THE DEVELOPMENT OF THE BRAIL INTO A VIABLE SAIL CONTROL FOR AEGEAN BOATS OF THE BRONZE AGE

When the concept of a sail emerged, probably after ineffective forays with a leafy branch, early boat-men would have been faced with the *problem* of suspending and restraining it from its four corners. Four corners because woven materials and large hides are so shaped. Suspending and restraining a four cornered sail does not take much imagination hence the range of techniques to be seen. What does demand ingenuity is devising methods of controlling it to suit current seamanlike requirements. Outstanding of these methods is that known as brailing which is used in various forms right down to the present day. Brailing requires that ropes may be pulled at deck level with the result that the square sail is furled upward to its yard. No yard has to be lowered with all its attendant clutter inorder to reduce sail. The technique is quick, safe for the crew and rapidly relieves the boat of speed or capsizing forces. A later application of the brail in the Bronze Age Aegean was to selectively trim the sail to suit conditions. This very important development will be discussed later.

To consider the earliest known version of a brailed sail we must step out of the Aegean and look at that well-known scene of mayhem and slaughter from the tomb of Ramses III at Medinet Habu (Casson 1959:40). The yards droop on unsupported masts and the sails are furled in great bights (Pl. XVII, a). From this we see, already established, an inherant fault in the system; that is brails rigged this way pull down on a light yard, increasing any curvature. That lifts were not fitted to brailed sails or that nothing was done to prevent this curvature for another 15 centuries is surprising when one considers that lifts were a predominant feature in other Egyptian and Aegean rigs. The bunching of the sail indicates that the brails were of the type which completely encircled it. Such brailing is not good for reefing since the sails billow while part brailed. The later development of lee side brails and brail rings were what made effective reefing possible. The eastern Mediterranean brails were limited in use but were a great step forward from the boomed mainsails of the Thera frescoes type.

Bronze Age Square-sails with Booms (Pl. XVII, b)

To begin to appreciate this improvement which the brailed square sail brought one should consider the well-established alternative still in use about 1500 BC. The finest technical drawing of it shows Queen Hatshepsut's fleet and our next best detail drawing is to be seen in the Thera fresco. The writer finds it difficult to accept certain detail of the reconstructed rigging of the only Thera boat under sail, since it implies that six ropes would need to be pulled inorder to raise a simple square sail and its yard... that is two halyards and four lifts. Two lifts as in Queen Hatshepsut's ships would be ample. The other lifts on the yards in those ships do not become active until the sail is lowered to its stowing position.

Booming a squaresail limits the ability to trim it. It may only be rotated to a position before the wind or at least so that the wind is filling it from a broad angle. Once the wind comes

from ahead of the beam problems arise because it is impossible to trim the windward edge of the sail tightly and so get the sail to set closer to the wind. This affects the close reaching performance of the Thera boat irrespective of the hull shape... and of course this applies to Queen Hatshepsut's ships too (Pl. XVIII, a).

Thomas Gillmer made a sound interpretation of the likely hull shapes of the Thera boats (Gillmer 1985:401). He did not persue the unusual mast position, well ahead of the mid water-line length, something not seen again until perhaps the 2nd century A.D. It implies that when the Thera boats heeled in a beam wind either the longitudinal Centre of Buoyancy moved aft slightly, or more likely that the Centre of Lateral Resistance moved forward, resulting in weather helm, that is the bows would try to turn towards the wind. By placing the mast ahead of the water-line mid point the pressure on the sail would counteract this turning moment. From Gillmer's lines this would not be much of a problem and this would be fortunate since the boomed square sail is inflexible in its ability to be trimmed to suit different wind strengths. For these reasons it seems that the boomed square-sail is to be associated with hulls having closely similar ends and an even distribution of buoyancy. There would be no urge to change a system that worked, especially in a vessel with an alternative propulsion system waiting to be exercised.

Queen Hatshepsut's boats have their masts placed at or abaft the mid-water-line position. Because of the great size of the rudders, the Centre of Lateral Resistance is shifted and maintained aft of the mast position. The rudders act as leeboards too. In ancient Egypt problems of hull and sail balance were cured this way. As we shall see later the same methods were applied in the Aegean when brailed square sails became the norm.

Under sail the Thera boats would also to a lesser extent have gained some benefit from their rudders as leeboards. Under power the leading rudder would probably have functioned alone, as a sweep. Setting sail the sailing rudder, which had been allowed to trail just clear of the water to lessen drag, was swung down into its position on its more substantial hangings. These trailing sailing rudders have been given curious interpretations over the years based mainly on the paintwork of the fresco's reconstructors (Basch 1983:403).

Both the Thera and the Egyptian boats would face considerable danger if running before strong winds. Though the rig is excellent for presenting a broad area of sail to a following wind, both vessel types would roll rhythmically in a following sea. The ends of the low boom would be liable to catch the waves at each roll. The results would be catastrophic. A partial cure for this is to be seen in the upward curve imparted to it by its lifts. Representations of the rig seen on coins etc. show this feature, though greatly exaggerated to fit within the circular shape (Landstrom 1961:33).

Adoption of Brails within the Aegean

Having such a long nautical history it is neither surprising that the Ancient Egyptians were the first to depict the use of brails, nor would it be surprising if they had developed the system. What is of interest is the alacrity with which brailed square-sails seem to have been adopted in the Aegean. Though the Thera-type, double-ended, volumetrically-balanced hull-form persisted, the predominant Aegean Bronze Age galley-form is quite different. It could develop as a viable sailing vessel only because of the introduction of the brailed square sail.

The predecessors of this form are to be seen perhaps in propelled boats of the Cycladic "frying-pan" type having protruding keels and prominent tail-fins. The function of the latter has been discussed elsewhere (Roberts 1987:309). In their development into efficient load-carrying galleys (Pl. XVIII, b), they would acquire a modest increase in beam, appearing inevitably at its maximum abaft the centre of the water line. The vertical stem would cause this since the vertical planking would need some distance to open out the hull section to the desired beam.

The most natural way to conclude the shape would be to return the planking to perhaps the original vertical stern post but this would cause the stern to suck down at any speed. Instead there seems to have developed a stern of Thera-type. Three advantages would be gained: a) retention of the high stern configuration which had proved beneficial in earlier sea-going; b) creation of a flat run aft combined with a sharp entry forard would raise the top speed/cruising speed potential under oars; c) retention of shallow draft, essential for beaching, due to the extra beam allowing a greater load per unit immersion.

To withstand the extra strain applied to the planking by the oars the vertical stem would be supported by an external stem knee built onto the extended keel, retained from the previous form for that purpose.

The earliest examples of this hull form rigged for sailing appear on a sword found near Dorak, Turkey and dated about 2,500 B.C. (Mellaart 1966:170).

Their forms indicate the use of a Thera-type square sail and that already the stepping of the unstayed mast near the mid-point of the water-line is established.

In the beginning it may have been found that to place the mast any further forward caused the fine bows to sail under in any useful following breeze.

Without doubt the early Aegean form of brails was of the sort shown in use in Ramses III fleet and that of his enemies though it seems that at first a stiffer yard was used. Some drawings show straight yards even when the sails are brailed up hard. These suggest that their major use was to furl the sails, that is the sails were in use or they were not. At that stage the use of the brails as an extension of sail control is not obvious. The limited use would arise from the continued use of the all-round type of brail.

However, the difference in behaviour under sail of the Thera type compared with that of the Aegean galley form would cause the invention of sail handling methods undreamt of by the sailors of Ramses III's fleet. Under sail the Thera type would have had a predictable performance capable of easy control by the rudders which the balanced hull form would not have been inclined to overpower. Because of its fine entry water-line, a flat run aft and light construction the Aegean galley under sail must have had a dazzling down-wind performance. Only across the wind would its vices become known as heeling was experienced in fresh breezes. Sailing would have been a knife-edge skill for the helmsman who at any slight increase in wind force could lose total control as the galley swooped wildly into the wind, sail aback with capsize a possibility. The direct cause of this was the hull form in which, unlike the Thera-type, the Centre of Buoyancy wandered aft on heeling, contributing to a massive griping force. The long, narrow rudders, ideal for their purpose in steady conditions, would stall under the helmsman's efforts.

Sail control using brails

When sailing down wind with a broad, loose-footed square sail the clews draw in towards the hull as the foot lifts up and forward. Wind is spilt and oscillation of the sail may occur which would aggravate down-wind rolling. The writer was able to demonstrate, when sailing in the replica KYRENIA II, that hauling-in a little on the middle brails forced the flow of air out to the sides of the sail and caused the clews to move out over the water, thus flattening the sail to the following wind. This would surely have been the first sail control technique devised by the ancient Aegean seaman. It was possible with the original all-round brail and would no doubt have been known to the Egyptians too.

Reduction of sail area by brailing in strengthening winds would also have been an early and obvious technique though somewhat untidy with the earlier all-round brail. The concept of removing the driving force from a sail or if running, to alter its action on the sail would somewhere have combined as a solution to the problem of control when sailing across the wind

in fresh conditions. In a great many drawings of Aegean Bronze Age galleys the sail is shown with its after half greatly reduced. This would have been done by only partly brailing the sail (Pl. XIX).

The effect of this would be to move the force on the sail well ahead of the mast. The sail would then counteract any inclination of the hull to turn into the wind. By careful playing of the sheet the galley would have its course controlled by the sail. The rudders would be used for fine adjustment or major changes in course. Their other main purpose on such hulls would be to act as lee boards to resist lee way (Roberts 1984:84).

Alteration of the sail to the desired shape was only possible because of the brails. Selective use of the brails came with an enforced search for a way of controlling the galley under a broader range of courses relative to the wind. Improvement of these controls would result from fixing regularly spaced rings on the lee or fore side of the sail and tying the brail-ends to the sail's foot. This causes the sail to stow progressively in tighter folds instead of billowing as with the older method.

Leech brails are a further sophistication. Some drawings show well-brailed sails with large untidy clews hanging down. These show that leech brails are not fitted. Those drawings of what appear to be two-part braces show in reality a brace and the leech brail. In sailing the reconstructed trireme OLYMPIAS the yard was never so difficult to brace that a two part system was felt necessary but in practice both brace and leech brail were handled together when yard trimming (Pl. XX).

Other hints at improvements are evidence of fairleads on the yards for guiding the brails (Morrison & Williams 1968), the use of clew rings (surely to withstand harder sailing conditions), and the reinforcing of the horizontal seams with leather.

The latter have been misinterpreted as buntlines but would be inoperable within such a rig. It is possible that the leather stiffened the seam, to which also the brail ring was sewn, in such a way that there was self-stowing action as the sail was progressively brailed, in the same manner as that of a fully battened Chinese lug sail.

The problem of bending the yard by the force of sail trimming or by brailing was never cured in the Aegean Bronze Age. This would have been a deficiency of the rig when attempting to sail closer to the wind since hauling down on the tack would only work up to a point thereafter resulting in further yard curvature. Out of period we find the Romans effecting a cure but not, this writer believes, by using lifts which did not appear until at least a thousand years later. They re-invented the Ancient Egyptian's mast-head multiple block system leading all the brails diagonally upwards to them and then down to the deck. The Portus relief is an example, there being no brails leading aft from the yard since they are all coming down the back of the mast. Mosaics from Tunisia also show evidence of this method (Foucher 1957:21).

Apart from detail improvements the brailed single square-sail rig established itself early in the form in which we recognize it. It could be stabilized for running before the wind yet it could progressively be shaped inorder to retain directional control with the wind on or ahead of the beam. Not until vessels get bigger and perhaps rounder is there any evidence that its balancing effect needed bolstering by the addition of another sail ahead of it. A boat-sail was fitted in the trireme reconstruction OLYMPIAS in recognition of the literary evidence for its occasional use in battle situations. Only later in the millenium is there incontrovertible evidence for a two-masted development of the brailed square-sail rig. Both Lucien Basch and Lionel Casson, amongst others, believe that the galley shown on a late sixth century crater has a two-masted rig (Basch 1982:353-Casson 1980:68). With respect, this writer must disagree.

If a foresail were needed to increase the control over the hull's tendency to gripe, what would be the point of part brailing the after half of the "main" sail and also the after half of the "fore" sail as is to be seen in the drawing ? The need for a brailed "main" surely indicates the

need for a full "fore" sail ? In even stronger winds the "main " would be stowed and the "fore" sail would provide all the balancing effect plus driving force.

If a foresail was being blanketed by the main then the answer would be to slightly brail the foot of the latter. By not spotting the unseamanlike practicalities of such sail settings much effort has been made to interpret detail which does not support this drawing as the earliest evidence of a two-masted rig in the Aegean.

Conclusion

The refinement of the brailed square sail rig was as important a development as any seen in the techniques of hull construction in the Bronze Age Aegean. In the beginning the brailable square sail allowed hull forms quite unsuited to propulsion by sail of the Thera-type the opportunity to extend their cruising range due to the lightness of gear and ease of control.

Skills learnt in handling the rig coupled with improvements in gear and fittings enabled effective courses to be sailed in a wide range of directions other than before the wind. The ability to conserve the strength of the rowing crew opened greater horizons to military adventurers. The ability to sail in most directions economically with small crews, given a slant of wind, extended the horizons of the merchants.

The brailed square sail may be traced in the Mediterranean area for about 2000 years. Much of its supremacy is due to the continued use of hull forms which required the active participation of a one-sail-rig to maintain directional stability. That nothing like it appeared in Northern European waters reflects the difference in origins of the respective hull forms and hence its confinement to the Mediterranean seas.

The usefulness of the brail was not lost on users of other rigs so that we see lateen, seteen and sprit-rigs controlling their sails by brailing at the end of the first millenium B.C. and onwards. In medieval Europe the only sail control method of any note to appear is a version of the brail in the form of buntlines. This essential bit of gear owed its usefulness to those Aegean Bronze Age sailors who had seen its great potential so long ago.

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Pl. XVII, b : Egyptian sea-going vessel -one of Queen Hatshepsut's- about 1500 B.C. Details from a relief found in one of the temples at Deir-el-Bahari (drawing by the author).

Pl. XVIII, a : A sailing vessel from the Thera fresco (drawing by the author).

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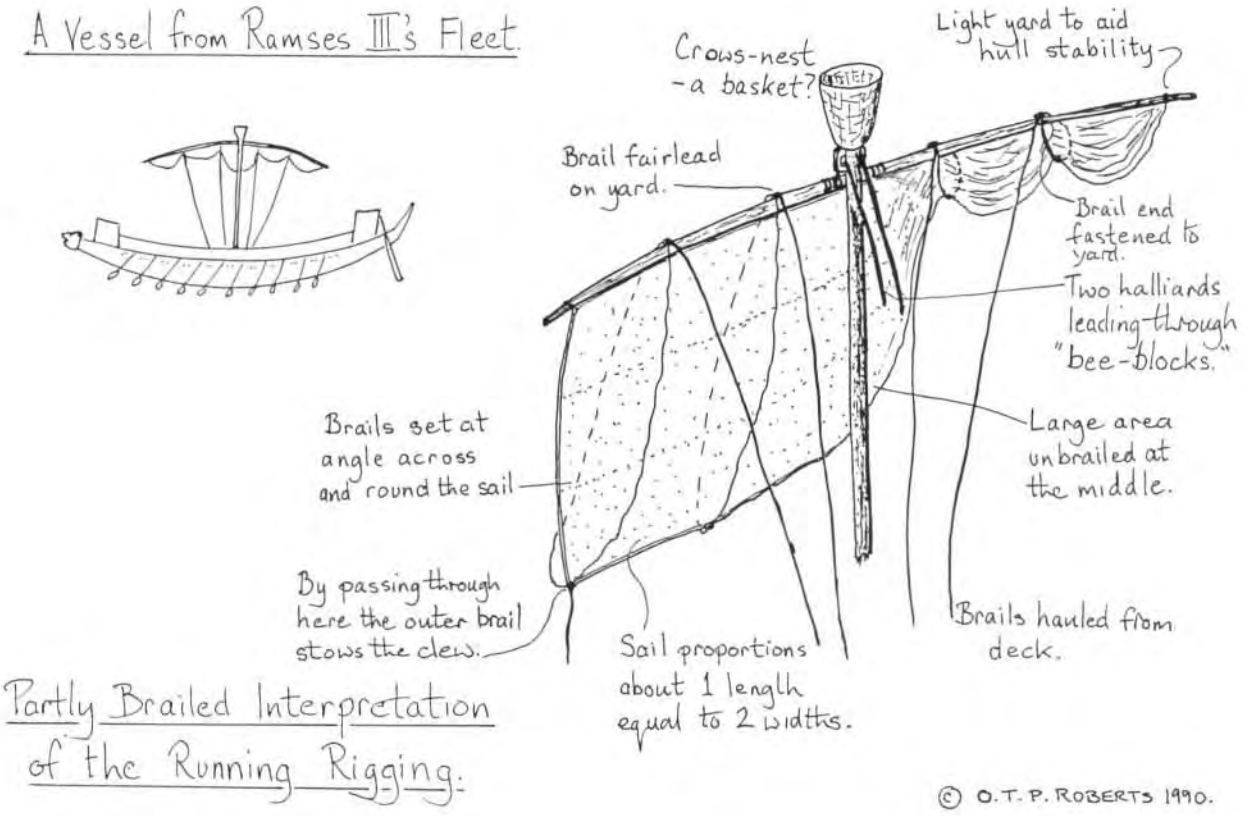
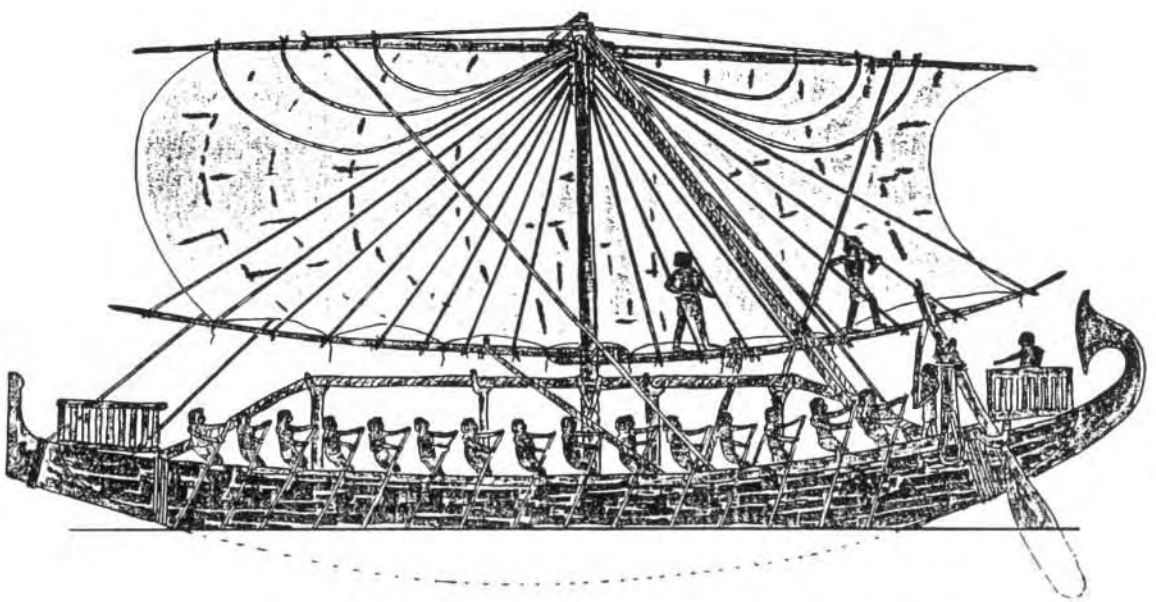
Pl. XIX : Forces acting upon a Classical galley when under sail (drawing by the author).

Pl. XX : Sail handling with brails (drawing by the author).



a

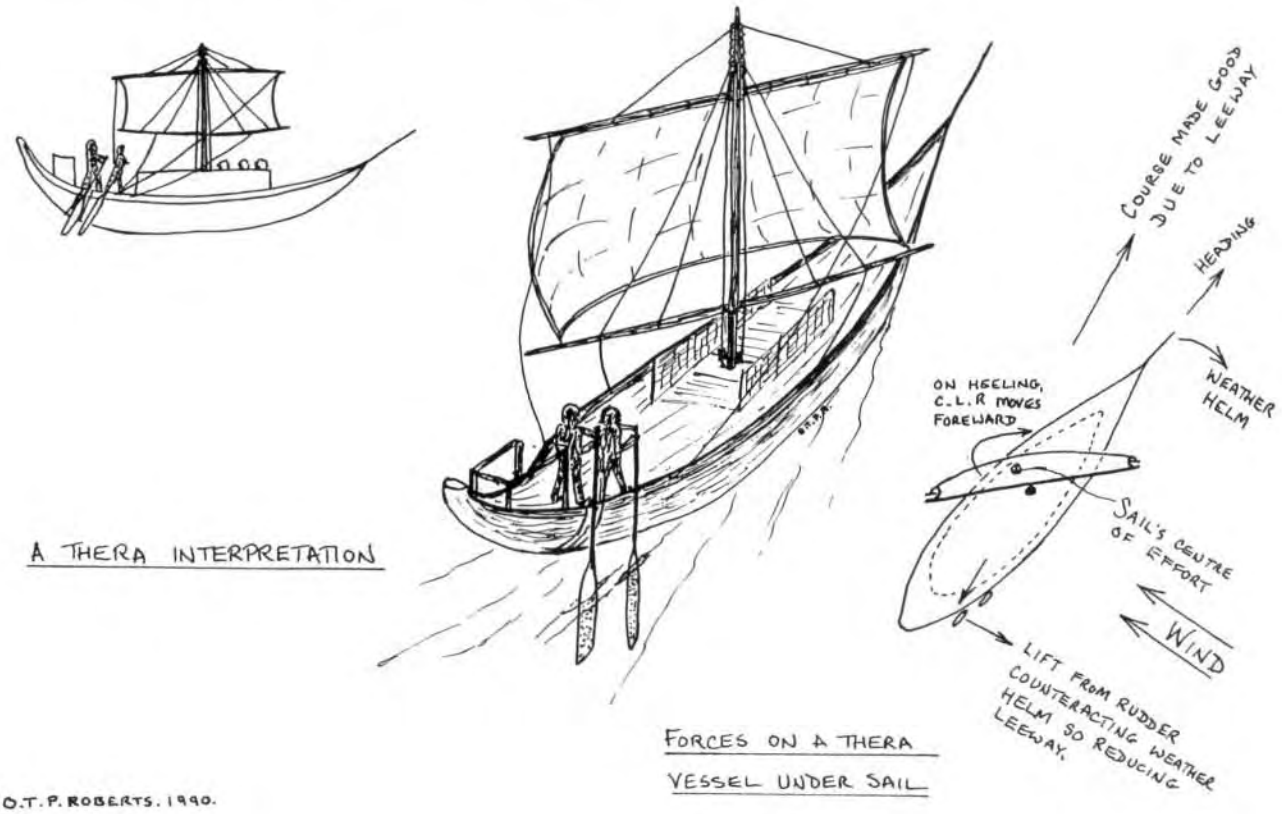


EGYPTIAN SEA-GOING VESSEL — ONE OF QUEEN HATSHEPSUT'S — ABOUT 1500 BC.

DETAILS FROM A RELIEF FOUND IN ONE OF THE TEMPLES AT DEIR-EL-BAHARI.
(O.T.P.R. 1990)

b

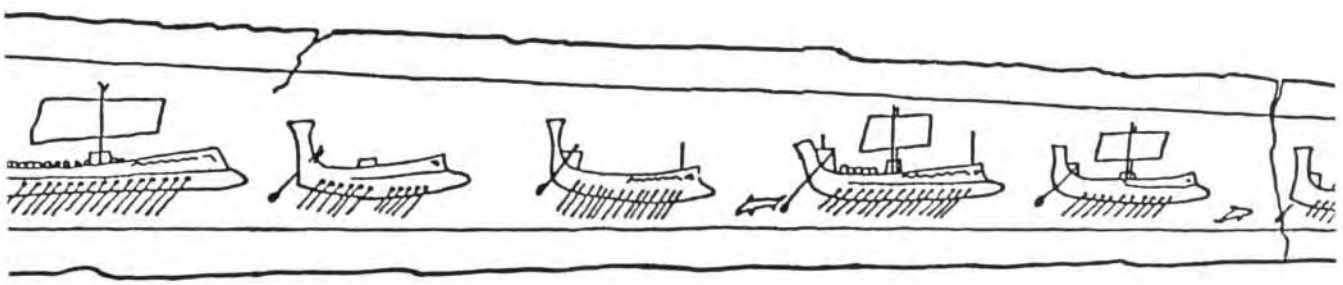
A SAILING VESSEL FROM THE THERA FRESCO.



A THERA INTERPRETATION

FORCES ON A THERA VESSEL UNDER SAIL

a



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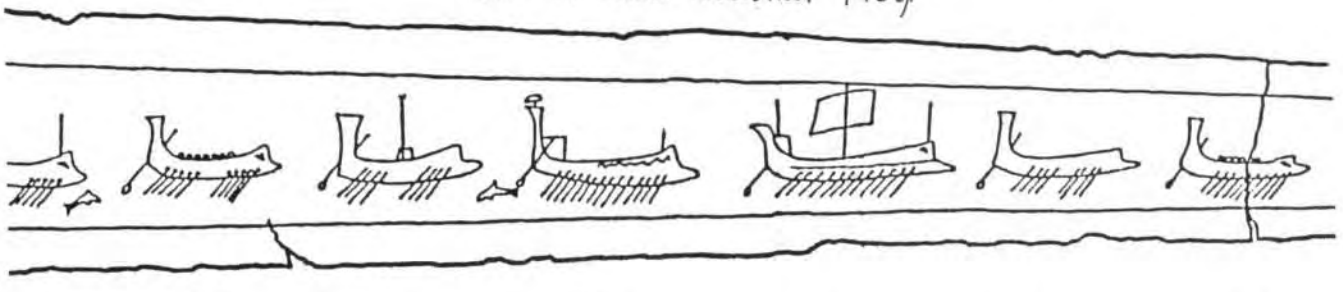
Galley drawings on a sword found near DORAK, TURKEY, dated about 2500 B.C.
(After J. Mellaart, "The Chalcolithic and Early Bronze Ages in the Near East and Anatolia." 1966).



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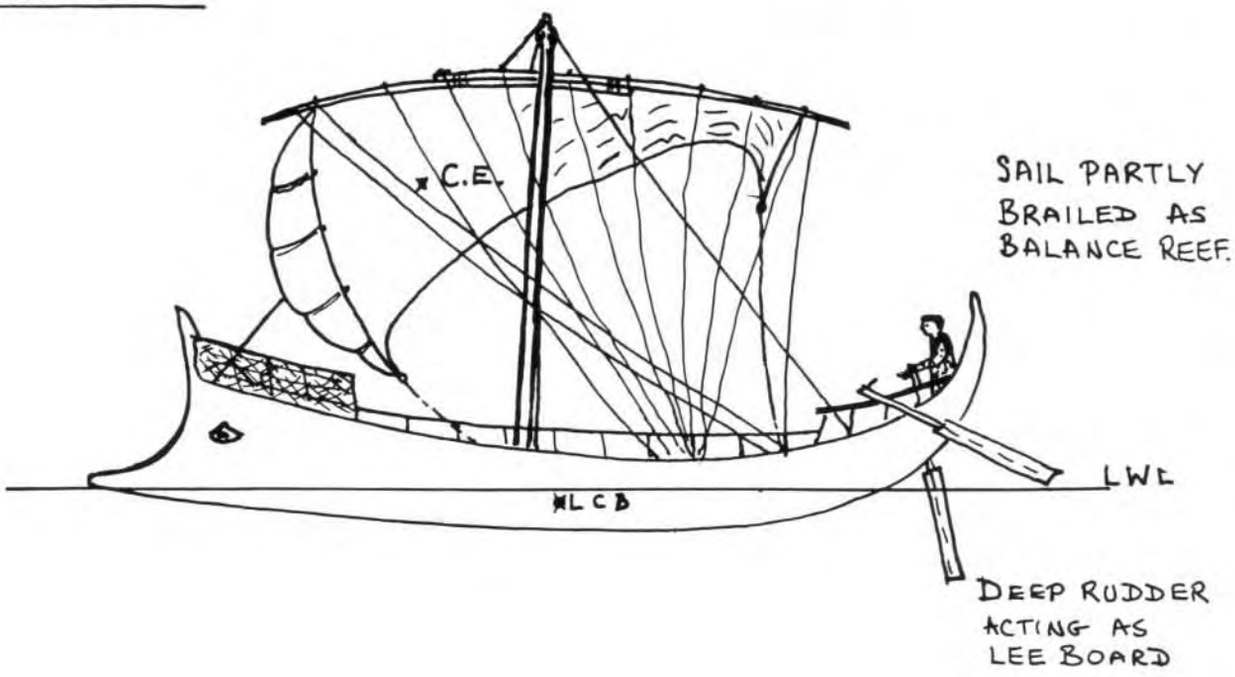
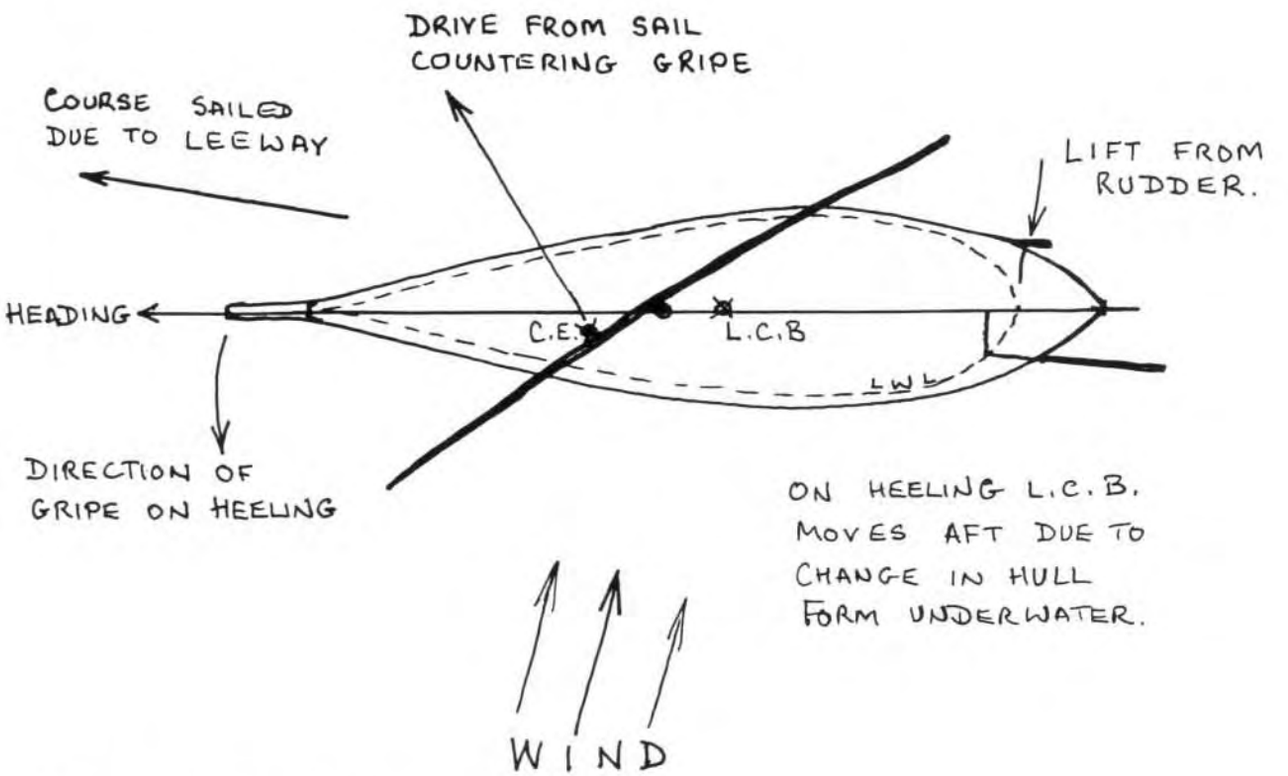
FORCES ACTING UPON A CLASSICAL GALLEY WHEN UNDER SAIL.



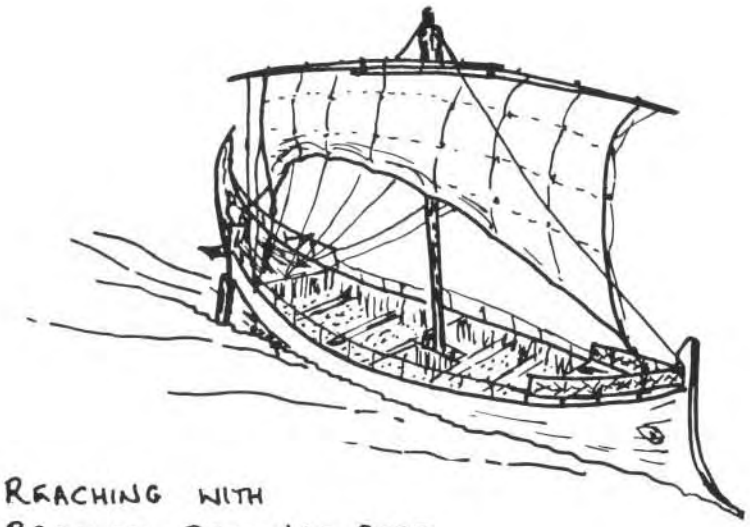


C.E. = CENTRE OF EFFORT OF SAIL

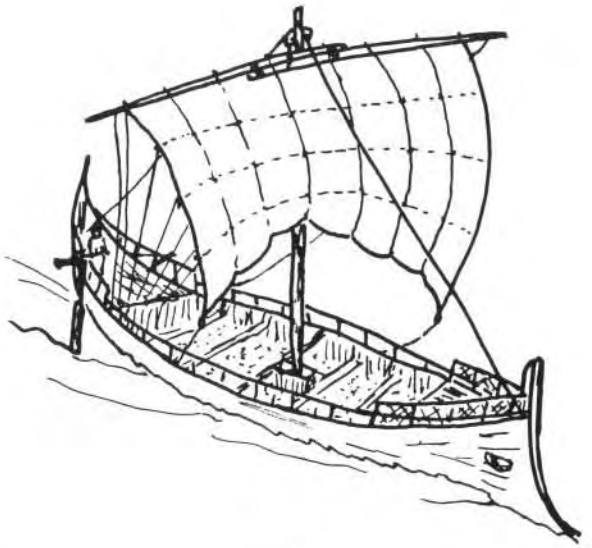
L.C.B. = LONGITUDINAL CENTRE OF BUOYANCY.

L.W.L. = LOAD WATER LINE WHILE UPRIGHT.

GRIPE = WEATHER HELM ACTION.

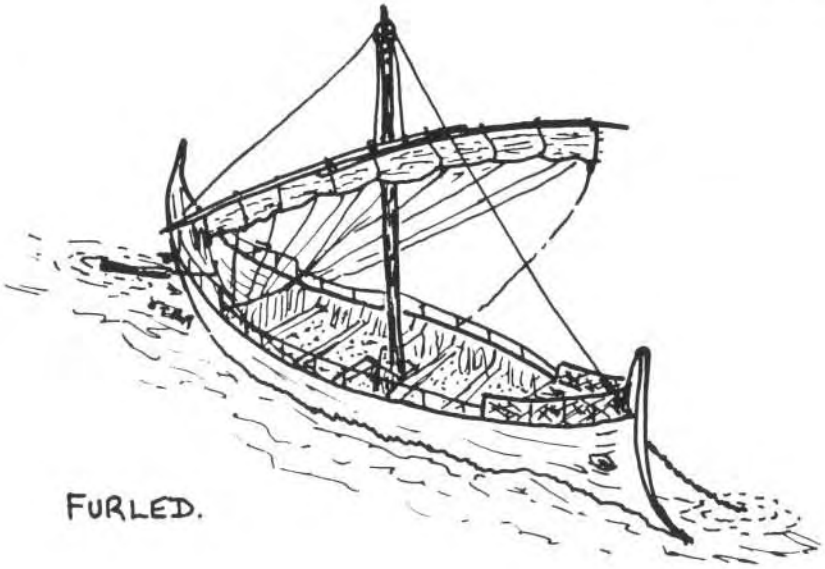


REACHING WITH
BRAILED BALANCE REEF.



RUNNING – FOOT BRAILED.

SAIL HANDLING WITH BRAILS



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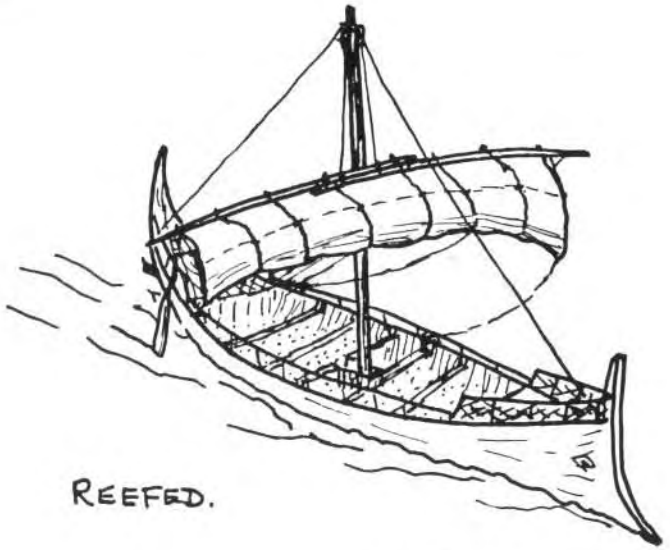

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