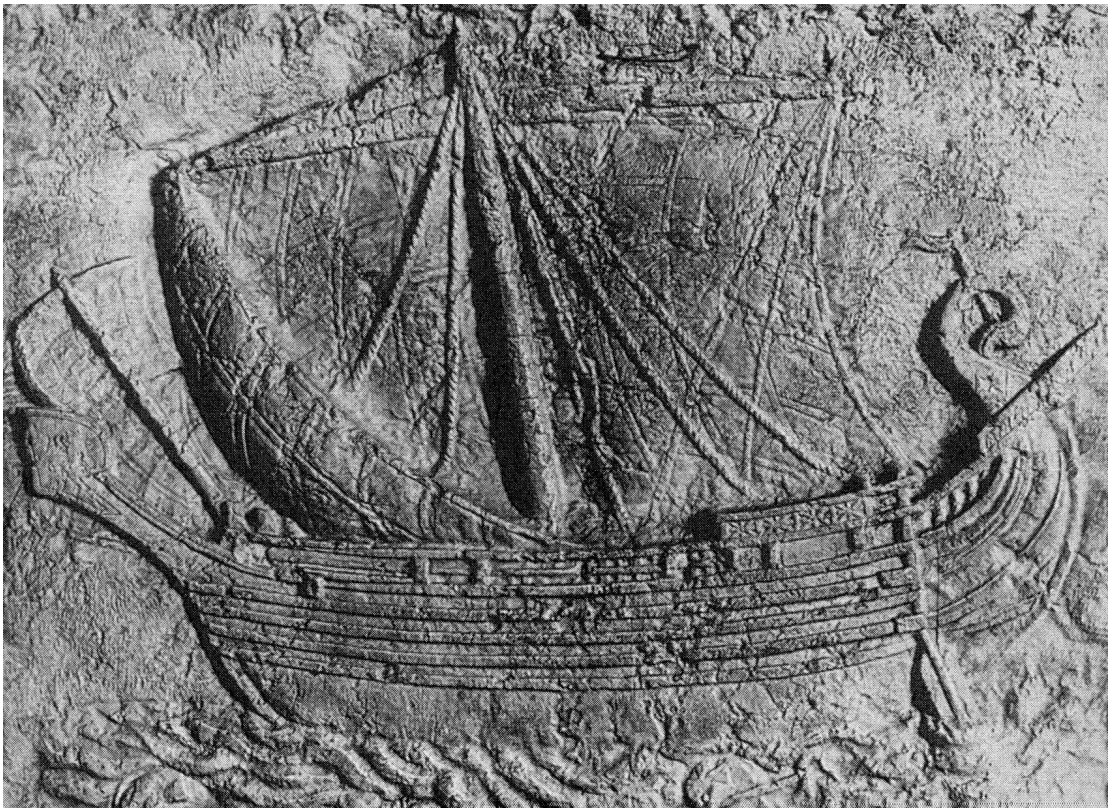
Medium: Graffito

Origin: Berenike, Egypt

Description: Ship graffito inscribed on two sherds found in a rubbish deposit during the 1995 season of excavation at the Roman port of Berenike on the Egyptian Red Sea coast. Its principle significance is that it is one of the few clear iconographic depictions from the wider Indian Ocean region from a Roman context. Unlike many other depictions of vessels from the Eastern Desert the deposit was securely dateable. Unfortunately the type of ceramic is not identified so it is unclear if the sherd is Indian Ocean or Mediterranean in origin. In any case the graffito could have been added at any point and place between the firing of the pot and its deposition at Berenike. The vessel has a main mast and it has been suggested that an artemon was also present, but that the majority of it has been broken off (Sidebotham 1996: 315). This may provide an explanation for the diagonal lines visible in the bow of the vessel. The horizontal inclination of the yard, the presence of braces at either end of it and the use of lifts to support it mean that the vessel was rigged with a square sail. None of these features would be expected to be present on a lateen or sprit-sail. The side of the vessel, just below the gunwale is pierced with eight or nine holes which may be oarports or crossbeams (*ibid*).

Related Literature: (Sidebotham 1996).

Vessel 06



Period/Date: Mid 1st century AD

Medium: Relief, Sarcophagus

Origin: Sidon

Description: Merchant ship depicted with a main mast and *artemon*, both rigged with square-sails. There is also some suggestion of a Roman topsail set above the mainsail. Several lines run from the mast head. The lines immediately abaft the mast are probably the halyards and may represent a similar block and tackle system to that depicted in **V04**. The remaining pairs of lines, one on either side of the mast are likely to be shrouds, their depiction aft of the sail supports this interpretation. The starboard braces are also visible running from the yardarm to the deck. The face of the sail is depicted with intersecting vertical and horizontal lines, brail rings are visible on the forward face of the sail. The pattern is repeated on the artemon. The hull projection in the bow of the vessel shows a remarkable similarity to the bow structure of **V04**.

Related literature: (Bass 1974: 80-81; Casson 1995: xxv & fig. 156; La Roërie 1957b; Sigaut 1957; Sottas 1928).

Vessel 07

Period/Date: AD 98-117

Medium: Relief

Origin: Trajan's Column, Rome

Description: Cargo vessel with a detailed depiction of a square-sail furled using brails. The brails have gathered up the folds of the sail in a manner reminiscent of V15 and V16. The brailing lines running up the face of the sail and the brail-rings attached to the face of the sail are both clearly depicted. The sheets are depicted hanging from the ends of the sail. Two lines run from the masthead to the deck of the vessel on either side and may represent shrouds.

Related literature: (Casson 1991: pl. 48; 1995: xxv & fig. 150).

Vessel 08

Period/Date: AD 200

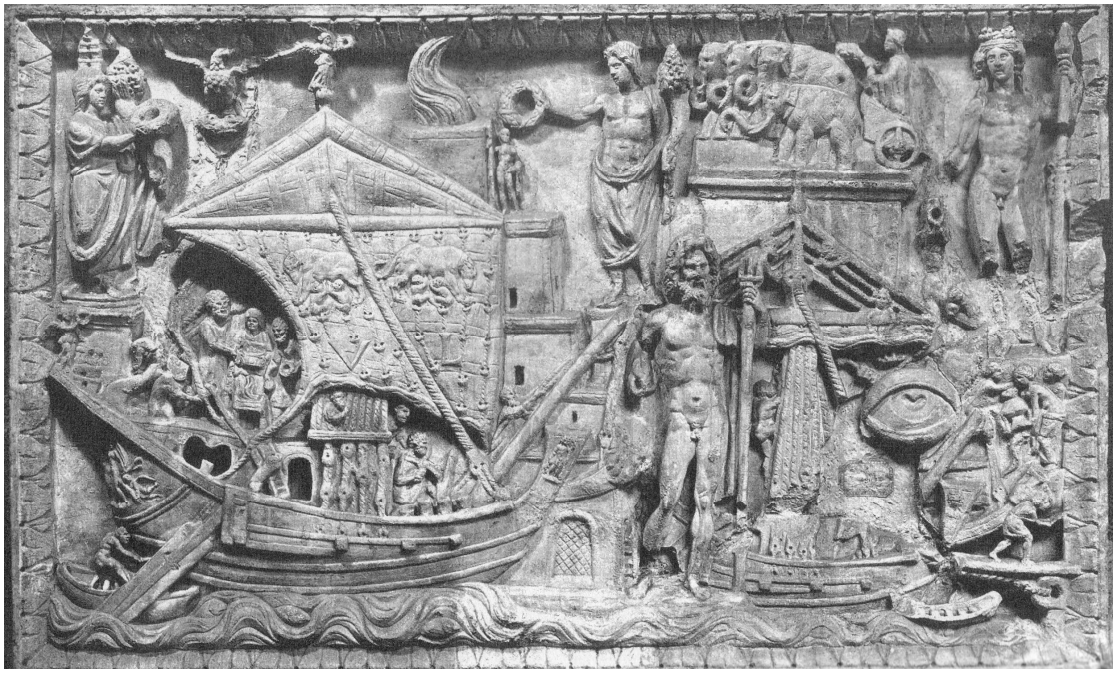
Medium: Stone relief

Origin: Utica

Description: Carved stone relief depicting a two-masted square-sail vessel. The equally sized masts and sails suggest that the vessel is truly two-masted rather then being rigged with mainsail and *artemon*. Similarly the location of the masts is also suggestive of a balanced two masted rig. Each mast is depicted in identical fashion. Ropes are shown running from masthead to deck on either side of the mast which may represent shrouds or stays. Both sails are also depicted with braces. Sail cloth is depicted with continuous horizontal lines and discontinuous vertical lines to form a 'brickwork' pattern.

Related literature: (Casson 1995: xxiv & fig. 142).

Vessel 09



Period/Date: AD 200

Medium: Relief

Origin: Rome

Description: One of the most frequently cited iconographic depictions, sometimes referred to as the Torlonia relief after the museum where it is now housed. This relief depicts a cargo vessel (on the left) entering the harbour of Rome, before depicting the same vessel (on the right) tied up alongside. In the first instance three people are shown in the stern of the vessel carrying out a thanksgiving ceremony, presumably because they have returned safely (Casson 1995: 182) The ship is rigged with a main mast and *artemon*, the former rigged with square-sail and Roman topsail. The relief is remarkable for the number and detail of the rigging elements which the artist chooses to include. Brail-rings pierced with two holes and brailing lines are clearly visible on the face of the sail, as is the bolt rope which reinforces the edge of the sail. Horizontal strips run across the face of the sail behind the brail lines. A forestay is visible which is secured at the base of the artemon mast. The footings of the shroud system, comprising pairs of deadeyes attached to the sides of the vessel near the mast are also clear. The moored vessel is shown with the sails furled to the yard and being secured by crewmen who are aloft in the rigging. As a result of this the lifts are visible.

Related literature: (Basch 1987: 463-7; Bass 1974: 86; Beltrame & Gaddi 2005: 80-81; Casson 1991: pl.42; 1995: xxiv & fig. 144; Meyer 1992: fig. 3b; Torr 1964: pl. 6).

Vessel 10

Period/Date: AD 200

Medium: Mosaic

Origin: Ostia

Description: Two sailing vessels depicted on the floor of the *Foro delle Corporazioni* (The Square of the Corporations) outside an office belonging (according to the inscription) to 'the shippers of Sullecthum' a town on the east coast of Tunisia. The left hand vessel is shown with a main-mast, *artemon* and *mizzen*. All are rigged with square-sails, lifts are also shown. The hull of the vessel has a cutwater. The right hand vessel has a more rounded hull and is rigged with a main-mast and *artemon*, both rigged with square-sails and supported by lifts. The sails of both vessels are shown crisscrossed by horizontal and vertical lines.

Related literature: (Bass 1974: 80-81; Becatti 1961; Casson 1991: pl. 43; 1995: xxiv & fig. 145).

Vessel 11

Period/Date: 3rd Century AD

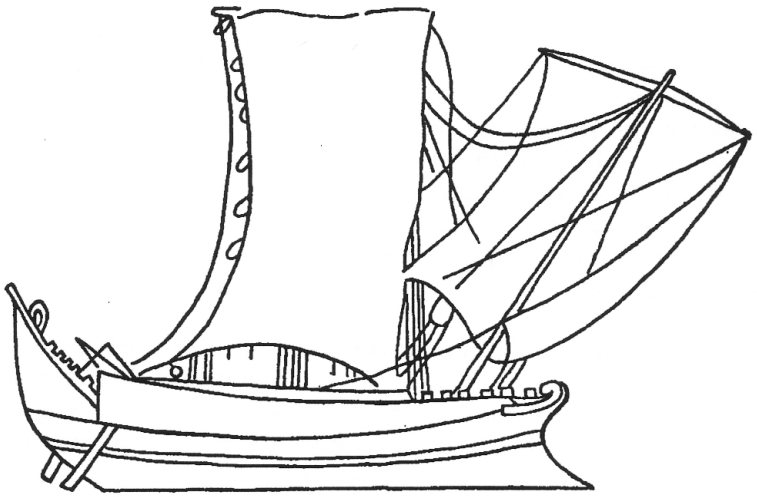
Medium: Relief

Origin: Portus, Italy

Description: Sailing vessel rigged with a main-mast and artemon, both with square-sails, also rigged with a Roman topsail. The forestay is visible as is the port brace. A series of lines are visible beyond the sail which may represent brail lines or perhaps shrouds. A crewmember is visible beside the mast who appears to be hauling on a line. The forestay is secured to the top of the mast at a point where a squarish object is depicted, this may be an extra fitting designed to secure the forestay to the masthead. The face of the sail is depicted with both vertical and horizontal lines which crisscross one another.

Related literature: (Casson 1995: xxv & fig. 149).

Vessel 12



Period/Date: 3rd century AD

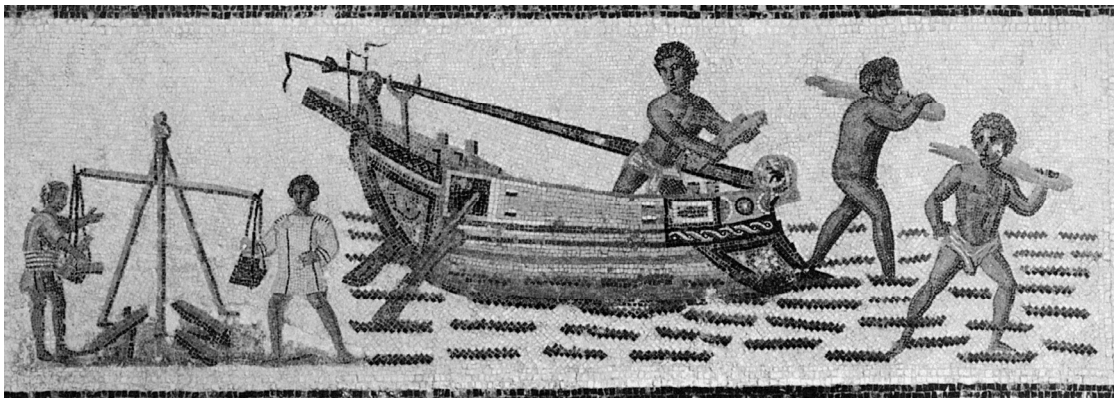
Medium: Mosaic

Origin: Themetra (Souani-el Adari), Tunisia

Description: Mosaic from the floor of a Roman bathhouse at Themetra, modern day Souani-el-Adari, 12 miles north of Sousse. The image shown here is a line drawing of the original, published by La Roërie (1956b). It has been interpreted (*ibid*) as being two-masted, presumably because of the similarity in size between the sails. Both masts are rigged with square sails. Sheets and braces are visible on both, as well as an indication of the vessels shrouds and halyards. The depiction is also seen as being significant because of the lines running from the luff of the mainsail to the foremast which have been interpreted as representing bowlines (*ibid*). This is a feature which is rarely depicted in the iconography but has significance for the interpretation of the potential sailing performance of ancient square rigged vessels (ch. 2.3).

Related Literature: (La Roërie 1956b; Foucher 1957).

Vessel 13



Period/Date: 3rd century AD

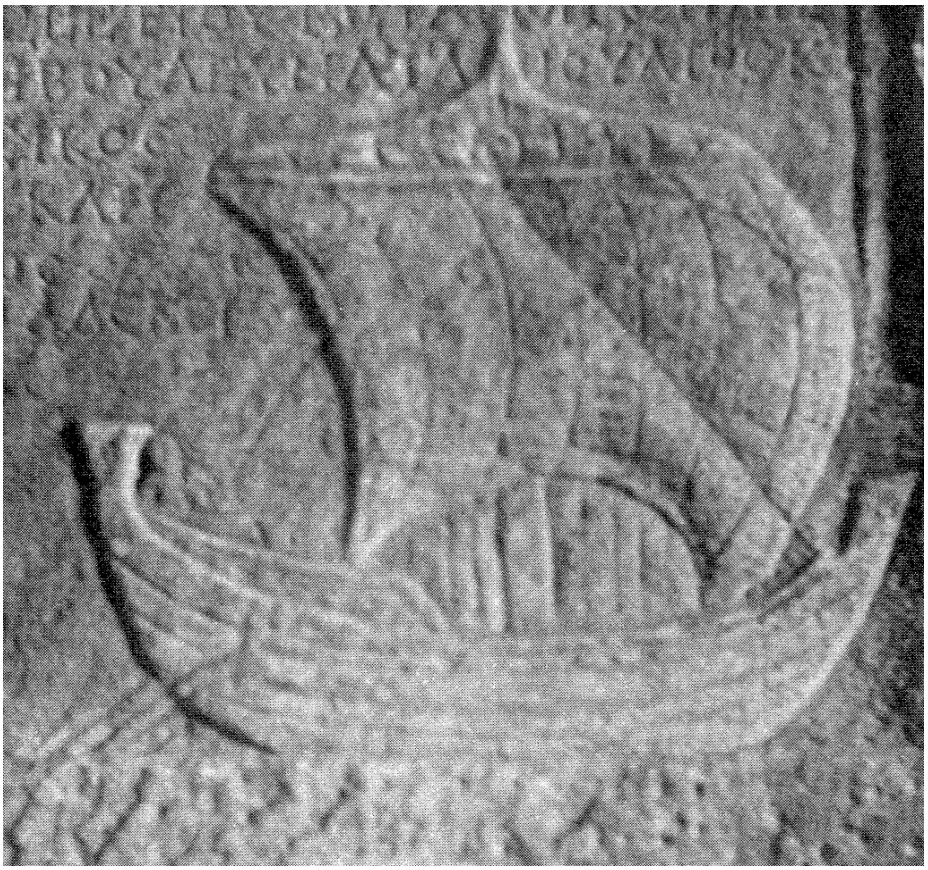
Medium: Mosaic

Origin: Sousse, Tunisia

Description: Mosaic found in a tomb chamber near Sousse depicting the unloading of lead bars from a beached vessel. Although rigging elements are largely absent it is worth noting that the mast has been stepped for the purposes of beaching the vessel. The location of the foot of the mast in the very bow of the vessel raises the possibility that it was rigged with a sprit-sail.

Related Literature: (Casson 1995: xxvii & fig. 191).

Vessel 14



Period/Date: 3rd century AD

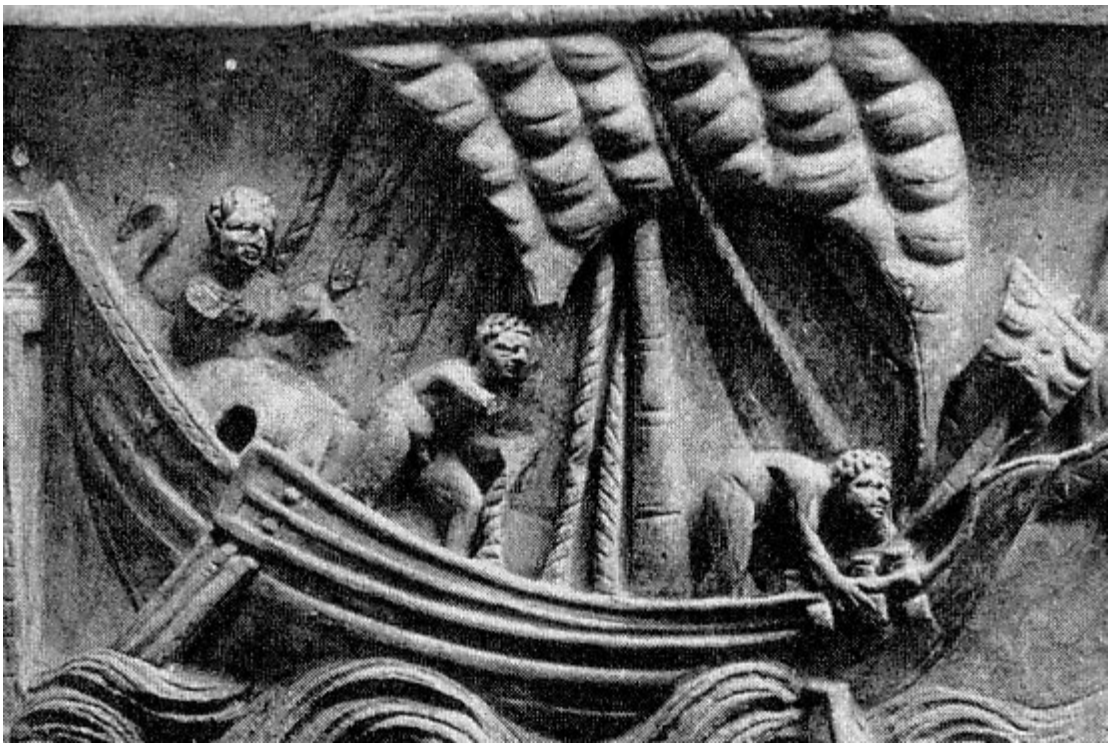
Medium: Tombstone

Origin: Constantinople

Description: Single-masted square-sailed vessel depicted on the tomb of Kalleinikos (a shipper) (Casson 1995: xxiv). As well as a square-sail the vessel is also shown with a Roman topsail. Vertical lines, assumed to be brails are shown running up the face of the sail with a corresponding number returning to deck on the far side. The vessel is also depicted with a forestay.

Related literature: (Casson 1995: xxiv & fig. 143).

Vessel 15



Period/Date: 3rd century AD

Medium: Relief on Sarcophagus

Origin: Rome

Description: The vessel is one of three depicted on the sarcophagus, for contextual purposes the full relief is shown after this entry. The vessel is shown rigged with a main-mast and artemon, both of which carry a square-sail. A forestay is shown attached to the foot of the artemon and the halyards are shown running near the mast. Other ropes are depicted running to the stern of the vessel which may represent braces or a backstay. Although none of the brailing system is depicted, the sail is carved in such a way as to suggest the presence vertical brailing lines and some form of horizontal strips.

Related literature: (Casson 1991: pl.45; 1995: xxiv & fig. 147).

The complete relief containing vessels 15, 16 & 27

Vessel 16

Period/Date: 3rd century AD

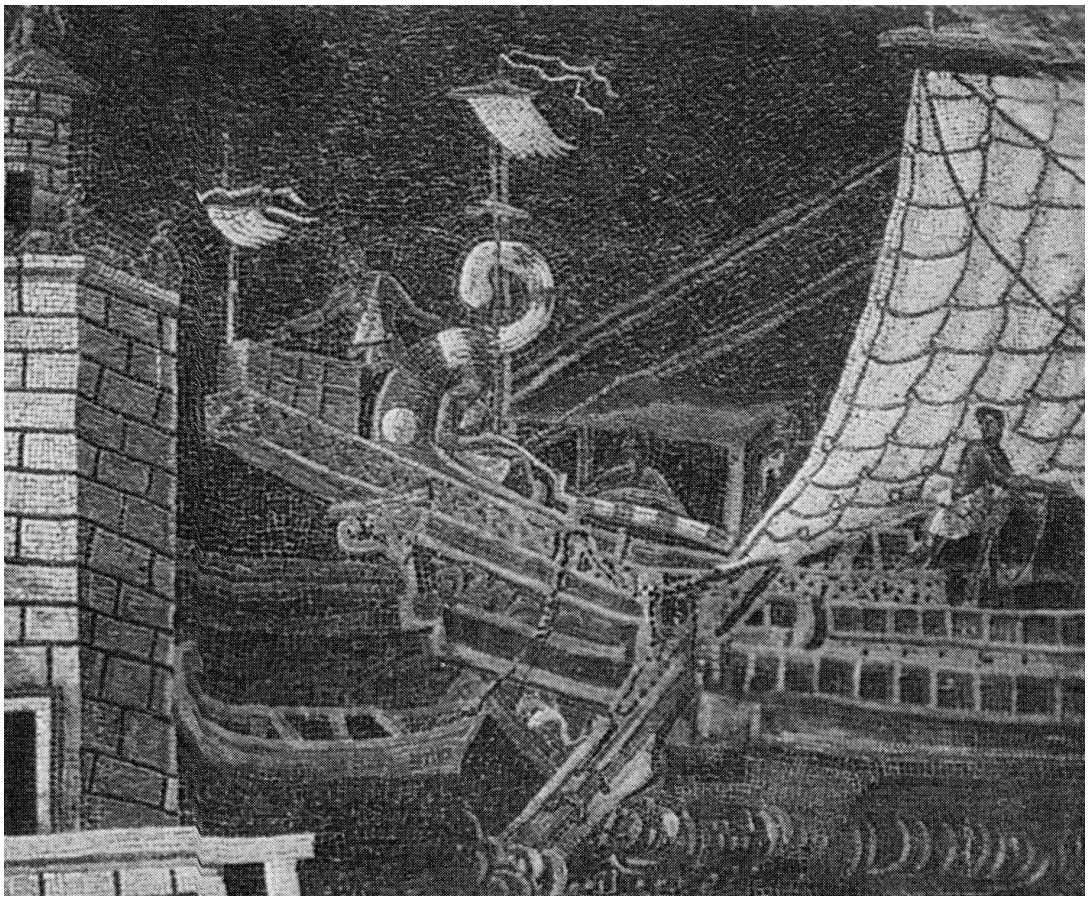
Medium: Relief on Sarcophagus

Origin: Rome

Description: The final vessel in the three vessel relief. The right-hand vessel is rigged with a main-mast and artemon, both of which are rigged with square-sails. The rig is generally the same as vessel 008 except that vessel 010 is viewed from its windward side rather than from leeward as in the previous case. The evidence for this lies in the fact that the mast can be seen in front of the sail, which in turn obscures the forestay. The sheets and braces of the vessel are also visible. The sail has been ruffled in a similar fashion to vessel 008 in a way which suggests the presence of brails.

Related literature: (Casson 1991: pl.45; 1995: xxiv & fig. 147).

Vessel 17



Period/Date: 3rd century AD

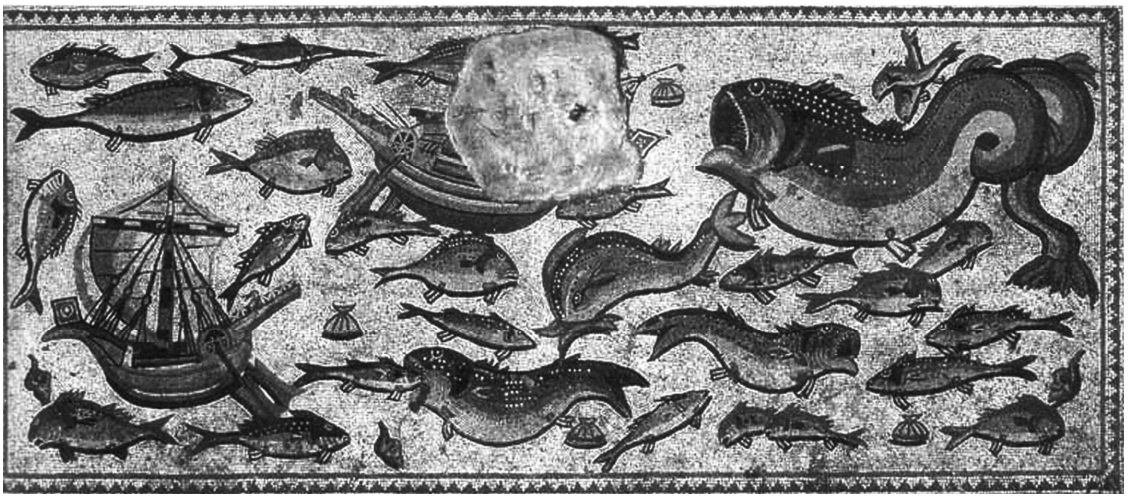
Medium: Mosaic

Origin: Rome

Description: Cargo vessel depicted on the floor of a house in Rome. The aft portion of a square-sail, probably the main, is visible. Two sets of lines run from behind the sail to the stern of the vessel, these may represent the backstay and the port braces. The starboard braces are visible running forward from the yardarm while the starboard sheet is secured near the steering oar. The sail is crisscrossed with intersecting lines and the brail rings are clearly depicted. It is worth noting the difference between the pattern of lines on the sail and the brickwork on the lighthouse to the left of the ship.

Related literature: (Casson 1995: xxv & fig. 154).

Vessel 18



Period/Date: Late 3rd/early 4th century AD

Medium: Mosaic

Origin: Lod, Israel.

Description: Maritime scene on a mosaic found on a floor within a Roman villa. The mosaic floor seems to be the product of a local workshop which used patterns from Antioch as well as from North Africa (Avissar 2001: 50). Two sailing ships are depicted, one has been damaged by a cesspit dug in the Ottoman period. The vessels are depicted on the open sea, as witnessed by the mass of fish which curve like waves. The damaged vessel has been interpreted as approaching disaster, this is reinforced by the presence of an enormous fish on the right of the scene. It may represent the sea swallowing the ship. Although the mosaic has been interpreted as showing two different ships, it seems more likely that it is in fact showing the same vessel. The left hand vessel is sailing without difficulty while the other shows the same vessel approaching destruction. The ship is a single-masted square sail vessel, it is also rigged with a Roman topsail. The mast is supported by six sets of ropes which may be shrouds, stays or a mixture of the two.

Related literature: (Avissar 2001; Friedman 2004; Haddad & Avissar 2003; Rosen 2004).

Vessel 19

Period/Date: Roman Imperial

Medium: Gems

Origin: Unknown

Description: Two depictions of an oared galley rigged with a single mast and square-sail. Their significance lies in the depiction of the spar from the bow of the vessel which is clearly acting to secure bowlines from the luff of the sail. Braces are visible in both vessels and lifts are evident in the left hand gem. The face of both sails are covered in intersecting vertical and horizontal lines.

Related Literature: (Basch 1989).

Vessel 20

Period/Date: AD 306 – Reign of Diocletian and Maximian

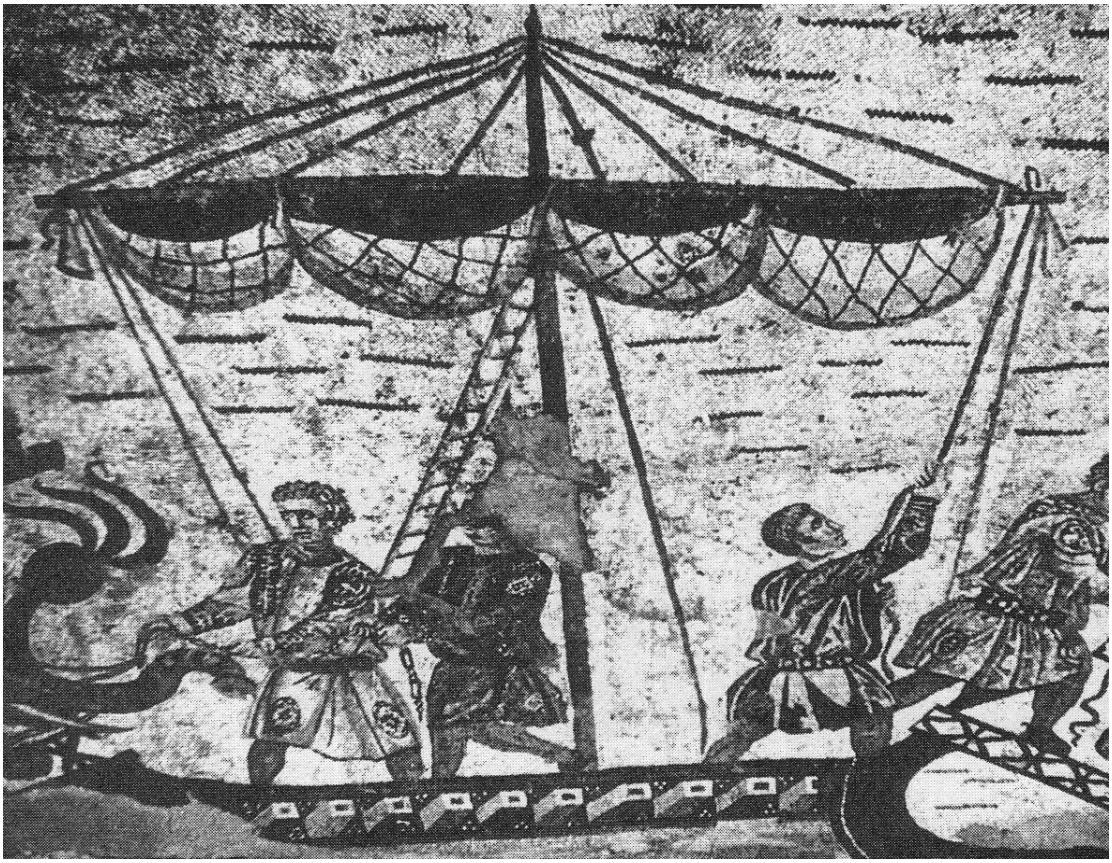
Medium: Coin

Origin:

Description: Fully two-masted vessel similar to vessel 004. Both masts and the square-sails with which they are rigged are equal in size. The yards are supported by lifts and the sheets and braces are also visible.

Related literature: (Casson 1995: xxvi & fig.169; Torr 1895: Pl. 6, figs 27, 28 & 34).

Vessel 21



Period/Date: 4th century AD

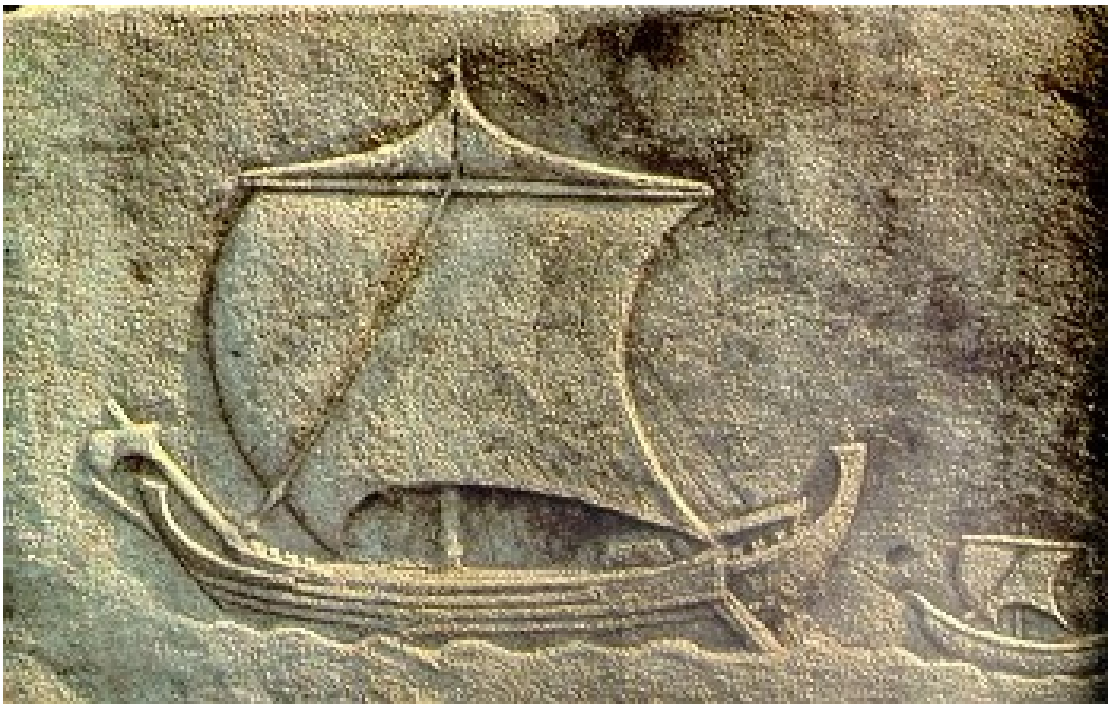
Medium: Mosaic

Origin: Piazza Amerina, Sicily

Description: Mosaic showing a galley unloading wild beasts, presumably for some form of gladiatorial games. The use of a galley for such a purpose highlights the fact that oared vessels could be use for cargo transport. Alternatively it demonstrates the issue of artists being unconcerned with the accurate depiction of such transport vessels. The ship itself is shown rigged with a single square-sail, the sail is shown furled to the mast, presumably with brails, although none are shown. The yard is supported with four lifts per side, a halyard is shown and the sheets and braces trail down from the mast. The sail is shown criss-crossed with dark lines.

Related literature: (Casson 1991: 192 & pl. 47; 1995: xxiv & fig.141).

Vessel 22



Period/Date: 4th century AD

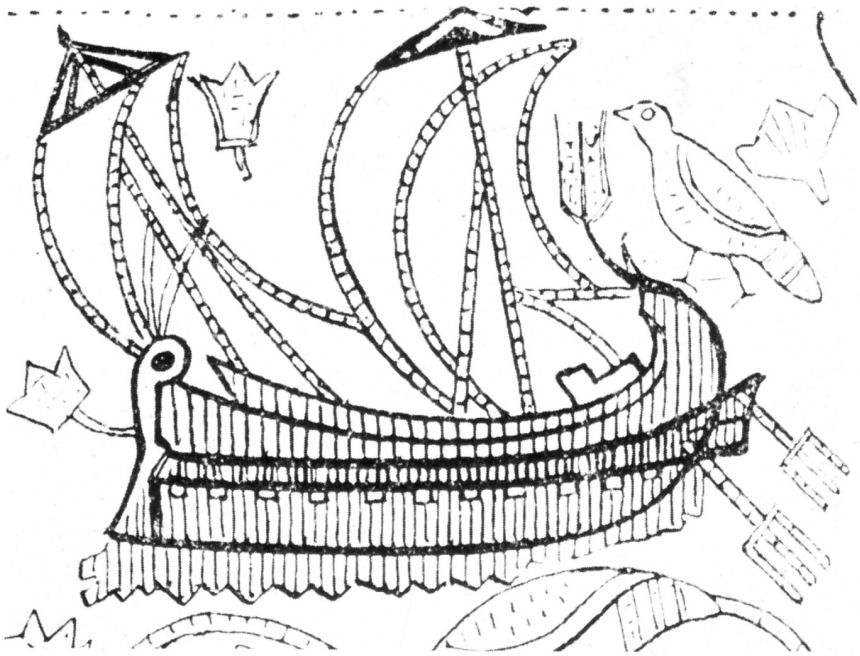
Medium: Relief, Sarcophagus

Origin: Sinope, Turkey

Description: Depiction showing a sailing ship, with a smaller ship towed behind. The larger has a main mast and artemon, both rigged with a square-sail. The ship is also rigged with Roman topsail, the relief is carved to show that in this case the topsail is formed from two pieces of sail-cloth, one rigged either side of the mast. A forestay is shown which is made off to the base of the artemon. Two incised lines run from the stern of the vessel toward the mast head as far as the leech of the sail, they may represent a double backstay, or a double halyard. Two incised lines, immediately abaft the mast, run toward the masthead from the deck to the foot of the sail. They may represent shrouds or a double halyard. The smaller vessel which is being towed has a single mast and square-sail and is shown with a forestay.

Related Literature: NAVIS II database.

Vessel 23



Period/Date: 5th Century AD

Medium: Mosaic

Origin: Tunisia

Description: Two-masted vessel depicted in a mosaic at Tabarka in Tunisia dating to the 5th century AD. The vessel has two equally sized masts and sails, the foremast is inclined slightly forwards. The two masts are set in a similar way to V004 & 016 with the mainmast aft of amidships and the foremast set slightly back from the bow of the vessel. The vessel has a concave stempost comparable to one of the ships in V007, V020 and the Saint Gervais C shipwreck. The rigging is too stylised to gain any information other than the fact that the ship is rigged with square-sail on each mast and has lifts to support the yard.

Related Literature: (Basch 1987: 482 & Fig. 1111).

Vessel 24

Period/Date: AD 500

Medium: Mosaic

Origin: Byzantine

Description: 6th century depiction of a sailing vessel from the floor of a church at Beit Loya, Israel. The vessel is clearly rigged with a single square-sail which appears to have vertical seams to the sail cloth. The parrel is depicted holding the yard to the mast with a black line depicting a halyard running from the masthead to the deck. Two more lines, representing the forestay and backstay run from the top of the masthead to the bow and stern respectively. The vessel is shown with the large twin steering oars typical of Byzantine sailing ships.

Related Literature: (Navis II; Patrich & Tsafrir 1993: Pl. XIX).

Vessel 25

Period/Date: 6th century AD

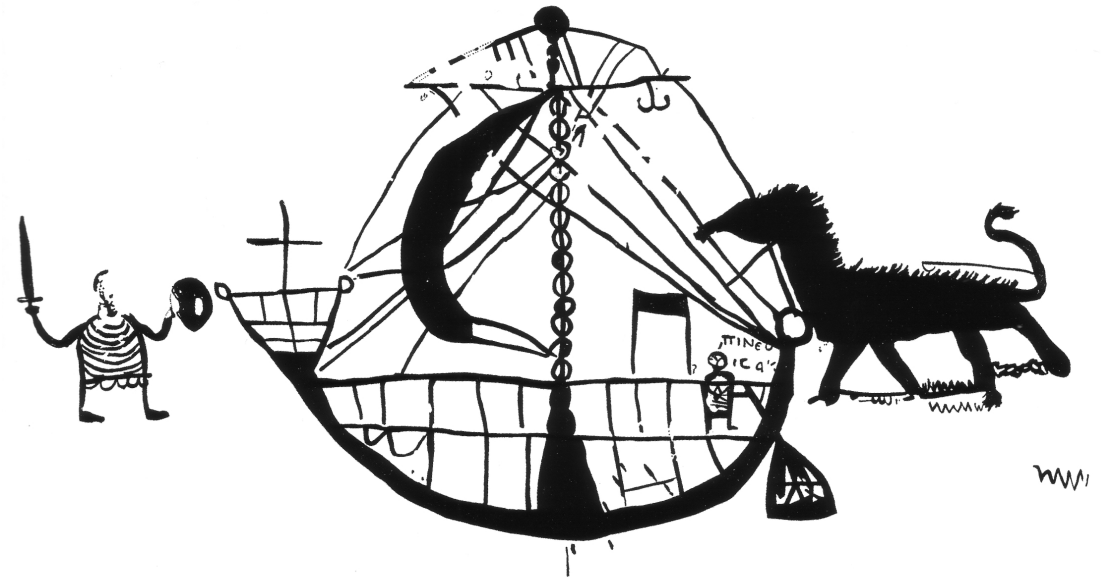
Medium: Mosaic

Origin: Sant' Apollinare Nuovo, Ravenna, Italy

Description: Mosaic showing three vessels adjacent to fortified walls. All of the vessels are rigged with a single mast supported by a double forestay and backstay. One of the vessel also has a square-sail set. The face of the sail is delineated by lines forming a ‘brickwork’ pattern. It is possible that the highest level of this pattern may represent a Roman topsail. The brickwork pattern on the face of the sail is similar to the marking on the nearby walls.

Related Literature: (Bass 1974: 154; Kingsley 2004a: 131).

Vessel 26



Period/Date: AD 600-630

Medium: Graffiti

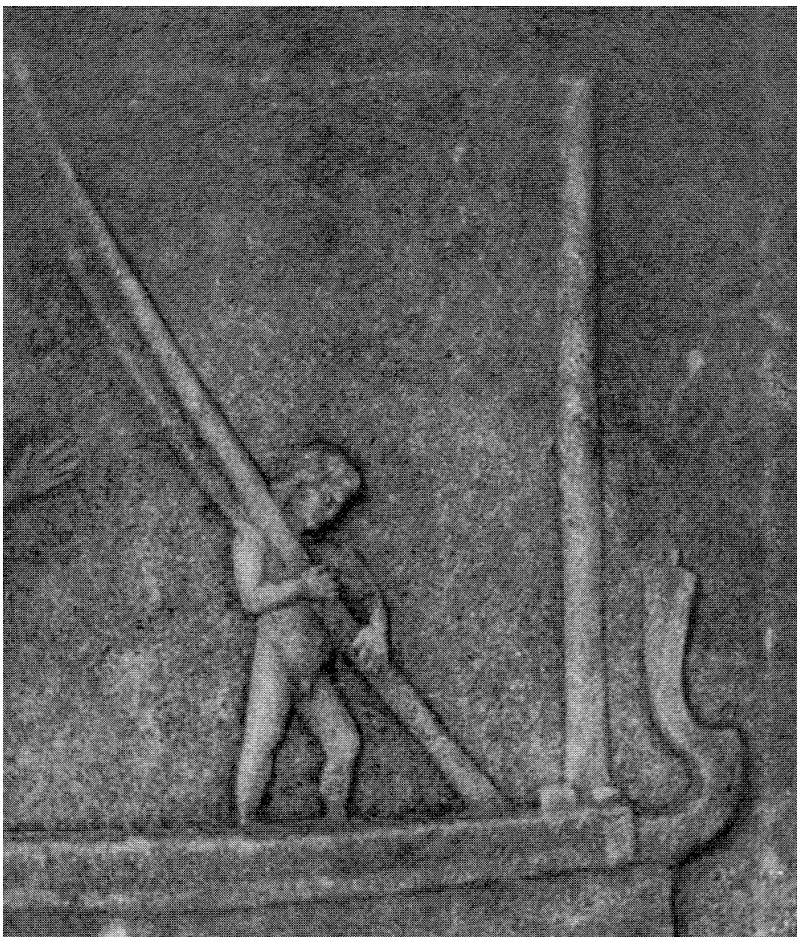
Origin: Monastery (Kellia) 80 km SE of Alexandria

Description: A graffito from the same monastic settlement as vessel 023. The vessel depicted is rigged with a single mast. The horizontal, symmetrical nature of the yard suggests that the sail (which is shown from the side) is a square-sail. The lines running from the mast, yard and sail are confused, however it is possible to interpret port and starboard braces, two sheets, forestay, backstay and possibly lifts. All of which could reasonably expected to be present on a vessel rigged with a square sail.

Related Literature: (Kasser 1978: fig. 156; Kingsley 2004a: 65).

5.3.2 The Mediterranean sprit-rig

Vessel 27



Period/Date: 2nd century BC

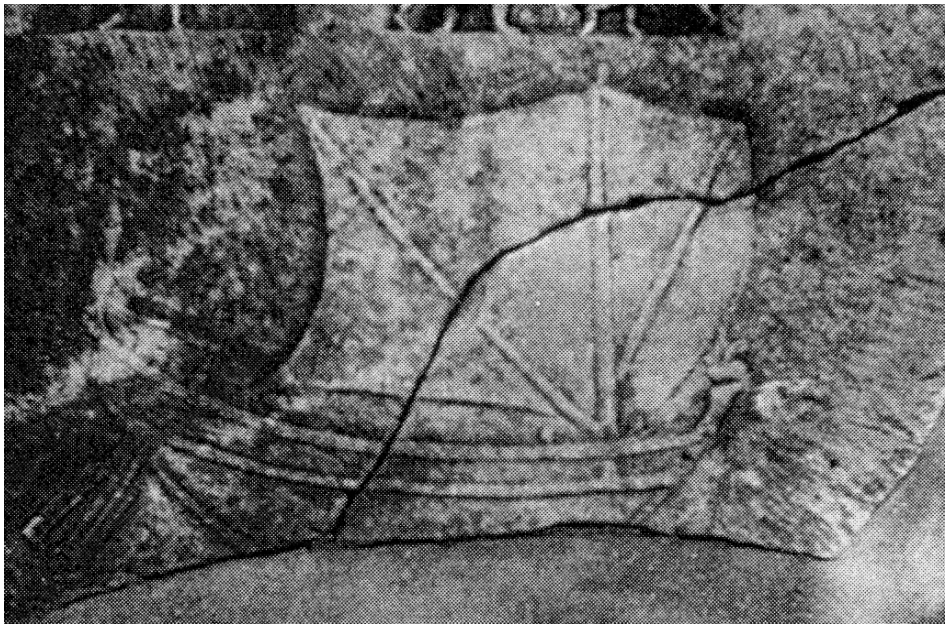
Medium: Relief

Origin: Thasos

Description: Clear depiction of a vessel rigged with a sprit-sail. The mast is set well forward in the bow of the vessel and a member of the crew is in the process of setting the sprit.

Related literature: (Casson 1960; 1995: xxvi & fig. 176).

Vessel 28



Period/Date: 1st – 2nd century AD

Medium: Relief, Gravestone

Origin: Çemberli-Taş, Turkey

Description: Vessel depicted on the gravestone of Peison of Cratea which has been interpreted as showing a vessel rigged with two spritsails (Casson 1995: xxvi) set 'goose-winged'. The sprits are clearly visible on each sail.

Related literature: (Casson 1956; 1995: xxvi; La Roërie 1956a; Le Baron-Bowen 1957).

Vessel 29

Period/Date: 2nd – 3rd century AD

Medium: Relief, Gravestone

Origin: Lampsacus, Turkey

Description: Gravestone of Demetrius of Lampsacus, showing a single-masted vessel. The mast is set forward in the bow of the vessel and the shape of the sail, particularly the concave curve to the head of the sail strongly suggests a sprit-rig. No other details are present

Related literature: (Casson 1956: fig. 2; 1991: pl. 50; 1995: xxvi & fig. 177; La Roërie 1956a; Le Baron-Bowen 1957).

Vessel 30

Period/Date: 3rd Century AD

Medium: Relief on Sarcophagus

Origin: Rome

Description: The central vessel in the relief. This vessel is an excellent example of the sprit-sail rig. The mast is mounted forwards in the vessel with a forestay/halyard secured slightly forwards of it. The sprit is not visible from this view but is depicted on the other side of the sail (c.f. Casson 1991: pl. 51), the braces used to control its upper end are visible however. The surface of the sail is characterised by a 'brickwork' pattern. Of further significance is the fact that this vessel is identical to vessel 008 in everyway except for its rig. This suggests that the artist made a conscious choice to depict this particular type of rig rather than the more usual square-sail present on the other two vessels.

Related literature: (Casson 1956; 1960; 1991: pl. 45 & 51; 1995: xxiv & fig. 147; La Roërie 1957a; Le Baron-Bowen 1956; 1957; Lyman 1957; Moore 1957).

5.3.3 The Mediterranean lateen/settee rig

Vessel 31

Period/Date: 2nd century AD

Medium: Relief, Tombstone

Origin: Piraeus, Greece.

Description: Vessel depicted on the tombstone of Alexander of Miletus. This relief has been cited by Casson (1956) as being the earliest depiction of a lateen sail. This conclusion is based upon the shape and inclination of the yard. While seemingly straightforward this interpretation has been disputed by some scholars (e.g. La Roërie 1956a) and the vessel has been interpreted as a poorly executed square-sail. Casson continues to refer to the depiction as the first concrete evidence of the lateen sail. The sail has a short luff, indicating its status as a settee sail. The larger of the two figure holds a stick which runs towards the yard at the point where a vang could be expected to be attached on a lateen/settee sail.

Related Literature: (Bass 1974; Casson 1956: 148; 1991: pl. 49; 1995: xxvii & fig. 181; La Roërie 1956a; 1957a; Le Baron-Bowen 1956; Moll 1929).

Vessel 32

Period/Date: 5th – 6th century AD

Medium: Mosaic

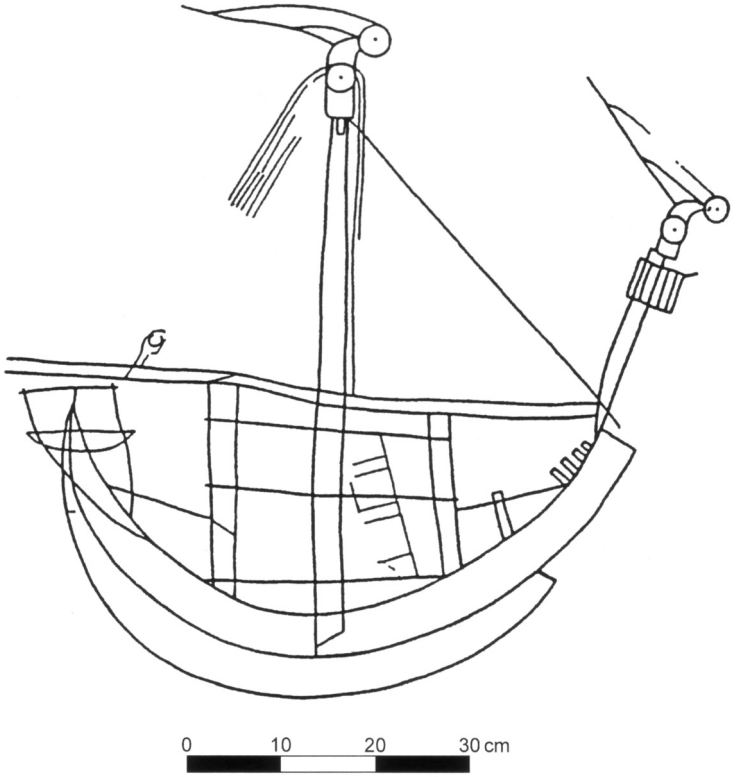
Origin: Kelenderis, Turkey

Description: The harbour scene shown above comprises one third of the mosaic, the remainder being comprised of geometric patterns. The buildings which border the harbour are depicted from a birds-eye view while the ships are shown from a more conventional side view (Friedman & Zoroglu 2006: 1). The scene itself shows a sailing vessel in the harbour of Kelenderis, the central ship is towing another sailing vessel and a rowing boat, both are small in comparison to the central ship.

The mosaic has only recently been published and has been at the centre of some discussion regarding the type of rig depicted on the large sailing vessel with both square-rig and lateen rig suggested. Several things point to the latter being the more likely solution to this problem. The yard is inclined and the head and foot of the sail are not parallel. In other words the upper and lower corners are closer together at the bow than they are at the stern. On other depictions, such as vessel 002 the upper and lower corners are the same distance apart at both ends of the yard. The latter suggests a sail which is square in plan-form, while the former points to a trapezoidal sail-plan. The structures at the foot of the mast bear comparison with those depicted on vessel 023 which is undisputedly a lateen rigged vessel. Finally the halyard system which is depicted also bears comparison with vessel 023 and other ethnographically observed lateen rigged craft

(chapter 2.2). The sail is also shown with a line of reefing points underneath the yard. These are also non-parallel with yard and foot which is consistent with later Mediterranean lateen rigged craft but not with square-sail vessels fitted with reefing points. A row of bitts, used in securing the tack and sheer of the sail are visible protruding from the gunwale at the bow and stern of the vessel. A forestay is also depicted. In summary, the relief from Kelenderis is almost certainly a depiction of a Mediterranean settee rigged sailing ship.
Related Literature: (Friedman & Zoroglu 2006; Pomey 2006; forthcoming).

Vessel 33

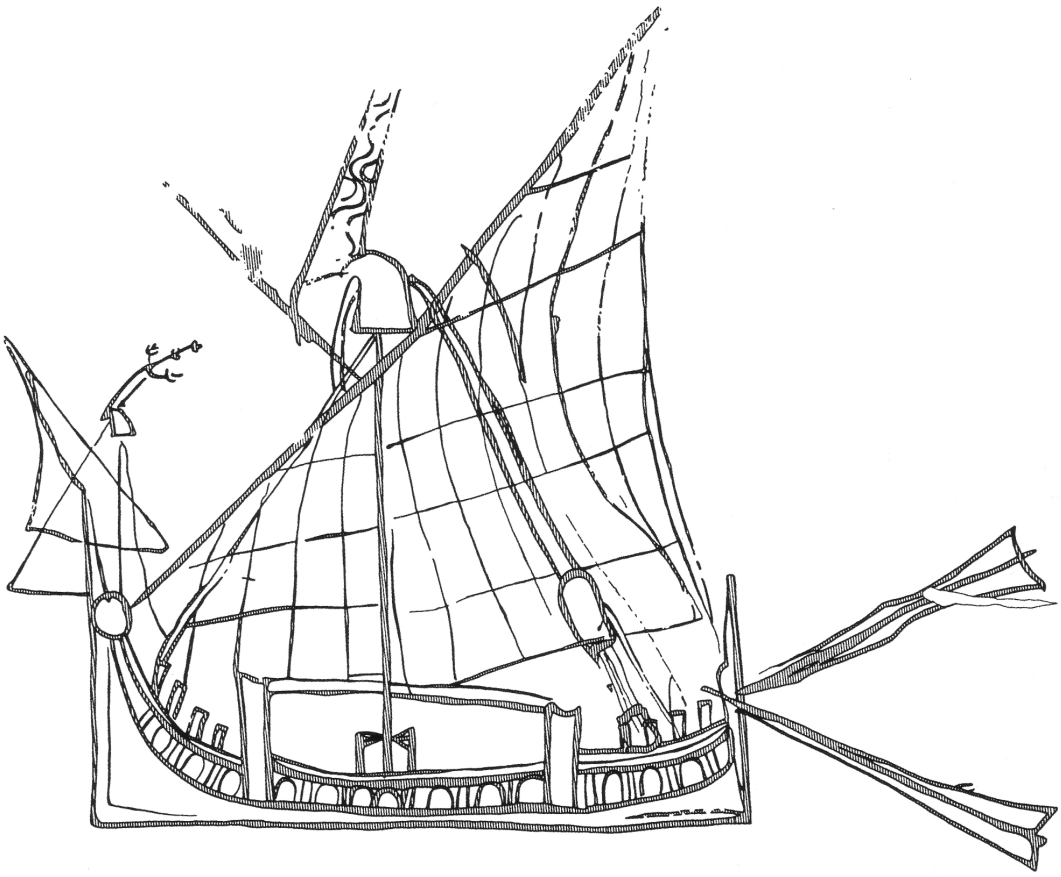


Period/Date: Byzantine, 5th-6th century AD
Medium: Graffito
Origin: Corinth, Greece
Description: Sailing vessel depicted with a main mast in the centre of the vessel and a smaller forward raking foremast set in the bow of the vessel. The foremast would be interpreted as an *artemon* if the vessel was from an earlier period. The top of each mast is finished with a hook-shaped masthead which points towards the bow, it is consistent with the mastheads shown on contemporary and later lateen/settee rigged vessels from the Mediterranean. The halyard system of the mainmast is visible passing through the masthead before returning to a double line which runs the length of the vessel, this represents the yard in its lowered position (Basch 1991b: 18). The mast is supported with a forestay. At the foot of the mast are a series of vertical and horizontal lines which have been identified by Basch (1991b) as a *xylokastron*, characteristic of

Byzantine ships (Pomey 2006: 327). Such a structure can also be seen on vessels from Kelenderis (V022) and Kellia (V023). A row of bitts near the bow is also comparable to similar features on V022 and V023.

The sail of the vessel is not shown, therefore its sail-form is open to speculation. However, several factors point to it being rigged with a lateen or settee sail. The vessel shares a number of features with other contemporary lateen/settee rigged vessels including the halyard system and gunwale bitts. Significantly the form of the masthead is the same as that shown on Mediterranean lateen/settee ships for at least the next 500 years and seen by some scholars as characteristic of Mediterranean lateen/settee rigged vessels. The possible yard, which the halyard is shown attached to, extends for the whole length of the vessel and protrudes over the stern. This is consistent with yard lengths from contemporary depictions (V022 & 023) and observed on modern Mediterranean lateeners (Moore 1925: 98). The yard of a square-sail vessel is unlikely to be of such extreme length. It therefore seems reasonable to classify V040 as rigged with a lateen or settee sail, it would also represent the earliest definite two-masted version of such a vessel in the Mediterranean.
Related literature: (Basch 1991a; 1991b; Pomey 2006).

Vessel 34



Period/Date: AD 600-630

Medium: Graffiti

Origin: Monastery (Kellia) 80 km SE of Alexandria

Description: Graffito of a vessel rigged with a lateen sail drawn on the wall of a monastic cell in the early 7th century. The triangular form of the sail suggests that it is rigged with a lateen sail. The supports around the masts are similar to those shown in vessel 022. A forestay is depicted and a double halyard which runs through a hook-shaped masthead before returning to a large block above the deck. This lower block is served by a series of smaller lines which connect it to a block set into the deck. The same arrangement can be seen on ethnographically observed lateen rigged vessels (chapter 2.2). There is the suggestion of a brace running from the peak of the sail to the deck. A row of bitts, used in securing the tack and sheer of the sail are visible protruding from the gunwale at the bow and stern of the vessel. Vessel 023 should be noted as a far more unambiguous depiction of a lateen rigged ship than the earlier depictions described above.

Related Literature: (Basch 1991a; 2001; Frost 1995; Kasser 1983: 314; Kingsley 2004a: 78).

Vessel 35

Period/Date: AD 880-883

Medium: Manuscript

Origin: Byzantine

Description: Scene depicting the story of Jonah on a Byzantine manuscript showing the sermons of St Gregory of Nazianus now housed in the Bibliothèque Nationale, Paris (MS. *Grec* 510, fol 3). As with many other depictions the same vessel is depicted twice. The left-hand vessel is getting ready to depart, while the right-hand vessel is under full sail, while throwing Jonah overboard. The ship is rigged with a lateen sail and as the right-hand depiction shows this is fully triangular, rather than trapezoidal. A double halyard is depicted, which the crew on the left-hand vessel are hauling upon, the block depicted on the halyard system presumably fulfils a similar role to that in vessel 022 and 023. Both ships are shown with the halyard running to a hook-shaped masthead. In both cases the ship is shown with a pair of braces rigged from the peak of the sail to the deck. In the right-hand depiction tack tackles can be seen to control the tack of the sail. Both vessels are depicted with a pair of lines forward of the mast, these may represent lateral support for the mast or some form of forestay, the latter seems more likely. The furled sail is similar to the foot of the sail in vessel 022 which may suggest that the sail of that vessel is not fully unfurled. The sail of the right-hand vessel is comprised of vertical lines intersecting with horizontal lines to form a 'sideways brickwork' pattern.

Related Literature: (Basch 1991b: Fig. 1; Bass 1974: 148--9; Hourani 1951: pl. 5; Landstrom 1978: Fig. 112).

Vessel 36

Period/Date: AD 880-883

Medium: Manuscript

Origin: Byzantine

Maritime scene depicted on a Byzantine manuscript showing the sermons of St Gregory of Nazianus housed in the Bibliothèque Nationale, Paris (MS. *Grec* 510, fol 367). The vessel depicted has a typically Byzantine style rounded hull and large steering oars. The mast is topped by a hook-shaped masthead indicative of a lateen rig. The sail is lateen/settee in shape, it is unclear if the artist has depicted the ship with a small luff or not, so either definition is possible. A forestay and backstay/halyard can be seen running from the masthead towards the deck. Between each of these and the mast is a further set of lines which probably represent some form of lateral support for the mast. The sail cloth is shown with a brickwork pattern (c.f. V024) with the continuous lines running vertically from the foot of the sail to its head.

Related literature: (Basch 1991b: Fig. 2; Landstrom 1978: Fig. 114; Pryor 1994: 66).

Vessel 37

Period/Date: 9th century

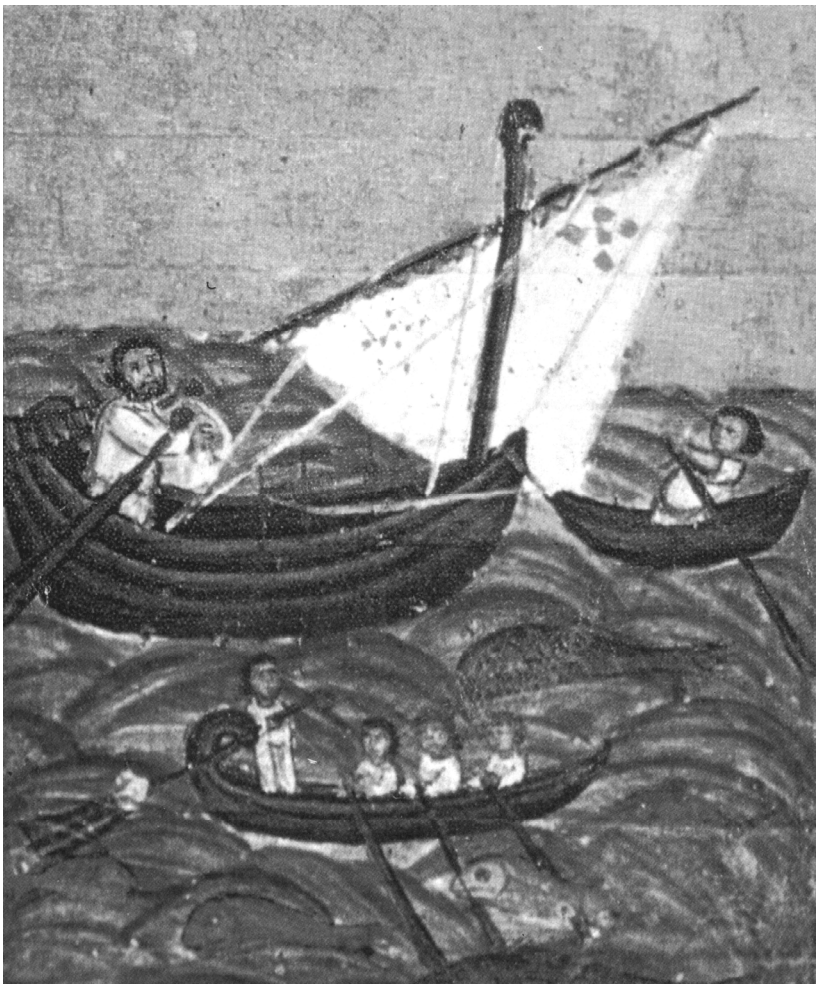
Medium: Manuscript

Origin: Chalki Island, Turkey

Description: Illustration from the Chludov Psalterium (Ps. LXXXVIII, 10) showing a sailing vessel. A figure representing Jesus is shown calming the tempest. The hull of the vessel is typically Byzantine in nature and a large pair of steering oars are depicted. A hook-shaped masthead is depicted from which runs the halyard/backstay of the vessel. A line representing a forestay may run from masthead to the forward deck of the vessel. The sail itself is settee rather than lateen shaped, illustrating their contemporaneous use in the Mediterranean at this time. A line controlling the tack of the sail is again present.

Related Literature: (Basch 1991b; Landstrom 1978: Fig. 113; Tikkanen 1895/1900).

Vessel 38



Period/Date: 12th Century AD

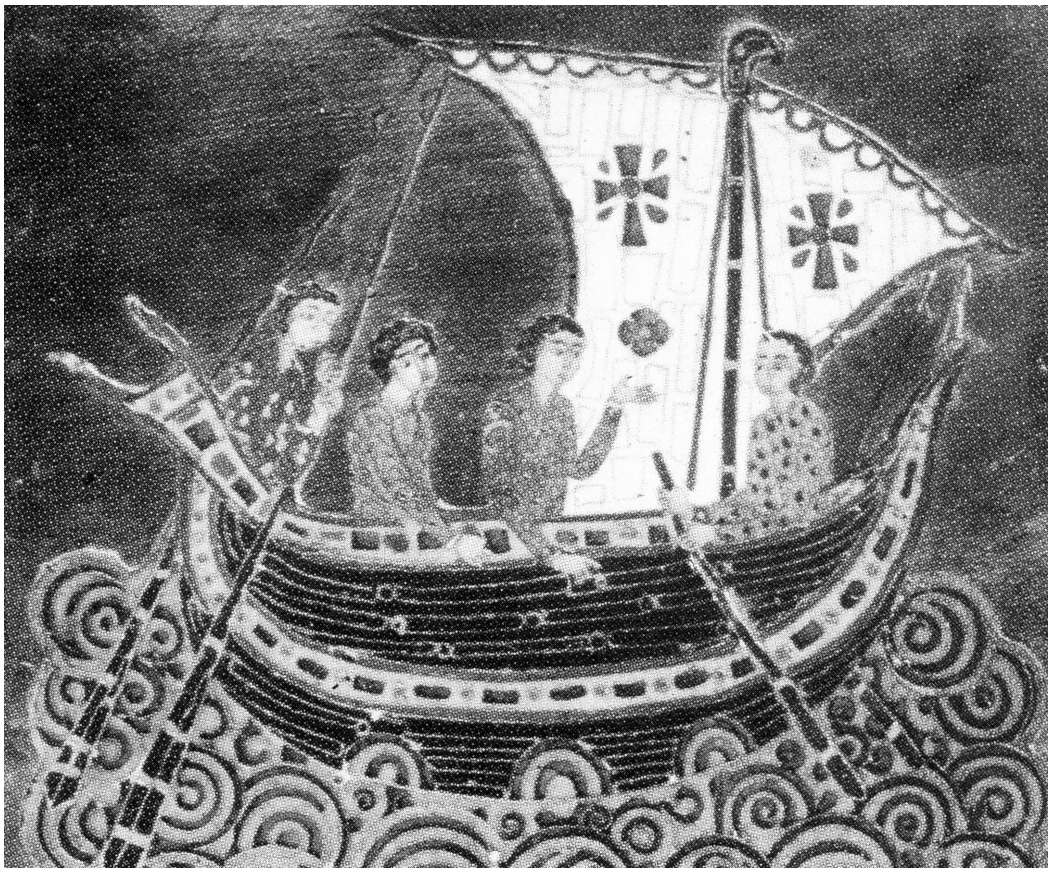
Medium: Manuscript

Origin: Mount Athos, Greece

Description: 12th century manuscript illustration depicting a single-masted lateen rigged ship. The vessel seems to be sailing downwind. Indicated by the squaring of the yard across the vessel and the rigging of an additional vang on the lower, forward half of the yard. The vessel is also rigged with the hook-shaped masthead characteristic of early lateen/settee rigged vessels.

Related Literature: (Pryor 1994: 70).

Vessel 39



Period/Date: 12th century

Medium: Enamelled altar screen

Origin: Basilica of St Mark, Venice. Originally from Constantinople.

Description: Depiction from the Pala d'Oro altar screen from the Basilica of St Mark in Venice. The artist has shown a single-masted vessel propelled by a lateen sail. The vessel has the hook-shaped masthead characteristic of early lateen/settee rigged vessels. A double vang is depicted to control the yard and a line is visible in the bow of the ship which may represent the tack tackle. The halyard is shown as a single line running to the masthead on the aft side of the mast. Another line runs from the masthead to the deck on forward side of the mast. This may represent a forestay, or may simply be intended to mirror the halyard line.

Related Literature: (Pryor 1994: 68).

Vessel 40

Period/Date: Indeterminate

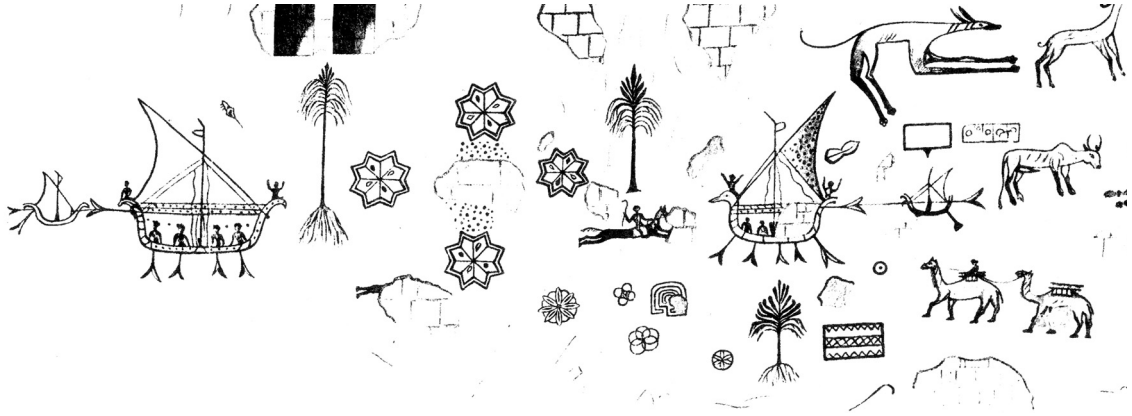
Medium: Graffito

Origin: Anfouchy, Alexandria

Description: Another depiction from *hypogea* No. 2 at Anfouchy in Alexandria, this time dated to the first century BC (Basch 2001: 80). The vessel is very simply depicted with only a few lines being used to represent the hull and rig. A single mast is shown and three lines form a triangle which may represent a lateen sail. Basch notes that there is no secure way of dating the vessel and that it could have been added at any time after the other vessels in the tomb.

Related Literature: (Basch 1989; 2001).

Vessel 41



Period/Date: Uncertain, possibly 6th century AD.

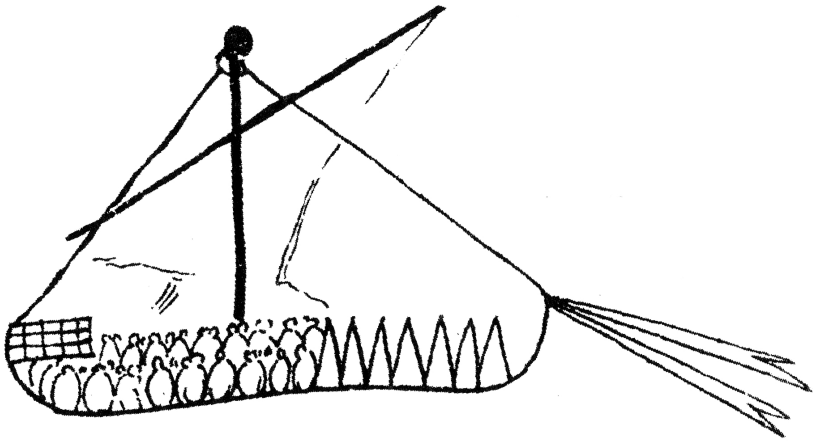
Medium: Fresco

Origin: Eboda, Israel.

Description: 3m long Fresco from a *hypogea* at the site of Eboda in southern Israel (Basch 2001: 70-71). Two vessels are depicted, each towing a very similar smaller vessel. The ships are surrounded by imagery associated with the desert such a palm trees and camels, as well as geometric shapes. The fresco may be depicting the same vessel twice, rather than two different ships. Interestingly the towing of a smaller vessel, a common feature of Mediterranean maritime iconography, is mirrored by/mirrors the camel caravan in the lower right corner. This is perhaps unsurprising given the nature of the site itself, founded by the Nabateaens and at a cross-roads of Levantine caravan routes The ships themselves are shown with single masts which carry a clearly lateen shaped sail. Other lines may indicate the halyard/backstay, a forestay and some form of running stays amidships. Both of the larger vessels are also shown with oars. The masthead of each vessel is surmounted by some sort of fitting, although this is inconsistently depicted across the four vessels.

Related Literature: (Basch 2001: 70-71 & Fig 19).

Vessel 42



Period/Date: Uncertain, possibly late-antique/early-medieval

Medium: Graffito

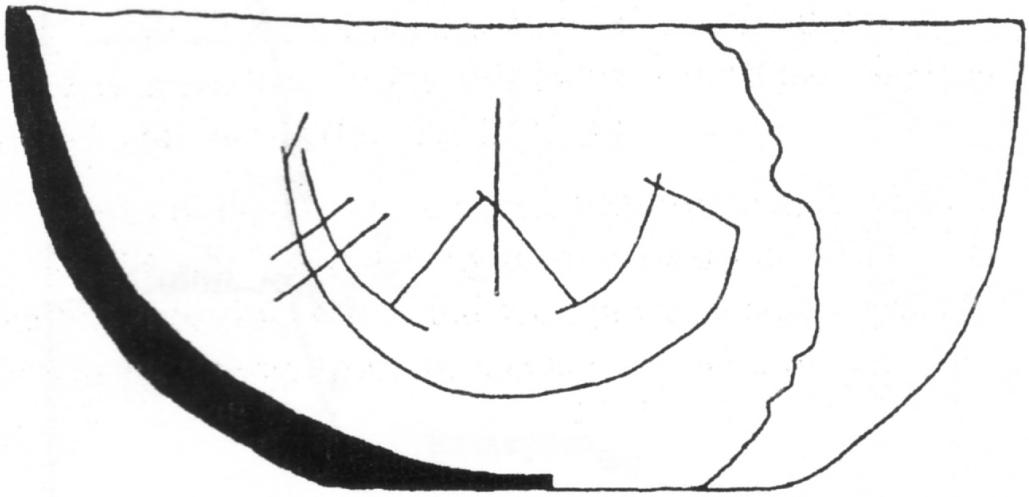
Origin: el-Auja, Israel.

Description: Graffito from a Byzantine church at the site of el-Auja in south-west Israel. The dating of the graffito is uncertain, but Basch feels that it was unlikely to have been done after the church was devasted following the Arab conquest in AD 634 (Basch 2001: 70). This feeling may be reinforced by the inclusion in the graffito of a pair of oversized steering oars similar to those seen on late-antique ship depictions from the eastern Mediterranean. The vessel is shown with a fore and backstay and a triangular sail suspended from an inclined yard which represents a lateen sail. The masthead carries some sort of fitting, but it is ambiguous in its meaning.

Related Literature: (Basch 2001: 70 & Fig. 17).

5.3.4 The Indian Ocean square-sail

Vessel 43



Period/Date: 360-190 BC

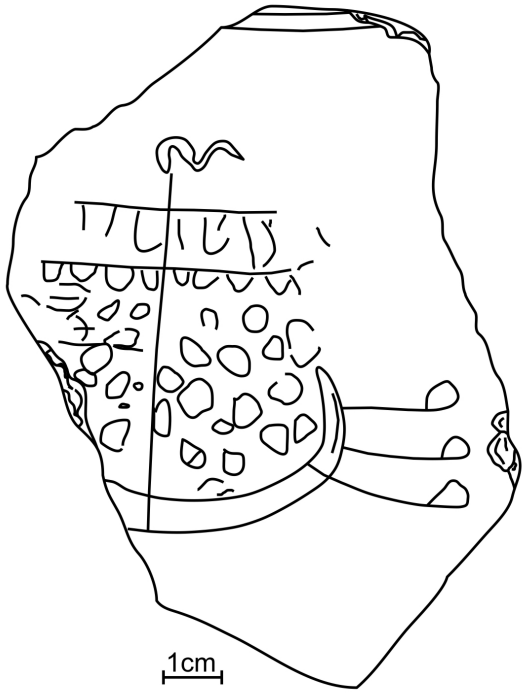
Medium: Graffito

Origin: Anuradhapura, Sri Lanka

Description: Graffito on a fine greyware bowl, from Period I at Anuradhapura. The shapes of such greyware seem to anticipate the Rouletted Ware of the Early Historic Period (Coningham*, et al.* 1996: 92). This represents the only evidence for early Indian Ocean seafaring found in a Sri Lankan context. It is not known when the graffito was incised on the pot. The vessel itself has a single mast supported by fore and backstay. In keeping with other Indian depictions of ships or boats no sail is shown. The two lines at one end of the vessel probably represent the twin steering oars, which are also common on other Indian Ocean depictions. The vessel has been described as 'ocean-going' (Coningham*, et al.* 1996: 92), although in reality there is no evidence for this other than the opinion of the viewer. Two other graffitos on potsherds from the site have also been interpreted as representing boats (Allchin 2006: 445-6). However they are far more ambiguous than V038 and could easily represent something very different. Accordingly they have both been omitted.

Related Literature: (Allchin 2006; Coningham*, et al.* 1996: fig. 16; Rajan 2002: fig. 4c).

Vessel 44



Period/Date: 300BC – 100 AD (Period II)

Medium: Graffito

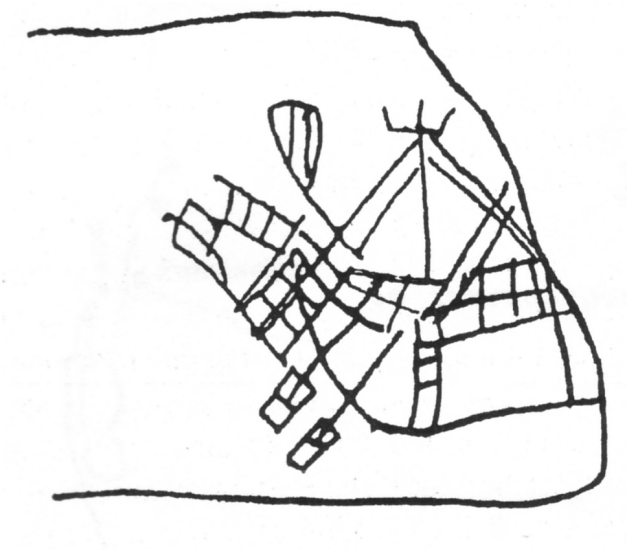
Origin: Alagankulam, Tamil Nadu, India

Description: Graffito on a sherd of local course ware from the site of Alagankulam. The significance of the graffito lies in the depiction of the yards of the vessel as well as its mast, a feature usually missing in depictions from this region at this time. The hull of the vessel is curved into a high end, one end of the vessel is damaged and missing. Three horizontal lines come from the surviving end, which terminate in ovoid shapes. These three objects may either represent steering oars or stone anchors. The latter is perhaps more likely given the fact that other depictions of Indian ships are shown with two steering oars and none are shown with three. There is no other indication if the surviving end of the vessel is the bow or the stern, it should be remembered that anchors can also be rigged from the stern as well as the bow.

A single mast survives and the curve of the hull suggests that the vessel had only one mast originally. Unlike other depictions of vessels from India, no stays are shown. Two horizontal lines cross the mast at its upper end and are evenly distributed either side of the mast. These strongly suggest the yards of a square-sail and may represent a square mainsail and square topsail. The use of topsails is paralleled in the Mediterranean, although there they are triangular in form (c.f. vessel 001, 005, 006, 011, 015, 030). The area between the lower yard and the hull is filled with round objects which may represent the cargo of the vessel. The lower line may

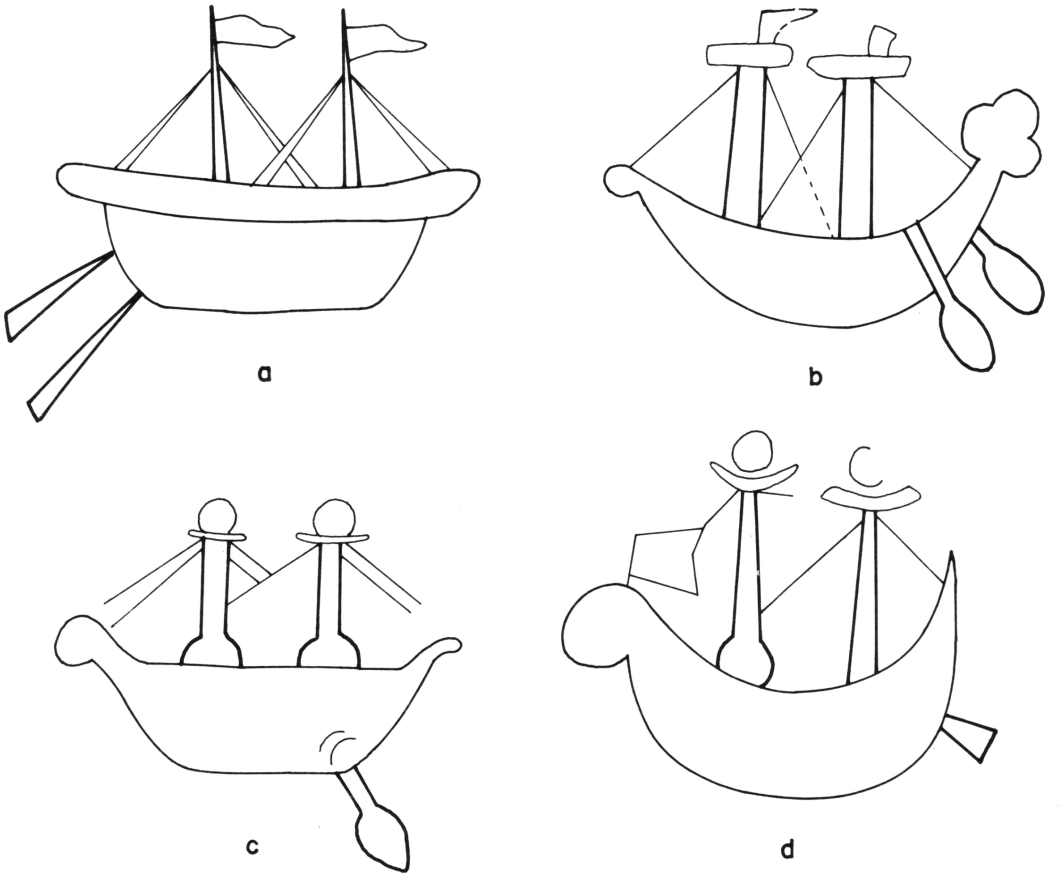
therefore represent the deck of the vessel with the cargo contained underneath, the upper line would then be the yard of the mainsail. In either interpretation the vessel is rigged with a square-sail. A series of lines hang from both horizontal lines which may represent the furled sail underneath the yards. A flag flies from the masthead of the vessel.
Related Literature: (Sridhar 2005: 67-73 & fig. 24).

Vessel 45



Period/Date: 1st-2nd century AD
Medium: Graffito
Origin: Alagankulam, Tamil Nadu, India
Description: Damaged graffito of a ship on a Rouletted Ware sherd from the Pandya port of Alagankulam on the south-east coast of India, excavated during the 5th season (1997) of work at the site. One mast is clearly visible which is supported by double fore and backstays. Two lines run from the foot of the mast forwards and upwards at an angle of 45˚, these would seem to be the double backstay for another mast. The rigging of such a vessel with two masts, supported by double stays is consistent with the depiction of vessels on coins from southern India (c.f. vessel 035). Likewise the presence of twin steering oars at the stern of the vessel. Some sort of gallery or projection is shown above the steering oars. The vessel has been interpreted as a large three-masted Roman trading vessel (Rajan 2002: 84; Sridhar 2005: 69-70). There seems little reason to draw such a conclusion and every reason to place the vessel within the existing corpus of Indian Ocean shipping.
Related Literature: (Rajan 2002: fig. 4b; Sridhar 2005: 67-73, fig. 7 & pl. 23).

Vessel 46



Period/Date: 2nd century AD

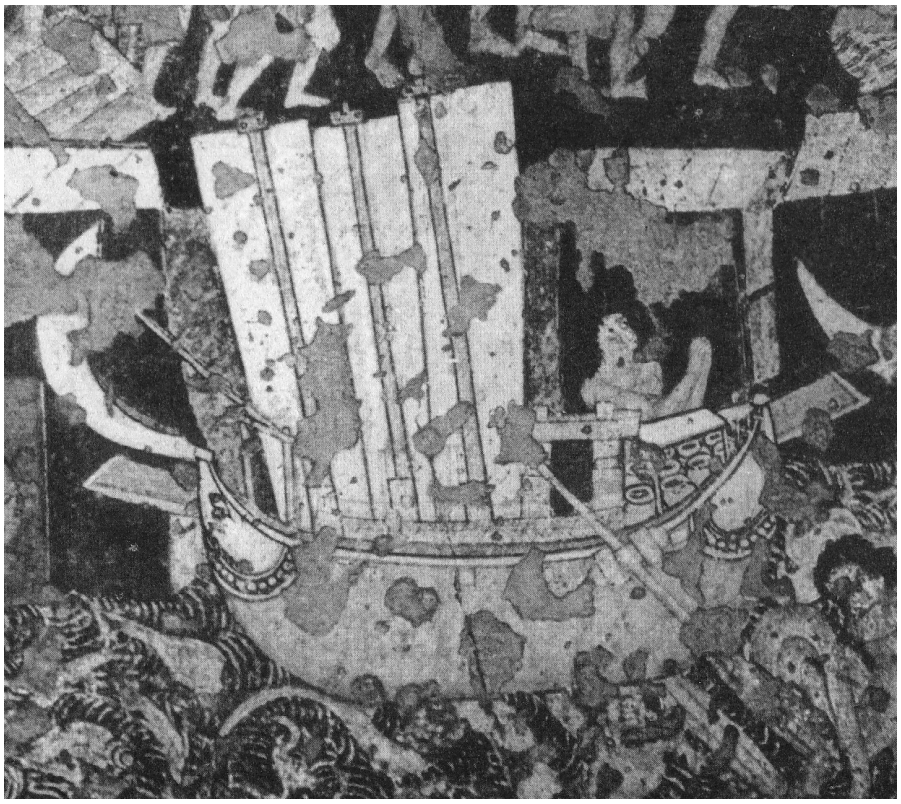
Medium: Coins

Origin: Andhra, Southern India

Description: Depictions of ships from coins of the Satavanhanas of southern India, which although individually distinct share certain characteristics. All the vessels are shown with two-masts supported by a forestay and a backstay. Likewise such vessels are usually depicted with either one or two steering oars. Some reconstructions of these vessels have been made which have rigged them with square-sails (e.g. Schoff 1912: 244). However, reference to the depictions shown above reveal that there is no definitive reason to conclude such a rig for these vessels.

Related Literature: (Deloche 1996: 243-4; Elliot 1885; McGrail 2001: 253-5; Schoff 1912).

Vessel 47



Period/Date: 4th-6th century AD (McGrail 2001: 254), AD 525-650 (Deloche 1996: 205), late 6th century AD (Nicolle 1989: 181), mid 7th century AD (Hourani 1951: pl. 4).

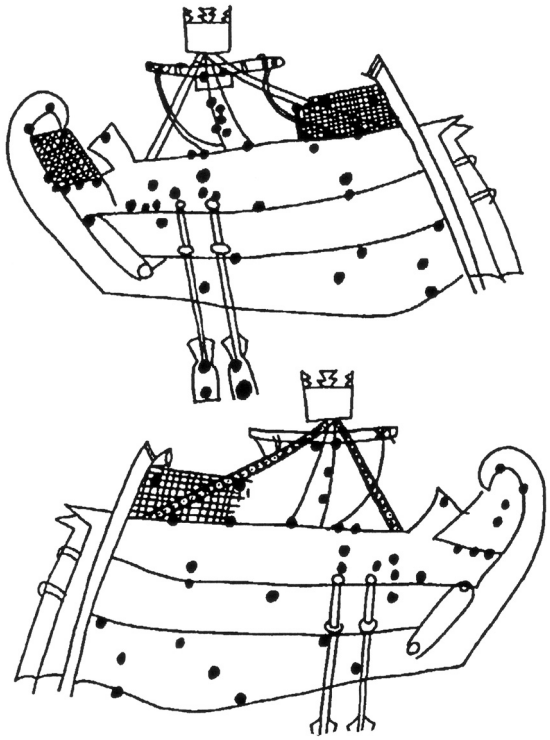
Medium: Cave painting

Origin: Ajanta, India

Description: Vessel depicted in cave number two at the Buddhist centre at Ajanta shows a vessel with three main masts and an artemon. All three of the main masts are rigged in the same way, with what is certainly a quadrilateral sail. The sails of this vessel have been likened to those of Chinese junks by some scholars (Hourani 1951: pl. 4; McGrail 2001: 255). Three-masted vessels are also depicted in other caves at Ajanta and also at Aurangabad and vessel 036 has been likened to these, suggesting an Indian origin (Deloche 1996: 205 & fig. 3). The artemon-like sail in the bow of the vessel has been compared to those seen on ships in the Mediterranean (c.f. vessel 006, 007, 008, 010, 011, 015, 029, 030) The twin steering oars are also reminiscent of the (presumed) Indian ships depicted on vessel 035. Twin steering oars were also standard fixtures on Mediterranean vessels of the period. The apparent diversity of the features of the Ajanta ship have resulted in an interpretation by Needham (1971: 454-5) that it is a composite image combining the characteristics from a number of different vessels.

Related Literature: (Deloche 1996; Hourani 1951: pl. 4; McGrail 2001: 254-5; Needham 1971; Nicolle 1989: No. 34).

Vessel 48



Date: AD 1134/5

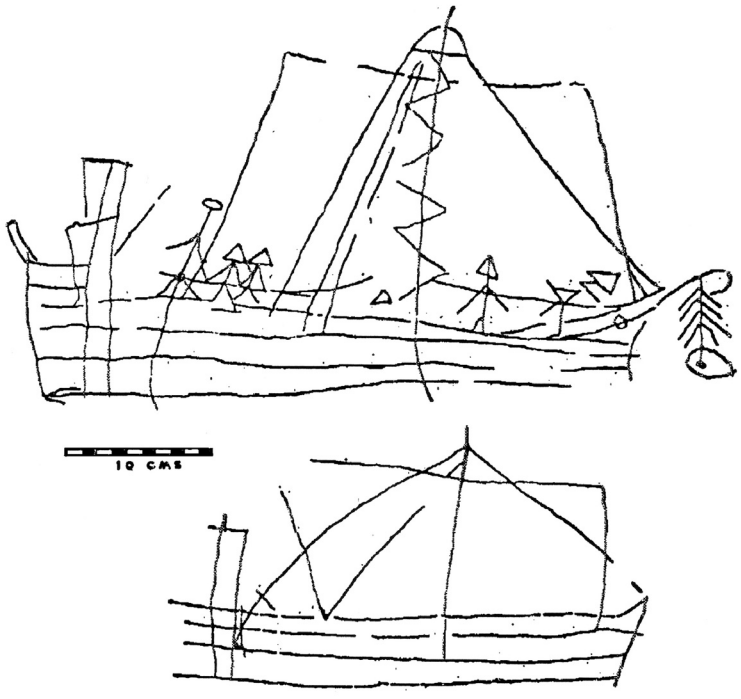
Medium: Manuscript illustration

Origin: Mardin, Mesopotamia.

Description: Depiction of 'Argo' in *Suwar al Kawakib (Book of Fixed Stars)*. The depiction is comprised of two mirror images of the same vessel. Various stars are associated by their depiction in different areas of the vessel. The vessel contains a clear depiction of a square-sail set on a mast supported by a forestay and backstay. On the upper vessel the artist has included a pair of braces running from the ends of the yard. Such an attachment position is consistent with the depiction of braces on other vessels rigged with square-sails. Nicolle also notes that the depiction contains a clear indication of a stern rudder, which predates that example on the Winchester Cathedral font by half a century

Related Literature: (Nicolle 1989: 173-4 & Fig 14a & 14b).

Vessel 49



Date: 15th century AD

Medium: Graffiti

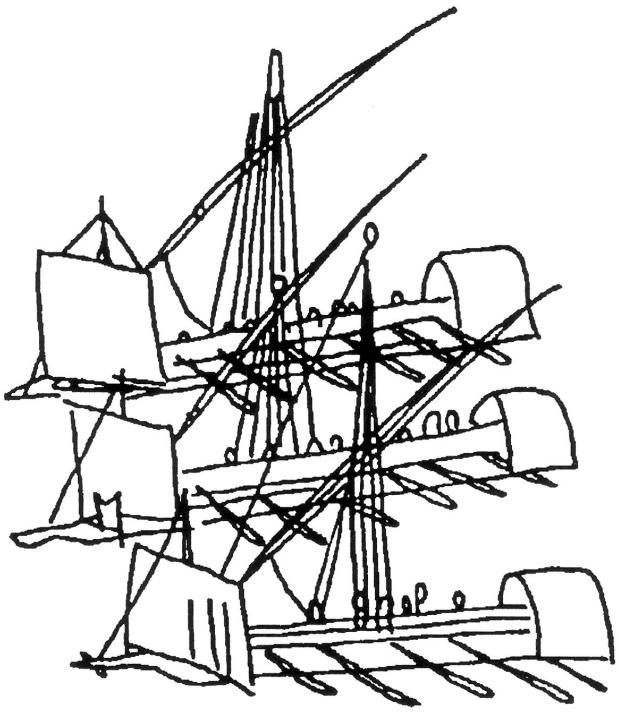
Origin: Kilwa Great Mosque, Tanzania.

Description: Two vessels incised in plaster on the walls of the Great Mosque at Kilwa. The dating of the vessels is derived from the fact that they seem to have been scratched in the plaster before it was completely set, shortly after it was applied to the wall. Both vessels are thought to represent local sailing vessels because of the resemblance of the hulls to vessels such as the *Mtepe*. Both vessels have single masts and what appear to be fairly unequivocal depictions of square-sails. The artists have also shown the vessels with a forestay and some elements of a backstay or halyard. However the most important feature is the rigging of the vessels with a square-sail.

Related Literature: (Garlake & Garlake 1964: Fig 1)

5.4.4 The Indian Ocean lateen/settee rig

Vessel 50



Date: AD 1564

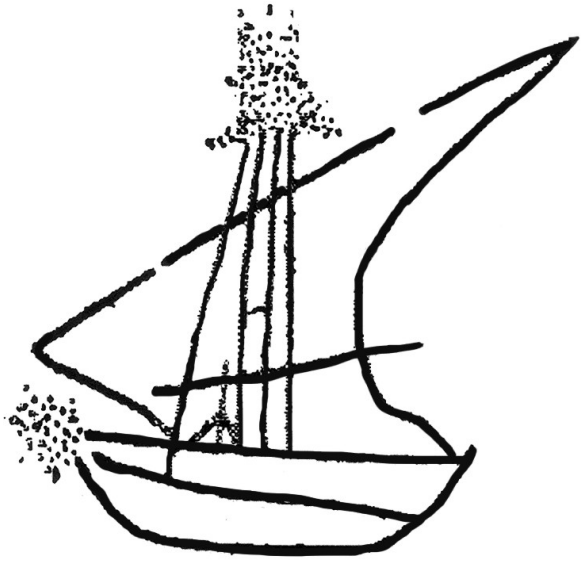
Medium: Manuscript

Origin: Portugal

Description: Three Ottoman galleys at the battle of Cape Musandam (AD 1544) depicted in the Portuguese *Livro de Lizuarte de Abreu* manuscript dating to AD 1564. The vessels are oared warships which are clearly depicted with lateen/settee mainsails and a square-sail *artemon*. The origin of the manuscript casts doubt on how representative such ships were of Indian Ocean shipping at this periods. The Portuguese creator of the manuscript may simply have illustrated Ottoman warships that were familiar to, rather than representative of reality in a distant ocean.

Related Literature: (Nicolle 1989: Fig. 79).

Vessel 51



Date: 16th century AD

Medium: Graffiti

Origin: House of the Cowries, Gedi, Kenya

Description: Small graffiti of a lateen rigged sailing vessel incised in the plastered entrance hall of the 'House of the Cowries' at Gedi in Kenya. The depiction is dated via is application before the plaster was fully set during the initial plastering of the building. Little can be said about the vessel other than that it carries a sail which is obviously lateen in form. Four vertical lines may represent the mast and a pair of running stays. The ship is the earliest example of the lateen rig in East Africa recorded by the authors. Later examples of lateen rigged and also settee rigged vessels come from 'The Captain's House' at Fort Jesus in Mombassa and date to the late 18th century AD (Garlake & Garlake 1964: Fig. 5).

Related Literature: (Garlake & Garlake 1964: Fig. 4.3)

Vessel 52

Date: 14th-15th century AD (Swamy 1997: 126); 18th century AD (Tripati 2006: 94-5).
Medium: Carving.
Origin: Aramda, Gujarat, India.
Description: Ship carved on a Hero Stone from the village of Aramda in Gujarat. The vessel has a forward raking mast in conjunction with an obvious lateen sail.
Related Literature: (Swamy 1997; Tripati 2006).

5.4 Appendix Four: Recorded voyages in square-sail and lateen/settee rigged vessels.

The following appendix represents the companion data for chapter 2.3. This represents an attempt to quantify the speeds of Mediterranean square-sail and lateen/settee rigged ships on the basis of the historically recorded voyages of real ships. By doing this it is possible to gain an insight into the relative performance on upwind (close-hauled) and offwind (reaches and runs) courses of such vessels. It is important to make a distinction between this work, which is specifically concerned with the *speed and performance* of ancient ships and other scholarly work which has been concerned with *overall journey speed* (e.g. Goitein 1967: 313-326; McCormick 2001: 481-500; Pryor 1992: 36; 1994: 73-4). The work of Englert (2006) has also been concerned with highlighting the difference between the two. The latter approach has tended to make no allowance for changes in weather conditions encountered on route and for stops made in ports or anchorages. Both of these, but the latter in particular, can suppress the resulting figures which may be calculated for a vessel's performance by increasing the time taken to complete the voyage, even when the vessel is not at sea. The information required for the current study is very simple, the point of embarkation, the final destination and the time taken to complete the journey are all that is required to complete the equation. The serves to create a picture of the performance and actual speed of a vessel, rather than overall journey time.

However, such an approach can give a false picture of the performance of ships under sail. For example, Pryor (1994 : 73) focuses upon the voyage of Ibn Jubayr from Ceuta to Alexandria in the spring of AD 1183. He notes the distance in nautical miles (2000) and the time taken to complete the voyage (31 days), this gives an average speed for the journey of 2.7 knots. However, this is not an accurate representation of the potential performance of the vessel on which Ibn Jubayr sailed. Ibn Jubayr records that they anchored near Cape St. Mark on the west coast of Sardinia from noon on Wednesday until the following Monday evening; over five days (tr. Broadhurst 1952: 27). This period of time obviously needs to be removed from the overall journey time to give a truer record of the speed of the ship (3.2 knots), rather than the average speed of the journey (2.7 knots). In this study, the same voyage of Ibn Jubayr has been utilised, but only some of its constituent parts have been drawn upon (Voyage 31 & 32) which can furnish accurate records of vessel speed in specific conditions, rather than journey time in general over a variety of conditions and circumstances.

Attempting to develop an understanding of the performance of ancient shipping in different conditions is far more complicated. As well as the information just noted, it is important to

know that a voyage was made without any stops and what the over-riding conditions encountered on route were. These are usually just expressed as favourable or unfavourable, fair or foul (e.g. Voyage 08). Such descriptive terms might be applied to the voyage or the weather conditions encountered. If this information is recorded then it possible to reconstruct the route of the voyage, the distance travelled and to calculate a Vmg for the conditions described. In some cases weather conditions tally with the known prevailing winds and at other times they do not. This approach to the problem is far more limiting of the historical data than simply calculating average journey speed. There in no room for ambiguity on the part of the literary sources. Consequently, some voyages which have been utilised and documented by other scholars have been omitted from this appendix following the study of the translated work. Finally it is worth remembering that the problems of literary evidence outlined in chapter 1.2 still apply and that all the sources must be treated with care.

5.4.1 Square-sail voyages made with unfavourable winds

Voyage 01

Period: mid-1st century BC.

Rig: Mediterranean square-sail.

Route: Sicily (Lilybaeum ?) – Anquillaria (Cape Bon).

Distance: 90 nautical miles.

Length of voyage: 2½ days.

Vmg: 1.5 knots.

Reference: Caesar, *Civil Wars.* 2.23 (translated by A.G. Peskett, 1914)

"At the same period Gaius Curio, who had set out from Sicily for Africa…after spending two days and three nights on the voyage touches at the place called Anquillaria."

Voyage 02

Period: 1st century AD.

Rig: Mediterranean square-sail.

Route: Myos Hormos - Leuke Kome.

Distance: c. 125 nautical miles.

Length of voyage: 2-3 days.

Vmg: 3 days = 1.7, 2.5 days = 2 knots, 2 days = 2.6 knots.

Reference: *Periplus Maris Erythraei* 19.

"sailing for two or three days from Mussel Harbour [Myos Hormos] eastward across the adjacent gulf, there is another harbour and fortified place, which is called White Village [Leuke Kome]"

Notes: The frequency of northerly winds blowing down the Red Sea in this area varies between 75% and 94% depending on the time of year (Davies & Morgan 1995: 28-30). The position of Leuke Kome has been established as lying on the Arabian coast to the east of the gulf of Aquaba (Ingraham, *et al*. 1981: 76-77; Sidebotham 1989: 208). The bearing of Leuke Kome from Myos Hormos is c. 030°, while the prevailing wind can be expected to be at c. 330°. A vessel making 60° including leeway might make the voyage on a single tack, given the likely strength of the wind and the associated sea state this seems unlikely. The voyage was probably one made under close-hauled conditions.

Voyage 03

Period: early 3rd century AD.

Rig: Mediterranean square-sail.

Route: Puteoli - Ostia.

Distance: 120 nautical miles.

Length of voyage: 2½ days.

Vmg: 2 knots.

Reference: Philostratus. *Life of Apollonius*. 7.16. (translated by F. C. Conybeare, 1912).

"They sailed from Dicaearchia [Puteoli], and on the third day they put in to the mouth of the Tiber from which it is a fairly short sail up to Rome."

Voyage 04

Period: Late-4th – early 5th century AD.

Rig: Mediterranean square-sail.

Route: Alexandria - Marseilles.

Distance: 1500 nautical miles.

Length of voyage: 30 days.

Vmg: 2.1 knots.

Reference: Sulpicius Severus, *Dial*. 1.1.3 (tr. Casson 1995: 290, n. 86).

"There [Alexandria] I found a merchant ship that was getting ready to shove off with a cargo for Narbo… On the 30th day I arrived as Massilia, and from there I came to here [Narbo] on the 10th. So prosperous was the voyage that fell to my pious wish"

Voyage 05

Period: AD 398.

Rig: Mediterranean square-sail.

Route: Gaza - Byzantium.

Distance: 875 nautical miles.

Length of voyage: 20 days.

Vmg: 1.8 knots.

Reference: Mark the Deacon, *Life of Porphyry. 26* (Hill 1913).

"he [St Porphyry] sent me away in a ship [from Gaza], and after twenty days we arrived [at Byzantium]"

Voyage 06

Period: September 25th – Oct 6th AD 401.

Rig: Mediterranean square-sail.

Route: Caesarea - Rhodes.

Distance: 400 nautical miles.

Length of voyage: 10 days.

Vmg: 1.7 knots.

Reference: Mark the Deacon, *Life of Porphyry. 34* (Hill 1913).

"and coming to Caesarea I found the most holy bishops making ready for the voyage; and after two days we put to sea and sailed…and by the mercy of Christ making a fair voyage after ten days we put in at the island of Rhodes."

Notes: Hill has calculated that the voyage took place in the autumn of AD 401, in the preceding passage, John Bishop of Caesarea expresses his concern about the voyage because of the lateness of the season.

Voyage 07

Period: September 25th – Oct 6th AD 401.

Rig: Mediterranean square-sail.

Route: Rhodes - Byzantium.

Distance: 445 nautical miles.

Length of voyage: 10 days.

Vmg: 1.8 knots.

Reference: Mark the Deacon, *Life of Porphyry. 37* (Hill 1913).

"and putting to sea on that day [from Rhodes], we sailed and after other ten days came to Byzantium."

Summary of square-sail voyages made in unfavourable conditions.			
Route	**Distance (n.m.)**	**Time**	**Vmg**
01) Lilybaeum - Anquillaria	90	2 ½ days	1.5 knots
02) Myos Hormos – Leuke Kome	125	2 ½ days	2 knots
03) Puteoli – Ostia	120	2 ½ days	2 knots
04) Alexandria – Marseilles	1500	30 days	2.1 knots
05) Gaza – Byzantium	855	20 days	1.8 knots
06) Caesarea – Rhodes	400	10 days	1.7 knots
07) Rhodes – Byzantium	445	10 days	1.8 knots
		Average	**1.8 knots**

Summary of square-sail voyages made with an unfavourable wind.

5.4.2 Square-sail voyages made with favourable wind

Voyage 08

Period: mid-1st century BC.

Rig: Mediterranean square-sail.

Route: Sea of Azov - Rhodes.

Distance: 880 nautical miles.

Length of voyage: 10 days.

Vmg: 3.7 knots.

Reference: Diodorus Siculus. 3.34.5-35

"From Lake Maeotis [Sea of Azov]…many sailors in merchant vessels, running before a favourable wind, have reached Rhodes in ten days, from which they have reached Alexandria in four"

Voyage 09

Period: mid-1st century BC.

Rig: Mediterranean square-sail.

Route: Rhodes - Alexandria.

Distance: 325 nautical miles.

Length of voyage: 4 days.

Vmg: 3.4 knots.

Reference: Diodorus Siculus. 3.34.5-35

"From Lake Maeotis [Sea of Azov]…many sailors in merchant vessels, running before a favourable wind, have reached Rhodes in ten days, from which they have reached Alexandria in four"

Voyage 10

Period: mid-1st century BC.

Rig: Mediterranean square-sail.

Route: Utica - Caralis

Distance: 140 nautical miles.

Length of voyage: 2 days.

Vmg: 3 knots.

Reference: Caesar, *The African War*. 98. (translated by A.G. Way, 1955).

"After making these arrangements he went aboard his fleet at Utica on June 13th and arrived two days later at Caralis in Sardinia"

Voyage 11

Period: mid-1st century AD.

Rig: Mediterranean square-sail.

Route: Rhegium - Puteoli.

Distance: 175 nautical miles.

Length of voyage: 1½ days.

Vmg: 5 knots.

Reference: Acts 28.13.

"and arrived at Rhegium; and after one day a south wind sprang up and on the second day we came to Puteoli."

Voyage 12

Period: mid-1st century AD.

Rig: Mediterranean square-sail.

Route: Ganges - Sri Lanka.

Distance: 900 nautical miles.

Length of voyage: 7 days.

Vmg: 5.4 knots

Reference: Pliny *Natural History* 6.82 (translated by H. Rackham. 1942).

"the voyage to it [Sri Lanka, from the Ganges] used to be made with vessels constructed of reeds and with the rigging used on the Nile, its distance was fixed with reference to the speeds made by our ships as seven days sail."

Notes: Archaeological finds from the Roman Red Sea ports of Myos Hormos & Berenike indicate that ships engaged in the trade between Egypt and the Indian Subcontinent were rigged in the same manner as contemporary vessels in the Mediterranean (Whitewright 2007).

Voyage 13

Period: mid-1st century AD.

Rig: Mediterranean square-sail.

Route: Straits of Messina - Alexandria.

Distance: 830 nautical miles.

Length of voyage: 7 days.

Vmg: 4.9 knots.

Reference: Pliny, *Natural History*. 19.1 (translated by H. Rackham. 1950).

Voyage 14

Period: mid-1st century AD.

Rig: Mediterranean square-sail.

Route: Puteoli - Alexandria.

Distance: 1000 nautical miles.

Length of voyage: 9 days.

Vmg: 4.6 knots.

Reference: Pliny, *Natural History*. 19.1 (translated by H. Rackham. 1950).

Voyage 15

Period: mid-1st century AD.

Rig: Mediterranean square-sail.

Route: Gades – Ostia.

Distance: 1030 nautical miles.

Length of voyage: 7 days.

Vmg: 6.1 knots.

Reference: Pliny, *Natural History*. 19.1 (translated by H. Rackham. 1950).

Voyage 16

Period: early 3rd century AD.

Rig: Mediterranean square-sail.

Route: Corinth - Puteoli.

Distance: 670 nautical miles.

Length of voyage: 4½ days.

Vmg: 6.2 knots.

Reference: Philostratus, *Life of Appolonius.* 7.10 (translated by F. C. Conybeare, 1912).

"and having landed at Corinth…embarked in the evening for Sicily and Italy. And falling in with a favourable wind and a good current that ran in his direction, he reached Dicaearchia [Puteoli] on the fifth day."

Voyage 17

Period: early 3rd century AD.

Rig: Mediterranean square-sail.

Route: Puteoli - Tauromenium.

Distance: 205 nautical miles.

Length of voyage: 2½ days.

Vmg: 3.4 knots.

Reference: Philostratus, *Life of Appolonius.* 8.15 (translated by F. C. Conybeare, 1912).

"and then they sailed for Sicily [from Puteoli] with a favourable wind, and having passed Messina they reached Tauromenium on the third day."

Voyage 18

Period: late 3rd century AD.

Rig: Mediterranean square-sail.

Route: Alexandria - Ephesus.

Distance: 475 nautical miles.

Length of voyage: 6 days.

Vmg: 3.2 knots.

Reference: Achilles Tatius. 5.15-17

"On the next day we made our preparations for departure [from Alexandria], being by good chance invited by a favourable wind…The wind was fair behind us; it was now evening and we had dined and were retiring to rest;…It took us five days sail after this to reach Ephesus."

Voyage 19

Period: AD 398.

Rig: Mediterranean square-sail.

Route: Byzantium - Gaza.

Distance: 855 nautical miles.

Length of voyage: 10 days.

Vmg: 3.6 knots.

Reference: Mark the Deacon, *Life of Porphyry. 27* (Hill 1913).

"And I after three days set sail from Byzantium, and come in ten days unto the city of the Gazaeans."

Voyage 20

Period: April, AD 402.

Rig: Mediterranean square-sail.

Route: Byzantium - Rhodes.

Distance: 445 nautical miles.

Length of voyage: 5 days.

Vmg: 3.7 knots.

Reference: Mark the Deacon, *Life of Porphyry. 54-55* (Hill 1913).

"We went aboard and set sail [from Byzantium]…on the eighteenth of April…Now we came to Rhodes in five days."

Notes: The date of this voyage is worth noting because it took place towards the very beginning of the sailing season.

Summary of square-sail voyages made in favourable conditions.			
Route	**Distance (n.m.)**	**Time**	**Vmg**
08) Sea of Azov – Rhodes	880	10 days	3.7 knots
09) Rhodes – Alexandria	325	4 days	3.4 knots
10) Utica – Caralis	140	2 days	3 knots
11) Rhegium – Puteoli	175	1½ days	5 knots
12) Ganges – Sri Lanka	900	7 days	5.4 knots
13) Straits of Messina – Alexandria	830	7 days	4.9 knots
14) Puteoli – Alexandria	1000	9 days	4.6 knots
15) Gades – Ostia	1030	7 days	6.1 knots
16) Corinth – Puteoli	670	4½ days	6.2 knots
17) Puteoli – Tauromenium	205	2½ days	3.4 knots
18) Alexandria – Ephesus	472	6 days	3.2 knots
19) Byzantium – Gaza	855	10 days	3.6 knots
20) Byzantium – Rhodes	445	5 days	3.7 knots
		Average	**4.4 knots**

Summary of square-sail voyages made in favourable conditions.

5.4.3 Lateen/Settee voyages made with an unfavourable wind

Voyage 21

Period: December, AD 1073

Rig: Lateen/Settee.

Route: Acre - Tinnis.

Distance: 180 nautical miles.

Length of voyage: 4 Days.

Vmg: 1.85 knots

Reference: (Goitein 1967: 316-317).

Notes: Goitein records the voyage of the governor of Acre (during December) from Acre to Tinnis in the eastern Nile Delta as taking four days. The direct course for the voyage is south-west. The available data suggests that although some favourable winds (easterlies) may have occurred at the outset of the voyage, the probability was unfavourable winds could be expected. The likelihood of this would increase the nearer the vessel got to its destination (Mediterranean Pilot, Vol V: 34-56). The likelihood that unfavourable conditions were encountered on route is indicated by the relatively slow passage time for the distance. If strong or stormy following winds had been encountered the passage would have been significantly faster.

Voyage 22

Period: 11th century

Rig: Lateen/Settee.

Route: Alexandria – Tripoli, Lebanon.

Distance: 360 nautical miles.

Length of voyage: 8 Days.

Vmg: 1.9 knots

Reference: (Goitein 1967: 321).

“This is to inform you that I arrived safely [in Tripoli on the Lebanese coast] after a journey of eight days…Water seeped into the ship and I worked the pumps from the very day we left Alexandria.”

Voyage 23

Period: 11th century

Rig: Lateen/Settee.

Route: Alexandria - Constantinople.

Distance: 730 nautical miles.

Length of voyage: 18 Days.

Vmg: 1.7 knots

Reference: (Goitein 1967: 326).

Notes: The generally northerly direction of this voyage could be expected to meet prevailing headwinds for the majority of the route.

Voyage 24

Period: 11th century

Rig: Lateen/Settee.

Route: Tinnis - Ascalon.

Distance: 125 nautical miles.

Length of voyage: 7 Days.

Vmg: 0.7 knots

Reference: (Goitein 1967: 326).

"At the moment we left Tinnis we were seized by an east wind"

Notes: This voyage records encountering headwinds immediately after departure. The slow time of the voyage, even with the prevailing currents suggests quite poor conditions. Despite this the master of the ship did not turn back to Tinnis but persevered beating into the wind, this in turn indicates a substantial faith in the abilities of both vessel and crew.

Voyage 25

Period: Medieval.

Rig: Lateen/Settee.

Route: Bahr al Zihār - Sha'b Sulaim (Red Sea).

Distance: c. 12 nautical miles.

Length of voyage: c. 7.5 hours.

Vmg: c. 1.6 knots.

Reference: Ibn Mājid, (Tibbets 1961: 317; 1971: 256).

"with a weak north wind from the four Zahras, the distance between them and Sha'b Sulaim is 2 or 3 *zām* with the wind in front. But with a favourable wind is does not exceed a single *zām*."

Notes: The direction of the voyage described by Ibn Mājid is north by east and the distance is approximately 10 nautical miles. When sailed on a direct course it takes less than one *zām* to

complete. A *zām* as used by Ibn Mājid is a period of three hours sailing (Tibbets 1961: 325) so the speed of the vessel can reasonably be put at around 4 knots with a light, favourable wind. With the wind from ahead however the journey takes 2-3 *zām* which would equate to about 7½ hours sailing time and produce a Vmg of 1.6 knots.

Voyage 26

Period: Summer 1916

Rig: Lateen/Settee.

Route: Khor Nawarat - The Brothers (Red Sea).

Distance: 520 nautical miles.

Length of voyage: 14 Days.

Vmg: 1.54 knots.

Reference: de Monfried 1974: 116.

Voyage 27

Period: December 1938.

Rig: Two-masted settee.

Route: Aden - Mukalla.

Distance: 266 nautical miles.

Length of voyage: 12 days.

Vmg: 0.92 knots.

Reference: Villiers 1940: 26-51.

Notes: The whole of this leg of Villiers' voyage on the Triumph of Righteousness took place in the light winds of the early stages of the north-east monsoon. Some idea of the speed of progress can be gained from Villiers (1940: 49) statement that the ship 'ghosted' along. The majority of the voyage took place close in to the coast in order to avoid the westerly flowing current in the Gulf of Aden at that time of year.

Voyage 28

Period: 21st century.

Rig: Lateen/Settee.

Route: Northern Red Sea (Marsa Alam).

Distance: 15 nautical miles.

Length of voyage: 12 hours.

Vmg: 1.25 knots.

Reference: Personal communication during interview by *Nakhooda* Said.

Summary of latee/settee voyages made in unfavourable conditions.			
Route	**Distance (n.m.)**	**Time**	**Vmg**
21) Acre – Tinnis	180	4 days	1.85 knots
22) Alexandria – Tripoli (Lebanon)	360	8 days	1.9 knots
23) Alexandria – Constantinople	730	18 days	1.7 knots
24) Tinnis – Ascalon	127	7 days	0.7 knots
25) Bahr al Zihār - Sha'b Sulaim	12	7.5 hours	1.6 knots
26) Khor Nawarat - The Brothers	520	14 days	1.54 knots
27) Aden – Mukalla	266	12 days	0.92 knots
28) Northern Red Sea	15	12 hours	1.25 knots
		Average	**1.4 knots**

Summary of lateen/settee voyages made in unfavourable conditions. The average Vmg of these voyages is undoubtedly skewed downwards by the slow times of voyage 24 & 27. If these are discounted, then the average rises to 1.64 knots, if only the medieval voyages 21, 22, 23 & 25 are counted then Vmg rises further to 1.76 knots.

5.4.4 Lateen/Settee voyages made with a favourable wind

Voyage 29

Period: 11th century AD

Rig: Lateen/Settee.

Route: Palermo - Alexandria

Distance: 1000 nautical miles.

Length of voyage: 13 Days.

Vmg: 3.2 knots

Reference: (Goitein 1967: 324 & 326).

Voyage 30

Period: AD 1140

Rig: Lateen/Settee.

Route: Tripoli, Libya - Seville

Distance: 1200 nautical miles.

Length of voyage: 8 Days.

Vmg: 6.2 knots

Reference: (Goitein 1967: 318).

Notes: Voyage recorded in the writings of an Italian Jew who noted that a large ship could sail from Tripoli, Libya to Seville in eight days with a favourable wind. As Seville is some way

from the coast it must be assumed that the final destination lies at the mouth of the Guadalquivir River.

Voyage 31

Period: Wednesday 16th March – Friday 18th March, AD 1183

Rig: Lateen/settee.

Route: Sardinia - Sicily

Distance: 190 nautical miles

Length of voyage: 2 days

Vmg: 4 knots

Reference: Ibn Jubayr (tr. Broadhurst 1952: 27-28)

"in the last quarter of the night [Wednesday morning], we parted from the coast of Sardinia…Early on the night of Wednesday the wind blew with violence upon us…The sea raged more, the horizon blackened, and the wind and rain rose to a tumult so that the sails of the ship could not withstand it and recourse was had to the small sails. The wind caught one of these and tore it, and broke the spar to which the sails are fixed…We remained in this state all that day, and only when night had fallen did there come some abatement, so that we moved throughout it with great speed under bare masts, and came that day opposite the island of Sicily."

Notes: As well as the graphic description of the storm conditions which the ship encountered, the passage is also illustrative of the extent to which a ship could reduce its speed when conditions were very bad. It was not always the case that very strong winds produced very high speeds.

Voyage 32

Period: Tuesday 22nd – Saturday 26th March AD 1183

Rig: Lateen/settee.

Route: Crete – Alexandria

Distance: 400 nautical miles

Length of voyage: 4 days

Vmg: 4.2 knots

Reference: Ibn Jubayr (tr. Broadhurst 1952: 29)

"In the morning we parted from it [Crete], aiming for our destination…there appeared the mainland connected to Alexandria…we sailed on with this coast to our right. On the morning of Saturday the 29th of the month [26th March], God gave us the good news of our safety with the appearance of the lighthouse of Alexandria some twenty miles away"

Notes: The route that Ibn Jubayr describes is not a direct course from Crete to Alexandria. Instead the ship sails directly from Crete for the North African coast. Once landfall is made, the

vessel sails along the coast with the prevailing winds and currents until Alexandria is sighted. The point of landfall on the coast can be estimated from Ibn Jubayr's remark that it was roughly 400 miles from Alexandria. Comparison of his previous notes of distances between Minorca and Sardinia and Sardinia and Sicily suggest that a modern nautical mile is roughly double a medieval Arab mile.

Voyage 33

Period: 15th century AD.

Rig: Lateen/Settee.

Route: Bahr al Zihār - Sha'b Sulaim (Red Sea).

Distance: c. 12 nautical miles.

Length of voyage: Less than 3 hours.

Vmg: c. 4 knots.

Reference: Ibn Mājid, (Tibbets 1961: 317; 1971: 256).

"with a weak north wind from the four Zahras, the distance between them and Sha'b Sulaim is 2 or 3 *zām* with the wind in front. But with a favourable wind is does not exceed a single *zām*."

Notes: The direction of the voyage described by Ibn Mājid is north by east and the distance is approximately 10 nautical miles. When sailed on a direct course it takes less than one *zām* to complete. A *zām* as used by Ibn Mājid is a period of three hours sailing (Tibbets 1961: 325) so the speed of the vessel can reasonably be put at around 4 knots with a light, favourable wind. With the wind from ahead however the journey takes 2-3 *zām* which would equate to about 7½ hours sailing time and produce a Vmg of 1.6 knots.

Voyage 34

Period: 15th century AD.

Rig: Lateen/settee.

Route: Jidda (Jeddah) - Saibān (Jazīrat aṭ Ṭā'ir).

Distance: 400 nautical miles.

Length of voyage: 35 *zām* (105 hours)

Vmg: 3.8 knots

Reference: Ibn Mājid. (Tibbets 1971: 244).

"set out from Jidda, beginning on the 260th or 270th of the year and they set course SW by S for 7 *zām* and then turned SE by S for 28 *zām* to Saibān"

Notes: The northerly winds at this time of year in the Red Sea make it likely that the course for this voyage was mostly a running course.

Voyage 35

Period: 15th century AD.

Rig: Lateen/settee.

Route: Saibān (Jazīrat aṭ Ṭā'ir) - Muqaidih

Distance: 55 nautical miles

Length of voyage: 4 *zām* (12 hours)

Vmg: 4.58 knots

Reference: Ibn Mājid. (Tibbets 1971: 249).

"Saibān is midway between them [the coasts of the Red Sea] although a little nearer Arabia. When you bear WNW from it for 4 *zām* you come to Muqaidih"

Notes: Such a voyage as this, across the Red Sea, rather than heading north or south, was probably done in reaching conditions with the prevailing northerly or southerly wind.

Voyage 36

Period: 15th century AD.

Rig: Lateen/Settee.

Route: Ras Madraka – Ras Sauqira (both Oman).

Distance: 107 nautical miles.

Length of voyage: 18/24/30 hours.

Vmg: 5.9/4.5/3.5 Knots

Reference: Ibn Mājid. (Tibbets 1971: 152).

"As for theoretical *zāms*, they are greater than the *zām* of routes and distances because for example from Madraka to Sauqira is 16 *zām* theoretically and the ship will make it into less than eight and an exceptional one will reduce it into six, and a loaded one, ten"

Notes: Ibn Mājid is commenting on the difference between the calculated distance between two headlands, measured in theoretical *zāms* (a fixed division of a circle) and the actual sailing time, measured in *zāms* of three hours. The normal time given amounts to an average Vmg of 4.5 knots.

Voyage 37

Period: Summer 1916.

Rig: Lateen/Settee.

Route: Suez - Dahlak.

Distance: 940 nautical miles.

Length of voyage: 9 Days.

Vmg: 4.3 knots

Reference: de Monfried 1974: 270.

Voyage 38

Period: 1939

Rig: Two-masted Settee

Route: Bahrein (Manama) - Kuwait City

Distance: c. 240 nautical miles

Length of voyage: 48 hours

Vmg: 5 knots

Reference: Villiers 1940: 333-343.

Voyage 39

Period: Mid 20th century.

Rig: Single-masted Settee.

Route: Lamu - Mombasa.

Distance: 145 nautical miles.

Length of voyage: 24 hours.

Vmg: 6.04 knots.

Reference: Prins 1965: 250.

Voyage 40

Period: 21st century.

Rig: Lateen/settee.

Route: Northern Red Sea (Marsa Alam).

Distance: 50 nautical miles.

Length of voyage: 12 hours.

Vmg: 4.2 knots

Reference: Personal communication during interview with *Nakhooda* Said.

Notes: The northerly winds in this area of the Red Sea probably mean that a downwind course such as the one described was probably a running course.

Summary of latee/settee voyages made in favourable conditions.			
Route	**Distance (n.m.)**	**Time**	**Vmg**
29) Palermo – Alexandria	1000	13 days	3.2 knots
30) Tripoli (Libya) – Seville	1200	8 days	6.2 knots
31) Sardinia – Sicily	190	2 days	4 knots
32) Crete – Alexandria	400	4 days	4.2 knots
33) Bahr al Zihār - Sha'b Sulaim	12	3 hours	4 knots
34) Jidda (Jeddah) - Saibān (Jazīrat aṭ Ṭā'ir)	400	105 hours	3.8 knots
35) Saibān (Jazīrat aṭ Ṭā'ir) - Muqaidih	55	12 hours	4.6 knots
36) Ras Madraka – Ras Sauqira	107	24 hours	4.5 knots
37) Suez – Dahlak	940	9 days	4.3 knots
38) Bahrein (Manama) – Kuwait City	240	2 days	5 knots
39) Lamu – Mombasa	145	24 hours	6 knots
40) Northern Red Sea	50	12 hours	4.2 knots
		Average	**4.5 knots**

Summary of latee/settee voyages made in favourable conditions.

Glossary of Nautical Terms

Subject in **Bold** with words in *Italics* referring to entries elsewhere in the glossary.

Abaft. Towards the stern relative to some other position on the vessel.

Aback. Usually in reference to 'being aback the mast' refers to something, usually the sail lying to windward of the mast and being blown against it. A sail which is set aback is on the windward side of the mast.

Abeam. Descriptive term referring to the side of a vessel, if the wind is from the side it is said to be coming from *abeam*.

Aft. Term used to describe the *stern* half of a vessel, if an object is located *aft* in a vessel, it is positioned towards the stern.

Amidships. In or toward the middle of a vessel.

Aspect Ratio, Sail. The physical dimensions of a sail. On a square rigged vessel *Aspect Ratio* (AR) is the height of a sail divided by width. The gives a number relative to one; greater than one being a high AR sail and lower than one a low AR sail. Tall narrow sails will have a high aspect ratio while lower, broader sails will be of low aspect ratio.

Athwartships. Lying across the width of the vessel.

Backstay. Line from the peak of the mast to the *stern* of the vessel, tensioned to prevent the mast from falling forward, comprises part of the *standing rigging*.

Beating. The act of sailing to *windward* is usually described as a *beat*, a vessel is said to be 'beating to windward.'

Bolt-rope. Rope running around the edge of the sail in order to reinforce it.

Boom. *Spar* supporting the lower edge of a sail.

Bow. The front end of a vessel, and things relating to it.

Bowline. Part of the vessels *running rigging*. A block and tackle attached to the *luff* of the sail, then lead forward and secured. Tensioning the bowline helps to keep the front edge of the sail taut and flat, thereby increasing the vessels potential windward ability.

Braces. Ropes running from the end of a *yard* to the deck, used to trim the sail by controlling the angle of the *yard* to the wind, comprises part of the *running rigging*. Often referred to as a *vang* on lateen/settee rigged vessels and attached midway along the upper portion of the yard.

Brails. System of lines used in the ancient world for reducing sail and altering the shape of the sail exposed to the wind. Lines attached to the foot of the sail run through fairleads up the front of the sail, before returning to the deck over the top of the yard.

Brail Ring. Part of the system of *brails*. Brail rings are attached to the front edge of the sail, usually to the horizontal reinforcement strips and provide a fairlead for the brail lines to run through. Usually made from lead, wood or horn.

Capstan. Deck mounted mechanism used for hauling or moving large loads on board a vessel. Consisting of a vertically mounted drum around which rope or cables can be wound, the drum is turned by placing bars into sockets in the top of the capstan and pushing them. A horizontal version, known as a **windlass** works on the same principle.

Centre of Effort (CE). The point on a sail that the forces imposed by the wind act through. On a square sail it is somewhere near the geometric centre.

Centre of Lateral Resistance (CLR). The point at which the hydrostatic forces imposed on the hull are acting, the hull will pivot in the vertical axis and the horizontal fore and aft axis about this point.

Clew. The lower corners of a square sail, or the aft-most corner of a fore-and-aft sail.

Close-Hauled. Point of sailing when the vessel is attempting to sail to *windward*. It is at the closest point to the wind that it can go, hence the rig is *close-hauled* in. Also described as *beating*.

Deadeye. Wooden block used in the *shrouds* to aid their tensioning, usually rigged in pairs. Comprises of a large, quite flat ovoid block of wood, pierced with two or more holes and finished to allow a rope to be made of around the outside.

Foot. With reference to a sail, the lower edge of the sail.

Forestay. Line connecting the peak of the mast to the *bow* of the vessel, tensioned to prevent the mast from falling backwards, comprises part of the *standing rigging*.

Halyards. Lines used to hoist the *yard* and sail, comprises part of the *running rigging*.

Head. With reference to sails, the upper edge of the sail.

Heel. Motion induced on a vessel as a result of the forces produced from wind hitting a sail. *Heeling* results in a vessel leaning over to *leeward*, it is most likely to occur when a vessel is close-*hauled* or *reaching* and less likely when a vessel is *running*. Heeling is also one of the factors that contributes to *leeway*.

Hogging. The tendency of large vessels to quite literally sag or droop at bow and stern, caused by the sheer weight of the vessel.

Lifts. Lines running from the *yard* to the masthead, they provide extra support for the *yard* and can be used to control the angle of it to the mast, comprises part of the *running rigging*.

Lead. The distance between the *CE* and the *CLR*. Modern yacht designers usually design with a lead of about 10% the waterline length, with *CE* being forward of *CLR*. This compensates for the inaccuracies in estimating the position of CE and CLR on modern yachts.

Leech. The trailing edge of the sail, on a square-rig it is interchanged with the *luff* depending on which *tack* the vessel is on.

Leeward. To *leeward*, something on the leeward side of the vessel has the vessel between it and the wind; it is said to be in the lee of the vessel.

Leeway. The sideways drift experienced by a vessel when sailing with the wind *abeam*, or when *close-hauled*.

Luff. The leading edge of the sail, on a square-rig it is interchanged with the *leech*, depending on which *tack* the vessel is on. Also the act of sailing to close to the wind which causes the front edge of the sail to flap; 'to luff'.

Mast. Principle length of wood from which rigging and sails are suspended, *conventional* masts consist of one component, while *bipedal* masts form an A shape and use two main components.

Parrel. Fitting, usually made of rope, to hold the yard against the mast once it has been hoisted into place.

Peak. With regard to the lateen/settee rig, the peak of the sail is the uppermost corner.

Point. Term of measurement of degrees, 1 point = 11.25°, this produces a standard 32 point compass.

Port. Mariner's term describing something on the left. The *port* side is the left side of a vessel.

Reach. Point of sailing when the wind is coming from the side of the vessel. A *close reach* will have the wind slightly forward of the beam, a *beam reach* sees the wind coming from *abeam* the vessel while a *broad reach* will see the wind coming from further *aft* still.

Roband. Line attached to the head of the sail and used secure the sail to the yard by being tied around it.

Run. Point of sailing when the wind is coming from *astern* of the vessel. A *dead run* sees the wind coming from directly *astern* and a *broad run* places the wind to either side of the stern.

Running Rigging. Ropes and lines that are concerned with the hoisting and trimming of the sail. Running rigging is not usually permanent as it is normally taken down at the same time as the sail is. Included in a list of running rigging will be *sheets*, *braces*, *halyards*, *lifts, brails* and *bowlines*.

Sail-camber. Measurement of the curvature of the sail, a sail with greater camber will have a greater curve to it.

Sail-chord. The width of the sail, measured from the luff to the leech.

Sheave. The moving part of a block, usually in the shape of a wooden disc or wheel. Mediterranean pulleys have distinctive cylindrical sheaves.

Sheets. Ropes running from the end of the *boom* to the deck, used to trim the sail by controlling its angle to the wind. On a loose-footed square sail the sheets are connected directly to the corner of the sail (the *clew*), comprises part of the *running rigging*.

Shrouds. Lines running from the head of the sail to the sides of the ship, they comprise part of the standing rigging. They give the mast lateral support and prevent it from falling to either side of the vessel.

Spar. General term for a boom, mast or yard.

Standing Rigging. Ropes and lines that are concerned with holding the mast in an upright position, they are not concerned with raising, lowering or trimming the sail. The permanence of standing rigging depends directly on whether or not the mast can be taken down. Standing rigging will usually include *forestay*, *backstay* and *shrouds*.

Starboard. Mariner's term describing something on the right. The *starboard* side is the right side of a vessel.

Stern. The back of a vessel and things related to it. E.g. *Astern* relates to things that have been left behind the vessel as it moves forward on its course, or perhaps to a wind coming from the stern of the vessel.

Tack. The act of turning the *bow* of the vessel through the wind in order to sail in another direction, especially likely during upwind work. Also refers to the direction that the wind is coming from during sailing, if a vessel is on a *port* tack, then the wind is coming from the *port* side. Likewise if the vessel is on a *starboard* tack then the wind is coming from the *starboard* side. Finally it refers to the lower forward corner on a fore and aft sail, or the lower corner of a square-sail closest to the wind.

Tack-Tackle. Block and tackle used to control the tack of the sail.

Thwart. A beam that lies across the vessel, perpendicular to its longitudinal axis. In small vessels a thwart is often used as, or refers to, a rowing bench. Something that is *athwartships* is said to be lying across the vessel from one side to the other.

Topping Lift(s). Rope(s) used to raise and lower the *boom* on a vessel, consequently not part of the rig on a loose-footed sail, but otherwise part of the *running rigging*.

Truss-Girdle. Rope running the length of the vessel and sewn into the upper strakes all the way around it, further supports the vessel and helps prevent hogging.

Vang. See *braces*.

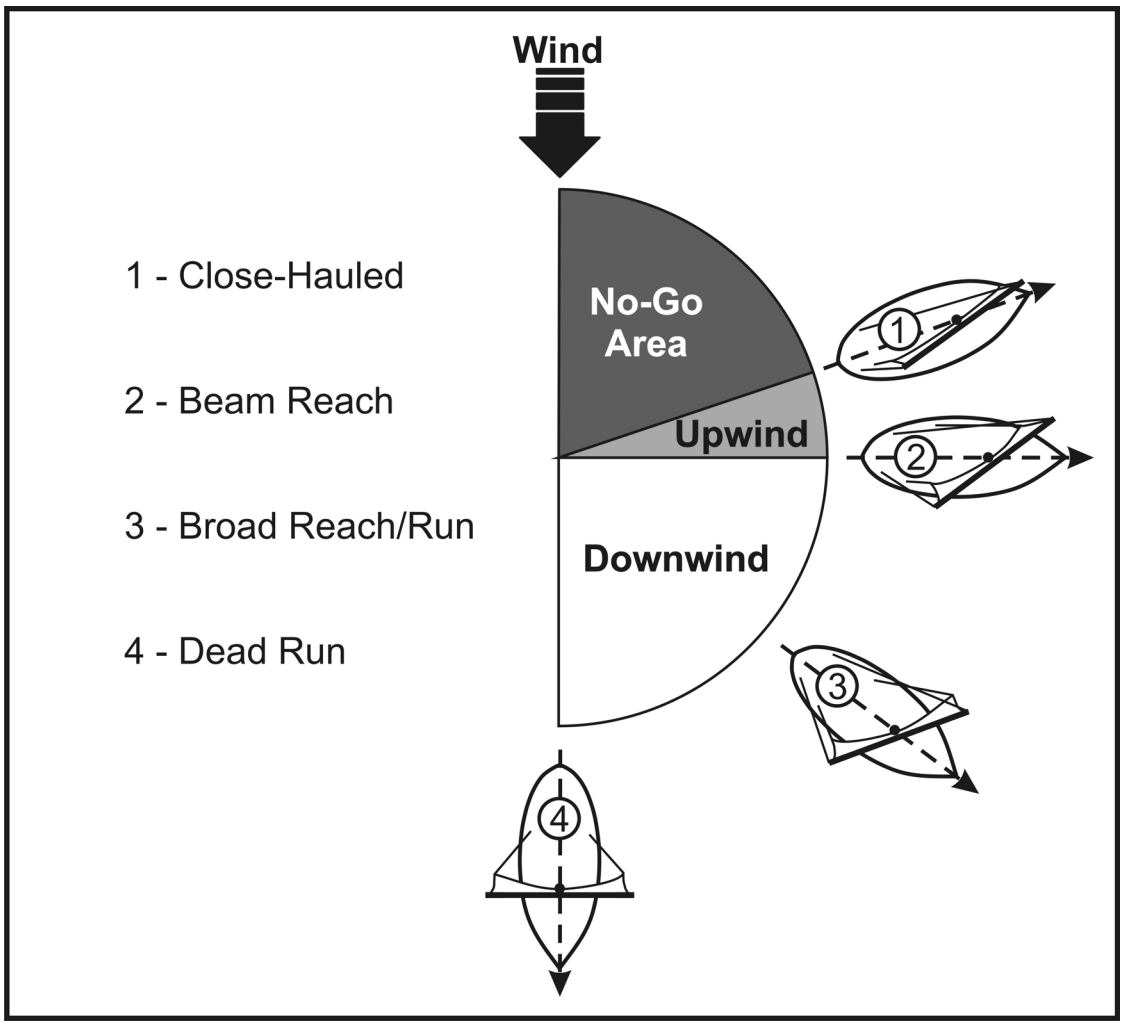
Vmg. Velocity made good. For example, a vessel may be sailing on an upwind course at 5 knots for 10 hours, over the course of the time the vessel will travel 50 nautical miles (nm). However, because the vessel cannot sail directly into the wind it will not have travelled 50 nm to windward. If the vessel is sailing at an angle of 45˚ including leeway (improbable but mathematically simple) it would travel 25 nm during the 10 hours and Vmg would be 2.5 knots (distance made good in the desired direction divided by the time).

Wearing. Sailing manoeuvre in which the *stern* of a vessel is passed through the wind in order to undergo a change of course. Especially likely if the vessel is *running* before the wind.

Windage. The profile that a vessel presents to the wind.

Windward. To *windward*, if something is on the windward side of a vessel it is the side that the wind is coming from. Thus the windward rail describes the side of the vessel that the wind hits first.

Yard. Spar supporting the top edge of a sail.



The basic points of sailing used to describe a vessel's relationship and orientation to the wind. The vessel shown here is on a port tack, terminology is the same for both port and starboard tacks. The closer a vessel sails to the wind, the closer the sail must come to the centreline of the vessel, the further the angle downwind then the more perpendicular to the centreline the yard and sail will be (J.Whitewright).

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Abbreviations:
IJNA - International Journal of Nautical Archaeology

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