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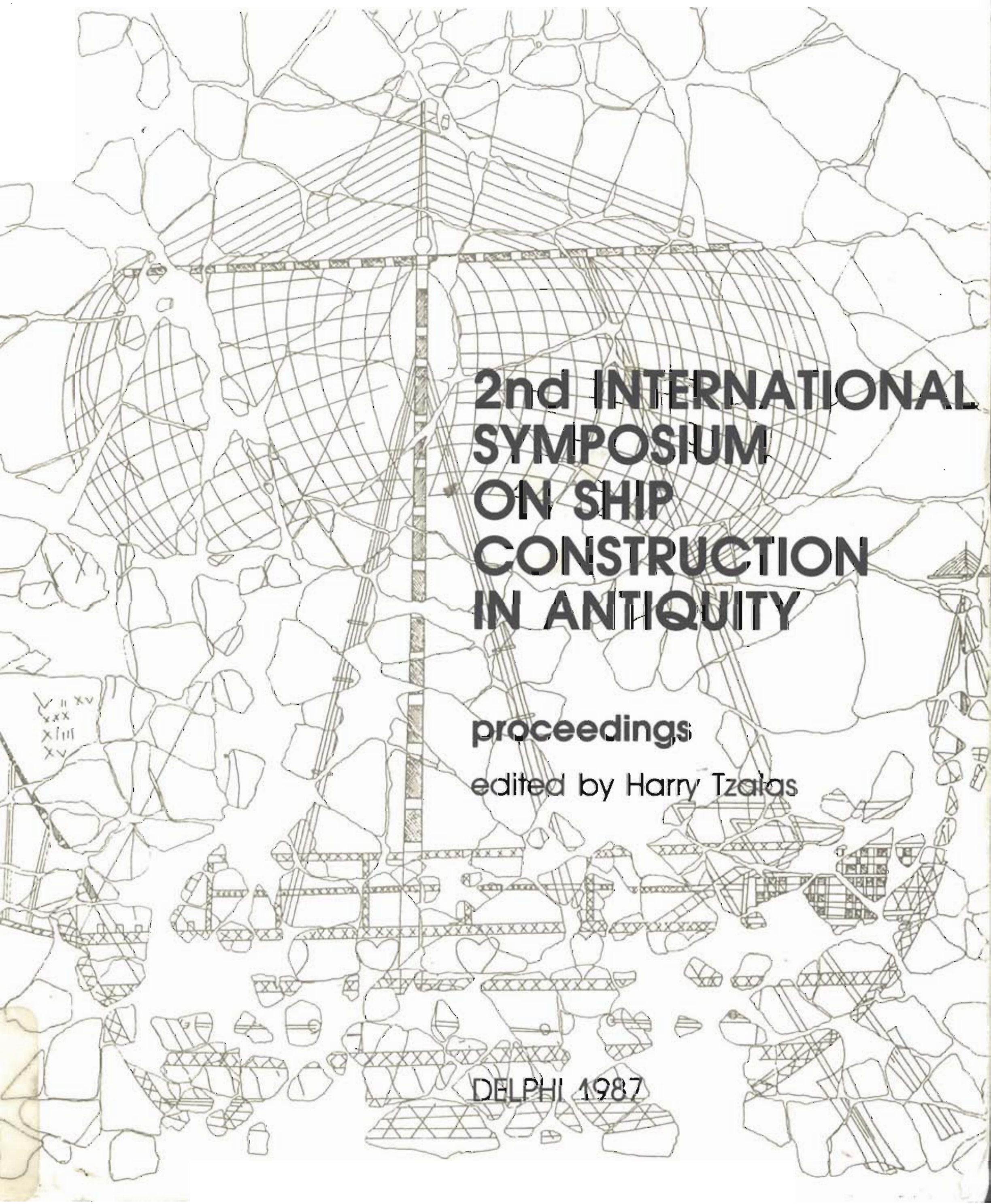

2nd INTERNATIONAL SYMPOSIUM ON SHIP CONSTRUCTION IN ANTIQUITY

proceedings

edited by Harry Tzalas

DELPHI 1987

HELLENIC INSTITUTE FOR THE PRESERVATION
OF NAUTICAL TRADITION

2nd INTERNATIONAL SYMPOSIUM
ON SHIP CONSTRUCTION IN ANTIQUITY

PROCEEDINGS

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ON
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PROCEEDINGS

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Ladies and Gentlemen,

I am deeply sad that I cannot be among you, distinguished scholars who have come from 16 countries and 3 different continents to meet in the sacred site of Delphi to discuss and exchange information on ancient shipbuilding and seafaring in Antiquity.

I would have loved to inaugurate personally your Symposium, but pressing obligations deprived me of this pleasure.

Yesterday I had the privilege to name the "Athenian Trireme" "Olympias" and wish her "Bon Voyage" as she will soon sail the Aegean waters.

Last year I wished "Bon Voyage" to the "Kyrenia II" and my wishes were heard and that ship had very successful crossings to and from Cyprus.

We want to learn more and more about the *Seafaring* history of our ancestors, that spread Greek civilization to the boundaries of the known world.

We Greeks are aware of our debt to our ancient shipwrights adn our Odysseus Mariners.

I wish you the best of success in your work and may your stay in Delphi be instructive and pleasant.

Melina Mercouri

* The welcoming address of Mrs. Mercuri was read by Dr. Olga Tzahou-Alexandri, Director of the National Archaeological Museum of Athens.

Ladies and Gentlemen,

Two years ago on the 31st of August 1985, in Piraeus, I had the pleasure and the privilege to address the participants of the "1st International Symposium on Ship Construction in Antiquity".

I am so glad today to see in this forum, many of the scholars who were present then.

The number of participants and the number of communications for the 2nd Symposium, that is about to commence have nearly doubled. I have to say that there has been such a great world-wide interest to make contributions that we had to discourage, much to our regret, numerous late-comers. The three days announced for the working sessions will just suffice for 45 papers that will be presented.

It is beyond any doubt that this reflects the ever increasing interest in this new field of Archaeology: Marine Archaeology.

I am convinced that there is a great future for Marine Archaeology and for Underwater Archaeology. Encounters like the one that is about to commence will help us to better understand how ships were built and equiped in Antiquity, and how ships sailed the seas.

I believe that the civilised world owes a lot to the ancient shipwrights and ancient mariners. It is because of their skill and audacity that civilisation spread. We Greeks in particular, acknowledge our debt to our seafaring ancestors and we are eager to learn more and more about the ships they built and sailed.

But let me not take more of your time as I know we are all eager to hear and discuss the so many interesting communications that have been announced.

Before doing so I would like to express, on behalf of the Organizing and Executive Committees and myself personally many thanks to you all who have come from 16 different countries to participate to this Symposium.

Let me express our many thanks to the Ministry of Culture and in particular to the Minister Mrs. Melina Mercuri for the enthousiastic support we have received.

I must also deeply thank the European Cultural Center of Delphi and its President Mr. Pericles Nearchou for their warm hospitality. Last but not least I owe many thanks to all the Members of the Executive Committee; all have worked hard to make this encounter possible, but I have to thank in particular Captain Tassos Tzamtzis and Mr. H. Kritzas as well as Mr. and Mrs. Kastanas, Miss Koukiari and my daughter Joanna who for one year have voluntary given hours of their time for the organization.

Let me conclude with a wish, a wish that there will be in another two years time a 3rd Symposium on Ship Construction in Antiquity and that the participation will be enlarged to comprise more scholars from many more countries. After all and notwithstanding the moments when the ship has been used as a war machine it has been for much longer periods of peace a mean of spreading Culture and welfare.

Harry E. Tzalas

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SHIP CONSTRUCTION IN CYPRUS, 1325-6

Introduction

Our knowledge of ship construction in the Middle Ages has been widened considerably since underwater archaeology became a scientific discipline[1]. Nevertheless, the data supplied by wrecks and other material evidence, such as illustrations, coins and seals, are hardly matched by the written sources, as is the case also regarding ship construction in the ancient world[2]. Only in the later Middle Ages, from the 15th century on, may we start to rely on written material. In the case of warships, the situation is almost the reverse. While very few ancient and medieval warships have been discovered and studied, the historical documentation is much more plentiful than in the case of merchantmen[3].

On the grounds of existing data for Mediterranean shipping, there are many questions we could not even hope to answer with any certainty: How much did it cost to build a ship? How long did it take? What were the relative costs of labour and materials? How many people were involved and in what capacities?

A group of documents, published in 1962 by J. Richard[4], answers exactly this kind of questions. These documents constitute a part of miscellanea concerning the island of Cyprus under the rule of the Lusignans. Being ecclesiastical in nature, they found their way into the Vatican archives. The editor has also elaborated on various aspects of life on the island during that period[5], but it seems these documents deserve further treatment, as they shed a rare light on naval construction at the beginning of the 14th century A.D.

The relevant material forms an inclusive list of expenses, concerning the construction of two boats[6]. We may regard the list inclusive because the boats were ordered by the papal emissary to the lands overseas, Geraud de Veyrines, who, in 1327, on becoming bishop of Paphos, had to settle his accounts with the Apostolic Chamber. The lists and receipts of his expenses on the boats should therefore be complete. They constitute a collection of many entries, in chronological order but under separate parallel lists, of various expenses. The aim of my study is to disentangle the entries according to different headings - materials, labour, other costs - and present the clearest possible picture of the process of building the ships: duration, timetable, procurement and relative cost of materials, amount of work put in, the socio-economic profile of the labourers, overhead costs.

The importance of the documents lies also in the fact that they deal with a type of boat little known to us. The boats constructed here are called taforesie(*tafforisiae* or *transforatae, also* taforee, taforeye and the like). The traditional description of these boats, as special horse-transports[7], seems to give too much weight to this particular function, with misleading results. In one local and most informed source they are described simply as "small boats"[8]. A. Luttrell notes that this type of boat is mentioned as a component of the *carovanna magiatri*, the fleet of the master of the Knights Hospitallers in Rhodes[9], which included also a *griparium* and a *cathphore*, all cargo ships. It was operated through the *Servitio Marina*, a tough and hated duty of the local population of Rhodes. They were definitely sea-going vessels of moderate size, probably not exceeding 100 metric tons in capacity, which may have been propelled by both sails and oars[10]. An armed escort was hired for their short sailing to Armenia (see below), so they could not have been sufficiently armed. Nevertheless, it should be emphasized already at this point that the documents cannot help us much in clarifying the features of this particular kind of boat.

Before discussing the documents in detail, a brief resume of the historical background is in order[11]. The two boats were part of a papal grant to the kingdom of Lesser Armenia, which had been attacked by the Mamluks of Egypt in 1322. The bulk of the grant was spent in repairing fortresses, chiefly in the port of Ayas (Layazzo), an important international emporium after the fall of the Crusader Kingdom in 1291. The exact use of the boats in the circumstances cannot be ascertained. They could have served as a general means of transportation in the local waters, plying between the ports and forts and collecting information.

Duration.

The first negotiations for construction and materials are listed in Jannuary 1325[12] - reference to a trip to Armenia, and in May[13], but the actual work started in August 1325. It lasted for five months, and was carried on intensively. By December very little remained to be done, and this was left to the beginning of the sailing season, March 1326. During March and April 1326 the boats were finished, caulked and rigged, and then provisioned with everything needed for the journey form Cyprus to Armenia, about 100 miles, which took place in May 1326.

It seems that shipwrights did not work during the rainy season, probably because of the difficulties in transportation, since materials and men had to arrive from inland. The docks must have been very rudimentary, as were other port installations in the Middle Ages, and inconvenient to use in winter[14]. In the winter, the most they would probably do was repair work. Consequently, the labourers were not laid-off sailors, for the sailing season coincided with that of shipbuilding.

Following are the classified lists of expenses on the boats.

I. MATERIALS

a. Timber

Aug. 1325 —	90 curved logs (ligna curva), each 1b. 16d.	— 120 b.[15]
	34 great logs (ligna magna) about 6.6d on average, made to order (ex conventione facta)	— 225 b.
	20 big strakes or wales (filyeri magni)	— 50b.
(another receipt)		
	69 pieces of timber (pecia lignaminum)	— 100 b.30d.
	21 pcs. of timber	— 30 b.18d.
	23 pcs of timber	— 23 b.
	timber from Limassol	— 75 b.
	34 great planks for making benches, each 10 b. (trabes magne pro tabulis faciendis)	— 357 b.
Oct. 1325 —	15 pieces of timber (lignamina in peciis)	— 58 b. 3d.
	timer from Limassol	— 55 b.30d.

Dec. 1325 —	1 great plank (trabs)		— 8.5
	Wood for making pegs, treenails (cavilli)		— 17 b.
March 1326 —	26 pieces of pine wood (lignus pinus sive zapinus)		— 37 b.
	9 pieces of elm wood (de ulmo)		—
			1158 b. 6d.
May 1326 —	20 oars (remi)[16]	about	— 163 b. 1s.
		TIMBER, total	1321 b. 18d.

The timber suited for ship construction was notoriously scarce in the Levant during the Middle Ages[17]. In Cyprus, however, the Troodos mountains have always been an excellent source of wood, which made the docks of Paphos famous since antiquity.

It is impossible to estimate the amount of wood put into the construction of the boats, or how the various woods listed were used. But, if our understanding of the terms is correct, we can draw some conclusions about the mode of construction.

The 90 curved logs were probably used for frames, stem, and stern posts, each log being cut to several pieces of the required curvature. The 34 great logs may have been for the straight constructional parts of the boats, such as keel, keelson, and deck beams. The fact that they were "made to order" or prefabricated is significant: this no doubt lowered costs and cut down the duration of the work.

The 69, 21, and 23 pieces of timber ordered would have sufficed for the outer planking, the first being the main order and the two others complementary. Or perhaps the three orders represented three different types of planks.

The 34 "great beams for making benches" may be interpreted as shelves or stringers for internal hull arrangements. Or they may have been some heavy, "stable like" fittings for carrying horses. They may, of course, have been benches for rowers, but we have no conclusive evidence that the ships were fitted with oars. In December one more great beam was ordered, presumably to fill out shortages in the preceding orders[18]. The order of wood for pegs and treenails in December could not have been connected with the boats in question, since their construction should have been finished by then. It was probably meant to replenish the yard's stocks, as treenails had to be well dry and seasoned when used.

The order of March 1326 was certainly for the superstructure, made of *zapinus,* the Aleppo pine, and elmwood, still popular in these parts to this day.

Some of the timber was bought where grown and transported by the builders, while some was procured form dealers or by the carpenters themselves. Most of it was paid for during the first months of work. In later months only "pieces of wood" - short planks for finishing - were ordered, as well as the traditional pine and elm for the superstructure. The heavier logs must have been oak or even cedar, then as now quite prevalent in Cyprus (although from replanted trees).

Part of the wood needed sawing - in September 1325 for 12 days and in October for 3.5 days and then 4 other. The cutters (secatores) were specialists who worked in pairs[19]: the brothers Romaniti (Theodorus or Thodorinus and Georgius, Michaelis and Manolis), the brothers Romathi (Costa and Michelis)[20]. Their pay was equal to that of the master carpenters.

The masts (arbores) are listed in May 1326, together with a long list of other finishing materials. This point remains unclear. The omission of any steering device is puzzling too. The 20 oars mentioned at the end of the list may have been intended for the *barca* — the ship's boat. Or the oars could have been simple sweeps to manoeuvre the ships in harbour and during calms.

b. Metal parts

May 1325	— Nails for a chest (clavi pro arca)[21]	— 30 b.
Sept. 1325	— nails, pledge and security (arra et caparium)	— 122 b.
Oct. 1325	— 50 tacks (scoparoli)[22]	— 2.5
Nov. 1325	— 40 rotl[23] big nails (clavi magni)	—
	2050 small nails (clavi parvi)	— 90 b. 6d.
	400 tacks	
	— 16 rotl 4.5 ounces nails	
	(10 ounces per besant)	— 19 b. 31d.
Dec. 1325	— 33.5 rotl nails	— 50 b. 1s
	450 small nails	— 2 b. 39d.
	50 nails of medium size	21d.
	25 other nails	18d.
	50 other nails	16d.
March 1326	— 14 rotl 6.5 ounces nails	— 21 b. 39d.
	15 small iron nails (parvi ferrei)	— 5 b.
	750 iron tacks	— 3 b. 3s.
	1 rotl 3.5 ounces nails	— 2 b. 17d.
	4 rotl 4 ounces nails	— 5 b.
May 1326	— 2 anchors, 68 rotl both	— 83 b. 3s.
	2 hooks (rampitoni sive ancori)	— —
	METAL, total	— 440 b. 7d.

As was the case with the wood, it is difficult to calculate accurately the quantity of nails that were used on these two boats, but it definitely reached hundreds of kg.

Most of the nails must have been copper or bronze, since the iron ones are specified as such. The wooden nails, or tree-nails, were specified separately too, and made on site (see Timber). There were several different sizes of nails, as well as tacks, and they were bought either by weight or by number. They were made by a specialist artisan, a *clavarius,* and bought directly from him, or through the carpenters.

As was stated above, the main body of the vessels was finished by October, so the September purchase represented most of the framing or planking nails. The November order, as well as that of December, were intended for fastening the lighter parts, such as decking. In March some more nails were bought, for the corresponding finishing timber.

The anchors were light and their number (one to each boat) does not match the shipping codes and general usage, whereby there should have been several anchors on board[24].

c. Tow and other caulking materials.

Oct. 1325	—	14 rotl tow, oakum (stuppa)	—	10.5 b.
	—	linseed oil and wax (sepum)	—	3 b. 15s.
	—	1 quintal 83 rotl tow	—	25 b. 30d.
(another list)				
	—	4 rotl tow, 1 heavy cloth (rista)[25]	—	5.5 b.
	—	1.5 rotl tow	—	1 b. 3d.
		wax		14d.
Nov. 1325	—	1.25 rotl tow	—	1 b. 3d.
		wax	—	14d.
May 1326		some tow and heavy cloth[26]		
		CAULKING, total	—	47 b. 28d.

The caulking was done mainly in October-November, by a group of specialist - calafati, organised in a guild in many other places[27]. There were around nine of them, headed by one Michael the Rhodian. Like the wood-cutting specialists, they got paid the same wages as master carpenters. It is noteworthy that on several occasions a cauldron (calderia) had to be rented for them[28]. They must have been refugees (see Labour) or working away from their regular places.

The large amount of tow — 264.12 kg — is a clear indication that the ships were built skeleton first, a fact which is not surprising at this date. A coat of pitch was usually added for further protection[29].

d. Sail cloth.

Nov. 1325	—	9 measures of canvas (rods - canne)	—	18 d.
May 1326	—	Cotton cloth and canvas for making 2 sails (tele cotonine)	—	640 b.[30]

The first order, 9 measures[31], is very small. The sails must have been made at the last moment, or even bought ready-made, although another entry, in April 1326, tells us of a fee of 7.5 b. paid to 2 men and 7 women who sewed the sails. Usually, more than one sail would be kept on a boat, even a small one[32]. This is especially true if the sail was of the lateen type, which was probably the case[33].

e. Rope.

Sept. 1325	—	2 coils of plain rope, each 2 quintals (agumena sive corde plane)[34]	—	220 b.

The cord industry was essential to ship-construction, for example at Venice, where it was part of the arsenal[35]. There was no problem in getting new rope in Cyprus, another advantage that made this island a preferred port of call for international shipping. In January 1325 canvas ropes or cables, costing the huge sum of 1000 b., were bought by the papal emmissary for fitting the war-machines and other armament sent to Armenia.

II. LABOUR (Man-power)

Aug. 1325	days[36]	pay
	25	41 b.
	25	20
(5 x 25)	125	120
(2 x 6)	12	12
(2 x 6	12	9
	3	3
	1	1
	6	6
	6	6
	6	4
	6	4
	6	3
	25	36
another list	?	40
(3 x 6)	18	18
(2 x 6)	12	18
	6	3
	3	4.5
	3	3
(2 x 6)	12	14
	312	365.5 b.

Sept.	days	pay
(6 x 6)	36	27.5 b.
(2 x 25)	50	72
(2 x 12)	24	24
(4 x 12)	48	48
	25	45
	25	30
	25	15
	25	4
	?	8.1 s.
	5	5
	?	13.5
another list		
(3 x 6)	18	18
	?	1
	3	12
	12	12
(3 x 12)	36	36
	25	22
(3 x 25)	75	120
	25	36
(2 x 6)	12	12
	469	561 b.1s

Oct. 1325	days	pay
	4.5	4.5 b.
	4	9
	11	24 b. 3 s.
	3.5	7.5
	7	11 b. 1 s.
	11	12 b. 18d.
	3	3
	9	9
	4	4
	8	8
	4	4
	2	3
	2	2
	2	2
	4	4
	4	4
	83	111

Nov. 1325	days	pay
	3.5	5 b. 1s.
	3.5	3.5
	3.5	3.5
	3.5	2.5
	1	2
	3.5	3.5
	3.5	3.5
	5.5	8 b. 1s.
	5.5	5.5
	5.5	5.5
	4.5	4.5
	3	3
	3	3
	3	5.5
	5.5	11
	4.5	6
	4.5	4.5
	4.5	4.5
	4.5	4.5
	?	43d.
	?	2
	4	5 21d.
	?	1
	4.5	39d.
	1.5	1 6d.
	4	4
	3	3
	4	4
	4	3.5
	4	4
	1	1

Dec. 1325	days	pay
	2.5	2.5
	2.5	2 b. 9d.
	2.5	4
	2.5	2.5
	2.5	3 3s
	2.5	2.5
	?	3s
	4	4
	4	4
	?	4
	3	2 30d.
	4	6
	?	
	30	39 b. 15 d.
(con. Nov. 1325)		
	4	6
	3	2 1s
	18	30 1s.
	136	169 b. 15d
March 1326		
(9 × 24)	216	324
(9 × 24)	216	324

TOTAL DAYS — 1246; TOTAL PAY — 1582 b. 42 d.

Around 1246 working days were put into the construction of the boats. An average of 20 persons a month were on the pay-lists. About one half of them were described as master carpenters, who got a monthly pay. The others were *proto magistri,* apprentices, plain labourers and even slaves.

In August,		8 men were paid on a monthly basis,
	5 -	7 men were paid weekly,
	2 -	4 men were paid daily.
In September,		7 men were paid monthly,
		8 men were paid weekly,
		7 men were paid daily.

In October and later, all worked on a daily basis.

Usually, the experts were paid weekly, while the others were paid by the day. Most of the men did not work the whole month. Among these, many were sons, servants and slaves of the masters[37].

The masters got 1 to 1.5 besant per day, as did the cutters and caulkers. One besant per day was definitely the average fee. The apprentices and simple labourers got half a besant and down, and the slaves about 4 besants a month.

The slaves were a common feature in Cypriote life, as in the Levant genarally[38]. In our documents, a much respected consultant was a slave of the king himself, who held the high position of "Head of the Royal Arsenal" in Famagusta ("Hazono, guardiano del tersena", or "Hassan Sclavo Regis"). He was apparently a Moslem or a Syrian (i.e., belonging to an eastem Christian community), who came with two slaves of his own. During the months of October, November, he worked 21 days on the boats.

Most interesting is the ethnic composition of this labour force, already expounded on by the editor of the documents. Many were refugees from the Crusader Kingdom in the Holy Land, people from Tripoli, Tyre, Sidon (Sageta), Haifa, etc. They were mostly Syrians or oriental Christians[39]. The majority of the labourers were naturally Greek Cypriots, but there were some "Franks" too — newcomers from Catalonia, France and Italy.

There was one person — Giorgio Zavari — who seems to have been a contractor (Rais), like the caulker Michael from Rhodes. Several men were paid through him, and in October 1325 he got 12.5 b. for his services, apart from his salary as a carpenter[40].

III. ADDITIONAL COSTS

a. Various

1. Aug. 1325	—	1 barca (ship's boat)	—	125 b.
2. Aug. 1325	—	transportation of carpenters from Niçosia to Famagusta	—	5 b.
	—	transportation of wood from Nicosia to Famagusta	—	10 b.
	—	transportation of wood from Nicosia to Famagusta	—	1 b.33 d.

	— Transportation of wood from Nicosia to Famagusta	—	6 s.
Sept. 1325	— transportation of carpenters back to Famagusta	—	8 b.
3. Oct. 1325	— renting a cauldron (calderia) for tow	—	12 d.
	— renting a cauldron for tow	—	3 b. 1 s.
Nov. 1325	— renting a cauldron for tow (that belonged to one of the carpenters)	—	12 d.
	— renting a cauldron for tow	—	12 d.
4. Sept. 1325	— cutting the wood, 12 days	—	24 b.
Oct. 1325	— cutting the wood, 3.5 days	—	7.5
5. April 1325	— Sewing the sails, a work done by 2 men and 7 women	—	7.5
			194 b.

These various additional costs were already referred to under different headings (timber, tow, sails), but are grouped here for the final account.

b. Organization

May 1326	— Coordinator's fee (in Famagusta)	—	48 b.
	— Coordinator's fee	—	100 b.
	— To another clerk who worked on the project for 3 monts	—	50 b.
			198 b.

IV. FITTING AND SAILING

a. Salaries

March 1326	— Salaries of the sailors who took the boats to Armenia	—	160 b.
April 1326	— Salaries of the commanders and captains of the escorting oared ship (comites et nuclerii)	—	65 b. 3s.
	— Salaries of two Pisan pilots, for conducting the boats to Armenia (pro ducendo)	—	50 b.
			275 b.

b. Escort

April 1326	— Fitting an oared ship (52 oars) as escort	—	592 b.

The payment for an escort may, in a way, be regarded as an equivalent of insurance.

c. Biscuits

Aug. 1325	— 5 quintalia biscoti pro Armenia	—	100 b.
Sept. 1325	— 14 quintalia biscoti (25 b. each)	—	350 b.
April 1326	— 8 quintalia biscoti and 81 rotl	—	83 b.
			533 b.

Ship biscuits were a staple food on boats until the last century[41]. They were made of hard wheat *(durum)* and stored in every important port of call. Cyprus, like the other big Mediterranean islands such as Crete and Sicily, could produce the necessary quantities. The first two entries are provisions for Armenia, which was in constant need of imported grain.

Total sailing expenses 950 b.

Some other data included in the documents are worth quoting:

Jan. 1325	— The emissary's trip to Armenia	—	800 b.
	— Fitting a boat for a trip to Armenia	—	769.5
	— Fitting a galley for a trip to Armenia (The papal emissary could not go because of infirmity, but expenses were not reimbursed)	—	1500 b.
Aug. 1325	— A messenger's trip to Armenia	—	40 b.
May 1326	— A messenger's trip to Armenia	—	315 b.

Note that the Bishop's trip to Armenia cost 700-800 b., while a lesser dignitary travelled for 315 b., and a messenger sailed for only 40 b. Note, too, that the charter of a galley cost twice or thrice as much as a round ship or a small warship (1500 b. compared to 769 or 592 b.), and once contracted, could not be cancelled.

Conclusions

From the preceding analysis of the documents, the following table emerges[42], showing the total expenditure on the construction of the two boats:

I. Materials	amount	percentage of total cost of materials	percentage of total cost of ship
a. Timber	1321 b. 18 d.	49.5	
b. Metal	440 b. 18 d.	16.5	
c. Tow	47 b. 28 d.	1.8	
d. Rigging	640 b. 18 d.	24	
e. Ropes	220 b.	8.2	
	2669 b. 17 d.	100	57.5
II. Labour	1582 b. 42 d.		34
III. Other costs	392 b.		8.5
	4644 b. 11 d.		100

The materials used in construction amounted to over half of the expenditure. Among them, timber was the most expensive (almost 50%), with the rigging coming next (24%) , and then the metal fittings (16.5%). The ropes, although essential, cost only 8.2%, and the price of the tow was negligible, although over a quarter of a ton of it was used.

The expenses for labour (carpenters' and caulkers' fees) were 34% of the total, with about 1250 work-days of various specialists spent on the job. Additional costs, like transportation and the hire of equipment (calderie), payments for coordinators and inspectors all added up to some 8.5% of the total. As the emissary was not an expert, and stayed in Nicosia while the boats were built in Famagusta, there was need of mediators, who were responsible for a share of the expenses.

The Taforesie sailing cost was about a fifth of their construction costs, a very low sum compared with the costs of sailing for dignitaries, as well as the costs of fitting other vessels, as quoted above. Finally, each Taforesia cost about 2322 besant blanc of Cyprus, or 387 florin, a mere fraction of the huge sum of 30.000 florin granted in support of the Kingdom of Lesser Armenia.

The availability in Cyprus of all the materials needed for ship construction, of both the professional and untrained labour force, which included many immigrants, as well as Cyprus' location on the international trade routes, presumably made the island an ideal ship yard for the whole eastern Mediterranean. Yet, as already pointed out by J. Richard, the documents reveal that the docks in Famagusta at the time did not carry on boat building as their routine work. They may well have been busy doing repairs and equipping boats in transit, but, even for the limited project of building the two boats, people and materials had to be fetched from far and wide.

From the point of view of ship construction, the boats were probably typical of the sort used in local Levantine trade and naval operations through the whole of the Middle Ages, between Cyprus, Lesser Armenia, Southern Armenia, Southern Anatolia, Rhodes and Crete. Although we are left in the dark concerning many important topics, such as the size of the boats, their exact type, rigging, etc., we are given a great deal of detailed information on a subject little knwon and dealt with — the socio - economic aspects of ship construction in the Levant in the first quarter of the 14th century.

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Sarah Arenson
Man and Sea Society
8 Calaniyot St.
Tivon 36000, Israel
Tel. 972-4-831644, 831479
Fax. 668028

NOTES

An earlier version of this paper was read in Porto, Portugal, 1985. This version has benefitted from the careful and much appreciated reading of Prof. Lionel Casson.

1. For a general view on the state of research, see: Bass, G., ed., *"A History of Seafaring based on Underwater Archeology"*, N.Y. 1972; Muckleroy, K., ed., *Archeology Under Water, An Atlas of the World's Submerged Sites,* London, 1980; Gianfrotta, P.A. and Pomey, P., *Archeologia Subacquea,* Milano 1980.
2. Casson, L., *Ships and Seamanship in the Ancient world,* Princeton 1971, esp. ch. 10; Basch, L., *Le musée imaginaire de la marine antique,* Athènes 1987.
3. See: Friel, Ian, "Documentary sources and the Medieval Ship", *International Journal of Nautical Archeology* 12/1983, 41-62; idem, "The documentary evidence for shipbuilding in England, 1294-c. 1500" in Villain-Gandossi, C., Busuttil, S. And Adam, P., eds., *Medieval Ships and the Birth of Technological Societies. Vol. I: Northern Europe,* Malta 1989, pp. 139-149; and the old articles by Anderson, R.C., "English Galleys in 1295", *Mariner's Mirror* 14/1928, 220-241, and Tinniswood, J.T., "English Galleys, 1272-1377", ibid, 35/1949, 276-315. A comparative study of this material is underway.
4. *Chypre sous les Lusignans, Documents Chypriotes des Archives du Vatican, XIVe et XVe siècles,* publiés par Jean Richard, Paris 1962 (Institut Français d'Archeologie de Beyrouth, Bibliothèque Archéologique et Historique, tome 83), pp. 33-49.
5. On Cyprus generally, see Hill, sir George, *A History of Cyprus,* 4 vols., Cambridge 1972.
6. I would like to express here my deepest gratitude to Prof. Richard Steffy, who has generously shared with me his thoughts concerning this material.
7. Jal, A., *Glossaire Nautique,* Paris 1848. Second edition in preparation by the International Commission for Maritime History, under the direction of M. Mollat, started Paris 1970.
8. Pegolotti, F.B., *Pratica della Mercatura,* ed. A. Evans, Camb. Mass., 1963, p. 17; quoted by Richard, p. 38, n.4
9. Luttrell, A., "The Servitudo Marina at Rhodes 1306-1462", reprinted in *The Hospitallers in Cyprus, Rhodes, Greece and the West, 1291-1440,* Variorum Reprints, London 1978, IV, p. 63.
10. In this respect, the Taforesia is similar to the Tarida and other hybrid types. See: Heers, J., "Types des navires et specialization des trafics en Mediterranée à la fin du Moyen Age", *Le navire et l'économie maritime.* Travaux du 2e Colloque International d'Histoire Maritime, Paris 1958, pp. 107-112; Mollat, M., "Problèmes navals de l'histoire des Croisades", *Cahiers de Civilization Médiévale* 10/1967, 345-359; Pryor, J.H., "Transportation of horses by sea during the era of the Crusades", *The Mariner's Mirror,* 68/1982, 9-27, 103-125; and "The naval architecture of crusader transport ships", ibid, 70/1984 pp. 171-219, 275-292, 363-386; idem, *Geography, Technology and War, Studies in the Maritime History of the Mediterranean, 649-1571,* Cambridge 1988, ch. II, "The Ships".
11. See Richard pp. 36-3, and Boase, T.S.R., ed., *The Cilician Kingdom of Armenia,* Edinburgh 1978.
12. Certainly the main timber orders were put in by then.
13. See below, metal parts and note 21.
14. See Richard pp. 40-41. Even today, most of the small shipyards in the Eastern Mediterranean are uncovered.
15. b = besant, s = solidus, d = denier. See J. Richard pp. 16-21 (Système monetaire et système de mesures). See also: Desimoni, C., "Observations sur les monnaies, les poids et les mesures cités dans, Les actes du notaire genois Lamberto di Sambuceto", *Revue de l'Orient Latin,* Paris 1895, t. 3, 1-25.
16. The price includes also some light ropes (cordes subtiles).
17. Lombard, M., "Arsenaux et bois de marine dans la Mediterranée musulmane, VIIe - XIe siècle", *Le Navire* etc. (see note 9), pp. 53-106. Also in *Annales: Economies, Sociétés, Civilisations,* 1959, 234-254, quoted by Richard p. 39, n. 4.
18. It is interesting to note the equal number of "great logs" and "great beams" (Richard pp. 41, 46). All the inner hull arrangements sugested above may correspond to the number of frames, but the latter seem to have been ordered in a greater number (90, see above). The single great plank was bought from the *portarius* of Famagusta, the harbour-master.
19. They probably used the large frame-saw, often seen in contemporary illustrations of construction work.
20. Richard pp. 41-43.
21. This may have been the safe used to keep the papal money.
22. The editor of the documents thinks these might be axes (p. 43), but the price does not allow this. They are quite cheap and different from nails. I suggest tacks.
23. The rotl equals 2.264 kg., the ounce - 188 gr., the quintal - 226.4 kg., the cane of cloth - 2.20 m. See the works cited in note 16.
24. Jacoby, D. - "Venetian Anchors in Crusader Acre", *Mariners Mirror,* 71/1985, 5-12, with references.
25. Richard p. 43, n. 7.

26. The last amount of caulking materials was listed together with other items, such as the masts mentioned above (p. 6).
27. Lane, F.C., *Navires et constructeurs à Venise pendant la Renaissance,* Paris 1965, ch. 4.
28. See further, "additional costs".
29. Richard p. 43.
30. The lump sum of 640 b. should be considered as covering general rigging expenses, including masts, sails, hooks, and some caulking material as well. It could be listed under timber, as the exact cost of each item was not specified. See also note 26 above.
31. The Canna or measuring rod for textiles in Cyprus equalled 2.2 m. See note 15.
32. Lane, Navires, pp. 10, 19f.
33. Ibid, p. 33f. Anderson, R. and R.C., *The Sailling Ship,* N.Y. 1963, ch. 6.
34. See note 23 above.
35. Lane, F., "The rope factory and hemp industry in the 15th - 16th centuries", *Venice and History,* Baltimore 1966, pp. 269-284. Originally in the *Journal of Economic History,* 4/1932, 830-847.
36. In these tables, a month's work was calculated at 25 days, and a week as 6 days. I aim to arrive at an estimate of the total of working days put into the construction of the boats.
37. Some of the following information conceming the labour force was deduced already by J. Richard (p. 39-40).
38. See for example *Nicola de Boateriis, Notaio in Famagusta e Venezia, 1355-65,* a cura di A. Lombardo, Venezia 1973; *Pietro Pizzolo, Notaio in Candia 1300,* a cura di S. Carlone, Venezia 1978.
39. Richard p. 40; Jacoby, D., "L'Expansion Occidentale dans le Levant: les Venitiens à Acre dans la seconde moitié du treizième siècle", *Journal of Medieval History* 3/1977, 245-250; and "Citoyens, sujéts et protégés de Venise et de Gênes en Chypre du 13e au 15e siècles", *Byzantinische Forschungen,* 5/1977, 159-187; both reprinted in his *Recherches sur la Mediterranée Orientale, XIIe-XVe siècles,* Variorum Reprints, London 1979, Nos. VI, VII; also "The rise of a new emporium in the Eastern Mediterranean, Famagusta in the late 13th century", *Meletae kai Hpomnemata, Hidryma Archiepiskopou Makariou III,* vol. I, Nicosia 1984, pp. 145-179, reprinted in his *Studies on the Crusaders' States and on Venetian Expansion,* Variorum Reprints, Northampton 1989, No. VIII.
40. Richard pp. 43-45.
41. Lane, F. Ch., "Salaires et régime alimentaire des marins au debut du XIVe siècle: Vie matérielle et comportements biologiques", *Annales: Economies, Societés Civilisations* 1963, 133-138; translated and reprinted as "Diet and wages of seamen in the early 14th century", in *Venice and History, The collected papers of F.C. Lane,* pp. 263-8.
42. In calculating the totals, only expenses directly connected with the two boats were taken into consideration.

It is regreted that the editor did not receive the text of the oral communication of Dr. M. Artzy on "Sea Peoples Ship rituals in the Eastern Mediterranean", nor an abstract

THE ORDER OF ROWERS IN THE ANCIENT SHIPS*

1. The beginning of the problem: from the first literary approach in the XV century to the experiment of Jal in the XIX century.
2. The first scientific approach in the work of Graser and its limits.
3. The great influence of Graser's hypothesis, that caused a few credibility in any model of an ancient ship with fourty orders of rowers, till the discovery of Nemi's ships.
4. The actual studies, based on "scaloccio" system, don't give a satisfactory explanation from a constructive point of view.
5. The idea of "sensile" system as the only way to explain the superposition of rowers in a great ancient ship.
6. The proportions of the ship must remain approximately constant increasing the dimentions and the orders of rowers.
7. A new hypothesis: starting form the possible positions of two rowers, we can build four models of dispositions with a three feet distance from a thoal to another and a fifth model with a greater distance.
8. From the first four models come the three types of "trieres" (without "parodos", with one oar from the "parodos", with two oars).
9. Increasing the third type of "trieres", we obtain the "tetreres", the "penteres" and the "eseres".
10. To build models of a greater number of orders we must apply the fifth disposition.
11. The ships with seven to twelve orders can be deduced thinking to a four feet distance and a disposition of one thwart of three rowers or a double thwart of two rowers each.
12. From thirteen to twenty orders we'll have a five feet distance and thwarts of four rowers or double thwarts of two and three rowers each.
13. Fianlly, the ship with thirty orders must have a six feet distance and double thwarts of five rowers each and the ship with fourty orders the same disposition with a seven feet distance.
14. The "tessarakontores" is the only ancient ship whose measures have been described in a text of the antiquity in our possession. Starting from these measures and applying the theoretical models, we may have a sure base to approach the real aspect of ancient ships.
15. The rules for building the ancient ships are simple and constant. like the harmony of Greek temples.

Maurizio Ascani,
Viale Bruno Buozzi,
Roma 00 197,
ITALY

* This is an abstract of Dr. Ascani oral communication.

RELIEF LENORMANT OU RELIEF PERVANOGLU? EN TOUT CAS, UN RELIEF NON DATE

Le relief dit "Lenormant", n° 1339 du Musée de l'Acropole, malgré son immense célébrité, mérite d'être examiné encore plus attentivement qu'il ne l'a jamais été.

Il a très généralement été accepté comme la représentation fragmentaire d'une trière des environs de l'an 400 — le marbre lui-même étant considéré comme un original de cette époque.

En ce qui concerne la croyance en la fidélité de la représentation, celle-ci reposait avant tout sur le fait qu'il était unanimement admis que le niveau de l'eau, tel qu'il est montré sur le relief, indiquait avec précision l'emplacement de la ligne de flottaison. Il peut être démontré qu'il n'en est rien, si l'on considère l'ensemble iconographique formé par ces trois documents étroitement apparentés que sont le relief Lenormant (centre de la trière), le relief n° 117 du Musée de L'Aquila (poupe de la trière) et le dessin n° 201 de la collection Dal Pozzo au British Museum (proue de la trière). Il est clair que le relief Lenormant représente une trière nettement trop émergée, ce qui met très gravement en cause l'exactitude des traits représentant les rames thalamites[1]. Un tel phénomène ne doit pas surprendre: il se produit d'une manière très générale dans l'iconographie navale, dans le temps et dans l'espace, de l'Egypte antique à l'Europe médiévale. Il se produit d'ailleurs régulièrement en Grèce, comme on peu le voir sur le socle de la Victoire de Samothrace et sur le relief n° 13533 du Musée de l'Acropole (vers 300 av. J.-C.)[2].

Par ailleurs, il n'existe aucune preuve certaine que le relief Lenormant soit un original du 5e ou du 4e s.: un examen stylistique n'est pas décisif et il n'existe aucune preuve stratigraphique.

Il a été affirmé que le relief Lenormant avait été découvert "within the foundations of the Erechtheum"[3]. Comme l'Erechtheion fut achevé en 408 et que, endommagé par un incendie, il fut reconstruit à partir de 395, il est clair que si le relief avait été trouvé dans les fondations du temple, il serait daté de façon évidente. Toutefois, comme les fondations de l'Erechteion n'avaient pas encore été fouillées en 1852 (date approximative de sa découverte[4]), une telle affirmation est dénuée de fondement[5]. Il existe d'ailleurs un témoignage formel au sujet du lieu de la découverte: dans son catalogue du Musée de l'Acropole (Athènes, 1985), p. 62, P. Kastriotis écrit que le relief n° 1339 a été trouvé επί της κλίμακας του Ερεχθείου ("sur l'escalier de l'Erechtheion"). Si l'on examine un plan du temple, on s'aperçois qu'il est entouré de "marches" de tous côtés, mais que ces "marches" sont, en fait, la *krepidoma*: le seul véritable escalier longe la face Nord de l'Erechtheion. Il n'existe donc aucune certitude quant à l'endroit précis de la découverte du relief.

Il suffit d'examiner les images que nous a léguées la première moitié du 19e s. pour constater que l'Erechtheion était, jusqu'en 1850 environ, entouré de toutes parts, à sa base, de débris divers. Je citerai particuliérement:

— un dessin de Thürmer (1819)[6]

— un dessin de Davidoff (1840)[7]

— un dessin de Rey et Chavanard (1843)[8]
— un dessin de du Moncel (1846)[9]

Les premiers témoignages iconographiques du dégagement de la base de l'Erechtheion sont constitués, à ma connaissance, par deux photographies datées de la période 1850-1855 de la collection R. Andreadis[10]. Il est probable que ce dégagement s'imposa immédiatement aprés la violente tempête qui endommagea gravement le temple le 26 octobre 1852.

L'incertitude est la même quant à la découverte: l'origine du surnom "Lenormant" est en effet loin d'être des plus claires. En effet, s'il est certain que François Lenormant s'est intéressé de très près au relief[11], il n'a pas, à ma connaissance, revendiqué la découverte elle-même, auprés de l'Erechthion. Un passage de *La flotte de César* (Paris, 1861), d'Auguste Jal (p. 229) me fait même penser le contraire. Jal écrit: "Le monument que le hasard m'a fait connaitre fut découvert à l'Acropole d'Athènes, *vers 1852. C'est, de son histoire, tout ce qu'a pu m'apprendre M. François Lenormant* (passage souligné par moi), jeune et savant antiquaire, digne du nom qu'il porte[12]. M. Lenormant a rapporté d'Athènes un moulage du fragment dont on voit, p. 228 *(ici fig. 1)* la représentation faite d'aprés la photographie; il a bien voulu me le montrer, et j'ai pu comparer l'épreuve de plâtre avec celle que la lumière a produite sur le papier. Elles diffèrent en ce point que, dans le marbre tel qu'il était quand on l'a moulé pour M. Lenormant, manquait le premier rameur (mutilé) de gauche que donne la photographie, et presque tout le dernier rameur de droite. Le monument a subi quelques dégradations, on le voit, entre l'époque où il fut photographié par M.D. Constantinos et celle où M. François Lenormant l'a fait mouler".

Plusieurs conclusions doivent être tirées de ce texte:

1° Jal n'aura pas manqué, soyons en sûrs, d'interroger Lenormant de manière approfondie au sujet du relief: c'est tout à fait évident de la part de celui qui a bien mérité le titre de "Pére de l'archéologie navale" et auteur, avec Dupuy de Lôme, de la "reconstitution" de la "Triréme Impériale"[13]. Or "tout ce qu'a pu apprendre" Jal est que la découverte a eu lieu "vers 1852"; si Lenormant avait découvert lui-même le relief, il me parait certain qu'il aurait au moins pu fournir l'année exacte.

2°. Le grand mérite de François Lenormant est d'avoir fait procéder à un moulage du relief: c'est cette priorité qu'il faut lui accorder. Il résulte de la précieuse comparaison que nous livre Jal entre le moulage et la photographie qu'il n'y a guère de différence entre ce moulage et l'état où nous voyons le relief aujourd'hui.

3°. Par contre, M.D. Constantinos a fait une photographie du relief à une époque où celui-ci était plus complet. Il est difficile de croire que F. Lenormant lui-même aurait chargé M. Constantinos de la photographie: il est logique de penser qu'il aurait fait photographier *et* mouler le relief à peu près en même temps. Il est plus que probable que Lenormant a fait mouler le relief en constatant, sur la photographie, qu'il avait été dégradé, depuis sa découverte par... qui ?

Un candidat possible est Pietro Pervanoglu, membre correspondant de l'*"Instituto di Corrispondenza Archeologica"* de Rome. On lit en effet, dans le *Bullettino* de cet Institut, n° X d'octobre 1859, que M. Pervanoglu, aprés avoir quitté la Ville éternelle au printemps et avoir promis de fournir à l'Institut des rapports sur les "archeologiche novità", avait tenu ses promesses en envoyant diverses lettres, résumées dans ce n° du *Bullettino.* Il résulte de ces lettres que les Propylées, à cette époque, servaient à la fois d'entrepôt et d'abri aux fragments d'inscriptions découverts sur la surface entière de l'Acropole. Après avoir décrit les antiquités entreposées dans la partie Nord des Propylées, M. Pervanoglu passe à l'"altra parte" (qui devait donc, toujours à cette époque, être proche de la "tour franque") et le rédacteur du *Bullettino* écrit: "Dall'altra parte de' Propilei ora si trova esposto il bassorilievo con rappresentanza d'una triere", ajoutant aussitôt: "del quale già fu parlato in una delle nostre adunanze" (p. 197): "dont il fut déjà question au cours de l'une de nos réunions". Je n'ai pas trouvé de précisions au sujet de cette réunion.

Il ne m'est pas possible de démontrer que le "relief Pervanoglu" est *certainement* celui dont François Lenormant fit connaître le moulage à Jal, qui le publia en 1861, mais la certitude est quasi-absolue: il ne devait pas exister, en 1859-1860, de nombreux reliefs de trières sur l'Acropole.

Il résulte de tout ceci:

— que Lenormant est, à notre connaissance, le premier qui fit procéder à un moulage du relief, mais qu'il le découvrit, plus que probablement, dans l'"entrepôt" des Propylées (il faut noter que Lenormant a simplement rapporté à Jal que le relief fut trouvé "à l'Acropole");

— que la premiére personne qui signala, dans une revue savante, le relief n° 1339 est M. Pietro Pervanoglu; si le *Bullettino* avait eu une plus grande diffusion, je ne doute pas un instant que le relief serait connu depuis plus d'un stécle sous le nom de "relief Pervanoglu";

— que même cette appelation serait inéquitable s'il s'agit de donner au relief le nom de celui qui l'a réellement découvert, et non seulement signalé à l'attention d'un institut archéologique, puisque le *Bullettino* fait clairement savoir que le relief avait déjà fait l'objet de conversations au cours d'une réunion de l'Institut antérieure à la communication de M. Pervanoglu. Le nom de l'auteur de la découverte restera probablement toujours inconnu.

Le but de cette communication n'est évidemment pas de provoquer une mesquine querelle d'attribution: peu importe la personnalité de celui qui a découvert le relief: Pervanoglu, Lenormant ou, ce qui me paraît le plus vraisemblable, un fouilleur demeuré anonyme, qui aura placé le relief dans les Propylées pour le protéger et où il aura été remarqué par M. Pervanoglu, à qui revient incontestablement le mérite de l'avoir signalé au monde savant.

Ce qui importe ici est, non pas une hypothése, mais une certitude: le relief n° 1339 est une trouvaille de surface; et, si du point de vue stylistique, il se rattache incontestablemnt au 5e siécle, cette caractéristique ne suffit pas à lui conférer la qualité d'"original".

En conclusion, toute information concernant la trière athénienne à l'époque classique ne peut être fondée, comme ce fut trop souvent le cas, en priorité sur le relief "dit Lenormant".

Lucien Basch
Avenue Armand Huysmans, 206-Bte 9
1050 Bruxelles

NOTES

1. J'ai traité cette question dans:
— mon compte-rendu de: Morrison, J.S. et Coates, J.F., *The Athenian Trireme* (Cambridge, 1986), dans *The Mariner's Mirror,* 73, 1987, pp. 93-105;
— mon article: "The Eleusis Museum Trireme and the Greek Trireme", *The Mariner's Mirror,* 74, 1988, pp. 163-197.
2. Article précédent, p. 190, fig. 125; aussi mon article: "La "caisse de rames" hellénistique et le relief n° 13533 du Musée de l'Acropole", dans: *Navires et commerces dans la Méditerranée Antique. Hommage à Jean Rougé - Cahiers d'Histoire,* XXXIII, 1988, pp. 291-301.
3. J.S. Morrison, "The Greek Trireme", *The Mariner's Mirror,* 27, 1941, p. 23
4. On trouvera plus loin les renseignements fournis par F. Lenormant à A. Jal.
5. La fouille de l'intérieur de l'Erechtheion, jusqu'au rocher, ne fut entreprise qu'en 1862 par l'archéologue allemand C. Bötticher *(The Acropolis at Athens, Conservation, Restoration and Reasearch 1975-1983* (Athénes, 1983), p. 16).
6. L. et R. Matton, *Athènes et ses monuments du XVIIe siècle à nos jours* (Athénes, 1963), pl. XLVIII, n° 61.
7. ibid., n° 62.
8. op. cit., pl. XLVIII, n°64.
9. op. cit., pl. XLVII, n° 63.
10. Photographies de J. Robertson: catalogue de la collection AΘHNA 1839-1900. ΦΩΤΟΓΡΑΦΙΚΕΣ ΜΑΡΤΥΡΙΕΣ, Athénes, 1985, n° 38 et 39.
11. C' est aussi Lenormant qui fut à l'origine de la publication d'un dessin du relief dans les *Annali dell'Istituto di Correspondenza Archeologica,* 1861, pl. M et dans: *Philologus,* 1863, pl. II.
12. François Lenormant (1837-1883) était le fils de l'archéologue Charles Lenormant (1802-1859).
13. dont l'histoire est relatée par L Th. Lehmann: "A triereme tragedy", *The International Journal of Nautical Archaeology",* 11, 1982, 145-151.

TRIREMES AND SHIPSHEDS

I offer this paper as a tribute to John Morrison. It was he who first inspired me as a schoolboy with an interest in ancient ships; he who, as my tutor at college, revived my interest; he who later gave me the opportunity to contribute to *Greek Oared Ships* and committed me to a lifelong involvement with shipsheds.

I have benefited from John Coates' comments on this paper, as delivered.

Abbreviations

AHM	D. J. Blackman, "Ancient Harbours in the Mediterranean", *IJNA* 11.2, 1982, 79-104; 11.3, 185-221.
AT	J. S. Morrison & J. F. Coates, *The Ancient Trireme.* (Cambridge 1986).
Evidence	D. J. Blackman, "Evidence of Sea Level Change in Ancient Harbours and Coastal Installations", in D. J. Blackman (ed.) *Marine Archaelogy, Colston Papers* 23, 1973, 115-39.
FSD	V. Foley, W. Soedel & J. Doyle, "A Trireme Displacement Estimate", *IJNA* 11.4, 1982, 305-18.
GOS	J. S. Morrison & R. T. Williams, *Greek Oared Ships, 900-322 B.C.* (Cambridge 1968).
Hurst 1977;1979	H. Hurst, "Excavations at Carthage: third (fourth) interim report", *Antiquaries Journal* 57.2, 1977, 232-61; 59.1, 1979, 19-49.
IG	*Inscriptiones Graecae* (Vol I covers Athenian inscriptions pre 404; Vol II post 404).
Lehmann-Hartleben	K. Lehmann-Hartleben, *Die antiken Hafenanlagen des Mittelmeeres, Klio* Beiheft 14 (Leipzig 1923).
SSAW	L. Casson, *Ships and Seamanship in the Ancient World.* (Princeton 1971).

The starting point for this paper is a long article published in 1982 by V. Foley, W. Soedel and J. Doyle (hereafter FSD). It contains some interesting ideas combined with some serious errors in the underlying argument; it is because of the interesting ideas that I feel it worth some discussion also of the errors.

The main aim of the article is to argue for a low trireme displacement estimate - closer to J. G. Landels' 36 metric tons (or, one could now add, Morrison & Coates' estimate, which I take to be about 48 metric tons) rather than 70 tons (W. L. Rogers 1937) or even 110 tons (D. H. Kennedy 1976). It is unfortunate for them that the main quantitative data from an ancient source which they have used, and assume to be reliable, are not in fact reliable at all; they are contained in an Athenian inscription of about 430 BC (normally dated "early in the Peloponnesian War" and most recently to 440-425: *IG* I³ 153), which refers to various activities with warships, which we may assume to be triremes (from references to trierarchs, and *trieropoioi*): Annex I. Unfortunately the stone is extremely fragmentary and their university colleague, who translated the text for them, failed to understand the meaning of square brackets in epigraphic publications — [hypothetical restoration] — or if he did understand it, failed to warn his Greekless colleagues, the authors of this article. They quote the key passage as follows (lines 6-10):

> "It is possible for no-one to draw out (a ship) with less than 40 men, nor to launch (one) into the sea with less than 20 men, nor to pitch or undergird (one) with less than 50."

This translation is of the text as published in the second edition of *Inscriptiones Graecae* (Kirchner/Hiller, *IG* I² 73 with addenda p. 302+), since the third edition appeared only in 1981. If the latter had been available, some but not all of the mistakes would have been avoided.

There are four objections to the translation:

(a) The numerals "40" and "20" are legible on the stone (lines 7, 8) but could well be incomplete — for "40 and [100]" and "20 [and 100]". The word "and" is legible after "40" while the following word is lost; after "20" the next words are lost. In Ancient Greek, after a negative verb, as in this case, "40 *and*" is likely to be part of a composite numeral (another verb would be preceded by "nor", not by "and"). In the third edition Lewis following Jameson does accept the larger numerals [1]40 and [1]20; I am sure that this is right, and I see that Morrison also agrees *(AT* p. 134).

(b) The numeral "50" is entirely hypothetical — the number of missing letters in line 10 would allow the restoration hεχσέκοντα or ὀγδοέκοντα just as well as πεντέκοντα: 60 or 80 rather than 50.

(c) The text has no certain reference to "pitching": the word "to pitch" *(pittôn)* was hypothetical in line 9 of *IG* second edition. There is no certainty of a verb between "launch" and "undergird" — indeed even the verb "launch" is a restoration in line 8, though a fairly certain one in the context. The space in line 9 on the stone would be filled by the "100" of "20 [and 100]" if that hypothesis is correct; we must of course beware of circular argument.

(d) The translation does not complete the sentence. The list of operations continues with one — "painting round (?)" *(IG* I²) or "conveying round" *(IG* I³) — which was to be carried out by a minimum of 100 men, and then continues with references to the obligations of the trierarch and helmsman, which conclude the decree. The numeral "100" in line 11 is the only certainly complete numeral surviving on the stone. As for the nature of the operation, the suggestion of Lewis *(IG* I³) seems more plausible: two alternative verbs, which would fit epigraphically, refer in Demosthenes (51.4) and Thucydides (7.9) to the operation of trierarchs bringing triremes round, after fitting out, from the smaller harbours of Piraeus which contained most of the shipsheds, Zea and Munychia, to the *choma* or hard in the larger harbour, Kantharos, for final inspection by the *apostoleis,* the commissioners responsible for overseeing the dispatch of a naval expedition. It is more plausible to have a minimum number of crew prescribed for this operation than for pitching or painting.

From this we may conclude:

(a) The word "undergird" *is* clearly legible (line 9), and it is clear that this was a difficult operation for which a minimum number of men was prescribed. Morrison & Williams *(GOS* p. 294 & n. 31) had restricted their use of the inscription to this point. Morrison & Coates *(AT* p. 170), with the advantage of the third edition of the inscription, note that the minimum number is not preserved *(AT* p. 170). It was 50, 60 or 80. For the operation involved see now J. Coates *(IJNA,* 16.3, 1987, 207-11).

(b) The whole argument which FSD based on the need for 50 men for the operations of pitching and undergirding is, one might say, based on sand.

(c) Similarly unfounded are their deductions from the minimum numbers of men needed for hauling out and launching a trireme: the figures are more likely on epigraphic grounds to be 140 and 120 respectively than 40 and 20 — and this would point to a higher trireme displacement.

A thought occurs to me at this point — when the oarsmen have finished their sea trials on the *Olympias,* could one not ask them to conduct tests on this point also, rather than have to rely on human physical performance *estimates* alone?

Could a slip be found with a gradient of 1 in 10 (much steeper than the usual slope nowadays — 1 in 20)? Or if not, could one be built? Then the *Olympias* could be properly housed, and one could also test the (plausible) assertions of Morrison and Coates about men standing beneath the outrigger to manhandle the ship *(AT* p. 134; compare FSD 308, Fig. 1). Coates tells me that he has assumed a weight at slipping or launching of 25 tonnes, which would mean that the pull up the slip required was 5 tonnes, a very feasible pull for 140 men (just under 36 kg. per man).

Is it still the intention, as Morrison and Coates hoped *(AT,* p. 8), to "house the ship in a reconstruction of a Piraeus shipshed of the fourth century BC from which it will be launched for historical research and demonstration at sea"? Will the new maritime museum contain a faithful reconstruction of a shipshed? I am glad to learn that this is the firm intention.

FSD also adduce as a further argument for the "light trireme" the lack of evidence for windlasses or similar apparatus in the fifth century BC. The point is not certain and deserves further investigation. What is not acceptable is the circular argument of FSD, who use the supposed reference in the Athenian inscription — "50 for an undergirding crew" — as evidence that the windlass was *not* in use ca. 430 BC. The earliest evidence known to me is from the pair of slipways at Sounion, cut for ships smaller than triremes and with an unusually steep gradient of 1 in 3.5 (launching calculations are needed to determine what ship could have been launched from such a steep slope). Admittedly in first publishing these remains, E.J.A. Kenny argued for a mid-third century date, but I would still favour a date in the late fifth century — the emergency of 413/12 (see my comments *GOS,* pp. 184-5). There is also no certainty that the bronze ratchet wheel found on the site belonged to a windlass; it has been suggested that it belonged to a catapult, installed in the fortifications at Sounion during the Chremonidean War (265/4) or the Macedonian occupation (263-229) (J.A. Dengate, *AJA* 71, 1967, 185-6). Casson, however, agrees that at Sounion "craft were necessarily drawn up with the aid of winches and the like" *(SSAW,* p. 364).

There are also what seem to be the mountings for three capstans at Thurii, at the back of the pair of slipways which are fifth-century or later; here, however, they were less necessary than elsewhere, for the gradient is only some 1 in 20 *(AHM,* p.205, fig. 12). The evidence from Munychia is not reliable *(Evidence,* p. 129, fig. 25).

There is no doubt that sophisticated hauling equipment existed later. Archimedes clearly achieved great improvements, such as the screw windlass used to launch Hiero's great ship, the *Syracusia* (Athenaeus, 5.207b, a passage quoted in full in *SSAW,* 194-5; Casson may be right that the description by Plutarch *(Marcellus* 14.8) of another launching by Archimedes, using a multiple block and tackle, was in origin perhaps a variant on the former description). Horace refers to *machinae* hauling "dry keels" down to the water in spring *(Odes* 1.4.2); Vitruvius (10.12) describes arrangements of blocks and tackle for hauling ships ashore and we *may* have references to hauling equipment as early as Herodotus. He uses the word *holkoi* of the installations, still visible when he visited Egypt in the mid-fifth century, built on the Red Sea for his triremes by the Pharaoh Necho (died 593) and by Greeks at a garrison post in the eastern Nile Delta at the same period (2.159.1; 2.154.5; *AHM* p.204 & n.107). Does the word mean "hauling equipment" rather than "hauling-way" (the normal interpretation)? Stone structures seem more likely to have survived nearly a century and a half for Herodotus to see, but Thucydides uses the word (3.15.1) of equipment for hauling ships across the *diolkos* at Corinth.

To complete my criticisms of FSD's article, before turning to the positive points:

(1) they strangely argue that triremes were beached or hauled into shipsheds stem first; but surely they could *only* have been hauled up *stern first,*

(a) to enable rapid re-launch and operation in an emergency; and

(b) to avoid the problems which the stem (or the ram) would create with mounding of sand on a beach, or with running the keel into a keel slot (if that was done-see below) or on to a runway on a slip. There were admittedly exceptions, but if *okellein* does mean grounding a ship bow first (as *AT* p. 163 n. 3), then it is clear from Thucydides (4.11-12) that the maneuvre ordered by Brasidas was unusual and unpopular with the Spartan trierarchs and helmsmen.

(2) they do not take into account the evidence from recent shipshed finds: they used my account published in 1968 *(GOS* pp. 181-6, written in 1966) but there is now much new evidence which I tried to summarise in 1982 *(AHM* pp. 205-6), the same year as FSD's article. To take only two examples which I discuss below: they ignore the evidence from the Carthage excavations of 1974-78; and Thurii provides clear evidence of the use of a timber "cradle" in slipways. Furthermore, they ignore evidence long known and published: for example, the Oeniadae slipways, which have a full length of 47 m and, like Sounion, have a steeper than normal gradient (just under 1 in 6), and which have the upper ends of the slips apparently prepared to fit the stern configuration of a warship. Incidentally, Heuzey recorded an oral report that the piers at the head of the colonnades dividing the five slipways bore bronze rings on their front faces, which could have served in making fast the ships; but the report has not been confirmed and must be regarded as doubtful *(Le mont Olympe et l'Acarnanie* p. 449, quoted by Lehmann-Hartleben, p. 117 & n. 2).

I now turn to the positive points in FSD's article. They have made an interesting contribution by conducting a series of friction coefficient tests with oak and fir planks on a polished granite surface, both wet and dry; the friction coefficients were high with dry surfaces, and higher with wet. (A question which occurs to me is: were the results the same with oak and fir?) They then made tests using lubricants — olive oil, beeswax and lard — producing friction coefficients which were again "too high" (for their theory). They then tested their lubricants again, dragging wood over wood, with the same results, and therefore conclude that the shipshed slips were not sheathed with planking or equipped with wooden skidways.

What FSD do not specify is whether they tested these lubricants on a *wetted* wooden surface, or only over a *dry* wooden surface; nor do they say what was the species of wood underlying. The question of a *wetted* wooden surface remains in my mind when I consider the last of their tests, which was very interesting: *pitch* lubrication of a wood/polished stone interface produced significantly lower friction coefficients, particularly when the pitch was *wet.* Since, however, they do not refer to having done tests of pitch lubrication of a wood/*wood* interface, I do not believe that we have to accept their denial of the possibility of wooden planking or skidways in the shipsheds.

FSD have carefully checked the different performance of wet and dry pitch, and investigated the reasons. They conclude that temperatures above 25° were needed for good results, and remark that Athens would normally have had those temperatures in the campaigning seasons. Even if this is true, I wonder whether the same is true of wax and tallow; with tallow as a lubricant, for example, would not hotter temperatures have made things worse?

FSD also conducted their tests with weighted planks of several configurations other than a plank with flat undersurface. Tests using keel-shaped boards (apparently lubricated with pitch) meeting the stone in an obtuse V, including about 170°, yielded significantly higher friction coefficients. "Hence", they argue, "here again is some slight experimental evidence for flat bottoms in trireme design, and some explanation for the frequent incorporation of keel slots into shipshed launching ramps. In such an arrangement, the weight of the ship would be taken mostly by the bottom planking and the ribs".

In reply to this I would make two points. First, on the evidence which we have keel-slots were *not* frequently incorporated into the rock-cut shipshed launching ramps, and on FSD's hypothesis we should have to reject the idea of timber runways laid on the stone ramps.

Secondly, we do have the evidence of Theophrastus, no mean authority on such things, that triremes were given keels of *oak* to withstand the strain and wear of hauling *(neôlkia: HP* 5.7.2). This seems to me clear support for the standard view that the keel took the weight of the trireme during hauling operations. In Coates' view "warships were most certainly slipped stern first, and it seems to me most unlikely that their weight was supported on the slip anywhere but through the keel. The problem of transmitting concentrated forces to the hull when the bow lifts would be acute if the ship did not hinge on the keel."

What is the ancient evidence for lubrication? There is one literary reference to smearing a keel with beeswax, in a fragment of the mid-sixth-century Ionian poet Hipponax (frag. 46 Diehl[3] ἔπειτα μάλθῃ τήν τρόπιν παραχρίσας). I am not sure whether one should give full force to the verbal prefix παρα-, used where one would have expected περι-: smearing the *sides* of the keel?) The lexicon entry of Liddell-Scott-Jones explained the purpose of the operation as caulking the ship. Morrison & Williams *(GOS* p. 120) suggested that the aim was more probably to enable the ship to run smoothly on a runway, and that Hipponax may have been describing a launching. Morrison & Coates now say *(AT* pp. 188-9): "The purpose of this treatment could be to make watertight the seam between the keel and the garboard strake, often a main source of leakage." But they then continue: "Applied to the underside of the keel, particularly, it could have been a lubricant to facilitate slipping and hauling up in a shipshed." It is not clear to me which explanation they prefer — or do they suggest a double purpose? Certainly lubrication must have been intended.

Morrison & Williams had already plausibly suggested *(GOS* p. 280) that we may find here an explanation of the "white *hypaloiphe*" ("white bottom paint") referred to several times in the fourth-century Athenian Naval Lists — notably in a miscellaneous collection of ship's stores in the list for 330/29 BC *(IG* II^2 1627.313). It is either wax, or "likely to be resin, probably mixed with lime" *(AT* p. 188), or some kind of clear varnish, or tallow. Federico Foerster Laures has provided some useful information about the use of tallow. In an immediate comment on the article by FSD, he noted that even nowadays wooden boats are hauled up on Mediterranean beaches over wooden beams greased with sheep's tallow (and apparently laid across the beach slope), and adds that these beams should never be of conifers, since most keels are of pine and use of the same type of wood causes bad friction *(IJNA* 12.2, 1983, 176). In a later note he describes the use of tallow on the underside of ships of 13th-century AD Aragon - and the tallow was "white" *(IJNA* 15.2, 1986, 161; cf *IJNA* 16.2, 1987, 171). Foerster suggests that the trireme crew could have laid their oars on a beach to provide a kind of slipway (N.B. the reference to the "60 oars of a trireme" must be an oversight).

Also included in the same Naval List are two type of "black *hypaloiphe",* which must be two varieties of pitch (sic *GOS* & *AT* loc.cit.). One wonders why the list does not use the word *pitta.* One reference to pitching must now be deleted — the reference in the Athenian inscription of ca.430 is entirely hypothetical (see above).

Morrison & Coates *(AT* p. 189) have usefully brought into the discussion a reference first noted by Casson *(SSAW* p. 211 n. 46): a description by Pliny the Elder *(NH* 16.56) of a mixture of pitch and wax with salt added, known to the Greeks as *zopissa,* "live pitch", which was used on ships' hulls and according to Pliny was "much more effective for all the purposes for which pitches and resins are useful". Morrison & Coates conclude that "pitch and wax were customarily applied, either successively or as a mixture, to the wetted surface of a ship's hull". On this I can only comment that Pliny clearly seems to refer to a *mixture,* and that he does not mention application to a wetted surface. (Interestingly enough, when I aired this subject in an earlier lecture, before the publication of *AT* reminded me of *zopissa,* I was asked if there was evidence of a pitch and beeswax mixture, since the wax would prevent cracking of the pitch). Casson (loc.cit.) stated that "It was usual to smear the seams or even the whole hull with pitch or with pitch and wax" and for pitch and wax quotes not only Pliny but also Vegetius (4.44): "unctasque cera et pice et resina tabulas" ("planks smeared with wax and pitch and resin").

To return to keel waxing: I had assumed that an oak keel was waxed to reduce friction over stone and timber — not, I think, within a "keel-slot" but on the ramp of the slip, whether timber-clad or not. I am now increasingly convinced that those "keel slots" which have been identified, with the possible exception of one at Apollonia, were not intended to take the ship's keel direct onto the stone, but may have contained a timber runner. FSD had suggested that the aim of the keel slot was to transfer the ship's weight from the keel to the lower strakes; if this were true, one would have to assume lubrication of the lower strakes also, but the evidence against this view seems to me compelling (see above, and note also the configuration of the slipways at Sounion and Oeniadae).

What is now becoming clear is that (pace FSD) timber *was* used on shipshed ramps. The time has come to review the main evidence. The best evidence has been provided by the excavations on the Ilôt de l'Amirauté at Carthage. One ramp from the stone shipsheds, the monumental phase destroyed in the Third Punic War, was excavated over slightly less than half its width and for a length of 28m (Hurst 1979, p. 24 and fig. 1). Mixed sand, clay and loam layers were deposited as a make-up of a ramp with a regular sloping upper surface, with a slope of about 1 in 10. Its maximum preserved height towards the centre of the island (not its original maximum height) is about 2m above earlier levels. In the upper surface of the ramp parallel timber sleepers, c.10 x 15 cm in section were set at regular intervals of about 60 cm, at right angles to the slope. At one point another timber ran at right angles to these sleepers, along the slope of the ramp, but the excavator maintains that it is not clear whether this was an intentional feature of the ramp (nor does he make clear its position within the ramp); in his conclusion, however, he says (p. 30): "there may also have been longitudinal timbers to serve as guides for the hulls of the ships or timber cradles when they were hauled up: the possible trace of one such longitudinal timber was found in the excavated ramp (pl. VIII a)". The reconstruction by Sheila Gibson (loc. cit. fig. 3) indicates a pair of longitudinal timbers which is plausible, but the evidence for two is not made clear (and her axonometric detail shows only the sleepers: fig. 4). The cross sleepers are much easier to explain as serving as a base and fixture for the longitudinal runways (Figure 1).

Absolute confirmation that the ramps were for slipways was provided by the discovery of acorn barnacles and copper nails (from ships' hulls) on the surface of the ramps and under the burnt destruction level — the superstructure of the shipsheds burnt in 146 BC.

A point to emphasize is that only the central part of the ramp was excavated, and not top or bottom, but there at least the ramp is not of stone. It *may* have been at the top, where the stone would have been robbed; and there is some evidence to show (what was in any case most likely) that the bottom of the ramp was of stone: on the south-east side of the island the Punic quay wall has been defined, with its top sloping down *outwards,* at −0.36 to −0.55 m below present sea level (which is now thought to be about 50 cm above Punic sea level: Hurst 1979, p. 27).

This could represent the continuation of the ramp; it is unfortunate that the question of the end of the shipshed ramps does not seem to have been fully borne in mind during the excavation of this area. It is worth noting that at this point (shipshed 4) the shipshed length would have been ca. 44 m — and these were the shorter ones; the longer ones such as number 16 would have been about 48 m long. This evidence must not be forgotten when considering the length of the shipsheds in the harbours of Piraeus.

I am left with the feeling that one major problem remains unsolved concerning the Carthage shipsheds. We have explicit evidence for 220 shipsheds at Carthage in Appian's description of the final phase before the destruction *(Libyca* 96, using an eye-witness account by Polybius). Hurst assumes 30 stone shipsheds on the island, which looks about right; but where were the other 190? Could the outer edge of the harbour have held so many?

So far the discussion has been confined to the stone shipsheds of the final phase before the destruction of Carthage. Belonging to an earlier phase, of the third century, are timber structures which Hurst originally interpreted as timber shipsheds (1977, p. 235). He later rejected this interpretation, saying the weight of evidence has shifted away (1979, p. 23), but I have not read anything which convinces me that his first reaction was wrong. The evidence is a series of parallel east/west slots or wall trenches (Hurst 1977, fig. 3), spaced 6 m apart like the lines of piers of the stone shipsheds. I am aware that I am thought to be inclined to interpret every structure 6 m wide as a shipshed, but here I think I am justified until stronger evidence against this interpretation is produced; the lengths would have been just right, also — 45-50 m.

Hurst points out that these wall trenches appear to be exactly parallel to each other, while the lines of stone piers radiate from the centre to fit the circular outline of the island. This suggests to me that the wall trenches belong to a phase before the island had undergone its monumental layout; the lack of evidence for parallel timber-period trenches on the west side of the island is in my view an argument *for* rather than *against* the timber shipshed hypothesis (in any case too little has been excavated to this depth scientifically on the west side - Hurst's work was mainly in the centre and east of the island). There is even evidence for raising of the ground level at the centre of the island at this period.

The only contrary evidence known to me is the existence of other, parallel timber-period trenches within the main 6 m intervals.

The evidence from Carthage confirms me in the interpretation of a feature of some remains of shipsheds at the south end of the little harbour (Mandraki) in Rhodes, at the north end of street P31, just north of and partly overlapped by a Roman tetrapylon erected over the junction with east/west street P6 (Figure 2). Excavations during the Second World War (never completed and never published) revealed remains of seven north/south lines of piers or walls which clearly belong to shipsheds. Unrecorded removal during the excavation of most of the levels between these lines has made it very difficult to reconstruct the original sequence, but there were at least two phases:

(i) Three rows of piers, at intervals of 7.35-7.85 m (clear width 6-6.3 m) west of a solid wall (D); and east of the solid wall three rows of piers at intervals of 5.45-5.94 m (clear width 4.20-4.40 m — no doubt for smaller ships). Depending on the height of sea level in (probably) the late third century BC, these shipsheds could have been 40-45 m long, with a slope possibly of as much as 1 to 4.6 (at least at the upper end). This phase belongs probably after the earthquake destruction of 227 BC.

(ii) In the second/first century BC the shipsheds were rebuilt at a higher level. Ramps were built over and round the solid wall (D) and round at least one line of piers to the east (C), and probably two (C & B); the piers apparently remaining in use as column bases (figure3). The ramps have a slope of at least 1 in 4 over their surviving length; again, this was near the upper end of the shipsheds, where the slope may have been greater (John Coates feels that this would have suited the after keel, say 10 m long from the after cut up of the keel to the after end of the ship, and would go well with a keel lying lower on the slip on a slope of 1 in 10; this idea cannot be tested without excavation).

The ramp was stepped (laterally), and in the lower of the two steps surviving slots were cut: 6 on the east side of ramp D, with a width of ca. 25 cm. and variable depth; 2 on the west side of ramp D; and 3 on the east side of ramp C, ca. 15-20 cm wide. (Figure 3). The ramp is missing on the west side of C, probably dug away during the wartime excavations, and no remains of ramps have been found on line E or line B (though I presume that one did exist on at least the east side of line E and the west side of line B); we therefore do not have slots surviving on both sides of any one shipshed, and cannot check if they line up. Assuming that they did, I had always favoured the explanation that the slots were to receive timber sleepers, probably on the surviving evidence set in the top of a solid ramp. The only other interpretation of the slots would be that they were to hold the timber shores which would have supported ships when slipped. These must have been used (*pace* the hesitancy of Morrison & Coates, *AT* p. 221 "before any bow or stern shores are knocked away"; but Coates comments to me "bow and stem shores, several of each, would most certainly have been set up when a ship was stored on a slip; during that period the *hypozoma* would have been relaxed or completely unrigged"); and I still believe that the word *parastatai* in the Naval Lists refers to shores (as *GOS* pp. 183, 293), not mast partners (as *AT* p. 160 n.1).

A final answer will depend on further excavation down the length of the slips, which are now, unfortunately, overlaid by houses of the period of the Knights; but the discoveries at Carthage have already provided a valuable parallel.

I have earlier suggested *(GOS* p. 185) that the rock-cut side ledge on either side of the Sounion slips may have held wooden runners. This cannot be proved, but it seems the sensible interpretation; Coates agrees in "believing that the steps would have been timber clad to make bilge groundways, either to take the weight of the ship (improbable) or to support stem poppets or a stern cradle about which the ship must hinge as the bow rises under its buoyancy on launching" — particularly important, I feel, with such a very steep slip.

I am tempted to see further evidence for the covering of slipways in an obscure reference in a fragment of the fifth-century Athenian Comic poet Cratinus (frag. 197 Kock; quoted by *GOS* p. 191 n. 24): "the triremes despite all their efforts cannot get (to) shipsheds and reed". How do we explain "reed"? Is it for roofing or fencing? — this does not seem to fit, though Pollux (X 184) preserves the quotation from Cratinus as an illustration of the use of reed in fencing. Is it for caulking? Pliny refers to this use of reeds *(NH* 16.158, quoted in *SSAW* p. 209 n. 39): "pounded and inserted in the seams of ships, (they) solidify the structure, being more tenacious than glue and, for filling cracks, more reliable than pitch". Or is it for matting, laid on the slip? Liddell-Scott-Jones suggest "reed mat" for its meaning here (cf. GOS p. 188).

Some curious remains found in Munychia and published by von Alten in 1881 may be relevant *(GOS* p. 181 & note; *Evidence* p. 128 and fig. 25). The parallel lines of blocks apparently slope seaward, and are now fully submerged at the top. If they *are* remains of shipsheds, then three explanations are possible: (i) if we assume a relative rise in sea level, then the upper part of the slip would be in the dry, but we should have to assume very short slips; (ii) if we assume that timber skidways were laid on the lines of blocks, this would raise the level, and one could perhaps project the theoretical length a good deal farther seawards; or (iii) a combination of (i) and (ii). I must emphasize that only one "slip" extended for any distance seawards, and doubt was expressed soon afterwards about the nature of the remains found. Angelopoulos noted the difference in the gradient reported by von Alten for the Munychia remains (2° - 3°) from the gradient of the Zea remains (7° - 8°); he assumed the slipped ships were not completely in the dry in Munichia! (Περῖ Πειραιῶς και τῶν λιμένων αὐτοῦ, Athens 1898, 50-1, 124-5 & Fig. A.3-4).

The question of the bottom ends of shipsheds and their slips remains a vexed one. The only shipsheds where the bottom end has (supposedly) been firmly established are those at Apollonia, and I am now less convinced than before that their original length was "just under 40m", since because of their slight gradient (1 in 14) we are left with a dry length of only ca. 28 m; or am I over-influenced by the preconceived idea that they "ought to" have a dry length of 35-40 m because they have the "normal" clear width of 6 m? Elsewhere we are guessing: the foot of the slips has been broken away e.g. at Matala and Siteia, or covered by sand or later buildings e.g. at Sounion and Rhodes.

At Piraeus it is best to confine our discussion to a small group of a dozen excavated by

Dragatzis and planned by Dörpfeld. The plan shows the columns continuing into the water (for some 5 m); the lower end was nowhere established. The longitudinal section, oddly, shows the slip ending at sea level. Although in fact the bed of the slip was not preserved in its lower part in the one shipshed excavated down in its entire length (and part of its width), it is obvious that such a reconstruction is impossible.

The slip must have continued into the water at least another 10 m, if we assume (i) a depth of 1 m at the foot for the trireme to float in and enter the slip stern first, and (ii) no change of sea level since antiquity. On the latter point I can only repeat what I said 20 years ago *(GOS* 182 n.1): "the possibility of a change in the relative sea level since antiquity has not always been taken into account in discussions of the shipsheds, though if it were established it would affect all the length measurements of the shipsheds and any conclusions drawn therefrom on the dimensions of the *trieres,* and also the general picture one tries to form of what ancient military harbours looked like". I have therefore to agree with Basch, particularly since he uses my words as the basis of his argument, that the measurement 37 m has been assumed too readily as a fixed point by many, including Morrison & Coates (Basch, *Mariner's Mirror 73.1, 1987, 94;* see now a response by Morrison & Coates, *IJNA* 16.2, 1987, 168-70: they still maintain that "the length of the vessel is determined more critically by three factors other than the length of the sheds" — but the sheds *were* built to house *these* ships). I would emphasize on the other hand that there is no firm evidence that the dry length of the Zea slipways was *not* 37 m — just that caution is necessary; also I feel that evidence *is* now accumulating of a standard measurement in the range 40 - 45 m. If Curtius' report *were* correct (see *GOS* 182 n.1) that in Zea basin the harbour bottom falls away sharply at a depth of 6 feet all the way round, then we have a maximum original length of slip of ca 55 m and a maximum dry length of slip of ca 45 m. If Curtius' report were correct, we cannot assume that the slips ran out to the edge, but it is plausible.

This shows how important it was and is to know all we can about the submerged remains in Zea and Munychia. Graser claimed to have measured 38 shipsheds in Zea and 9 in Munychia and this has never been adequately checked. I wonder how much is left to be checked after modern dredging and construction work, and I must ask the question: what records were kept of finds and observations during those operations? It is important now, with the prospect of a reconstruction project of a shipshed for the *Olympias,* that areas of the shore of Zea and Munychia which remain unscathed are checked again, above and below water level, to see if any further information can be obtained, notably on the questions of (i) underwater length of slip and (ii) evidence for the use of timber on the slips.

There would also be value in following up the ideas of FSD. One test I have already suggested — with the *Olympias* on a slip. Their friction tests should be repeated and expanded, to include as comprehensive as possible a range both of species of wood and of lubricants: of species of wood known to have been used for building ancient hulls and keels (fir, pine, oak, beech, cedar?, cypress?); and of lubricants and coating materials for which there is ancient evidence (pitch, pitch and wax, wax, tallow, resin, bitumen?); tested on wet and dry stone (limestone as well as granite) and on wet and dry wood (of various species, laid as skids and as sleepers). Then we should be better equipped to look again at the questions of man-handling a trireme, and the need (or not) for mechanical aids, and the alternative readings of the Athenian inscription: 40 or 140 men minimum for hauling out a trireme, 20 or 120 minimum for launching a trireme.

Throughout this discussion I have concentrated on the question of slipping, or more generally beaching, ancient warships. It is worth remarking, in conclusion, that though ancient merchant ships were not slipped in shipsheds, they certainly were beached *(pace* many scholars). One need only recall the passage of Theophrastus referred to above *(HP* 5.7.2): "Triremes have an oak keel to endure hauling ashore (νεωλκία), merchant ships have a pine keel (πεύκη) but they place under [it] also an oak keel when they are hauling it ashore (ἐπὰν νεωλκῶσι), and smaller ones a beech keel; and the false keel (χέλυσμα) is totally of beech." Casson translates the key phrase "but they put on an underlayer of oak" *(SSAW* pp. 212-13 n.51). I do not quite see how this is to be distinguished from the false keel referred to in the next sentence. Are we dealing here with an (obscure) reference to a cradle? or simply to a timber runner laid on the slip, possibly in a "keel slot"? This is not clear, but it *is* clear that merchantmen were beached. (Morrison & Coates, *AT* p. 181, translate χέλυσμα as "breastwork" [of the bows], which avoids the problem but goes against the explicit definition of the word by Pollux (1.86); *SSAW* p. 221 quotes the evidence). Even Hiero's gigantic *Syracusia,* later called the *Alexandris,* was eventually, after finding no ports to accommodate it, beached at Alexandria (Athenaeus, 5.209b, quoted in *SSAW* pp. 194, 199; Casson rightly takes the story of the ship seriously; he translates ἐνεωλκήθη as "docked", but the ship was clearly "hauled out of the water"). A fragmentary inscription of the later third century BC from Thasos quotes port regulations concerning the size of ships which could be "hauled out" within the harbour limits (IG XII Suppl. No. 348). We must allow for light timber structures on the shore of commercial harbours in antiquity or, at least for light boats and warships, on any beach site which was frequently used — just what one still sees in the Mediterranean today. Traces of such structures would have disappeared, or at least have not been found or recognised.

What operations could be carried out in the shipsheds?

FSD assume that a trireme could have been tipped over within the shipshed for such purposes as pitching the bottom (314, fig. 3); this seems inherently unlikely, and indeed would be necessary only with a ship as flat-bottomed as that proposed by FSD. The wine-glass mid-section of the *Olympias* provides for the bottom to be accessible when the ship is upright. Work on the outside of the hull would be cramped but feasible (compare *AT* p. 135, fig. 35b). Caulking and pitching would probably have needed to be repeated after all but the briefest periods on a slip. Most work on the inside of the hull could have been carried out in the shipshed. Certain operations may have been carried out outside the shipsheds with the ship afloat or slipped in the open air. This leaves unanswered a major question:

Where were ancient warships (and merchant ships) built?

In Piraeus no remains have been found which can be linked to shipbuilding. Lehmann-Hartleben (p. 119) suggested Eetioneia as the site of the shipbuilding yards — a theory incapable of proof or disproof since that area of the main harbour has been completely redeveloped, but it remains plausible. We do have one reference in a late Athenian inscription *(IG* II^2 1053.43:

first century BC) to *psyktras tas pros tois neoriois* — "drying-places close to the dockyards" (or "shipsheds" — the word *neoria* is sometimes to be translated thus): I would imagine these to be sites where ships were careened, caulked and pitched, somewhere just west of the main port. The main impression one has of *naupegia,* however, is that they were *in* the *neorion.* There are several references to the Athenian *naupegia,* even perhaps the *Telegoneia [naupegia] (IG* II² 1611.130-3); in a fifth century Athenian inscription the *trieropoioi* are to deposit material in the *naupegion.* But we get no idea of what the *naupegia* were like. (For the details of the literary and epigraphic evidence, and the question of public or private shipyards, see B. Jordan. *The Athenian Navy in the Classical Period,* [University of California Publications: Classical Studies, vol. 13], 1972, 46-54).

Some indications may be given by the large open area around the pair of slips found at Thurii: here we have clear evidence of a double timber cradle, and here at least there was an unusual amount of space (6.2 m) on either side of the slips (which together measure 12.4 m in width: Plan reproduced in *AHM* p. 205 fig. 12). The Oeniadae slips seem to have an open space beside the group at one end, but this looks more like normal storage space for slipped warships; fuller investigation is needed here and we look forward to hearing more from W. M. Murray.

A side chamber by one of the slips at Dor has been described as a rock-cut basin which could have been used for pre-soaking timbers (I followed this interpretation in *AHM* p. 211 n. 114); but on inspecting it I am not convinced that it was anything other than a storage chamber — there is no evidence that it contained water. Poidebard suggested that the eastern end of the "South Harbour" at Tyre was closed off by a shipbuilding yard and repair basin (with a provision store and fresh-water tank nearby), but strong doubts have been expressed about its identification as a harbour.

Flemming reported "ship-formed depressions" in the rock at Apollonia, at the north-west corner of the "inner harbour", inside the "Grotto reef", and suggested that these may have been part of a shipyard. He speaks of "an area of rubble from which a set of parallel walls lead down to the ancient harbour (Fig. 14, C.5). The walls are cut out of the solid rock and are badly weathered, so that the upper part tapers slightly, but it is clear they separate a series of four flat-bottomed bays with floors at a depth of about 2.4 metres. The bays are 18 metres long and 4 metres wide, and though the floors are flat, the tops of the walls slope down towards the ancient harbour, being nearly 2 metres high at the western end and only 75 centimetres high at the eastern end. In both the southern bays the floors are indented with boat-shaped hollows about 10 metres long, and the southernmost bay has square slots of side 15 centimetres cut into the top inner edge of both its walls at 1-metre intervals."

"It is quite impossible to be certain about the use of this strange assembly of walls and hollows, but perhaps a little speculation will do no harm. The proportions of the bays make them suitable to accommodate boats slightly smaller than those which used the slipways and the quays, but the bays themselves are obviously neither. The niches in the walls of the southern bay were probably to take the ends of beams of wood lying across from wall to wall, and the set of beams 1 metre apart would then have made a strong surface with a slope of 3 to 4 degrees towards the harbour. This would have made an ideal slipway up which to drag light boats for easy access to the bottom of the hull. Anyone who has seen fishermen scraping and painting boats at low tide will know that a craft of 10 to 15 metres with a 4-metre beam is far too heavy to turn over, and that it is very difficult to get at the keel and bilge keels. A light raised slipway may have been just the answer to this problem, and the boat-shaped depressions in the floor may have been intended to allow a bit of extra headroom. It is also possible that boats were actually built on these sloping rests." *(Cities in the Sea,* 1971, 108-9).

If Flemming's interpretation is correct, then one should bear this possibility in mind for other slipways, except where there is clear evidence that sleepers rested directly on a solid slip.

In the Western Mediterranean the harbour of Pandateria might have offered some evidence if it had been properly studied before being almost completely built over (compare (a dismal experience) the plans and views in L. Jacono, "Un porto duomillenario", *Atti del III Congresso nazionale di studi romani, 1933* (Bologna, 1934) Vol. I, Tav. XLVI, fig. 2, XLVII and Schmiedt, *Livello antico* (1972), pp. 176 ff.). The "harbour" entrance at Motya may have been used for shipbuilding or repair in a late phase. It would be interesting to know more of the mysterious structures at Fos-sur-Mer — 2 complexes of 156 blocks in 6 parallel rows (6 x 26) which could have been the bases for timber posts or stocks. All that has been published is a sketch plan, with inadequate information on the dimensions (L. Monguilan & others, *Archéologia* 110, 1977, 59-65). There is certainly nothing as convincing as the remains of a late 3rd century BC shipyard found in Canton (Chao Lei, *Archéologia* 118, 1978, 70-1).

The question remains: what precisely are we looking for? Rows of bases for stocks? We have the ancient Greek word *dryochoi* — "oak-holders", for the keel was traditionally of oak; and a picture on Longidienus' tombstone (ca. AD 200: *SSAW* Fig. 163). Basins for pre-soaking timbers? It is hard to find other diagnostic criteria to suggest. The Thurii complex as a whole looks plausible.

Was it normal to launch ships when part-built, like Hiero's *Syracusia (SSAW,* p. 195)? This would be quite feasible, once the hull was structurally complete; Theophrastus tells us that new constructions were let stand until they had set, then launched so that the wood closes up and becomes watertight *(HP* 5.7.4, quoted in *SSAW,* p. 205 n. 21). Casson has pointed out that early launching could speed up completion of the job, since work on the superstructure could be done with the ship already in the water for the wood to close up. Where would the last stages have been carried out? The quays in the inner harbour at Apollonia may provide an explanation (E9 on Flemming's plan: loc. cit. pp. 100-01 Fig. 14, 105), but they are only 3.5 m apart. Again one suspects that at least part of the answer is "light timber structures on the beach".

I conclude with another question: where in a wider sense were triremes built? If a Greek city had timber sources close at hand, then obviously the ships would be built in the city's own shipyard; but what if the timber sources were distant?

The *communis opinio* is that in these cases the timber would be shipped or towed for construction "at home". Thinking in particular of the case of Athens, I do not find this answer fully satisfactory. Evidence to support my doubt is provided by an inscription in which the Athenians honoured King Archelaos of Macedon *(IG* I³ 117; R. Meiggs and D.M. Lewis, *A Selection of Greek Historical Inscriptions,* 1969, no. 91; previously *IG* I² 105); it contains a specific reference to the occasion, probably (following Meritt's studies) in 407/6 BC, when Archelaos seems to have allowed Athenian shipwrights to go to Macedon to build ships there. This reference has been explained away as an exception, justifying an honorific decree — a valid point; according to Meiggs *(Trees & Timber in the Ancient World,* 1982, 228) the timber would normally have been shipped to Athens, but at this crucial period of the Peloponnesian War "merchantmen under sail with heavy timber cargoes would have been more vulnerable to interception by an enemy than oar-powered triremes". Precisely on these grounds I wonder whether shipbuilding near the timber source may have been the norm, not the exception, at least in wartime.

Now Honor Frost has provided a new element for the discussion: a large group of the stone anchors of the triremes are of a dark stone not found in the Athens area, but found, she argues, in Thessaly and Chalcidice: and she reports finding a similar anchor in Volos Museum *("Les Constructeurs Puniques"* in Symposium on *Flotte e Commercio Greco, Cartaginese ed Etrusco nel Mar Tirreno,* Ravello, Centro Universitario Europeo per i Beni Culturali, 19-25 January 1987).

If it is true that the source of the stone can be so precisely defined, then we have a little more evidence for Athenian ship construction in Macedon/Chalcidice, or perhaps in the region of ancient Pagasai, using timber from the slopes of Pelion and Ossa. Anchors are unlikely to have been imported from Macedon or Thessaly to Athens for ships built at Athens, but if ships were built in Macedon or Thessaly and brought down to Athens by skeleton crews (sailing and if necessary even rowing), they would have needed anchors from the start. The Thessalians were allies of Athens for most of the fifth century BC, and rather more reliable allies than the kings of Macedon (the Athenians were always trying to pin down kings such as Perdiccas, e.g. to deliver oar timbers exclusively to the Athenians: *IG* I^3 89.31, variously dated 435, 431/0, 423/2 or 417-13; the later dates seem preferable). However, not too much should be made of this until we have firmer evidence about the source of the stone for the anchors.

David Blackman
European Parliament,
Brussels

ANNEXE I

The naval decree as published in the second and third editions of *Inscriptiones Graecae.*

FIGURES

1. Carthage: Reconstruction of the Punic shipsheds. (Hurst 1979, fig. 3, with the permission of the author).
2. Rhodes shipsheds: Plan of the surviving remains.

3a. Rhodes shipsheds: Row D from the west. Two slots are visible in the second course of the ramp (phase ii). On the right, the solid wall of phase i. Beyond, Row C.

3b. Rhodes shipsheds: Row D from the east. Slots visible in the second course of the ramp.

IG I³ 153 DE TRIREMIBUS. Piraei, nunc EM 6617. Stela venis micae insignis, a dextra et partim a tergo integra, a. 0,466, l. 0,268, cr. 0,11.

Litt. Att. formae variae ΕΞΚΛΛΠΠΣΦ, a. 0,009–0,011, O 0,008; στοιχηδόν 0,0121, 0,0103.

Edd. IG I 77; IG I² 73 c. add. p. 302 + (c. suppl. ex parte Kirchneri). *Ech*

a. 440–425

IG I¹ 73 DE TRIREMIBVS. Piraei. Stela a dextra integra. Nota formam Φ. Ed. IG I 77; cf. Frenkel *Neue Jahrb.* 1888, 475; Kolbe *Ath. Mitt.* XXVI 1902, 417; B. Keil Anon. Arg. 217. *Ecl.*

. . . . ²⁰ . . . . Ο . . . . . ¹² . . . . . ΣΤΟΙΧ. 33.
[. . . . . ¹⁷ . . . . Τ.]Ν ΤΡΙ[ΕΡ. . . ⁸ . . . .]
. . . . ¹⁹ . . . . ΝΕΟΝ ΕΚ . . . ⁴ . . . .
[. . . . . ¹¹ . . . . . hΟΙ ΔΕ ΤΡΙ]ΕΡΟΠΟΙΟΙ Κ[ΑΙ hΟΙ]
[ΠΡΥΤΑΝΕΣ hΟΙ(?) ΑΙΕΙ ΑΝΑ]ΓΡΑΦΟΝΤΟΝ ΤΟ[Σ ΤΡΙ]-
[ΕΡΑΡΧΟΣ. ὑ ΕΧΣΕΣΤΟ ΔΕ] ΜΕΔ' hΕΝΙ ΑΝΕΛΚ[ΕΝ ΑΝ]-
[ΔΡΑΣΙΝ ΕΛΑΤΤΟΣΙ Ε ΤΕΤ]ΤΑΡΑΚΟΝΤΑ ΚΑΙ [ΚΑΘ]-
[ΕΛΚΕΝ ΕΣ ΤΕΝ ΘΑΛΑΤΤΑΝ] ΕΛΑΤΤΟΝ Ε ΕΙΚΟ[ΣΙ Α]-
[ΝΔΡΑΣΙ ΜΕΔΕ ΠΙΤΤΟΝ Μ]ΕΔΕ hΥΠΟΖΟΝΥΝΑ[Ι ΕΛ]-
[ΑΤΤΟΝ Ε ΠΕΝΤΕΚΟΝΤΑ Α]ΝΔΡΑΣΙΝ ΜΕΔΕ ΠΕΡ[ΙΑ]-
[ΛΕΙΦΕΝ? ΕΛΑΤΤΟΣΙ ΑΝΔ]ΡΑΣΙ Ε hΕΚΑΤΟΝ ΜΕ[Δ' Α]-
[ΦΑΙΡΕΣΘΑΙ ΣΚΕΥΟΣ ΜΕ]ΔΕ hΕΝ, ΜΕΔΕ ΤΕΝ ΟΡ[ΜΕ]-
[Ν ΕΠΑΓΓΕΛΛΕΤΟ hΟ ΤΡΙ]ΕΡΑΡΧΟΣ ΚΑΙ hΟ ΚΥ[ΒΕ]-
[ΡΝΕΤΕΣ· Ε ΔΕ ΦΥΛΕ Ε ΟΙ]ΝΕΙΣ, hΟΠΟΣ ΑΝ ΤΑΥΤΑ Γ-
[ΙΓΝΕΤΑΙ hΟΣ ΚΑΛΛΙΣ]ΤΑ, ΕΠΙΜΕΛΕΣΘΟ. ΕΑΝ ΔΕ
[ΤΙΣ ΤΟΥΤΟΝ ΤΙ ΠΑΡΑΒ]ΑΙΝΕΙ Ε ΤΡΙΕΡΑΡΧΟΣ Ε
[ΚΥΒΕΡΝΕΤΕΣ Ε ΑΛΛΟΣ] ΤΙΣ, ΟΦΕΛΕΤΟ ΧΙΛΙΑ[Σ] Δ-
[ΡΑΧΜΑΣ hΙΕΡΑΣ ΤΕΙ Α]ΘΕΝΑΙΑΙ ΚΑΙ ΖΕΜΙΟΝΤ-
[ΟΝ ΑΥΤΟΝ hΟΙ ΕΠΙΜΕ]ΛΟΜΕΝΟΙ ΤΟ ΝΕΟΡΙΟ. Τ[Ο] Δ-
[Ε ΦΣΕΦΙΣΜΑ ΤΟΔΕ ΑΝ]ΑΓΡΑΦΣΑΤΟ hΟ ΓΡΑΜΜ[Α]Τ-
[ΕΥΣ hΟ ΤΕΣ ΒΟΛΕΣ ΕΣ]ΤΕΛΕΙ ΛΙΘΙΝΕΙ. hΟΙ Δ[Ε] Κ-
[ΟΛΑΚΡΕΤΑΙ ΔΟΝΤΟΝ ΤΟ Α]ΡΓΥΡΙΟΝ. hΟΙ ΔΕ Π[Ο]Λ-
[ΕΤΑΙ ΑΠΟΜΙΣΘΟΣΑΝΤΟΝ]. ὑ ὑ

– – – – – – – – – – – – – – – – –
[. . . . . ²⁰ . . . .]ο[. . . . . ¹² . . . . .] ΣΤΟΙΧ. 33
[. . . . . ¹⁹ . . . .]ν τριε[. . . . ⁹ . . . .]
[. . . . . ¹⁸ . . . .]ν νεὸν ἐκπ[λο . . ⁵ . .]
[. . . . . . ¹³ . . . . . . hοι τρ]ιεροποιοὶ κ[. . ⁵ . .]
[. . . . ⁹ . . . . τὰ ὀνόματα] γραφόντον τὸ[ν τρι]-
[εράρχον· μεδ' ἐχσέστο] μεδ' hενὶ ἀνελκύ[σαι]
[ἀνδράσι ἔλαττον ἒ τε]ττα̣ράκοντα καὶ [hεκ]-
[ατόν, μεδὲ καθελκύσαι] ἔλαττον ἒ εἴκοσ[ι κ]-
[αὶ hεκατὸν ἀνδράσι, μ]εδὲ hυποζονύνα[ι ἔλ]-
[αττον ἒ . . ⁵ . . κοντα ἀ]νδράσιν, μεδὲ περι[ο]-
[ρμίζεν ἐλάττοσι ἀνδ]ράσι ἒ hεκατόν, με[δὲ]
[. . . . . . . ¹⁵ . . . . μ]εδὲ hὲν· μεδὲ τὲν ορ[. .]
[. . . . ¹⁰ . . . . hο δὲ τρι]έραρχος καὶ hο κυ[βε]-
[ρνέτες ἑκάστες τε̑ς] νεὸς hόπος ἂν ταῦτα γ-
[ίγνεται hος κάλλισ]τα ἐπιμελέσθο· ἐὰν δὲ
[τις τούτον τι παραβ]αίνει ἒ τριέραρχος ἒ
[κυβερνέτες ἒ ἄλλος] τις, ὀφελέτο χιλία[ς] δ-
[ραχμὰς hιερὰς τε̑ι] Ἀθεναίαι καὶ ζεμιόντ-
[ον αὐτὸν hοι ἐπιμε]λόμενοι το̑ νεορίο. τὸ δ-
[ὲ φσέφισμα τόδε ἀ]ναγραφσάτο hο γραμμ[α]τ-
[εὺς hο τε̑ς βολε̑ς ἐσ]τέλει λιθίνει· hοι δ[ὲ] κ-
[ολακρέται δόντο]ν τ[ὸ] ἀργύριον· hοι δὲ πολ-
[εταὶ ἀπομισθοσάντ]ον *vacat*

vacat 0,14

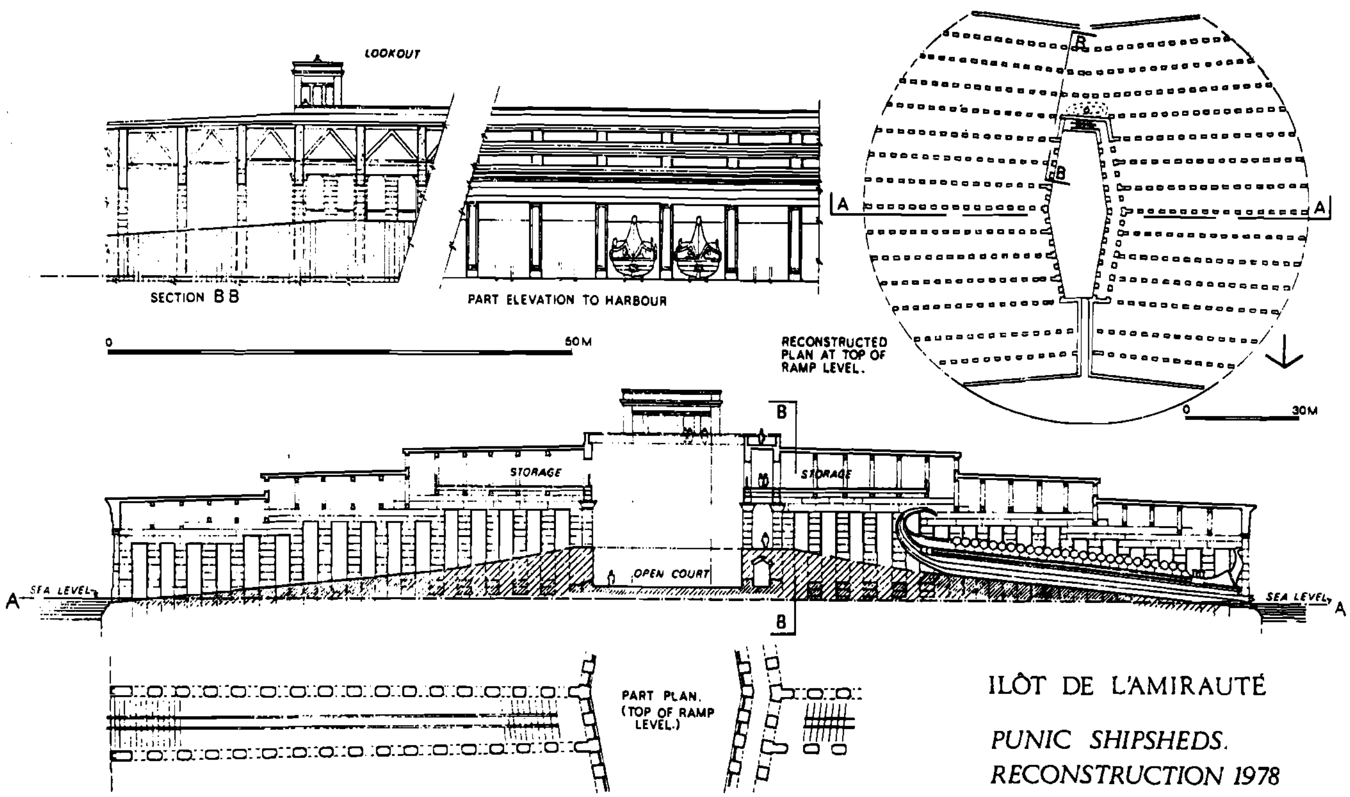
LOOKOUT
SECTION B B
PART ELEVATION TO HARBOUR
0
50M
RECONSTRUCTED PLAN AT TOP OF RAMP LEVEL.
A
A
B
B
0
30M
B
STORAGE
STORAGE
OPEN COURT
SEA LEVEL
SEA LEVEL
A
A
B
PART PLAN. (TOP OF RAMP LEVEL.)
ILÔT DE L'AMIRAUTÉ
PUNIC SHIPSHEDS.
RECONSTRUCTION 1978
S.G.

FIG.1.

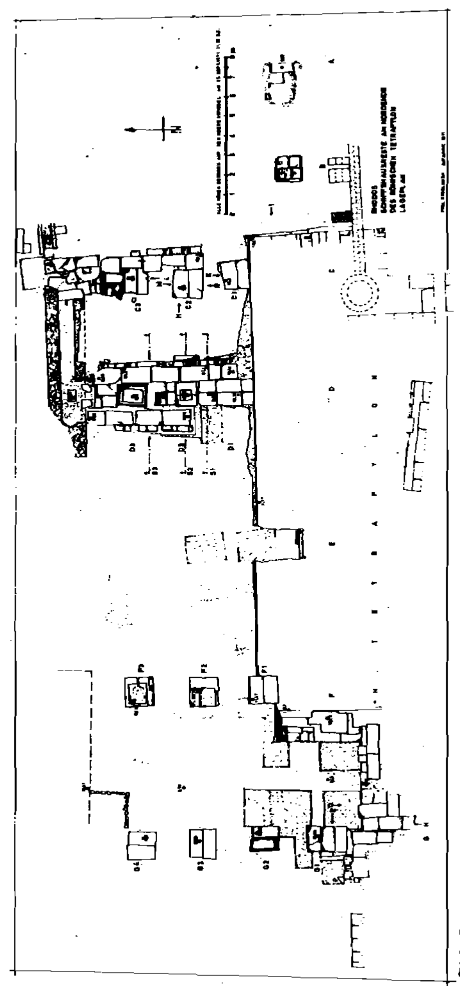

FIG. 2


3a


3b

NOTES ON THE STEERING DEVICES OF ANCIENT SHIPS

Our basic knowledge about steering by means of multiple or lateral devices like the ancient πηδάλια or *gubernacula,* or Medieval *temones,* can be developed from the study of the better known examples, no matter how recent they are, in order to ascertain which are the basic principles and to set up a correct classification pattern. So the study of classic steering devices can be undertaken with correct physical principles and with an experience which hopefully let us understand similarities, differences and technical needs.

Lateen medieval ships carried *temones* which, according to figurative and written documents, appear to have been quite large; they were leaning against a joke and were suspended by means of a rope, or of tackles, if the *temo* was larger, and in this last case a second leaning point was available. The aim of the rope or of the tackled was similar: the *temo* was a heavy instrument, so it had to be hanged, secondly there was the need to lift the blade in order to diminish the immersed surface, or to avoid damage against the sea bottom or when in harbour. The *temones* in some Italian harbours had to be removed, or anyway for removing the *temo* suspension ropes or tackles were necessary. In Fig. 1 Instances from Tuscan school of sculpture are proposed: Bonino da Campione and Giovanni di Balduccio, XIV Cent, but many other examples (mosaics of S. Mark in Venice) show the interest to keep the immersed portion of the blade under control. The manoeuvre of the *temo* consisted therefore in:

— rotation around the stock by means of a tiller;
— rotation around the joke (in some cases of smaller ships) to lift more or less the blade;
— immersion at different stages of the blade, in order to correct lateral displacement of the ship; in case of bowline navigation, different immersions of the two *temones* could be of help.

Therefore the *temones* functioned also as lee-boards. The upper part is less clear: in some improbable instances it is handed like an oar; in many cases a tiller is evident for each *temo* and the two tillers are worked from an upper deck of the *paradisus* by a single man. In one case (Ottaviano Nelli at Gubbio, about 1450) there is a single tiller for the two *temones*. These elements can be completed by a selection of written sources, which define uses, proportions and behaviour:

1 - From Francesco da Barberino, *Documenti d'amore (IX)*

Doc. IX: *Se bisogna scampare,*
l'un timon leva suso:
l'altro leggier tien giuso.
Ma convien levar mano,
non mica com soliamo,
ma per contrario: e face
cosi il guidar verace.

2 - *From the Statuti* of Rimini, XV cent, recalling previous rules.

R. 217: Statutum et ordinatum est quod nullus habens navem in portu Arimini debet retinere temones in sua navi ultra unam diem postquam fuerit in portu...

3 - From the Venetian manuscript *Fabrica di galere* (1410), *nave latina:*

... (Fig. 1,D)

E vole essere el timon de questa nostra nave el terzo de rio che la longheza de la cholumba, sera adoncha passa 4, el scharon sera passa 2, el fuso passa 2 e de volzer la lagola pedi 1 per passo de la longheza del timon: sera adoncha pedi 4.

E vole esser larga la pala de questo nostro timon tanto quanto volze el timon a la gola, serano doncha pedi 4.

E vole esser longe le mize tanta quanto è tuto lo timon longo, seran adoncha passa 4, & per questa fami ogni altra raxon.

4 - Leon Battista Alberti, *De re aedificatoria* (ab. 1450) Lib. V, c. XIII:

Temonum numerus navi auget firmitatem, minuit velocitatem.

Starting from early XIV cent., single rudders pivoted around the sternpost were introduced in the Mediterranean, with a consequent change of the shape of the stern area, in terms of surface to contrast lateral displacement (in Italian *deriva*) more than in terms of volumes, although this was not solved in the same way throughout the Mediterranean. In fact in Venice, still in the XVII Cent. The *timon alla faustina* was in use (Fig. 1 E): a remembrance of Medieval round stems when there were two *timones*.

Lateral steering devices were kept in conservative areas, where exigencies for speed were not so important as those of *firmitas,* quickness of manoeuvre or good steering in shallow waters with wide boats. So until the 50's of this century multiple and side steering devices were used in some traditional crafts of Italian lakes and rivers. They had the same design and functions of their Medieval ancestors and in 1967 I was lucky enough to discuss this subject with a boat-builder of Lake Iseo, who probably is the last person in Italy who had personal knowledge of this type of manoeuvre.

Recent lateral or multiple steering devices in Italy were:

Steering oars (not taking into account steering made with normal oars without rudder):

Lombardy: *combàll* (Lake Como, Milanese canals), *nav/nau* (Lake Maggiore *mutajö* (Milan-Pavia canals).

Piedmont: *nau* (Lake Maggiore, Po).

Steering lee-boards:

Latium: *ciarmòtta* (Tiber, before XIX Cent).

Emilia: *rascòna* (Guastalla, Boretto), *Nave* (Modena and Bologna canals before XIX Cent.).

Lombardy: *burcèla* (Milanese canals), *saràn* (Milan-Pavia canals), *barcù (Lake Iseo), gòndola* (Lake Come before XVIII Cent.).

Veneto: *burchio* (before XVIII Cent), use of *rascòna* from Emilian Po.

The short description of the manoeuvre of the *rascòna* published by A. Guglielmotti in 1889 can be completed with the information I could collect on the *combàll* and on the *barcù.* Unfortunately A. Cuglielmotti wrote during a period of purism common to many European languages, so his notes need some reshaping before translation:

There was one *timone* at each side, hanged to a stay by means of a binding, its blade was fastened with a *frenèllo* (rope or chain) and the *timone* was leaning to the *targone* (literally the *apostis,* but actually a hook or the joke) at the bulwarks. The tillers, which crossed each other, could be worked by a single man. Mechanic theories of angled levers, of fluids and of lateral displacement are consistent and add further details. If the blades are parallel to the centre line, they did not alter the course of the boat. If both blades were turned symetrically to the same extent (by converging their fore edges) they slew down the headway without changing the course, but if they were manoeuvred by contrast, one parallel and the other angled with respect to the centre line, they compelled the bow to turn to the direction of the angled blade (the tiller was pulled, so the fore edge of the blade turned towards the centre line); the boat turned quicker, the longer was the brace and the wider the angle of incidence. Therefore in order to turn right, it was necessary to release the tiller of the left *timone,* so that its blade could follow naturally the direction of the stream, then it was necessary to pull the right tiller, so that the right blade hit the stream in such a way that the bow of the boat turned rightwards. These manoeuvres were well known by skillful sailors and were alive also nowadays on the boats of the low Po area; they cannot be understood by certain scholars... who would steer with the same angle of both blades. No! steering with side rudders is always by contrast, as in F. da Barberino (see doc. 1) or in verse 1203 of *Orpheus, Argonautica,* where helmsman Anceus suddenly turns leftwards a large ship, by putting in contrast into the sea only the left rudder ((Σχαïόν υπεγαλινάς ὀιήχιον).

In the last part of this passage it appears that A. Guglielmotti generalizes the manoeuvre of quick steering, also in case of any danger, such as that of stranding.

On Lake Iseo the side *timù (timone,* rudder, Fig. 2 C) was considered as a good device to assure a sure course to the large flat bottomed *barcù.* The boat could be up to 28 m long and carry 50-80 tons. The *timù* was applied to the side of the stern by leaning against a *rampi* (hook) of walnut root at the bulwarks; its stock was bound against a vertical pole (*omasi,* stay), where a suspension rope from the blade was fastened or arrived at a block. The suspension of the blade and the binding of the stock against the stay could be adjusted in order to have the *timù* more or less immersed, according to the state of the lake and to the load of the boat. After such adjustment the *timù* was manoeuvred like a normal rudder with its tiller. When the boat was taken in the dry for repairing it was necessary to take its rudder out, because it was so heavy that it could have distorted the stern of the boat. On the contrary when the rudder was immersed it did not give any difficulty of weight and of uneven lateral displacement.

The steering oar, such as that of a *combàll* (Fig. 2 E), normally was not manoeuvred alone, but with the help of one or two oars at prow, or simply pushing poles, mainly when boats were large. *Nau* (or *nav)* of Lake Maggiore had also lee-boards to help keeping the course, when the wind tended to be transverse, but this is a limited example. The long steering oar of the *combàll* needed a heavy counterweight (a stone) and was moved simply left and right; very seldom its blade was turned like that of an oar.

Ferry boats of the Po near Turin, which were made of twin boats (*nau*), had two rudders at the ends of the platform, between the two hulls (Fig. 2 D). They were worked like the multiple rudders of the ferry boats of the Strait of Messina of the beginning of this century and I could watch their efficiency while the ferry boat was crossing the river. Also in this case the two rudders worked by contrast.

Connections between the parts of the *timoni* were made normally with wooden pegs, with the help of metal stripes or of the lower horizontal wooden board composing the blade of the *timone* of the *raseona* (Fig. 2 B). This last item had two functions: preventing adsorption of water from the cut perpendicular to the fibers and to strengthen connections made of wooden pegs among the parts of the blade and with the stock. The blade of the steering oars of the *combàll* was only nailed to the stock without any mortise, sometimes with iron stripes or rope bindings.

These elements coming from the Middle Ages and our traditions can be completed with some physical principles, to approach the study of ancient πηδάλια.

The composition of forces exerted on a rudder of compensated type indicate that quickness and capacity of steering is proportional to (Fig. 3 C):

— surface of the blade,
— ratio between the surfaces of the blade fore and aft the centre of gravity,
— brace between the centre of gravity of the hull and the point of appliance of the force N (or T), or centre of gravity of the,
— angle of incidence,

— velocity of the ship.

If there are two side rudders, the above points can be affected as follows:

— the surface increases,

— the torque theoretically may double, but hydrodinamically there is a lower yeld, because resistance and whirlpools affect negatively the forces N and T. Moreover brace a is shorter. Differences of angles a and a' make the forces not arithmetically addable. However the overall behaviour improves the steering capacity of the system, even though speed is diminished.

The single steering oar, such as that of the *combàj* (Fig 2 E) takes advantage of the increase of the brace a of the torque.

The effect of the surfaces of the πτέρυξ implies also their balance with the vertical surface of the immersed part of the hull, which contrasts lateral displacement. In ancient ships the shape of the stern was much curved, often fairly symetric with that of the prow (Fig. 3 D), but in many cases not, because the stempost could have been almost perpendicular to the keel, or there was a cutwater or a ram (Fig. 3 E). The surfaces of the blades could have been effective to balance those surfaces, since they provided auxiliary surfaces to contrast locally or generally lateral displacement. We do not know which was the balance among the centres of sail, immersed hull (*carena*), surface contrasting lateral displacement (*deriva*) and of gravity, however it is clear that the surfaces of the steering lee-boards played an important role in it. In fact, for instance, when the cog was introduced in the Mediterranean, the stern had a small surface added (Fig. 3 F), in order to compensate for the lower surface of the rudder in comparison to the previous two side *timoni*. The mentioned difference between the *timone alla Faustina* and the *timone alla ponentina* (Fig. 1 E,F) is in the same background.

The volumes of the immersed part of the hulll exerted another influence on the steering capacity. Larger volumes (Fig. 3 H) or rammed prows gave to the hull a reserve of buoyancy, which affected positively the trim and the tendency to bear up. But a larger volume, even with similar longitudinal section of the immersed part of the hull *(piano de deriva)*, increased the resistance, but not that towards lateral displacement. Therefore a larger surface of the πτέρυξ of the πηδάλιον was necessary to keep a reasonable steering capacity and to reduce sagging to leeway.

By bearing in mind these principles and the functional differences mentioned above ancient steering devices can be catalogued in the following way.

Egyptian ships had paddles, oars and single and double steering devices. Double side rudders are documented already during the Old Kingdom, single rudders appear mainly in Middle Kingdom models and figures, but evidence of them is found from the VI Dynasty. Determinatives and words used to define steering devices are rather generic, however they are different from those which defined oars or paddles. Single or double side rudders had the same arrangements and functions as those described for our traditional *barcù* (Fig. 4 C,D and 2 C): all details fit well within a similar pattern as represented e.g. by Deir El Bahari reliefs or published by Reisner or by Landström.

Aegean crafts appear to have had a similar evolution from paddles (Cycladic craft) to single side rudders (Thera, Aegina, Jolkos, Pilos, Tragana, Melos, Skyros, etc.), to double side πηδάλια, sometimes coexisting with the single arrangement (definitive from the IX Century: Geometric, Cyprus). In these cases documents are more evocative than descriptive, so that it is necessary to come to later times before identifying technical details with some chances of probability. Unless we transfer directly Egyptian typology to some of them (Thera, Aegina), which is not always possible, due to an apparently less rigidity of the systems of Aegean crafts, we have to come to Geometric and Attic figures before finding something sufficiently descriptive. As described in appendix, Greek πεδάλια appear to have been worked with a higher degree of freedom in comparison to the well fixed Egyptian devices, therefore the Greek helmsman had to work with a different skill, different also to that of the Italian traditional boatmen, since the κυβερνέτης needed to keep the οίαξ in his hand, but also to adjust more frequently or continously the immersion of the πτέρυξ.

However a "fixed" system was known also by the Greek helmsmen, such as that of the Amathus terracotta ship at the British Museum, the rudders of which could be turned around the stock by means of the οίαξ and from time to time could be immersed more or less with vertical displacements and different fixing points of the stock (Fig. 5 A).

When the αποστις was introduced (with the trireme) the πηδάλια were displaced to the back ζευγα of the αποστις (Fig. 5 B), thus eliminating the rail system of the previous arrangement. With the new system the stock could rock around the ζυγόν and in the meantime it could be turned with the οίαξ. It is difficult to think of the possibility to diverge the bottom end of the πτέρυξ. The rocking movement was limited by a transverse frame above the main ζυγόν, so that the πηδάλιον could be put almost horizontally (as in Lindos relief), but not perpendicularly with respect to the floating line. It was necessary, anyway, to achieve a good balance, the importance of which can only be assumed and tested in physical tests.

Coming to pre-Roman and Roman documents, we still have single rudders and steering oars. The Novilara boats of VII-VI Cent (Fig. 6A) had a single steering device which was worked both as an oar and as a rudder with a small tiller and a counterweight. The Etruscan stele of Bologna (Fig. 6B) still has some Attic remembrances, however it is clear that the rudder is single.

The *caudicariae* of the Tiber (Fig. 6C) had a steering oar similar to that of our traditional *combàj* (Fig. 2E), and this is in line with the usual river crafts manoeuvres.

But generally Roman ships appear to have inherited the Hellenistic arrangement, as clearly shown by the first Nemi ship (Fig. 7A) and by figurative documents. As soon as the volume of the hull became larger it was necessary to increase the size of the πηδάλιον and consequently its weight. The Torlonia relief and the mosaic at the Antiquarium of Rome show that the blade was suspended to a hoist (Fig. 7B). Part 1 of the rope was fixed e.g. to the upper transverse frame and part 2, after passage through a block or something similar beyond the hole of the blade, could be pulled and fixed elsewhere in order to adjust the height of the heavy *gubernaculum*.

The stock had to be bound some way to the joke, otherwise the system was not fixed enough and written documents let us think that there were two series of bindings: one for supporting and one for adjusting the position of the blade. In the Acts (VIII-40): είων εις τῆν θάλασσαν, άμα ανέντες τᾶς ευκτηρίας τῶν πηδαλίων, και επάραντες τὸν ἀρτέμωνα τῆ πνεούση κατεῖχον εις τὸν αιγιαλόν, hint is made to loosing the bindings of the *gubernacula* in order to leave the blade follow the course of the waves without contrasting them, still with a minimum control of the course also with the αρτέμων. This could be possible by loosening the bindings of the stock against the joke, but by keeping the hoist in function, since we understand from the text that the ship did not lose her *gubernacula*. Also Vegetius refers to similar bindings: (Re. Mil. 4-46) *secreto incidunt funes quibus adversariorum ligata sunt gubernacula*, and Theophilus' translation of Jerome (Epist. 100,14) describes the function of the tightening ropes and mentions the manoeuvre by contrast *(flectentes in diversum gubernacula)*:

> *sicut enim gubernatores magnarum navium, cum viderint immensum ex alto venire gurgitem... spumantes fluctus suscipiunt, eosoue prorae obiectione sustentunt, flectentes in diversum gubernacula, et prout ventorum flatus et necessitas imperarit, stringentes funiculos vel laxantes; cumque unda subsederit, ex utrocue navis latere laborantia clavorum vincla dimittunt, ut parumper quiescentia venturo gurgiti praeparentur; qui cum rursus advenerit, stringunt clavorum capita et palmulas dilatant, ut huc atque illuc scissis flatibus, aequalis sit utriusque lateris labor, et quod simul non poterat sustineri, divisum tolerabilis fiat.*

This arrangement and manoeuvre can be extended to the cases of double steering systems: one at stern and one at prow. In a manner similar to that seen on traditional ferry boats, large ships like the Syracusia or the second Nemi ship needed another pair of *gubemacula* in order to make the manoeuvre quick enough or to turn the vessel more efficiently, as it was tested by Chabrias, acording to Polyaenus (3.11,14): Θάτερα δια της παρεξειρεσίας κατά τας θρανίτιδας κώπας παρετίθει, τους αυχένας έχοντα και τους οίαχας υπέρ του καταστρώματος ώστε εξαιρομέντης της πρύμνης τούτοις την ναίν κατευθύνεσθαι.

So we arrive to a situation similar to that documented for the Middle Ages and a direct link between Antiquity and oral tradition is indicated also by the relics of ancient technical words in our dialects. Mainly in Como Lake area we have remembrances of these words and this is consistent with the preservation of shell building technique. We have in fact:

guernàćć = *gubernaculum*, gouvernail, rudder
cavíćć = *clavus*, tiller
pènna = *pinna, palmula*, blade

In Sicilly the tiller is *iásciu (οιαξ - οιαχον)*, a form which follows the history of this Greek word through Byzantine and neo-Hellenic languages. Similarly *temo* at an unknown time of late Antiquity was used to indicate the tiller (instead of *clavus)* and then it became the general name for the rudder in Italian languages. The intermediate phase of this generalization remained in neo-Hellenic τιμόνι, clearly derived from latin (not from the Medieval *lingus franca)*, refering to the tiller.

At this stage of the research we cannot say that the circle is closed: during the centuries some aspects may have been lost or other traditions may have complicated the picture. Norman ships from Southern Italy (from XII century) do not appear to have affected steering techniquies in local traditions. German types from the Bodensee have some common features with the *barcù* of Lake Iseo: bottom frames are called sõi (Säule), sails have similar bowline ropes. Ladi such as these of a XVII Cent. glass painting in Kostanz or a XIX Cent Model in Rorschach Heimatsmuseum had side rudders, but different from their Mediterranean relatives since they were hinged like doors, but we cannot exclude possible links.

The items discussed so far hopefully describe the main functions and needs of a manoeuvre like that of the ancient side πηδάλια. On this light the discussion given in appendix may be an example, but conclusions are still far from definite.

Appendix: hypothesis about the πηδάλια of the Kirinia ship.

The study of geometric and Attic figures leads to set some technical features of steering devices. The comparison with Kirinia ship is possible due to the peculiar similarity of the Attic kylix at the British Museum and of the almost contemporary Campanian askos (on Attic-like style) found in Spina (Ferrara).

— The stock is bound against the joke;
— it is well balanced around its bindings, with a long upper part and, in some instances (Fig. I,2), with a counterweight.
— it has a tiller.
— a particular rail of the stern supports the stock; in some cases the stock is enclosed by the rail (Fig. I, 2.5.6) and in other cases it is bound outside the rail (Fig. I, 1.4).
— vertical frames of the rail project outboard in the first case, in order to give room to the stock of the πηδάλιον, and this appears to be indicated also by the Etruscan painting of the Tomba della Nave in Tarquinia.
— In case the stock is bound outside the rail, vertical frames are just straight vertical, as in the Athenian bronze lamp from Erecteum.

Such arrangement, in the first case, has the following advantages:

— the stock does not need being always bound against the rail;
— the helmsman needs only pushing and turning the tiller, with little worry about the verticality of the πηδάλιον, since this last is kept by two points: the binding against the joke and the rail, with the help of the topgallant bulwarks when the οιαξ is pulled.

The waves could not push the blade against the hull's side, since the rail limited lateral displacements of the stock within a definite angle (Fig. II). The steering device could be pushed until the second frame of the rail and pulled backwards as far as the first frame allowed (Fig. II, 1). In addition to these, normal rotation round the stock was possible. In describing the movement of the tiller, probably Aristotle (Mech. 6) mentions one of the first two or both together, although he does not appear to have correctly understood the lever system of the oars (the fulcum is not the thole, but the point of immersion of the blade).

If the πηδάλιον is well balanced (a fairly easy thing when it is in water, but more delicate when it is outside) the above manoeuvres are not difficult, provided a good binding system is used. The bindings of the stock against the joke should be not too tight, to allow rotation of the stock and the other movements, but also not too lose, to avoid sinking of the rudder or undue lateral movements. This aim, according to some tests made on models, could be achieved with two bindings: one fairly loose, but heavy and strong, which I would define the main ευχτηρία and another, which could be a loop around the main binding, which could be made of a thinner rope, adjusted by the helmsman according to the manoeuvre he had to perform.

So, when the helmsman thought that the immersion of the blade was correct to adjust lateral displacement, he could bind the stock against the rail, tighten a little the loop around the main binding and make rotatory movements of the tiller. If more complicated manoeuvres were needed, he could loose the binding against the rail and the loop around the main binding and trust partially on his forces to avoid undue sinking or lateral movements of the rudder. If the system was well balanced and the main binding not too loose, the helmsman's work should not have been too hard even in dramatic events.

The results of the study of the items discussed above are given in Fig. II, where a re-shaped stern of the Kirinia ship is proposed.

A wood fragment found in the Kirinia wreck has been first interpreted as a part of the πτέρυξ of one of the πηδάλια. The following actual features can be observed (Fig. III):

— three mortises for tenons are present, only one of which is passing, the other two being blind and on the same side;
— one passing square nail;
— a rabbet in one of the longer parallel edges;
— two wooden pegs on the same edge of the rabbet;
— two parallel scarfs on both faces of the end part of the board, which is obliquously cut.
— one wooden peg near and parallel to the passing tenon;
— the board is 7 cms thick and is made of oak.

All above indicate that:

— a second board was joined by means of the rabbet and the two wooden pegs;
— metal bindings, a double series of bronze stripes, clamped the two pieces together, with a characteristic angle;
— on one side a longitudinal piece of wood was connected with three tenons, one peg and one nail;
— on the opposite side another piece of wood was connected with one tenon (the passing one), the peg and probably the nail; this had a different joining system if compared to the other, a little looser; we cannot exclude that metal bindings could have held also the superimposed pieces of wood;
— it can be assumed that the second board could have had a size similar to that of the first and a similar end angle.

By connecting these elements and comparing them with that has been discussed so far about steering devices, we should exclude that this part belonged to the πτέρυξ for the following reasons:

— the piece is too thick;
— connections with other parts could support relatively low stresses;
— connections with other parts have different structural solutions on the two faces of the board;
— connections between the stock and blades of the πηδάλια, according to the Nemi found, to recent tradition and to logics of avoiding structural interruptions of the stock, were different anf resulted in a symmetrical structure, as shown by the most elaborated figures (Lindos, Sperlonga).

At the present stage of our researches it is not possible to propose any credible hypothesis about the nature of this fragment.

Marco Bonino
Via S. Petronio Vecchio No 42
I - 40125 BOLOGNA
Bologna: 4th December 1988

L'esame dei documenti medioevali e tradizionali italiani sui sistemi di governo laterali o plurimi consente di definire alcune caratteristiche e necessità di manovra dei *gubernacula* antichi e di studiare i principi fisici alla loro base. Ne risulta, tra l'altro che tali sistemi antichi avevano la funzione di deriva, oltre che di manovra. In questa luce vengono esaminati i sistimi egizi, egei, greci e romani, con cenni si timoni singoli egizi, pre-romani e romani ed ai doppi sistemi di πηδάλια a prua ed a poppa di età ellenistica e romana. Ricordi antichi, oltre ai tipi tradizionali citati all'inizio, sono nei termini dialettali usati nel Comasco ed in Sicilia.

Descritti i criteri generali validi per le varie età antiche, si considerano in dettaglio i documenti geometrici ed attici, nell'intento di dare indicazioni per la ricostruzione dei πηδάλια della nave di Kirinia. Un esame attento del frammento dal relitto di Kirinia, a suo tempo interpretato come parte del πτερυξ di uno dei πηδάλια, fa escludere tale interpretazione.

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APPENDIX

Fig. I

1. Protoattic fragment from Sunion, Analates Painter, National Museum Athens (700-650 B.C., Morrison Arch. 2, p. 73). The steering devices are leaning against the joke. The rail appears to be strictly con nected to steering, although it is not clear wether the stock is inside or outside the rail.
2. Attic fragment from Athens, Akropolis (600-550 B.C., Morrison Arch 34, pp 85-86). The stock is bound against the joke and is inside the rail; it has a counterweight on top and a tiller.
3. Corinthian plaque from Penteskouphia (600-550 B.C., Morrison Arch. 40, p. 87): a πηδάλιον with a long stock leans against the ζυγόν and is pivoted around it, as shown by the different slope of the left πηδάλιον. Probably the stock is outside the rail and bound to it.
4. Dinos by Exekias, Rome, Museo di Villa Giulia 50599 (550-530 B.C. Morrison Arch. 53, pp 93-94): the stock is outside the rail and bound to it. The ζυγόν is not shown; the rail is an individual structure connected to steering.
5. Attic dinos in the manner of Antimenes, Louvre, Paris, F. 61 (530-510 B.C., Morrison Arch 67, p. 103): the stock is inside the rail, which appears to be strictly connected with steering.
6. Attic black figures cup, Berlin, Antiquarium (530-510 B.C., Morrison Arch 74, p. 104-105): a situation similar to that of Fig. I. 5.
7. Attic black figures cup, London, British Museum 436 (510-500 B.C. Morrison Arch. 85, p. 109): The stock is lashed to the joke, between the two upper wales. The upper end of the πηδάλιον is represented in a simplified way: the rail is not complete, but it appears that the stock of the πηδάλιον is inside it.

Fig. II

Reconstruction of a possible steering device for the Kirinia II replica.

Fig. III

Fragment from the Kirinia II wreck, formerly interpreted as a part of the πτέρυξ of one of the πηδάλια.

FIGURES

1 – A, B: Bonino da Campions, Pavia, S. Pietro in Ciel d'Oro (1362-1406);
 C: Medieval stern, from G.Di Balduccio, Milan, S. Eustorgio, 1340.
 D: From the treatise: *Fabrica di galere,* 1410.
 E: Stern *alla Faustina,* Stefano de Zuanne, Venice 1686.
 F: Stern *alla Ponentina,* Stefano de Zuanne, Venice 1686.

2 – A: *ciarmòtta,* Tiber 1680
 B: *rascòna* of the Po, Boretto end of XIX Cent.
 C: *barcú,* Lake Iseo, 1950.
 D: *port* (Ferry boat made of twin *nau*), Piedontese Po, 1950.
 E: *combàll,* Lake Como, Milanese canals, early 1900.

3 – A: steering forces with a single rudder;
 B: steering forces with two rudders;
 C: forces exerted on the blade of a rudder;
 D: surface contrasting lateral displacement *(deriva)* of a hull;
 E: auxiliary surfaces of *deriva* on ancient ships;
 F: surface of *deriva* added to the hull of a cog (XIV-XV Cent);
 G-H: transversal sections of hulls with the same surfaces of *deriva:* more volume is displaced in case H.

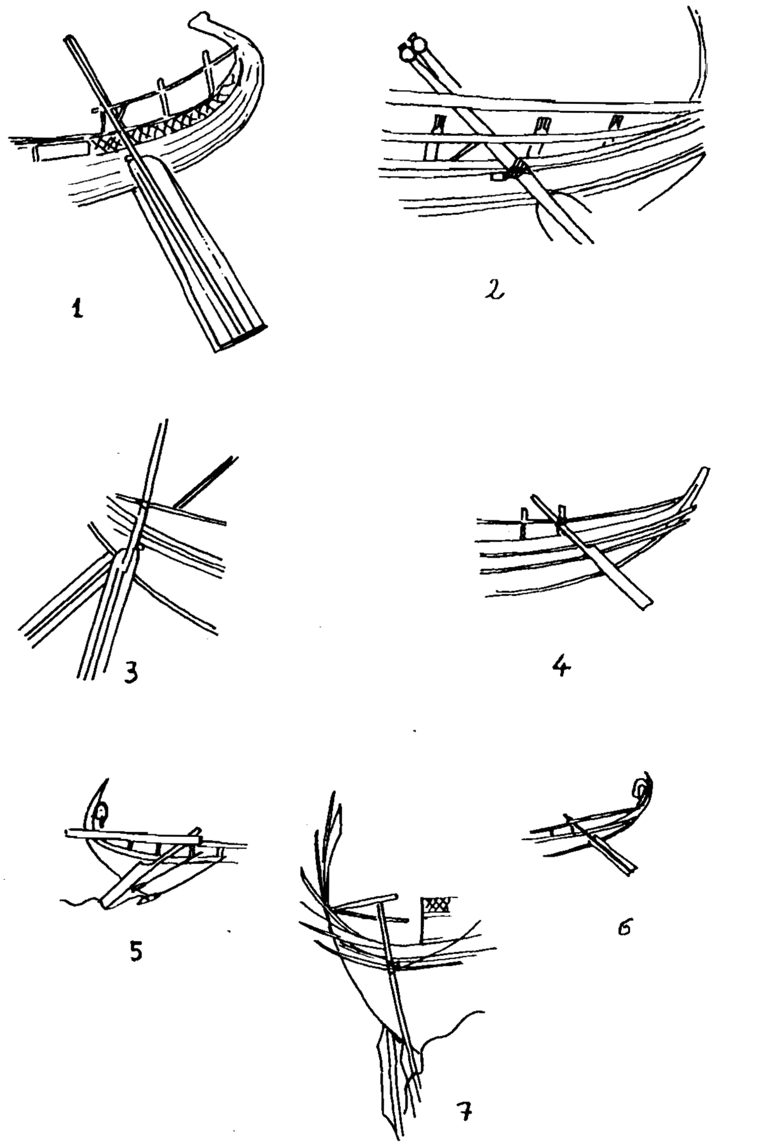
4 – Egyptian steering devices.

5 – A: stern of the Amathus boat, British Museum, V cent B.C.
 B: πηδάλιον arrangement of a Hellenistic polieres.

6 – Single steering devices of Pre-Roman and Roman boats:
 A: Novilara (Pesaro), VII-VI Cent. B.C.
 B: Bologna, V Cent. B.C.
 C: *caudicaria* of the Tiber, I-III Cent. A.D.

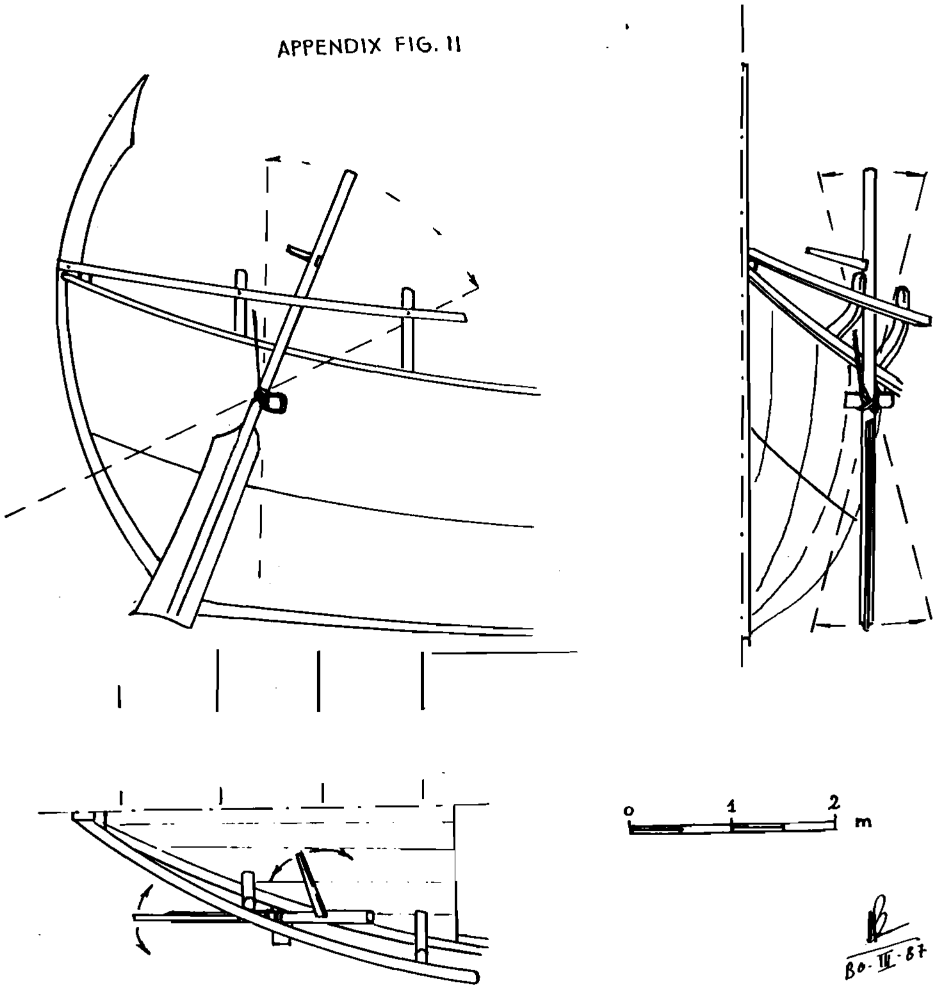
7 – Roman *gubernacula:*
 A: First Nemi ship;
 B: From Torlonia relief and the Antiquarium mosaic (II-III Cant A.D.)

APPENDIX FIG I



30-IV-87

APPENDIX FIG. 11



APPENDIX FIG. III

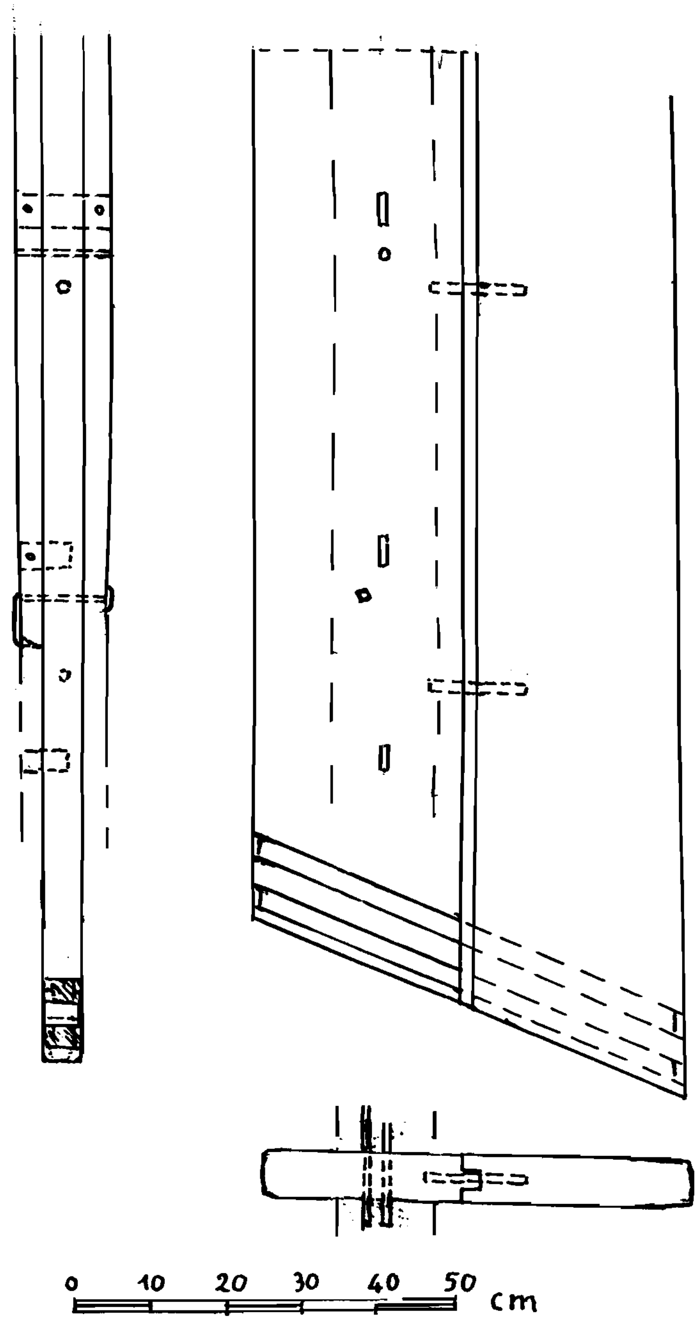


FIGURE 1

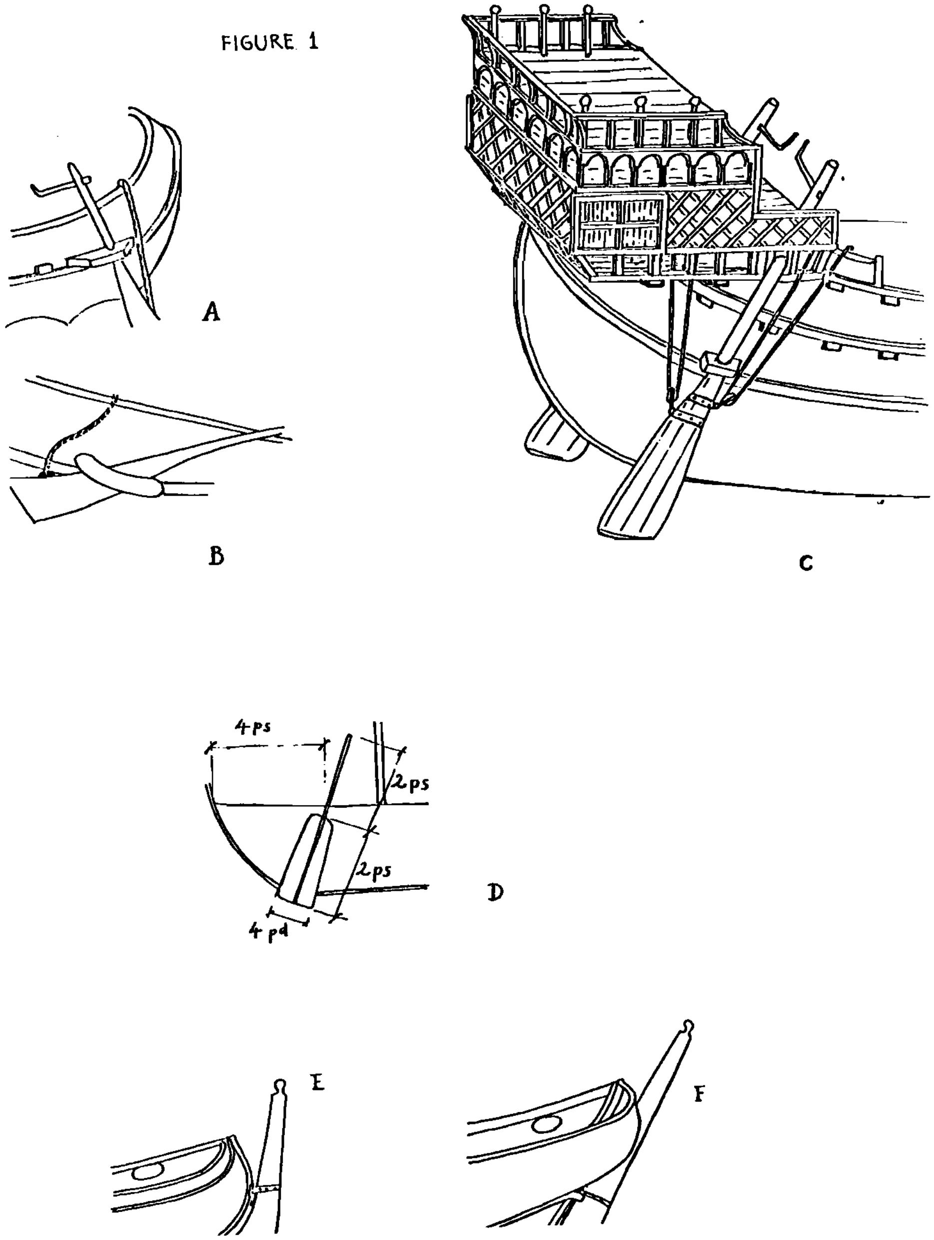


FIGURE 2

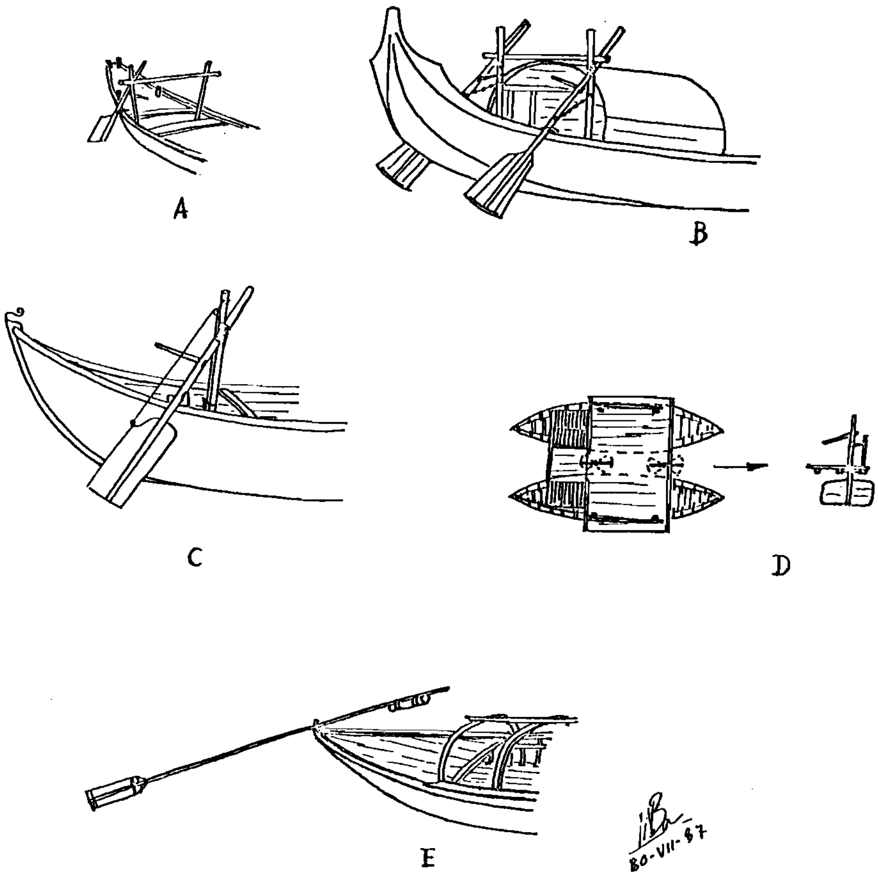


FIGURE 3

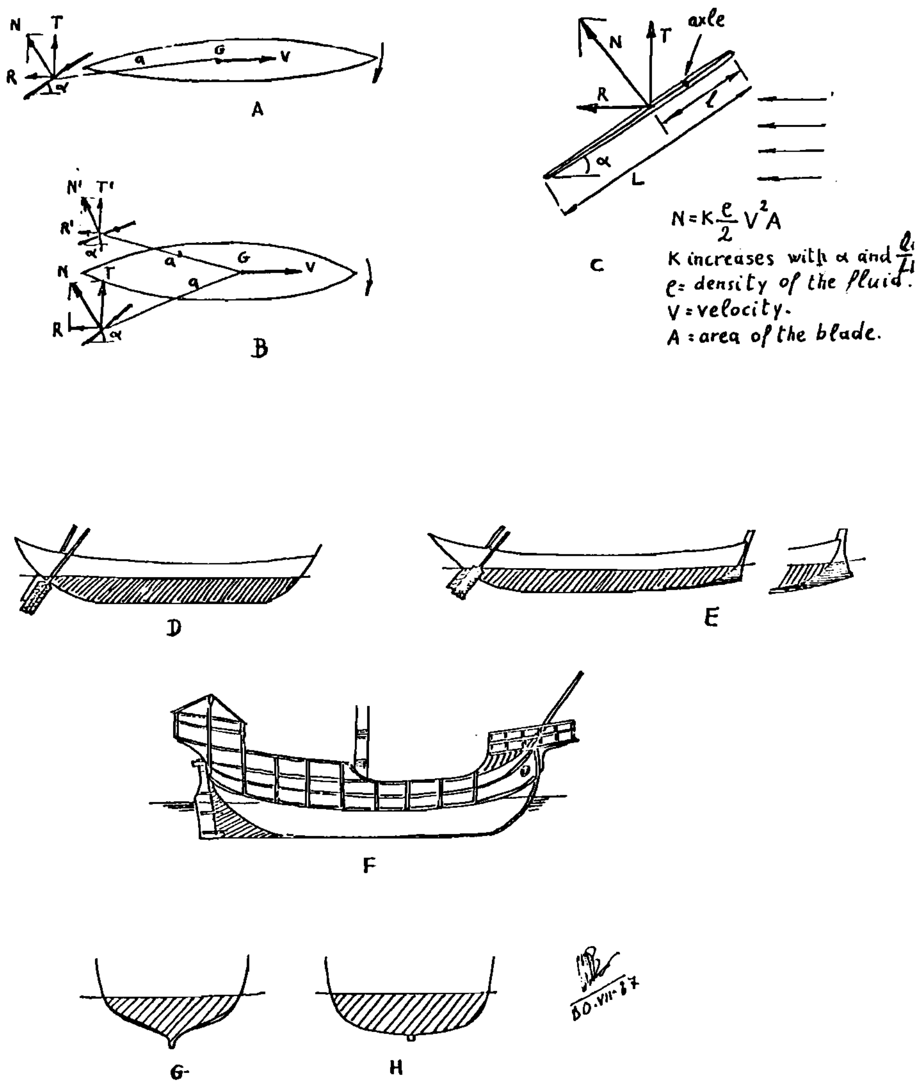

N
T
R
G
V
A
N' T'
R'
B
axle
C
L
N=K ρ/2 V²A
K increases with α and l/L
ρ= density of the fluid.
V=velocity.
A : area of the blade.
D
E
F
G
H
30.VII.87

FIGURE 4

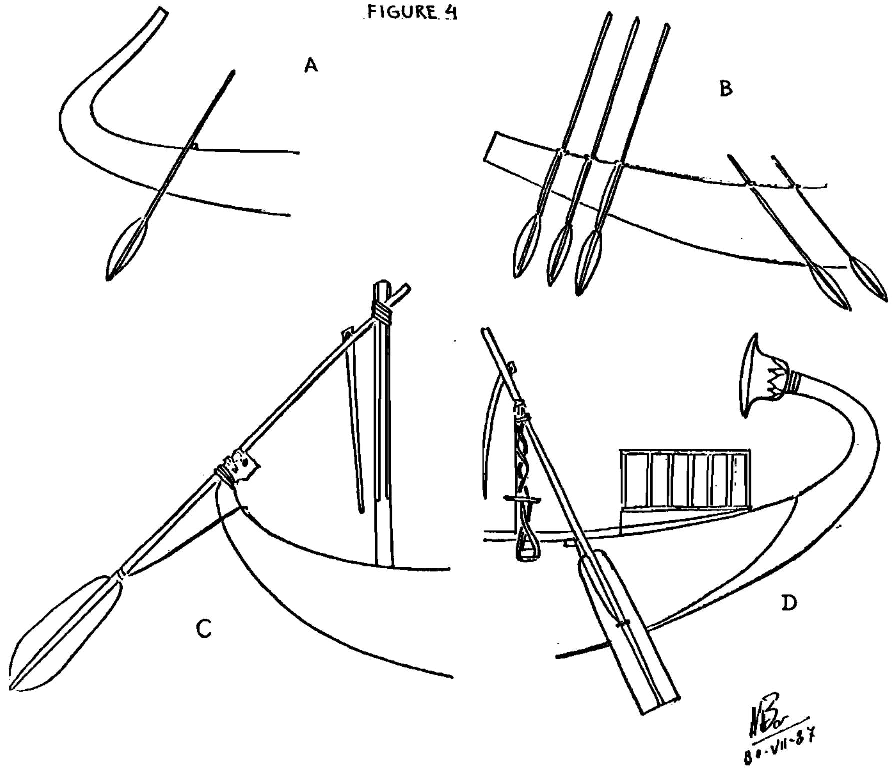
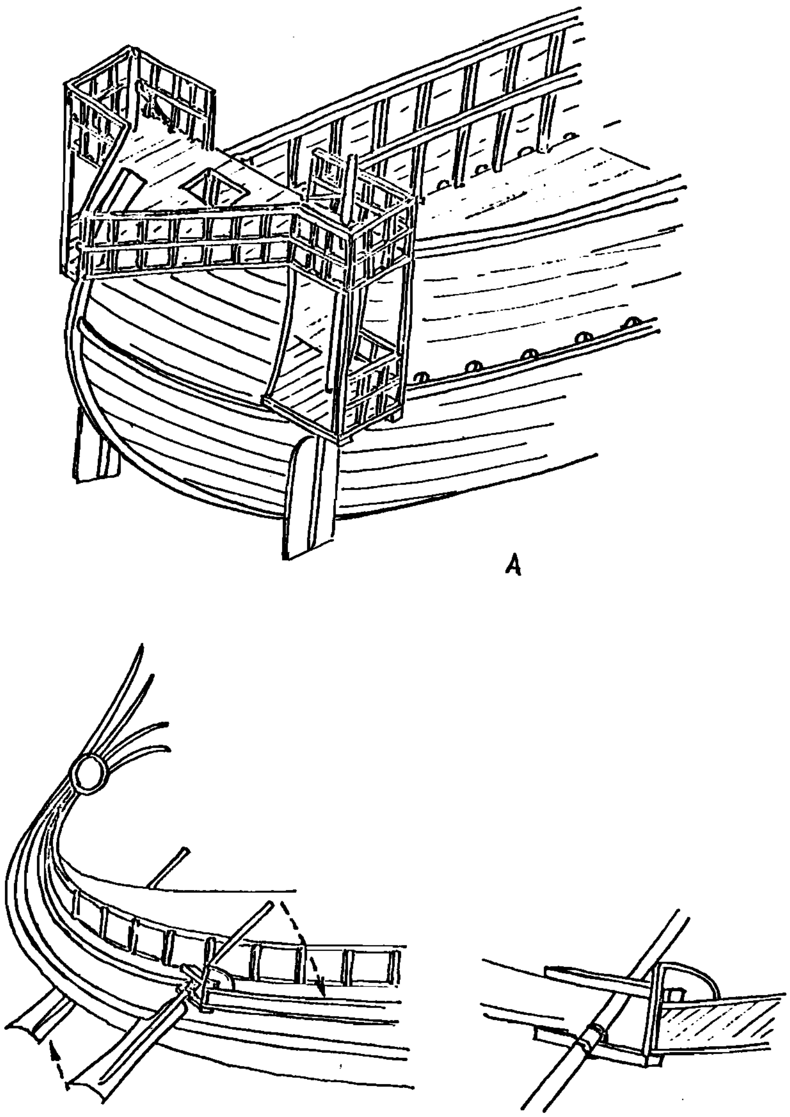


FIGURE 5



A

B

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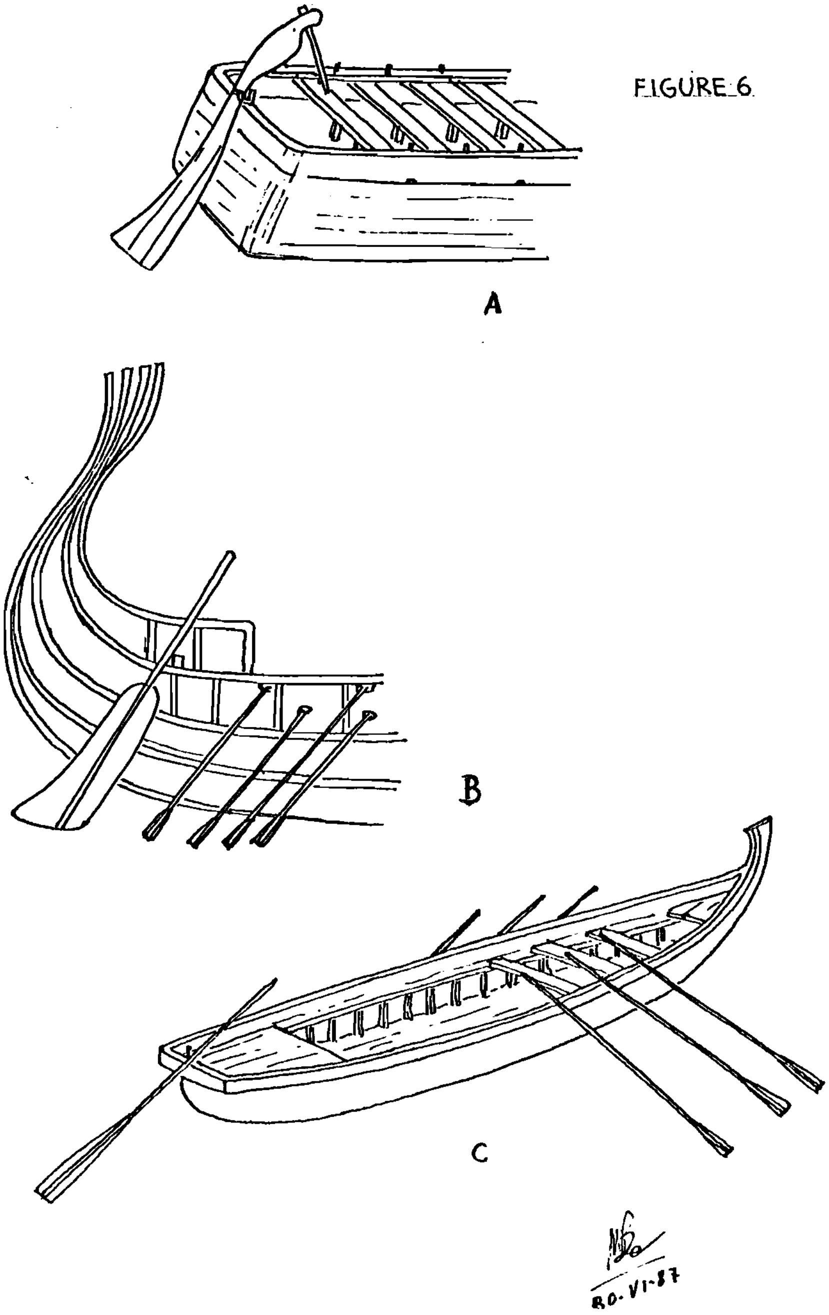
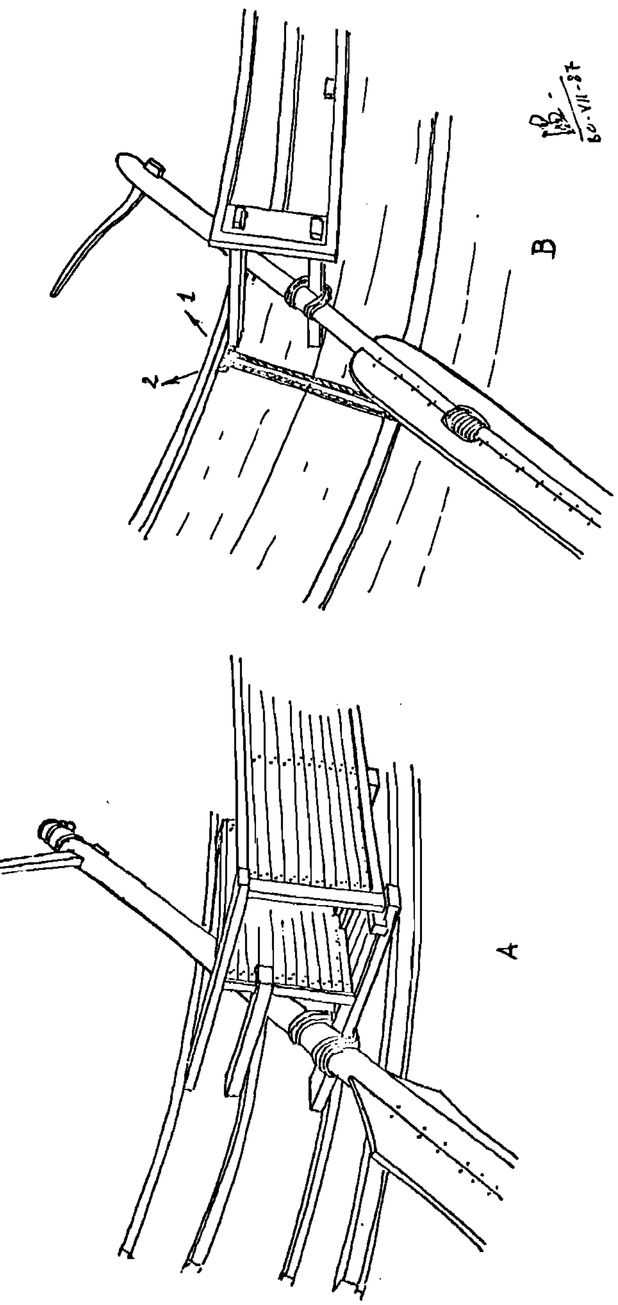


FIGURE 6

FIGURE 7



Mr Christos Boulotis' communication "Le screau CMS V 1, No. 184: Commandant du navire ou dieu de navigation;" will be include in Tropis III. .

EARLY EUBOEAN SHIP BUILDING*

Last year's (1986) Greek-British excavations in Lefkandi, Euboea which are conducted under my direction and with the cooperation of Prof. Mervyn Popham of Oxford University, were once again centred around the Toumba cemetery[1]. These tombs lie to the east of the low mound which covered a large building and two important central burials of the early 10th cent. B.C. The Toumba cemetery as a whole belongs to the years following 950 B.C. up until approximately 825 B.C., whereupon all burials on the hill ceased entirely and the site was abandoned[2].

From the excavated disturbed tomb T.61 come six spherical pyxides belonging to a local ceramic workshop, two imported attic pyxides of the early "Middle Geometric I" period (ie. the years immediately after 850 B.C.), as well as a few other grave offerings. The attic pyxides accurately date the rest of the finds and especially the local spherical pyxides which bear cross-hatched maeanders and swastikas as main decoration. It can thus be concluded that all the pottery from the tomb belongs to the years from 850 to 825 B.C., and perhaps to the end of this 25 year period.

One of these local pyxides (height 0.29 m) also bears a pictorial decoration as - something rare for the pottery of the period. The drawing on the belly of the vase is bordered and depicts a long ship moving towards the right. Above it and facing in the same direction are two birds in flight, while in the sea below, swim two fish schematically rendered[3].

The description of this early ship of the years around 840-830 B.C. is of particular interest but also presents us with certain difficulties since, in the absence of contemporary written sources, relevant information can only be found in the "Homeric" Epics - although this oral tradition was codified and written down at least 100 years later.

Despite the schematic design of the ship (fig.1), one can discern the curved stem at the back, where the steering oar is also to be found. The prow is elevated and vertical with small projections, while it ends above in a backward-turning component, possibly the "ἄφλαστον" of the Epos. Down at the front at the ship's waterline, a protruding part (the later-named ram) can be observed. It is not clear whether the series of small vertical lines on the long side of the ship (31 in number) indicate a series of thole pins (the Homeric "κλεῖδες") where the oars were fastened or if, in conjunction with the horizontal lines, they mean to depict the ship's side fremework and rail. It should be noted that the ships of the Geometric period do not as yet appear to have a deck. There is also a main mast which is forked at the top, where a rope is fastened (the"πρότονος").However, no sail is shown[4].

At the rear end of the ship 2-3 spears are depicted. They were, I believe, intended mainly as an indication of the ship's combative capacity. Spears in this position appear quite frequently in later examples of war ships of the 8th cent. The depiction of the spears should not, in my opinion, be connected with some abstract mythological representation[5], but understood simply as stating the military intention of the ship (perhaps it is the Homeric "ναύμαχον ξυστόν",

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* This paper was delivered in August 1987 in Greek and translated with some alterations and corrections during the summer of 1988. The translation into English, for which I thank my daughter Eleni Calligas for her help, was undertaken so that the language of this contribution would harmonise with that of the other papers of the Delphi Symposium.

Il.XV, 388-9 and 677). Neither, I believe, do the birds shown above the ship have any allegorical meaning, as some scholars have stated[6] regarding similar examples of a later date. Together with the fish depicted below, I think that they constitute a schematic rendering of the surroundings, the sky and the sea, in which the ship is moving, desiring perhaps to show that she is on a voyage and not in harbour.

However this representation of an early Eubean ship from the Toumba cemetery is not the only example from Lefkandi. In the older excavations of the nearby group of tombs called Skoubris (after the owner of the site) and in the fill of a gully which is dated in the 9th cent., a fragment of a crater (original diameter ca.0.45m.) was found and has already been published[7] (fig.2). The pot was the product of a local workshop of the years before the site was abandoned, that is prior to 825 B.C. The representation of a ship can be seen in a metope, although unfortunately only the front of the vessel is preserved, depicting the elevated prow with its backward-turning component. A mast can not be discerned, but the body of the ship is divided into smaller parts, which might indicate positions for the oarsmen, or the frame-work of the vessel[8] or even railings. Below, in front of the ship's waterline, the ram can be observed. Obviously the ship is again one of war.

Regarding the form of these Eubean ships it is interesting to compare an example from nearby Oropos. This is a clay model of a ship dated, as V. Petrakos suggests in his publication[9], in the Geometric period and not in the Mycenaean age as scholars have recently maintained[10]. It was pulled along on four wheels and would have been a child's plaything, probably from a child's tomb, like similar examples of clay animals and carts with or without wheels from tombs in Lefkandi. Unfortunately today the Oropos model is incomplete and reconstructed but the elongated shape of the ship, the high prow with the ram, as well as the curved stern can be clearly distinguished. Also well formed are the vertical sides of the ship, without a deck. The long shape and the presence of a ram are, in my opinion, vital elements of these early vessels and denote their military character.

I believe we can discern the existence of these elements in an early form already from the beginning of the 9th cent. (around 900 B.C.), in the two ships that are designed in outline on a crater from Fortetsa, Knossos[11]. Of great interest in these cretan ships are the four small protrusions in the prow, which are also to be found later on the Lefkandi ship. Perhaps this element is an Eastern influence.

More developed are the two ships noted by D. Gray, painted below the handles of a crater which was found by G. Bass on the Halicarnassus peninsular, near Dirmil, in Asia Minor[12]. These ships are, like those of Fortetsa, designed in outline but their relatively elongated shape, the ram and the formation of the elevated prow are depicted more clearly. It would appear that these ships are connected with those from Lefkandi, since the Dirmil crater as well as the vases found with it, belong to the early 9th cent. and are probably Euboean.

A still more advanced warship form can be found on the engraved catchplate of an early "Boeotian" bronze fibula dated ca. 850 B.C. from a grave in the Athenian Kerameikos[13].

The study of the representations of the two ships from Lefkandi, in conjunction with the more general study of the area where they were found, lead to certain observations regarding the important position of shipbuilding within the early Euboean economy and the advanced standard of the relevent skills:

1. Towards the end of the 9th cent. B.C., it seems that the inhabitants of Lefkandi had at their disposal ships of war whose similarities of construction allows us to speak of a common type: the long shape, the elevated backward-turning prow and the existence of a ram.

2. The timber for the construction of such ships must have come from the high mountains of the Euboean mainland and, as we know from the Epos, pine was used for the hull and fir for the mast of the ship[14]. The art of carpentry was generally very advanced in Lefkandi as we can conclude from the large wooden posts used in the building ("oikos") of the 10th cent. Beautifully worked wooden planks were also found lining the large tombs of this period.

3. Weaving skills - for the possibility of linen sails - were also of a high standard as the exceptionally well woven, thick linen garment that has been preserved in Lefkandi and belongs to a contemporary tomb shows[15].

4. The natural location of Lefkandi is also of note, as it is a coastal site with small, sheltered sand bays, where the ships could be towed during the winter months.

5. The intense commercial activity between Lefkandi and the East which is noted in the 10th and 9th cent., would certainly have also caused the mooring of Eastern (Phoenician?) ships in Euboean waters[16]. From these ships, local ship-builders were perhaps inspired refinements and improvements for the construction of their own vessels.

Nevertheless, the portrayal of ships, is most unusual for 9th cent. Lefkandian pottery, all the more so as we have two such cases, the crater and the pyxis. Vase decoration during this period in general is, as we know, exclusively confined to linear designs: circles, semi-circles, wavy lines, triangles, diamonds etc. The portrayal of people, animals or objects is totally absent - or almost so. Ships must have played a very important role in the life of the inhabitants of Lefkandi during the end of the 9th cent. B.C., for contemporary potters to wish to depict them on their vases.

Additionally, the fact that the only two surviving representations from Lefkandi are specifically of war ships is not, I believe, mere chance. It is already known from the Mycenaean period that - according to the surviving representations - ships can be divided into simple, sailing merchant ships without an offensive ram (as the one from Skyros[17]), and ships of war (as the one from Tragana, Messenia[18]). The fact that after two centuries of peaceful commerce, the refined representation of war ships appears for the first time in Lefkandi at the close of the 9th cent. B.C., must be due to specific reasons. It might be proven that the Euboean ship builders of the period reinforced their vessels with the military component of a ram and designed longer and more dynamic hulls, for the more successful confrontation of rivals that their sea-faring countrymen would now face with increasing frequency along the sailing routes of the Aegean.

I believe that the new views and fresh interpretation of the historical facts as they are revealed by the recent archaeological excavations, can lead to the understandig of this phenomenon.

The recent excavations in Lefkandi, Euboea lead to the disclosure of a rich and dynamic Greek world that was active from the end of the 11th cent. until the end of the 9th cent. B.C.[19]. It is possible that Lefkandi will prove to have been an enterprising centre of this world, outposts of which have been identified - with new ones being added continuously - in the whole of Greece, in the south, central and north parts, islands and mainland alike.

This early Greek world was not solely Athenian-centred, as had initially been assumed because of the conclusions of earlier excavations, undertaken mainly by German archaeologists, in the

Athenian cemeteries of Kerameikos and elsewhere. More recent investigations indicate the existence of other centres, such as the Euboean-Thessalian group, which were not dominated by Athens. Further research will show whether the name "Lefkandi Period", which I attributed generally to the whole of this period is justified. The period covers the years from the end of the 11th cent. B.C. until the end of the 9th cent. B.C. - and according to the conventional terminology derived from the ceramic styles, from the beginning of the "Protogeometric" up to the end of the "Middle Geometric I" period.

This world was orientated towards the sea of the Aegean and thence towards the East: Cyprus, the Syrian and Palestinian coast and perhaps also Egypt. The movement towards the East is verified by the first migration movement from Central Greece towards Asia Minor and Cyprus (around 1000 B.C.), while that from the East is in turn witnessed by the eastern products found in Greece. One can additionally bear in mind the eastern origin of certain Greek heroes such as Pelops, Kadmus, Phoinix, Aigyptus, and others.

It was however a peaceful world, without walled cities or fortified acropolis, unlike the earlier, Mycenaean, period. Now habitation was dispersed, based on detached unfortified households (the "oikoi"), each one of which was founded at the top of a low hill. Each "oikos" housed one family ("οικογένεια") of a patriarchal type, perhaps a "genos". The normal architectural type of the "oikos" was a megaron-like building with double-reclining roof and one of its narrow sides apsidal, a brilliant example being the "oikos" found in Lefkandi, (length 48m)[20]. Such an "oikos" would hold the family's possessions and provisions in store-rooms, as well as housing the family worship - since there did not as yet exist communal temples or sanctuaries. Neither were there common, extended cemeteries but each genos usually buried its own dead at the foot of the hill upon which the "oikos" was built, thus forming many, small and dispersed cemeteries. Special burial honours were reserved for the leading members of the families, including the erection of a tumulus, sacrifice of horses, etc. For this world was based on the personal bravery and prominence of the leaders of the families. In later years, it was in my opinion these leaders who were named "heroes", and the exploits and deeds attributed to them formed the corpus of the rich, Greek mythology, as in my opinion, the age of these mythical heroes coincides with the Protogeometric period, the "Lefkandi Period"[21]. Not the least because it evokes the concept of a closed and isolated community, while the new facts point to an enterprising, sea-faring one, whose commercial interests cultivated the art of ship-building and refined it through contact with the seafarig peoples. The knowledge gained from such peaceful commercial interchange could also be put in use for the construction of ships of war.

The economy of the "oikoi" must have been based mainly on pastoralism and the exchange of goods (barter system and gifts) and less on agriculture. On the other hand the sea routes were also exploited as is shown by the archaeological finds.

The bonds with the East (chiefly Cyprus, Syria, Phoenicia and Palestine) are positively verified by the finds of the excavation in Lefkandi. Almost all of the Toumba tombs included luxury goods originating from the East and devotedly placed as ornaments and offerings for the dead: jewellery and vessels of faience, gold or ivory jewels, bonze vessels, scarabs, and other such. All these articles, imported in a peaceful place such as Lefkandi, indicate prosperous and continual commercial activity, obvioulsy based on the exchange of products. In this interchange, Euboea would have offered, apart from the clay vessels (containing wine, oil etc.) that have been found in the East, perhaps also timber and metals, possibly iron products, as the fine iron swords and other weapons that were found in tombs of this period, indicate.

To this brilliant Greek world of the 10th and 9th cent. B.C., as it is now revealed from the excavations, one can not of course apply the term "Dark Ages", which is nevertheless still used by various historians and archaeologists.

By the end of the 9th cent. B.C. the peaceful world of the patriarchal "oikoi" is fast nearing its close amid general unrest. Facts that remain as yet unknown to us, overthrew the existing social and economic order and the patriarchal isolated "oikoi" were deserted. Now, for the first time in the historical age, organinsed, fortified settlements were established, and there the inhabitants of the district flocked. The fortified settlements of Old Smyrna, Emporio in Chios, Zagora in Andros, Ag. Andreas in Siphnos, the Oikonomou islet of Paros, Donoussa near Naxos, Xoburgo in Tenos, Thorikos and the Athenean Acropolis in Attica, Eretria and Chalkis in Euboea, must have been established for the first time in these tumultuous years of the close of the 9th cent. B.C.

The economy of the new settlements now turns more towards agriculture, abandoning pastoralism, since concentrated populations must be fed. The inhabitants of these concentrated settlements also establish, for the first time, organised sanctuaries and temples of the community and new, communal cemeteries. An intense involvement in naval activities is also noted. The danger which brought about these new conditions in the Hellenic world seems to have originated from the sea, from the Aegean, if we judge by the great number of new, fortified settlements in the islands and coastal regions[22]. I believe that this change, noted at the end of the 9th cent. (around 830-800 B.C.), is a very deep and substantial one, a land mark in the historical development of ancient Greece, whose importance has not yet been adequately emphasised.

The new circumstances led to the creation of the Greek "polis", the establishment of the Greek sanctuaries and temples, the founding of new institutions. But the crowding of populations within the tight confines of fortified settlements engendered internal social unrest too, which soon reached explosive dimensions, during the 8th cent. The exodus of some of the inhabitants in the form of colonisation then became the only possible solution with the Euboeans again in the lead[23].The 8th cent. was a century of strife, as the now common figure-scenes of hoplites, land and sea battles on vase decoration indicate[24], but also one of social upheaval, the originating causes of which are to be found in the late 9th cent. It is within that turbulent world of the end of 9th cent., that we note the first depictions of war ships, such as the ones from Lefkandi. Sea-ward dangers seem to have forced the inhabitants of the coastal regions to react and seek refuge in the "wooden fortress" (if the anachronism of the later Delphic oracle may be allowed). The ships however did not succeed in saving the world of Toumba, nor the new, unfortified settlement of Xeropolis in Lefkandi which were both eventually absorbed by their new powerful neighbours, the fortified cities of Chalkis and Eretria. Greece was now living the stormy but intensely creative 8th century B.C.

Peter G. Calligas
Ephor of Antiquities
Athens, Greece

NOTES

1. *Arch. Reports* 33 (1986-87) (H.W. Catling), 12 ff. For the pyxis: figs. 17-18.
2. M.R. Popham et al.,*Lefkandi I:* The Iron Age Settlement and Cemeteries (London 1979-80); M.R. Popham et al., B.S.A. 77 (1982), 213 ff; M.R. Porham et al., Antiquity 56 (1982), 169 ff; P.G. Galligas. *A.E.M.* 26 (1984-85), 253 ff; M.R. Popham, "Lefkandi and the Greek Dark Ages" in (ed. B. Cunliffe), *Origins*, (B.B.C. Books 1987), 67 ff.
3. See now M. Popham, "An Early Euboean Ship", *Oxf. Jounr. of Arch.* 6 (1987), 353 ff. I thank Prof. M. Popham for discussing with me the problems of the Lefkandi ship before its publication.
4. For the representations of the Geometric ships: G. Kirk, "Ships on Geometric Vases", *B.S.A.* 44 (1949), 93 ff; J.S. Morrison and R.T. Williams, *Greek Oared Ships* (Cambridge 1968), 12 ff; L. Casson, *Ships and Seamanship in the Ancient world* (Princeton 1971, 1986), 43 ff. About the ram: F. van Doorninck, *I.J.N.A.* 11 (1982), 283 ff.
5. cf. G. Ahlberg, *Fighting on Land and Sea in Greek Geometric Art* (Stockholm 1971), 45 ff.
6. cf. J.L. Benson, *Horse, Bird and Man* (Amherst 1970), 26 ff
7. *Lefkandi I* (1980), 267, pl.274:918 and pl.284:11.
8. For the rendering of the ship's framework compare the Late PG (9th cent.) clay model of a boat from Crete: J.K. Brock, *Fortetsa* (Cambridge 1957), 53, no.542, pl.36; (ed. A. Delivorrias), *Greece and the Sea* (Amsterdam 1987), 162, no. 59.
9. V. Petrakos, *A.D.*29 (1974) - Mel. 98-9, pl.57; (ed. A. Delivorrias), *Greece and the Sea* (Amsterdam 1987), 154, no.53.
10. F. van Doorninck, *I.J.N.A.* 11 (1982), 282, fig.6b; K. Davaras, *A. Eph.* (1984), 62, no.23.
11. J.K. Brock, *Fortetsa* (Cambridge 1957), 12, no.45, pls.4 & 135.
12. G. Bass, *A.J.A.* 67 (1963), 357 ff, pl.83, fig.15; D. Gray, "Seewesen", in *Arch. Hom. I* (Gottingen 1974); G.21 (D.3), 57, Abb.16b.; F. van Doorninck, *I.J.N.A.* 11 (1982), 277 ff.
13. K. Kübler, *Kerameikos V.1* (1954), Grave 41, 193 ff, pls. 160-1l; J.N. Coldstream, *Geometric Greece* (London 1977), 58, 64; H. Catling, in *Lefkandi I* (1980). 242-4; F. van Doorninck *I.J.N.A.* 11 (1982), 283.
14. For the timber mentioned by the Epos: Casson, 46, note 22; For the Euboean timber in antiquity: P.G. Calligas, "Euboea and the Cyclades" in (ed. L. Fitton) *Cycladica, Studies in Memory of N. P. Goulandris* (Br Museum, 1984) 89, note 15; For "μεσόδμαι" connecting megara with ship-masts see Morison-Williams (1968), 52 and H. Plommer, *J.H.S.* 97 (1977), 80.
15. For the linen cloth see M. Popham et al, *Antiquity* 56 (1982), 173, pl.xxv.
16. J.N. Coldstream, "Greeks and Phoenicians in the Aegean", *Madrider Beitrage* 8 (1982), 261 ff. For the problem of the position of the Phoenicians in modern historiography, see the interesting views of Martin Bernal, *Black Athena* v.1 (London 1987), 400 ff., esp. 426 ff.
17. Stirrup jar from Skyros (LH. III C-1); L. Parlama, *Η Σκύρος στην Εποχή του Χαλκού* (Athens 1984), 146 ff, no 9, Dr 31-32, Pl.A and 62-64; (ed. A. Delivorrias) *Greece and the Sea* (Amsterdam 1987), 153, no.52.
18. Cylindrical pyxis from Tragana, Messenia (LH. III - C); K. Kourouniotes, *A. Eph.* (1914), 107 -9, figs. 13 -15 ; Fr. Schachermeyer, *Griechenland im Zeitalter der Wanderungen* (Wien 1980), 117, Abb.31b, Taf.15 (= a new reconstruction showing that a bird and not a fish was depicted on the stem); (ed. A. Delivorrias), *Greece and the Sea* (Amsterdam 1987), 156, no.56.
19. Basic handbooks: (a.) A. Snodgrass, *The Dark Age of Greece (Edinburgh 1971); (b.) V. Desborough, The Greek Dark Ages* (London 1972). Also M. Popham, in *Lefkandi I* (1980), 355 ff. See also P. Galligas, Η Ελλάδα κατά την πρώϊμη Εποχή του Σιδήρου, in *Ανθρ. και Αρχ. Χρονικά* 26 (1987), 17ff.
20. M. Popham and al., "The Hero of Lefkandi", *Antiquity* 56 (1982), 169 ff; P. Calligas, Ανασκαφές στο Λευκαντί Ευβοίας, 1981-84, in *Αρχ. Ευβοϊκών Μελετών* 26 (1984-5), 253 ff.
21. M.I Finlay, *The World of Odysseus,* (Harmondsworth 1982^2), 26 ff. Also P. Calligas, "Hero-cult in Early Iron Greece" in (ed. R. Hägg) *Early Greek Cult Practice* (Stocholm 1988), 229 ff; P. Calligas, Αρχαίοι Ευβοϊκοι Μύθοι, in *AAX.* 1 (1986), 103 ff.
22. cf. A. Snodgrass, "The Historical Significance of Fortifications in Archaic Greece", in (ed. P. Leriche et H. Trésiny) *La Fortification dans l' Histoire du Monde Grec* (C.N.R.S. Paris 1986), 125 ff (farours the theory of piracy);P. Calligas, *A.A.X.* 2 (1987), 17ff. (takes a more general view).
23. M. Popham, "Why Euboea?" *A.S.Atene* LIX- N.S. LXIII (1981), 237-9. To the 8th cent. posibly also belongs the general characterisation of Euboea as "famous for her ships" (ναυσικλειτή Ευβοια) found in the Homeric Hymn to Apollo (lines 31, 219)
24. T. Webster "Homer and Attic Geometric Vases" *B.S.A.* 50 (1955), 38 ff; G. Ahlberg *"Fighting on Land and Sea in Greek Geometric Art"* (Stockholm 1971), passim; See also: A. Snodgrass "Towards the Interpretation of the Geometric figure-scenes" *A.M.* 95 (1980), 51 ff. (on Webster's theory).

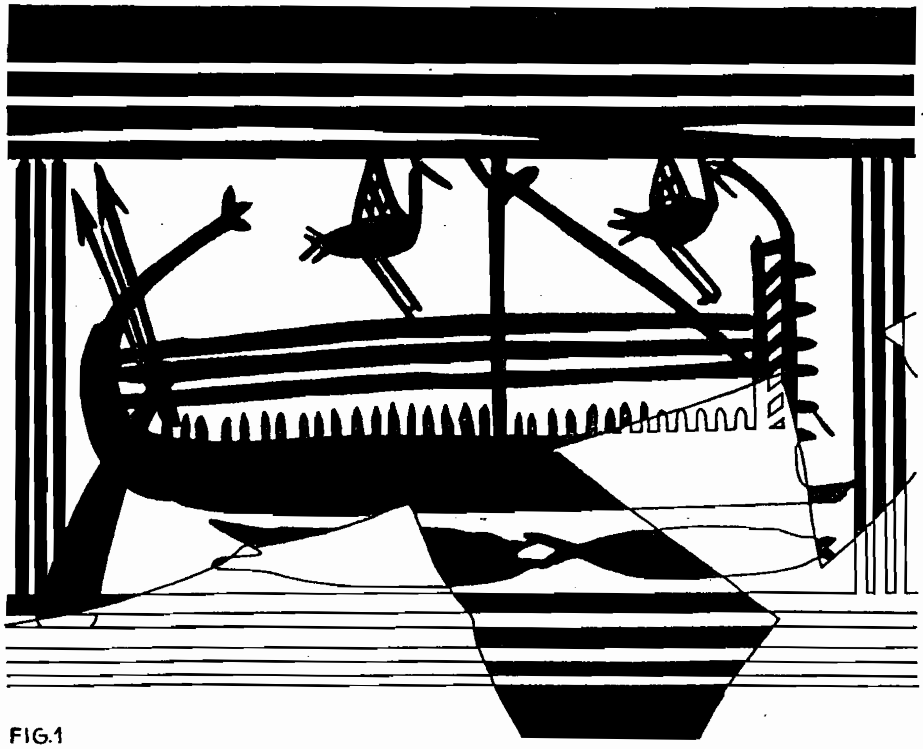

FIG.1

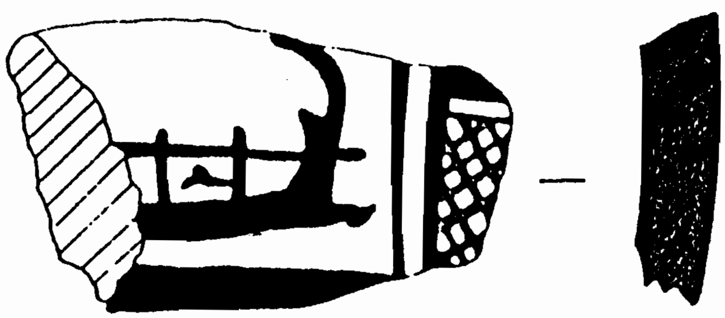

FIG. 2

HULLS AND BARRELS: UNDERWATER ARCHAEOLOGY'S VITAL CONTRIBUTIONS TO THE HISTORY OF NAVAL TECHNOLOGY*

High on the list of underwater archaelogy's significant contributions is the discovery of something we had been totally unaware of, that in the ancient Mediterranean world the standard way of assembling a hull was shell-first with edge-joined planking; this was true from at least the 14th century B.C. (Kaş wreck) down to the early centuries of the Roman Empire. By at least the fourth A.D. shipwrights began to move toward the frames-first technique (Yassi Ada 4th century wreck) and by the seventh A.D. this move was in full progress (Yassi Ada 7th century wreck). By 1000 A.D. the transition had been completed (Serçe Liman wreck), and from then on frames-first was to be standard throughout the western world.

Yet the frames-first technique need not have been an evolution from its predecessor. We know from hull remains found in northern Europe that it was used there in ancient times not only for river boats and barges but also seagoing vessels; there are indications that the Celts may have been its originators. It would seem that, after centuries of limited use in northern Europe, it gradually spread until by 1000 A.D. it finally drove the edge-joined technique, which had enjoyed a long life of two millennia or more, into oblivion.

By a curious coincidence another similar, important switch connected with naval technology took place at just about the same time. A second great contribution of underwater archaeology has been the revelation that, right up to the Middle Ages, the standard shipping container was the clay amphora. It then disappeared, replaced from the Middle Ages on, by the wooden barrel or cask. And the wooden barrel, just like the frames-first technique for assembling a hull, had long been in use in northern Europe. The pros and cons of the two types are clear. The amphora was cheap; it was made of cheap material and able to be cheaply produced in quantity. The barrel was expensive; it was made of costly material and required much highly skilled labor to produce. However, though barrels demanded a large initial outlay from a shipper, they paid for this cost by almost doubling the profits he could derive from a shipment. For the cheap amphora was enormously heavy and the expensive barrel comparatively light. Of the weight of a shipment of wine in amphorae, the containers accounted for 40%, the wine for 60%; in barrels, the containers accounted for but 10% and the wine 90%. For anyone with the cash to invest in barrels, it was clearly the container to use. Yet why was the switch made at this patricular time? Historians of technology can offer no answer.

What of the pros and cons of shell-first edge-joined construction as against frames-first? The older technique was costly in labor, wasteful of wood, and limited the hull shapes that could be fashioned, but it produced a hull that was strong, durable, staunch and needed minimal caulking. The later required far less labor, involved far less waste of wood, and, moreover, permitted more varied hull shapes with a greater cargo capacity. But it produced a hull that was less staunch, and that had to be caulked.

Thanks to the excavation of the Serçe Liman wreck, we can pinpoint the date of the transition, 1000 A.D. But, as in the case of the switch from amphorae to barrels, the causes of the switch are obscure, although here historians of technology are willing to speculate. They do not attribute it purely to a shortage of labor, particularly of the skilled labor demanded by the edge-joining of planks, nor a shortage of timber. They look to certain economic and political factors. Lynn White, foremost expert on the history of Mediaeval technology, cautiously suggests a connection with the great upsurge in maritime activity that took place in the Italian ports of Amalfi, Pisa, Genoa, and Venice during the tenth century; the frames-first technique put at their disposal vessels that could be built relatively quickly and required a smaller initial investment. Barbara Kreutz, author of numerous studies in Mediaeval naval matters, equally cautiously suggests that the Arabs may have been in good part responsible for the switch: needing to build fleets form scratch, they adopted the method best suited for doing so. A recent, detailed study by Richard Unger suggests that the centuries after 700 were marked by a shrinking of commerce, and the use of the cheaper frames-first vessel enabled shippers to survive these difficult times. When, in the second half of the 10th century, the volume of trade expanded dramatically, the speedier frames-first technique enabled shipyards to keep up with the demand for more and more vessels.

Whatever the answer, it is clear that the switch was a technological event of the highest importance, comparable to that in later centuries from wooden hulls to iron. And we owe our awareness of it totally to the findings of underwater archaeology.

Lionel Casson
New York University

* The above is an abstract of Professor Casson oral presentation.

SOME REMARKS ON THE MEDITERRANEAN AND RED SEA SHIPS IN ANCIENT AND MEDIEVAL TIMES

Part II: Merchant - Passenger VS. Combat Ships

In the present paper I continue the comparison between the ships of the Eastern Mediterranean and those of the Gulfs and the Indian Ocean. It should be taken into consideration that while the Byzantine and Islamic navies reached their peak in the Eastern Mediterranean at the turn of the 11th century, the Arabs continued to dominate navigation in the Red Sea and the Indian Ocean until the 15th century. Thus, the time span of this article has been placed somewhat arbitrarily from the late Roman period until the coming of the Portuguese (15th century).

In this paper my research is restricted in the following topic "Merchant-Passenger vs. Combat Ships". The most conspicuous difference between navigation in the Mediterranean and that of the Gulf-Indian Ocean is that in the latter the role of the combat ships was heavily diminished. There were no decisive naval engagements like that of Dhāt aṣ - Ṣawārī or that in front of the gates of Constantinople (Christides, 1985). Both Greek and Arabic treatises of naval warfare containing detailed information about warships, naval preparedness and tactics refer to the war fleets of the Mediterranean and leave us at dark about the activities of combat ships beyond this sea.

The limited activities of war fleets in the Gulf and the Indian Ocean include a small Moslem raid against the coast of Ethiopia already in the middle of the 7th century and a number of Moslem naval expeditions originating from the Persian Gulf, launched against the northwestern

›towns of India (Christides, forthcoming a; F. Gabrieli, 1964-5).

The types of the warships that sailed in the seas beyond the Mediterranean are little known. On the one hand they had to be constructed in accordance with the model of the merchant-passenger vessels used in the treacherous waters of the Gulfs and the stormy Indian Ocean, and on the other, much was borrowed from the Mediterranean naval technology since there was a constant interchange of naval technology in the construction of vessels between the two areas.

I have emphasized in the Second Symposium of Ship Construction in the Antiquity (Athens, 1989) in the discussion following Prof. L. Casson's paper on the invention of barrels, that there were no Chinese walls between the Mediterranean and the Gulfs and Indian Ocean and that most probably the single rudder, perhaps the lateen sails, barrels and certain types of the Greek fire, were inventions transmitted from China to the Mediterranean via the Arabs.

There is no doubt that the equipment and various types of weapons used in the warships of the Mediterranean should also be traced in the ships of the Gulfs and the Indian Ocean.

From the vague information in the Arabic sources on warships we understand that no permanent large fleets anchored by the coastal towns of western India. Valuable goods — pepper, precious stones and other spices — were transported on merchant ships accompanied by warships and only in minor naval expeditions well equipped combat ships were used. Actually Islam in the Indian subcontinental and Indochina spread with limited application of the *jihād* which was the moving force in the Mediterranean naval activities (Christides, 1981). The Islamic orbit beyond the Red Sea constantly increased through international trade, mercantilism and the activities of the adventurous roaming fuqahā' personified by Ibn Battuta. (For Moslem expeditions in northern India, see Christides, forthcoming a; for south India see N. Venkata Ramanaya, 1942; for the cosmopolitan activities of the Moslem learned men, see N. Levtzion, 1986).

The most important information on combat ships and their equipment in the Indian Ocean is found in the *Riḥla (Travels)* of Ibn Battuta. Unfortunately, this peripatetic *mujawir* (scholar-sojourner) who writes from first hand experience is little interested in naval architecture and his eyes are turned mainly towards local folklore, animals and passengers; nevertheless we can glean with proper scrutiny valuable information. (For Ibn Battuta in general see R.F. Dunn, 1986; for the folkoristic elements in his work, see S. Fanjul, 1981-82; H.F. Janssens, 1948; see also the introduction in H.A.R. Gibb's translation 1929).

Ibn Battuta reports stone and fire throwing machinery on ships along with other military equipment. (For the use of liquid fire on the ships of the Mediterranean, the Gulfs and the Indian Ocean, see Christides, forthcoming b). The most conspicuous example of the transmission of technology between the Mediterranean and the seas beyond it is revealed in a passage of Ibn Battuta's *Riḥla*. It refers to the most sophisticated amphibious vessels used for transportation of horses, along with armed cavalry men. The Byzantine sources briefly report the use of such vessels from where cavalry men disembarked mounted on their horses, while the Arabic sources offer us more details about these speedy ships, their protective doors and the number of horses carried by them. (Christides, 1988, 318 ff.).

The horse carrying ships were called *ṭarrida*, a term used also commonly for various transport Arab ships, transmitted to other languages, as for example to Spanish, "tarides per cavalls a portar" (F.F. Laures, 1987, 25).

Ibn Battuta describes a minor naval expedition of the Moslems on the Malabar coast of South India in which he also participated (C. Défremery and B.R. Sanguinetti, IV, 107):

«فركب مركبا منها وأنا معه ... فلما
اصبح «الصباح» ضربت الطبول والانفار
والابواق وزحفت المركب ورموا عليها
بالمجانيق ... وكان عندنا طريدات مفتوحتى
المواخر فيها الخيل وهي بحيث يركب الفارس
فرسه في جوفها ويتدرع ويخرج ...»

"He embarked on a vessel with me... In the morning, the cymbals, the trumpets and horns (sounded) and the (Moslem) ships advanced and the ballistic machines of the attacked coastal town threw against them... There were next to us two *ṭarrida* ships, open in the stern where the horses were placed and they were constructed in such a way that the horseman could mount his horse, dressed in his armour and disembark...".

It is noteworthy that in the above mentioned passage, in addition to the revealing information on the *ṭarrida* vessels, there is an interesting statement about the musical instruments used by the Arabs in the naval battles. It seems that the use of the Arab horns on the ships, called "Saracenic horns", was passed to the crusaders.

Details about the construction of strictly combat ships sailing on the Indian Ocean are missing. Most probably like the merchantmen of this sea, they were sewn boats tied together with strings. The Arabic sources report that in addition to the few combat ships all merchant ships were armed and often permanent African marines embarked on them. (For these merchantmen see Kaplan 1974, and figs. 2, 3 of our text).

In contrast to the irregular and sporadic use of war fleets in the Gulf-Indian Ocean areas, combat ships played a prominent role in the Eastern Mediterranean. The warships of both Byzantines and Moslems, who dominated the Eastern Mediterranean until the 11th century, driven by sails in times of peace or propelled by oars when engaged in naval battles, were in constant battle preparedness, guided by naval war manuals, trained in naval tactics and manned by highly skilled crews. (See the relevant material in A. M. Fahmy, 1950, reprinted 1980; H. Ahrweiler, 1966; M. Reddé, 1986; J. H. Pryor, 1988, and J. L. Delgado, 1990). A detailed analysis of the Moslem and Byzantine combat ships will appear in my paper to be published in the Acts of the Fourth Symposium of Ship Construction in the Antiquity.

Byzantine and Moslem combat ships often accompanied merchant ships in the Mediterranean in long convoys and sometimes precious merchandise — mainly gold — was transported on warships. (For examples see the Geniza documents, Goitein, 1973, 311-12). Occasionally certain important passengers were transferred by warships, as for example Saint Theodore of Cythera at the time of the Arab occupation of Crete moved in the Aegean on a patrol Byzantine ship. (Oikonomides, 1967).

Turning now our attention to the cargo and passenger vessels of the Eastern Mediterranean, there was little difference between cargo and passenger vessels. Exclusively cargo ships were rarely used, as for example those giant vessels for the transportation of corn from Alexandria to Constantinople. In the Life of Saint Gregorios of Agrigente it is described how the Saint embarked onto a vessel where there was cargo which belonged to the bishop of Panormite of Sicily. (*P.G.*XCVIII, col. 580): «κατ' οἰκονομίαν δὲ Θεοῦ εὗρον ἐκεῖσε σκάφος ἐπισκόπου τῆς Πανορμίτου πόλεως τῆς Σικελίας ἔχον πραγματείαν τινά».

The average Byzantine merchantman from the 7th to the 11th centuries seems to be, as Pryor describes it, "small, of less than 250 tons deadweight tonnage, powered by a single lateen sail, steered by two steering oars on the stern quarters... with no deep keel..." (Pryor, 1988, 27-28). Pryor's description is correct and can be applied to the majority of the Byzantine and Moslem vessels of this period but smaller ships were also used as fishing and passenger boats while much larger ships were also constructed. The artistic evidence, based on miniature, mosaics, ceramics and other offers us ample evidence of such vessels. A thorough research on this topic leading to the standard three-masted vessels as it appears in a Byzantine icon of Patmos and on a drawing fragment of paper from Egypt, both of the 17th century, is still a desideratum. Such research should not only include the study of shipwrecks (G. Purpura, 1985, in addition to the other works mentioned below) but also thorough examination of the textiles. Thus, for example an Egyptian ship on a Coptic textile, dating from the 4th c. A.D., depicts an axial stern rudder (Fig. 1), while the introduction of this invention is usually dated much later.

Any technical analysis of the merchant ships of the Mediterranean is beyond the scope of the present study which will be limited to some remarks concerning the transportation of passengers along with the goods.

Regulations concerning travelling at this period in the Eastern Mediterranean appear in the Rhodian Sea Law and other Byzantine legislation. (W. Ashburner has studied thoroughly the relevant material, 1909, repr. 1976; for an Arab translation of the Rhodian Sea Law see S. Leder, 1985). The Moslem Sharī 'a laws have certain references to navigation of general character, i.e., fasting during sea-voyage, death on board ship, etc., but no specific regulations.

The Greek *Lives* of the Saints and the narration of Arab travellers offer us fresh material about voyages. In general people of various ethnicities could mingle freely in any boat and the crews could come from any faith and ethnicity. (For Moslems and Christians travelling on the vessel wrecked in Serçe Limani, see Christides, 1988, 328).

While piracy was a definite threat on navigation, it took place in far lesser scale than in the Red Sea and the Indian Ocean and we should not confuse naval warfare — including attacks on merchantmen — with actual piracy (Christides, 1981).

The passengers travelled freely without any passports. Thus for example Saint Gregorios of Agrigente changed ships simply with the consent of the captain of the ship. (P.G. XCVIII, col. 560). Similar flexibility and easy changes appear in the Geniza documents (Goitein, 1973). It is only in the river navigation of Egypt that we meet the restricted use of passports. (Arabic sijill). Such passports were issued in order to control the movement of Egyptian taxpayers and it is characteristically reported in an Arabic church source that when a crocodile ate a little girl who was carrying her passport, her mother was obliged to pay a fine and replace it. *(History of the Patriarchs of the Coptic Church of Alexandria,* ed. B. Evetts, P.O.v, p. 70).

In the Mediterranean it was not unusual that a passenger was simultaneously a merchant and in ancient times the word "επιβάτης" was applied to both passenger and merchant (J.

Velissaropoulos, 1980, 338). But a good number of simple passengers travelled short or long distances simply to visit families or for pilgrimage. The pilgrims suffered heavily to perform their religious duties. Western sources describe what the Christians went through and how they managed to survive. Thus Jacques de Vitry, travelling in 1216-7, describes how the poor pilgrims were put offboard when supplies were running short (Pryor, 1987, 1709).

Many of the ships in the Mediterranean sailed coastwise and the passengers spent the nights lodging in ports, but it was not unusual for passengers to spend whole weeks on land (Life of Gregorios, P.G. XCVIII, col. 628-9).

From the Byzantine and Arabic sources it is clear that the passengers provided for their own food and water and this information is confirmed with the evidence of underwater archaeology and the Rhodian Sea Law (W. Ashburner, 1909, repr. 1976, cl).

Most of the passengers travelled carrying their own mattresses and cooking utensils and were restricted in the small assigned place on the deck, but richer merchants had their own cabins. (Christides, 1985, 77). Most probably the cabins were arranged according to their special position as in the Western ships. (A. Scialoja, 1944; Pryor, 1987, 1698-1699).

The merchant ships in the Eastern Mediterranean sailed to various directions, avoiding the winter, frequently overloaded in spite of the legal restrictions.

The passengers' transportation and security depended on the whims of the captain. His responsibilities and power, similar to those of his colleagues in the Gulf-Indian Ocean vessels, will be discussed at the end of this paper.

Turning to the vessels sailing in the Red Sea, we notice a vessel which carried passengers, i.e., pilgrims. It is the usually two-masted ship called *jalīb* which carried pilgrims from Aydhab to Jidda. (Fig. 4). The Arabic sources state that the Beja-Sudanese black tribe which controlled this traffic overloaded these ships and pilgrims suffered many hardships.

Of course, even in the vessels of pilgrims and those that sailed in the Red Sea cargo could be added, and overloading was almost a norm. Ibn Battuta complained about the mingling of passengers with camels and his remark is supported by artistic evidence (Fig. 5). Such mingling of animals and passengers was not unusual in the Mediterranean vessels, since it appears even in the 15th century Venetian ships in spite of the legal prohibition (D. Gofas, 1965, 95).

The vessels which moved beyond Aden following the spice route as far as India or the silk route to China were passenger-cargo ships. Ibn Mājid, the pilot and author of a treatise on navigation, describes the average transoceanic vessel as two or three masted, which had already existed from the early, even pre-Islamic times. It was equipped either with two-steering oars (miqdafayn) or a single rudder (sukkān). (Ibn Mājid, ed. of the Academy of Moscow, II, 1984 Passim. For Ibn Mājid in general see T. Shumovsky, 1960; G. Ferrand, 1921-1923; G. Wiet, 1925; G. R. Tibbets, 1971; and the introduction in the edition of his text by the Academy of Moscow, I, 1985).

The artistic representations provide us with concrete information about those early three - masted transoceanic vessels. Thus a wall painting in a cave *in situ* in Ajanta of India, dating from the 6th c. A.D., and a graffito of a ship *in situ* at Siraf of Iran, dated by Nicolle to the 11th century, offer us illuminating examples (D. Nicolle, 1989, 173), (Figs. 6, 7).

This is not the place to discuss at any length the construction and function of the transoceanic Arab vessels which are beautifully represented in the *Maqamāt* of Ḥarīrī (Fig. 8). We must of course take into consideration that the ship depicted in Ḥarīrī's *Maqamāt* represents one of the most solid vessels of the different types of transoceanic ships. Smaller vessels partly decked, where cargo was covered with hides and passengers suffered in bailing out water constantly, were also used. (See for examples given by G. Hourani, who nevertheless failed to understand that there was not just one type of transoceanic vessel; Hourani, 1951, 98).

Tim Severin constructed an Indian-going vessel based mainly on the Ḥarīrī vessel, which he named Sohar, and sailed from Oman to India and China (Severin, 1982). Severin's reconstructed 87-foot long ship wore two settee sails and a jib and it was built without the use of any nails like the typical Gulf-Indian sailing Arab vessels (Fig. 3). Although Severin's experiment revealed intriguing details about the construction of the ocean Arab-going vessels, stitched together with cord made from coconut husk-jiber, and his adventurous trip manifested the real problems sailing according to ancient practices, many questions still remain unanswered. Thus the function of the superstructures which we observe in Ḥarīrī's ship remain an enigma. For example two strange figures (sailors?) appear below the passenger-merchants' decked cabins dumping something into the sea (Fig. 9).

Another problem is the exact position of the special cabin used for the owner or *his* agent, a deck-house richly decorated in form of a crow's nest (Figs. 23, 24a, a simplified sketch by Nicolle). While in the best known Ḥarīrī's illumination, it appears far from the stern-rudder, in another illustration of Ḥarīrī's *Maqamāt,* it is placed far from the stern rudder, on the other end close to the grampled anchor.

It is to be noticed that the Arabo-Islamic tradition of the "crow-nest", dome-like structure, continued in the Ottoman period as manifested in an illumination of the *Diwan Najati,* dated to 1518/19 (Fig. 10). I believe that it is this tradition which was followed in the "kadirga" galley where a shelter was placed in the back of the ship for the sultan, in the form of a luxuriously decorated wood-carved dome. (Fig. 11). (For this kadirga see L. Basch, 1979, 1989).

The size of the cabins on the merchant-passengers which so clearly appear in Ḥarīrīs manuscript as well as the facilities they offer remain unknown. While details are lacking it is obvious from numerous references in Ibn Battuta's *Riḥla* that wealthy merchants could have ample space in their headquarters to accommodate their slaves and concubines. Special lavatories were attached to each of these luxury compartments. But Ibn Battuta's lust for luxury could be fully satisfied only in the Chinese junks. They were five-masted huge vessels with watertight apartments and numerous stern rudders; they could accommodate animals in especially provided spaces and in their large compartments whole harems and any number of slave servants could fit.

Concerning slaves on board, it must be said that in both the Mediterranean and Gulf-Indian Ocean vessels no slaves were used. Byzantine and Arab warships were manned by efficient and well paid crews and in the merchant vessels the members of the crew engaged in the risky profession of sailing were lucratively rewarded (Christides, 1982, 80, 84 ff.). Actually the Byzantines followed the Roman tradition according to which no slaves served in warships and the enlisted men felt proud to serve in the navy. Heated discussions took place on this subject (L. Casson, 1966 and more extensively M. Reddé, 1986, 473 ff.), but I believe that the evidence of the papyri is undisputable. Thus in a letter, dating from the second century A.D., a father named Sempronius expressed his great grief because his son did not enlist in the Roman navy and threatened to disavow him (J.C. Winter, 1927, 245-246):

Σεμ[π]ρώ[ν]ιος Γαίωνι τῷ υἱῷ μο[υ] ...
.σοι ο[ὐκ ἐ] στρατεύσου εἰς κλάσσαν, καὶ
ἐποίησα δύο ἡμέρας λυπούμενος.
λοιπόν οὖν βλέπε μὴ πισθῇς καὶ οὐ-
κέτι ἔσῃ μου υἱός. ...

In the cargo-passenger ships of the Red Sea and the Indian Ocean, while slaves were not used — under the harsh conditions we meet in the later Western galleys — we notice some trusted slaves that occasionally undertook the task of supervising the crews and taking care of the interests of their masters. (See examples in the legendary story of Sindbad the Sailor and other sources in G. Hourani, 1951, 112 ff.).

It is noteworthy that the captains and the members of the crews of the Mediterranean and the Gulf-Indian going merchant vessels enjoyed the same privileges and had almost the same duties. A comparison between the relevant passages of the Rhodian Sea Law and the maritime customary law which has been practiced off the Arabian coasts from the pre-Islamic times until the present day reveals the obvious resemblance (Ashburner, xcii;, R.B. Serjeant, 1966). The great navigator of the Indian Ocean, Ibn Mājid, offers us moreover a code of ethics, the *siyāsāt,* correctly labelled by G. R. Tibbets, "the nautical etiquette" (Tibbets, 1971, 3): "We members of the fraternity of pilots are enslaved by our duties being ordered never to leave our ships, even at the very end. Thus we go aboard our ships and stay bound to them for ever, as long as they remain safe we are safe and when they perish we die with them."

Vassilios Christides
University of Ioannina

ILLUSTRATIONS

1. Egyptian ship on a Coptic textile (4th c. A.D.). Primitive axial stern rudder.
2. A qatar shipwright uses an adz to strengthen ribs. (M. Kaplan, 1974, photo on page 346).
3. Sewn boat. (T. Severin, 1982, photo on p. 10).
4. Jalīb, vessel of the Red Sea. Courtesy photo of Kuwait Museum.
5. Men loaded along with camels in a Moslem manuscript. (S. Maher, no. 59).
6. Three masted Indian Ocean-going ship. Wall painting in cave, 6th century A.D. *In situ* in Ajanta, India. (Nicolle, 1989, fig. 34).
7. Three masted Indian Ocean-going ship. *In situ,* Siraf. (Nicolle, fig. 10).
8. The famous Indian Ocean-going vessel depicted in Ḥarīrī's MS. A.D. 1237. (Bibliothèque Nationale, MS arabe 5487, Paris).
9. Nicolle's simplified version of Ḥarīrī's vessel. (Fig. 24a).
10. Ottoman vessel with "crow nest". *Diwan Najati.* (Nat. Lib., Ms. Turk. 18, Cairo). (Nicolle, fig. 56).
11. Kadirga ship with "crow nest". (L. Basch, 1989, p.33).

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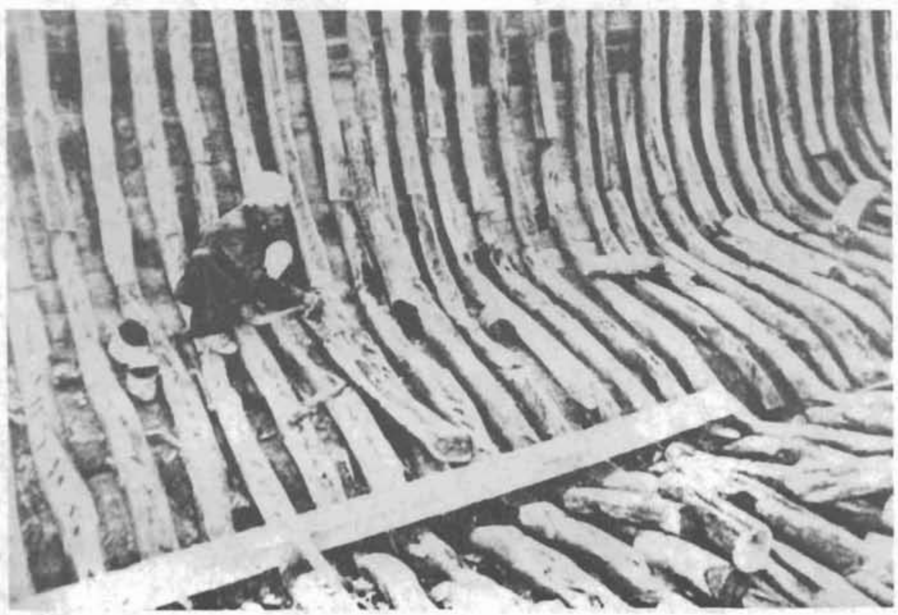

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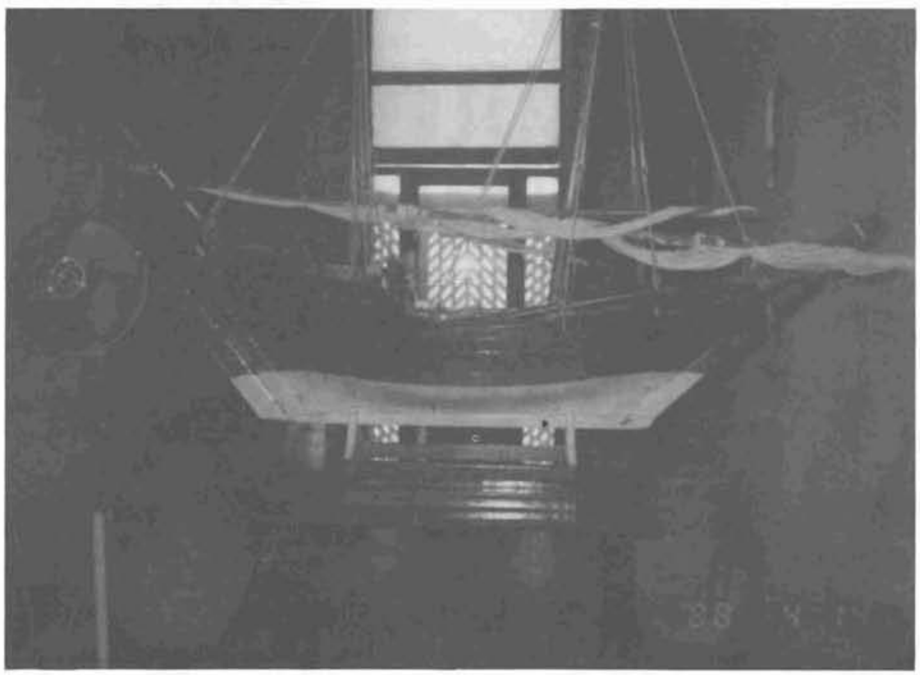

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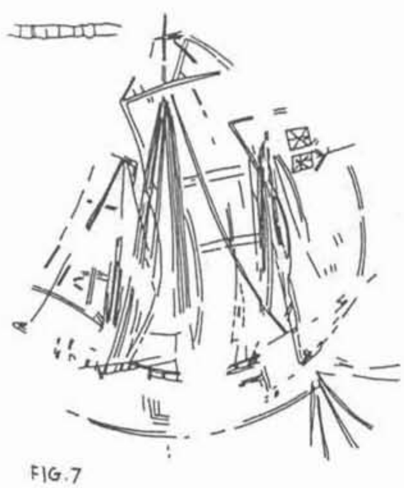

FIG.7

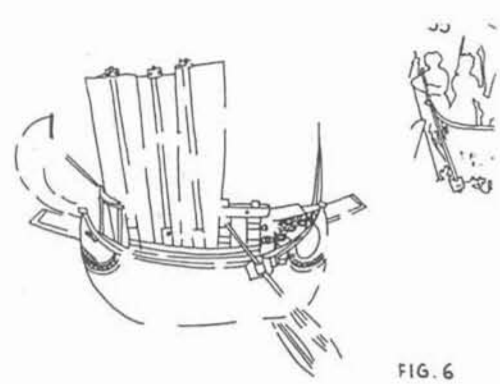

FIG. 6

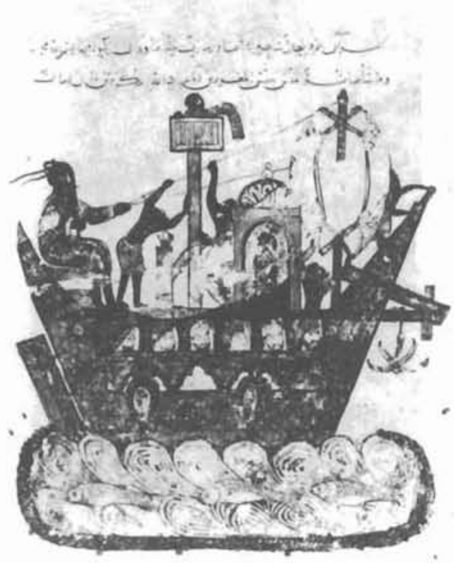

FIG. 8

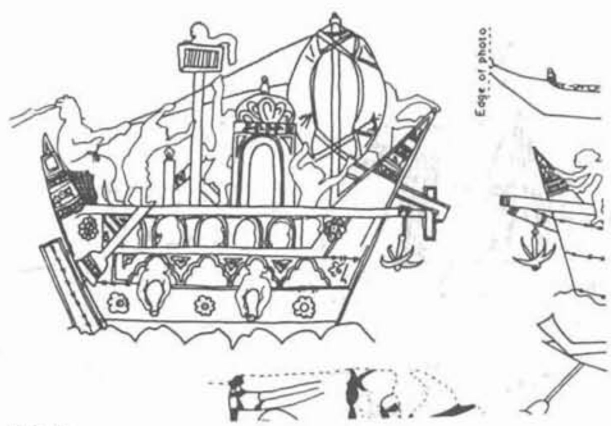

FIG. 9

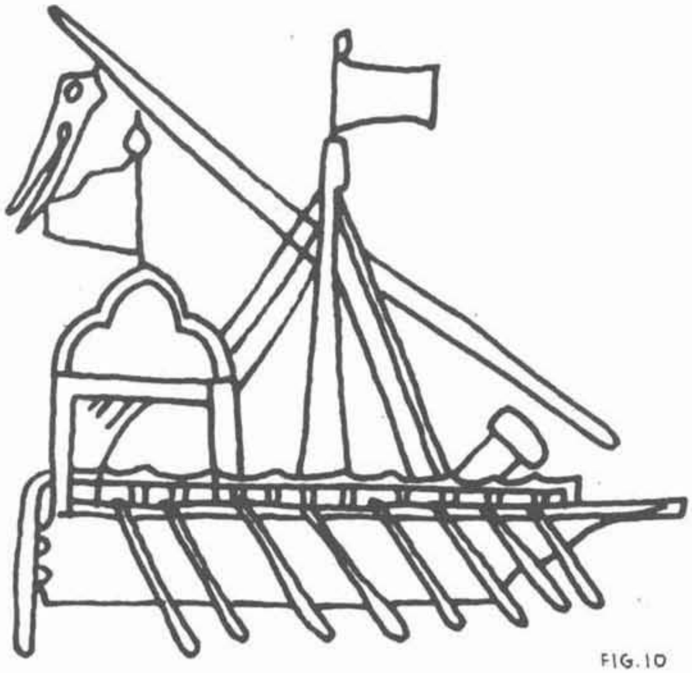

FIG. 10

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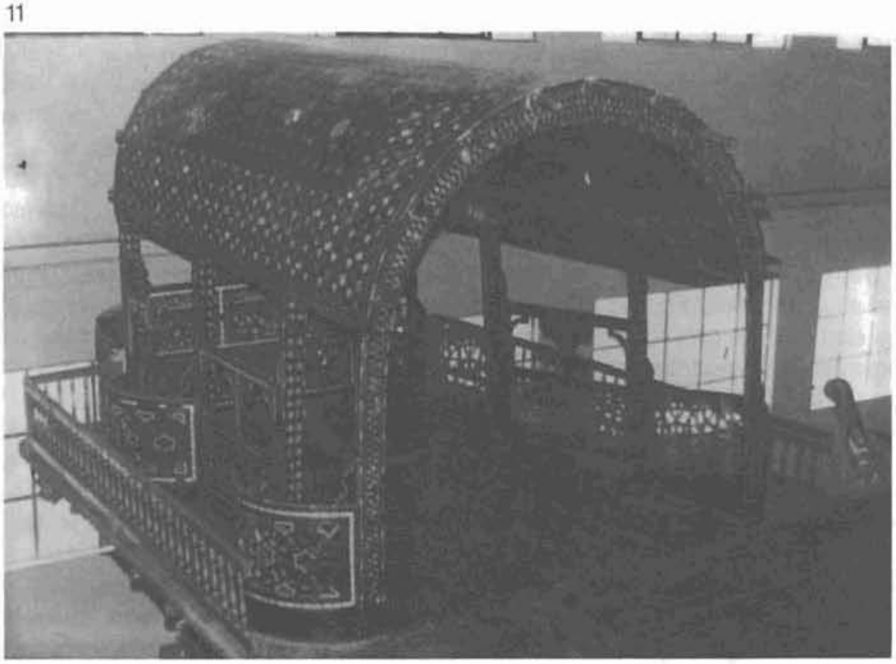

ΚΙΒΩΤΟΣ: UNE APPROCHE

L'idée de l'arche dans la mythologie hellénique

A travers les siècles, les hommes, traversaient la mer qui separait la terre avec leur bateaux. Mais que se passait-il lorsque la terre se transformait en mer d'un moment à l'autre et que les eaux couvraient totalement la surface terrestre?

L'histoire du déluge a laissé, dans la tradition mythique des peuples de la Méditerranée orientale, suffisamment de traces pour exciter la curiosité et l'imagination des chercheurs.

Le récit sumérien, qui est le plus ancien, a été transcrit en grec par Bérose (Βηρωσός) de Babylone, un historien de la première moitié du troisième siècle avant J.C.; le texte, ayant subi divers avatars, fut integré (en état fragmentaire) dans la Chronique d'Eusèbe[1] disponible aujourd'hui grâce à une traduction arménienne et à une version en grec écrite par Georges le Syncelle (fin du 8e - début du 9e siècle ap. J.C.).

Dans ce récit sumérien hellénisé, le héros Ziusuddra — qui s'apelle en grec Xisouthros (Ξίσουθρος) — fait un rêve dans lequel Cronos, lui apparaît pour lui révéler le grand cataclysme qui aura lieu et lui indiquer les moyens d'y échapper. Le dieu lui ordonne d'enterrer les écritures qui relatent l'histoire du monde près de la ville de Sippar et de construire ensuite un vaisseau, d'y mettre des vivres et de quoi boire, d'y entrer avec les siens et avec les oiseaux et les animaux à quatre pattes, puis de mettre à la voile et, si on lui demande dans quelle direction il navigue, de réponde "vers les dieux". L'inondation terminèe, Xisouthros laisse quelques oiseaux sortir, puis, il ménage une ouverture dans la paroi du bateau (τῶν τοῦ πλοίου ραφῶν διελών μέρος τι) et comprend ainsi que le vaisseaux est posé sur une montagne. Il sort, baise la terre, dresse un autel, sacrifie aux dieux, et, tout d'un coup, disparaît. Lorsque ses compagnons le cherchent, une voix leur annonce qu'il habite maintenant parmi les dieux avec sa femme, sa fille et le gouverneur du bateau. Ainsi, le thème d'une immortalisation entrevue à travers les eaux diluviales et obtenue grace à l'arche est dejà annoncé. Les mots grecs qui, dans le récit de Bérose, désignent l'arche sont "σκάφος" (vaisseau) (14), "πλοῖον" (bateau) (15), "ναῦς" (navire) (15 et λάρναξ (caisse, coffre, se dernier étant donné par F. Josephe[2].

Les mot πλοῖον et ναῦς sont employés invariablement le mot σκάφος étant préfére lorsqu'il s'agit de la constrution du vaisseau. Ce σκάφος construit par Xisouthros était environ de (2770 m) deux mille sept cent soixante dix metres de long sur (370) trois cent soixante dix de large ou, selon d'autres sources, de (925) neuf cent vignt cinq mètres de long sur (370) trois cent soixante dix de large[3]. Ces chiffres sont, bien entendu, fictifs; on retient cependant cet aspect d'un vaisseau très long qui évoque precisément la forme d'une λάρναξ, c'est a dire d'un coffre (en bois) plus long que large. Ces dimensions invraisemblables sont probablement justifiées par une capacité hors du commun suceptible de loger un grand nombre d'animaux.

C'est d'une façon, semblable que les choses se passent dans la version babylonienne. Les dieux de Shuruppak décident de détruire la terre par un déluge. Le dieu Ea apparaissant derrière le toit de paille de la maison d'Utnapishtim (ou, selon une autre version, d'Atrakhasis), lui annonce la catastrophe et lui conseille de démolir sa maison et de construire à la place un navire. Ce navire était bâti avec une veritable coque, il disposait d'une carene et il contenait une sorte de maison en forme de cube; il y avait sept étages et chaque étage comportait neuf parties séparées entre elles.

D'après les estimations de G. Contenau[4] ses dimensions etaient à peu près cent cinquante six (156) m de long sur soixante deux virgule cinq (62,5) de large et (62,5) de haut. Marie Delourt constate avec justesse que le rapport entre ses trois dimensions (2,5 sur 1 sur 1) est à peu près celui qu'on trouve dans les sarcophages.

Quoi qu'il en soit, Utnapishtim finit le bateau, enduit l'intérieur de goudron (poix) et l'extérieur de bitume et, au moment du déluge, il y entre avec sa femme, sa famille, ses proches prend, ègalement, des sémences de tout ce qui vit et ferme la porte. Ils sont sauvés et obtiennent, lui et sa femme, l'éternel séjour auprès des dieux.

Dans la Génèse, c'est, on le sait bien, Noë qui a trouvé grâce devant Dieu. Jahvé lui donne des directives précises quant à la construction de l'arche:

"Fais toi une arche en bois résineux (tu la feras en roseaux et) tu l'enduiras de bitume en dedans et en dehors. Voici comment tu la feras: trois cent coudées pur la longeur de l'arche, cinquante coudées pour sa largeur, trente coudées pour sa hauteur. Tu feras à l'arche un toit par-dessus, tu placeras l'entrée de l'arche sur le coté et tu feras, un premier, un second et un troisième étage". Ces dimensions donnent en metres environ cent cinquante metres de long sur vingtcinq de large et quinze de haut.

Telle est la κιβωτός decrite dans la Génèse, l'arche que le dieu en personne a concue pour sauver la race humaine en fermant lui même la porte de l'arche sur Noé. Le terme qui la désigne est le mot têbá qui caracterise également la caisse de joncs enduite de bitume où la mère de Moise dépose son enfant. On se souviendra de cette analogie en parlant de Danaé. Pour le moment rappelons seulement que dans ces trois récits du Proche-Orient on constate des similitudes caractéristiques. Il est probable que les peuples sémitiques, lors de leur installation dans la plaine d'Euphrate, se sont familiarisés avec la version sumérienne du déluge qui est la plus ancienne. Car l'histoire du déluge est probablement antérieure au troisième millénaire avant J.C.

Il faut souligner que dans la version sumérienne de Bérose il y a un souci pour la continuité de la culture humaine puisque des documents écrits sont enterrés près de la ville de Sippar pour être protegés des eaux diluviennes.

Ziusuddra, Utnapisttim-Atrakhasis et Noé sont, tous les trois, les survivants élus d'une cataclysme qui marque la fin d'une époque et le début d'une nouvelle époque. Pour tous les trois le salut est obtenu gràce à une désignation céleste qui aboutit, à l'exception de Noé, à une divinisation individuelle. Pour tous les trois la survivance et, donc, la nouvelle succession de genres humains, s'acquiert au moyen de l'arche et cette arche, telle qu'on l'a decrite, est toujours suggerée conçue et protegée par un dieu, le même qui inflige le déluge à la terre.

Le sujet de l'action change lorsqu'on aborde les récits helleniques sur la déluge. D'après Apollodore qui donne la version la plus complète (Bibl. 1,7, 1-2), Zeus est décidé à detruire les hommes de l'âge du bronze. Prométhée conseille alors à son fils Deucalion, roi de Phthie, de se construire un coffre (λάρναξ) et de s'y embarquer avec Pyrrha, sa femme, la fille d'Epiméthée et de Pandora. Le déluge éclate. Il dure neuf jours et neuf nuits — tandisque, dans les récits du Proche-Orient, c'est le chiffre sept qui prédomine — et puisque l'idée du déluge correspond à un voeu de régéneration, à une deuxième naissance qui résulte, en quelque sorte, de l'arche, le chiffre neuf qui marque la durée du voyage de l'arche prend, peut-être, une valeur plus significative encore. Deucalion et Pyrrha débarquent sur le Parnasse et sacrifient à Zeus Phyxios. Zeus leur envoie Hermès et leur promet d'exaucer leur désir. Deucalion souhaite voir des hommes autour de lui et Zeus conseille aux deux survivants de jeter derrière eux des pierres qui deviendront des hommes. Des pierres jetées par Deucalion naissent les hommes, de celles jetées par Pyrrha naissent les femmes. C'est la génération née des pierres d'après l'explication parétymologique due à la ressemblance des mot λαας-pierre et λαός-peuple.

Deucalion et Pyrrha ont eu des enfants en dehors de cette génération (Hellen, Amphictyon, Protogéneia, une généalogie qui tente d'expliquer l'origine des peuplades helléniques).

La première chose qu'il faut retenir dans cette histoire est le fait que Deucalion n'agit pas d'après les ordres de Zeus mais d'après l'intitiative humaine. La larnax est construite grâce au conseil de son père Prométhée ou, selon Ovide, grâce à une idée qu'il a eu lui même (Met. I 318).

Un autre détail qui mérite une mention particulière est le problème de la postérité de Deucalion. Si Deucalion et Pyrrha souhaitaient avoir des enfants pourquoi, au lieu de lancer des pierres, n'ont-ils pas pensé à la mthode repandue et agréable que les gens adoptent habituellement? on a supposé (M. Delcourt, Oedipe) que, dans les traditions primitives, Deucalion faisait seul l'épreuve de la traversée dans l'arche. Il faut, d'après cette analyse, tenir sèrieusement compte du récit d'Ovide (Héroines XVI, 166-170) selon lequel Deucalion a plongé dans la mer près des Roches Blanches de Leucade pour se libérer de son amour pour Pyrrha qui y restait indifférente. L'anagramme Deucalion-Leucarion, evoqué souvent à propos du nom du héros, indique peut-être, qu'il y avait au début, deux personnages différents, Leucarion qui était le héros d'un plongeon cathartique de Leucade et Deucalion qui était le rescapé d'une larnax.

On a encore pensé[5] que Pyrrha, la "Rousse" est, comme son nom l'indique, une femme soumise à l'epreuve du feu, comme Deucalion est un homme soumis à l'épreuve de l'eau, est que c'est par cette équivalence qu'elle trouve sa place à son côté.

Pyrrha est, en effet, la fille d'Epiméthée (frère de Prométhée) et de Pandora (la première femme "fabriquée" par les dieux). Son histoire est inséparablement liée à celle de Deucalion tandis que le nom Pyrrha désigne plusieurs personnages féminins en restant, toutefois, toujours lié, d'une façon on d'une autre, à la couleur rouge du feu.

Or, Pyrrha s'embarque dans l'arche de Deucalion comme son épouse mais, en réalité, comme le substitut du feu.

Car la λάρναξ de bois, l'arche flottante de Deucalion, issue de l'ingénuosité de Prométhée, à savoir de l'esprit créateur humain par excellence, sauve et transporte non pas les animaux, non pas les sémences de tout être vivant mais le feu, le même feu que Prométhée avait offert aux hommes caché également dans un receptacle de bois, le feu qui est de nouveau sauvegradé en dépit des eaux diluviennes et en faveur de l'humanité.

Est-ce que les mythes qui parlent de l'arche à laquelle ils attribuent la forme d'un coffre, d'une caisse rectangulaire, d'une larnax, tout en lui octroyant la fonction d'un vrai navire, reposent sur une réalité quelconque? En prenant les distances nécessaires la réponse doit être affirmative. D'après Cecil Torr[6] "le principe sur lequel repose la navigation n'est pas la légéreté du bois mais la légereté de quelque objet creux où l'eau n'entre pas et le véritable progrès commence avec le μονόξυλον (canot, pirogue) quand le marin creusa le tronc d'un arbre et s'assit dedans au lieu de l'enfourcher ou avec la λάρναξ, quand il assembla des morceaux de bois pour former une sorte de coffre".

En dehors de ces estimations, des allusions discrètes mais claires sont proposées par les mythes eux mêmes et ces allusions sont, cette fois, soutenues par des renseignements sur certaines partiques sociales.

Selon les récits mythiques, Thoas fut sauvé par sa fille Hypsipylé au moment du massacre des hommes par les femmes lemniennes. Pour qu'il puisse partir, cet unique survivant mâle a été mis dans une λάρναξ creuse. Thoas était le fils de Dionysos et le frère de Staphylos qui a enformé sa fille Rhoio enceinte (par Apollon) d'Annios dans un coffre et l'a livrée aux flots. Cette affinité aisni que la suite du destin réservé à Thoas (arrivée à l'île d'Fenoé — la Vineuse, union avec la nymphe du lieu, de laquelle naît un fils, Sikinos, qui donnera par la suite son nom à l'île) et d'autres détails encore, situent l'histoire de Thoas dans le contecte du culte de Dionysos qui est souvent representé lui même dans un bateau et qui, d'après Pausanias (III, 24,3) avait subi, enfant, le même épreuve: Cadmos avait enfermé Sémélé dans un coffre avec l'enfant qu'elle venait de mettre au monde. Quand le coffre est arrivé par mer à Prasiae Sémélé était morte et sa soeur Inô a élevé le petit Dionysos dans une grotte.

Par ailleurs, Tennès le fils de Cycnos, ayant repoussé la passion coupalbe de sa belle-mère s'est retrouvé traîtreusement accusé par elle même. Cycnos l'a enfermé dans un coffre avec sa soeur Hémithéa et les a jetés à la mer. Le bateau-coffre a abordé à l'île de Leucophrys que Tennès a nommé, d'après son nom, Ténédos.

En outre, Télèphe, le fils d'Heraclès et d'Augé a été également enfermé par son grand-père Aléos, le roi de Tegée, dans un coffre flottant en compagnie de sa mère. Le coffre a navigué jusqu'à la côte mysienne avec, encore une fois, son equipage intact.

Mais la larnax flottante qui a été surtout illustrée dans la peinture des vases grecs est celle qui a transporté, à travers la mer Egée, Persée et Danaé.

Acrisios, le roi d'Argos, craignant l'oracle qui lui avait annoncé la mort par le main de son petit-fils, a enfermé Danaé, sa fille unique, dans un prison souterraine. Lorsque la semence de Zeus transformée en pluie d'or a penetré la cellule de la fille pour mettre au jour Persée, Acrisios a enfermé la mère et l'enfant dans une larnax et les a jetés à la mer. Les flots ont poussé l'arche vers l'île de Sériphos où le pécheur Dictys l'a récuperée. Danaé est alors devenue la captive du tyran local Polydectès sous l'ordre de qui Persée fut envoyé plus tard pour ramener la tête de Méduse. Sa mission terminée, ayant en plus gagné Andromède, Persée refourne à Sériphos, libère sa mère et part avec elle et avec Andromède. Peu de temps après, en lancant le disque, il tue accidentellement son grand père Acrisios et verifie ainsi l'oracle qui lui avait coûté le séjour dans la κιβωτός flottante.

Thoas, Tennès et Deucalion, sont les trois personnages adultes qui ont navigué enfermés dans une larnax.

Dans cette caisse flottante, appellée tantôt larnax tantôt kivotos, il faut voir en partie l'instrument d'une ordalie telle qu'elle est refletée dans les mythes sur le déluge ainsi que dans les mythes sur le sort des êtres persécutés enfermés dans un coffre et livrés à la mer.

Glotz ("L'Ordalie") voit dans la larnax le coffre un bois qui a dû servir aux ordalies primitives et qui a subsisté dans le droite pénal romain pour le châtiment des esclaves (arca). D'après lui "jusqu'â la fin de l'histoire grecque, la mise en coffre s'est conservé dans le droit pénal de la famille et ce châtiment à effet suspensif a toujours paru comme une invite à l'intervention des dieux" (p. 27). L'aspect d'une epreuve est indubitablement présent dans toutes les récits où le héros est mis dans un coffre fermé et jeté à l'eau. Mais l'idée de l'ordalie n'est pas la seule impliquée dans cette pratique.

Il y a aussi l'aspect d'un sacrifice expiatoire soutenu par les rites de l'expulsion des φαρμακοί (émissaires) à savoir des êtres présumés coupables de la misère de la communauté; ces êtres sont expulsés et plus particulièrement précipités à l'eau, d'après le rite pratiqué dans l'île de Leucade.

Il y a encore l'aspect de la boite magique, du coffre flottant mystérieux, un thème qui est souvent détecté, dans les récits, quand au moment de l'ouverture les prisonniers sortent miraculeusement de la λάρναξ scellée. Ainsi, par cette epiphanie, la kivotos flottante devient souvent un tabernacle de divinisation ou, du moins, de sublimation.

Et enfin, il y a, bienentendu, l'idée de l'exposition des enfants, ce qui est, en fait, beaucoup plus qui une idée. C'est une pratique fléquemment attestée en dépit des efforts faits pendant l'époque classique d'en diminuer la gravité. Une maternité indésirable, un héritier imprévu, une naissance illégitime, un enfant difforme, un bouche à nourrir supplementaire posent souvent des problèmes, résolus, les cas échéant, de cette manière qui, malgré sa cruauté, présente l'avantage de ne pas souiller les mains du sang de la victime puisque la mort arrive — quand elle arrive — par des causes naturelles. C'est pourquoi, mettre un enfant dans un barque et le livrer à la mer c'ect, en quelque sorte, le livrer à la mort ou, disons-le d'une autre façon, le confier aux puissances de l'au-delà. Si ces puissances s'avèrent bienveillantes, l'enfant est sauvè. Mais la mer a par elle même une valeur mortuaire. Tout voyage maritime est un peu, dans la conscience des gens, un voyage dans l'au-delà. Tel est le cas du voyage des Argonautes, tel est les sens du bateau de Charon, telle est la signification des îles des Bienheureux, situées au milieu de la mer. Et c'est justement de sa ressemblance au cercueil que la larnax obtient sa signification à la fois de moyen d'ordalie, de sarcophage, de navire et de ruse de survie.

Dans un sens plus général, l'idée de l'arche en Grèce est plus directement liée à l'épreuve et beaucoup moins au salut du danger représenté par l'eau. Chez les Hellènes, la surface de la mer est chargée d'une autre signification: elle n'est pas tout simplement le résultat ou l'origine d'une catastrophe mais elle constitue plutôt une provocation adressée à l'homme. Or, la conception d'un bateau comme l'arche qui condense en elle des éléments d'une caisse, des éléments d'un bateau destiné au transport, des éléments d'un coffre où sont placés les enfants exposés pour être livrés aux flots, un coffre qui est à la fois cercueil et instrument de sauvetage, de survie, de naissance, me paraît une conception très importante parce qu'elle donne, par une seule image, tout l'éventail sémantique de la mer à savoir un espace d'intelligence, un passage, un concours, et même un pretexte d'errance.

Menelaos Chistopoulos
Centre de Recherches de l'Academie d'Athènes

NOTES

1. La version de Bérose serait parvenue á Eusébe à travers Apollodore, Alexandre Polyhistor et Jules l' Africain.
2. A.J. I 93 = Eusebe P.E. 9,11.
3. 15 stades de long sur 2 de large ou 5 stades de long sur 2 de large.

4. G. Contenau, *"Le déluge babylonien"*, Paris, 1941.
   M. Delcourt, *"Oedipe ou la légende du conquérant"*, Liège-Paris, 1944.
5. Glotz, *"L' Ordalie en Grèce primitive", N. York, 1979² (Paris, 1904).*
6. sv navis (Daremberg-Saglio).
7. Sur ce point il faut, peut-être, évoquer la boite de Pandora, mère de Pyrrha; le contenu du coffre comme celui de l' arhce, est lié au sort de l' hummanité.

ILLUSTRATION

1a L' arche de Noé
Le titre exacte est "L' arche de Noé et la colombe" et l' oeuvre se trouve à la Bibliothecque Royale de Gravenhage de la Haye. En dépit de l' anachronisme artistique on remarque le souci de l' artiste de repreésenter l' univers clos de l' arche.

1b Sarcophage chretien de Trèves représentant l' arche de Noé concue, on le voit, complètement comme une caisse. Le mot κιβωτός est pris à la lettre. On voit Noé et se femme, leurs trois fils avec leur femmes également et les animaux; il y a même le corbeau et la colombe avec le rameau d' olivier.

2a D' après un simulacre de bateau (bronze), une trouvaille d' Etrurie (Vetulonia). Ici l' arche est presentée comme un vrai navire. Les hommes ne sont pas presentés; il n' y a que des animaux, ordonnés par couples sur le bord des murailles et pas sur le pont.
On ne voit ni des pièces ni des étages.

2b Les rescapés de l'arche. Deucalion et Pyrrha.
Sarcophage romain. (±270 ap. J.C). Rome, Museo Capitolino, 329.

3 Monnaie de la ville Apamée (Απάμεια) de Phrygie qui depuis Auguste portait le surnom Κιβωτός (arche). Il s' agit d' une monnaie de 3e siècle frappée sous (Macrin et) Philippe (verso: ΑΥΤΟΚΡΑΤΩΡ ΚΑΙΣΑ ΙΟΥΛΙΟΣ ΦΙΛΙΠΠΟΣ ΑΥΓΟΥΣΤΟΣ et le tête de Philippe).
L' inscription gravée est ΕΠΙ Μάρκου ΑΥΡΗΛΙΟΥ ΑΛΕΞΑΝΔΡΟΥ Β ΑΡΧΙΕΡΕΩΣ ΑΠΑΜΕΩΝ.
On voit à gauche Noé et sa femme dejà sortis et à droite les mêmes, cette fois dans l' arche flottante (on voit les flots en bas) et la colombe sur le couvercle levé. Le nom de Noé est gravé sur l' arche qui vogue mais certains chercheurs (Usener, "Die Sintfluthsagen", Bonn, 1899, Delcourt - "Oedipe") éstiment qu' il y a une influence du mythe de Deucalion et de Pyrrha sur la repreésentation de l' arche de la monnaie d' Apamée.

4 C' est une monnaie de la ville d' Elaia, le port de Pergamos frappée à l' époque de Marc-Aurèle. Elle représente Augé, le mère de Télèphe, sortir de la λάρναξ que les pecheurs ont recuperée. On voit en bas le filet dans lequel la larnax a étré prise et, à gauche, la poupe d' une barque.

5 Le thème de Danaé e été souvent illustré dans l' iconographie surtout après les repreésentations des tragédies et des drames satyriques d' Echyle (Phorcides, Polydectès - Dictyoulkoi), de Sophocle et d' Euripide ainsi que des comédies de Sannyrion et d' Apollophane - oeuvres qui datent presque toutes du 5e siècle. Les peintures des vases sont, par consquent, influencées par les représentations scéniques. On voit ici une hydrie attique à figures rouges du peintre de Gallatin (vers 490 av. J.C.) qui se trouve à Boston (Museum of Fine Arts, 13200). A gauche Acrisios, vetu d' himation, s' appuie de sa main gauche à son sceptre. Il lève la main droite vers un groupe de personnages: on voit le ménuisier qui s' occupe de la fermeture de la larnax en travaillant au trépan, au milieu Danaé avec un geste de protestation et à droite la nourrice portant le petit Persée. C' est la scena juste avant la mise au coffre.

6 Hydrie attique à figurtes rouges, Boston, Museum of Fine Arts 03.792. Vers 440-430 avant J.C.
On voit à gauche Akrisios barbu et couronné, relativement jeune vetu d' un himation, la main drate levée, lamain gauche te ant un bâton noueux. Il semble regarder à l' intérieur du coffre dans lequel se trouve dejà Danaé avec le petit Persée. Devant le roi il y a deux femmes probablement une servante et une parente de Danaé (on a pensé à une soeur plus jeune).

7 Lecythe attique f.r. Providence, Phode Island
School of Design 25084
Vers 460 avant J.C.
Danaé vetue d' un himation, avec un bandeau sur les cheveux est assise dans la λάρναξ flottante en compagnie de Persée. Les oiseaux qui volent autour d' eux situent la scene en pleine mer. C' est la seule représentation de Danaé dans le coffre qui vogue sur les flots et il est interessant de rappeler que, dans un poème de Simonide, les lamentations de Danaé qui navigue dans la larnax nous font partager, apart les sentiments de tendresse qu' elle manifeste à l' égard de Persée, la vue gu' elle a de l' interieur de l' arche sur la mer agitée. Dans ce poéme, elle parle de l' obscuité qui regne à l' interieur de l' arche, des vagues bleues qui entourrent la larnax sans faire peur au petit Persée, inconscient de son sort et du sel de la mer posé sur ses cheveux. Danaé demande que l' enfant s' endorme et que l' océan s' endorme aussi pour que le malheur qui les presse en fasse autant. 37 (50) Bergk.

1a

FIG. 1b

FIG. 2a

2b

FIG. 3

FIG. 4

FIG. 5

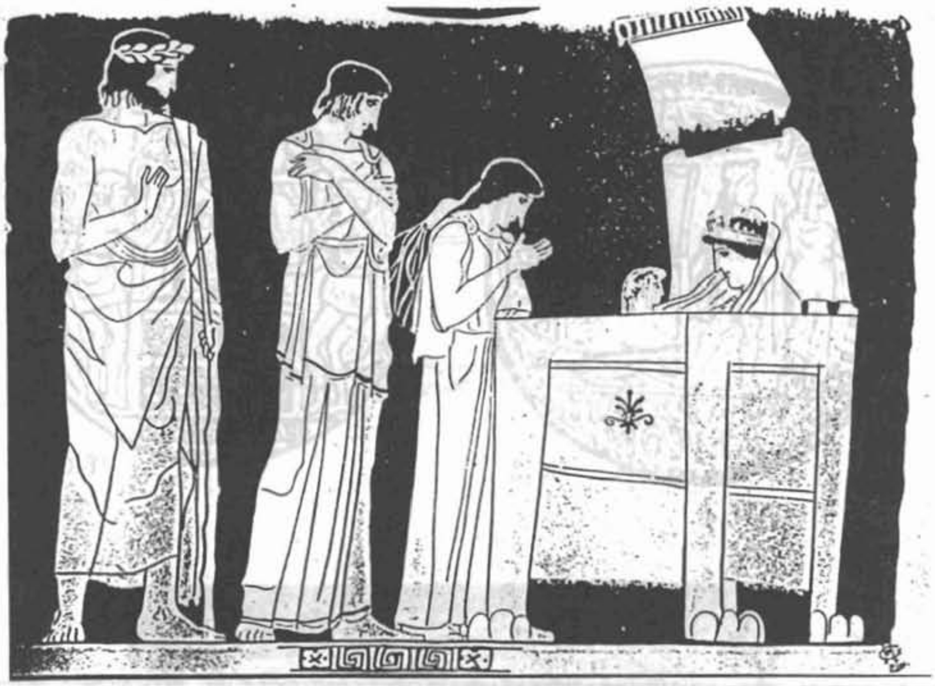

FIG. 6

FIG. 7

PENTEKONTORS AND TRIEREIS COMPARED

Having spent some time designing modern warships according to the physical possibilities of the time, and the changing needs of a naval staff, the author is well aware of the response when the cost of building a new design promises to be sharply higher than of the equivalent ship already in service. If the increase were fivefold — in present terms for frigates from the order of one hundred million Pounds Sterling to five hundred million — the resistance to accepting the new design would be, to say the least, considerable. The designer would certainly have to justify his proposal against searching enquiry of the kind which political contributions might cause to continue indefinitely, and without result. Though organisations and professions within navies may have changed down the millennia, that response to raised cost has been ever thus. Let us then look at the two-level pentekontor and the trieres in this light.

Surviving information, fragmentary and probably therefore misleading, invites us to believe that the trieres was "invented" by Ameinocles in Corinth sometime before 600 BC. Some people believe that that brilliant technical achievement took place in Phoenicia, but for the purpose of this paper it does not much matter where it may have happened. The important question is not so much Where? but How? — How did such a great and very expensive development of the ramming warship ever come to pass? The acceptability of a five fold increase in cost, and weight, per ship would be truly astonishing if it occurred in one great inspired leap from 50 to 170 oars, 24 to 36 metres in length and from 10 to 45 tonnes in weight. Such a leap would need much explanation not merely technically but also as a political reality.

Without benefit of our present knowledge of the physical world and its laws, such a development would more probably have followed a course of groping steps of trial and error, seeking a design better than the extant pentekontor in some particular ways. Even with modern knowledge the prototype would not be quite right first time. In ancient times it must be supposed that a series of many ships had to be built: some would have suffered from insufficient strength, others would have been crank and in many it is likely that the waterline was at the wrong height for oars to work properly. It is likely that the best part of a century of highly motivated development would have been needed to reach something like a trieres from a two-level pentekontor. There is evidence (Iliad Book 2, 509-10) of intermediate — sized ships: the Beoetians are credited with ships having 120 men on board.

No change in technology appears to have been involved in the development so it may be regarded as akin in that respect to that of the sailing warship between the sixteenth and nineteenth centuries AD, though in relative cost terms it was larger and it was certainly faster. What quality was being so assiduously sought almost regardless of cost?

We are thus led to look at the trieres and the two-level pentekontor to compare their probable performances and the likely naval requirements of that period.

In passing we may recall that Necho built triereis quite early in Egypt (Herodotus 2.159.1), and that they were also built in numbers at Miletus with Persian money, presumably to exercise control of the Eastern Mediterranean for the imperial expansion of Persia.

EFFECTS OF DIMENSIONAL CHANGES

When exploring the effects of changing the size of anything, physicists and engineers commonly use a technique which goes by the name of dimensional analysis. It is a broad way of seeing why, for example, the bones of elephants are so much thicker in relation to their length than those of a mouse or bird. By it one can see why birds are limited in size, and so on. We may compare ships in this way, for instance the trieres and some of her predecessors (Figure 1).

COMPARISON OF SHIPS

Figure 2 is a table of comparative figures for five types of ship. The figures may be to some extent speculative, but variation within realistically possible limits would not greatly affect the main comparisons between the columns of figures for each type of ship. It is assumed that all five types were built in much the same way with similarly shaped hull sections, though they would have varied in dimensions in different ratios, one type from another.

Keeping to a constant interscalmium distance of two Athenian cubits on the assumption that in all of these types one man pulled one oar and that the interscalmium would have been no larger than it need have been, one can find the minimum size of hull to accommodate the number of oarsmen in each type. In some cases the section of the hull has to be increased above the minimum to provide adequate stability or longitudinal strength. These calculations lead to the estimates of length, beam, draft and displacement in the table. They show the triakontor to be a large boat rather than what we would think of as a ship. The single-level pentekontor needs a depth of hull (H) greater than the triakontor, though it is also a single-level oared ship, to give sufficient bending strength. The need for that property is indicated at the bottom of the table by the magnitude of the quantity.

$$\frac{\text{Weight} \times \text{Length}}{(\text{Hull depth})^2}$$

The single-level pentekontor would therefore have had much more room in it for carrying people, gear or cargo than the triakontor, and there are references to colonies of people being carried in them to distant waters. The pentekontor may at the time have had some advantage against the majority of pirates — always a consideration in the ancient (and indeed not so ancient) Mediterranean. The single-level oared ship gained in speed, say 12%, compared with the triakontor. She was probably a little down on acceleration, and paid a heavy price in agility, in her rate of turning under oar. As this type was armed with a ram, this is a curious matter for in ships so armed, agility must surely have been valued. Was the ram the principal weapon at that time?

TURNING UNDER OARS

Rate of turning is much affected by the underwater profile of a ship. By comparing two simple profiles (Figure 3) of the same length and to which the same turning moment is applied (assuming for instance the same number of oarsmen in each vessel), a very simplified analysis indicates that Ship No. 2 turns more than one and a half times faster than Ship No. 1. The equations apply more to vertical vanes of the two shapes than to the rounded forms of ships, so that actually the difference in rate of turning will be greater. The profile of No. 2 is a close approximation to that of most Mediterranean warships. This comparison shows how important the tapered ends of the underwater profile were in ram-wielding ships, indeed it is unlikely that any ship thought to have had a profile more like No. 1 was a warship.

Length of hull impedes turning. In similar hulls the moment resisting turning increases directly with draft, with the square of angular rate of turning and with the fourth power of the length. Thus single-level pentekontors could be expected to have turned little more than half as fast as triakontors, a considerable penalty. In a ramming battle the pentekontors would probably be rammed first. On the other hand, being faster, the pentekontors could always escape from the triakontors. Was the ram in pentekontors a weapon of opportunity whose main purpose lay in reducing wavemaking at the bow by extending and so fining the waterlines there?

The two-level pentekontor is shown in the table to be a ship very well suited to wield a ram as its main weapon. The shorter hull greatly increases rate of turning: speed is up and so is acceleration. Agility has been improved all round. Cost is actually less than that of the single-level ship and longitudinal bending troubles with the hull have been disposed of. In this type of two-level ship hypozomata may have been unnecessary. In view of so many virtues it is not surprising that the two-level pentekontor was in service for several centuries extending well into the period dominated by the trieres.

The gain in speed achieved in the two-level pentekontor would have arisen from a reduction in the frictional resistance of the hull owing to its smaller wetted area compared with the longer single-level ship with the same number of oarsmen. On the other hand sprint speed would have been a little less than that advantage by itself would indicate on account of increased wavemaking at higher speeds, another quite separate effect of shortening hulls. In its time the two-level pentekontor would have been able to catch and ram any other type of vessel then extant as far as we know.

WHY WAS THE TRIERES DEVELOPED?

What stimulus arose in the Eastern Mediterranean during the seventh century BC to push this economical and balanced design of warship further? What qualities beyond those of the two-level pentekontor became so much desired? They may well have arisen from the growing prosperity in that period. Trade and therefore shipping flourished, rich pickings for pirates who could have grown prosperous enough to ply their trade in pentekontors themselves. If so, a faster type of ship would have been needed to destroy them. In support of these suggestions it seems that Necho used triereis against pirates.

If speed were the aim of the development, a natural first step would be to lengthen ships to accommodate more oarsmen on two levels. The longer hulls would probably have run into trouble with longitudinal bending and so leakage and short ship life. To remedy that, greater depth of hull would have commended itself and suggested the addition of a third, top, file of oarsmen on each side. That could have been Ameinocles' invention — and to do so with the help of an outrigger. Elsewhere, for instance in Phoenicia, others may have come to other structural solutions.

It is particularly notable that the development was taken so far in length of hull and numbers of oarsmen. Herein lies the great increase in cost. The figures in the table indicate how the improvement gained was confined to speed and numbers of men on board but in both the gain was spectacular. Length of hull, as in the single-level pentekontor, became stretched to the limit structurally and hypozomata were again clearly necessary, as indicated by the figures at the bottom of the table.

The key to the apparently high value put upon speed probably lies in the naval operators' problems of the time, and those quite likely centered on protection of trade as much as the ability to challenge a hostile fleet for the command of an area of sea. Higher sustainable speeds enable fleets to be deployed more quickly: a trieres could reach in two days a destination for which a pentekontor would need three. May be that had become a crucial advantage worth its very high cost even at the loss of some ramming agility. These are questions which historians working on this period might find rewarding to ponder.

A single trieres among a group of merchant ships would certainly have made any pirates in the area keep their distance. The trieres could take her pick of beaches for refreshing her crew, forcing the pirate to go elsewhere to his discomfort and fatigue. A trieres could tow merchant ships at about twice the speed possible for a pentekontor — fast enough to beat the Bosphorus current. There was much shipping to the Black Sea and there is evidence of trieres towing grain ships, quite possibly on the outward voyage.

Lastly, in considering the size of the step from two-level pentekontors to triereis, it is not impossible that the change proceeded at a rate at which the real increase in ship cost kept pace, in this prosperous period, with the growth of real wealth in the city-states rich enough and with sea trade enough to be interested in the emerging new type of warship. In those circumstances it would be possible for a navy to maintain the same number of hulls in service as they evolved from pentekontors to triereis on a fixed naval vote when expressed as a percentage of Gross National Product, or its ancient equivalent.

It is hoped that this paper may stimulate historians of the Eastern Mediterranean of the eighth to the sixth centuries BC to relate naval requirements in the region as they may be indicated by their studies, to the factors affecting the performance and cost of the warships of that period.

John F. Coates
Sabinal,
Lucklands road,
Bath,
Avon BA1 4AU
England

Type of ship	Triakontor	Pentekontor 1 level	Pentekontor 2 levels	Trieres Open	Trieres Covered
Length on WL, m. (L)	17.5	26	18	33	33
Breadt on WL, m.	2.2	2.2	2.3	3.5	3.8
Hull depth, m. (H)	1.0	1.2	1.6	2.4	2.4
Draft, m.	0.55	0.6	0.6	1.0	1.1
Block coefficient of hull	0.33	0.35	0.37	0.39	0.39
Weight fully loaded, tonnes (W)	7	12	9.5	45	50
Number of oarsmen	30	50	50	170	170
Number of files on each side of the ship	1	1	2	3	5
Max. continuous speed, knots	4	4.5	5.5	7.6	7.2
Speed increase type-to-type	—	12%	22%	38%	-5%
Acceleration inc. type-to-type	—	-3%	26%	-28%	-17%
Rate of turning inc. type-to-type	—	-45%	109%	-38%	-5%
Capital cost inc. type-to-type	—	75%	-20%	360%	20%
Number of soldiers on board	31	50?	5?	14	14 to 40
Number of men available to fight (ship remaining mobile)	13?	70?	30	100	100
$\frac{W \times L}{H^2}$	122	216	67	258	286
Hypozoma	?	Yes	?	Yes	Yes

Figure 2 - Table comparing ship types

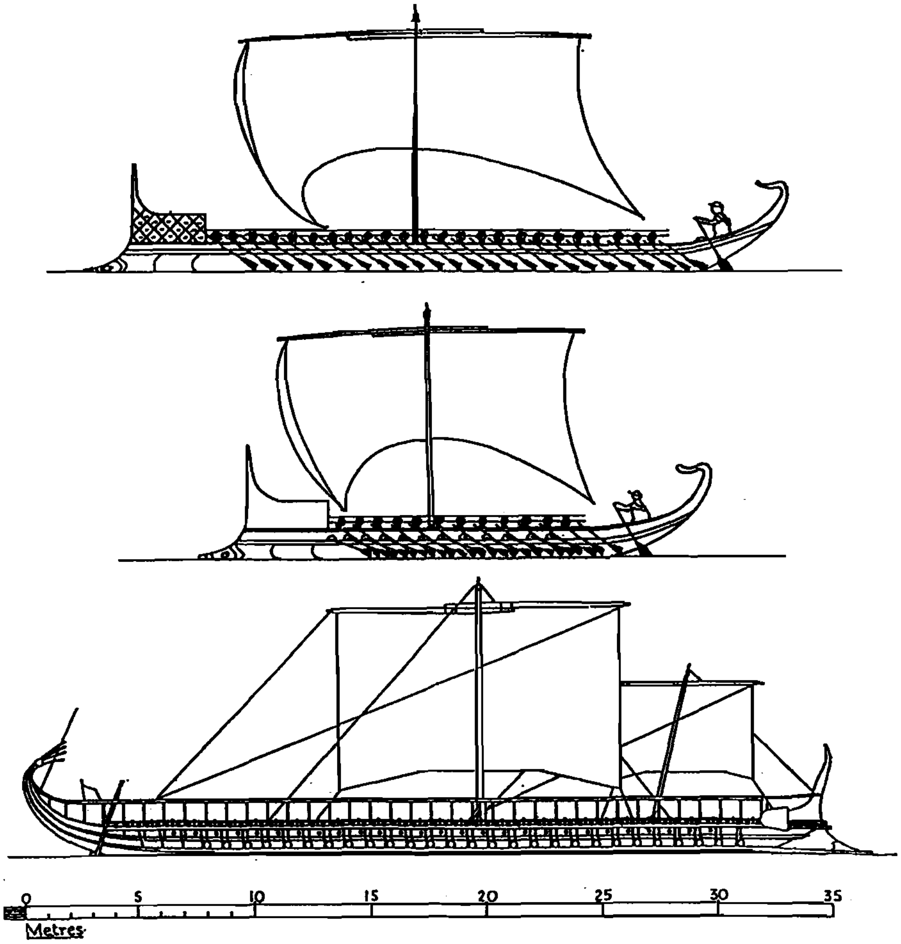

Figure 1 - Single and two level pentekontors and trieres drawn to the same scale.

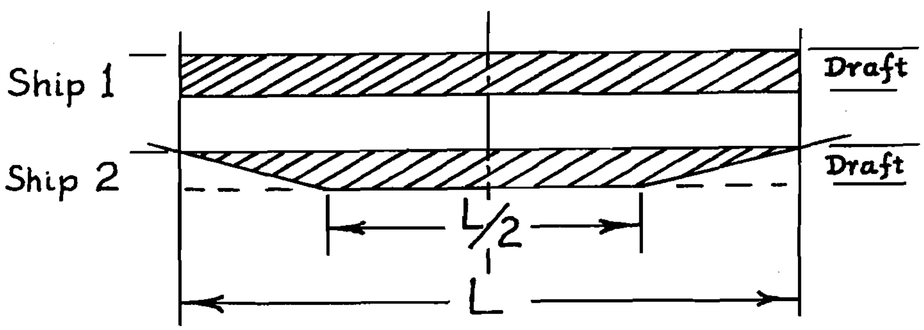

Figure 3 - Two simplified underwater profiles

WAR-SHIPS ON SHERDS OF LH III C KRATERS FROM KYNOS

Ladies and Gentlemen

Working on this paper I was astonished to find out how meagre the evidence available is as far as the real picture of Late Bronze Age ships is concerned.

When I am speaking of Late Bronze Age I have in mind mainly the correspondant period of Mainland Greece and of what we call conventionally Mycenaean period.

Though we can obtain a faint idea of how ships looked like generally during that period and we are aware from other elements that Mycenaeans were involved in maritime enterprises and that seafaring must have played an important role for the expansion of Mycenaean civilization, we still cannot say much about warships.

Until now we didn't have a secure example of a war ship and the theories expressed were all based on different indications found on different items, such as vases, seals, clay models, and often of a different period.

I was lucky enough to find recently during my excavation in Pyrgos Livanaton[1] two sherds of two big kraters of LHIIIC period upon which are preserved the picture of two war-ships.

Pyrgos Livanaton is a small hill at the seashore north-east of the modern village Livanates and is identified by many scholars with Kynos, the main port of Opountian Lokris, referred to by Homer[2]. Opountian Lokris in Central Greece opposite Euboea is the homeland of Ajax and Kynos was settled by Pyrrha and Deukalion or by Lokros and the ancient writers report that on Kynos the tomb of Pyrrha was to be seen.

The sherds were found in the debris thrown into a deposit after the destruction of a building caused by fire and they were together with ashes, animal bones, shells and a very big quantity of sherds from vases dated from LHIIIB2 until the middle of LHIIIC periods.

The excavation is still going on and it is premature to say anything about the history of the place.

It could be also regarded as premature the fact that I am presenting these two sherds before the other material of the excavation is studied. But I have an excuses, I think. Having in hand such an evidence as these two ships which are unique until now to my knowledge I thought and I know that it would be useful for other scientists specialized in ancient shipbuilding to be aware of these new examples.

That the ships are war ships is obvious not only because of their general characteristics but also because upon them warriors in full action are represented.

On the first sherd is preserved the right part of a ship with shallow hull[3] (Photo 1).

The ship and the fighting warriors on it are not executed very skillfully but still many characteristics are exact though others aren't.

The question is what part of the ship is pictured? The prow or the stern? The absence of steering oar at this part of the ship speaks for the prow, which is raised well above the gunwale and the deck and at the end turns inward forming a horn with a small bulbous end[4].

This feature, the high curving stem and the presence of a horn at either prow or stern or both, was thought as non existing on Mycenaean ships or that their presence was doubtful[5]. However some ships of LHIII show equally high stem and stern. Some other examples show one end higher than the other and the determination of this higher end as prow or stern it was an object of controversies among the scholars[6].

From other examples of the same period namely that of Skyros[7] and Asine[8] we have the proof that prow could be higher than the stern and to my opinion at the Asine example an attempt to shape the prow like horn is to be seen[9]. Many scholars agree that the ships of geometric period have many characteristics inherited by the Late bronze Age and Sub-mycenaean ones, in other words they see a continuous development of the form from late Bronze Age ships to the geometric ones[10]. Since, then, the high horn shaped prows of the last ones is a standard feature fully developed why can't we suspect that such a prow existed already during the Late Bronze Age? I think that now with the help of Kynos example and taking into consideration as an intermediate example the ships on the protogeometric krater from Knossos[11], we are permitted to support that horn shaped prows existed on Late Bronze Age ships, and they were developped through the Early Iron Age into the form pictured by the geometric artists.

Could, otherwise, this part of the Kynos ship be the stern? We know that many LHIII ships have equal high stem and stern, and the Protogeometric ship from Knossos mentioned above shows that horn shaped could be both stern and prow. The other features of the Kynos ship don't help to decide. The structure near the prow or stern could belong to foredeck as well as to afterdeck[12]. It could be a deck-house for the helmsman[13] or a platform[14] or a seat[15] or a ladder to a cabin under the deck[16]. The man upon this structure, with his dramatic posture shows that he can't be the helmsman.

The scene which is depicted on the deck is very provoking so that one can bring in mind the description of the capture of the ship of Ajax by Hector in Ilias[17] and interpret the horn shaped prow as a stern. But scientist must have more secure proofs to speak for one or another solution.

So I think that this is the prow. And the reason why, is given by a detail on it. The fringes along the inside face of the horn. The same fringes can be seen on the inner face of the prow of the second ship (Photo 2). And same fringes decorate the shields the helmets and the border of the clothes of the warriors.

It is known that helmets of this period were made of hide either of goat, ox, hedgehog[18]. Also shields were made mainly of leather with the hair on the outer face of them[19]. Warriors used to wear a chiton of leather, a jerkin with fringed border[20]. Some examples of these items in the mycenaean painting are rendered in the same way fringed. Also the hair of animals is usually pictured in the same way[21].

After that do you find it non logical to interpret these fringes on the prows as covers of leather?

Leather should be to my opinion, an important material for the shipbuilders of prehistoric periods because first of all is water proof. It is otherwise accepted by many scholars that leathers were used on different parts of ancient ships[22]. Was then this custom of using animals' skins to cover the prow which is always the very first part of a ship that comes into the water and takes in all weathers the first schok of the waves, that was transformed to the prows decorated with animals' characteristics?

The ship on the other sherd (Photo 2) is better preserved and many of her features are already known from other examples of the same period. She is both oar and sail propulsed. She has a mast fastened at the botton of the hull. Ring at the top of the mast to suspend the forestay and two brails.

It is remarkable that the backstay is not pictured. Platforms or seats or compartments with a bulwark at both after and fore deck can be found on others examples too[23]. Steering oars are to be seen often and even with a tiller like Kynos example[24].

What new then offers this recent find?

First the helmsman, a person that to my knowledge is for the first time appearing in the Mycenaean iconography. Then come the oarsmen again for the first time pictured. Where are they? They are sitting immediately above the gunwale facing the prow[25]. That these are oarsmen is concluded from their position which is the same as this of the helmsman and from the fact that the number of the lines under the keel, which are obviously oars, correspond exactly to the oarsmen. The ship has 19 oars at each side and the number is not very usual but still existing[26]. Where are the heads of the oarmen? Not cut of course but hidden behind a zone filled with antithetic semicircles, which runs along the side of the ship. This zone that lies under the deck perhaps can be interpreted as a screen for the protection of the oarsmen. What are these semicircles? Decoration, smaller leather screens or bags[27] or shields[28]. Shields slung along a rail above the gunwale can be seen an a fibula from Boeotia of geometric period and earlier on the well known reliefs from the palace of Sennacherib[29].

One astonishing feature of this second ship is the total absence of a ram. The stem seems to be angular like the stems of the claymodels from Athens[30] and Keos[31] which also are of LHIIIC period. The small protrusion seen in the middle of the stem can't be a ram but perhaps a zoster or a belt[32] or an horizontal plank which reinforced the sides, the deck and the cabins of the ship[33].

The sherd unfortunately is broken at the point where the end of the prow and of the stern were. It is however sure and can be seen that both were high enough above the deck[34]. The prow seems to be a little thicker and more resistant than the stern a device that characterises a high level of knowledge of seafaring at that period and it was thought as a geometric development[35].

But though we can't say anything about the end of the stern we can be sure how the prow looked like. A sherd from the same krater preserves the end of the prow of another ship which had an opposite direction (Photo 3). So the prow was crowned by a bird's head whose beak turns upwards like a horn. If this is a bird's head or a monster or a hippocambus cannot be decided but since the existence of bird shaped prows in the Aegean tradition as early as Early Minoan period[36] and through the whole Bronze Age[37] is testified, it is likely to describe this prow as bird shaped[38].

I think that you agree that much time would be needed to discuss every detail of these ships and the problems arosen by them are worth for deeper and more detailed elaboration.

For the moment and assuming the evidence given by these new sherds we can be guided to the following conclusions.

First that there existed war-ships in Late Bronze Age with distinguishable characteristics and function.

Second the presence of the oarsmen and above them the warriors engaged with military actions or fighting on the first sherd presuposes the existence of a kind of deck, which means that war-ships of Mycenaean period were not totally undecked.

Third the absence of the ram, means that actually war ships of Mycenaean period did not have rams and consequently they did not know the function of the ram for the naval battle.

When projections like rams are to be seen on other examples, there is nothing but an extension of the keel and it has to do with ship building techniques and it was not a normal equipment of war ships having nothing to do with the tactic of naval battle at that time.

Fourth Naval battles took place in Mycenaean period and this is prooved by the presence of the opposite ship on the krater of Kynos upon which warriors in attacking position are pictured. That the ships were in battle situation is also prooved by the fact that helmsman and the oarsmen are at their place and the sail is taken down[25].

Fifth the war-ships had high prows and sterns, hornshaped, a feature that until now was thought as characteristic of geometric ships only and the description of Homer of ορθοκραι-ράων νεων or κορωνίσι νηυσί was believed as suiting to the ships of geometric period.

Now that we have the evidence that horn shaped prows existed already in the 12th century and the war-ships of this period didn't have rams, Homer sounds trustworthy describing ships of the Achaeans and not of his time.

Dr. Fanouria Dakoronia
14th Ephorate of
Prehistoric and Classical
Antiquities
35100 Lamia
August 1989

ILLUSTRATIONS

1. Sherd of LH IIIC krater with part of a ship.
2. Part of a LH IIIC krater with a ship.
3. Part of LH IIIC krater with the prow of a ship and a warrior.

NOTES

1. F. Dakoronia, Kynos, *Deltion 40,* 1985 (under press) *Deltion 41,* 1986 (under press) *Deltion 42,* 1987 (under press) *Deltion 43,* 1988 (under press).
2. *Ilias B,* 531 W. Oldfather Kynos *R.E.* 29. A. Philippson, *Die Griechischen Landschaften* 1, 2, 348, 360. W. K. Pritchett, East Lokris revisited, *Studies in ancient Greek Topography,* V, 79ff.
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10. Kirk s.a. 95, 135. Morrison - Williams s.a.44. Lucien Basch: *Le musée imaginaire de la Marine Antique,* Athènes 1987, 148.
11. Gray s.a. 21,1 Abb. 16a.
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17. Ilias XV, 716-717.
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21. Vermeule - Karageorgis s.a. 220 fig X1, 21.
22. Fik. Meijer; *A history of seafaring in the Classical World,* London 1986, 5. Basch s.a. 70, 73.
23. Perhaps the Homeric "ικρια" *(Ilias XV, 435).* Basch s.a. 142 fig. 298 Gray s.a. 20 No 56.
24. For example on the ship of the pyxis Tragana s.a. footnote 23.
25. The opinion that from about 1250 B.C. crews are represented rowing with their faces towards the stern (Cecil Torr, *Ancient Ships,* Chicago 1954, 2) is not based on real examples since we don't have representations of oarsmen oaring from LHIIIB-C period. Meijer has a different opinion s.a. 14.
26. Casson s.a. 54.
27. Torr s.a. 43 & 52. The practice is known form the Athenian ships of classical period. Even by Homer are referred such screens (Odys. V, 256-57). Also Casson s.a. 48. Kirk s.a. 138.
28. Kirk s.a. 137. Basch s.a. 180.
29. See above footnote (28).
30. Hesperia 8, 1939, 407 fig. 89v. Gray s.a. 53, Taf. Glc.
31. Hesperia 31, 1962, 273, pl. 99f. Gray s.a. 53, Taf. Gld.
32. Torr s.a. 40 footnote 99, fig 20-23 & 26 & 29. Basch s.a. 199 fig 420.
33. Basch s.a. 199 fig 420.
34. Gray s.a. 54. Morrison - Williams s.a.8
35. Casson s.a. 49.
36. I. Σακελλαράκης: Ελεφάντινον πλοίον εκ Μυκηνών, *AE* 1971, 211 κε Εικ. 10.
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39. s.a. foot note.

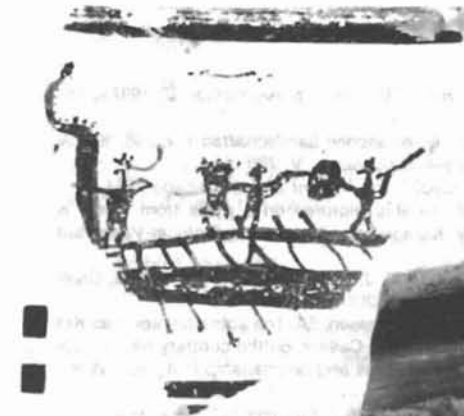


FIG. 1

FIG. 3

FIG. 2

SHIP REPRESENTATIONS FROM PREHISTORIC ARGOLIS (MH PERIOD)

Our knowledge on the beginnings of the construction of vessels in the Aegean can be based on the iconography, which in the earliest times is not satisfactory in general and especially regarding ships and vessels.

Although the earliest representations date from the early bronze age and appear on the so called Cycladic frying pans. It has already been said that the presence of obsidian, originating from the island of Milos, in the Peloponnese (Franchthi cave and preceramic strata of Dendra Midea) proves that the navigation in the Aegean begins before the 8th millenium B.C.

I am not a specialist in the problems of the navigation and the construction of vessels but the discovery of a middle Helladic jug found among several other finds on the top of a tomb No 140 of the tumulus Delta in Argos[1] has given me the opportunity to study the decoration on it, which includes seven vessels.

The vase is a small jug 10.5 cm high, offered to a very young girl buried in a shaft grave which dates from the middle of the seventeenth century B.C. It is decorated in dark on light.

Its decoration consists of bands and bands ending in semicircles around the neck. Then comes a row of six big double spirals representing obviously the waves of the sea. Just below and between the spirals are depicted seven small vessels in motion. Under the base of the handle there is a double circle, from which hang four long stemmed spirals. The design cannot be clearly explained. But could be possibly a kind of turtle or with less possibility a floating structure seen from above.

The seven vessels are not identical. Although the general characteristics have much in common, each one presents differencies in the details.

So, the number of oars, the height and shape of the prow or stem or stern and the position of the superstructure or sail vary.

The size of the vessels depicted is very small (about 1.2 cm each). The design is made with study and acurate hand. Although it is difficult to the painter to give details in so small representations, he is good enough to give us a legible profile of the vessels he could see sailing in the Argolic gulf.

Each vessel is depicted with its details and peculiarities. The bodies are thiner or thicker: the prow and sterns are flat, or crescent shaped, or angular, with or like a hook or a horn.

It is problematic the distinction between the prow and the stern when they are of equal height. If we could be sure that the superstructure is a sail, then the direction of the swelling of the sail cloth points out the prow. But the superstructure cannot be easily explained. The superstructure in discussion raises above the gunwale. It is semicircular inclining on one side. There is not a sign of a mast and one vessel only has an angular top.

Otherwise the superstructure could be explained as a cabin made of cloth or straw or wooden planks.

FIRST VESSEL (Phot.1 on the right side).

Prow and stern have almost the same height, thin body, gunwale rectilinear. Circular superstructure in the middle of the body. Six oars depicted (10 oars + the steering oar wich is the shorter on the right). In this case the motion is towards the left. The prow is hook shaped, the stern like a horn. We have examples showing that the prow could be as well in the right side. (like the later example of Skyros).

VESSEL No TWO (Phot.2, left).

Thin body, flat stern, twisted in a shape of closed hook prow. Superstrucrture in the center. Seven lines (that means 12 oars + one steering - oar. The prow could end at a head of animal).

VESSEL No THREE (Phot.2, right)

Crescent shaped body - cabin position in the middle of body direction to the right 14 oars (8 lines the first on the left could be the steering oar).

VESSEL No FOUR (Phot.3, center)

Prow angular and high, stern lower and flat. Direction left. Six oars, superstructure closer to the stern. (10 oars + 1 steering - oar). It has a flat boat.

VESSEL No FIVE (Phot.3, right, Phot.4 left)

Like No 4 with thiner body, higher stern and seven oars. Superstructure as in No 4, (10 oars + 1 steering oar) type of EC. vessel on an askos from Orchomenos = the same prow in earliest time.

VESSELS No SIX and SEVEN (No 6 = Phot.4, center No 7 = Phot.4, right and Phot.1, left)

They have both thin crescent shaped bodies. The prows are higher than the sterns. No 6 is longer with 14 one steering oar. No 7 has 12 oars + the steering oar. No 6 has the superstructure higher than No 7. Both are closer to the stern.

Summarising we may distinguish five types of the oar - vessels depicted on the jug from Argos. 1) The first is the type of vessel No 1 like a hook and like a horn. 2) The second is the type of No 2. One side like a hook and one flat. 3) The third of No 3 crescent - shaped. 4) To the fourth type belong No 4 and 5, one side rectangular and one rounded. 5) And to the fifth. No 6 and 7. Crescent - shaped but one side higher than the other.

Questions to be discussed and problems to be cleared and solved are: 1) The distinction between the prow and the stern especially when they are of equal height. 2) The explanation of the superstructure, which raises above the gunwale on the deck of the ship.

If we could recognize the sail in it we could easily solve the first problem, because the direction of the swelling of the sail points out the prow. But the superstructure cannot be easily explained. There is not a sign of mast and only the third vessel has an angular top. So the idea of a cabin is the best explanation because of the existance of oars, which make the presence of sail not necessary.

The oars are depicted as short lines below the body of the ships and they have been the only moving power for the vessels, as they are depicted. There are two vessels with six lines (that means 10 + one steering) two with eight (14 + one steering oar) and three with seven (12 oars + the steering one). All vessels depicted have been in reality of medium to small size (7.5 to nine meters long). They have been not small boats neither big ships.

The number of depicted ships, belonging to five different types and the ability of depiction indicates that the argives in M.H. times were acquainted with ships, and seamanship.

Although miniature in size, the complete representation of seven ships contributes in our knowledge about the bronze age seamanship.

Usually we have fragments of pictures and our conclusions are partially based on imaginary more or less additions. In several cases — for example — the type of the ship is guessed by the scholar who is trying to reconstruct in one the fragmentary representations of two or more different vessels.

As it concerns the oars, paddles and sails, I believe that the presence of both oars and sail on the same figure of a ship is rare and exceptional.

Even in the Thera - frescoes, only one ship can be considered as a sailing boat and it had not oars. The rest are exclusively boats, specially decorated with girlands and festoons hanging from a central pole, probably for a religious ceremony or celebration. The heavy decoration of the bodies is suitable for this event and seems to come from a myth. There is certainly a mythic scene as occurs often in the representations of mycenaean frescoes.

The normal vessels are the smaller plain boats depicted in the interspace.

A number of normal vessels from the Bronze Age are depicted on a mycenaean vase from Thera. They look like the older ships from Aigina. But discussion on this subject is to take place during the International Congress for the Aegean area[2].

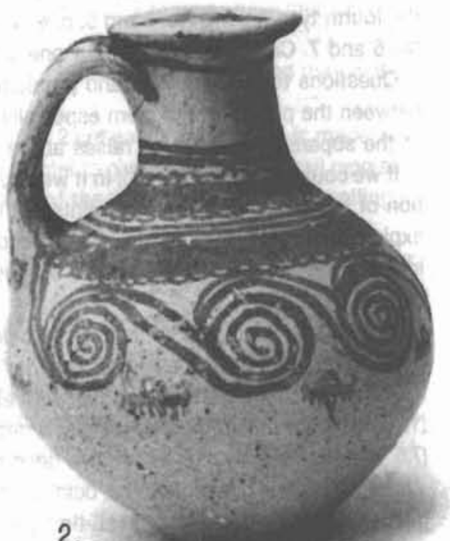
Dr. E. Protonotariou - Deilaki

NOTES

1. See E. Protonotariou - Deilaki, The Tumuli of Argos, Athens 1980 (in greek).
2. More details on the Argolic ships of the MH period and archaeological documentation will be reported at the forthcoming Congress on the Aegean.

ILLUSTRATIONS

The Middle Helladic jug of the tomb No. 140 of the tumulus Delta in Argos.


1.

2.

3.

4.

UN HABITAT HELLADIQUE ANCIEN II A PLATIYALI ASTAKOS

La recherche archéologique subaquatique de Platiyali Astakos sur la côte Ionienne en Akarnanie, a été une recherche due au projet de la Banque de Développement Industriel (ETVA) d'y construire des chantiers de ferraille de navires ainsi qu'une zone industrielle.

La premiére exploration subaquatique dans la région a été faite par le Département des Antiquités Subaquatiques en février 1986. Nous avons alors fortuitement découvert des restes de structures murales couvrant un espace étendu dans la baie du golfe.

Le Ministère de la Culture, à fin de pouvoir adopter une décision définitive en ce qui concerne l' établissement des industries a pris la décision d'effectuer une recherche plus étendue qui se réaliserait par notre Département, subventionné par la Banque interessée.

La recherche, dont nous présentons les remarques préliminaires, a duré de juin à décembre 1986.

Platiyali est situé à une distance de 12km au sud d'Astakos et à 22 milles nautiques à l'est de l'ile d'Ithaque. Il s'agit d'un golfe étroit de 1700 m de long et de 1100 m. de large, dont l'entrée est protegée par le petit archipel d'Echinades, lieu de la fameuse bataille navale de Lepante en 1571. La côte de Platiyali est un bassin sans torrent tandis que les flancs sont des monticules rocheux. Le terrain est essentiellement calcaire et la il y a surtout des buissons et des chênes. Les fonds de la baie sont parsemés de céramique de l'époque héllenistique et postérieure que nous en avons aussi trouvées dans la baie voisine de St Panteléimon où l'acropole héllenistique.

L'habitat préhistorique se situe dans la baie qui avant la submersion dévait être aussi un bassin. Nous ne pouvons pas encore discuter les raisons de la submersion sans avoir étudié la géomorphologie de la région.

Les structures murales de l'habitat se distinguent encore dans une zône parallèle à la côte de 400m. de long et jusqu'à la ligne de profondeur égale de 5m. au moins. Certaines d'elles continuent sous la terre ferme. La partie de l'habitat aujourd'hui submergée, dévait couvrir un espace de plus de 50.000m².

Après avoir éstimé les restrictions économiques et temporelles ainsi que les inconvénients de la recherche archéologique dans le milieu aquatique, nous avons pû obtenir relativement vite grâce à la méthode suivante, l'aspect géneral de l'habitat sans tenir compte des difficultés et du rythme lent d'une recherche sous-marine, ainsi que du fait que la partie principale des structures était difficilement visible.

En premier lieu, nous nous sommes impérativement occupés d' établir les plans topographiques et architecturaux de l'habitat. Nous avons donc essayé de tracer les contours de l'habitat et de dresser sa forme urbaine.

Nous avons effectué quelques sondages aux lieux choisis à fin de déterminer la stratification et aussi dégager les trouvailles superficielles aprés avoir relevé leur position précise et avoir enregistré les éléments de leur contexte.

Le plan topographique rattaché au Systeme National Géodésique et la position du quadrillage ont été effectués par la méthode de la takimétrie (EDM). L'environnement liquide posait évidamment beaucoup de problèmes à la tâche du géomètre (mauvaise diffusion de la lumière, difficulté de communication etc.). Pour tous les piquets, on calculait la profondeur précise ayant comme point de répère le niveau moyen de la mer. Le plan est fait à la centième (1:100). Les points de répère coincident avec les coordonnées cartesiennes de la carte de l'Etat major.

Les sites déjà dessinés malgré leur caractère fragmentaire, dû aux alluvions (boue, algues) et aux destructions de causes diverses (mouillage de la flotte Brittannique, pêche à la dynamite etc) forment un réseau urbain orienté suivant les axes nord-ouest / sud-est de la côte.
D'après le plan topographique nous distinguons trois groupes de bâtiments occupant la partie principale du site.

Les intervalles jusqu' à la côte se couvrent partiellement aussi de structures et de murs qui ne sont pas dessinés. Au sud et à l'est du site subsistent des restes des murs et d'autres structures dont nous n'avons pas pû terminer la dessination. De toute façon nous pouvons conclure que les groupes des bâtiments n'étaient pas des édifices isolés mais que le site était densement bâti.

La disposition de l'habitat était probablement linéaire[1]. Les formes des édifices varient du type mégaroide (pareil à celui de Troie, Lerna, Akovitika etc) (KS3), au type d' espaces rectangulaires successives KS1-KS2. Les dimensions des "chambres" sont d' ordinaire 20m² et 40m². Les murs subsistent au niveau de fondation et ordinairement reposent sur un niveau de gravier et de pierres, étendu sur toute la surface du sol vierge.

Ils sont soigneusement construits et on distingue trois types de construction:

1) le plus fréquent est le "double mur" de pierres calcaires du bâtiment KS1[2].

2) le deuxième type est le mur en plusieurs rangs de petites pierres, probablement plus an-

cien que le "double mur"[3].

3) nous avons localisé un seul cas de mur de double façade bâti avec de grandes pierres et l' espace entre elles rempli de petites pierres.

D' après les vestiges réperés, la toiture et la construction supérieure dévraient être d' ardoise calcaire et de terre cuite. Les sols étaient naturels (sable et gravier) et plus rarement dallés (KS3).

A défaut de stratigraphie verticale et à cause des conditions particulières des sites sous-marins, nous avons essayé de découvrir la succession horizontale des couches stratigraphiques: nous avons effectué deux sondages aux lieux choisis dans le 1er et le 3éme groupe de bâtiments (KS1-KS3) ainsi qu'une troisiéme dans un espace determiné par des points de repéres, à fin de dégager un vase.

Les couches sont plus ou moins homogénes et n' ont pas été mélangées, sauf la couche du 3éme sondage (T2). Selon la superposition nous rencontrons:

— une couche fine de sable
— une couche de boue
— une couche de gravier, proprement archéologique, contenant des vestiges de nature diverse (tessons, silex, obsidienne etc).
— une couche de pierres sèches irregulières
— de la terre vierge rouge.

Dans les lieux I et II du 1er groupe (KS1), nous avons excavé 3 inhumations d' enfant dans des vases utilisés comme des urnes. Un 4ème vase situé dans le lieu VI du même groupe contient aussi probablement une inhumation mais il n'a pas été fouillé. Les trois vases n' avaient pas la même orientation et étaient déposés latéralement près des murs des chambres, dans la couche de gravier jusqu' à la terre rouge. Chacun contenait un seul squelette d' enfant.

Il s' agit d' inhumations individuelles où les corps sont ensevelis entiers au temps de leur décès, sans être transportés d'ailleurs. Les têtes sont orientées toujours vers la bouche des vases. Nous n' avons pas trouvé de vestiges d'offrandes funéraires sauf une petite quantité de matière fine et fibreuse de couleur foncée qui, à première vue nous paraît être du tissu végétal. (INH1/INH3). Les inhumations intramurales de la période HA sont rélativement rares[4]. Certaines d' elles sont des inhumations d' enfants, des autres des adultes et des autres des translations. Les exemples des inhumations HAII d'Olympie[5], de Samos[6] ainsi que de Kirra[7] sont des inhumations d'enfants. Le cas de Strefi Elie[8] est d' adulte et les cas, d'Askloupi de Kos[9] et de Pélikata d' Ithaque[10] doivent être considerées comme des translations.

Parmi l'outillage lithique nous avons trouvé dans la couche de gravier, de l'obsidienne en petite quantité: des lames triédriques, trapézoides, des éclats (déchets) et des nucléi. Dans la même couche, nous avons aussi trouvé de la silex en abondance (lames, éclats, nucléi). Après avoir exploré la région jusqu'à 5km. de Platiyali, nous avons découvert que la provenance de la silex est locale. Les pierres calcaires contiennent de la silex, soit en forme de "rognons", soit en "nodules". Les couleurs varient du beige clair au noir.

En ce qui concerne la poterie, il est trop tôt pour en parler en détail puisque les travaux de restauration ne sont pas encore terminés, et par conséquent la céramique n'est pas entiérement étudiée. Selon les premières remarques sur le genre et la qualité de la pâte, ainsi que, et d'après les types de formes (saucières, vases au décor imprimé, au tenon court, au bord étalé ou rentré, cordé etc.), la majorité des trouvailles céramiques semblent appartenir à la poterie de la période HAII[11].

L'agglomération urbaine du site, la céramique, l'outillage etc. nous permettent d'ajouter Platiyali aux sites HA, si rares en Grèce Occidentale. L'étude plus approfondie des vestiges du site nous donnera certainement plusieures informations sur le rôle que Platiyali aurait joué dans la Grèce Occidentale par rapport aux autres sites HA déjà connus.

Le facteur géographique (arridité des sols, difficulté d'accès terrestre) semble avoir obligé la population à dépendre plutôt du milieu maritime que du milieu continental.

Ce n'est pas d'ailleurs accidentel que la plupart des sites HAII sont localisés aux endroits côtiers. En plus nous possedons des arguments ex-silentio tels que celui-ci: les spécimens de la céramique et l'obsidienne semblent confirmer que les habitants du site dévraient avoir par mer des relations étroites avec d'autres centres HA.

Les spécimens d'obsidienne nous dévoilent un genre de marchandise importé. Nous pourrions donc rechercher dans le site un port disparu, une escale de navigation côtière où les marchands prenaient ce qui leur était nécessaire en échange d'autres marchandises. La situation géographique du site semble être une station au carrefour des routes maritimes qui commençaient au sud du Péloponèse (où nous connaissons déjà des sites HA tels que Voidokilia, Samikon etc. où l'obsidienne n'était pas inconnue) se dirigeaient vers le nord-ouest de la Grèce (où les sites HA sont plus rares, mais toujours accessibles par mer) et se croisaient avec la route maritime du golfe de Corinthe (où nous connaissons déjà les sites de Perachora, Kirra etc.).

Platiyali pourait donc être consideré comme une entrée de communication de la Grèce continentale occidentale grâce aussi à la géomorphologie de l'interieur qui offre un passage à travers la valée d'Astakos. Cette communication devrait être effectuée par mer jusqu' aux temps modernes à cause de l'accès difficile de la région. Nous citons à titre d'exemple le temoignage du capitaine Mansell qui décrit les problèmes d'accès de la région par voie terrestre et les avantages de la route maritime, dans une époque si récente: "Immediately south of Dragamesti bay is the snug *and land locked* Port of Platea, protected from the westerly winds by the Echinades Islands and encircled with thickly wooded undulating hills, this is the most sheltered anchorage along the whole coast of Akarnania. There is neither village or fresh water..."[12]

Des vestiges des naufrages postérieurs en dehors du golfe comme le naufrage d'amphores de l'ilôt de Pistros, ainsi que des restes sous-marins et littoraux dans le golfe voisin de St Pantéléimon (datés de l'époque héllénistique et post-romain) montrent la continuité archéologique-historique du site côtier. Ce site HA de la Grèce occidentale est disparu définitivement, car la région a été cédée aux industries de la Banque sans que la recherche ait été complète.

La fouille s'est effectuée à échelle réduite. Nous n'aurons donc plus l'occasion de resoudre le problème en question que par l'étude du materiel et des éléments qu'on a eu la possibilité de récuperer pendant la recherche.

La tâche archéologique se heurte souvent aux sérieuses difficultés administratives et aux interêts privés, et il faut de la volonté et de la patience pour essayer de les vaincre.

Catherine P. Delaporta - Elie Spondylis
Departement des Antiquités Subaquatiques

NOTES

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2) ΤΖΑΒΕΛΛΑ - EVGEN X: Λιθαρές, Αθήνα 1984, σ.93 σχ. Γα.
3) op cit. p. 93, σχ. Γβ
4) ΔΕΛΑΠΟΡΤΑ Κ.Π. - ΣΠΟΝΔΥΛΗΣ ΗΛ. - ΜΠΑΞΕΒΑΝΑΚΗΣ Ι., Πρωτοελλαδικός οικισμός στο Πλατυγιάλι Αστακού (πρώτες παρατηρήσεις). Ανθρωπολογικά Ανάλεκτα, τομ. 49, τευχ. 1, Ιαν. 1988, σ. 15.
5) DORPFELD W.: Untersuchungen und Ausgrabungen zur Geschichte des ältesten Heiligtums von Olympia und der älteren griechischen Kunst, Berlin 1935, s. 94.
6) MILOJCIC VL.: Samos I, Die Prähistorische Siedlung unter dem H eraion, Grabung 1953 und 1955, Bonn 1961, s. 10
7) DOR et alt.: Kirrha. Etude de préhistoire phocidienne, 1960, p. 119.
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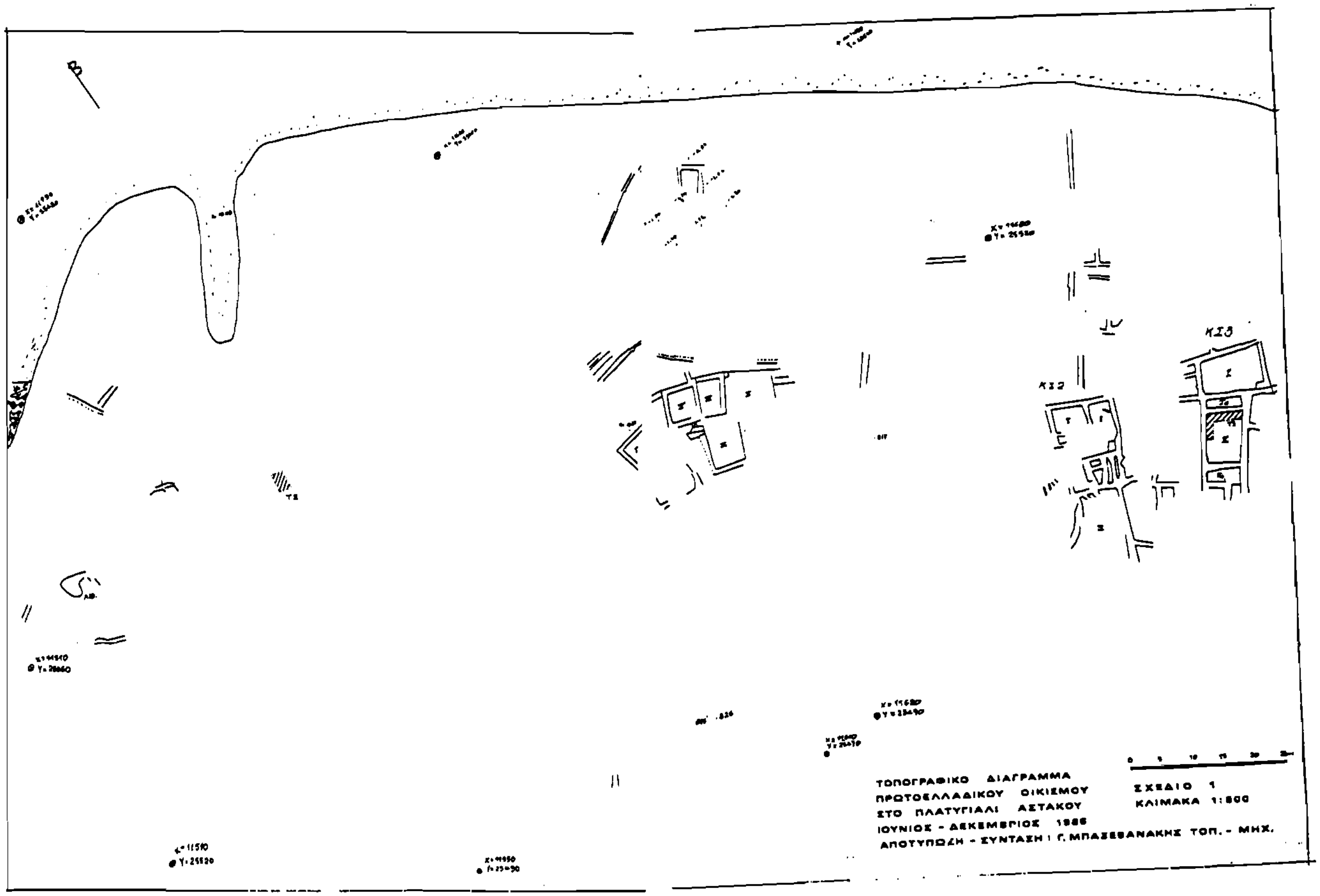
FIGURES

1. Plan de l'Habitat Helladique Ancien II à Platiyali, Astakos. Vestiges des structures.
2. Mur du bâtiment KS1. Urne funeraire/UF3.
3. Mur du bâtiment type 3.

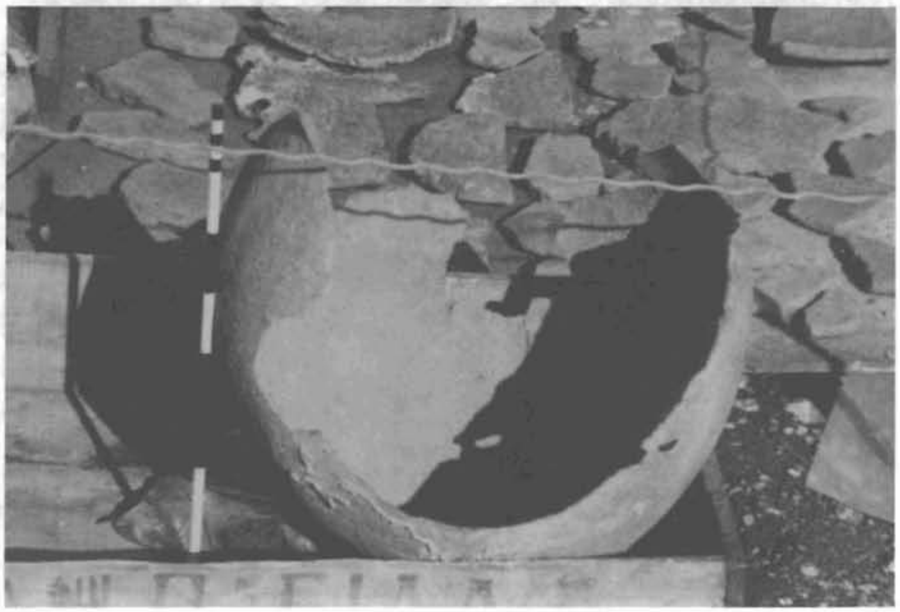
4,5. Urne funéraire, squelette d'enfant.



Σχέδιο 1. Κάτοψη αποτυπωμένων κτιριακών λειψάνων.


2


3



4

5

ΠΑΡΑΣΤΑΣΗ ΠΛΟΙΟΥ ΣΕ ΧΡΥΣΟ ΕΛΑΣΜΑ ΑΠΟ ΤΗ ΣΙΝΔΟ

Το έλασμα πιν. 1 προέρχεται από το αρχαίο νεκροταφείο της περιοχής της Σίνδου, δυτικά της Θεσσαλονίκης, και βρέθηκε μέσα στο γυναικείο τάφο 28, που χρονολογείται απ' τα κεραμεικά του ευρήματα γύρω στο 560 π.Χ.[1]. Ανήκει στην κατηγορία των ρομβόσχημων ελασμάτων που είχαν χρησιμοποιηθεί για την κάλυψη του στόματος του νεκρού. Έχει σχήμα άτυπο, με κομμένες κάθετα την αριστερή και τη δεξιά γωνία του ρόμβου, και αποτελεί το πρωιμότερο παράδειγμα από τα ελάσματα της κατηγορίας αυτής της Σίνδου. Το ύψος του είναι 6 εκ. και το μήκος του 12.4 εκ.

Ολόκληρη η επιφάνειά του κατέχεται από τη χαρακτή παράσταση ενός πλοίου, εξοπλισμένου μ' ένα πανί, με μια σειρά από δεκαοχτώ κουπιά και με δύο πηδάλια στην πρύμνη του. Το πλοίο εικονίζεται σε κίνηση, με το κατάρτι του όρθιο στο μέσο της παράστασης, με το πανί του φουσκωμένο αριστερά κατά το μέρος της πλώρης και όλα τα εξάρτια του στα δεξιά κατά την πρύμνη του. Το σχέδιο στο σύνολο του δίνει τη γενική ιδέα μιας «μακράς νηός», ο χαράκτης ωστόσο απέδωσε με σχετική ασάφεια τα επί μέρους στοιχεία του πλοίου και τις λειτουργικές του ενδείξεις, όπως θα φανεί πιό κάτω.

Δύο μακριές οριζόντιες γραμμές περιγράφουν τη μορφή του σκάφους από την πλάγια όψη, δηλώνοντας περιληπτικά την κουπαστή και την καρίνα[2]. Μια τρίτη γραμμή ανάμεσά τους, που μπροστά φτάνει περίπου ως τις τρείς κάθετες γραμμές του εμβόλου, διαρθρώνει εξωτερικά το τοίχωμα κατά μήκος του πλοίου και υποδηλώνει ένα ζωστήρα, ίσως στο σημείο αρμογής του πάνω μέρους του κοίλου με το παραπέτο[3], τονίζοντας έτσι την τεκτονικότερη διάρθρωση κατά μήκος του σώματος του σκάφους[4]. Η γραμμή αυτή ωστόσο βρίσκεται χαμηλότερα από τη θέση που μας παραδίδουν οι σχετικές παραστάσεις στη λίγο υστερότερη αρχαϊκή αγγειογραφία και από την άποψη αυτή η παράσταση στο έλασμα της Σίνδου συγκρίνεται καλύτερα με παλιότερες απεικονίσεις, όπου το σκάφος διαχωρίζεται κατά το μέσο σε πάνω και κάτω μέρος[5]. Στην παλιότερη ζωγραφική παράδοση εξάλλου συναντάμε και τον κάθετο διαχωρισμό του πλοίου με παράλληλες γραμμές[6], που αν και αφορούν το πάνω κυρίως μέρος του, φτάνουν εδώ ως κάτω στην καρίνα. Οι κάθετες αυτές γραμμές στο έλασμα της Σίνδου διαιρούν το πλοίο σε διάχωρα, σε καθένα από τα οποία θα αντιστοιχούσε ένα κωπηλάτης, όπως προκύπτει από την κατονομή των κουπιών, ένα σε κάθε διάχωρο (παραλείφθηκε η δεύτερη από αριστερά γραμμή). Τις δεκαοχτώ λοξές χαράξεις που υποδηλώνουν τα κουπιά ξεκινάει ο τεχνίτης από την καρίνα, σαν να πρόκειται για ένα είδος ποδιών[7]. Μερικά από τα κουπιά κατά τα άκρα του πλοίου έχουν χαραχτεί σε αδιανόητες στην πραγματικότητα θέσεις, κάτω από τη θέση του πηδαλιούχου ή το πρωραίο θωράκιο. Αν την υπερβολή αυτή την αποδώσουμε στην καλλιτεχνική ελευθερία, συνηθισμένη άλλωστε σ' αυτές τις περιπτώσεις[8], το πλοίο νοείται πιθανότατα ως τριακόντορος. Τα πηδάλια, που καταλήγουν σε τριγωνικό πτερύγιο με μιά κατά μήκος νεύρωση στο μέσο, εμφανίζονται και τα δύο στην ίδια πλευρά του πλοίου. Κρίνοντας ωστόσο από τον τρόπο που παραστάθηκε το πανί, όπως θα εξηγηθεί πιό κάτω, ο αέρας που κινεί το πλοίο υποτίθεται ότι φυσάει από την πίσω και λίγο δεξιά πλευρά του. Επομένως το πηδάλιο που δουλεύει και νοείται μέσα στη θάλασσα ανήκει στην αριστερή, δηλαδή σταβέντο (υπήνεμη), πλευρά του σκάφους, ενώ το πηδάλιο το ανασηκωμένο ως την υποτιθέμενη επιφάνεια της θάλασσας ανήκει στη δεξιά[9].

Το έμβολο[10] διαμορφώνεται με υπερβολική προέκταση της πλώρης και απολήγει σε ζωόμορφη κεφαλή. Ο οφθαλμός του εμβόλου δηλώνεται κατά περίεργο τρόπο δυό φορές, μία φορά μικρότερος στη θέση που κατέχει συνήθως η κεφαλή του εμβόλου στις αρχαίες παραστάσεις πλοίων και μια φορά μεγαλύτερος ως οφθαλμός της ζωόμορφης κεφαλής. Ο διττός αυτός αριθμός θυμίζει τις «τετραελίκωπες» (Ησύχιος: τέσσερας οφθαλμούς έχουσαι ναυς), για τις οποίες όμως η έρευνα κατευθύνεται προς άλλου είδους παραδείγματα[11]. Το σχήμα του οφθαλμού, κυκλικό με μια στιγμή στο μέσο, είναι σπάνιο στα αρχαϊκά χρόνια και χαρακτηρίζει κυρίως παραστάσεις παλιότερων χρόνων[12]. Το μπροστινό περίγραμμα της κεφαλής του εμβόλου δε σχηματίζει το συνηθισμένο ρύγχος, αλλά ανεβαίνει ψηλά προς τα πάνω και μετά καμπυλώνεται πίσω, όπου διακλαδίζεται σε δύο σκέλη, που φέρονται στη συνέχεια προς τα κάτω, προς το περίγραμμα του υποτιθέμενου λαιμού. Η μορφή αυτή είναι ασυνήθιστη και αποτελεί ίσως έναν υπαινιγμό παράστασης κερασφόρου ζώου[13]. Ολόκληρη όμως η μορφή της κεφαλής δε θυμίζει γνωστά μας από άλλα μνημεία ζώα, ενώ εξάλλου η παράλειψη του μυτερού ρύγχους δεν υποδεικνύει πρακτική χρήση του εμβόλου. Είναι ίσως πιθανότερο ότι ο χαράκτης θέλησε να υποδηλώσει εδώ ένα θαλάσσιο κήτος[14]. Σε τέτοιου είδους παραστάσεις έχει αποδώσει η έρευνα συμβολικό χαρακτήρα, διαμορφωμένο από τις δοξασίες που γέννησαν οι κίνδυνοι της τότε ναυσιπλοΐας. Μέσα από τέτοιες αντιλήψεις θα προέκυψε και η παράσταση του δεύτερου οφθαλμού που στοιχειοθετεί το διπλασιασμό της αποτροπαϊκής δύναμης που ενυπάρχει στο σκάφος-κήτος[15]. Από την άποψη αυτή δε διαφέρει η παράσταση της Σίνδου από τις υστερότερες, όπου ένας δεύτερος οφθαλμός προστίθεται σε ένα άλλο μέρος της πλώρης και τις οποίες επικαλείται η έρευνα για την εικονιστική απόδοση της λέξης «τετραελίκωπες»[16]. Οι τρείς στικτές γραμμές, που διαχωρίζουν την κεφαλή απ' το υπόλοιπο σώμα, σημαίνουν μάλλον και στο έλασμα της Σίνδου τα όρια της κεφαλής του εμβόλου[17].

Το ακρόπρωρο έχει τη μορφή κέρατος που κλίνει ελαφρά προς τα εμπρός[18]. Το μπροστινό κυρτό περίγραμμά του συνέχεται με την κοίλη γραμμή μετάβασης προς το έμβολο, ενώ το πίσω, ευθύ και λοξό, με την οριζόντια γραμμή του πρωραίου θωρακίου. Από την τελευταία είναι εξαρτημένες τέσσερεις κάθετες σειρές που αποδίδουν το κιγκλίδωμα[19]. Με σχηματική απλοποίηση, μια οριζόντια γραμμή πάνω από τρείς κάθετες, δηλώθηκε και το κιγκλίδωμα του άλλου θωρακίου στην άκρη της υπερυψωμένης πρύμνης, της οποίας τα δύο άφλαστα απολήγουν σε σχηματική κεφαλή, που μοιάζει με κεφαλή φιδιού[20].

Από την αρματωσιά του πλοίου παριστάνεται το κατάρτι με μιά κάθετη χάραξη στο μέσο περίπου του σκάφους. Δεξιότερα απ' αυτό μιά άλλη γραμμή, λοξή προς το μέρος της πρύμνης και ενωμένη στο πάνω μέρος με το κατάρτι, παρόλο που στη βάση βρίσκεται σε κάποια απόσταση απ' αυτό, αποδίδει μάλλον ένα από τα δύο μαντίκια (κεροίακες)[21] για τη συγκράτηση της κεραίας και του πανιού στην καθορισμένη θέση. Από τις άλλες οχτώ γραμμές, που καταλήγουν στην κουπαστή και είναι λοξές προς το μέρος της πρύμνης, η επάνω ίσως δηλώνει το ξάρτι (τον επίτονο) για την εξασφάλιση της αντοχής του καταρτιού από την πλευρά της πρύμνης. Με τις άλλες υπονοούνται προφανώς τα μπρούλια (συστολείς)[22] και ίσως ακόμα τα μπράτσα (ολκοί) και οι σκότες (πόδες), σχοινιά με τα οποία ρύθμιζαν τη στροφή του πανιού και της κεραίας[23], αν και η τελευταία παραλείφθηκε από το σχέδιο του ελάσματος της Σίνδου. Η φαινομενική εξάρτηση των σχοινιών αυτών απ' το μαντίκι της κεραίας οφείλεται σε λάθος του χαράκτη.

Το πανί, παρόλο που δίνει την εντύπωση τριγωνικού σχήματος, θα πρέπει για την εποχή του να νοηθεί ορθογώνιο[24]. Διασχίζεται από κάθετες και οριζόντιες γραμμές, που επεκτείνονται με αμέλεια ως την κουπαστή και ως το κατάρτι αντίστοιχα. Η τελευταία λεπτομέρεια υποστηρίζει μάλλον την άποψη ότι ο χαράκτης είχε υπόψη του τα σχοινιά που, όσο μας επιτρέπουν να κρίνουμε οι παραστάσεις των αγγείων της εποχής, ήταν προσαρτημένα στην εξωτερική πλευρά του πανιού, την αντίθετη δηλαδή από την πλευρά του αέρα[25]. Αν δούμε σύμφωνα μ' αυτόν τον κανόνα την παράστασή μας, η κατεύθυνση του αέρα δηλώνεται από την πίσω και λίγο δεξιά πλευρά του πλοίου, όπως άλλωστε συνάγεται και από το γενικό σχεδιασμό του πανιού. Κατά τις ενδείξεις αυτές πρόθεση του τεχνίτη ήταν η παράσταση ενός πλοίου που ταξιδεύει με ούριο άνεμο[26]. Το θαλάσσιο χώρο γύρω του υποδηλώνουν τα τέσσερα δελφίνια, με ιδιαίτερα τονισμένο το υπερυψωμένο ρύγχος, που τοποθετήθηκαν σε καίριες θέσεις, από ένα πάνω και κάτω από το έμβολο, σαν «προπομποί», και από ένα πάνω απ' το πρωραίο και το πρυμναίο θωράκιο, αντί άλλου «πρωράτου» και «κυβερνήτου»[27]. Η ραχοκοκκαλιά των δελφινιών αποδόθηκε με στικτή γραμμή, όπως επίσης το πρωραίο θωράκιο μαζί με το κέρας και το έμβολο, καθώς και τα δύο άφλαστα. Ο ιδιαίτερος ετούτος τονισμός, μάλλον όχι τυχαίος, αφορά τα βασικά, πιό πολυσήμαντα σημεία της παράστασης[28].

Τα ρομβόσχημα ελάσματα που βρέθηκαν στη Σίνδο κάλυπταν το στόμα του νεκρού και ήταν επομένως αποκλειστικά νεκρικής χρήσης, όπως άλλωστε γενικά πιστεύεται γι' αυτή την κατηγορία μνημείων. Αυτό μας υποδεικνύει μια χρονολόγηση σύγχρονη ή ελάχιστα παλιότερη από την ταφή του νεκρού, στον οποίο ανήκε το κάθε έλασμα. Το έλασμα με την παράσταση πλοίου που μας απασχολεί εδώ βρέθηκε, όπως αναφέρθηκε στην αρχή, σ' ένα τάφο των χρόνων γύρω στο 560 π.Χ. Το δεδομένο τούτο υπαγορεύει μια χρονολόγηση όχι πιό μακριά από εκείνη των άλλων κτερισμάτων, ακόμα και στην περίπτωση που το έλασμα είχε εκ των προτέρων ετοιμαστεί. Ορισμένα εξάλλου στοιχεία της ίδιας της παράστασης, όπως π.χ. το κατακόρυφο ακρόπρωρο ή οι κάθετες ενδείξεις για τα όρια της κεφαλής του εμβόλου, πιστοποιούν μια ανάλογη χρονολόγηση[29]. Αυτές όμως οι εκτιμήσεις αποτελούν εν μέρει αντίφαση σ' εκείνες που προκύπτουν απ' τη συγκριτική διαδικασία. Πολλά άλλα στοιχεία της παράστασης, όπως σημειώθηκε επανειλημμένα, βρίσκουν παράλληλα σε παραστάσεις του 7ου, ακόμα και του 8ου π.Χ. αι. Ένα συνηθισμένο τρόπο συμβιβασμού σε τέτοιες περιπτώσεις, ιδίως όταν έχουμε μνημεία από περιφερειακές ελληνικές περιοχές, αποτελεί η υπόθεση ότι επιβιώνουν σε αυτά στοιχεία από παλιότερη παράδοση. Αυτή όμως η υπόθεση φαίνεται λίγο απίθανη για την παράστασή μας, όχι μόνο γιατί οι συγκρίσεις οδηγούν σε κάποιες εποχές αρκετά απόμακρες, αλλά γιατί και μόνο αυτό το υλικό που έδωσαν οι τάφοι του νεκροταφείου της Σίνδου βεβαιώνει μια ζωηρή και συνεχή επικοινωνία και κίνηση συναλλαγών με τη νοτιότερη Ελλάδα, τέτοια που δε στηρίζει ως βάσιμη μιά υπόθεση για τόση καθυστέρηση[30]. Φαίνεται πιθανότερο ότι πρόκειται για αναχρονιστικά στοιχεία που επιλέχτηκαν συνειδητά γιά κάποιο λόγο[31]. Με το τετράματο έμβολο, τους δράκοντες ίσως της πρύμνης και μ' ένα σκαρί ερχόμενο από χρόνο ξέμακρο δεν είναι απίθανο καθόλου να στόχευε ο τεχνίτης στη χάραξη ενός πλοίου συμβολικού για τη νεκρή, για την οποία έγινε το έλασμα. Δεν θα ήταν άλλωστε και το μοναδικό παράδειγμα[32]. Ειδικά για το νεκροταφείο της Σίνδου, ανάμεσα στ' άλλα εφόδια που περιείχαν οι τάφοι, όπως τα σκεύη που σχετίζονται με συμπόσια στον άλλο κόσμο και τα ομοιώματα των αμαξιών για το ταξίδι του νεκρού[33], το έλασμα με την παράσταση όπως την ερμηνεύσαμε αποτελεί απλώς ένα άλλο τρόπο έκφρασης της ίδιας πίστης. Το πλοίο που παράστησε ο τεχνίτης να το κυβερνούν δελφίνια με ούριο άνεμο, κλειστό και σιωπηλό, είναι ένα μικρό μόνο δείγμα του πνεύματος ενός πολιτισμού, που την ξεχωριστή υπόστασή του αποκαλύπτει ένα πλήθος ευρημάτων τα τελευταία χρόνια από το χώρο της Μακεδονίας.

Αικατερίνη Δεσποίνη
Κότσικα 6
104 34 Αθήνα

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4. Από τον Williams χαρακτηρίζεται ως main wale, *GOS,* 97, 85 arch.34,93 arch.53,95 arch.56 κ.α. Σχετικά Casson, 64,223. Πβ. και την ανάγλυφη παράσταση πλοίου στη Basel, K. Schefold, *Führer durch das Antikenmuseum Basel,* 18 κ.ε. εικ.10. Casson, 55 σημ.71 εικ.73. Gray, 28 αριθ.19 πιν. 12d.
5. Πβ. το θραύσμα κρατήρα Μ. Αγοράς P 26817 (R. Tölle, *AA* 1963, 654 *AA* 1963, 654 κ.ε. εικ.12 κ.λπ. Gray, 23 αριθ.4 πιν.96. Tréziny, 22 σημ.17 εικ.7), το θραύσμα κρατήρα Μ. Αγοράς P 6094 + P 2400 (Agora VIII, 73 αριθ.379 πιν.22. Gray, 23 αριθ.5 πιν.10a. Tréziny, 24 σημ.20 εικ.8), τον πήλινο πίνακα από το Σούνιο Εθν. Μ. 14935 (*GOS,* 73 arch. 2 πιν. 8b. Gray, 26 αριθ.4 πιν. 11d) κ.ά.
6. Βλ. τα αττικά παραδείγματα της σημ.5, πβ. επίσης την παράσταση της οινοχόης από τη Θήβα, Βερολίνο V.I. 3143, 45 (Gray, 23 αριθ.2 εικ.18d) και τις σχετικές παρατηρήσεις του Williams, *GOS,* 8, 32 κ.ε. geom.28, geom.35, geom.37.
7. Αν και ο τρόπος αυτός μπορεί να χαρακτηριστεί ως αδέξιος και τυχαίος, οφείλω να υπενθυμίσω πολύ παλιές ανάλογες παραστάσεις, ένα από τα τελευταία δείγματα των οποίων βλέπουμε στην οινοχόη της Κοπεγχάγης, Nat. M. 1628 (Kirk, 110 κ.ε. αριθ.36 εικ.3. *GOS,* 33 geom.29. Gray, 23 αριθ.6 πιν.10b).
8. Για το συμβατικό αριθμό κουπιών ή κωπηλατών R.T. Williams, *JHS* 78, 1958, 128. *GOS,* 94 arch.53. Casson, 54,62 σημ.96. *Gray,* 58,88. Στ. Αλεξίου, *Πεπραγμένα Γ' Διεθνούς Κρητολ. Συνεδρίου, Α'* (1973), 5.
9. Για τη χρήση των πηδαλίων σε περίπτωση πλάγιου αέρα *K. Schefold, δ.π. (σημ.4), 20. Casson, 228.*
10. *Για το έμβολο γενικά F.H. van Doorninck, IntJNautA* 11, 1982, 283 κ.ε. Τη σχετική μελέτη του R. Steffy στο *Mariner's Miror,* 69, 1983, 229 κ.ε. δεν την είδα.
11. RE Suppl. V, 916 στη λ. Seewesen (F. Miltner). Πβ. και J.N. Svoronos, *ΔΕΝΑ* 16, 1914, 131. Η υπόθεση ότι ο οφθαλμός της πλώρης αποδίδει ίσως το άνοιγμα για το σχοινί της άγκυρας αμφισβητείται (Kirk, 133. J. Rougé, *La marine dans l'Antiquité* (1975), 74. *Tréziny,* 30 κ.ε. P.F. Johnston, *Ship and Boat Models in Ancient Greece* (1985), 47), ωστόσο και αν τη δεχτούμε, ο μικρός οφθαλμός στο έλασμα της Σίνδου δεν προσφέρεται για τη χρήση αυτή εξ' αιτίας της θέσης του, πολύ προχωρημένης προς τα εμπρός και χαμηλά. Για τους οφθαλμούς των πλοίων συγκεντρωμένη βιβλιογραφία Wachsmuth, 87 κ.ε. σημ.82, 256 κ.ε. Χρ. Σαατσόγλου - Παλιαδέλη, *Επιστ. Επετηρίδα Φιλ. Σχ. Πανεπιστημίου Θεσσαλονίκης* 18, 1979, 413 κ.ε.
12. Kirk, 132. Tréziny, 24, 30 κ.ε.

13 Πβ. «νεώς προτομήν επί της πρώρας εχούσης κριού» (Διόδ. IV, 47), «επι κριοπρώρου σκάφους» και «νεώς κριοπροσώπου» (Σχολ. Απολ. Ροδ. I, 256 και II, 168) που είναι σχετικά με το κριάρι τοιυ Φρίξου και της Έλλης. Πλοία της Λυκίας αναφέρονται ως κριοί και τράγοι από τον Πολυδ. Ονομ. I, 83, βλ. Casson, 343 και *Die Seefahrer der Antike (1979), 407. Για άλλα είδη, π.χ. υόπρωρος, ταυρόεις κ.λπ. Svoronos, ό.π., 148 κ.ε. Wachsmuth, 89 κ.ε. σημ.83, 251. Λίγα πάντως γνωρίζουμε γενικά για τη μορφή των εμβόλων, βλ. L. Basch - H. Frost, IntJNautA* 4,1975, 204 κ.ε.

14. Για τα κήτη γενικά και τις δοξασίες των αρχαίων ναυτικών Wachsmuth, 250 κ.ε.

15. Για το συμβολισμό του οφθαλμού στα πλοία Wachsmuth, 256 κ.ε.

16. Ό.π. (σημ.11). Πβ. και τον οφθαλμό του θωρακίου της πλώρης στην παράσταση του αμφορέα της Ταρκινίας, M. Civico 678 (*GOS*, 110 arch. 86 πιν.20b. Casson, 64 πιν.85. A.W. Sleeswyk, *IntJNautA* 11, 1982, 41 εικ.4) που είναι μικρότερος του οφθαλμού του εμβόλου. Ένα δεύτερο μικρότερο οφθαλμό έχει στην πρύμνη το πλοίο της οινοχόης από τη Θήβα, Βερολίνο V.I. 3143, 45 (ό.π. σημ.6. *GOS*, 34 arch.33. Tréziny, 25).

17. Ανάλογης σημασίας είναι και οι χαράξεις του εμβόλου στον κρατήρα του Κλειτία (*GOS*, 34 arch.33 πιν. 11b, καθαρή εικόνα επίσης Kirk, 138 εικ.10) και στην υδρία Μ. Λούβρου Ε 735 (π.κ. σημ.31). Για το τυπικό σχήμα τέτοιων γραμμών στα επόμενα χρόνια της μελανόμορφης αγγειογραφίας και την ερμηνεία τους ως ορίων του μεταλλικού εμβόλου *GOS*, 95 κ.ε. Casson, 64. Doorminck, ό.π. (σημ.10).

18. Για το πρωραίο κέρας Tréziny, 27 κ.ε. με παλιότερη βιβλιογραφία.

19. Για το «πρωρατικόν εδώλιον» και το προστατευτικό του θωράκιο Svoronos, ό.π. (σημ.11), 130 κ.ε. *RE* Suppl. V, 933. Χρ. Σαατσόγλου-Παλιαδέλη, ό.π. (σημ.11), 418 κ.ε. Το κιγκλιδωτό θωράκιο έχει πάντως πολύ παλιά παράδοση.

20. Για τα άφλαστα Wachsmuth, 83 κ.ε. σημ.79. Στην αρχαϊκή αγγειογραφία έχουν συνήθως τη μορφή κύκνου. Για τον αποτροπαϊκό χαρακτήρα του φιδιού ή δράκοντα στα πλοία Wachsmuth, 241 σημ.876, 244 σημ. 900, 389 σημ.1787. Για παρόμοιες κεφαλές σε άλλου είδους κτερίσματα βλ. Σίνδος ό.π. (σημ.1), αριθ.60, 134, 156, 310, 486, 491 κ.ά.

21. Συνήθως παριστάνονται δυο μαντίκια ή και κανένα, ένα είναι σπάνιο. Πάντως στις παραστάσεις των αγγείων, όταν η θέση των σχοινιών αυτών δεν είναι η τυπική κατά μήκος των δύο πλευρών του καταρτιού, δεν είναι εύκολη η αναγνώριση, αν πρόκειται γι' αυτά ή για άλλα σχοινιά του πλοίου, πβ. *GOS*, πιν.21a,c και Casson, εικ.91. Για την αρχαία σχετική ορολογία τελευταία P.G. Dell, *IntJNautA* 10, 1981, 66 κ.έ.

22. Για τα σχοινιά αυτά RE ό.π., 910. Torr, 81. *GOS*, 56, 299. Casson, 47, 70.

23. Τον αρχαίο όρο «υπέραι» ερμηνεύουν γενικά ως μπράτσα (Torr, 80. *GOS*, 56. Casson, 47. Dell' Orco, ό.π., 71 σημ.4), κατά μερικούς όμως πρόκειται για τα μαντίκια (S.Marinatos και G. Jörens: Gray, 149 και 155 αντίστοιχα).

24. Casson, 47,60,68. Πβ. και KlPauly 5,69 στη λ. Seewesen (D. Wachsmuth).

25. Φαίνονται καλά, τόσο τα οριζόντια όσο και τα κάθετα σχοινιά, στην παράσταση του αμφορέα της Χάγης, Rijksmuseum Meermanno-Westreenianum 608 (Köster, πιν.47. Casson, εικ.91. Beazley, *ABV* 98 αριθ.38, 683). Για τη χρήση τους *GOS*, 93 arch.52, 98 arch.57 κ.α. Casson, 68 κ.ε. Rougé, ό.π. (σημ.11), 60 κ.ε. Δεν έχουμε πάντως από τα αρχαϊκά χρόνια παράσταση, όπου να φαίνεται ολόκληρη η επιφάνεια του πανιού με τα σχοινιά, γι' αυτό δεν αποκλείεται και σ' αυτή την περίπτωση να αναφέρεται ο τεχνίτης της Σίνδου στην παλιότερη παράδοση με τα ζατρικιοειδή πανιά που θεωρούνται ότι αποδίδουν ραμμένα τεμάχια υφάσματος (Torr, 80. Casson, 60. Gray, 106), αν και ο Kirk, 131 κ.ε. δεν αποκλείει να πρόκειται για ζωγραφική επινόηση των αγγειογράφων. Σε ανάλογες προϊστορικές παραστάσεις ο Μαρινάτος, *BCH* 57, 1933, 207 θεωρεί πιθανότερο ότι αποδίδονται ενισχυτικά σχοινιά.

26. Το πλοίο ουριοδρομεί όταν έχει τον καιρό πρύμα ή δευτερόπρυμα, δηλαδή από την πρύμνη ή λίγο από το πλάι της, βλ. Wachsmuth, 364 κ.έ.

27. Για τα δελφίνια ως προπομπούς και σύμβολα της «εύπλοιας» Wachsmuth, 100 κ.έ.

28. Στα αρχαϊκά χρόνια και το θωράκιο της πλώρης είναι κατά κάποιο τρόπο καθιερωμένο, αφού είναι ο φορέας του οφθαλμού, και ως τέτοιο λειτουργεί, κατά τα φαινόμενα, και στη συνείδηση του χαράκτη της Σίνδου.

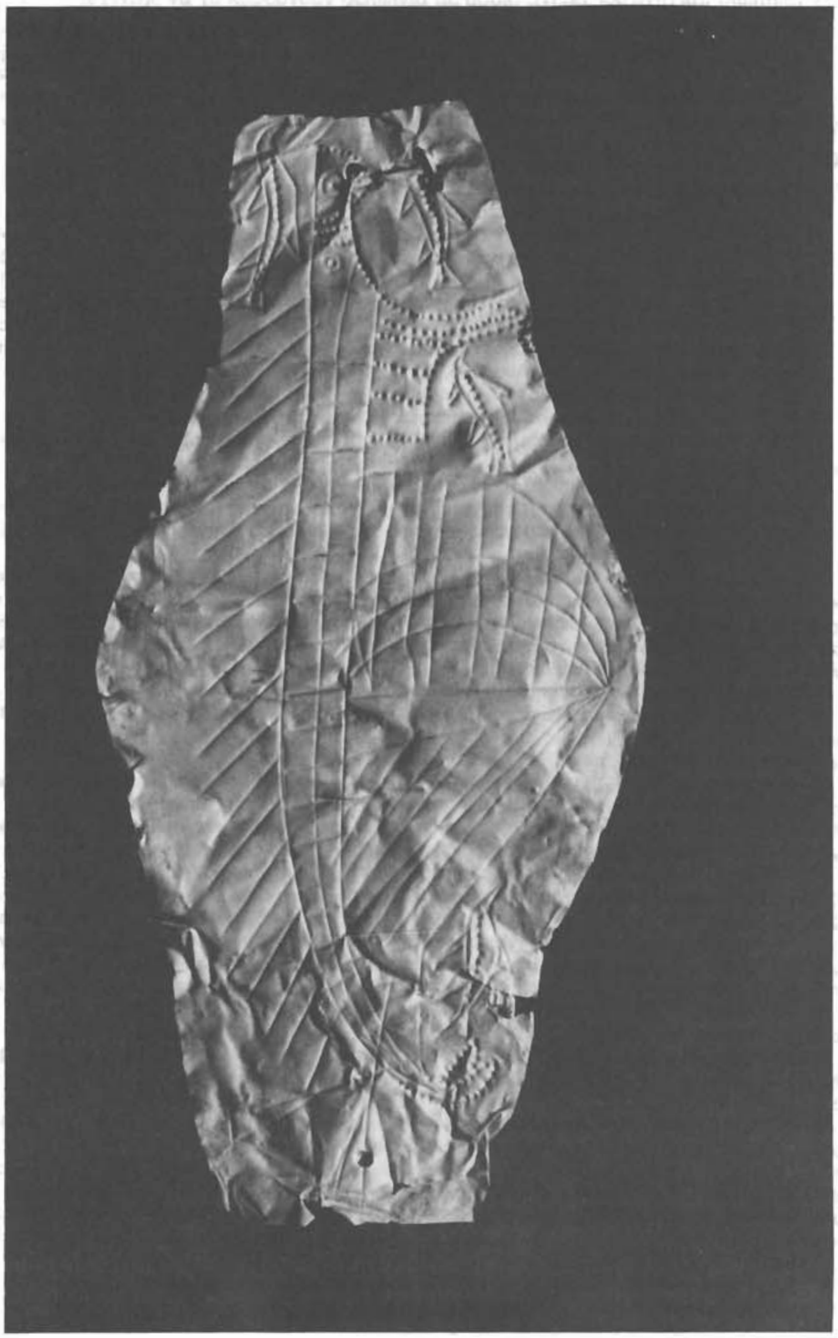
29. Για την εμφάνιση αυτών των λεπτομερειών στα αγγεία των αρχαϊκών χρόνων GOS, 84 arch.33, 90, 95 κ.έ.

30. Ένα μέρος του υλικού δημοσιεύεται στο Σίνδος, ό.π. (σημ.1).

31. Για αναχρονιστικά στοιχεία σε απεικονίσεις πλοίων βλ. GOS, 2. Πβ. την παράσταση στην υδρία Μ. Λούβρου Ε 735 και τις σχετικές γι' αυτή παρατηρήσεις: *GOS*, 86 arch.35. EAA V, 374 στη λ. nave (N. Alfieri). P. De La Coste-Messelière, *Au Musée de Delphes* (1970), 188 σημ. 2, 192 σημ.5 πιν.13. Η τριακόντορος με μια σειρά κουπιά (μονήρης) επανειλημμένα συνδέθηκε και με μυθολογικές παραστάσεις, βλ. Marinatos, ό.π. (σημ.25), 119. Coste-Messelière, ό.π. Gray, 64.

32. Για συμβολικά πλοία σε ταφικά μνημεία Αλεξίου, ό.π. (σημ.8), 9 κ.έ. και *AE* 1972, 15 κ.έ. Κ. Δαβάρας, *AE* 1984, 72 κ.έ. με προηγούμενη βιβλιογραφία.

33. Σίνδος, ό.π. (σημ.1), αριθ. 123,124,125,157 κ.ά. σποραδικά.



Σίνδος. Χρυσό έλασμα με παράσταση πλοίου

LA FOUILLE SOUS-MARINE DU PORT ANTIQUE D'AMATHONTE DE CHYPRE (Résumé)

De 1984 à 1986, l'Ecole Française d'Athènes a procédé à une fouille d'urgence du port antique d'Amathonte, à la demande du Service Chypriote des Antiquités. Avec une vingtaine de plongeurs, travaillant au total durant six mois, grâce à l'aide technique de la Garde Nationale Chypriote, de la RAF et au soutien financier d'une association locale (le SALPA), nous avons pu réaliser une vingtaine de sondages qui ont permis de comprendre la manière dont a été construit ce port en bon état de conservation (de 1 à 6 mètres sous la surface de la mer) et d'en fixer la chronologie. Les deux môles (150m de long) ont pu être partiellement dégagés, révélant jusqu' á six assises de boutisses de belle taille. Elles bordaient le côté intérieur du bassin, retenant une sorte de trottoir qui butait contre un brise-lames constitué d' énormes blocs grossièrement taillés. Construit á la fin du IVe siècle-début du IIIe siècle avant notre ère, ce port fut très peu employé s'il fut même jamais terminé. Une ré-occupation tardive a fourni un lot de céramique (surtout du VIIe siècle) qui offre un panorama de la vaisselle en usage à Chypre à cette époque.

Jean-Yves Empereur
Ecole Française d'Archéologie
d'Athènes
6, rue Didotou
Athènes
Grèce

Note: Résumé de la communication orale de Mr. Jean - Yves Empereur

THE *BARCO DO MAR* AND THE THERA BOATS BREED

The discovery, in 1972, of the mural paintings from Thera (Santorin), particularly of those depicting the procession of boats, is fundamental for the study of the spread of Minoan — Mycenaean cultural influence — hence the "The Lybia Fresco of Thera" designation (±1500 BC; S. Marinatos, 1974, 44-57; cfr C.G. Doumas, 88, 105) — but also because all at once the scarce information on the Bronze Age boats in the area was considerably widened by these accurate and detailed pictorial series (C. Casson, 1975, 4.1).

This second point has given rise to abundant literature on the subject, as referred by the International Journal of Nautical Archaeology (I.J.N.A. 14, 1985, 320 + L. Basch. 1986, 20).

Yet, the complexity of the subject, the relatively recent orientation of Naval Archaeology towards a method of analysis and comparison of *data* (including "ethnographic" *data*: S. Mc Grail, 1984, 11 ff.; O.Haslöf, 1977, 65 ff.; O.L. Filgueiras, 1977, 77 ff.); as well as the notorious lack of communication between researchers belonging to different cultural areas and separated by language barriers and by their particular conceptions, all this makes the study of that literature a difficult task.[1]

Considering the challenge in the situation, I am resuming the case of the *barco do mar* from the Portuguese central coast (fig. 1) (O.L. Filgueiras, 1975 and 1977) and, so, trying to ascertain the identification of the boats breed on the mural paintings from Thera.

Then I shall begin with a question:

The boats in the Thera frescoes had they a keel?

S. Marintatos (1972, 707) makes a reference to this structural element. And the models (hypothetical reconstitutions) in the Hellenic Maritime Museum of Athens (Fig. 2) and in the Naval Museum of Crete (Fig. 3) have a structure with kell, fore-post, stern-post and ribs, similar to those of more recent boats like the Kyrenia II (M. & S. Katzen).

This is a detail of utmost importance for the study of the typology and origin of these Bronze Age crafts. However for finding the key to the problem we must establish a connection between both the form of the boats and their constructive/structural nexus[1]. And what is more this should be done in a clearly determined archaeological context.

S. Marinatos when proposing the guidelines for the evolution of the Aegean Sea boats, in "La Marine Creto-Mycénienne" (1933), pointed out three main types (Fig. 4):

> 1 - *"Le type le plus primitif a les deux extremités anguleuses. Il est semble-t-il, originaire des Cyclades (n^{os} 1-8); mais il se recontre en Crète aussi (n° 19) et dans la Grèce continentale (n° 9) [...]/ La carène est très caractéristique; elle se prolonge à l'avant par une sorte d'éperon [...]/ La poupe se dresse plus haut que la proue [...]"* (S. Marinatos, 1933, 212).
>
> 2 - *"En deuxième lieu apparaît le type courbé-anguleux, dans lequel l'étrave est encore fixée à la carène selon un angle obtus. Mais la poupe a reçu une forme recourbée et arrondie. La poupe reste toujours plus haute que la proue. Cette modification est due sans nul doute à l'influence de la construction navale egyptienne [...]/[...] le type nouveau s'impose dès le commencement du MM et les modéles les plus caracteristiques sont les n^{os} 28-31, 34-35 ainsi que le n° 41, bien que dans le dernier exemplaire l'éperon ait déjà disparu"* (id. ib. 213-214).

3 - *"Le dernier type est celui du bateau recourbé également aux deux extremités [...]/ Comme types intermédiaires ont pourrait donner les n^{os} 33, 36 et 37, ou l'on aperçoit, quelque dégénéré,* ***l'éperon*** *de la proue. Plus tard le type devient assez simétrique, comme on le voit sur les n^{os} 38-40"* (id. ib. 214).

Björn Landström takes those of the *first type* as being derived form dug-outs. Comparing the pictures in the ceramics of Syra (n° 42, 2800 BC), with a clay model found in Crete (n° 43), *"and with a little guesswork"* he arrives

"at an oak dug-out, the sides stitched on, with a high, almost vertical stem post decorated with the image of a fish. Perhpaps it is also possible to discern a little historical development in the three pictures from Syra (42). The boat with the flat waterline would be the oldest type. Later it was attempted to lift the bow out of the water by choosing a curved trunk, and in the third phase a fore-post might have been attached to the dug-out" (B. Landström, 1961, 26) (Fig. 5).

As to the *second type* (according to Marinatos) Landström writes:

"On Cretan gems and seals of a somewhat later date, perhaps 2200-2000 BC, we find pictures of sailling craft (45) with a sharply rising fore-post sometimes as if it were a ram, and a less curved stem-post. In those days when it blew too freshly, the ships were sailed or rowed down the wind and a slightly raised and rounded stem would have made the hull more buoyant and given shelter to the helmsman. The curiously shaped fore-post has given many reason for believing that the pictures are of fighting-craft fitted with many rams, but I prefer to think of the ***cutwater*** *as a relic from earlier boats. When it was definitely found that this extension of the keel made it easier to keep the boat on course and furthermore lessened drift when sailing closer to the wind, many places continued to build merchant vessels with such a cutwater. A small clay model with a cutwater, painted with strips (ribs) and eyes in the bow (n° 49) supports this theory, and I belive that a trader from the days of Cretan power might well have appeared as in the reconstruction"* (id. ib. pgs. 26, 27) (Fig. 6).

About the *third type* he just comments briefly:

"[...] after 2000 BC we find pictures of boats with both fore — and stem — post gracefully curved (n° 47) and even if it is difficult to make out anything of the hull, the rigs show clear Egyptian influence (n° 48)" (id. ib. 27).

Nevertheless he cautiously adds:

"Perhaps the influence was from the opposite quarter? Perhaps the Egyptians were learning from the Cretans as early as that? It is generally agreed that the peoples around the Aegean Sea, having access to excellent ship's timber, began to build their boats with kell (sic) *and ribs at an early date"* (id. ib. 27) (Fig. 6).

Lionel Casson, after his study of 1964, gives in 1971 a more precise version about the typology directly related to our theme: - the third type:

"The Cretan vessel we can be surest of, since it is portrayed on a number of carefully

engraved seals (nos 37-40), dates from shortly after the middle of the second millenium BC. It has a slender rounded hull, with identical or nearly identical prow and stern, both devoid of any ornamental device [...]. Other carefully done seals of the same age show a hull so rounded that it seems almost crescent-shaped (nos 47, 48). Again, stem and stern are generally undecorated, although one end (nº 48) occasionally is finished off with an ornamental bifurcation. The ends can be of equal height (nº 47) or the stern slightly higher (nº 50)" (L. Casson, 1971, 33) (Fig. 7).

Or, neither this Author, nor Björn Ländström try to establish the relationship between this highly peculiar boat breed and the so called *"sacred barges"* (H. Hutchinson, 94), the *boats of worship* (S. Marinatos, 1933, 224 ff.; cf. C. Laviosa, 20). However Hutchinson, although following closely the work of Marinatos *("still the best general account of this subject"*/H. Hutchinson, 359) observes about the Tiryns boat (nº 7.50 of L. Casson):

> *"The Tiryns boat may, of course, be a Mycenaean variant unknown in Crete, but there are other similar boats, except that they have no deck cabin as a rule, appearing on Minoan seals, usually in religious scenes. These boats resemble an old Mesopotamian type employed by the Marsh Arabs[2] and illustrated by a silver model found in the royal graves at Ur"* (H. Hutchinson, 359, cf. O.L. Filgueiras, 1975, 28).

When studying[3] the probable relations between our *barco do mar (xàvega* boat, Aveiro) and the boat type of the silver model of Ur (Figs. 8, 9) I came across the following text about the evolution stage of boat-building as represented by the *plank-built boats:*

> *"Another quite distinct* (from that of the dug-outs) *technique is that of the plank-built boats, which very often are mistook with the dug-outs with added planks on the sides./ The plank-built boats gave origin to our present* ***chalands*** *and to the Venice* ***gondolas****, as well as to several other boat types in Europe, like those in Portugal and Rumania. The most privitive forms correspond to boats built with three planks [...] They are built with three planks of approximately the same breadth, bound by a stitch. Several separate, ie. not tied to a backbone, beams are fixed in the inside. Their ends tied together rise so that the boat form is that of a four days moon, as wrote a chronicler when referring to those of the Chilean archipelagos. Their diffusion points out that they appeared later than the dug-outs, and they are almost not to be found out of the regions of high culture. With this type of boat, for the first time, we can try a study of its place of origin and the routes of its diffusion in the world. In a silver model of Sumerian origin, from before 3000 BC, found in Ur, in Mesopotamia, is reproduced a type of plank-built boat still in use in that region, although at present with more planks./ As Mesopotamia is the place where this boat appears for the first time, we can accept that its presence in other places in the world is due to migrations from here./ It seems it have been known in Minoan Crete, much before the Greek, what explains its survival in the Mediterranean, and in the aforementioned places in Europe. Also derived from it are our flat-bottomed* ***chalands*** *with no keel. The number of planks used have augmented, but in many places, like Portugal, Rumania and Venice,, the characteristic form with equally raised ends is till preserved [...]"* (I. Grasso, 1955, 53-56)[4] (Fig. 10).

is round, while that of the Mesopotamian plank-built boats is a square/trapezium. In the former, in a certain period we can observe the beginning of the use of a keel (Fig. 23), while in the latter the structural concept of hard-chined box (although with raised ends) is preserved (T. Heyerdahl, 14-15) (Fig. 25). Furthermore, the thesis of a Mesopotamian influence in the Levantine coast during this period seems acceptable:

> *"Sargon of Akkad (2330-2295 BC) the first Semitic dynast of Mesopotamia, and his grandson Naram-sin claimed dominion* ***from the Upper to the Lower Sea,*** *that is from the Mediterranean to the Persian Gulf, and tell in their inscriptions of expeditions to the* ***Cedar Forest,*** *and the* ***Mountain of Silver.*** *These localities are almost cretainly Mount Lebanon and the Taurus range and indeed the Amanus is expressly mentioned in the text which describes the extent of Naram-sin's rule. But we cannot ascertain the political relationship of these western districts to Mesopotamia in Sargon's day, for the third-millenium civilization of Syria is little known, though archaic cylinder seals show distinct Early Dynastic influence. The recent discovery of Akkadian seals at Ugarit has led to the suggestion that the Akkadian seals at Ugarit has led to the suggestion that the Akkadians maintained a trading fleet in Syrian waters as a northern parallel to Sargoris trading enterprises with Magan (Oman?) and Meluhha (India?) on the Lower Sea"* (W. Cullican, 17; cf. Gabriel-Leroux 18-20, T. Heyerdahl, 115, P. Demargne, 28, 29, 37, 81-84).

In Ugarit will be perhaps found the answer to the mysterious rising of a new boat typology in the Aegean Sea during the third-millenium BC. And even to the now bradly accepted idea of a Sumerian influence in the Egyptian boat building (B. Landström, 1970, 14-15; P. Montet, 249, 260; Z. Herman, 81)[9] (Fig. 26).

Besides, M. Malowan (1916, 17) states clearly that indeed, the Euphrates was the real umbilical cord of Mesopotamia: from the most ancient times it served as a trade route between the Persian Gulf and the Mediterranean - and to Ugarit, we may add.

Based on the most relevant iconographicsources,let us try to outline the progression of the planked-canoes of Mesopotamian type and/or of their "ancestors".

Sumeria		**Egypt**
Eridu	4000 BC	
Djemdet-Nasr	3500 BC	Gebel-el-Araq/Gersean
Ur - 1st Dinasty	2500 BC	
Ugarit		
Crete	2000 BC	
	1300 BC	
Hagia Triada	1600 BC	
Thera	1500 BC	

The Argentinian Authors in their main work take as a meaningful example the boat painted in the Hagia Triada (Crete) sarcophagus (I. Grasso, 1949, 171). This gives special relevance to the comparison (quoted above) by Hutchinson between Aegean engravings of boats and the Sumerian types still in use in the Lower Euphrates.

It is admissible that the Sumerian *plank-built boats* are in a lineage originating from the reed rafts and having as an intermediate element the *zaima*[5], a canoe of stiched reeds covered with bituminen.

For A. Salonen the evolution of boat-building in Mesopotamia was the same as in the ancient Egypt, where the reed rafts have been in a similar way the prototypes of the succeeding wooden boats. (T. Heyerdahl, 1982, 116; cf. A. Salonen 14-15, H. Hodges, 80-84)[6].

We can follow this evolution by considering the clay models of Eridu (Fig. 11) and El Obeid (Fig. 12), the rafts and boats in the cylinder-seals of Uruk (Fig. 13) and Djemdet-Nasr (Figs, 14, 15)[7], the engraving of Misilim (Fig. 16), and the silver (Fig. 9) and bitumen (Fig. 17) models of Ur (cf. O.L. Filgueiras, 1977, Fig. 9.9)[8], when duly compared to the present models in the zone, like the rafts (Fig. 18), the *zaima* (Fig. 19) or the *mashuf* (Fig. 20).

L. Wooley (1954, 41) gives the following description of the silver model corresponding to the latter (Figs. 9,20):

> *"Some 2 feet long, it has high stern and prow, five seats and amidships an arched support for the awning which would protect the passenger, and the leaf-bladed oars are still set in thwarts; it is a testimony to the conservantism of the East that a boat of identical type is in use today on the marshes of the Lower Euphrates, some 50 miles from Ur".*

According to T. Heyerdahl, though they were formerly made of local reeds, nowadays they are of imported wood and with a light cover of black asphalt like their wooden prototypes (T.H. 14-15).

And he also adds that the features of the present crafts are identical to the small reed models covered with silver or asphalt that were placed as offerings in Sumerian temples (T.H. 17).

This theory on the origin and development of types is much broader and more comprehensive than J. Hornell's, so faithfully condensed by J. Needham in his "Chart of the Development of Boat Construction" (IV/3. 384). Indeed, the part dealing with the evolution of reed rafts does not refer to Mesopotamia or to its influence on the planked canoes family.

We may thus establish the ancestry of Minoan boats of the third type — the moon-shaped and similar. Among them I shall point numbers 47, 48, 50 and 51 (Fig. 7) in L. Casson's op. cit.; the boat on the Hagia Triada sarcophagus (Fig. 21) and, of course, those depicted in the Thera frescoes (Fig. 22).

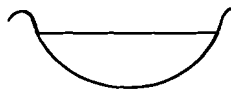
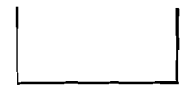
As we have just seen, the present theory on this naval typology is based on two main presumptions:

— of a specific technical evolution (reed rafts → reed canoes → planked canoes);
— of a specific cultural area — Mesopotamia — for their birhtplace.

The first of them has already been treated. We shall now deal with the second.

Actually if we compare the Egyptian papyriform boats with the "Mesopotamian" plank-built boats we conclude that the evolution of the raft to the boat assumes different expressions in Egypt[9] and in the region of the present Iraq. The transverse section of the papyriform boats

Nevertheless, let us reconsider the basic characteristics of the plank-built boats of Mesopotamian type. The schemes

 a  b

presented by Clelia Laviosa in her paper "La Marina Micenea", which apparently represent the transverse sections of two "opposing" boat breeds, denote that the problem was not unknown to the Author:

> *"Il confronto fra più rappresentazioni permette invece di chiarire alcuni dettagli, ed insieme di individuare quali erano gli elementi che venivano retenuti essenziali dagli artisti micenei per qualificare una nave. Questi stessi elementi respecchiano ovviamente quali erano le caratteristiche fondamentali delle navi micenee. Quindi se, per fare un exempio, nel mondo cipro-fenicio per appresentare una nave si tende a un disegno che potremmo riasumere schematicamente [**a**], e nel mondo miceno, od egeo, a un disegno [**b**], è evidente che per gli uni la nave era charatterizzata dallo scafo rotondo e dal ponte, per gli arltri dalla chiglia angolosa e cava, le **navi cave** appunto della tradizione omerica"* (C. Laviosa, 8) (Figs. 23, 24, 25).

On the other hand, as we have already seen, one of the more concrete elements in the theory of D. and J. Ibarra Grasso is the diffusion of these type of plank-built boat across the Mediterranean until the extreme south-west of Europe: Portugal. Although they refer in Portugal only one model — *"with the form of the gondola"* (I. Grasso, 1949, 172 & fig. 175) — the *barca serrana* of the river Mondego, there are many others. In a direct enquiry I made in 1961 (O.L. Filgueiras, 1962) I found four distinct groups as shown in the annex table (O.L. Filgueiras, 1967, 1975, 1977).

Although in Italy there subsists an equally big number of models of the same breed (M. Bonino, 1978, 24 ff., figs. 23-28; 1985, 5), the fact is that the places of its greater developement are located in Iraq and in Portugal. Those models are still in use in the countries where they appeared centuries or milleniums ago. From the four groups I mentioned I emphasize the first two as they preserve the basic lines of the primeval types.

It must be said that in spite of their primitiveness these boats are not circumscribed to the rivers and lagoons, as they are used for fishing along the (Atlantic) coast. Furthermore "migrations" of fishermen from Ilhavo and Ovar (in the central zone of the Portuguese western coast) to the South of Spain searching for fish have been recorded nowadays:

> *"these boats (**bateiras*** from Aveiro) *explore all the lagoon [...]. Outside their own zone* (the lagoon of Aveiro) *they can be found in every river where there are colonies of fishermen from Aveiro: the Douro, the Mondego, the Tagus, the Sado, the lagoons of Lagos and Portimão, the Guadiana. Some of these colonies settled in Spanish havens, like Cadiz and Sevilla, always preserving the identity of their nationality, their practices, uses and types"* (L. Magalhães, 60) (Fig. 29).

Until the 19th century, in the zone of Aveiro and in the river Tagus there were other specimens which meanwhile disappeared. Among them the old *varino* which carried goods from Aveiro to Lisbon (Fig. 28).

This shows the nautical abilities of these so rudimentary structures whose construction system we shall now analyze.

In Portugal the building system for both the double-ended *plank-built boats* and the boats of Nazaré is the "skeleton-first". The central plank of the bottom is used as a keel for assembling the stern-post/fore-post and for placing the floor timbers and ribs. The side planks are then fixed and, finally, the bottom is finished (Figs. 30, 31, 32). This explains how it is possible *"the building of hulls with a pre-erected inner structure [without a] prominent keel plank, as in ancient and some modern Nile boats"* (L. Casson, 1971, 27, ref. to J. Hornell, 216-221).

The photographic documents available show the similarity of the building methods used by the Ma'dan of the Lower Euphrates[10] and in Portugal. Moreover L. Casson, based on J. Hornell, notes that

> *"such a procedure (skeleton first) cannot be proved until after the arrival of the Portuguese in India at the end of the 15th century [...] before that time, whatever information we have points to the use of the shell-of-planks technique. Egypt offers an illuminating parallel. There the shell-of-planks technique maintained itself without a break from earliest antiquity to the present all along the Upper Nile; however to the north of Aswan, the area that felt western influence in the earliest and strongest, it was replaced by the skeleton-first technique, introduced presumably from Europe. The Tigris and Euphrates must have shared the fate of the Lower Nile"* (L. Casson, 1971, 25; ref. to J. Hornell, 229-241).

Obviously, besides the relations with Egypt, in which the Mesopotamian influence is a theme deserving a carefull study, we should not forget India./ T. Heyerdahl emphasizes the importance of the contacts between Sumer and the Indus (T. Heyerdahl, 233 ff.; cf. L. Casson, 1971, 23-24)[11].

M. Mallowan (1961, 23) states that by 2000 BC. Barhain in the Persian Gulf appears as an important tradepost between Mesopotamia and India (ie. the river Indus) (Fig. 35). This is given in more detail by M. Wheeler (1962, 230) with a direct reference to the kingdom of Sargon, ca. 2300 BC.

Or one of the more reasonable plank-boat building systems is documented by Basil Greenhill in the river Indus, and described as follows:

> *"On the banks of the Indus [...] some years ago I watched the construction of a large flat-bottomed river boat (the* ***bohatja****). First her two sides were assembled. They were made of planks joined edge to edge with wooden pins driven in holes drilled diagonally across the seams from plank face outside to plank face inside. The vertical columns of cut off pin-heads are clearly visible in the Figure [...]. The heads are of oval shape because of the angle at which the pins emerge from the plank face. Behind the complete sides the bottom is being made and is clearly visible in the photograph. A row of floor timbers, like railway sleepers across the dry mud of the river bank, has the planks fastened across it, outside ones first working inwards. The finished bottom is then turned over and the sides fastened to the beam ends. The ends of the bottom are forced up at either end to follow the shape of the sides. Side frames or timbers are then added and then deck beams and decks, the whole making a strong box-like boat [...] admirably*

suited to her environment and purpose, which is to be the great cargo carrier on the River Indus" (B. Greenhill, 68) (Figs. 33, 34).

Being the *neta* of Nazaré (Figs. 36,37) a model very close to the *bohatja* it would not be surprising if we found out that the original building method for our plank-built boats of Mesopotamina type was the same: (O.L. Filgueiras, 1981, 22 ff.). And this would explain even the fact that the side planks in our *bateiras,* as in the *mashuf,* are set in horizontal straight lines from stem to stern and not crescent shaped (Fig. 38).

A logical explanation, before the strange hypothesis of a supposed Celtic influence — as suggested by P. Johnston (1980, 91 Fig. 8.6).

At this point we have to approach a fundamental problem, that of the relations beteween peoples and cultures, in order to answer the question of how and when this boat breed has been introduced in Portugal.

The influence of Akkad through Ugarit and the sea-bordering Syrian-Palestinian towns explains much of what would have happened in the eastern Mediterranean and in the Aegean Sea, before the Phoenicians (S. Moscati, 22 ff.; cf. S. Marinatos, 1974, Plate 95 fig. a).

Whenever the Near East influence in the extreme west of Europe during the (local) Bronze Age is discussed the Phoenicians are immediately evoked (A.C. Ferreira da Silva, 124; cf. R. Parreira & C. Vaz Pinto, 4-6).

But the foundation of the Phoenician colony of Cadiz, in the South of Spain, would have had much to do with the importance which Tartessus already had (S. Moscati, 244-250). The relationship of this emporium with Mycenae is frequently mentioned:

> *"... Les caractères géneraux de la colonisation phéniciénne en Meditéranée s'harmonisent parfaitment avec l'instalation d'entrepôts sur les côtes espagnoles à partir de l'an 1100 environ, époque à laquelle justement des Phéniciens succédent aux Mycéniens dans le commerce avec l'Occident. Or Cadix était un point d'interêt vital parce qu'il permettait le controle de la zone des mines argentiféres de Tartessus"* (S. Moscati, 247).

And also the control over the Straight of Gibraltar: (Fig. 39,,41) (Charles-Picard. 180, 182, 186, 190; cf. A. Schulten, 61 ff.)

Nevertheless from the 6th century BC onwards, when Carthagus exerts its hegemonic power (it would have destroyed Tartessus between 520 and 509 / cf. A. Schulten, 125)[12], the relationship of the Carthaginean with local peoples would not have been easy (cf. Charles-Picard, 183).

Among the subsequent migrations, that of the *Turduli* from the area of Guadalquivir, in the 3rd century, is of special interest (A. Alarcão, 18-19). Those that come to stay in the area where the plank-built boats of Mesopotamina type predominate (Fig. 44). If the Phoenicians would have by any chance arrived at the South of the Peninsula in boats of a more developed type (Fig. 40)[13], one would have to find out the diffusion agent of our plank-built boats among their past contacts with Mediterranean navigators/sea traders. And this because the spread of those plank-built boats from the zone of Gibraltar to the Rio de Aveiro, Mondego and Tagus seems to be depicted by the distribution map of the Turduli (O.L. Filgueiras, 1975, 35-37; 1977, 103).

This does not contradicts that in a second wave, during the Moslem dominion over the Peninsula (since the 8th century AC), the conquerors would not have brought some of the same or similar models (Fig. 43) (O.L. Filgueiras, 1975, 52-54; 1977, 23-24) as the Arabs still do in the present days (for instance in Melilla - N. Africa).

To summarize,in this search concerning the realtionship between the forms of the Thera boats and their constructive/structural nexus, in a well defined archaeological context, we tried to identify the tipology of these boats — the plank - built boats of Mesopotamian type — whose diffusion from Ur (Fig. 39) to the Levantine coasts and from them to Crete seems to have happen during the kingdom of Sargon of Akkad (2330-2295 BC). So it would have been before the begining of the Phoenician History (1200 BC). However, long before (ca. 4000-3500 BC) the influence of the Mesopotamian boats in Egypt is documented (Gebel-el-Araq).

The "explanation" of the existence of an important center for this boat type in the central coast of Portugal — perhaps more important than that in Italy — would consist in the evoked relations between the Near East and Tartessus, before the foundation of the Phoenician Cadiz (1100 BC), and in the migration of inhabitants of the South of the Peninsula to the zone of the *Turduli* in the 3re century BC. This does not contradicts the hypothesis of the use of the same boat type by the Moslem conquerors of the Peninsula many centuries after, as they still do in the North of Africa (Melilla) and in the Near East.

On the other hand, these boats, that at present are built in compliance with the Mediterranean "skeleton-first" system, could have been built in earlier times as the *bohatja* of the Indus. This latter system is more rational for plank-built boats, and its diffusion can be explained by the relations between Akkad, Dilmun (Barhein) and Mohenjo-Daro (Indus), ca. 2350 BC (Fig. 35).

Now we can repeat the question: had the boats in the Thera frescoes a keel? If they belong to the Mesopotamian plank-built boats breed[14], like the Portuguese ones, the answer is, obviously, no. This implies that they must have a rectangular or trapezoidal transverse section, with a flat bottom with no keel, as in the present day Iraqui, Italian and Portuguese boats, and as is clearly shown by the clay model from Kofinas, Crete (2000 BC, S. Alexiou, 45)[15] (Figs. 45, 46)

Octávio Lixa Filgueiras

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NOTES

1. This research requires a deep knowlegde of the practices of traditional boat-building and of the meaning of each different procedure.
2. W. Thesiger (1958, 212) considers the Mad'ans to descend from the Sumerians, Babylonians and Persians. L. Woolley (1954, 12) ref.: *"Ur, so called* ***of the chaldees,*** *the home of Abraham".*
3. I was first interested in the subject in 1957 (O.L. Filgueiras, 1958, 7, note 12).
4. As there are several types of plank-built boats, most probably they had their origin in different places. Hence my designation of *Mesopotamian type* for Protuguese plank-built boats of this breed. The Ur model dates from ±2500 BC.
5. Contrarily to W. Thesiger (1976, Fig. 45), T. Heyerdahl (1982, 22) calls it *jullabie;* he considers the *zaima* as a variant of the *mashuf.*
6. In the photos, before page 96 and after page 128, the Author presents a boat shaped raft, as a survival of Barhain old times, made of palm penduncles and of ."tores".
7. To A. Parrot (1963, 189 ff), the Gebel-el-Araq knife (pre-Thinite period) suggests some affinity with the Warka hunting stela (Djemdet Nasr; cf. B. Landström, 1970, 14-15).

8. I have followed the chronological, instead of the evolutive order of the documents (reed bundle crafts — Fig. 13, 14, 15 —; reed framework covered with bitumen crafts — Fig. 11, 12, 19 —; planked-built boats, Fig. 20). Nowadays all these specimens can be found in the same places.
9. In ancient Egypt, besides papyriform boats there were also other types, including the Mesopotamian one (B. Landström, 1971, 26-53; cf. H. Hodges, 54-57). See note 7 and fig. 26..
10. W. Thesiger (1976, fig. 73) documents the beginning of the *mashuf* building by the central plank of its flat bottom: the adaptation of the Mediterranean system (skeleton first) seems clear. As it happens in Portugal. In Italy, when starting the construction of the *gondola*, a blocking is employed instead of the central piece of the flat bottom.
11. Cf. the theory of Sumerians arrival (by sea) from Dilmun (T. Heyerdahl, 1982, 8, 118, cit. L. Woolley).
12. Contrarily to Schulten, G. and Charles Picard (180, 182, 186) admit that the destruction of Tartessus was due to the Celts.
13. Strabo refers the use of *hippoi* by Gades inhabitans (A. Garcia y Bellido, 223; cf. D. Harden, 173 & Fig. 47). We do not know whether Phoenicians have ever used planked boats.
14. As in the Thera mural (S frieze, room 5, W House) the boats are ashore, with no props or wooden rolls.
15. On the interpretation (ritual celebrations) of the scenes depicted, see chapter V of Nannó Marinatos' work; and the reference to the importance of such festivities in Egypt and specially in Mesopotamia (op. cit 52).

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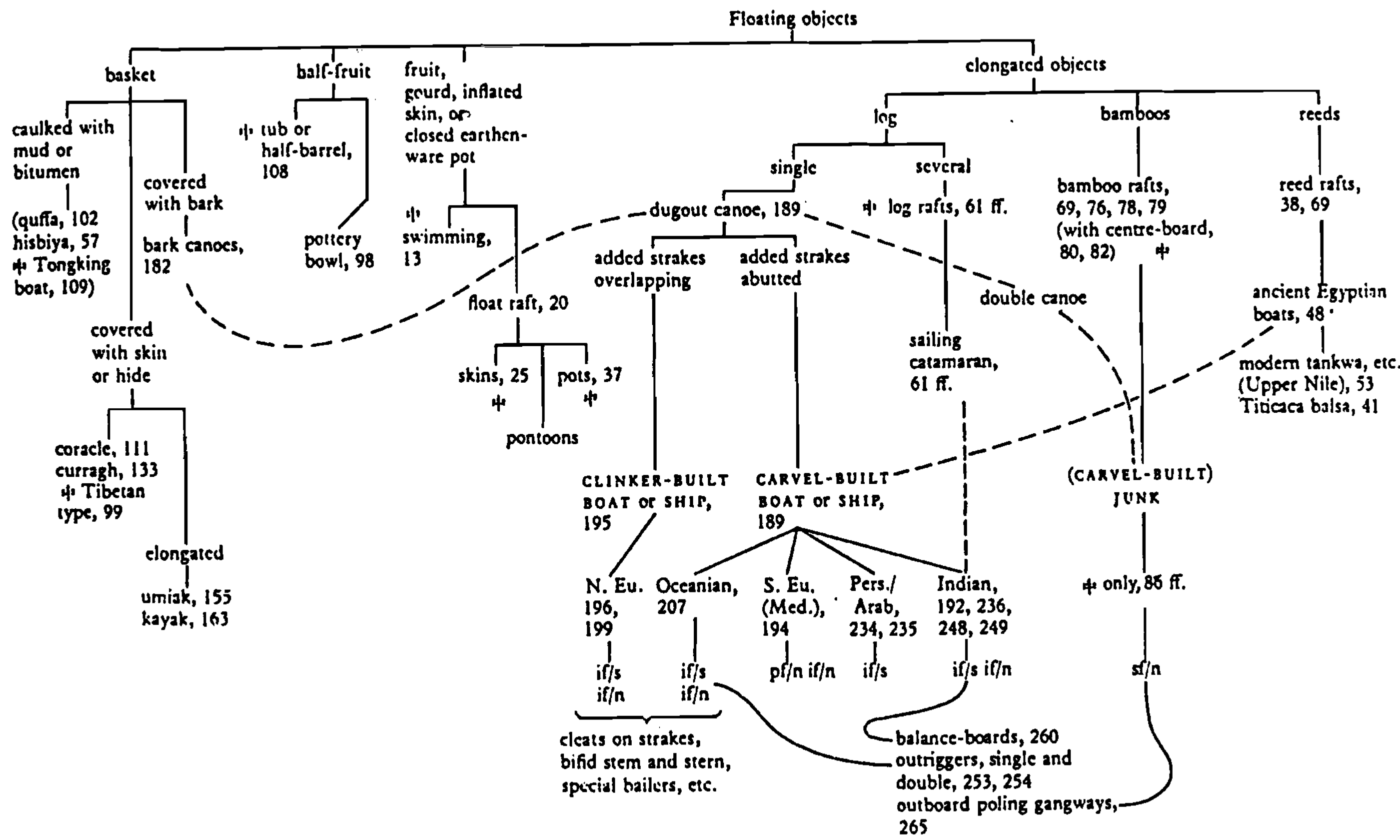
ILLISTRATIONS

Fig. 14, 15 - Reed bundle crafts: cylinder-seals of Djemdet-Nasr (3200 BC, after A. Salonen figs. III$_2$ & III$_3$).
Fig. 16 - Boat in a bas-relief from Misilim (3000 BC, after A. Salonen, fig. VI).
Fig. 17 - Model of a reed and bitumen craft - Ur/1st Dinasty (after A. Salonen, fig. XIV$_2$).
Fig. 18 - Ma'dan reed raft (after W. Thesiger, fig. 48)
Fig. 19 - The *Zaima* (after W. Thesiger, fig. 45)
Fig. 20 - The Ma'dan *Mashuf* (after Gavin Young, p. 132)
Fig. 21 - Hagia Triada sarcophagus painting - detail (after P. Demargne).
Fig. 22 - Reconstitution of a boat from the Thera mural (after S. Marinatos, fig. 5).
Fig. 23, 24 - Transverse sections of an Egyptian (no 40) and a Phoenician boat (no 62) (after B. Landström, pp. 25, 31).
Fig. 25 - *Barco do mar*: plans (Maritime Museum of Lisbon).
Fig. 26 - The foreign boat in the Gebel-el-Araq knife (**a**), compared with the Assyrian model from Khorsabad (**b**) (after Winkler, in J. Hornell, fig. 16).
Summerian boat (**1**); Egyptian models of the Pre-Dinastic Period (**2, 4, 5**); Mesopotamina model (Egypt/**3**); model of the second Intermediate Period (**6**) (after B. Landström, 1971, figs. 21, 23, 26, 28, 29, 31).
Fig. 27 - *Barca Serrana*, of Mondego river (photo Arqt° Vasco Cunha).
Fig. 28 - *Bateiras murtoseiras*, Afurada/Douro river (photo O.L. Filgueiras).
Fig. 29 - *Varino* of the Tagus, or *Enviada:* plans by R. Monléon (after A. Pâris).
Fig. 30, 31, 32 - Main steps in the building of *barca serrana* (photos Alfredo Barroca): **30** - the central plank of the flat bottom with the stem and the stern posts, and the floor timbers, 31 - then the first strake and the futocks, 32 - the flat bottom is not completed until the sides are finished.
Fig. 33, 34 - The *bohatjia* of the Indus and its construction (after B. Greenhill, figs. 22, 23).
Fig. 35 - Mesopotamia, and its doorways to the Mediterranean and the Indian Sea (from M.E. Mallowan, pp. 128, 129): Ugarit (**A**), El-Obeid (**B**), Eridu (**C**) Ur (**D**), Djemdet Nasr (**E**), Mohenjo Daro (**F**).
Fig. 36, 37 - The *neta* of Nazaré (photo O.L. Filgueiras).
Fig. 38 - The side planks of the *mashuf* are set in horizontal straight lines (after Gavin Young).
Fig. 39 - Main stages in the westward progression of the plank built boats
A - Eridu, Djemdet Nasr, El Obeid, Ur
B - Ugarit; **1** - caravan route to Aleppo
AE - Egypt
C - Crete; **2** - Mesopotamian vector
D - Byblos, Sidon, Tyr; **3** - Phoenician vector
4-5-6 - Cretan vector
a - Venise
b - Marseilles; **8** - the Rhône; **9** - Tin route (Garonne)
7 - Gibraltar - control of the sea tin route
c - Tartessus
d - Main area of the Portuguese planlk built boats of Mesopotamian type
e - Scilly Islands
f - Castro Urdiales (Muslim)
g - Arcachon
Fig. 40 - Gibraltar and the control of the sea tin route (after M. Mazel, kp. 164)
Fig. 41 - Migrations after the fall of Tartessus - 3rd century BC (after T. Sousa Soares).
Fig. 42 - Portugal: type of boats: **1** - Germanic tradition; **2** - Box-like river *barcas;* **3** - Rafts; **4** - Local crafts; **5** - *Masseiras;* **6** - Mesopotamian tradition; **7** - Nordic tradition; **8** - Double-ended Mediterranean *barcas;* **9** - after-tramson keel boats (after O.L. Filgueiras, 1975, p. 37).
Fig. 43 - A Phoenician *hippos* (after B. Landström, fig. 64, p. 31).
Fig. 44 - Muslim fishing boat from Faro, in a illumination from the Codex "Cantigas de Santa Maria" (after J. Cortesão, vol 1o, pp. 160, 161).
Fig. 45, 46 - Clay model from Cofinas (Heraklion Museum, room II, vitrine 21).



MAP 1 — "Chart of the Development of Boat Construction (Bazed on Hornell", repr. da ob. cit. de J. needham, pág. 384.

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28 THE ANCIENT WORLD

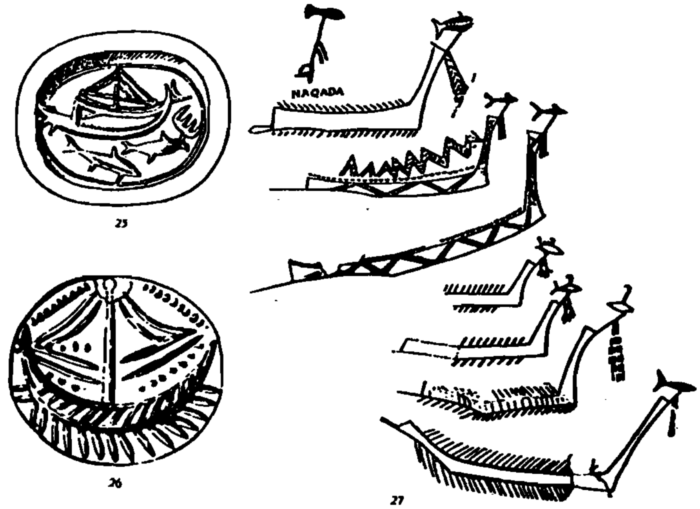


FIG.4

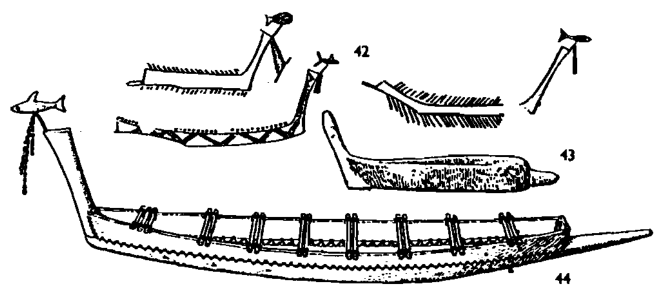


FIG.5

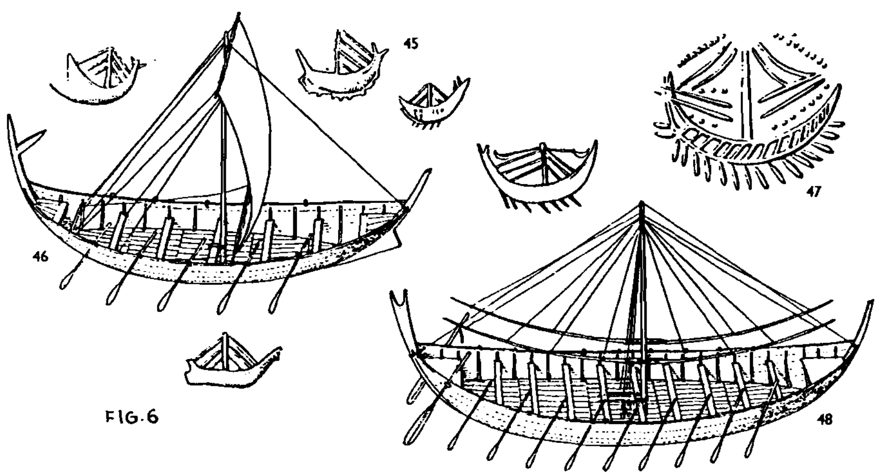
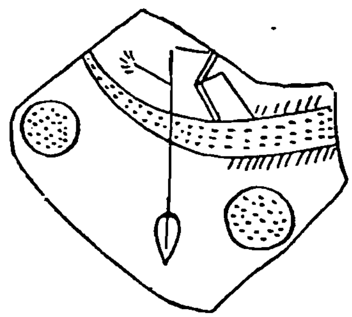
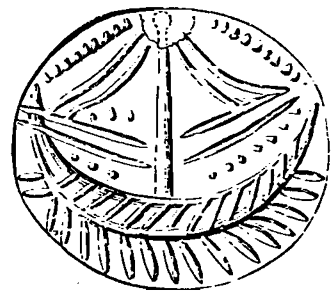


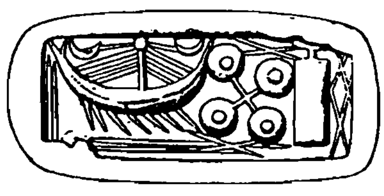
FIG.6



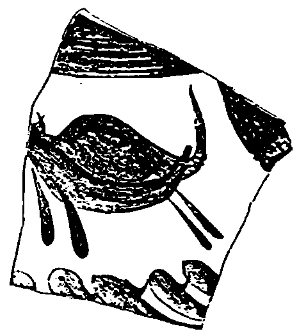
46. Fragment from Phylakopi on Melos, 3rd millennium B.C.



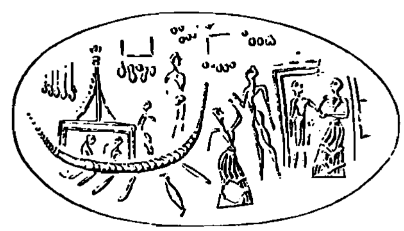
47. Minoan seal, ca. 1800 B.C.



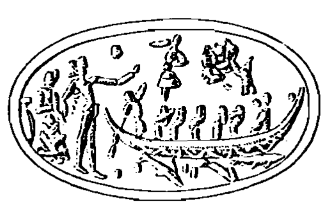
48. Minoan seal, ca. 2000-1600 B.C.



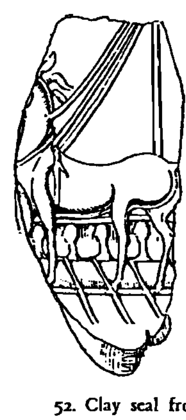
49. Fragment from Mycenae, ca. 1200-1100 B.C.

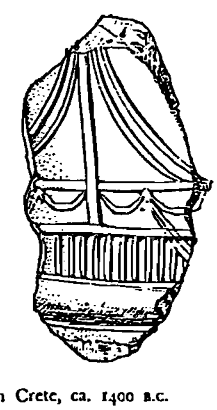


50. Gold ornament from Tiryns, ca. 1300 B.C.

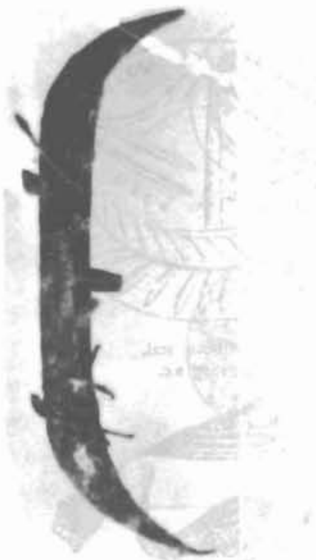


51. Gold ring from Crete, after 1400 B.C.





52. Clay seal from Crete, ca. 1400 B.C.
53. Clay seal from Crete, ca. 1400 B.C.



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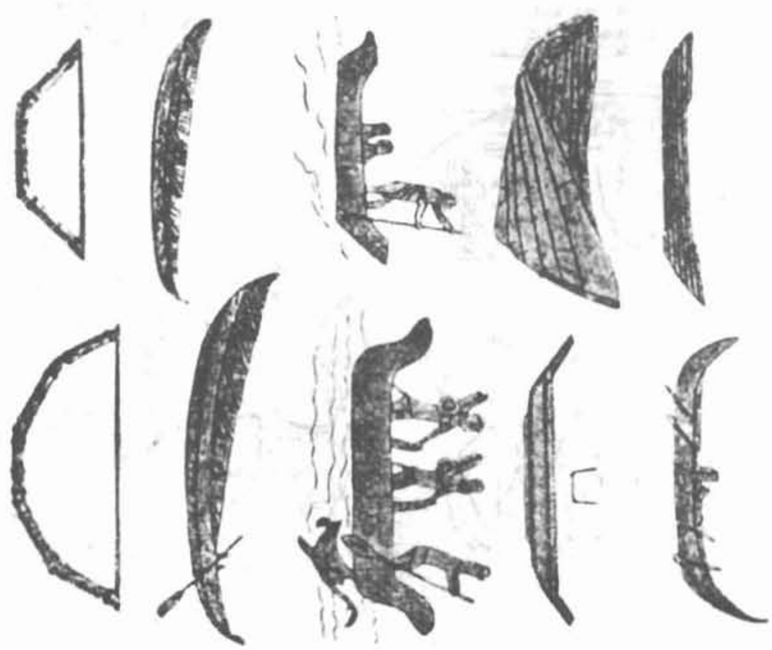

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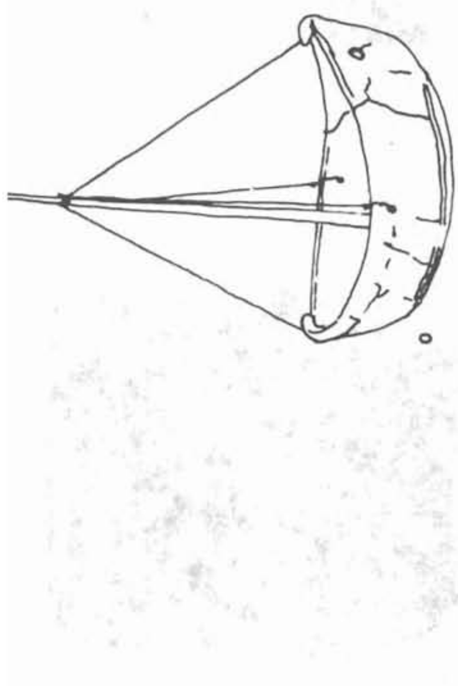
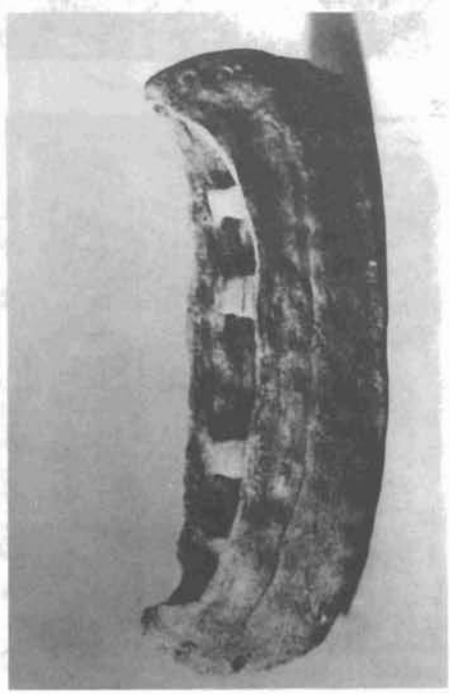


FIG. 11



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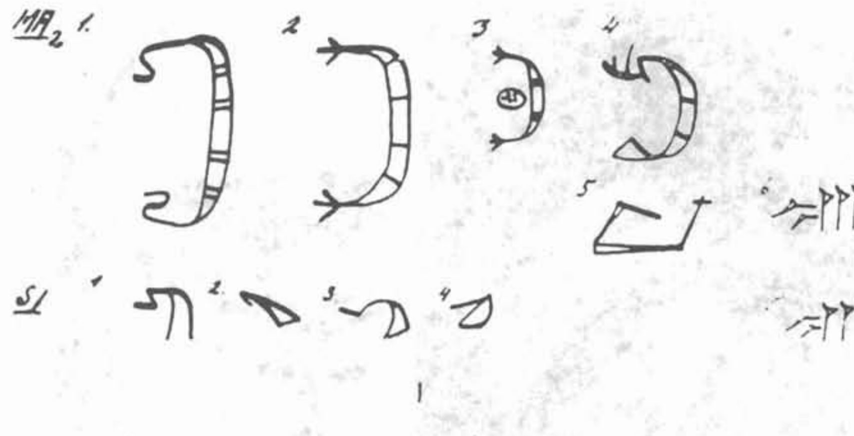

FIG. 13

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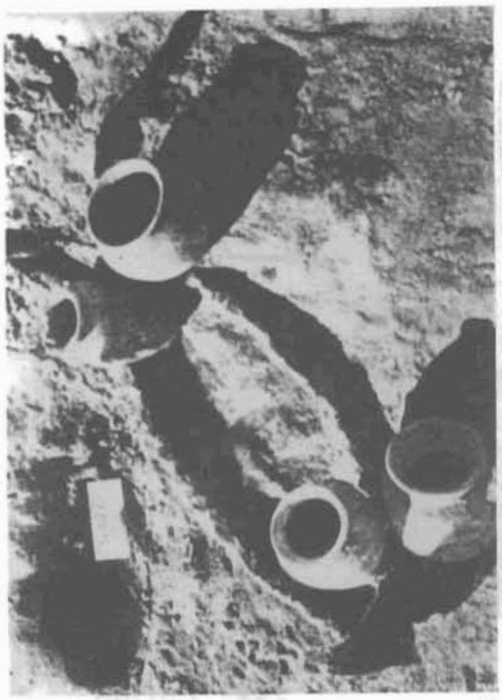

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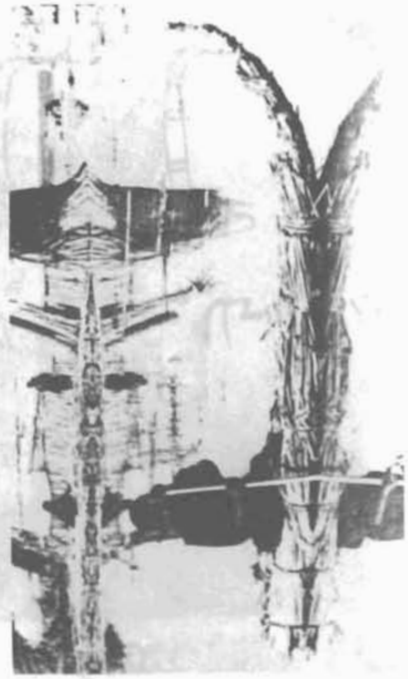

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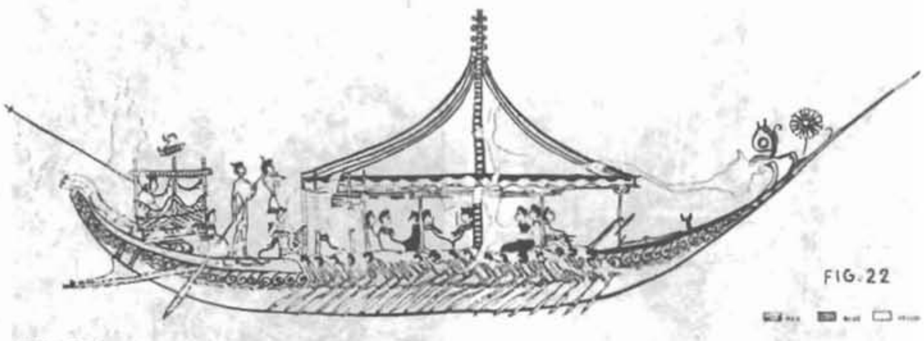


FIG. 22

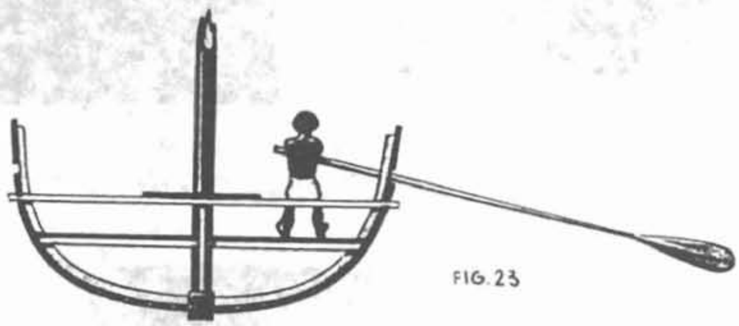


FIG. 23

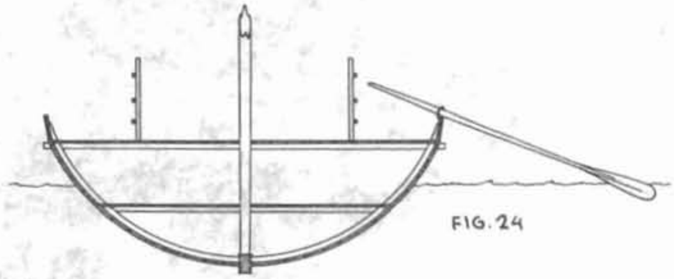


FIG. 24

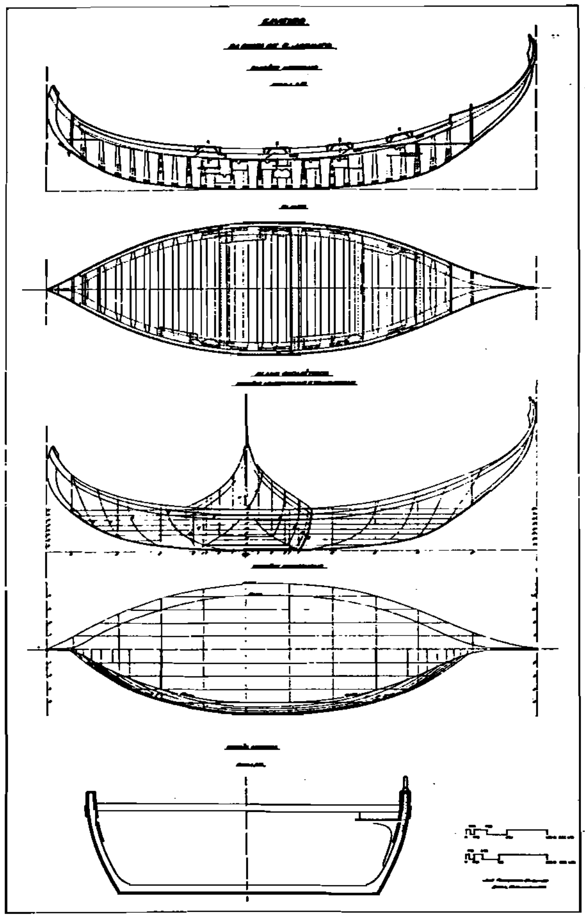
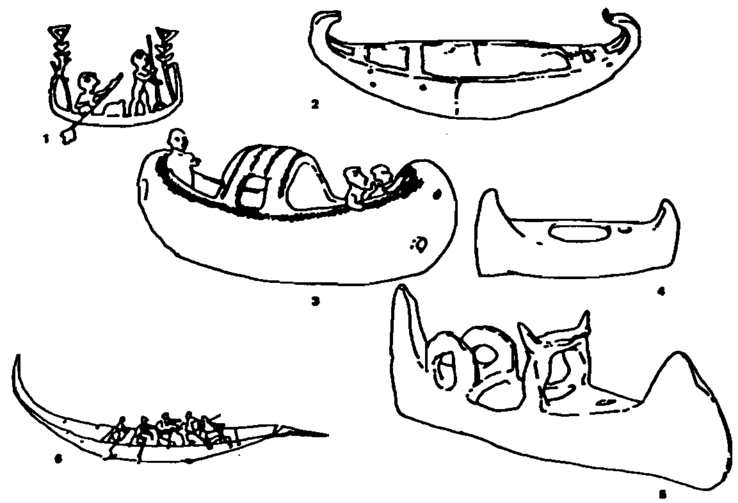


FIG. 25



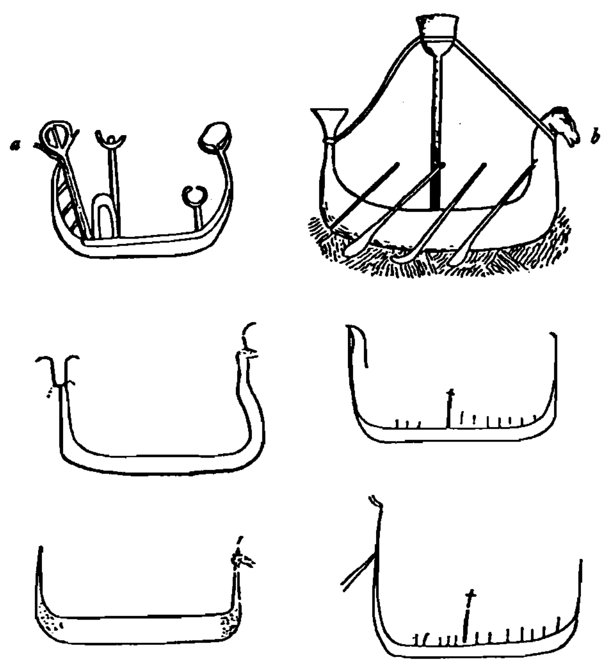


FIG. 26

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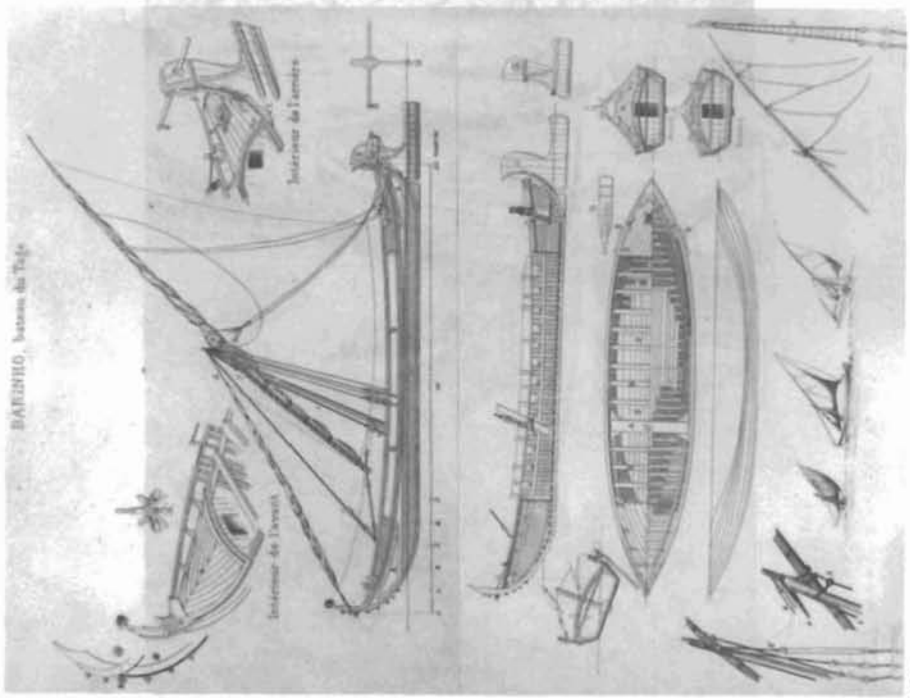

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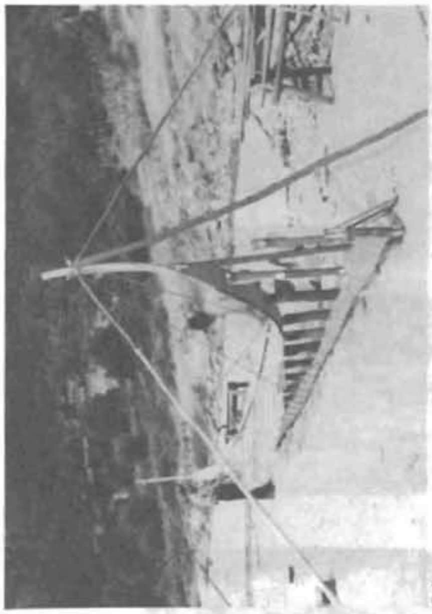

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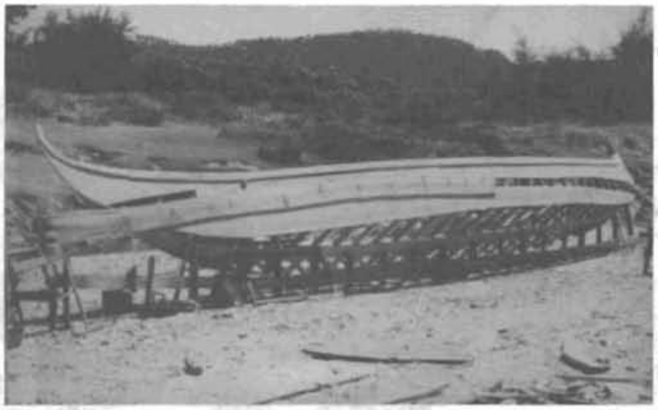

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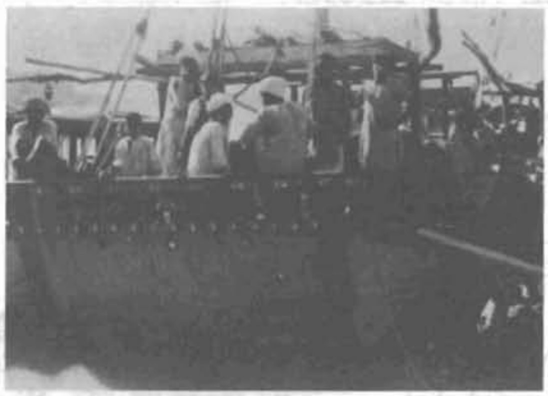

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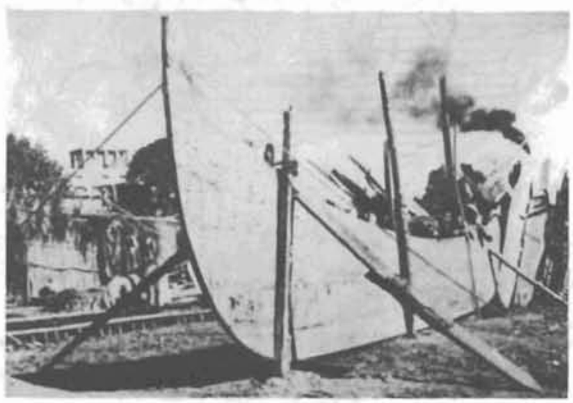

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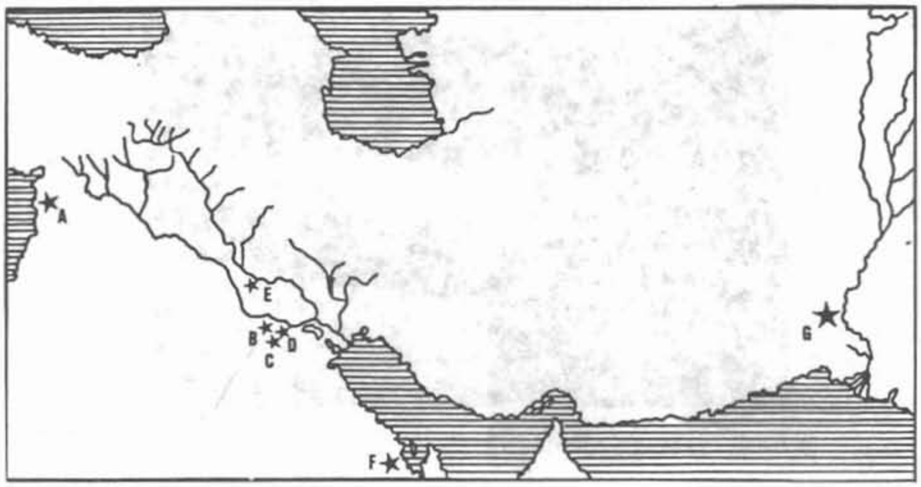

FIG. 35

FIG. 39

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FIG. 40

FIG. 41

FIG. 42

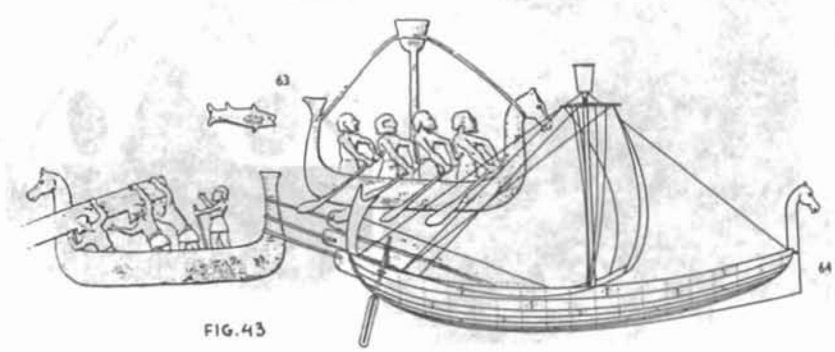
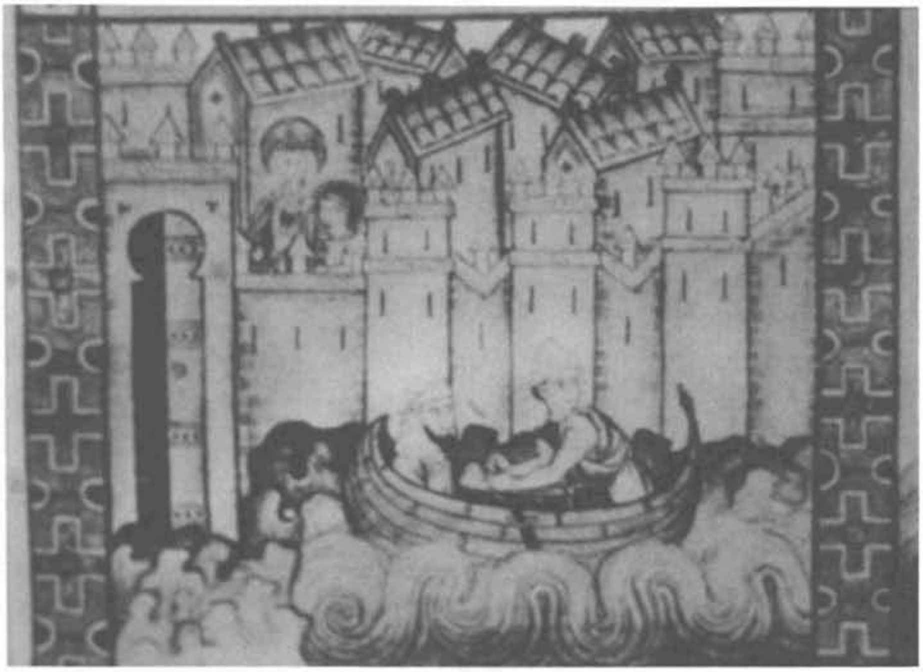


FIG. 43



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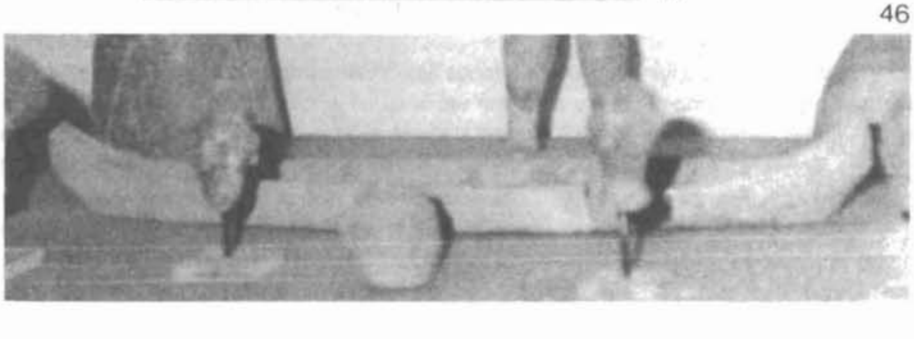

THE CYLINDRICAL NAILS OF THE "KYRENIA"
One too early technical sprout

First of all I wish to thank Prof. Steffy for all the supplementary information which has made my work possible.

So far as we actually know, the KYRENIA merchantman was the only one of ancient times to use metal (copper) nails as a general and essential element of union for the planks and frames. All other wrecks show the use of treenails for this purpose; only those of warships show also the metal (bronze) nailing.

But there is also one other important detail about these copper nails: they have a cylindrical shaft with a point; a form which is usual in our time, but unique in antiquity. From what we know, no other similar nails have been found. All metal nails of ancient times, whether they be of copper, bronze or iron, have a square section and tapered form.

From our point of view it is difficult to understand why this form for nails has been used unchanged for such a long time, considering its many disadvantages:

1. Its long and thin point made it difficult to be hammered directly into the wood, specially if this was hard and the nails were of copper or bronze.

2. Its long, tapered form could cause the wood to split easily.
3. Therefore, its use required mostly the drilling of a hole in the wood first, and then using the nail hammered down together with a split treenail.
4. The production of this square section and long tapered form was expensive.

Considering this last point, when comparing production costs, we are not comparing forged nails with those made of wire, as produced today, but the difference in price of forged cylindrical as opposed to square, tapered ones. This we can only do by reference to documents concerning the forging of iron nails, as this was done during the last centuries. As to how this would differ with the method of producing the older bronze or copper ones, we may only conjecture, since we have insufficient data. The mass production of forged iron nails, as this was achieved for centuries at Ripoll (Province of Gerona, Spain), for example, required first, the iron ore to be mined to obtain the iron oxide powder which was then reduced to iron within a furnace. The resulting incandescent spongy iron mass was then hammered, reheated and hammered again several times until the correct density and maleability of the iron was achieved. In the water driven hammer mills near Ripoll wrought iron was produced in the form of rods for the nail manufacturers.

Therefore, we know that the basic material for their production was rod, which was forged to get the tapered shaft and point, cut to the correct length and finished with the head. For us now it is clear that it would have been cheaper to heat only the ends of the piece and to forge the point and the head, rather than to heat the whole piece in order to produce a completely tapered form. With the last nails forged at these mills, about 1800 AD, it is to be seen that they got slowly to this idea, as some, mostly the long ones, have only the point tapered, but the shaft being square, is parallel.

For copper and bronze the conditions are somewhat different. Copper and bronze can be hardened only by hammering until cold. Therefore the copper and bronze nails needed a general forging to achieve uniform hardness, but again the round or square parallel forging of the shaft would have been cheaper if the material blanks were rods, that We do not know.

So much for the technical considerations of the production of nails.

The fact is, cylindrical copper nails have been used generally on this ship wrecked near Kyrenia but there is no evidence of a later use. We do not know why, but we shall try to follow the thinking of these ancients who build with them. The investigation of the wreck has revealed that these nails are of different diameters, 7 to 10 mm. This and the circumstance known from many other wrecks, that the diameter of the holes, drilled in the wood, changed with the whetting of the tools, obliged them to use splitt treenails similar to those used with the tapered ones. This was an important handicap. There was a long experience with tapered square nails and treenails of the adequate quality and size. The tapered nail was put in a split treenail of about the same diameter as the hole, could easily be introduced and then hammered in. The necessary force of the blows would slowly increase with the thickness of the nail and a strong union could be achieved. With the cylindrical ones the split treenail had to be thinner or of softer wood, as the thickness of the nail would be evident from the beginning. On the other side the fastening would have been more uniform all over the length of the bore. But in this special case of a union of a plank and a frame, this was not important, as the thickness of the frame was much more than that of the plank and the strength of the fastening of the treenail within the interior half of the frame was secondary, as the nail was clenched. As long as the technical possibilities could not produce cylindrical nails of uniform diameter nor the corresponding holes, there was no possibility of eliminating treenails, getting a cheaper, stronger and tight union with less man hours. Even if the nails were not clenched, the cylindrical ones would hold better than the tapered.

These advantages could not be evident at those times and therefore the change was not worthwhile.

If we contrast the qualities of the square tapered and the cylindrical nails in those times, the result is only:

SQUARE TAPERED	CYLINDRICAL
- Easier to hammer in with a treenail	- Less bending of the stronger nail
- Treenails of the diameter of the bore easy to control	- Stronger point for clenching
	- More uniform pressure on the surrounding-wood: Less splitting

Cost of production?

From this we see that, for the special use on planks and frames, the advantages were not so important in those times as to induce a change from the usual way to produce and to use nails.

There is now the question:

Were these cylindrical nails an experiment by some shipyard for the construction or for the repair of a ship?

If we look at the problem as a repair, many things change. First, there is the possibility that the copper nails could be hammered into the water softened old treenails. This would reduce the work about one half, as it was not necessary to:

— drive the old treenails out, with danger of damage to the planks.
— produce new treenails of the many different diameters.
— fix the less worn with wedges
— drill bigger holes where those in the planks were damaged.

It could be that, just for hammering them into the softened treenails, it was necessary to have a stronger point and shaft to resist bending, and that it was also convenient to use cylindrical ones, to get uniform pressure on the wood of the planks, reducing the danger of splitting. Considering the surely higher cost of the copper nails, only such a repair would justify economically their use instead of the habitual treenails.

The repair of an old treenail, putting a new one through its center, if it is not enough to hammer a wedge into it, is usual. We know that it was done also in antiquity because we have found these reinforced treenails at the Perduto wreck, off the southern part of Corsica. Normally, this new treenail is cylindrical or a little conical with a short point and is smeared with fat to be hammered in. Could it be that this was the basic idea for the cylindrical copper nails? Since a copper peg could not swell in the water like a new dry treenail, it was necessary to have a head at one end and to clench it at the other.

Federico Foester Laures †

REFERENCES:

THE KYRENIA SHIP. An interim report on its hull conservation, J. RICHARD STEFFY, 1985, *American Journal of Archaeology,* 89

LA INDUSRTRIA DELS CLAUS A RIPOLL, EDUALDO GRAELLS - 1972 - *Arxiu-Museu Folklorik de Ripoll*

APPENDIX

Jointly with the text on the "Kyrenia" cylindrical nails" presentation, F. Laures Foerster had sent a note and a drawing on the "Ecueil Perduto" wreck asking that it be published as an appendix to his paper.

A third ancient ship of the 0° type, with cargo from Catalonia

The wreck near the "Ecueil Perduto" (The Lost Reef), east of the southern tip of Corsica, has been plundered since the beginning of scuba-diving and therefore the references are scarce and confirm only, that there have been amphoras of the Dressel 2/4 type, with stamps difficult to read, anchor stocks and some wood.

Thanks to the patient work of a single diver, Wolfgang Schultheis, who, following my guidance, dedicated for several years his holidays to this work, actually we know something more:

I. It was a ship of the 0° class, the same construction we know of the "Los Ullastes" and "Cap del Volt" wrecks; both off the Catalan coast and with a cargo of "Pascual 1" amphoras, of local production.

II. The shreds found have given complete stamps which relate the cargo with a kiln in Catalonia.

III. We know now three ships of the same type with cargo of Catalan amphoras of two succesive forms and therefore the perdurance of building of the 0° class ships is documented for a period covering part of the first century BC and the first AD.

The question, if the 0° class was a local way to build ships, or a special type to be used in coastal waters with shallow river mouths and lagoons, remains open.

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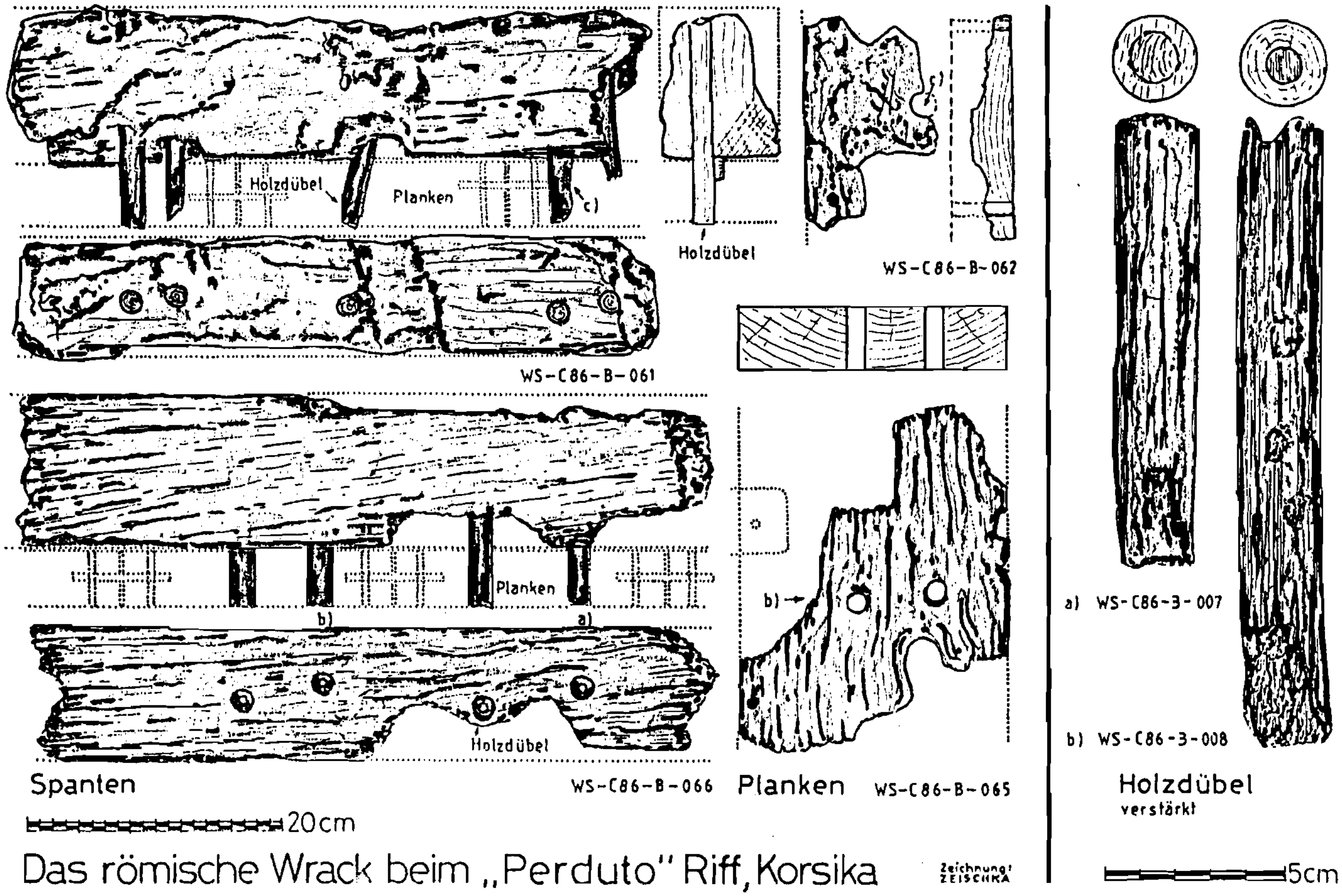
M. Corsi-Sciallano and B. Liou, "Les Epaves de Tarraconaise à Chargement d'Amphores Dressel 2/4 — L'Epave Perduto I", *Archaeonautica,* 5/1985, p. 145.

F. Foerster Laures, "Roman naval construction, as shown by the Palamos wreck". *IJNA* 12.3:219-228, 1983.



Das römische Wrack beim „Perduto" Riff, Korsika

Zeichnung: ZEISCHKA

WHERE DID THEY BUILD ANCIENT WARSHIPS ?

Excavation has told us something about ancient Mediterranean ports and rather more about Mediterranean ship construction, but nothing about the yards where the ships were built. This gap in our knowledge of the Classical Period remains so great, that the tendency is to assume that harbours and ship-building-yards were one and the same, although this cannot have been any more true in antiquity than it is today, especially in regard to warships.

We all know that the 1987 "Athenian trireme" was built at Perama, but just as no scrap of any ancient trireme has survived, so no evidence has been put forward for the place where the Athenians built their trireme fleet in the 5th century BC... surely not on the *slipways* at Limani Zea? Slipways perform another function: they are designed to garage warships, then shoot them down into the sea so as to intercept an enemy as quickly as possible. Consequently slipways no more represent ship-yards, than launching pads represent factories for assembling space-ships.

A 3rd century BC building-yard complete with shipwrights' tools has been excavated in China (1), but not until the Middle Ages does equivalent evidence start emerging in the Mediterranean area; it takes such forms as archives in Genoa and in Venice, of course, the Arsenal as well. Clues from the sea are now adding to this information and beginning to hint at some ancient building practises; let us examine two of them.

Already at the first of these Symposia, in Piraeus in 1985, I began to wonder why that group of 18 large, pyramidal stone-anchors dredged up from *in front of the slipways* at Limani Zea had come to be there (2). This pyramidal form is one of the rarer and more distinctive shapes among early anchors and it is further set appart by curious features such as lead inlays. By 5th century BC standards, such stone weight-anchors would have been old fashioned, because by then the stock had already been invented (3) thus producing the basic "modern" anchor shape consistiong of stock, shaft and arms. The most striking feature of the pyramidal group at Zea is that half these anchors are made from a grey, volcanic stone found in Northern Greece, but foreign to Athens and the south. The 9 remaining anchors are, incidentally, of a limestone common - in general appearance - to both regions and probably throughout the Mediterranean. Could the Northern stone be a clue to the place where 5th century trireme hulls had been built? for the dark volcanic rock comes from the self-same region which supplied the trees for making the Athenian triremes. This question might be answered (since volcanic rock is often more diagnostic than lime, or sandstones) by a lithological comparison of thin-sections taken from samples of the grey anchors with others taken from the appropriate northern rocks.

Texts do not relate whether the timber which Philip of Macedon sold to the Athenians had been shipped as tree trunks, or cut up into planks and other more or less finished units. If the latter (given that ancient shipwrights used green wood), the more finished the better. Instead of transporting forests to some distance south, it would clearly have be simpler and more expeditious - especially in time of war - to send a gang of shipwrights to the forests, there to start building hulls which could then be floated down, as empty shells, to the military port of Athens for finishing and equipping (perhaps, among other things, with more up-to-date anhors). The primitive anchors of Northern stone, dredged up outside the trireme slipways, might have served during the southward journey as both emergency anchors and ballast, before being jettisoned and replaced by stocked-anchors.

Texts give few clues to the building practices of the period; hopefully, new readings may produce more. According to Boromir Jourdan's recent work on the *Athenian navy in the Classical Period* (4) the very profession of naval architect is none too clearly defined. The word *architectones*, he points out, is used only once in the *Naval Lists* and then only in the context of elections... which does not make sense, because those with specialized skills are appointed rather than elected.

Reverting to excavated material: some light is shed on ship builders by the Marsala Punic Warship, the only example of a "long" ship of the Classical Period as yet investigated (5). All the analyses from this excavation: botanical, lithological, metallurgical and ceramic, agree that the vessel (which - exceptionally - sank when it was new) was *not* built in either of the Punic harbour towns with which it is connected: the capital Carthage, or Lilybaeum (modern Marsala) the shore where it sank. The indications as to where it *was* built are far less clear: they point tantalizingly towards Campagna and Latium, regions by then administered by Rome (although recent research hints that there were still pockets of Punic influence there). Whether shipwrights could have done their job on some forested island off the Campagnian shore, depends on their methods of work. We know that they must have been very highly organized, since ancient historians including Polybius give several instances of warships being produced at such almost incredible speeds as two per day - a feat that would be impossible in modern yards building wooden craft over 20m. long! In this regard, findings on the Marsala Punic Warship are most significant.

First, the discovery of this wreck off Western Sicily needs to be recalled: in 1969 a dredger uncovered ancient wood opposite the Egadi Islands (which give their name to the naval battle that ended the First Punic War in 241 BC with a victory for the Romans against Carthage). In 1970 I accepted an invitation to take a team to survey the area and found it to be filled with very unusual wrecks, marked by ballast-stones rather than cargo. In 1971, excavation started on the one now known as the *"Punic Ship"*. Its remains consist of the well preserved stern and port side of a "long" ship, breaking off as its sides start to become parallel - that is to say before the midships section.

It was the unusual position of the keel on the sea-floor that explained the loss of the prow. The stern had been driven down into the bottom at such an angle that, the depth being only 2.50 m., the prow must originally have protruded above the surface (so it would soon have been broken off, then destroyed by buffeting waves). The stern could not have lodged itself in the very hard seabed (composed of compacted layers of algea) then stuck firm at this un-natural angle for a couple of millennia, had it not been driven in by some un-natural force like collision - or ramming. After the excavation ended in 1974, sand receded from the contiguous site which has become known as the "Sister Ship".

This wreck also revealed signs of violent sinking and - even more dramatically - a prow with the wooden structure of a "beaked" ram. This structure was wrapped in some woven fabric, impregnated with a resinous substance of the consistency of chewing gum, over which (to judge from fallen tacks and a fragment metal) a flimsey sheathing of copper had probably been affixed. But sensational as the discovery was at the time, what is relevant to the present argument lay beneath this wraping: when it was removed a Phenico-Punic calligraphic letter *WAW,* could be seen painted into the wood, in the same manner as the lettering which had already been found on the excavated hull.

The painted signs, incised guide-lines and spills of paint on the Punic Ship provide a direct link with its builders and to some extent demonstrate how they worked.

After the wooden remains had been raised, a total of some 100 marks were painstakingly recorded then identified by William Johnstone, Professor of Semitic languages at the University of Aberdeen. Luckily he had no previous interest in boats ancient or modern, so it was impossible for him to have any of the preconceptions and prejudices which would inevitably have coloured the judgment of a naval architect, or a shipwright familiar with all the "modern rules", knowledge which would have lead to a degree of tendentiousness in interpretation. Every centimetre of every side, of every scrap of wood was scrutinised, then the marks photographed and traced. Next, using the exhaustive and detailed records of the hull kept during its excavation, Johnstone established the original positions of each mark on the inside and on the outside of the vessel... work that took several years.

The repertory consist of over 100 marks, including 40 letters and 2 words, as well as equally significant painted and incised guide-lines and accidental spills of paint. Five points emerge:

1) The Phoenician alphabet (often used in place of numerals) had been set out along the port face of the keel marking out, *from the outset,* the positions for all the floor-timbers and frames that were to come.

2) After the erection of the 11th strake up from the keel, this same sequence seems to have been repeated along its inner face (FIG. 1 KAP & LAMED), because by this stage, builders who were working inside the hull could no longer see the instructions on the *outer* face of the keel, although they still needed to consult them in order to adjust the skeletal timbers (which the alphabetic sequence represented) within the shell of planking.

3) Outlines scored in the planking, around each floor-timber and frame, had evidently been drawn as each component was being tried for fit. Thus, after adjustments to a component's shape had been completed and dowel-holes drilled through both planks and timbers in appropriate places, each frame and floor-timber could then be put back into position and then secured. The dowels, incidentally, were so spaced that each one passed through the centre of a strake.

4) At the level of the water-line, circular imprints (left by the dirty bottom of a paint pot each time it was set down inside the hull) spanned the edges of certain pairs of strakes. These im-

prints indicate a procedure that is not fully understood and which could have more than one explanation. The waterline in the stern was at a height above the keel where the side of the ship was becoming vertical, consequently where no paint pot could have stood upright. It therefore follows that when the paint pot had been set down over joins between two planks, the planks in question must have been on a horizontal plane. They might, for instance, have been joined together (at least two at a time) before being erected on the side of the hull; alternatively the whole hull might have been turned over into its port side at some point during its construction.

5) Finally, the greatest concentration of signs occur, predictibly, on the extremity of the stern, where a vessel's curvature is at its most complex and therefore where the fitters were most in need of guidance.

As to the calligraphy itself: besides the alphabetic sequences, it produced two words for the Phoenico-Punic Dictionary. One of them, *ABHAR*, occurs above the spot where the keel suddenly curves upwards as it turns into the rise of the stern. This position well accords with Professor Johnstone's linguistic arguments that the meaning of the word itself is: "curve" (6). The second word: *WAWIM* (the letter *WAW* written twice) clearly signifies "nail", since it repeatedly appears next to structurally important nails as an instruction for their placing. This, incidentally, has a bearing on a linguistic problem in the Biblical account of the building of Solomon's Temple (by Phoenician wood-workers): the hanging of its great curtain by means of silver *"WAWIM"*. Whether this meant "curtain rings", "ruchinghooks", or some other method of hanging a curtain, was a matter of scholarly speculation, before the word's meaning became clear in the context of the Punic Ship.

On the ship itself, the calligraphic *WAWIM* tell us something about the men who built her, for the letter is *written in 7 different ways,* that is to say in 7 different handwritings, implying *7 literate workmen.* This is astonishing because, even in contemporary shipyards (in the Mediterranean and elsewhere) where wooden craft are still built in a traditional manner, the workmen are well-nigh illiterate and their marks consist of rudimentary signs such as crosses.

To sum up: the signs on the Punic Ship show that, from the laying of the keel, a preconceived idea was being transmitted and carried out by men who could write. Men could have said: - "pass me an *aleph* - *a bet* - or a *gimmel* -shaped floor timber". This also contrasts with what is known of medieval and later shipbuilders, who chose a timber by eye because its shape was naturally suited for making a floor, a frame, or a knee, whereas Punic shipwrights seemed to have joined wood together, in order to produce a predetermined shape. The strength of such components was achieved by the elaborateness of their scarphing, in the same way that the mortise and tenon joinery uniting planks, gave strength to shell of a hull. Anyone who has had to dismantle such joinery underwater soon finds that mortises and tenons are tougher than the central part of a strake.

To conclude: the northern stone of the anchors associated with Athenian triremes, coupled with the northern provenance of their timber, hint at the possibility that trireme hulls were built in Chalcidice. Similarly, the results of the "Punic ship" excavation indicate that, while this vessel was unlikely to have been built at Carthage or Lilybaeum, it too could have been built near a source of timber. Further, the elaborate signs on this "long ship" (which have no paralell on the many wrecks of merchant ships hitherto excavated) show that its construction was pre-planned, then carried out by a skilled work-force. It follows that such men could have taken their tools to a forest, in less time than it would have taken to fell trees then send their trunks by sea to some Punic base such as Carthage or Lilybaeum, a procedure which might also have been dangerous in wartime conditions.

Hypotheses can be proposed, but no single excavation can produce conclusive answers. In this respect the Punic Ship is no exception. Future findings will either confirm or disprove the points that have been raised. For this reason, it seemed important to conserve and reconstruct the remains of this first example of a "long" ship, also to put all the excavation findings on display, so that specialists and public alike could examine them. Unfortunately, although the remains were conserved, the conditions in which they were subsequently kept put them at risk. Thanks to petitions from the Hellenic Institute for the Preservation of Nautical Tradition, also the Ecole des Hautes Etudes and the Musée de la Marine in Paris, the Sicilian authorities became aware of the danger. The Director of the Assessorates for the Region has now instructed that measures should be taken to preserve the antiquity and to insure that the excavation findings be shown.

Honor Frost
31 Welbeck street
London WlM 7 PG

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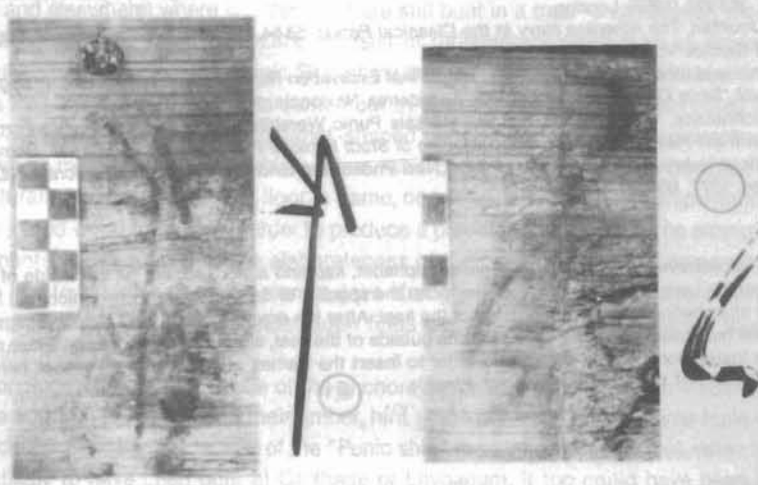
3) Honor Frost, "The birth of the Stocked Anchor and the Maximum Size of Early Ships", *The Mariner's Mirror* 68, 3, 263-273 (1982), London.
4) Boromir Jourdan, *The Athenian Navy in the Classical Period*, 53-54, University of California Publications: Classical Studies Vol. 13 (1972).
5) Honor Frost and other Authors, *The Punic Ship: Final Excavation Report*, Supplemento: *Notizie degli Scavi di Antichità*, Serie Ottava, vol. XXX (1976), Accademia Nazionale dei Lincei, Rome.
6) William Johnstone, "The Epigraphy of the Marsala Punic Warship. New Phoenician Letter Forms and Words", *Atti del Primo Congresso Internazionale di Studi Fenici e Punici*, (1979), III, 903-917, Rome 1983. "The Biblican Hebrew *WAWIM* in the Light of New Phoenician Evidence", *Palestine Exploration Quarterly*, Jul.-Dec. 1977, 95-102.

CAPTION

Fig.1: These successive letters of the Phoenician alphabet, *kap* and *lamed,* appear on the inside of strake no.11 (up from the keel) of the Punic Ship. They echo the spacing of its skeletal timbers, which had initially been set out alphabetically along the outside of the keel. After the erection of the 11th strake, workmen (by then inside the hull) could no longer have seen the outside of the keel, although they would still have needed to follow the instructions written thereon, in order to insert the frames of this shell-built vessel; hence the apparant repetition of the instructions on the inside.

1



LE GRAFFITO DE CUCURON: UN NAVIRE MARCHAND A PROPULSION MIXTE

En 1983, les fouilles d'une villa gallo-romaine, située près de Cucuron (Vaucluse), occupée du Ier au IVème siècle après J.-C ont mis au jour un des *graffiti* de bateaux les plus grands et les plus soignés du monde romain occidental daté de la première période d'occupation de la *villa*, soit du milieu du Ier siècle après J.-C.[1] (fig. 1).

Il représente un bateau de commerce romain, avec ses deux gouvernails latéraux, sa grand-voile, son mât de proue non gréé, le tout dessiné à la pointe sèche sur un panneau d' enduit peint ocre uni tandis que d'autres éléments du bateau, comme la cabine, la partie inférieure du mât principal, la mèche du gouvernail tribord, étaient, pour leur part représentés selon la technique du champlever, c'est-à-dire apparaissant en blanc après grattage de l'enduit peint.

Lors de notre première publication avaient aussi été identifiés les préceintes, le pavois, le prélart et même le petit mât arrière ou *stylis.* Seule était restée dans le domaine de l'hypothèse, l'interprétation des cercles situés entre la préceinte basse et la préceinte de pont, dans lesquels nous avions suggéré de voir des sabords de nage, d'où surgiraient des avirons saisis à l'horizontale. Nous aurions dans ce cas la représentation d'un bateau de commerce à voiles et à rames, ce qui est bien attesté par les textes comme nous le verrons plus loin.

Depuis, notre réflexion a progressé et nous sommes maintenant persuadés du bien fondé de cette interprétation, d'autant plus qu'un nouveau document iconographique est venu conforter notre hypothèse il s'agit d'une fresque trouvée en 1982 sur le site de *Nymphaeum,* ville du Bosphore Cimmérien (Crimée), datée de 270-250 avant J.-C. et publiée récemment par L. BASCH; elle représente "une hypergalère à trois étages de rames sortant toutes de la coque par des sabords de nage"[2] (fig. 2). Bien qu'il s'agisse ici d'un navire de guerre, la comparaison nous a semblé éclairante en raison de la manière très schématique avec laquelle l'artiste a exprimé les sabords de nage par de simples ronds et les rames par des traits sommaires.

Ces trous latéraux par lesquels sortaient les rames sont par ailleurs évoqués très nettement dans les textes. Déjà au IIème-IIIème siècle après J.-C., Festus, dans son résumé du grammairien augustéen Verrius Flaccus, cite un passage fragmentaire de Plaute qui compare ces trous aux ouvertures des pigeonniers et les qualifie de ce fait de *columbaria*[3]. Aprés lui, au VIIème siècle après J.-C., Isidore de Séville dans le chapitre intitulé *De Partibus navium et ornamentis*[4] reprend cette comparaison de façon encore plus imagée[5].

Le nombre de ces sabords importe peu et nous n'en tirerons aucune indication quant au nombre des rameurs: il faut garder présent à l'esprit l'aspect symbolique et conventionnel de ce type de représentation. Sur la mosaïque du Musée de Tebéssa par exemple (fig. 3) un petit nombre d'amphores situées sur le pont indiquent la présence d'une cargaison; leur nombre n'a aucune importance (non plus que leur place dans le navire!).

Quoi qu'il en soit, nous avons ici sans aucun doute la représentation d'un navire à voiles et à rames tel que le décrivent les textes c'est-à-dire d'une *actuaria*.

En fait les textes nous donnent quelquefois des noms de navires, mais le plus souvent ce ne sont que des listes sans définition aucune. Le terme *actuaria* se rencontre au IIème siècle après J.-C. dans les *Nuits Attiques* d'Aulu-Gele[6] où nous apprenons que les *actuariae* étaient appelées par les Grecs ιστιοκώποι (bateaux avec voiles et rames) *vel επακτρίδεσ (petites embarcations de pêcheur ou de pirate).* Au IVème siècle dans la liste des noms de navires énumérée par Nonius Marcellus[7], les *actuariae* sont qualifiées de *naviculae celeres* et ainsi appelées *quod cito agi possint.* Chez Isidore de Séville, ce type d'embarcation est défini comme "un bateau actionné à la fois par des voiles et par des voiles et par des rames[8].

C'est bien ainsi que l'entend P.-M. DUVAL dans son commentaire de la mosaïque d'Althiburus datée de la deuxième moitié du IIème siècle après J.-C. qui n'est pas sans évoquer elle-même d'aileurs l'énumération des divers types de navires donnée par Aulu-Gelle comme le remarque R. MARACHE dans son édition commentée d'Autu-Gelle[9].

Pour P.-M. DUVAL en effet l'*actuaria* appartient à la classe des navires mixtes: c'est un voilier actionné à la rame dont la caractéristique est d'être à la fois pourvu de voiles et de rames[10]. Mais c'est à J. ROUGE, qui a si bien su utiliser avant nous les textes antiques et s'est longuement interrogé sur ce problème, que nous devons la description la plus fine et l'affirmation la plus véhémente de l'existence de ce type de navire. Nous le citerons intégralement tant notre *graffito* semble en être la parfaite illustration[11]: "Barques, navires de guerre et navires de plaisance à rames, navires de commerce à voiles ne doivent pas nous faire oublier l' existence de navires mixtes, utilisant d'une manière normale la voile et la rame. Ce sont de petits navires servant au cabotage ou à la navigation dans les îlés de l'Egée... Souvent représentés sur les monuments, ils ne doivent pas être confondus avec les navires de guerre: ce sont des navires ronds et non pas des navires longs; de plus, leur voilure est beaucoup plus développée par rapport à leur taille que celle des navires de guerre, souvent ils comportent grand-mât et mât de proue, leurs rames sont bien moins nombreuses, car ils ne cherchent pas la vitesse, si nécessaire dans le combat naval antique; ils ne semblent disposer que d'une dizaine de paires de rames. Ils portent un nom traditionnel, ce sont les *actuariae naves...*"

Les rames, au nombre de six sur notre *graffito,* n'étaient sans doute utilisées qu'épisodiquement au cours de manoeuvres portuaires pour lutter contre la dérive, aider à la remontée au vent[12] ou encore par calme plat.

Cela nous conduit à nous demander quelles sont les hypothèses raisonnablement envisageables au sujet de la position des rames et surtout de leur liaison avec la coque.

Jusqu'à présent, nous avions interprété les deux lisses situées au-dessous et au-dessus des sabords comme les préceintes basse et haute du navire. Or, il semble qu'elles correspondent en fait plutôt à la base et au sommet d'un caisson situé en encorbellement sur la muraille, délimité sur notre *graffito* à l'avant par la première rame et à l'arrière par le trait vertical figuré au droit de l'appareil de gouverne.

De tels caissons apparaissent ailleurs par exemple sur la mosaïque de Dougga datée du IIIème siècle après J.-C., représentant Ulysse et les Sirènes[13] et plus nettement encore sur la mosaïque de Tébessa déjà évoquée.

Ce caisson qui délimite l'espace de manoeuvre des avirons, devait être soutenu par des consoles figurées sur le *graffito* par une série de traits en forme de S. Ces consoles prennent appui sur une préceinte basse représentée sur notre dessin par un double trait. Nous avons déjà trouvé un dispositif de ce genre sur l'épave II des Laurons où l'aile de protection de l'appareil de gouverne s'appuyait sur une préceinte basse par l'intermédiaire d'une console[14] (fig.4).

La représentation de la préceinte inférieure n'est d'ailleurs pas étonnante pour un bateau figuré hors d'eau: on remarquera en effet que nombreuses sont les mosaïques (par exemple Dougga, Thémétra[15]) où les navires ne sont, comme le nôtre,que "posés" sur l'eau.

En son sommet, le caisson est tenu par le prolongement d'un bau dépassant de la muraille, comme c'est le cas sur les navires de Nemi par exemple[16]. Lisses haute et basse du caisson sont reliées par des consoles représentées par des S, situées à l'aplomb des sabords auxquels elles servent de supports. Le caisson enfin doit être surmonté d'un pavois le couronnant.

L'exiguité du caisson ne doit en tout cas pas être considérée comme gênante, car le rameur, situé tout près de l'eau, n'a nul besoin d'un long aviron. En effet, les rameurs ne prenaient certainement pas place sur le pont, contrairement à ce que montrent certains documents iconographiques[17], car ils seraient trop haut par rapport au niveau de l'eau et dans l'impossibilité d'actionner leurs avirons (fig.5). Les rameurs sont donc installés dans le caisson au-dessous du niveau du pont: c'est bien ce que suggère le dessin de notre *graffito.*

Sensibles surtout à la forme arrondie de la coque, nous avions évoqué, dans notre premier article, le nom de la *corbita* à propos de notre navire de Cucuron. Nous avons ici prononcé celui d'*actuaria,* navire à propulsion mixte, voiles et rames. Peu importe le nom, que nous ne saurons jamais, que l'auteur du *graffito* aurait donné à son beau bateau, voilier susceptible d'être à l'occasion mû par les avirons esquissés avec leurs sabords de nage: nous avions dès l'abord indiqué ce caractère mais sans le souligner suffisamment. Il nous a donc paru utile de reprendre ici, en la développant, notre argumentation[18].

Aix-en-Provence, le 29 Juin 1990

Jean - Marie Gassend (Architecte DPLG) IRAA-CNRS.
Marie - France Giacobbi - Lequement (Ingenieur) IRAA-CNRS.

FIGURES

Fig. 1:Le *graffito* naval de Cucuron, J.-M. Joulain, CNRS-IRAA d'Aix-en-Provence, d'après *Archaeonautica 6.*

Fig. 2: Fresque de *Nymphaeum* d'après N.L. GRACH dans L. BASCH, *Le musée imaginaire de la marine antique.*

Fig. 3: Mosaïque de Tébessa, photo Centre Camille Jullian-CNRS d'Aix - en-Provence.

Fig. 4: Reconstitution axonométrique babord arrière de la carène de l'épave II des Laurons à partir des données archéologiques, J.-M. Gassend, J.-M. Joulain, CNRS-IRAA d'Aix - en-Provence.

Fig. 5a: Schéma impliquant un rameur sur le pont, position incompatible avec la manoeuvre des avirons.

Fig. 5b: Position du rameur en encorbellement sur la carène au - dessous du niveau du pont.

NOTES

1. Cf. L'étude complète de J.-M. GASSEND, M.-F. GIACOBBI-LEQUEMENT, J-M. JOULAIN, L.LAMBERT, Le *graffito* de Cucuron (Vaucluse): un navire sous voiles figuré sur un panneau d'enduit peint dans *Archaeonautica,* 6, 1986, pp, 9-30.
2. Cf. L. BASCH, Le musée imaginaire de la marine antique. Athènes, 1987, p. 493 et fig. 1130-1131, p. 495.
3. Festus, *De verborum significatione quae supersunt,* New York, 1975, L. XIII, p.169 *Sive quod columbaria in nave appellantur ea.*
4. Isidore de Séville, *Etymologiorum sive originum lib,* XIX, 2, 3 (éd. W.M. LINDSAY, Oxford, 1971, t.2), *Columbaria in summis lateribus navium loca concava per qua eminent remi; dicta; credo; quod sint similia latibulis columbarum in quibus nidificant.*
5. Cf. à ce sujet le récent commentaire de L. BASCH, dans *ibidem,* pp. 438-439, et fig. 957-958, p.439.
6. Aulu-Gelle, 10, 25, 5, éd. R. MARACHE, Coll. des Univ. de France, Paris, 1978, t.2, p. 186.
7. Nonius Marcellus, *De genere navigiorum,* chap. XIII, éd. par W.M. LINDSAY, Oxford, 1903, tome III, p.857.
8. Isidore de Séville, *op.cit.* Livre XIX, 1, 24, *actuariae qui naves sunt quae velis simul et remis aguntur.*
9. *Loc. cit.* note 24.
10. P.M. DUVAL, La forme des navires romains d'après la mosaïque d'Althiburus dans *MEFRA,* LXI, 1979, n° 13, *actuaria,* p. 137.
11. J. ROUGE, *L'organisation du commerce maritime en méditerranée sous l'empire romain,* Paris, 1966, chap. III, le navire de commerce, pp. 60-61.
12. Nous remercions A. MAURIC, architecte naval, pour les précieuses remarques qu'il nous a faites.
13. Tunis, Musée du Bardo, cf. la dernière représentation en date dans L. BASCH, *op. cit.,* p. 484, fig. n° 1100.
14. L'épave II des Laurons, gréement et accastillage, étude de J.-M. Gassend, à paraitre.
15. L. FOUCHER, *Navires et barques figurés sur des mosaïques découvertes à Sousse et aux environs* (Musée Alaoui, Notes et documents, X), Tunis, 1957, p.12, fig.4;p.14, fig.5.
16. G. UCELLI, *Le navi di Nemi,* Rome, 1950, pp. 171-172, fig. 182 et 184.
17. Cf. par exemple L. BASCH, *op. cit.* p.446, bas-relief de Pouzzoles, daté du Ier siècle av. J.-C, au Ier s. après J.-C.
18. Nous remercions B. LIOU qui a bien voulu prendre connaissance de cette étude et nous aider de ses conseils.

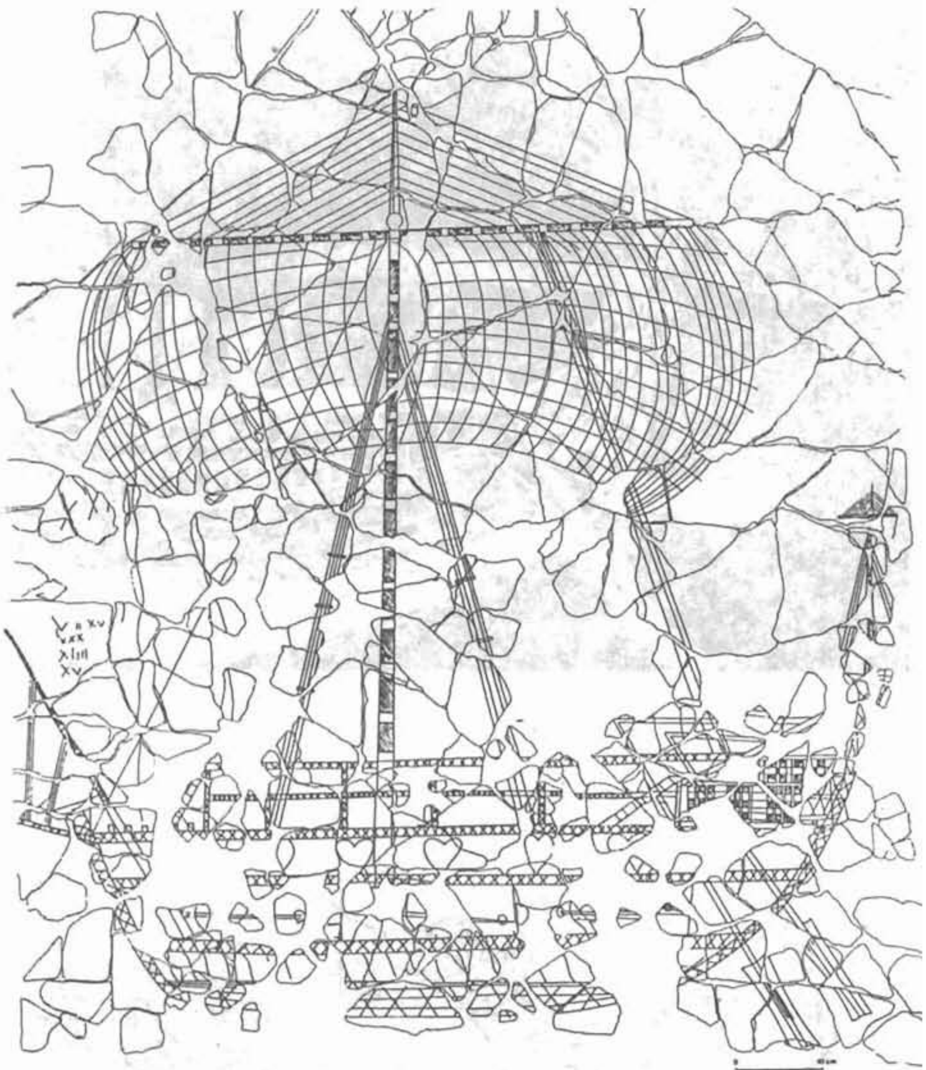
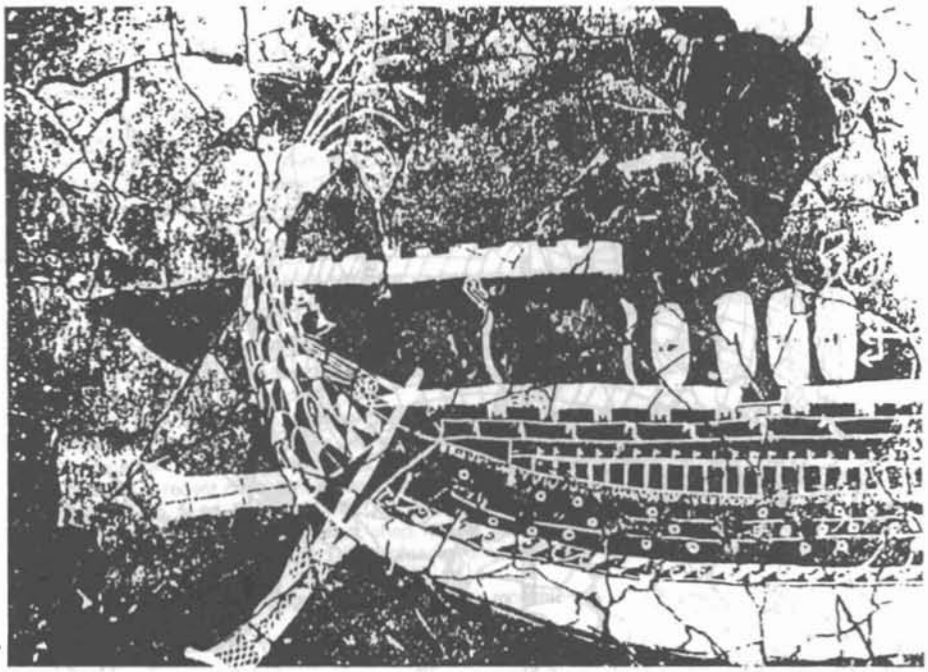


FIG. 1



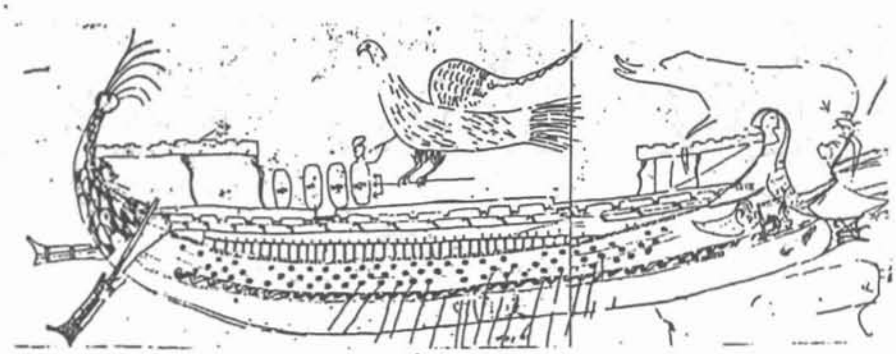
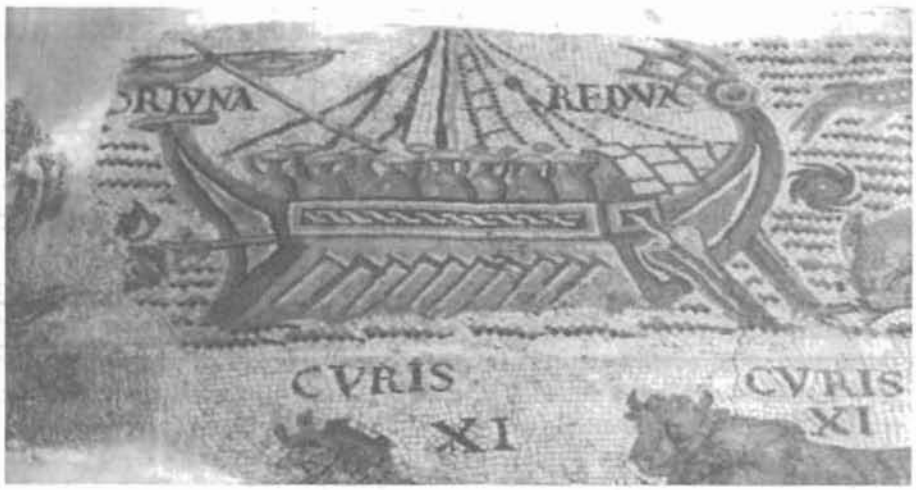


FIG.2



RTVNA
REDVX
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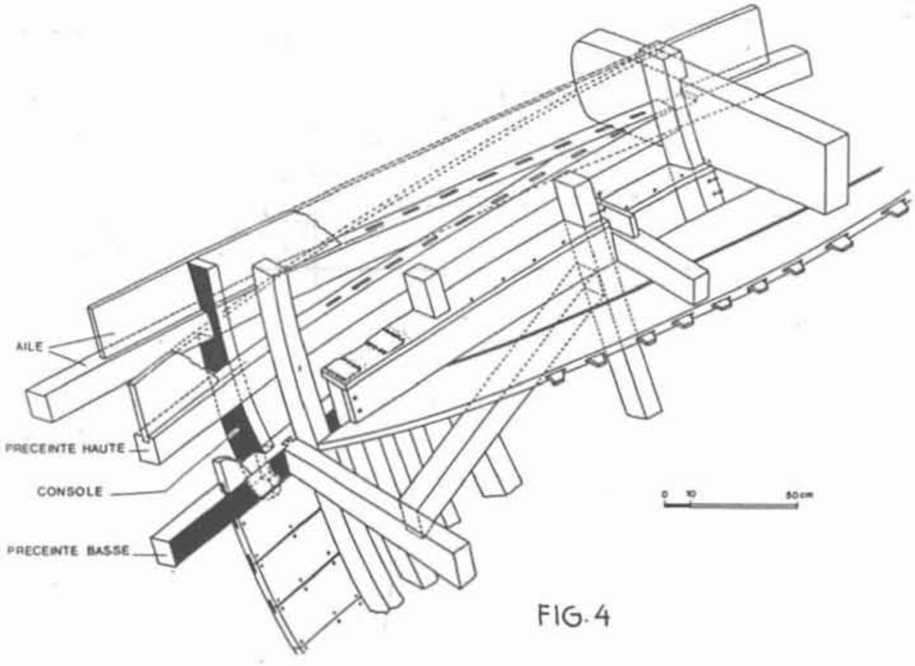
XI
CVRIS
XI

3



AILE
PRECEINTE HAUTE
CONSOLE
PRECEINTE BASSE
0 10 50 cm

FIG. 4

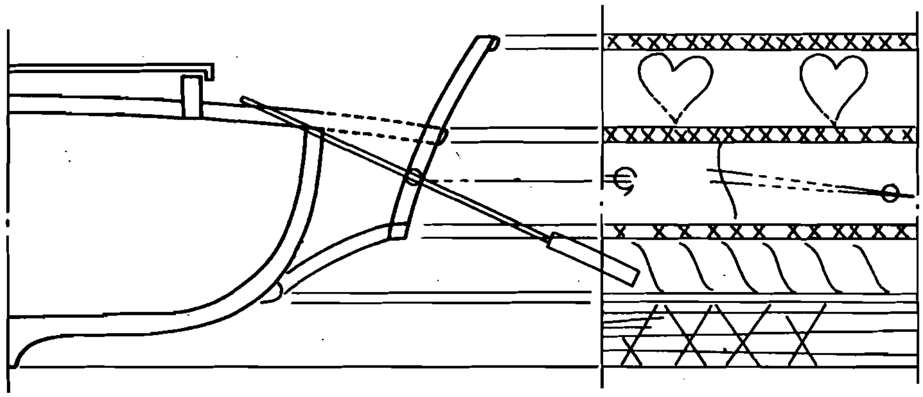


FIG.5a

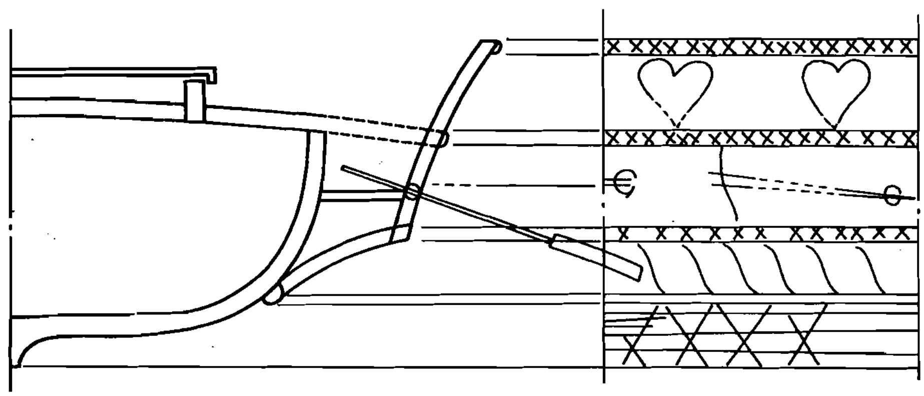


FIG.5b

A ROMAN SHIPYARD AT MINTURNO: INDICATIONS FROM UNDERWATER ARCHAEOLOGY

During the last few years, research carried out in the western Mediterranean, along the French and Italian coasts, has brought to light a considerable number of Roman shipwrecks characterised by particular cargoes. In some cases, the wrecks located have subsequently been the object of underwater excavations which have been completed to a greater or lesser extent (for example at La Garoupe, near Antibes, at Ile Rousse, in northern Corsica; at Diano Marina, in Liguria; at Petit-Congloué near Marseilles; at Grand-Ribaud D, near Toulon; and at Ladispoli[1]. In other more numerous cases, the presence of wrecks was indicated by chance discoveries (as for example at Palermo, at Ventotene, at Circeo, between Circeo and Ponza, off Ostia, at Santa Marinella, at Baratti, at Punta Ala, at the Isola dello Sparviero, at La Gorgona, at Porto Maurizio, at Olbia, at La Maddalena and at Cap Bénat)[2].

The definitive results of the excavations, as well as much information regarding isolated discoveries, are still largely unpublished. However, there is already sufficient information to unite all the wrecks in a single, homogenous group, on the basis of the type of cargo, methods of stowage and chronology. In fact the material available, which it would take too long to list here, dates practically all of them to the time of Augustus and the first half of the first century A.D., with the exception of the Cap Bénat wreck, which belongs to the first century B.C., and that found at Punta Ala, which dates to the middle of the third century A.D.[3].

The main factor uniting them is that of the presence of *dolia* on board as containers for transport. The discovery of this particular maritime use is in fact entirely due to underwater archaeology, and it would otherwise have been unsuspected on the basis of findings on dry land, where the *dolia* are usually found as a permanent feature in the *horrea* (for example at Pompei or Ostia). However, if one considers carefully, an iconographic document conserved at Ostia itself, in the *domus* of Annius, now seems quite indicative. This large building, dating to the time of Hadrian, contains a warehouse with numerous *dolia* sunk into the ground and on its façade it has two brick tablets, one showing the owner, Annius himself, standing amongst his *dolia*, whilst the other shows a ship sailing with unfurled sails[4].

Returning to the wrecks, it has been observed that the central part of the cargo was in fact contained in the *dolia* placed in the central section of the ships, whilst amphorae were stowed in the narrower areas to the prow and stern. The number of *dolia* carried on board obviously varied according to the size of the ship, but fifteen or sixteen were present on the Petit-Congloué wreck, where they were found still in their original stowage position, and a similar quantity has been confirmed at Diano Marina, Ladispoli and Gran-Ribaud D.

The size of the *dolia* themselves varies between a minimum capacity of two or three hundred litres and a maximum of three thousand and half. A reasonably indicative reckoning proves that the use of the *dolia* allowed for an advantageous saving of space, roughly a third, as compared to that occupied by the number of amphorae necessary to hold a similar total capacity. Therefore their use would also have been motivated by technical and economic advantages[5].

The *dolia*, which varied in form (spherical or cylindrical) and size, even on the same ship, often retain the lead cramps which were generally inserted as reinforcement during manufacture, as well as a compact covering layer on the inside consisting of resinous pitch. It is probable that they contained wine. This is indicated by the remains of grape pips found in the *dolia* discovered at Diano Marina, as well as by the internal coating of pitch[6].

Thus the wrecks with *dolia* reveal the introduction of a substantial change, especially in the time of Augustus, in the methods of transporting wine by sea, in that it was no longer contained exclusively in amphorae — although the Dressel 2-4 type were present on board in small quantities — but mainly in the *dolia.*

The amphorae also contained wine. In fact, wine amphorae of the Dressel 2-4 type were always present on the wrecks examined, although their origin varied from case to case: those found at La Garoupe, Ladispoli, Grand-Ribaud D were mainly italian in origin (southern Latium and Campania), whilst those found at Diano Marina, the Ile Rousse and at Petit-Congloué were mainly Spanish. However, rare examples of Spanish or Gallic amphorae were present in cargoes coming from Italy (Ladispoli, Grand-Ribaud D), while a few examples of Italian amphorae are present in cargoes that are principally Spanish in origin (Petit-Congloué).

On the other hand, as already mentioned, the *dolia* constitute an invariable constant. This is demonstrated by the stamps that they bear. All these stamps are *in planta pedis* (sole of the foot) type, sometimes accompanied by smaller rectangular stamps. In the case of all six wrecks investigated, the *dolia* all bear the same stamps with the names of the freedmen of the *gens Pirania (Primus, Cerdo, Felix, Sotericus, Philomusus)*[7]. Another two pieces of evidence are provided by the isolated cases of the *dolia* recovered at Porto Maurizio *(Piranus Primus)* and at Piombino *(Piranus Philomusus)*[8].

In some cases, however, on the same wreck, together with the *dolia* of the *Piranii,* others with *in planta pedis* stamps bearing different names have been found, but they are thus closely connected with those of the *Piranii* (for example, at Grand-Ribaud D and at Santa Marinella). Technical characteristics link other isolated discoveries to the group (Ostia, Civitavecchia, Porto Ercole, La Gorgona). Counting the latter, no fewer than thirteen wrecks (more than half of those known up to date) have the same commercial connections. This documentation, quantitatively without precedent in underwater archaeology, reflects a commercial phenomenon of remarkable dimensions.

Moreover, the stamps on the *dolia* also provide useful information for locating the area in which they were manufactured. The great rarity of the gentilitial *Piranus* is particularly indicative, and it appears to have been used exclusively in the area round Minturno, a place in which the gentilitials on the stamps present on the other *dolia* are also to be found[9]. The link with Minturno is strengthened by the geographical origin of the form of the name *Piranus,* which derives from *Pirae,* a place located near Minturno (*Plin, nh* 3,59) and the characteristic form of the stamps, that is to say *in planta pedis,* is foreign to other areas in which these containers were produced in large quantities (as for example, Rome) and seems to be typical of the south Latium coast[10].

An important confirmation derives from the results of the fabric analyses of the *dolia* from several wrecks (conducted by T.Mannoni, S.Sfregola at Genova and by Istituto centrale per il restauro at Rome), which point to a provenance around the mouths of the Garigliano river.

Thus, according to our present state of knowledge, the transport of wine by sea in *dolia* would seem to have been exclusive to Minturno, which was, moreover, situated at the centre of a large and prestigious wine producing area. A huge export trade in wine contained in Dressel I amphorae already existed in Republican times, as is widely attested by the wrecks dating to this period and by kilns for manufacturing Dressel 1 and Dressel 2-4 amphorae discovered in the area[11].

Returning once again to the wrecks investigated, it should be noted, as we have seen, that the *dolia* constitute a permanent presence, as compared to the variation in the amphorae that accompanied them — in three case, Italian in origin and in three cases Spanish —, that is to say with the role of fixed containers well placed in a rational system of cargo stowage, that was clearly valid both for outward bound as well as homeward bound journeys.

It is in fact because they were a fixed element, although not necessarily as a compulsory one, that the *dolia* should be considered as part of the ships apparel. And the stamps on the *dolia* indicate that this apparel was made in the important harbour area of Minturno, at the mouth of the river Garigliano *(Liris)*. A veritable river port whose main buildings/docks must have been situated at the marshy mouth of the river as it is described by Plutarch (*Mar* 37), with regard to the final, unfortunate vicissitudes of C Marius. Moreover, it was easy to carry the agricultural products from the hinterland destined for maritime trade along the river, which was navigable for a long stretch[12].

Leaving aside the numerous commercial questions regarding the wrecks containing the *dolia*, we are here concerned with stressing that the attribution of the apparel to Minturno makes it very probable that the ships themselves were also built in the same place. Moreover, as is natural for a large port which has a hinterland capable of providing large quantities of wood that are easily carried along a waterway such as the *Liris*, the activity of shipbuilding is securely attested at Minturno by the inscriptions of an *architectus navalis (Q. Caelius)* and of a commercial association, that of the *picarii*, whose role was of fundamental importance in the construction and maintenance of ships[13].

It should then be noted that the presence of the *dolia* on board, as part of the ship's apparel, qualifies and specifies the function of the ships that carried them together with their contents, that is to say wine: thus it would be justified to use an appropriate adjectivation to describe them, such as that of *naves vinariae* mentioned in the *Digestus* (47,2,21,5) to which A. Tchernia has for some time drawn attention.

Rather substantial remains relating to the hulls of wrecks with *dolia* have been found, up to now, at Diano Marina and at Ladispoli, whilst at Grand-Ribaud only a few fragments of the upper structures remain. However, only a small part of the Diano Marina wreck's hull has been excavated, and therefore for the moment only the one found at Ladispoli can be considered in an attempt to individuate the structural characteristics determined by the stowage of the cargo, with the remarkable weight of the *dolia* being amassed in the central part, or to recognise particular construction techniques that could identify the shipyard of origin.

As far as Ladispoli is concerned, the remains of the hull, conserved at a length of approximately seven metres, formed part of the lower structures of the central section: planking, floor timbers, a small section of the inner keel with a hollow cavity for the foot of the mast, several strips of dunnage. Judging from what has survived, the total length of the ship probably did not exceed twenty metres. It was therefore a vessel that was modest both in size and in the quality of its construction, which appears to have been carried out with a saving in materials (with excessive joints in the planking and also in some of the floor timbers) and a lack of finishing (in the cutting of the wood). The exterior lacks lead sheathing.

Particularly worthy of note is the profile of the bottom, which has a rather unemphasised curvature and culminates in a keel which protrudes barely eleven centimetres: these characteristics are not entirely in accordance with the needs of sea navigation, but rather more suitable for the more shallow waters of river navigation (on the *Liris,* perhaps). The impression that emerges leads to a comparison with vessels such as those found in the port of Claudius at Fiumicino (the largest ones) or those discovered recently in the former marshes at Comacchio (other examples can include those of County Hall, Port Vendres I, etc.)[14].

No remains have been found relating to the broadsides or the upper structures, although the excavation is still incomplete, and there is still nothing which allows us to determine the way in which the stability of the *dolia* on board ship was secured. Other pieces of apparel found include a sounding-lead with a hollow bottom divided into compartments and a dozen wooden discs, discovered in the bilge channel and evidently belonging to the mechanism of the pump which expelled leakage[15].

The types of wood used to build the ship do not prove to be, as is usually the case, very representative: oak (for the floor timbers and the inner keel), elm (for the floor timbers), larch and fir-wood (for the planking, the dunnage and the stringers walnut (for the limber boards), pine (for the keel), and chestnut (for the wooden pins). However, some less generic indications are provided by the Grand-Ribaud wreck, where willow wood is used in the upper structures. This wood is found especially in waterlogged areas, such as Minturnae, where Cicero mentions very large willow-groves (*leg. agr.* 2,14,36: *"... salicta ad Minturnas"*)[16].

Obviously, the factors allowing the work of a particular shipyard to be recognised are still very scarce and we are well aware that it is very difficult to manage to individuate a ship's place of origin and construction. In maritime navigation, in particular the circumstances that compete with the construction and the duration of a ship can be numerous as well as bizzare, and often cannot be estimated by the modern observer. Following the same logic, even the ship's apparel may not constitute determinating proof, although now, in the case of the ships containing *dolia*, we find ourselves faced for the first time with an apparently large and chronologically homogeneous group which is, without a doubt, capable of providing, as investigation continues, the necessary documentation.

Piero A. Gianfrotta
Università degli studi di Bari
Facoltà di Lettere
Palazzo Ateneo
70121 Bari / Italy

NOTES

1. This communication is based on findings which come from the excavation of the Ladispoli wreck, just north of Rome. On this wreck see V.D' Atri - P.A. Gianfrotta, *Un relitto con dolia a Ladispoli,* in *Archeologia subacquea 3,* suppl. to Bollettino d'Arte, n.37-38, Roma 1987, pp. 203-208.
2. See P.A. Gianfortta - A. Hesnard, *Due relitti augustei carichi di dolia: quelli di Ladispoli e del Grand Ribaud D,* in *El vi a l'Antiguitat,* Badalona (1985) 1987, pp.285-297. See also F. Cambi, *Isola di Gorgona. Un relitto romano con dolia?,* in *Annali della Facoltà di lettere e filosofia dell' Università di Siena,* IX, 1988, pp.221-226.
3. Gianfrotta - Hesnard, *art. cit.,* p. 292.
4. See R. Meiggs, *Roman Ostia,* 2 ed. Oxford 1973, p. 275.
5. CF. A. Tchernia, *Le vin de l' Italie romaine,* Rome 1986, pp. 138-140.
6. F. Pallarés, *Relazione sulla VII campagna archeologica sottomarina sul relitto del golfo Dianese (IM),* in *Forma Maris Antiqui, Rivista di Studi Liguri* 51, 4, 1985, pp.612-622.
7. Gianfrotta - Hesnard, *art. cit.,* pp. 288-291.
8. Gianfrotta - Hesnard, *art. cit.;* M. Corsi Sciallano - B. Liou, *Les épaves de Tarraconaise à chargement d'amphores Dressel 2-4, Archaeonautica 5,* Paris 1985. See also M. Massa, *Ritrovamenti subacquei lungo le coste dei Comuni di Piombino e San Vincenzo (Livorno),* in *Rassegna d'Archeologia,* 5, 1985, p. 218, fig. 5. Unpublished, another *dolium* with a stamp of *Piranus Primus* at Porto Maurizio (Imperia).
9. Gianfrotta - Hesnard, *art. cit.,* pp. 290-291.
10. Ph. Cluver, *Italia antiqua,* II, Lugduni Batavorum 1624, p. 787; A.P. Frutaz, *Le carte del Lazio,* Roma 1972, pp. 45-46, tav. XXIV, 2.
11. See A.-Hesnard - M. Ricq - P. Arthur - M. Picon - A. Tchernia, *Aires de production des gréco-italiques et des Dr.1, Amphores romaines et histoire économique, Atti del Colloquio di Siena* (maggio 1986), in press.
12. For shipways near the mouth of the river, see J. Johnson, *Excavations at Minturnae, I, Monuments of the Republican Forum,* Philadelphia 1935, pp.7 and 77. See also S.D. Ruegg, *The underwater excavation in the Garigliano River: final report 1982. The roman port and bridge at Minturnae, Italy,* in *The International Journal of Nautical Archaeology and Underwater Exploration,* 12, 1983, pp. 203-218.
13. Cf. *CIL* X, 5371. See Corsi Sciallano - Liou, *op. cit.,* p. 171; A. Giardina, *Allevamento ed economia della selva in Italia meridionale: trasformazioni e continuità,* in *Società romana e produzione schiavistica,* I, Roma - Bari 1981, pp. 87-113, esp. p. 101-102.
14. References in P.A. Gianfrotta - P. Pomey, *Archeologia subacquea,* Milano 1981. See also F. Berti, *Rinvenimenti di archeologia fluviale ed endolagunare nel delta ferrarese, in Archeologia subacquea 3, cit.,* pp. 25-32.
15. Cf. M. B. Carre - M. R. Jézégou, *Pompes à chapelet sur des navires de l' Antiquité et du début du Moyen-Âge,* in *Archaeonautica,* 4, 1984, pp. 115-143.
16. Cf. Giardina, *art. cit.,* p. 102.

I am indebted to A. Hesnard for exchanges of information taken from her excavation of the wreck Grand Ribaud D.
The final study of the wooden keel of the Ladispoli wreck is now being conducted by M. - B. Carre.

CAPTIONS

1. General plan of the Ladispoli wreck.
2. A *dolium* from the Ladispoli wreck.
3. Detail of the area around Minturnae (from Ph. Cluver, *Italia antiqua,* 1624).
4. Boat with cargo of petrol in plastic containers in the port of Hydra (Greece). The form, dimensions and the type of containers can recall an image of the ancient Ladispoli ship. (Photo: Courtesy F. Fouilland).
5. Plan of the wooden keel of the Ladispoli wreck.
6. Section of the floor timbers nn. 16,17 and 18 of the Ladispoli wreck.
7. Detail of the kell.
8. Sounding-lead from the Ladispoli wreck.
9. Wooden discs of the pump from the Ladispoli wreck.

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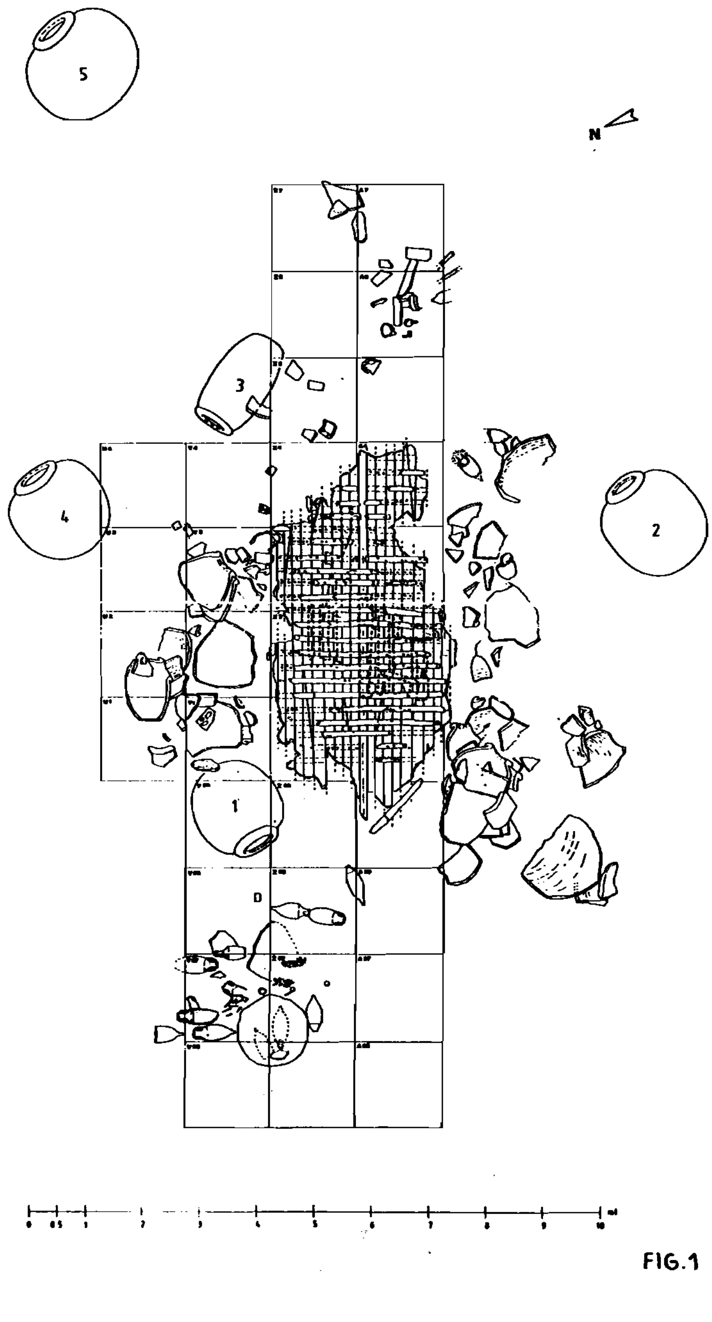


FIG.1

FIG. 2

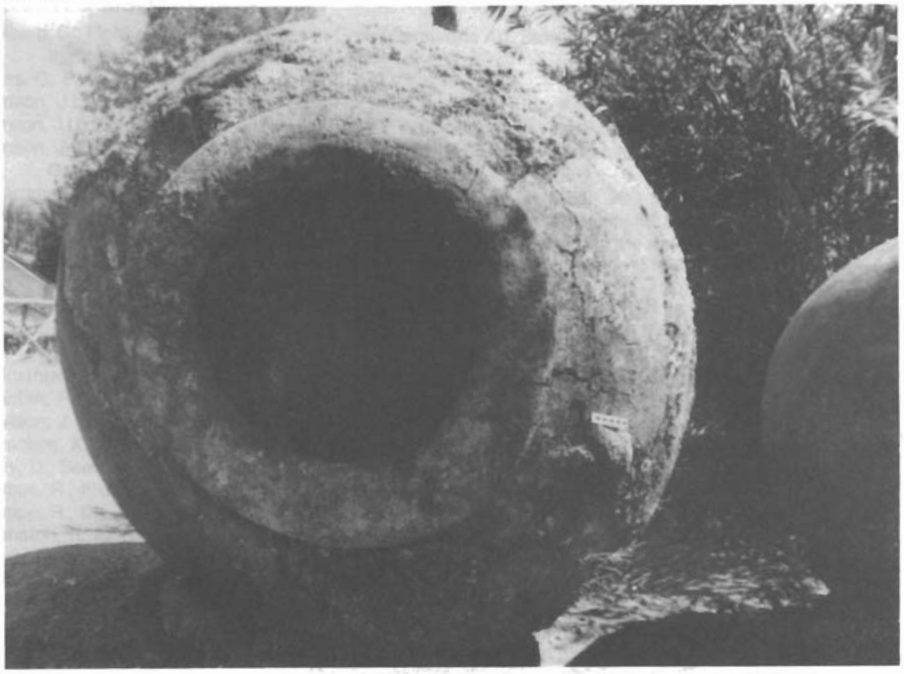
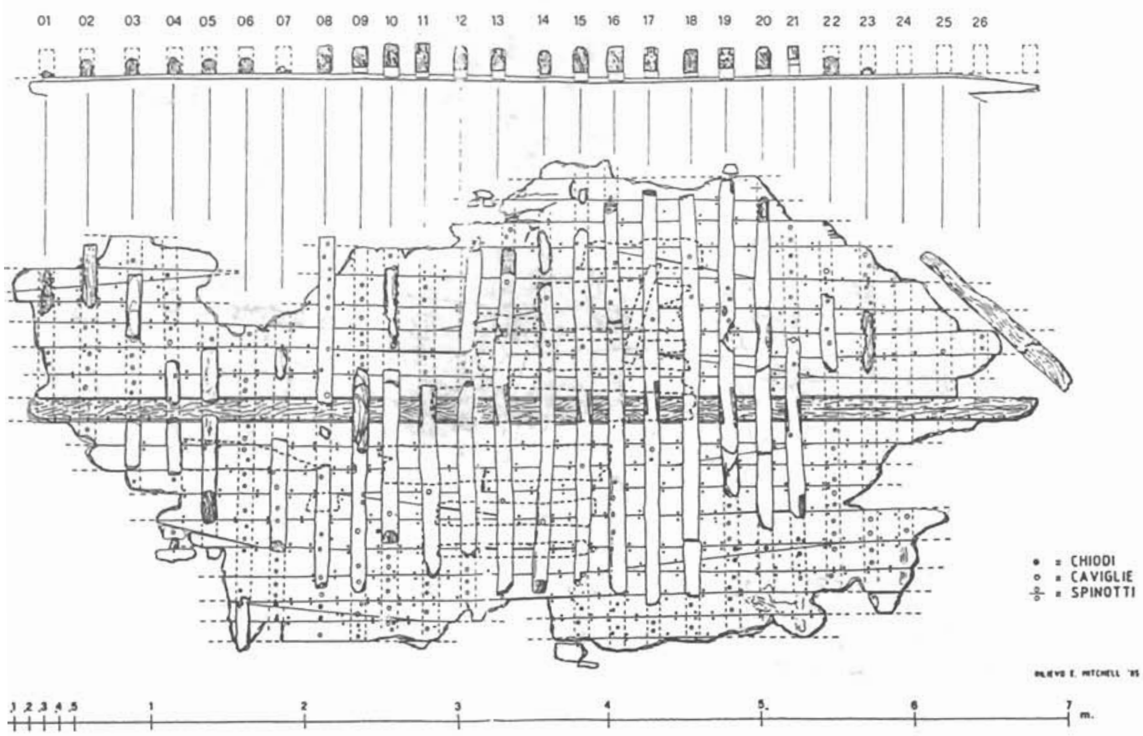


FIG. 3


Fabrateria
Liris fl.
AVRVNCI
NIÆ
Suessa Aurunca
Lautulae
Fundi
Amyclae
Formiae
Minturnae
Pyrae
Trifanum
Sinuessa
PARS.
SCUM.
41
38

FIG. 4



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IG. 5

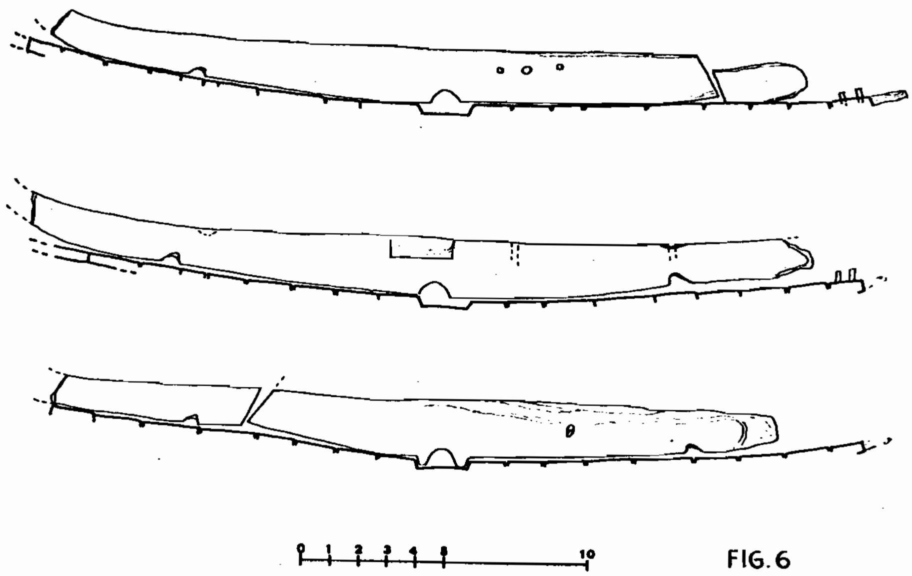


FIG. 6

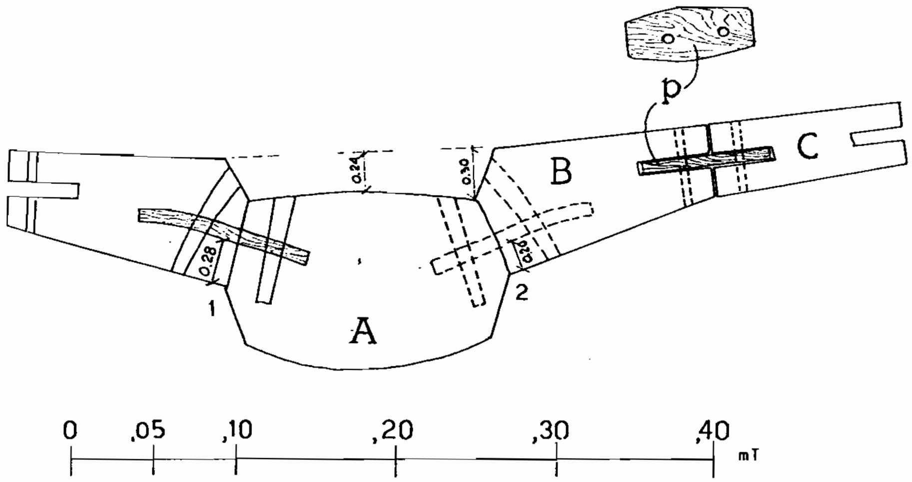
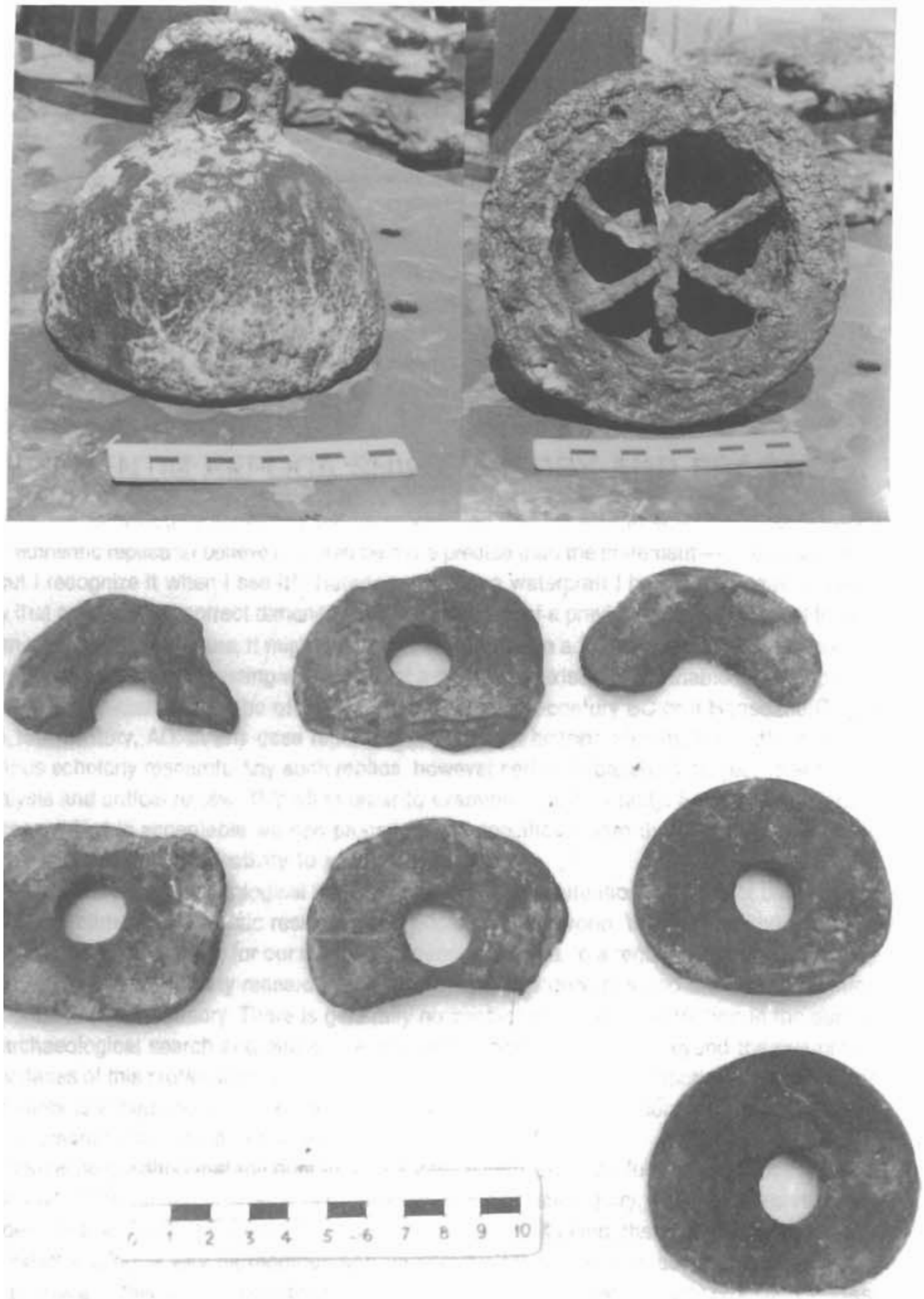


FIG. 7

FIG. 8



AUTHENTIC REPLICA SHIPS: THEORY AND PRACTICE

It becomes obviously necessary before proceeding that we should agree on what is meant by "authentic replica". I believe it should be more precise than the statement — "I cannot define it but I recognize it when I see it". Refering to replica watercraft I believe it is reasonable to say that a replica is a correct dimensional reconstruction of a previously existing vessel in both form and material structure. It might be further admissible to add that a replica can be, instead of a specific previously existing vessel, one of a previously existing identifiable type or species of vessel. For example, a type of Greek trireme of late 4th century BC or a Hanseatic Cog of the 15th century, AD. In any case replication implies an historic identity, being the result of serious scholarly research. Any such replica, however seriously based, is subject to scholarly analysis and critical review. This all in order to examine its authenticity. So, if such definition of the subject is acceptable we can proceed more specifically into our experiences keeping at the same time the objectivity to general application.

There is in today's technological and international society situations of conflict between our deep commitments in historic research, and our work-a-day world. We are required at sea as well as ashore to conform, for our safety, and general welfare, to a regulated conduct. We may isolate ourselves in literary research; in the preparation of drawings and the communication of our findings, and theory. There is generally no conflict with public restriction in the pursuit of archaeological search and disclosure. However, when we proceed beyond the customary boundaries of this professional work, when the endeavor involves reconstruction of replica ships and ultimately their operation we may very easily and unwittingly find ourselves in conflict with an adversarial and hostile public world.

There is no question that the operation of a replica ship, built carefully to reproduce a vessel which was most common several centuries ago is legitimate inquiry. Where such a vessel in its own time was sailing in waters surrounded by others of its kind, there was a common base of understanding, a very harmonious and unreproducible scene. It is something different to put a replica of this vessel afloat today; a bleating lamb among mechanically propelled wolves;

vessels of all sizes and descriptions agressively pursuing entirely different and more urgently indifferent objectives under lawful 20th century rules. Or if we put it far to sea without it having complied with legal certification, even though it is operating privately with a crew of dedicated volunteers it is quite at the mercy, not only of the timeless unfriendly sea, but of the hoards of public disbelievers, and the uncompromising requirements, and total disinterest in its purpose by public officialdom. Finally, to accommodate the requirements of increasing official scrutiny in pursuit of legal certification, — here's a rub with authenticity. The question immediately is illuminated and becomes a very real obstruction. Under such pursuit of truth, to build a replica authentically? Consider but a few obstructions:

• Does watertight subdivision below decks with perhaps as many as five completely watertight bulkheads, interfere with authenticity?

Yes and no. Assuming no change has taken place to the exterior hull form, its floatation centers of buoyancy and gravity, spars and rigging, etc., the performance under sail should remain the same. There is no question on the other hand that the crew's daily life-style is different because of this unnatural compartmentation, whether for better or worse it is not important — the authentic performance of the crew and consequently the vessel as an historic replica at sea is no longer reproducible.

• Does mechanical propulsion equipment installed for mobility make an effective difference in the authentic replication?

Again one can try to be objective and say that under certain conditions it can be minimized to the point of negligibility. The propellers can be off-center and feathering or folding and the vessel will sail as though they were not there at all under brisk sailing weather. The engines or engine can be very small and compact and tucked away in a very remote compartment — again a slight and possible tolerable concession. The operational purpose must decide this question of intrusion on authenticity.

• Can the sails be made of modern fabric such as dacron, nylon or duradon?

Here we can be more specific I believe. If our pursuit of authenticity is honest and rigorous the answer must be *"no"*. There are still available today sail cloths of the same kind as those of many centuries past. There is good flax sail cloth in many grades and weaves. There are the same in cotton weaves from long staple Egyptian plants to light or heavy regular sail cloth common to the 17th and 18th century. But how much disadvantage for the sake of pragmatism are we to surrender if we compromise wisely? Cotton and flax used over a short time lose their strength. They are subject to rot or and are expensive to replace. If operational economy is important there is little to be lost in using a new fabric called "duradon". It has texture, appearance and handling quality and feel of cotton or flax. It is dimensionally stable, it does not rot mildew and is stronger for its weave than the vegetable fabrics. It has much to commend it as a practical alternative.

There are innumerable other concessions that must be considered along the way that fall on the consciences of the designer and builder. In most cases these compromises are those that must be weighed against economy and time — or plainly — just how authentic can products be made? A vessel can be built in many cases extremely close to the original and this is most commendable and most advisable especially if it is to be a museum exhibit with little environmental exposure. If the resulting ship is to be closely authentic, or of archaelogical experimental quality, it should be made from typical wood species (this is not necessarily a difficult demand). It should be made with the original replica tools or most similar available — this is more difficult. There should be the same techniques in fabrication, such as the same type fastenings, as sewn edge or draw tongue, locked tenon joints, hand-forged nails, etc., whatever the period demands. These procedures may be excessively demanding and consequently costly but not impossible. This sort of dedication has also serious and demanding intensive labor training involved.

On balance with time and costs processes must be examined with the effects on the resulting product. Are such demanding processes truly effective? Is it possible today to find craftsmen with the necessary skills? Most have gone centuries ago or possibly millennia ago. Is it possible to redevelop skills? Regardless of the enthusiasm and dedication of available shipwrights, some strange and forgotten crafts must occasionally be taught and mastered.

As rarely as we undertake a full-scale replica project (this writer is presently confronting two large historic reconstructions) the economics and the calendar restraints seldom can justify the total dedicaton with the consequent time and costs suggested above. Original replica tool use is largely hypothetical; correct wood species are likely to be a priority consideration but availability is a constraint. Correct fastenings can be considered in the category of close duplication. (Example: large cut boat nails vs. similarly tapered hand-forged iron nails). The skills in ancient tools as the adze are frequently employed because of practicability but are limited in scale; large timbers can be reduced far more economically to the specified dimensions by power saws. The synthetics in sail cloth of the new duradon are advantageous as has been indicated. However, oddly there was official criticism after the capsizing loss of an 18th century replica American topsail schooner because her sails were partially synthetic duradon. This criticism was directed toward advisability of the blowout safety factor of cotton or flax that might have preceded the knockdown. Such backup safety consideration as this conjectural finding must be considered on its improbable merits.

These factors are typical and relevant but limited to examples arising in the larger vessel's shipbuilding process. Small craft replication can be more realistically close to historic concepts. The goal, in my case, is revelation of knowledge in sailing replicas and must continue to be the end-frame of the reconstruction endeavor.

Having discussed by rather sparse examples and experience above, mostly confined to the design and reconstruction phases of experimental archaeology and with a reference to the constraints of modern society, we must logically proceed to some discussion, however limited, of the operational rewards of replica building. It is here that perhaps lie the fruits of the labor as well as unexpected holes and fallouts.

There is a basic consideration in construction involving vessels of greater age than five or six centuries. Vessels that must be built according to a more ancient art of such great age or older must face partial or complete "shell-first" construction. The builder and/or architect must make a decision early on whether to follow conscientiously the original techniques or build to some modern system which achieves a proximate ultimate result.

This should be a very well-considered decision in classic "shell-first" hulls. For example archaeological experience, among other things, reveals that of ancient wrecks, hulls are invariably found to be asymmetrical about the longitudinal axis. It is not the result of deformation due to age or decay. This is quite understandable considering the assembly and fastening of longitudinal planking without the help of at least a few fully centered complete frames. The degree of asymmetry, port or starboard which is favored as full or slack, would have no predictable variation or consistency. This factor likely was a varient of the builders' skill, dedication to work, the type of vessel, the time of building, and inumerable variables that surrounded this tedious craft. We must believe that these ancient shipwrights were motivated to building, as best they could, symmetrical ships. They were certainly familiar with levels, plumb bobs, measures and devices to maintain reasonably close adherence to desired form. Their problem was not of their making, of course, they were working with a traditional system wherein symmetry was most difficult to establish. With total well-intentioned effort to achieve a correct hull, because of the method it could not be maintained and would lapse into a port or a starboard condition of laxity. A conclusion here of success in achieving a symmetrical hull, from the rule of averages, is not unreasonable, in perhaps one in a thousand tries.

It would seem if this assumption is true, that we have a situation wherein we can better use modern techniques to directly achieve a result of symmetry. So consequently the ancient method is clearly unjustified to build an authentic replica.

There was probably never of all the thousands of triremes that ever existed more than a very few that were symmetrical about the longitudinal vertical plane. The great length-to-beam ratio would reasonably preclude it. It is probably not too great a speculation to think of a new trireme being manned for the first time, where the commander exercised his new crew through a considerable practice time to determine the placement of his oarsmen to work most compatibly with the resulting ship's behavior. Surely he did not realize that he was managing a balance between an asymmetric hull and an asymmetric crew.

It would be better, if the construction of a trireme today were directed toward a hull of optimum symmetry. This seems necessary if it is to lend itself to archaeological experimentation. Such a hull would be best constructed over a pre-built rigid mold. This would serve the requirements of "shell-first" building. The insertion of symmetrical prefabricated frames after the shell is complete would provide an authentic replica by a technologically controlled process.

In an ultimate confrontation with the truth while we consider replica construction we must admit our latent weakness to fail in achieving genuine authenticity. If we only examined for a moment the problems of reproducing the past we are forced to admit that it is not totally possible. Our best source of knowledge is archaeology and it is never whole or complete. We are left to speculate the rest. We are fortunate to have a reasonably accurate underbody of Kyrenia II. But what of its upper works? — The interpretations of pottery renderings? What of its sail and rig? Can we simply measure the proportions on an attic bowl decoration or the like? We can because it is our only source, however dim. It is to be wished that there were more known about its stem form and the stern above the waterline. The sailing performance does not depend much on these things however and it is invaluable already as an enlightenment. It is a successful archaeological experiment within these known bounds.

If we can assume that our historic nautical knowledge is adequately correct, that our proper procedures and considered concessions in construction are wisely chosen and followed and that we can call the resulting ship a reasonable replica and defend its basic authenticity we can cast-off our lines and set sail.

At the outset operational difficulties were mentioned of the present time with craft that were for a vastly difference time. In this direction and in its extension there is another and related factor that will inevitably shade our conclusions. It is a very simple factor contributing to the viability of all replicas and their authenticity. In historic research, as we recede into the past, our information sources diminish in both quantity and reliability. Replicas of two to four centuries past benefit from a reasonable amount of documentation and the design of the most significant ships can be reconstructed with relatively reliable authenticity. However, to penetrate farther than five hundred years into the past is to enter a realm of very sparse and limited documentation. Indeed, this sort of nautical researching is to grope in dim and misty corridors that often disappear into darkness. At such relatively recent past as AD 1500 most accurate knowledge of the ship depends on archaeology. Much excellent knowledge has come through underwater archaeology to us and has frequently resulted in restoration of actual vessels. The seventeenth century *Vasa, and* sixteenth century *Mary Rose*, are the most shining instances. Many underwater sites further into the past have been and are being uncovered. Along the way ships are spotlighted in contemporary graphic art and these are few but valuable sources. Finally, how do we approach ships of antiquity that are not actually revealed in archaeology? Instead of 300 years we are refering to more than 10 times that age. So what can we expect of their sailing performance?

How do we judge the performance of Kyrenia II or the grand trireme of the 5th century BC? They are necessarily to be judged against a far more remote background. The reports and revealed performance will be compared against historic expectations, classical literature and recent predictions. It will be of greatest interest.

Thomas Gillmer
Professor of
Naval Architecture
U.S. Naval Academy (Ret.)

THE ANCIENT HARBOUR OF PHALASARNA, WEST CRETE*

Phalasarna was a Classical and Hellenistic harbour town, which seems to have reached its peak in the late c. 4th B.C.. It is situated in far West Crete, and its location is strategic as it guards the trade routes from West Europe to Africa. In ancient times, the harbour of Phalasarna must have provided shelter, anchorage, and supplies to many passing ships, as it was the only safe and artificial harbour on the windy coast of West Crete.

Its *kleistos limin* was praised by many of the ancient geographers (Scylax, Stadiasmus, Dionysius Kalliphon), but the harbour seems to have been destroyed in the first centuries A.D. and never reinhabited. The Venetians list Phalasarna as a lost city. The harbour was tentatively identified in the 1860's by Captain Spratt, but not until last summer, when excavations uncovered harbour fortifications and ancient harbour debris, was the controversy over the location of the harbour completely settled.

We have uncovered one of the four fortification towers that surround part of the port. It is one of the best preserved ancient harbour towers yet found. It is built upon carefully carved bedrock, in an isodomic style, and without mortar.

The most heavily fortified harbour measures 75 x 100m, surrounded by towers, connecting walls, and quays. A narrow artificial channel connects it to the sea. Behind the most heavily fortified harbour seems to be a second one. Eleven nearly identical stones equally spaced at intervals of four meters are situated along the perimeter of this second port. A strong hypothesis is that these stones are the remains of 30m long ship-sheds. All of these features apparently belong to a military harbour. The location of the commercial harbour may be found with future excavation.

Elpida Hadjidaki
Department of Classical Antiquities
Chania, Crete, Greece

* The above is a brief abstract of Dr. Hadjidaki communication, the complete text was published in the American Journal of Archaeology 92 (1988) 463-479.

ROMAN DANUBE VESSELS FROM OBERSTIMM, GERMANY

The Roman frontier fortress of Oberstimm, some 70 km north of Munich, has for many years been excavated and is now known to have formed a major supply base for the maintenance of a wide stretch of military control lines on the Upper Danube frontier of the Early and Middle Empire. - The fortress is sited near the east bank of a minor tributary of the Danube, the Brautlach River, that nowadays discharges into the Danube some 1.5 km north of the fortress. There is evidence, however, of the Danube having run farther south during the Roman period. - Last autumn, Prof. Schoenberger, retired director of the Romano-Germanic Commission of the German Archaeological Institute, had soundings undertaken to the east and west of the fortress in order to get some idea of its surroundings.

The one bridging the area between the west wall and the Brautlach River, a narrow cutting less than 2 m wide, happened to hit well-preserved remains of the hulls of two vessels that could be dated to 90±10 A.D. and 102±10 A.D. by tree-ring investigations performed by Prof. Becker of Hohenheim University. It should be kept in mind that only those narrow sections of both hulls are known up to now. The results of those limited investigations, however, seem to merit a preliminary and in part tentative report.

North of the Alps a considerable number of Roman boats have been found, most of them in the catchment of the Rhine River (Fig.1). Such finds on the Danube, though alleged in Hungarian literature, had not yet been assessed.

As you will be aware, almost all of those boats in the Rhine and Thames areas feature variants of "frame-first" construction. It is unusual enough that both Oberstimm boats are "shell-first" constructions instead. Their strakes are joined by mortises and tenons in a way not to be separated from finds in the Mediterranean. That "Mediterranean" flavour is enhanced by both shells consisting of pine whereas most of the Rhenish vessels have been constructed from oak. There is one notable exception though: the "shell-first" boat from Vechten in the Netherlands, also built of pine. I shall come back to it soon.

In the narrow area of the excavation the strakes seem to run parallel (Fig. 2). There might be indications that, in Boat 2, they start to bend inwards slightly, but the evidence is ambiguous. At any rate the sides will have been parallel for some part of both vessels' lengths. Both cross sections are alike, being formed by shallow continuous curves that turn inwards more markedly only near their upper ends. Beam is 3 m, height of the sides 0.55 m only from surface of keels to the level of the thwarts.

Let me give you a tentative idea of the hull of Boat 2 in a three-dimensional view (Fig. 3). Its backbone is a keel, made of oak, to which the garboard strakes have been mortised. Normal strakes number six at each side of the keel. In Boat 2 the uppermost one is followed by a wale, the upper surface of which features a square depression some 20 cms long and 2.5 cms deep (Fig 4,1). It hardly can have been anything but a thwart-rest, implying the boat had been propelled by rowers. By necessity a gunwale strake has to be postulated. In Boat 1 the gunwale has been preserved, being of somewhat different shape without a separate wale; but the thwart-rest is there, too. The gunwale in Boat 2, thwarts and ceilings in both hulls have been dismantled in antiquity.

The cross-sections of both keels are rather unsymmetric (Fig. 2) not only in the angles of their lower sides but also those of the narrow faces meeting the garboard strakes. These faces run parallel to each other, i.e. there is an acute angle at one side and an obtuse one at the other. This conspicuous irregularity makes me think both keels have originally been meant to be wales; in such a position their cross-sections would make sense (Fig. 8,1). These timbers being used for keels might, in my opinion, imply they had been prefabricated and then used inappropriately due either to ignorance of yard personnel inexperienced in boat construction or some special situation in which keel timbers were so urgently wanted that anything more or less fitting the purpose was substituted.

Be that as it may, mass-production using prefabricated timbers appears likely. Mass - construction of warships had been known to the Romans, and Carthaginians, since the First Punic War. The Oberstimm evidence seems to indicate that this technique was not forgotten but also applied later when need arose.

On top of their keels both vessels feature a component that, at first glance, might look like a keelson (Fig. 5,2): a massive oak plank standing on its narrow side. I would not call it a keelson, however, since, at least in Boat 2, this component has been formed by at least two parts that meet bluntly without any attempt at scarfing. This hardly will make sense for a keelson meant to strengthen the keel against bending. Moreover, those elements, here provisionally called "Central timbers", are joined to the keels by only a very few treenails, insufficient for achieving structural strength. The actual function of those timbers is to be deduced from square holes sunk into the upper surface of the Boat 2 specimen, the bigger one of which being in line with the thwart-rest in her wale (Fig. 2). This should mean the "Central timber" held in place short stanchions that supported the thwarts (Fig. 3).

You recognise the same feature in the Roman boat from Vechten, mentioned before. In Fig. 6 its components are to be found as numbers 2, 4, 10, and 12. In the bottom side of this "Central timber" (no. 4) there are square notches for the frames, or rather half-frames; similar notches recur in those timbers from Oberstimm. But at least in Boat 2 , the ends of the half frames did not, or did not in any case maybe, reach those notches in reality (Fig. 7). This seems to imply that also this "Central timber" had not individually been adapted to its very positions, but rather prefabricated like the keels. The half-frames, made of oak and joined to the strakes by tree-nails, consist of two parts each that are scarfed together in not too careful a manner. This may not hold true for all of the frames, however.

Among the fragments of Boat 1, ripped apart by the mechanical excavator prior to the archaeologist's moving in, there are two very similar ones (Fig. 4,2-3; 5,1) that, consisting of oak, seem to form part of a frame, in spite of differing markedly from all other frames (Fig. 4,4-6). They are considerably more massive than the rest, measuring 9 cms in height. That height conforms to the one of a partly preserved notch in the "Central timber" of Boat 1, likely to indicate that those fragments form the ends of a single floor-timber that passed over the keel from side to side. There is another observation in favour of this. The bottom side of one fragment is slightly concave. This is a very unusual shape indeed for the outer side of a frame. But in the cross-section of Boat 1 there is just such an irregularity at the seam between strakes 2 and 3 of the preserved side of the hull (Fig. 2,2;5,1). So it becomes possible to assess the exact position of that fragment, and reconstruct the floor-timber itself. - It should be noted the other notch in the "Central timber" is but 5 cms high, conforming to the proportions of normal half-frames. The massive floor-timber seems to be a singular exception.

The irregularity in the hull of Boat 1, her side buckling inwards, is highly unusual in itself. Since the floor-timber assures this feature being original we have to assume the hull of Boat 1 has been unsymmetric not only in the shape of its keel, but also in itself.

I simply feel unable to believe such grave blunders were possible at a shipyard working under normal conditions. In my opinion the evidence leaves the impression Boat 1 has been constructed, by inexperienced or poorly supervised shipwrights, under so pressing an urgency that even so faulty a boat had to be accepted. It evidently had been completed, though it seems to have been on duty but for a short period; its keel is in prime condition without any of the scars of running aground that characterise the keel of Boat 2 at Oberstimm, or all of the keels of the Mainz boats.

Is it mere chance that the felling year of the timbers for Boat 1, 90 ± 10 A.D., comes intriguingly close to Domitian's campaign against Marcomannians, Quades, and Iazygians in present-day Austria and Hungary ? At the same time as Boat 1, some wooden harbour installations were constructed at Oberstimm, implying some major operation of the Roman river navy.

Boat 2 has been built of timber felled in 102 ± 10 A.D. This year might be historically significant also since at that time Trajan, preparing for his Dacian Wars, moved two legions and several cavalry units from Upper Germany to present-day Rumania. Transportation by Danube vessels, likely to have been mass-produced, would certainly have facilitated those large-scale movements. It should be kept in mind, however, that there exists a few years' margin of error for the felling dates. Since these margins overlap the possibility cannot be dismissed for good that both vessels might have been built at the same time. It is hoped future excavations will suply timbers that will permit exact ascertaining the felling years.

To sum up, the evidence now known seems to indicate both Oberstimm boats are oared vessels mass-produced by a military shipyard for two major operations 12 years apart. An interpretation as "personnel carriers" would be in keeping both with the historical context of their construction, and the fact their thwarts were supported in the centre - a measure hardly necessary if they should have carried only one oarsman at each side.

It is hoped future excavations will shed more light on those two "shell-first" boats, the first Roman boats known from the Danube.

Olaf Höckmann
Römisch-Germanisches Zentralmuseum
Forschungsinstitut für Vor -
und Frühgeschichte,
Ernst - Ludwig - Platz 2,
6500 Mainz,
WEST GERMANY.

ILLUSTRATIONS

Fig. 1 Finds of Roman ships and boats north of the Alps. Not included: Guernsey (to the west). Triangle = 1 find. Square = 2 or more finds. Open sign = "Northwest-Roman" types (Zwammerdam and related; Mainz A + B). Black sign = Mediterranean shell-first construction.

Fig. 2 Oberstimm. Elevations and cross-sections of both boats (H.-J. Köhler). Dark grey = oak. Light grey = pine. Hatched = elements ripped out of context by the mechanical excavator, rearranged in their original positions.

Fig. 3 Boat 2 from Oberstimm (Germany): isometric reconstruction of hull section with terms used in the paper. Beam is c. 3 m. Black: oak. White: pine. Hatched: conjectural. Shadow (vertical light) indicates distance between strakes and ceilings.

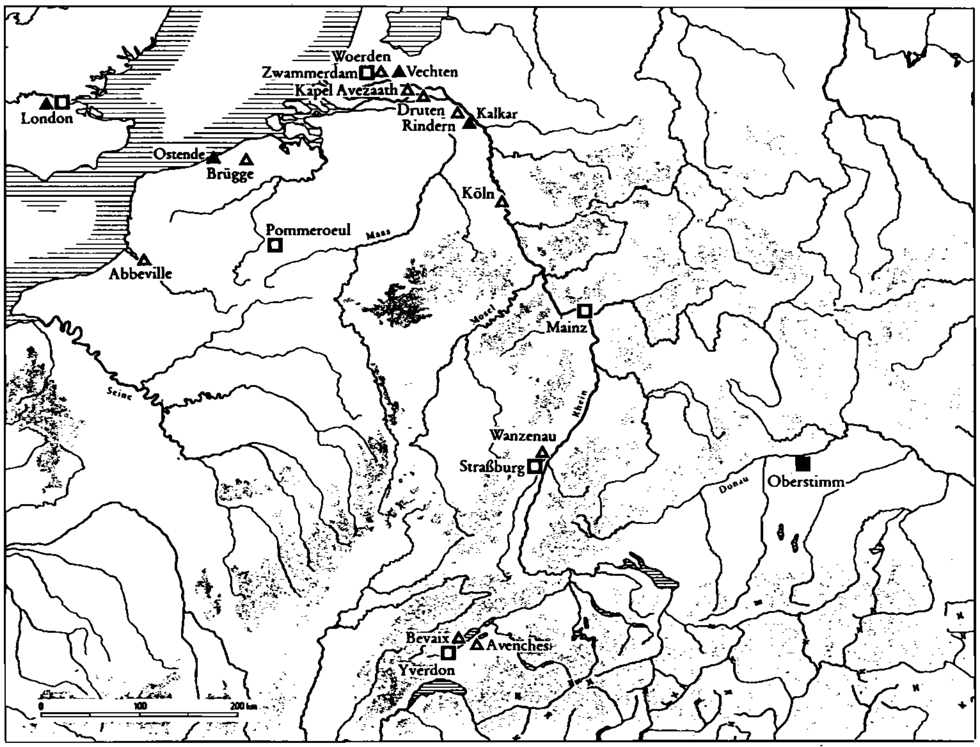
Fig. 4 Oberstimm. 1 Wale, Boat 1; in centre insertion for thwart. 2 + 3 Ends of massive frame, Boat 1 (cf. Fig. 5, 1). 4 + 5 Fragments of "floors". 6 End fragment of "floor" scarfed for meeting "futtock". 7 Ornamental knob. 8 Oversize treenail (from water-wheel? Cf. Fig. 8, 2). 1 + 8 = pine. Rest = oak. 1 = c. 1/8. 2-8 = c. 1/4.

Fig. 5 Oberstimm. 1 Massive frame, Boat 1 (cf. Fig. 4,2-3). 2 "Central timber", Boat 2. 3 Gunwale, Boat 1. 1 + 2 = oak. 3 = pine. Hatched = parts removed for dendrochronological dating.

Fig. 6 Vechten, gemeente Bunnik, The Netherlands. "Shell-first" boat of early 1st century A.D. 1 Perspective reconstruction (outlines after De Weerd, internal details added by author. Grey = hull section found in situ by Muller in 1894). 2 Cross-section (after De Weerd). 3 + 7 Mortise-and-tenon joinery. 4 "Central timber" with two iron nails (black) and square notches for thwart supports. 5 Frame. 6 + 8 Upper ceiling planks with notches for thwarts. 9 Thwart. 10 Thwart-support stanchion. 11 Keel with mortises and treenail holes (3-11 after Muller, 1895).

Fig. 7 Oberstimm: Boat 2 (centre) and upper strakes of Boat 1 (upper right). It is evident that in Boat 2 the ribs do not touch the keel and "central timber" (below measuring rod). Horizontal planks (centre right) have been laid out for the excavation. Photograph: Köhler.

Fig. 8 Oberstimm. 1 Cross-section through keel in supposed position as wale. 2 Position of oversize treenail (cf. Fig. 4, 8) as component of water-wheel; such a wheel has been suggested for supplying water to the camp.


Woerden
Zwammerdam
Vechten
Kapel Avezaath
London
Druten
Kalkar
Rindern
Ostende
Brügge
Köln
Pommeroeul
Maas
Abbeville
Mosel
Mainz
Seine
Rhein
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Donau
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0
100
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FIG. 1

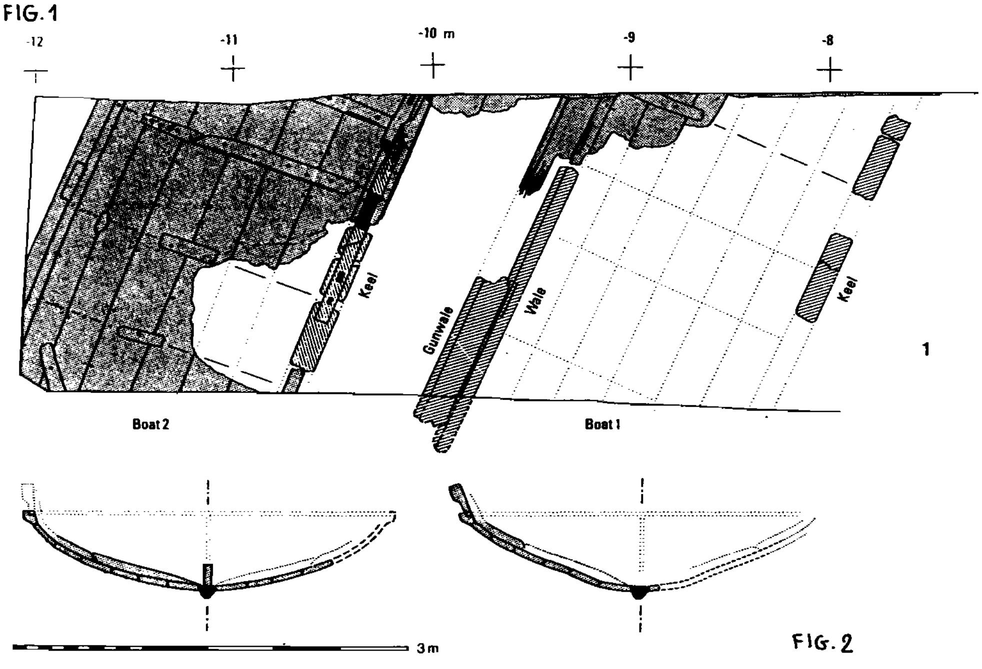

-12
-11
-10 m
-9
-8
Keel
Gunwale
Wale
Keel
1
Boat 2
Boat 1
3 m
2
3

FIG. 2

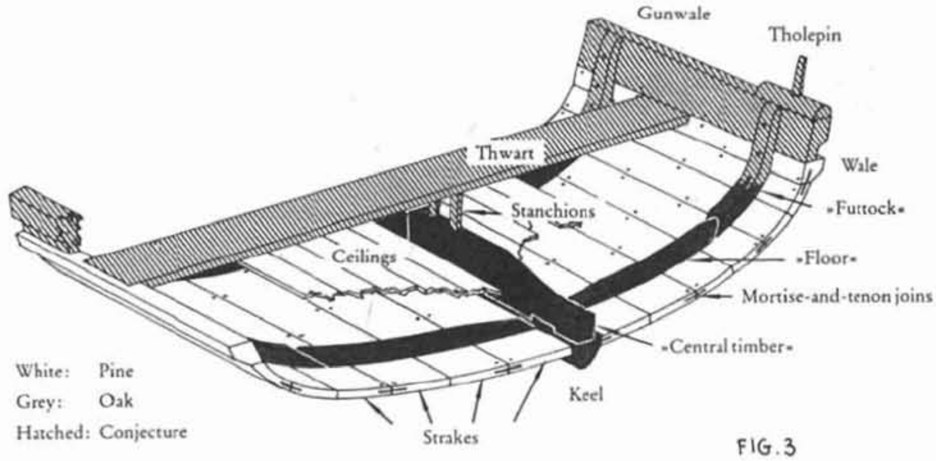

Gunwale
Tholepin
Thwart
Wale
Stanchions
»Futtock«
Ceilings
»Floor«
Mortise-and-tenon joins
»Central timber«
White: Pine
Grey: Oak
Hatched: Conjecture
Keel
Strakes

FIG. 3

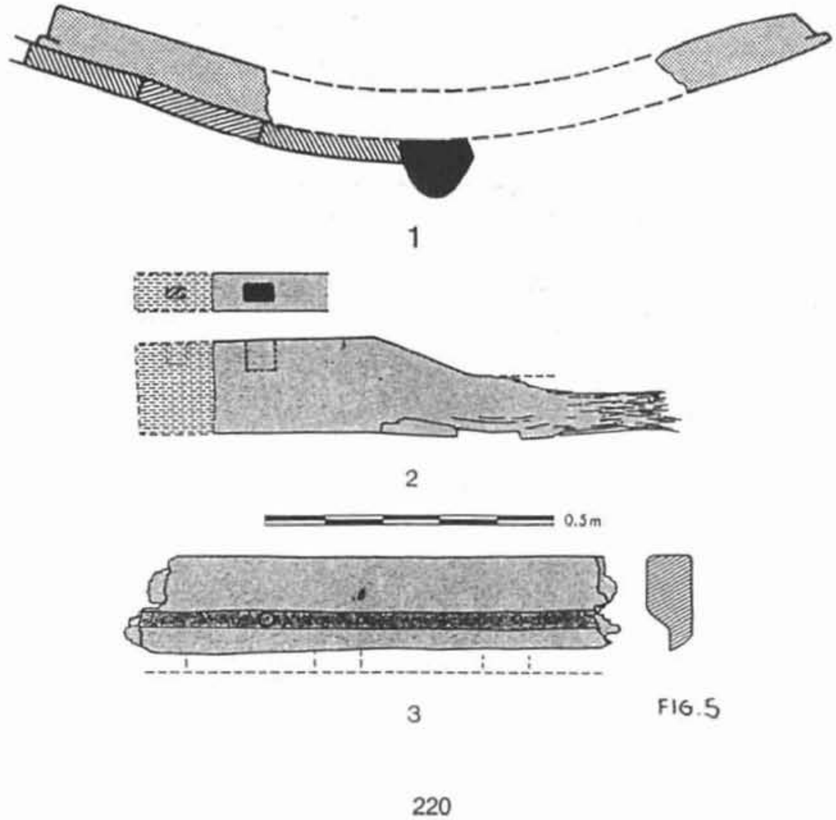
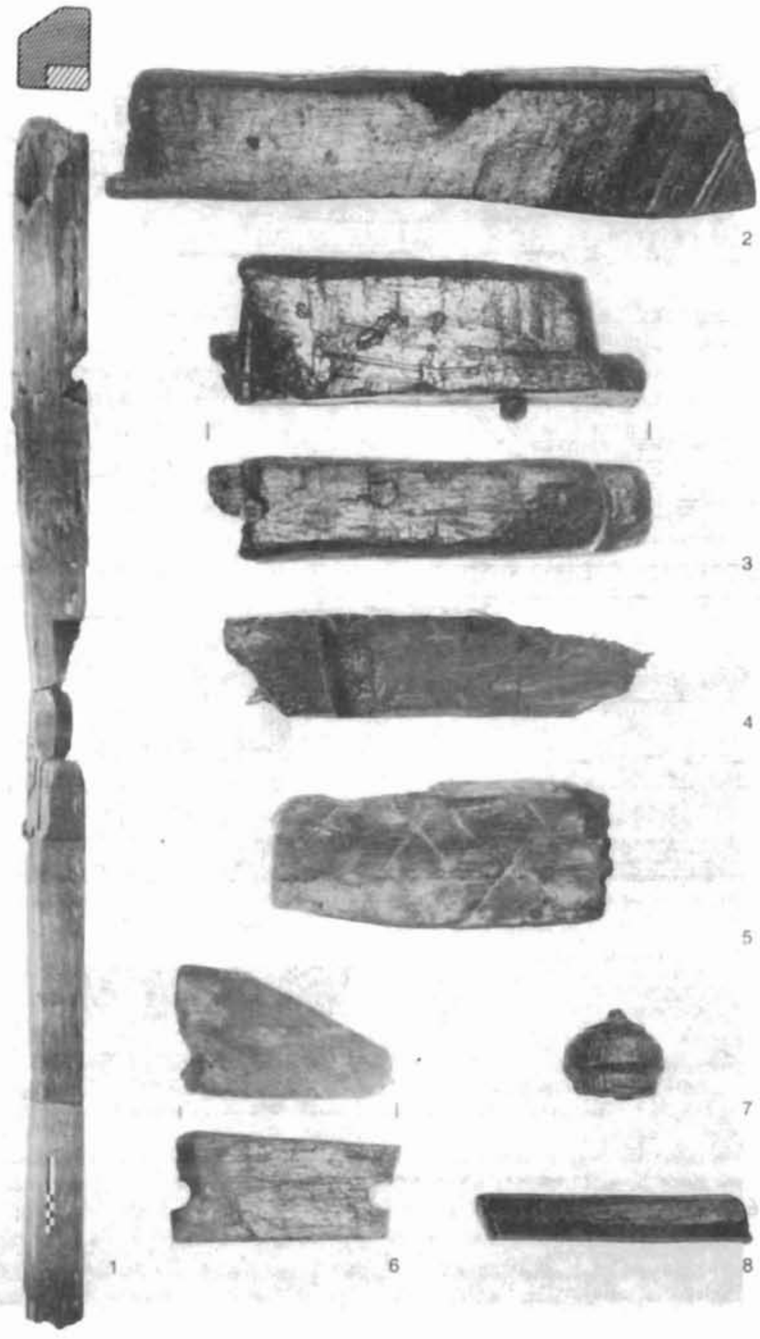

1
2
0.5m
3

FIG. 5

FIG. 4



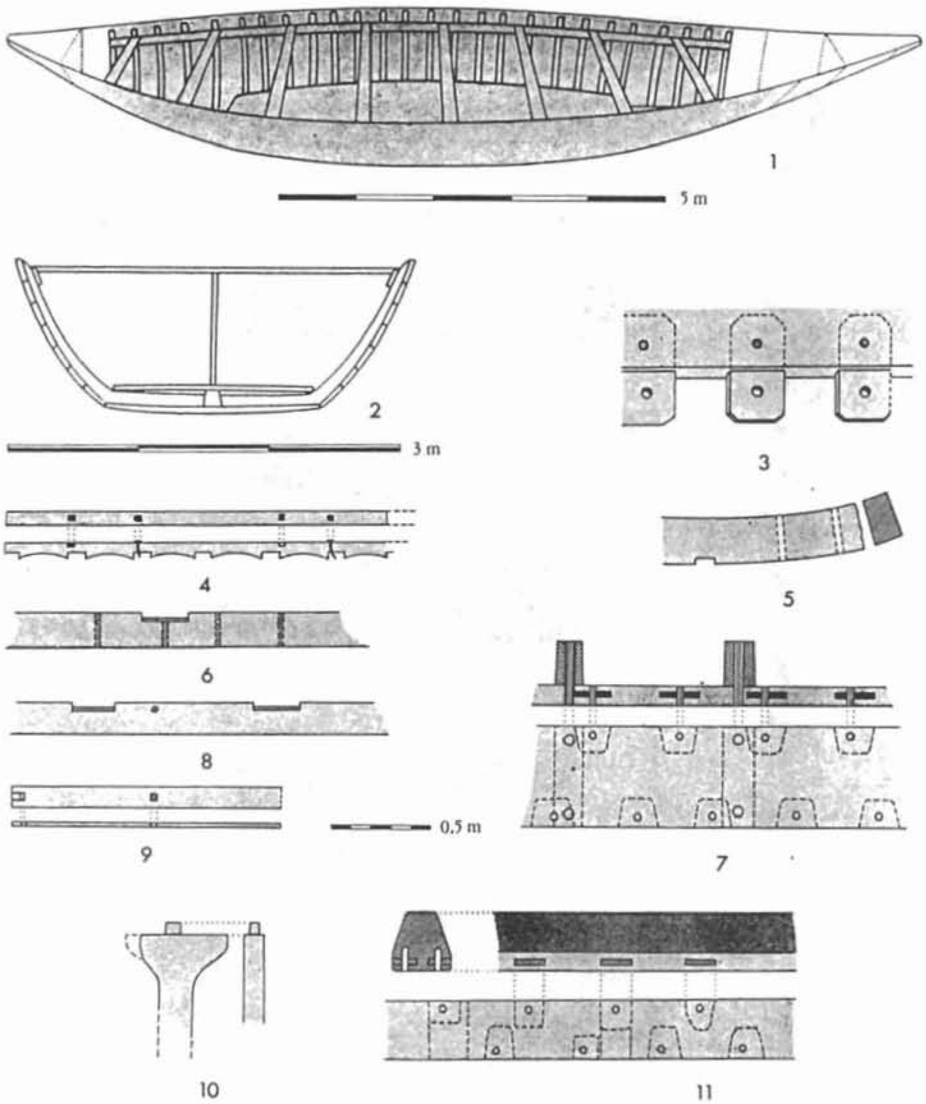


FIG. 6

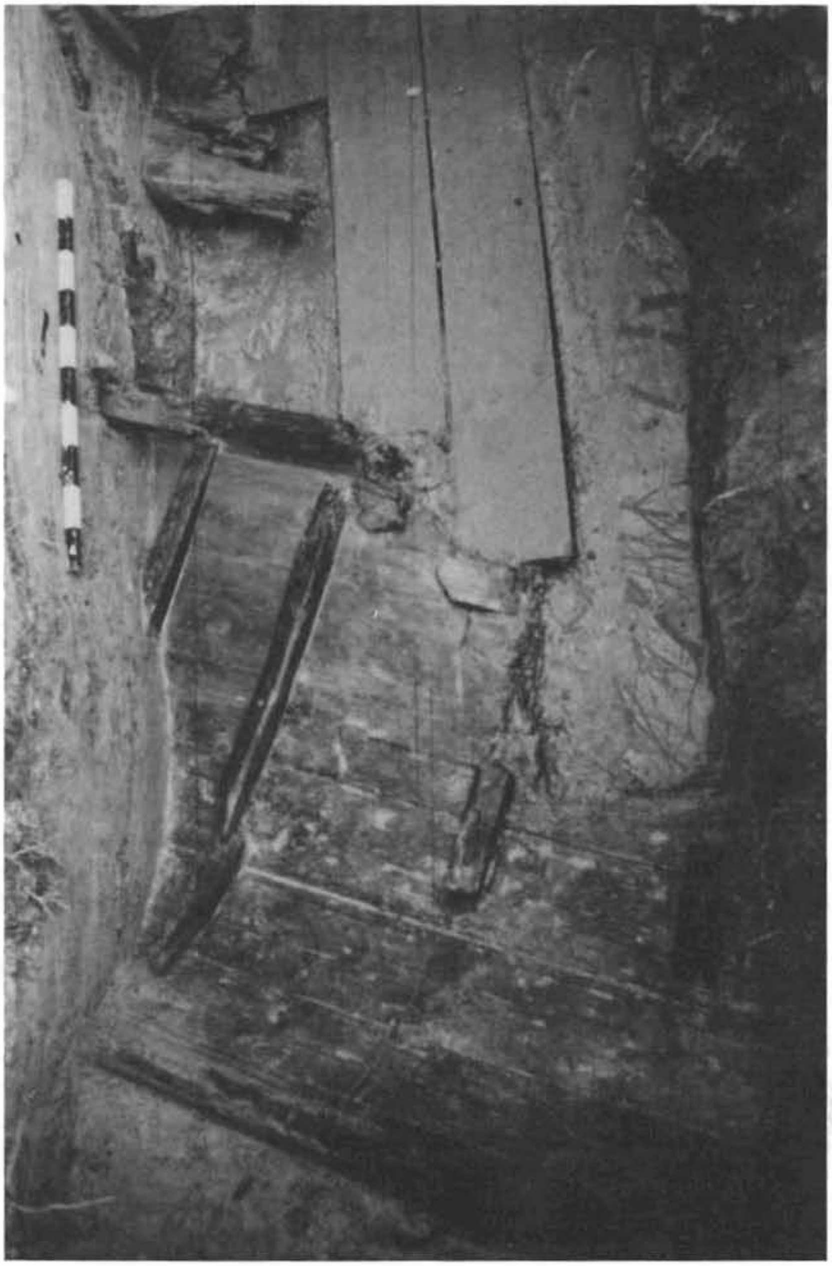
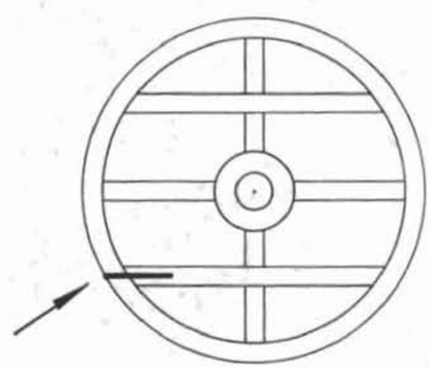


FIG. 7

1



2 FIG. 8

THE HERMONTHIS TRIERE-MODEL, MODELS AS SOURCE MATERIAL*

We have preserved just some few shipmodels from different periods of antiquity in the Mediterranean area. In this communication I will give an interpretation of one of these models and I will give an evaluation of this model as source-material for our knowledge of the appearance and construction of this kind of ship.

Other shipmodels and shiprepresentations too will be evaluated in the light of their function in their age. Is there any difference between the accuracy in the models found in graves, in sanctuaries and toymodels and is it at all possible to separate these things?

It is important by the evaluation of models to remember that the creators of these not necessarily need to have had any deep knowledge about shipbuilding and most probably just wanted to depict a representation of a ship.

Steen Ole Jensen
Frederiksvej 11
Dk - 4180 Soroe
Denmark

* Mr. Jensen made an oral communication. no writen text was received by the editor.

THOUGHTS ON THE ORIGIN OF THE EARLY MEDITERRANEAN PLANK BOAT

Abstract

The introduction starts with the oldest known plank boat in the East-Mediterranean region, the Cheops ship, and discusses questions related to the water craft available in the Early Neolithic. More than other nautical activities, requirements connected with Neolithic. More than other nautical activities, requirements connected with Neolithic longdistance migration voyages must have stimulated the development of suitable seaworthy vessels. These were log rafts similar to the present-day shaped log rafts used for fishing in the Indian Ocean.

Like plank boats, log rafts are assembled craft and have many other features in common with early plank boats. The similarities of Indian seagoing log rafts are described together with the main differences between rafts and boats. The latter, when examined dialectically, turn out to be only temporarily different stages of the evolutionery process which led from log rafts to plank boats.

Even in the earliest times log rafts had been fitted with prow pieces and lateral shelter. In boat-shaped rafts the latter appears as a hull cavity. The next step, the application of an additional device, indispensable for passenger voyages with rafts during Neolithic migrations, consisted of a platform set accross the higher outer logs of the raft. This addition transformed the vessel into a "platform raft" which is known as "freighter raft" from a few early records of ethnological examples. The platform raft is considered to be the prototype of the plank boat, which, however, from a technical view-point, was still a raft, with water flowing through the logs.

Necessary alterations of large examples of this new sea-craft transformed the raft structures gradually into those more similar to plank boats. After the invention of sailing in the Late Neolithic, which quickly became the preferred kind of propulsion for voyages over long distances, caulking of the fissures between the plank-shaped logs became indispensable for reasons of buoyancy and speed. This was the stage at which the plank boat was definitely achieved.

However, for the time being, the practice of stowing the cargo on deck continued, as is shown in Egyptian ship representations. Only after the invention of new assembly techniques using tenons and mortises instead of lashings and stitchings did the hull become more reliably watertight. The increasing demands of cargo capacity and seaworthiness during the Bronze Age, both incompatible with deck loads, stimulated the last step of this evolution in which the hull cavity was transformed into a hold for cargo.

Introductory considerations

The Cheops ship, some 4500 years old, is at present the oldest known archaeological find of watercraft in the eastern Mediterranean region. 1) This large sewn plank boat which survived in all parts with almost no damage thanks to the favorable conditions in its "ship storage burial" was for river navigation, but literary and pictorial evidence prove that at the same time similar vessels were habitually used on the sea. Previously, the ancestors of the Egyptians and other Mediterranean people had already experienced sea navigation for at least four thousand years. Indeed, from about 6500 BC on, if not earlier, when Early Neolithic culture began to spread out from the Near East to the west, over other Mediterranean coastal regions and to islands, significant parts of the migrations were made by "shipping".

We do not know with which type of vessel these early voyages were undertaken, but it must have been a sea-craft which had proved to be suitable and sufficiently safe for the transport of a certain number of persons including women and children with all their house - hold goods of tools, pots, animals, plants, seeds and everything else needed to establish at the place of destination the same kind of life and economy as in the home settlement, a culture which after transfer developed rather uniformly in each new village.

In Early Neolithic coastal settlements on the Mediterranean shore as well as elsewhere men were prevailingly engaged in agriculture and various other work on land, as for instance the manufacture of tools, weapons and pottery, but seasonally also with activities on the see. These were fishing and the transport of products to be exchanged in other coastal villages. In the Mediterranean the wide spread of obsidian used for tools and arms, from deposits on a few vulcanic islands to the various Neolithic settlements, some of which were rather distant from the places of provenance of this vulcanic glass, is clear-cut testimony for sea transport in this period (Johnstone, 1980 55 f.; Camps and D'Anne, 1980: 5 and fig.5).

The various activities of Neolithic man required particular skills and periodically some full-time engagement. For instance, a transport voyage to distant places may have taken several days or even weeks, during which the crew on sea had to be replaced at home in their habituel occupations, at least in the indispensable ones. From this and similar occasions resulted a division of work which gradually branched out. Accordingly, in coastal villages a carpenter producing watercraft must sooner or later have appeared. Perhaps this man had at first only occasionally made things in wood, for a variety of purposes, but the more often he was occupied with these, the more his experience and ability grew, with the result that he increasingly became the required specialist in this field.

If this carpenter belonged to the people engaged on the sea, in fishing or transport voyages, he would have acquired the particular know-how of watercraft carpentry, and if he was a member of the crew making long voyages during which he sometimes may have had to execute some urgent repair, he also would have gathered knowledge on how the craft behaved on the sea under various conditions. The experience gained aboard would have enabled and encouraged him to try to improve the structure and certain particularities of the vessel, when a new construction had to be made: thus, the performance of experts in watercaft carpentry was doubtless an important precondition for progress in improving seagoing vessels during the Neolithic.

One of the reasons for going on the sea in the Neolithic was fishing. This was probably only carried out close to the shore and in good weather conditions. All kinds of primitive craft may have sufficed for this, reed and wooden rafts as well as dugouts and coracles of basketry, and in some areas also bark and hide craft. The modest navigational requirements of fishing probably remained unchanged over a long period and therefore cannot have stimulated very much the development of the craft. More or less the same is true for small-scale sea transports of goods over short distances made with the same craft as used for fishing.

The employment over large distances of mere dugouts is unlikely. As everybody knows, dugouts and log canoes are only seaworthy if they are additionally provided with a system of stabilization, consisting either of a balance cross beam, a single or double out-rigger float, or stabilizing logs set lengthwise aside the hull. Another seaworthy solution is a double-log canoe with platform. However, it is very unlikely that either of such craft was ever used in the Mediterranean. If this had happened, one or the other type should have survived as local fishing or shipping craft, at least until early historic times, and in this case ancient writers would have reported them as curiosities. The ancient literary sources mention only log rafts used for transport. Moreover, in my opinion, no dugout with a stabilizing system would have been transformed into a plank boat without the same stabilizer. No balance system is shown in the earliest representations of sea-craft in the Mediterranean region. This is why I think that for our problem here dugouts, whether plain or with additional structures, do not need to be discussed[2].

The formation of Early Neolithic villages on Mediterranean islands, some of which were rather distant from the nearest coast, proves that the settlers had arrived by sea. Which type of craft could have been used for these voyages? Plank boats like the Cheops ship or similar, being the result of a rather sophisticated carpentry using metal tools, are out of question. Craft built solely by means of stone adzes (which initially were not even smoothed) must have been much simpler. On the other hand, the Early Neolithic vessels were certainly not rudely constructed rafts joined from wooden floatsam, as Paleolithic man may have used some 30.000 - 40.000 years ago in tropical regions for his attempts to reach the next near island - attempts which occasionally finished as a drift to unknown destinations. Early Neolithic man had doubtless much experiecne of sea - going craft. With it, if need be, a safe return voyage could also be made. Indeed, it is well imaginable that the Neolithic migrations overseas were as a rule based on information, gathered in previously undertaken exploration voyages, about the preconditions of life at the new place. To know the availability of basic requirements such as fresh water, soil for agriculture, a good solid ground for setting up the huts etc., must have been essential.

More than any other use of water craft in the Neolithic, the migration voyages overseas and the elevated demands connected with them were obviously the factor which stimulated the further development of the available sea-craft. The preliminary conjecture is that it was the addition of a new device, opportune if not indispensable for passenger voyages, which transformed the original craft into a new transitional shape. This would have been a kind of a prototype of the plank boat, and further improvements of this intermediate craft would gradually have led to the development of the true boat. At the bottom of this evolution would have been a long, uninterrupted tradition in carpentry of assembled sea-craft, the roots of which go back to the Paleolithic. Accordingly, the conjectured transitional shape or prototype of the plank boat as well as the original wooden sea-craft should be similar to the plank boat in various features. Of all types of primitive water craft which could have been used in the Early Neolithic, shaped log rafts present, in my opinion, the closest similarities to plank boats.

Log rafts exist still in various parts of the world, conveniently shaped types especially on the south and east coasts of India and in the northern parts of Sri Lanka. These correspond largely to those which could have been produced with the woodworking techniques of the Early Neolithic, apart perhaps from the perfectly smoothed surfaces which are met on the logs of the present-day rafts. The conjecture that the shaped log raft was the basis of the plank boat would also be in accordance with the ancient sources which testify to the employment of wooden rafts in the Mediterranean region in early historic times (Casson, 1971: 3 f., note 2; Köster, 1934: 125 ff.).

As to the question of whether log rafts are seaworthy under fair weather conditions - we must remember that early navigation was prevailingly an activity in favorable seasons, as it was still in classical times and later - I think that no demonstration is needed here after all that is known about it[3]. With regard to geographical origins, the possibility should be taken in consideration that the first sea-craft on the Mediterranean were perhaps not developed there, but may have been introduced from South or South-West Asia. This would mean that either the Indian Ocean, or the Persian Gulf, the Arab Sea or the Red Sea could have been the waters on which shaped log rafts first were used in the Neolithic after those of Paleolithic times assembled from unworked trunks.

Similarities and differences between present-day Indian log rafts and early plank boats

Indian seagoing log rafts are prevailingly used by fishermen of Tamil populations. I had the opportunity to examine several types of them in Sri Lanka *(Figs. 1-5)*, and at the same time I have studied the available reports on the rafts in India *(Fig. 6)*[4]. They are made from shaped logs and are either lashed or pegged. In Tamil Nadu, South India, they are known as *kattu-maram* meaning "lashed logs", and in Andhra Pradesh, the central region of India's east coast, they are usually called *teppam*. Both terms are also used in Sri Lanka, where *teppama* (sing.) is the pegged raft.

As to their similarities with early plank boats, the following main features may be considered: the material, its maintenance, the shape of the main components, their layout in plan and relief, techniques and means of junction, the general shape and the main lines of the craft, and, as an important particular, the raised prow timbers. In addition, the principal diversities between these rafts and early plank boats may be examined.

1. Wood is the material used in both types of craft for the main components, though kinds and qualities are different because of different requirements and diverse local sources. Raft logs should if possible be of a wood which is light but does not absorb water too quickly. There are other requirements for the timbers of plank boats not to be discussed here. In this context it is essential to note that both types of craft are products of woodworking and above all of a specific carpentry producing watercraft by assembling.

2. For both types of craft there is also a common method of maintenance. During bad-weather periods, when the craft remain unemployed for a longer time, both log rafts and early plank boats, of the latter those assembled with lashings and stitchings, are dismantled for storage. Log rafts are also dismantled periodically during the season of use in order to allow the logs to dry out completely. Are sewn plank boats perhaps also dismantled from time to time for the same reason or was beaching considered to be sufficient?.

3. The main components of both craft, the logs of the raft and the planks of the early plank boats, are shaped with the adze from trunks or from big boughs. Sawing of trunks lengthwise was probably not possible before the Copper Age, although small saws with teeth of obsidian or flint may have been used earlier. A point which is significant for our question is that both logs and planks are carved into rectangular cross sections, except the outer sides of the outer logs which are more or less rounded properly. Planks are usually thinner than logs, but in early or primitive plank boats they are comparatively big. In certain plank boats this is only initially the case, i.e. before the outer surface is partly removed and smoothed with the adze. This is,

for example, done on the *dhoni* of the Maldive Islands, when the construction in shell-first technique by means of treenails in the joined edges of the planks is completed. In Egypt rather big planks were still used in the early 2nd millenium BC Dashur boats (Ward Haldane, 1984: 13,21). Perhaps Herodotus refered also to big planks when "he likened Egyptian boatbuilding... to the laying of bricks". (Casson, 1971:14).

A certain type of Indian log rafts has horn-shaped cross timbers joining the logs near both ends. This may be taken to be a model for frames in the plank boat, but the joining cross timbers are doubtless a more recent device than lashing. More significant a similarity is the fact that frameless plank boats also existed or still exist, e.g. the Dashur boats (Ward Haldane, 1984), in our times Egyptian river cargo boats (Hornell, 1939/40), and in India the *masula* surf boats (Kentley, 1985). Frameless plank boats considered to be an early design are doubtless the simplest rationalisation of the plank boat, and therefore they may well be the oldest. To this it corresponds that shell-first building precedes skeleton construction and that the former is rather similar to the way in which shaped log rafts are assembled.

4. As to the layout in plan of the main components in the craft, both logs and planks are edge-joined, one aside the next. Seen in relief, or in cross section, there are necessarily differences in height. In shaped log rafts the logs are almost never set all in one level; usually the outer logs are found to be somewhat higher than the inner ones, in some types even strikingly higher. In this way the cross sections of shaped log rafts show almost always a slightly rounded cavity and, correspondingly, a convex bottom at the underside of the raft which is also the most convenient shape for beaching. In some *kattu-maram* the outer logs are set overlapping the inner ones. There is of course never the same precision in joining logs as is applied in matching planks.

In boat rafts the corresponding conformity with plank boats may be still greater, but some of them with perfectly sawn, high side planks *(Fig. 7)* appear rather to be stimulated from plank boats than conversely. However, the device for lateral protection is certainly old. It is indeed indispensable where rafts have continiously to cross the prevailing wind direction and waves come over at the weather side. The boat-shaped design prevents the fishing equipment, the catch and everything else aboard the raft from being washed away. Rafts with higher side logs (cf. Wiebeck, 1987: ills. p. 136-7) are doubtless an original conception stimulated from early experience on sea. The application of this arrangement can be considered to present the first important step in the evolution which gradually led to plank boats.

5. Next come similarities in the technique and means of joinery: To the lashing with ropes of shaped log rafts which usually are assembled at both ends, correspond lashings and stitchings with lines and cords in early plank boats. Indeed, the earliest plank boat we know of, the Cheops ship, is a sewn construction.

Pegging, too, is an early means of connection, used namely when it could be done easily, as e.g. in banana stem rafts which are assembled by means of pointed sticks readily passed through the soft stems (Hornell, 1946: pl. IX). In hard wood, pegging was probably not very much used before suitable metal tools became available, also because lashing was simpler and quite adequate. On a large scale, pegging may have started only in the Bronze Age, when the fastenings in early plank boats consisting of lashings and stitchings were substituted by a more efficient technique.

6. With regard to the general shape and the main lines of the craft to be compared, similarities in the cross sections were already stated (in section 4). Seen in plan, the fore end of shaped log rafts is almost always the most tapering part, as it is in boats. The maximum with of these rafts is sometimes found about amidships like in early plank boats, e.g. in the Cheops ship. In other rafts it is near the after end. Are there perhaps examples for this also among early boats ?

In some of the Indian and Sri Lankan *kattu-maram* and *teppam* rather pronounced hydrodynamic lines appear, either in plan or in profile, or in both. On these lines depends the speed of the craft. Like the tapering fore ends of these rafts, formed by several taparing logs which were the upper ends of trunks, the hydrodynamic lines were certainly developed in early times. In part, they may be stimulated from similar lines of other early craft, such as bark boats or dugouts with tapering ends. The experience which Neolithic man had with his sea-craft must sooner or later have aroused his interest in speed, at the latest during his first attempts in sailing. The perfect lines of the Cheops ship may partly derive from the elegant shapes of Egyptian papyrus rafts, which on their part are doubtless the result of experimenting with shapes. Such lines, however, cannot have been entirely missed in the craft which were the forerunners of the plank boat.

7. On *kattu-maram,* an important detail is the separately carved logs forming prow pieces. According to the number of floating logs of the raft, there is a single prow piece on a 3-log *kattu-maram,* a double prow piece on those assembled from four logs, a triple prow piece on 5-log *kattu-maram* etc. (cf. *Fig. 6).* Each timber of these prow pieces has on its underside, at two fifth or at a third of its length, a step with which it matches the fore end of the corresponding inner log, on to which it is lashed when the fishermen assemble the raft *Fig. 5).* The raised fore ends of the prow pieces are similar in shape to those of water skis and have the same function, i.e. to pass over the waves.

To the prow pieces correspond the raised bow of the plank boat. Its bow timber is likewise a prolongation of the central bottom timber (cf. e.g. McGrail, 1987: 116, fig. 8.16), and later of the keel of the boat. In both craft the use of the device is to facilitate passage through the surf, which almost continuously, and even in good weather conditions, beats the coasts almost everywhere, especially on unseltered shallow beaches. Because the seagoing *kattu-maram* are a beach craft, their prow pieces must have been indispensable from the beginning and, consequently, have doubtless been an original part of these rafts since earliest times. In view of the conformity of purposes and similarities in joint and shape, I think it is well justified to see in the prow pieces of these shaped log rafts the forerunners of the upward curving bow timbers of plank boats.

After having briefly reviewed the main features of Indian log rafts compared with those of early plank boats and after having ascertained a lot of common elements, conformities, parallels and similarities which demonstrate relationships, it is necessary to point out the main differences.

In rafts the water flows through the logs. Partly because of this, but mainly on account of their broad extension at water level they are rather stabilized and safe against capsizing. Their buoyancy, however, is only that of the floating material (being lighter than water) used in their constructions and as far as it dips under water, the structure above water level as well as anything else aboard being weight. A hull cavity exists only apparently, where the cross sections of the raft are curved, and somewhat more in so-called boat rafts, but always with the same through-flow situation of water in the bottom, already mentioned.

Plank boats have a hull cavity which is watertight, usually achieved by caulking. They have important additional buoyancy from the displacement of water by air in the part of the hull cavity found below water level. On the other hand, the watertight hull, if without ballast in the bottom, is generally much less stable against capsizing than a raft.

These differences between log rafts and plank boats seem to contrast unbridgeably. However, if one examines them dialectically, i.e. as temporarily different states in an evolutionary process, they turn out to be only apparently opposed features and by no means incompatible. A suitable type of shaped log raft, when completed by an additional device, assumes a transitional shape between raft and boat, and this, in a further stage of evolution, also achieves intermediate qualities. Based on this perception and on the previous reflections and results of comparison, we can make an attempt to trace the step which transformed the log raft into a prototype of the plank boat and the further improvements which from this intermediate shape led to the real boat.

The conjectured evolution from the shaped log raft to the plank boat.

Departing from the assumption that the requirements connected with Early Neolithic migration voyages were the stimulating factor behind this evolution, we may start from the following situation:

Among the water craft use in that period on sea were log rafts, if not yet on the Mediterranean Sea, then certainly somewhere in the subtropical sea regions of South-West Asia. These rafts were probably not all of the same type, but in different states of development according to the use which was made of them. Among the rafts suitable for the envisaged purpose and already experimented with in offshore navigation, a certain type would have been chosen for the first attempts to transport passengers to another coast or an island visible from the landing place of the settlement. Most probably this was a rather large raft made from side logs set higher up than the inner ones, in other words, a raft of the type with a more or less curved cross section (similar to that of *Fig. 8, 3)*. While the crew, perhaps fishermen, were accustomed to the situation of water flowing through the logs, the passengers were not, and some of their goods may have sustained damage or even loss during the voyage. Consequently it became indispensable to provide for the next voyage a device which even in an agitated sea remained out of the water and on which goods and persons were sufficiently protected.

This device would be a platform set crosswise over the higher outer logs of the raft and fastened there. Rafts with platform over parts of their floating structures are known from ethnological evidence (cf. e.g. Mc Grail, 1987: 52, fig. 5.6). It is this transitional shape of the "platform raft", also termed "freighter raft"[5] which I consider to be the prototype of the plank boat. A part of the apparent hull of the raft is covered by a kind of a deck or by some single cross beams supporting a light deck structure. Seen in cross section, this design is already much more similar to the usual hull structure of early frameless plank boats than is that of the mere log raft *(Fig. 8.4)*.

For the time being, these platform rafts for passenger transports, then certainly also employed for transports of goods, remained, from a technical view point, rafts; that is to say, their hull cavities continued to be flowed through by water. Consequently, they had to be beached like other rafts whenever this was possible, in order to maintain their buoyancy.

Because of the platform and the weight of the cargo, the draught of the platform rafts compared with that of plain rafts was already somewhat increased. Sooner or later platform rafts of the usual maximum length with logs each made from one trunk only, may no longer have answered the demands of the "modern" sea-craft. To enlarge and prolong a platform raft was probably not so much the problem, since the attachment of the prow pieces had already bean a prolongation. The real problem which must now have arisen with large examples was that of their weight; they became difficult to handle during launching and beaching.

A solution could have been to carve thinner logs and eventually to strengthen them with some transverse timbers in order to maintain the original sturdiness of the structure. However the result of such "rejuvenation" of the timbers was a diminished buoyancy and, accordingly, an increased draught. This may at first have been put up with, as long as the platform of the raft remained sufficiently over water. However, the crew must have noticed the loss of speed caused by the increased draught, no matter whether the craft was paddled or sailed.

Sailing, probably practised since the late Neolithic if not earlier, may have stimulated the next step. From experience with a craft which was usually paddled but occasionally was rigged, it must have been noticed that speed under sail is much greater than that which can be achieved by paddling. Since sailing, once it was invented, probably quickly became the preferred kind of propulsion in voyages over long distances, the crew of a platform raft having the deficiencies described would not have contented themselves with a diminished speed. They would have reflected on how the draught could be again diminished and the buoyancy increased, though in their thoughts they certainly did not use these terms and definitions; they had probably questions in mind as to how the floating raft might be raised higher. At that time the effect of additional buoyancy (from water displacement by air) in craft with a watertight hull, as e.g. in a dugout or a hide craft, had doubtless long since been noticed as being different from the buoyancy of rafts with their water-through-flow situation. Sooner or later, somebody must have drewn the conclusion that the problem can be resolved, when the gaps between the floating timbers are closed.

It is obvious that caulking, like the other important previous improvements, started because there was a need to apply it, and it is possible that this time, besides the conditions created by the indispensable alterations of large platform rafts, the invention of sailing was its main stimulator. Caulking was the step by which the plank boat was definitely implemented; no matter what the structures and details of the first examples were, they had obtained a water - tight hull -or at least one which was more or less watertight.

This last remark alludes to another aspect of this evolution, the use of the hull cavity as hold for cargo. Initially, this was conditioned by the situation to which the crew was accustomed on the craft of origin as well as by the inefficiences in caulking plank craft; the last, you know, have not been completely eliminated even today.

On simple log rafts, fishing equipment laid on the bottom of the raft lies awash. In the apparent hull of a platform raft, the bottom (because of the additional weight of the superstructure and of cargo and passengers) is covered by water at least over the inner logs. No cargo could be or was stowed there except for things which could stay in sea-water without damage. The results of the first attempts at caulking may have been so scanty that just as much of the penetrating water could be bailed out as came in, with one man continuously working in the bilge. This situation would be that of an intermediate state between watertight and water-through-flowed, which is well known from leaking hulls.

In any event, either because of the bilge water situation in the caulked hull or because crews were accustomed to the hull cavity being unused, the hulls of early plank boats must have remained, for the time being, impossible to use as a hold. Early Egyptian boat and ship representations from wall paintings and reliefs in tombs of the Old Kingdom, and later also in temples, show everything aboard as being on deck, crew and passengers as well as cargo, for which container-shaped superstructures were used (Landström, 1970: 37 ff.). Most of the Egyptian boat models from tombs, prevailingly made of wood, are so-called "block models" carved from a single piece of wood or from a massive block glued together from several boards (Göttlicher/ Werner, 1971:6). These models do not show a hull cavity, but at most a shallow depression on deck, and the human figures and everything else is put on deck. Presumably the hull cavity was not considered to be important.

Certain small Egyptian wooden craft imitating the lines of papyrus rafts were made, according to pictorial and literary evidence, from short pieces of timber "put together like courses of brick", according to Herodotus (Casson, 1971:14 n. 15). If these raft imitations were boats, they would have been, with men standing on deck, rather unstable and shaky, compared with the papyrus rafts. Until now, interpretation departed always from the conception that boats are concerned, and it was not considered that the features of these vessels could be still those of their predecessors, that is to say, of reed and log rafts.

Moreover, certain Egyptian ships or boats with heavy deck loads or high superstructures probably employed in river transportation, as shown in wall paintings and reliefs, should have had ballast in the hull in order to prevent capsizing. Or is it possible that their hulls were still flowed through by water ? This and similar questions, means of transverse dowels. The 14th century BC shipwreck at Ulu Burun, near Kas, Turkey, is at present the oldest example of this improved technique (Bass, 1986: 275) which remained in use until Roman times. In the cited report it is not discussed whether the cargo was stowed in the hold or on deck, since the former has until now been taken to be self-evident, and indeed, it became the rule from a certain period on.

The part of the evolution which after the implementation of the plank boat led to the use of the hull as hold for cargo concludes here. Once more it is certain that socio-economic necessities had stimulated the inventions of the tenon-and-mortise techniques, and in other regions of those using other kinds of pegs. The increasing demand in cargo capacity and seaworthiness, incompatible with deck loads, required the transformation of the hull cavity into a hold for cargo[7].

Gerhard Kapitän
V. le Tica 53 (v. Regia Corte 4)
I - 96100 SIRACUSA
Tel. 0931/64652

NOTES

1) References in Lipke, 1984: 133-136; good illustrations in Jenkins, 1980.
2) Among the Tamil sea-craft in South-west India and in the northern parts of Sri Lanka there is a logboat canoe named *vallama,* without a stabilizing system. These *vallam* (plur.) are so seaworthy that they can also be sailed (Hornell, 1920: 155). However, their perfectly carved broad shape and elegant lines with tapering ends cannot be the product of early woodworking techniques using stone adzes, but probably result from the use of metal tools after long experiments on coastal waters. In Sri Lanka *vallam* without outrigger are also used, especially in shore seining; smaller examples employed in fishing on the open lagoon of Puttalam are simultaneously poled and sailed.
3) In a recently published book by Seán McGrail an entire chapter is dedicated to log rafts and is introduced with statements on their widespread use on inland waters and as sea-craft (McGrail, 1987: 44-55). On p. 45 a conjecture by E. McKee is mentioned, according to which "certain plank boat types were developed from raft structures", with reference to the volume *"Working Boats of Britain"* 1983. I have not yet been able to examine McKee's ideas which may be in a way similar to mine, as McGrail also mentions curved raft structures and contiguous transverse timbers. The latter, however, would not be a construction system required for the rigid fastening of the logs, but are in my opinion an additional structure, by which the log raft is transformed into a new type of craft, intermediate between raft and boat.
4) With regard to Indian log rafts, the following publications were examined: Daniel, 1981, Hornell, 1920 and 1946, Menon 1980, Paris, 1841-43, and Wiebeck, 1987. Mookerji, R.K., *A History of Indian Shipping,* London 1902, and Wilson, N.F.J., *The Native Craft,* Bombay 1909, were not yet available to me. Brief references to log rafts in Sri Lanka are found in Hornell, 1943:53, and in De Zylva, 1958: 4 ff. Of particular importance is the early record of the original shape of the pegged log raft termed "Japan" by E. Paris (1841-43: 34 and pl. 20, n. 10-12), from which developed in the 1940s the present-day *teppama,* which has the side logs projecting at both ends (Kapitän, 1985).
5) Some records of freighter rafts which were observed in Extra-European regions by early European voyagers are listed in Johnstone, 1980: 8. Obviously stimulated by these, some fifty years ago A. Köster interpreted as platform raft a certain type of water craft which is repeatedly figured in early Scandinavian rock carvings (Köster, 1934: 119, 125). After the development of plank boats, or in some regions after their introduction, the platform or freighter raft inevitably fell into disuse and disappeared almost completely. This is why its evolutionary role in the development of prehistoric sea-craft now seems to be obscure rather than evident.
6) In a footnote to this explanation Lipke writes: "The argument in favour of planking without caulking rests on the lack of obvious caulking material in a find which seems otherwise complete... and the suitability of the stable Egyptian climate to no-caulking techniques. These points do not clearly establish this view, but rather lend credence to it in the face of the widespread supposition that a hull must have caulking". (Lipke, 1984: 130, n. 52). Lipke's judgement of the Cheops ship as a product of "superb workmanship" providing "watertight integrity only by tight planking", in reference to a sewn construction, is a mere assumption. If perhaps tar had been used for water proofing, it would certainly have left traces also on the dismantled craft, but not so if papyrus fibres had been employed for caulking. Watertight integrity without caullking can be obtained in plank boats joined with tenons in mortises fastened in place by means of transverse dowels, as the experience with the replica construction "Kyrenia II" has shown. In the Cheops ship the internal battens over the seams between planks are indispensable for the lashings since they prevent the cords of the stitchings form cutting into the edges of the stitching holes. Whether these battens also complete a water-tight construction has yet to be demonstrated.
7) Further insights in the subject dealt with here may come from experiments with models and full-size replicas of platform rafts and their conjectured intermediate shapes as well as of early plank boats, but definite confirmations can only be expected from further archaeological discoveries of prehistoric sea-craft. These must have survived, at least partly, under certain conditions on Neolithic beaching places, especially in silted-up sites, where the Neolithic layers may be found several metres under the surface of the soil and below present sea level.

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ILLUSTRATIONS

Fig. 1 Drawings to scale of lashed log rafts seen in the fishing harbour Modera, Colombo, Sri Lanka, 1985-87: a. paddled 3-log *kattu-maram,* b. small rowed and paddled 4-log *kattu-maram,* c. large rowed and paddled 4-log *kattu-maram.*

Fig. 2 Fore end of a large 5-log raft termed *maramma,* beached near Wennapuwa, Puttalam District, Sri Lanka, 1985.

Fig. 3 Small rowed and paddled 4-log *kattu-maram* (between pegged *teppam),* near the northern breakwater of the fishing harbour Modera, Colombo, Sri Lanka, 195; (cf. Fig. 1.b).

Fig. 4 Large and small 4-log *kattu-maram* on the western breakwater of the fishing harbour Modera, Colombo, 1985. The after end of the rowing rail of the raft in the foreground is unraised; the last large raft in the background is dismantled.

Fig.5 Lashing of the double prow piece on to the inner logs of a large 4-log *kattu-maram*; fishing harbour Modera, Colombo, 1986.

Fig. 6 Lashed log rafts in Tamil Nadu, India (from: Menon, 1980: 18).

Fig. 7 Boat *kattu-maram* in Andhrea Pradesh, India.

Fig. 8 Schematic cross sections: 1-2 log rafts, 3 boat-shaped log raft, 4 platform raft developed from a boat raft, 5 conjectured developed shape of a platform raft before caulking. Water levels in log rafts used for fishing: *a* unloaded, *b* with crew and equipment. Water levels in platform rafts for transport: *c* unloaded, *d* with crew, passengers and cargo. (The positions of the level in *c* vary according to the extension of the plaform and in *d* according to the total load).

Fig. 9 The Dashur boat Pittsburgh: flattened planking plan, not to scale (from: Ward Haldane, 1984: 49, fig. 27).

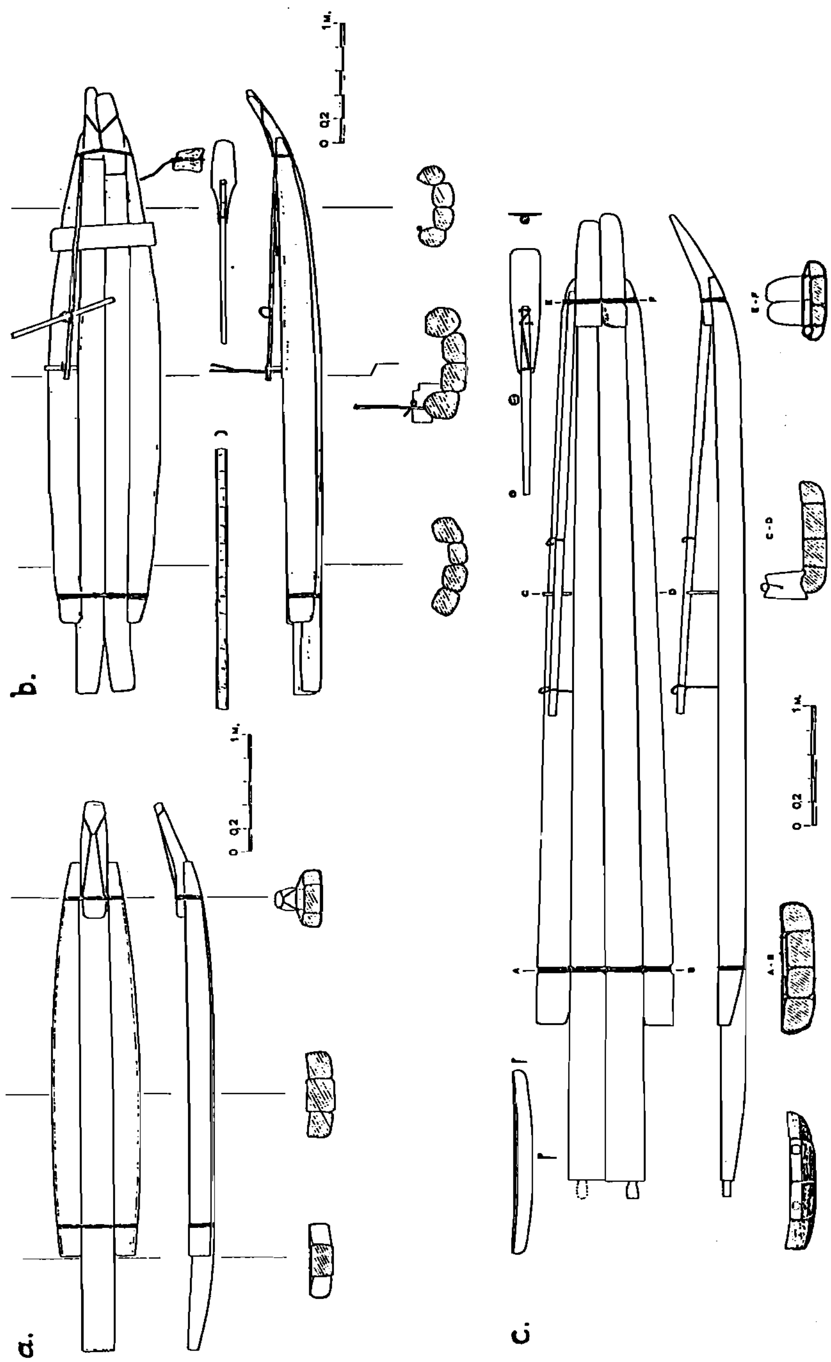

FIG.1

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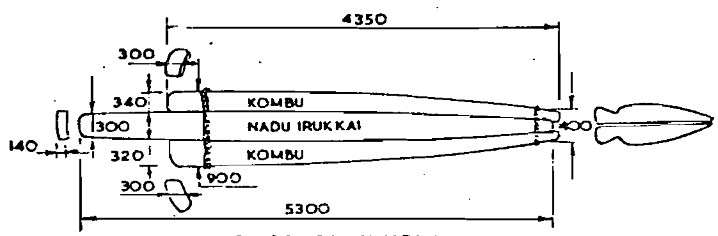
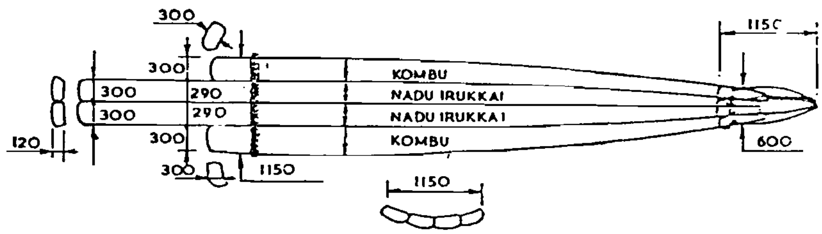
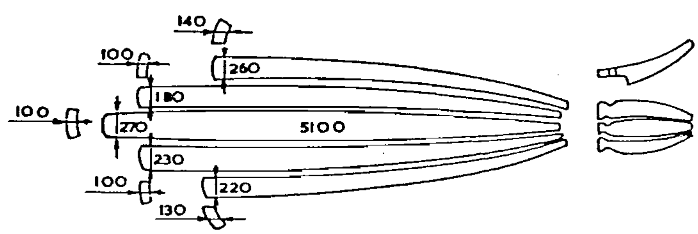


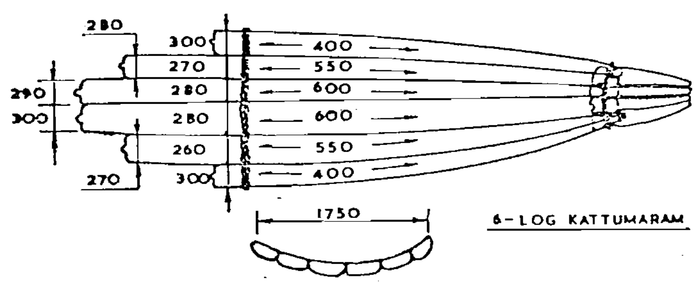
3-LOG CHINNAMARAM



4-LOG PERIAMARAM



5-LOG CHINNAMARAM



6-LOG KATTUMARAM

FIG.6

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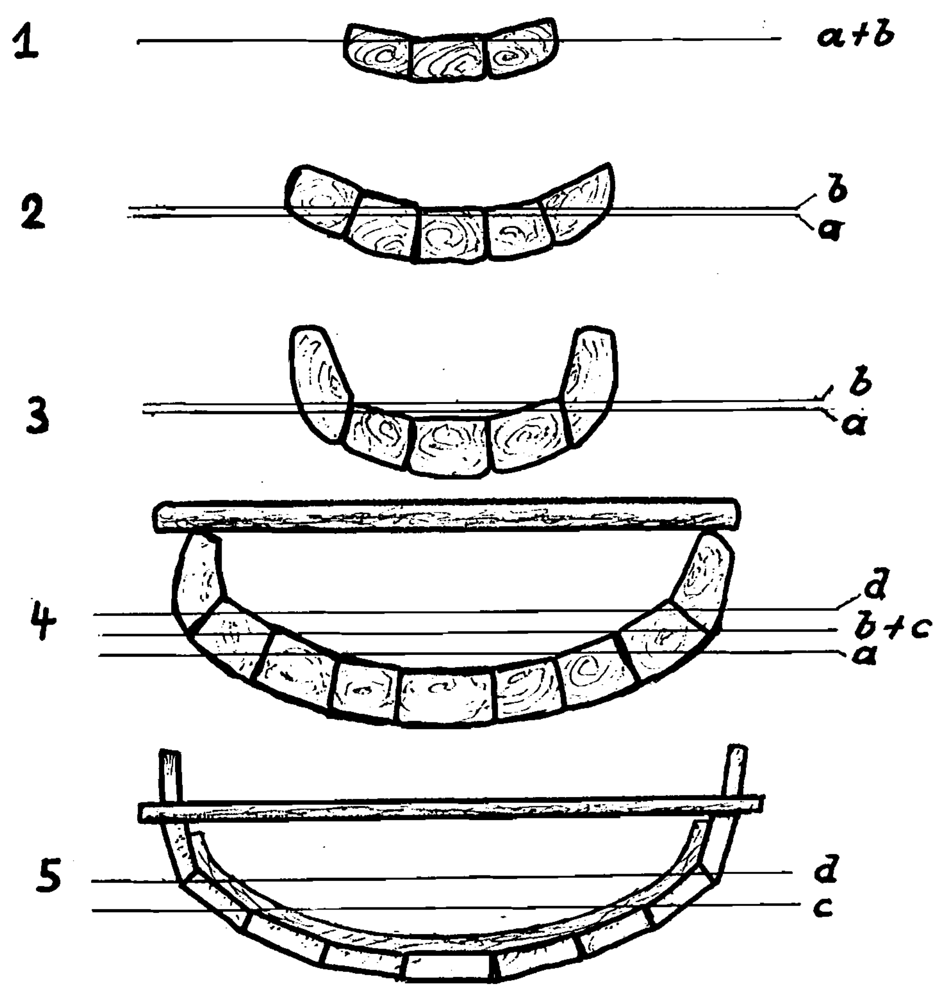


FIG.8

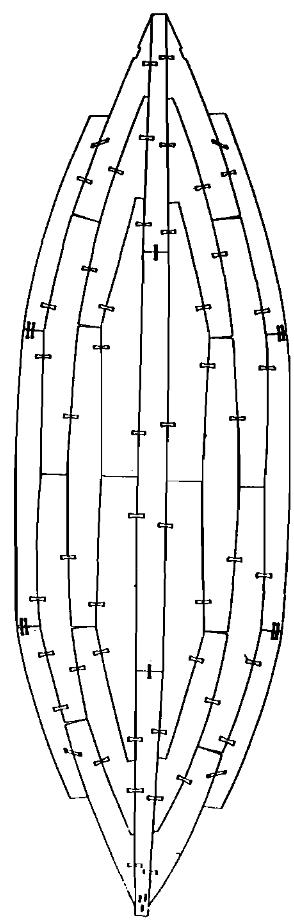


FIG. 9

"AN ANALYSIS OF THE EXPERIMENTAL VOYAGES OF KYRENIA II"

Summary

KYRENIA II is an authentic replica of a fourth century B.C. Greek merchant ship excavated almost 20 years ago off the north coast of Cyprus. She was built as a cooperative effort in experimental archaeology by the Hellenic Institute for the Preservation of Nautical Tradition and the American Institute of Nautical Archaeology at the shipyard of Manolis Psaros in Perama, Greece, between 1982 and 1985. She, like her antique prototype, is 14 meters in length, capable of carrying upwards of 30 tons burden, and propelled by a single square sail.

In September of 1986 KYRENIA II sailed from the Piraeus to Paphos, Cyprus. The voyage, in part duplicating the route of her ancient predecessor, took place over 25 days, covered almost 600 nautical miles, and varied from becalmed to strong breeze (Beaufort 6) conditions. During that trip the ship sailed almost 70% of the time, during which she averaged 2.95 knots.

On the return voyage of 19 days in April of 1987, KYRENIA II covered almost 660 nautical miles in becalmed to whole gale (Beaufort 10) conditions. She sailed over 70% of the time, while averaging 2.85 knots.

The remains of a Greek merchant ship from the fourth century B.C. were excavated off the north coast of Cyprus almost 20 years ago. Approximately 75% of the ship's representative timbers survived to be raised, preserved, and reassembled for exhibition in the Crusader Castle at Kyrenia.

The Hellenic Institute for the Preservation of Nautical Tradition and the American Institute of Nautical Archaeology cooperated to build an authentic replica of the ancient KYRENIA SHIP. In November of 1982 work began at the shipyard of Manolis Psaros in Perama, Greece, and on June 22nd of 1985 KYRENIA II was formally launched. Like her ancient prototype she is 14 meters in length, capable of carrying upwards of 30 tons burden, and propelled by a single square sail.

On September 6th of 1986 KYRENIA II began a project in experimental archaeology, as she sailed from Greece to Cyprus. However, it must be noted that on this voyage her itinerary and arrival times at specific ports were strictly dictated.

6/IX/86

run 1: Mikrolimano to Sounion (Legrena)

	nautical miles	%	hours: minutes	%	average knots
sail	22.5	86.5	5:05	75.3	4.4
sail/oars					
oars	0.5	1.9	:30	7.4	1.0
towed	3	11.5	1:10	17.3	2.6
immobilized					
total	26	99.9	6:45	100.0	3.9

On a clear, warm day KYRENIA II manned by 8 was towed out of Mikrolimano into Phaleron Bay. With the wind from the northeast, first at 4 Beaufort but soon increasing to 5 and then 6 Beuafort, she set a course to the southeast on a broad reach, port tack. Between the mainland and Phleves Island in moderate seas of 1-2 meters and gusts up to 28 knots, the sail was brailed into what has come to be called a "bra" configuration. Making 4 to 5 knots, Captain Vassiliades sailed the ship close-hauled into the narrow channel between the mainland and Patroklos Island (Gaidhouroniso). Encountering strong adverse winds, which severed many lines, the crew rowed out of the narrows,* and KYRENIA II was towed around Patroklos to Sounion.

* I have been told that there are remains of shipwrecks off Patroklos Island.

8/IX/86
run 2: Sounion to Kythnos (Merihas)

	nautical miles	%	hours: minutes	%	average knots
sail	26	100	6:25	100	4.1
sail/oars					
oars					
towed					
immobilized					
total	26	100	6:25	100	4.1

With clear skies and mild to warm temperatures the run from Sounion to Kythnos was made totally under sail with a crew of 5. The wind was from the northeast, initially 4 Beaufort but gradually increasing to 6 Beaufort, and the course was southeast on a beam reach, port tack with the sail reefed about one half, through moderate seas of 2-3 meters. On this leg of 26 nautical miles KYRENIA II averaged slightly over 4 knots.

10/IX/86
run 3: Kythnos (Merihas) to (Phoinikas)

	nautical miles	%	hours: minutes	%	average knots
sail	1	3.0	1:45	19.1	0.6
sail/oars	3	9.1	:55	10.0	3.3
oars					
towed	29	87.9	6:30	70.9	4.5
immobilized					
total	33	100.0	9:10	100.0	3.6

Because of very light, variable winds and the necessity to meet a dictated schedule, this part of the journey was mostly under tow, hence contributing little data to the project of experimental archaeology.

12/IX/86

run 4: Syros (Phoinikas) to Naxos

	nautical miles	%	hours: minutes	%	average knots
sail	11.5	35.4	10:20	65.3	1.1
sail/oars	0.5	1.5	:10	1.1	3.0
oars					
towed	20.5	63.1	4:50	30.5	4.2
immobilized			:30	3.2	
total	32.5	100.0	15:50	100.1	2.1

In light, variable winds KYRENIA II tried to sail from Syros to Naxos. About one-third of the 33 nautical mile distance was covered under sail through a variety of situations. Her average speed under sail was just over 1 knot. However, since mostly towed during this journey, relatively little useful data was acquired.

14/IX/86

run 5: Naxos to Schinousa

	nautical miles	%	hours: minutes	%	average knots
sail	23	83.6	8:15	82.5	2.8
sail/oars	0.5	1.8	:10	1.7	3.0
oars	1.5	5.5	:50	8.3	1.8
towed	2.5	9.1	:25	4.2	6.0
immobilized			:20	3,3	
total	27.5	100.0	10:00	100.0	2.75

Out of Naxos with a light north wind KYRENIA II sailed slowly west on a beam reach, starboard tack. Turning south, she ran at 3 knots with a 3 Beaufort north wind over her starboard quarter. Changing course to the southeast with a 3 and 4 Beaufort north wind she made 3 to 4 knots on a quarter reach, port tack, later altering course to the south-southeast. Then she turned east on a beam reach, port tact, under similar conditions.

Just before sunset the wind shifted to the east and became very light. KYRENIA II changed course to the north on a beam reach, starboard tack. At dusk, becalmed, she was towed into Schinousa for an unscheduled overnight stop.

15-16/IX/86
run 6: Schinousa to Kos (Kephalos)

	nautical miles	%	hours: minutes	%	average knots
sail	50	51.5	11:35	46.5	4.3
sail/oars	1	1.0	:30	2.0	2.0
oars					
towed	46	47.4	10:10	40.8	4.5
immobilized			2:40	10.7	
total	97	99.9	24:55	100.0	3.9

In the morning with a north wind gradually rising from 3 to 6 Beaufort KYRENIA II sailed eastward on a beam reach, port tack, attaining speeds of 5 to 6 knots. Around midday the wind fell to very light, but in the afternoon it rose again from the north-northwest to 5 Beaufort, and the ship continued her same course. After sunset, however, she was becalmed and taken in tow, through the night, to complete the second half of the voyage to Kos.

18/IX/86
run 7: Kos (Kephalos) to Nisyros (Mandraki)

	nautical miles	%	hours: minutes	%	average knots
sail	13	100	4:00	94.1	3.25
sail/oars					
oars					
towed					
immobilized			:15	5.9	
total	13	100	4:15	100.0	3.1

Manned by a crew of only four, KYRENIA II sailed the entire distance from Kos to Nisyros, 13 nautical miles. With a north wind of 2 to 3 Beaufort, on a broad to quarter reach, port tack, she averaged a little over 3 knots. This day perhaps more than any other in the voyages of KYRENIA II duplicated a day made during the last voyage of the ancient KYRENIA SHIP.

19/IX/86
run 8: Nisyros (Mandraki) to Rhodos (Mandraki)

	nautical miles	%	hours: minutes	%	average knots
sail	57	98.3	12:20	94.9	4.6
sail/oars					
oars					
towed	1	1.7	:20	2.6	3.0
immobilized			:20	2.6	
total	58	100.0	13:00	100.1	4.5

In virtually ideal conditions for KYRENIA II the passage from Nisyros to Rhodos was made almost entirely under sail. With a west wind initially 2 Beaufort, gradually increasing to 5 Beaufort, she ran with the wind until mid-afternoon, when it shifted to the southwest, and she sailed on a quarter to broad reach, starboard tack. Gradually the wind diminished, until around sunset it died completely. During this passage KYRENIA II sailed 57 nautical miles at an average speed of 4.6 knots.

25-26/IX/86
run 9: Rhodos (Mandraki) to Ro

	nautical miles	%	hours: minutes	%	average knots
sail	25.5	31.1	12:10	50.7	2.1
sail/oars					
oars	1	1.2	:20	1.4	3.0
towed	55.5	67.7	11:30	47.9	4.8
immobilized					
total	82	100.0	24:00	100.0	3.4

Out of Rhodos with a gentle breeze from the southeast at 3 Beaufort KYRENIA II sailed northeast on a beam reach, starboard tack. As the wind dropped to light during the late afternoon KYRENIA II tried to sail more easterly on a close-hauled, starboard tack. Taken in tow through the night, about two-thirds of the trip were completed. And the next morning she was rowed to the deserted island of Ro for a ceremonious stop.

26/IX/86
run 10: Ro to Kastellorizo

	nautical miles	%	hours: minutes	%	average knots
sail	7	82.4	3:35	84.3	2.0
sail/oars	0.5	5.9	:15	5.9	2.0
oars	0.5	5.9	:15	5.9	2.0
towed	0.5	5.9	:10	3.9	3.0
immobilized					
total	8.5	100.1	4:15	100.0	2.0

With a light to gentle breeze from the west-northwest the short distance between Ro and Kastellorizo was covered on a quarter reach, port tack.

27-30/IX/86
run 11: Kastelorizo to Paphos (Maa)

	nautical miles	%	hours: minutes	%	average knots
sail	178	92.7	65:10	91.1	2.7
sail/oars	4.5	2.3	3:30	4.9	1.3
oars	0.5	0.3	:15	0.3	2.0
towed	9	4.6	1:30	2.1	6.0
immobilized			1:05	1.5	
total	192	99.9	71:30	99.9	2.7

KYRENIA II made the passage from Kastellorizo to Paphos, holding a fairly steady course, in four days with a crew of five.

Out of Kastellorizo she found light wind from the northwest but made headway on a quarter reach, starboard tack, and with the assistance of oars. After noon the wind veered to the southwest and then slowly shifted to the west, gradually increasing to 5 Beaufort before sunset, and KYRENIA II sailed from a broad to quarter reach, starboard tack. During the evening the wind dropped to 3 Beaufort from the northwest, and she ran with it over her starboard quarter.

These conditions continued during the early morning of the second day. However, after sunrise the wind veered to the south-southwest, dropping to 2 Beaufort, and KYRENIA II sailed on a beam reach, starboard tack. With the wind increasing to 4 Beaufort, she maintained the same course through the afternoon and evening.

In the early morning of the third day she was beclamed. After sunrise the wind rose from the north-northwest gradually increasing to 3 Beaufort, and KYRENIA II progressively changed course to sail on a beam, broad, and quarter reach, port tack. Around noon the wind became very light and variable, and she was rowed. During the mid-afternoon with a west-northwest wind KYRENIA II ran with it over her starboard quarter. After sunset the wind slowly increased from 2 to 4 Beaufort coming from the northwest, and the ship changed course slightly to sail through the night on a quarter reach, port tack.

KYRENIA II's situation remained the same, until at dawn on the fourth day she was taken in tow to Maa.

Summary of voyage of KYRENIA II
Piraeus to Paphos September 1986

	nautical miles	%	hours: minutes	%	average knots
sail	414.5	69.6	140:40	74.0	2.95
sail/oars	10	1.7	5:30	2.9	1.8
oars	4	0.7	2:10	1.1	1.8
towed	167	28.0	36:35	19.2	4.6
immobilized			5:10	2.7	
total	595.5	100.0	190:05	99.9	3.1

Notes:
25 days in transit between Mikrolimano and Maa (6/IX/86 - 30/IX/86)
15 days — part or all — of actually sailing (60%)
September 6, 8, 10, 12, 14, 15-16, 18, 19, 25-26, 27-30
10 days in port (40%)
September 7, 9, 11, 13, 17, 20-24
number of crew on each run: 8, 5+, 6, 5+, 6, 6, 4+, 5, 5+, 6+, 5+
(+plus observer on 6 of 11 runs)
averaging 5.5 (not including observer)
note: crew of 4 only on Kos - Nisyros run.
instruments: 2 VHF, 1 anemometer, and 1 log — always
compass on last 3 runs
7.8 or 8.5 tons of ballast (gravel), plus 2 tons of supplies and crew
(food and belongings) according to Tzalas; let's say ladened about 10 tons burden
ballast reportedly put "in front part of ship"

Through 25 days in September, 1986, KYRENIA II traveled almost 600 miles from Greece to Cyprus. Sailing 70% of this distance during all or part of 15 days, she averaged almost 2.95 knots under sail.

The return voyage from Cyprus to Greece was made during April of 1987, KYRENIA II had no set schedule for this trip, and her course was dictated only by the wind and sea. As a means of introduction may I cite the advice of a Boeotian landlubber:

There is one other sailing season for men, in spring time.
At that point, when you first make out on the topmost branches
of the fig tree, a leaf as big as the print that a crow makes
when he walks; at that time also the sea is navigable and this is called the spring sailing season.
I for my part
do not like it. There is nothing about it that I find pleasant.
It's snatched. You will find it hard to escape coming to grief. Yet still and even so,
men in their short-sightedness do undertake it.

* Hesiod. *The Works and Days*, translated by Richmond Lattimore, lines 678-685.

8-12/IX/87
run 1: Paphos to Rhodos (Mandraki)

	nautical miles	%	hours: minutes	%	average knots
sail	281	93.7	94:00	95.9	3.0
sail/oars					
oars	1	0.3	1:00	1.0	1.0
towed	18	6.0	3:00	3.1	6.0
immobilized					
total	300	100.0	98:00	100.0	3.1

Manned by a crew of five on a warm, clear Spring day, KYRENIA II ran out of Paphos to calm, smooth seas with a light breeze variable but for the most part from the northwest. After clearing the port, she changed course on a beam reach, starboard tack, and later sailed close-hauled through the night.

During the second day she continued to sail close-hauled, starboard tack, with the wind gradually shifting to the west-northwest, rising to 3 Beaufort, through slightly choppy seas. I began to wonder whether Captain Glafkos Cariolou, like Odysseus, was planning a visit to the land of the Lotophagi. But after sunset, he changed tack, wearing the ship around to the north-east and sailing through the night close-hauled, port tack.

The next day she found light, variable winds mostly southwesterly, and she tried to sail on a broad to beam reach. But becalmed much of the day, she made little progress.

As dull as the third day was, the fourth was exciting. Encountering a storm with 8 Beaufort easterly gale winds and gusts of over 50 knots, KYRENIA II sailed through high seas spread with spindrift on a quarter to broad reach, starboard tack. For the first time she sailed through rain. Although heeling considerably, no water came in over her sides, and the hull remained relatively dry. Furthermore, some 35 amphoras, alas empty of wine, moldmade by Sophocles Mourides of Nicosia and representing about one-tenth of the ancient ship's cargo of Rhodian amphoras, ladened atop sacks of gravel, did not move at all.

Around noon with winds over 25 knots KYRENIA II reached speeds of at least 12 knots while sailing "downhill". Thereafter Captain Cariolou lowered the yard about 1.5 meters to lower the sail's center of gravity and reduce her heeling and speed. Shortly before the peak of the storm, he partially brailed the sail. In the afternoon and through the night it was decided to alter KYRENIA II's destination from Mandraki to Lindos, then to the south of Rhodes, and finally back to Mandraki. During the 24 hours of April 11, 1987, KYRENIA II sailed 138 nautical miles, making an average speed of 5.75 knots.

In the morning of the fifth day out of Paphos she was taken in tow for the last 18 nautical miles to Rhodes, and the crew then rowed her into the port of Mandraki.

While in Mandraki a minor leak through the lower seam of the aft Z-scarf of the main wale, port side, was dammed. Cutting partially through the shelf clamp to gain access to the area, oakum was inserted into the seam, grease was spread over the area, a leather patch tacked into place, and finally a small sheet of lead applied here, held by copper tacks. The shelf clamp was then braced by several short pieces of timber.

Provisions on board KYRENIA II for the Captain Glafkos Cariolou and crew of Costas Agathangelou, Stamatis Chrisaphitis, Nikos Mertiris, and George Pafitis were water, milk, wine, brandy (zivania), olives, olive oil, honey, salt, oregano, garlic, onions, lemons, oranges, bananas, raisins, dried figs, almonds, peanuts, hardtack (paximadia), goat cheese (haloumi), lentils, white beans, sardines, tuna, salami, and smoked pork (hiromeri). Food was not cooked aboard but ashore, where the crew ate it hot on primitive pottery with wood spoons. By the way, the Captain made a delicious lentil and onion stew. Leftovers were eaten on board simply warmed by the sun.

14-16/IV/87
run 2: Rhodos (Mandraki) to Astipalaia (Skala)

	nautical miles	%	hours: minutes	%	average knots
sail	126.6	80.1	44:23	87.9	2.85
sail/oars	0.5	0.3	:30	1.0	1.0
oars					
towed	31.0	19.6	5:37	11.1	5.5
immobilized					
total	158.1	100.0	50:30	100.0	3.1

Out of Mandraki under partly cloudy skies KYRENIA II encountered a 3 Beaufort breeze from the east-southeast and ran with it over her port quarter. After noon occasional light rain fell, and the wind gradually dropped; KYRENIA II became becalmed, and three of the crew briefly rowed her with the sail partially brailed, trying to catch wind. Later with clearing skies and cooler temperatures a variable light wind rose primarily north-northwesterly, and she sailed close-hauled, starboard tack, through the night.

The next day under gray skies KYRENIA II found a light breeze from the northeast and sailed on a broad reach, starboard tack. Captain Cariolou altered course slightly to sail past the east side of Nisyros. Through midday rain fell, becoming heavy with frequent lightning. Passing between the small islands of Strongyli and Yiali, she changed course to clear Kos. Late in the afternoon the rain ceased, the temperature dropped to a cold 8°C., and the wind increased to 3 and 4 Beaufort, gradually shifting to the north. Before sunset KYRENIA II set a close-hauled, starboard tack. Through the night a strong storm developed, reaching 8 Beaufort after midnight with gusts well over 40 knots. During a three hour period around midnight KYRENIA II averaged over 7 knots on a close-hauled tack and frequently made speeds of 10 to 12 knots. However, during the 24 hours of April 15, 1987, she sailed only a total of 78 nautical miles, making an average speed of 3.25 knots.

After midnight the tiller of her port quarter rudder broke. She altered course to the southwest to ride out the storm in the lee of Amorgos. A little before sunrise, while brailing the wet heavy sail, three-quarters of the lead guide rings became detached from the sail. As the storm was increasing in intensity with winds gusting to 50 knots, it was decided to take KYRENIA II under tow to Astipalaia.

While in Astipalaia the tiller and its quarter rudder were repaired by the shipwright Konstantinos Nikolakis, free of charge. The crew resewed the lead guide rings to the sail and mended other frayed lines. It is worth noting that the lead patch applied at Rhodes had proved effective in stopping the leak there. And we all enjoyed the hospitality of the mayor of Astipalaia and his wife on Easter Sunday.

20-21/IV/87
run 3: Astipalaia (Skala) to Syros (Ermoupolis)

	nautical miles	%	hours: minutes	%	average knots
sail	66.7	57.7	27:53	71.3	2.4
sail/oars					
oars	1.3	1.1	1:55	4.9	0.7
towed	47.5	41.1	8:39	22.1	5.5
immobilized			:38	1.6	
total	115.5	99.9	39:05	99.9	3.0

Rowed out of Astipalaia by a crew of only four, KYRENIA II found no wind and was taken in tow to northeast of Amorgos. There with light south winds she sailed through much of the afternoon on a broad reach, port tack. Later in the afternoon the wind shifted to the southwest. During a two hour period around sunset KYRENIA II sailed 50 to 60° off the eye of a 2 Beaufort wind, close-hauled, port tack, making over 2 knots speed — evidence of her ability to sail effectively into the wind.

After midnight she altered course and continued westward with very light wind. On a cool, lovely Spring morning, she was virtually becalmed. However, just before noon the wind picked up to 4 and 5 Beaufort from the south-southwest, and KYRENIA II sailed north of Naxos on a beam reach for the most part, port tack. Shortly after noon the loom of the port quarter rudder broke at its juncture to the blade. While under sail it was replaced by a spare quarter rudder, the task being completed within two hours. Later in the afternoon with the force of the wind increasing, the sail was brailed into its distinct configuration. Subsequently Captain Cariolou requested that KYRENIA II be taken in tow to the north of Syros, but finding strong winds there it was decided to take refuge in Ermoupolis.

There the quarter rudder was repaired, and they were reinforced and remounted so that their blades were parallel to the ship's centerline. Meanwhile, the crew waited for calmer weather before continuing the journey.

25-26/IV/87
run 4: Syros (Ermoupolis) to Zea

	nautical miles	%	hours: minutes	%	average knots
sail	8	9.5	3:14	20.8	2.5
sail/oars					
oars					
towed	76	90.5	12:04	77.8	6.3
immobilized			:12	1.3	
total	84	100.0	15:30	99.9	5.4

Towed out of Ermoupolis to the north tip of Syros, KYRENIA II initially found a 4 Beaufort north-northeast wind and sailed on a beam reach, starboard tack. However, the wind dropped, leaving KYRENIA II becalmed, and off Giaros she was taken in tow to Zea where she arrived early the next morning.

Sleeping on board KYRENIA II while she was at sea was relatively comfortable. In the cuddy beneath the foredeck there was adequate space for two of the crew. Here it was dry, and one was sheltered from the cool, damp, night air.

Summary of voyage of KYRENIA II
Paphos to Piraeus April 1987

	nautical miles	%	hours: minutes	%	average knots
sail	482.3	73.3	169:30	83.5	2.85
sail/oars	0.5	0.1	:30	0.2	1.0
oars	2.3	0.3	2:55	1.4	0.8
towed	172.5	26.2	29:20	14.4	5.9
immobilized			:50	0.4	
total	657.6	99.9	203.05	99.9	3.2

Notes:

19 days in transit between Paphos and Zea (8/IV/87 - 26/IV/87)
12 days — part or all of actually sailing (63%)
 April 8-12, 14-16, 20-21, 25-26
7 days in port (37%)
 April 13, 17-19 (Easter), 22-24

number of crew on each run: 5, 5, 4+, 5+
 (+plus observer on 2 of 4 runs)
 averaging 4.75 (not including observer)
 note: crew of 4 only on Astipalaia - Syros run

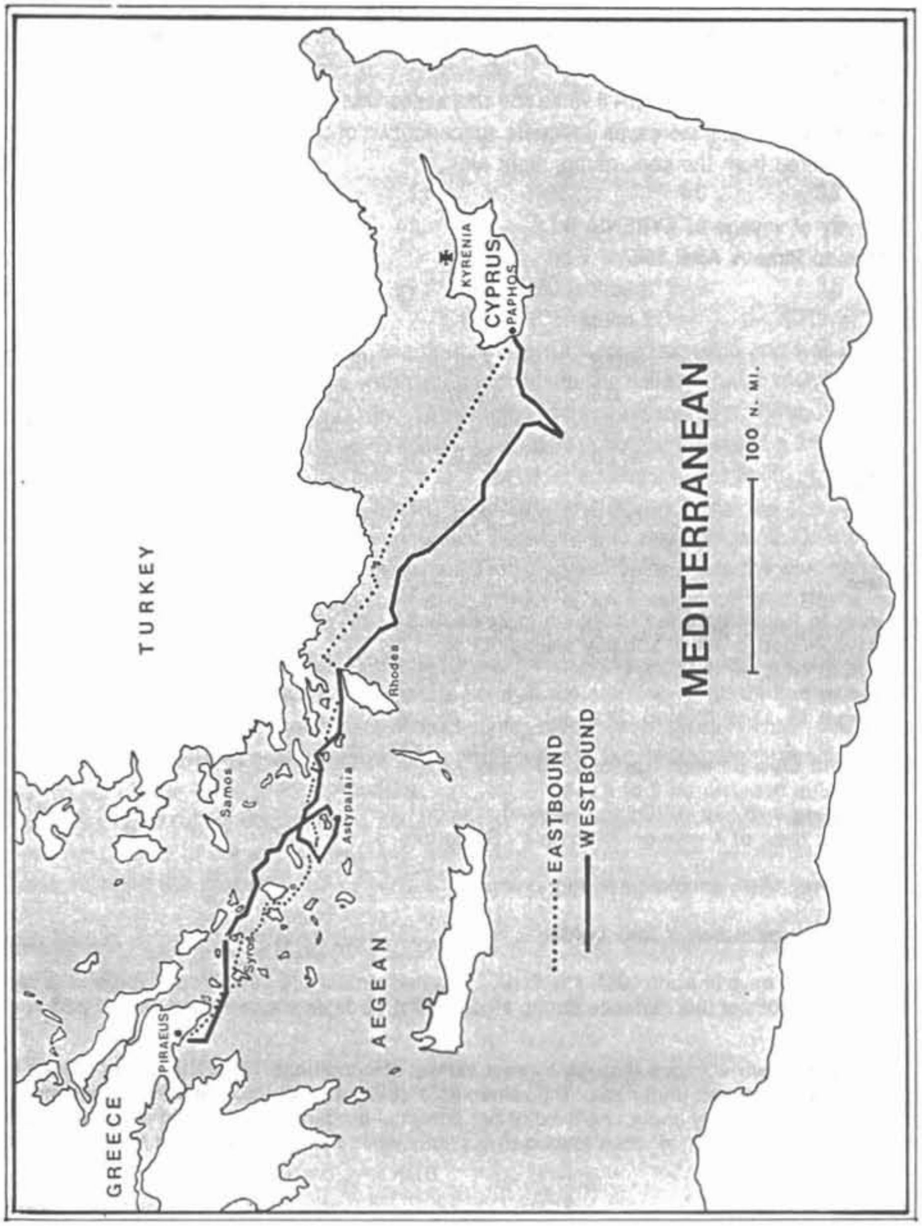
instruments: VHF, anemometer, log, compass

ladened approximately 7 tons burden

Through 19 days in April, 1987, KYRENIA II traveled almost 660 miles from Cyprus to Greece. Sailing over 70% of this distance during all or part of 12 days, she averaged almost 2.85 knots under sail.

During her two voyages through a great variety of conditions KYRENIA II has proven her seaworthiness, speed under sail, and remarkable ability to sail into the wind. However, she was ladened with only about one-third of her potential burden. I hope still at a future meeting to report her performance when loaded to capacity while sailing through the eastern Mediterranean.

Michael L. Katzev
The Old Parsonage
Post Office Box 125
Arlington, VT 05250
USA


GREECE
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THE FATIMID NAVY AND THE CRUSADES, 1099-1171

I.

A host of complex developments paved the way for the ability of the European nations to establish their sea-borne empires in the Americas, Africa and South-East Asia. A technological advantage — the combination of sails and guns — was one of the crucial components behind the European success. The Muslim Middle East was one of the first regions to feel the impact of the Portuguese maritime expansion in the fifteenth century which was marked by th appearance of Portuguese fleets in East Africa and Yemen. The Mamluks, the Muslim rulers of Egypt and Syria, and later the Ottomans, responded to the Portuguese challenge by dispatching fleets to the region. During the period of the Mamluk rule (thirteen-sixteen centuries) the Muslim naval power in the Mediterranean was on the decline. The Mamluks were a cast of Turkish slave soldiers whose primary military specialization was archery. The sea was not their natural element and they showed little aptitude for adapting themselves to the need of naval warfare - dismounting. Islam, although predominantly a land power, had not always been indifferent to sea power. During the ninth century and the first half of the tenth century, for example, Muslim navies were very active in the Mediterranean and, on the whole, they were successful. The Fatimids (ruled in Tunisia 909-973, and in Egypt and Syria until 1171) from the inception of their rule had been involved in the multiple naval struggle in the Mediterranean.(1) Prior to the Portuguese naval challenge, the Crusades had posed the greatest naval threat to Islam to which the Fatimid navy failed to respond.

II.

The main features of the Fatimid naval failure against the Crusades can be summarized as follows:

1) Between 1099-1110 the Fatimids lost most of the coastal towns of the Levant; Tyre fell in 1124 and Ascelon in 1153. The most that the Fatimid navy could achieve in those years was to slip occasionally into the coastal towns endangered by the Crusaders bringing fresh troops and provision. At crucial times, however, the Fatimid navy was always late or inactive.

2) When combined land and naval offensives were launched by the Fatimids (against Jaffa in the summer of 1102, in 1115-6 and in 1123) the navy played a minor role in these operations.

3) The Fatimid navy showed very little activity or success in raids aimed against the coast of Palestine and Syria held by the Crusaders or against Christian shipping in general.

In my view the following points must be considered as a possible explanation for the Fatimid failure:

1)The initiative was in the hands of the Crusaders who chose their targets at will. Given the naval limitations of the period (speed, range and the availability of ships) a swift naval response to attacks initiated by enemy was problematic.

2) The Fatimids faced enemies whose naval resources were larger than their own. The Fatimid fleet was a small force. In 1163, Fatimid enemies estimated the overall strength of their navy as 100 galleys (authors of the Mamluk period give lower figures; 75-80 galleys) and 20 transport ships of various types. To these numbers, 20 ships hurling Greek fire, referred to in other sources, must be added. In comparison, the fleet that participated in siege operations against Acre in

1104 was 90 ships strong and that which operated against Tripoli in 1109 was composed of 60 ships. The fleets that fought against Tyre (November 1111-April 1112), Damietta (1169) and Alexandria (1174) included more than 200 ships.

3) John H. Pryor has shown recently that due to geograghical and naval reasons the shipping lanes used by European navies on their way to Acre were practically out of range for the Fatimid navy operating from Egypt.(2)

III

Fatimid failure must be examined in the broader context of the naval realities of twelfth century Mediterranean, especially in light of the following factors:

1) Caution was the main characteristic of naval warfare. Vassilios Christides has shown that Byzantine and Arab authors of manuals of naval warfare advocated avoiding direct confrontation with the enemy fleet. Both sides adhered to this principle even when the defence of their territories (Thessaloniki in 904, and Crete in 960-1) was at stake.(3)

2) It is important to remember the illuminating remarks of John F. Guilmartin Jr. that fleets of galleys could not achieve naval supremacy and control of the sea in the modern sense of these terms.(4)

3) The Fatimid navy was responding to threats to coastal towns. Naval power was a precondition for a successful siege against a coastal town but not a guarantee of success. The role of the navy, by its very presence at the scene, was to cut off the besieged town from its sources of supply. Siege operations were decided however by land fighting.

Conclusions. In light of the above discussion we can define more accurately the essence of the Fatimid naval failure. Despite the naval assistance extended to the coastal towns of the Levant their conquest by the Crusaders was not averted. Fatimid land army which failed miserably against the Crusaders on several occasions can fairly be blamed for these disasters. The limited naval resources of Egypt together with several other factors pertaining to the naval realities of the twelfth century were a contributing factor to this state of affairs.

Dr. Yaacov Lev
25 Ha-Yud-Dalet str.
Holon 58435
Israel

NOTES

1) The points in this paper are elaborated, with a full documentation, in my book *State and poitns Society in Fatimid Egypt, 10th-12th Centuries,* to be published. The naval history of Islam has not been written yet. There is no study of Muslim navies comparable to H. Ahrweiler's *Byzance et la Mer,* (Paris, 1966). For the Muslim naval activity in the ninth-tenth centuries, see Y. Christides, *The Conquest of Crete by the Arabs (ca. 824),* (Athens, 1984); for the Fatimid navy, see V. Lev, in *Byzantion,* (1984), 220-52; W. Hamblin in *The American Neptun,* (1986), 77-83; for the Mamluks, see D. Ayalon's paper in his *Studies on the Mamluks of Egypt, 1250-1517,* (London, 1977).
2) J. H. Pryor, *Geography, Technology, and War. Studies in the Maritime History of the Mediterranean Sea, 649-1571,* (Cambridge, 1988), 80-6, 116-22.
3) V. Christides in *Byzantina,* (1985), 1336-7.
4) J. F. Guilmartin, *Gunpowder and Galleys,* (Cambridge mass., 1975), 17-9, 34-5, 131-2; Pryor, *Geography,* 106, 109; *idem* in *J. of Medieval History,* (1983), 179, 212-3.

ROWERS PADDLING SAILING SHIPS IN THE BRONZE AGE AEGEAN

An interesting approach towards a classification of early water transport (mainly boats) has been made by Sean McGrail, based principally on the combination of building techniques (reduction, construction and transformation), as well as on the builder's fundamental concept of the boat[1]. Evidence from the Bronze Age Aegean does not permit though a classification following structural characteristics.We would rather consider shell technique more probable[2], and therefore have a choice among log-, plank-, bark- or hide boats. It seems planked boats would be more probable, even in an earliest form[3], judging from the raw materials available and the Bronze Age Aegeans' technological progress[4]. The mortise and tenons joints of the Kas wreck seem to corroborate these thoughts[5].

Furthermore, if technique rules construction methods as well as environment seems to determine raw material choices, culture can impose certain patterns or designs[6]. At the same time, function has its own prerogatives and, even though shape depends as well on raw materials, it seems plausible to suggest that the shape of a boat has to answer not only to weather and water conditions, but also to a functional necessity: a boat was originally meant as a means of transport.

Boat representations indicating a shape and suggesting propulsion and steering systems provide (with a very few exceptions) our only information about Bronze Age Aegean watercraft and shipping. It should nevertheless be borne in mind that form as well as propulsion and steering systems on their own would not lead us to a totally reliable classification scheme[7]. Moreover, artistic conventions, material or technical restrictions and, finally, the primary or/and secondary functional character of a boat representation are quite confusing. These reserves kept in mind, Aegean boat representations could thus be distinguished and classified according to represented motive power and shape, possible functions could then be suggested.

Regarding boat[8] types (not function), Bronze Age Aegean material could be devided in three categories, according to propulsion systems. From the simplest to the more complex we can distinguish: a) rowboats, b) sailing-ships and c) rowed sailing-ships. We should not forget of course oars might just not be represented *artis causa,* whereas what we interpret as "oars" on or under the hull of an engraved gem-ship could be ribs or merely the swelling of the waves.

As a matter of fact, a rowed sailing vessel could be just a sailing boat fit up with oars used as auxiliary power, either in case there is no rear wind[9], since they could only sail before the wind, or along some coasts because of the lack of water[10], or to carry off manoeuvres: even nowadays the wind changes quite often in the Aegean[11], and actual mechanical power propulsed boats are fit out with subsidiary oars. On the other hand, we can imagine oars were more reliable in a first experimental stage of sailing[12], before trusting entirely the newly invented (or borrowed) sail. The third category would then rather precede the second one from the chronological point of view. Furthermore, even though sails help to cover quickly a large distance with favourable wind, rowing could have been used on any sailing-ship in those occasions when speed and accuracy were absolutely necessary, even when the wind is not favourable. Even though the speed factor was not essential for ancient economic systems[13], it would be of primary importance in matters of life or death, that is, in case of piratical raids, and that, not only from the victims' point of view: The Ugaritic texts describing small fleets plundering the coastal areas indicate the impact of rapid ships surprising the Bronze Age inhabitans and vanishing immediately afterwards[14].

In the Early Bronze Age, evidence seems to be more or less homogeneous[15]: the exclusively rowed (or paddled) asymmetrical boats arrive up to an approximately 1/12 beam/keel ratio, they have a quite low gunwale (and are therefore easier to get paddled by a seated crew), a mysterious projection almost at waterline at the lower balky end (which I take to be the stern), and an astonishingly high and slender bow, decorated with a fish- and banderole emblem. In this well-known "cycladic" type, attested on the "frying-pans" (fig. 1) and the Naxian lead models, the cretan (Palaikastro) model could be included, even though the small number of thwarts (two) could indicate a small boat; it belongs to a surprisingly similar category.

It has recently been suggested this cycladic longboat represents a development in social organization beyond the level of the nuclear family, because of the necessity to recruit a sufficient number of young paddlers from the contemporary cycladic settlements. Trade control could be a possible function for these longboats[16].

In the following Middle Bronze Age, the first sailing-ships appear on early cretan prisms, dating from the Middle Minoan II onwards (fig. 2 from Platanos). In this period, rowboats and ships represented under sail arrive each at hardly 20% of the existing representations, whereas rowed sailing ships, that is, sailing ships equipped with oars, represent the 60%. The hull shape of the first ships using a sail, at least as an alternative motive power, seems to be the direct descendant of the Early Bronze Age craft, and the forerunner of the Late Bronze Theran vessels.

At the same time, the continuing importance of paddling is attested by the Aegina pithos ships (fig. 3). It is as well attested by a steatite prism (fig. 4) showing three human figures in a crouched attitude - paddlers? - on one face, while two asymmetrical sailing ships are shown on another[17]. According to L. Basch in many cases they could be piratical ships[18]. Differences in population in the Cycladic Early Bronze Age and the fortifications in Middle Bronze Age seem to result from the insecurity reigning during that time[19].

Concerning more or less contemporary Linear A inscribed sealings and roundels from Khania, Brice[20] suggests the boat-prow L 35 sign, appearing in lists in the same context and presumably with the same significance as "human" signs (:L 99) could be related "to some category of personnel". Should we see here records of mariners, rowers for instance? In relation to this, the association of the signs L 35 (boat-prow) and L 87 , the so-called "stepped altar"[21] would seem consequent, if the L 87 sign was in fact a "boat cabin" (cf. fig. 5).

During Late Bronze Age[22], seal-, fresco-, model- ships and ships painted on pottery belong to similarly represented hull types, but their propulsion systems arrive at different percentages: about 10% rowboats (fig. 6), 18% sailing ships (fig. 8) and 24% rowed sailling ships (fig. 7), but we may arrive at 62 or 68% on either sailing ships or rowed sailing ships if we add the "talismanic" seals with engraved "*Kajütenschiffe*"[23] (fig. 9) to the one or the other category.

They constitute in fact 44% approximately of the ships represented during this period. They contrast strongly to the accurate image given[24] by the other contemporary seal-ships. Micheline Van Effenterre[25] considers the part of the ships represented on these talismanic seals to be the forepart (hull, high prow and stern canopy or stayed mast); the hooked prow and cabin depicted on inscribed roundels corroborates this interpretation. Onassoglou[26] on the other hand thinks these "cabin-ships" are a *pars pro toto,* an abreviated ship image, representing only the essential ship elements from the captain's point of view: the cabin (an honour construction) and the prow. These talismanic representations have scarsely been used sphragistically: were then prophylactic[27] talismanic seals in fact captain's seasl?

A totally different picture is given by several fragmentary impressions of the same seal found in a palatial deposit at Knossos, dating of the Middle Minoan III-Late Minoan I date[28], as well as five similar impressions in the contemporary Zakro hoard[29], said to be exact replicas of the Knossian sealings[30]. They represent two series of four crouched men, each separated by means of a horizontal line (fig. 10), which have been taken to be rowers[31], or, more probably, paddlers, as having their typical posture[32], the blades of the oars held are also represented[33].

During Early Bronze Age paddling instead of rowing could have been exclusively practiced, as rowing constitutes a further stage in propulsion technique; since its discovery, rowing is preferred to paddling on large ships[34]. Despite this fact, padding is preferred to rowing in certain cases even later. In the miniature Theran fresco, rowers and paddlers are represented at the same time on different boats (figs. 6 and 11). For some unknown reason some ships are being paddled by men leaning over the gunwale in order to reach the sea. Ordinary seated paddlers, on the contrary, operate in small boats on the same fresco[35]. In addition to this, the above mentioned rowers' sealings represent actually rather paddlers.

There is one further point: the paddled vessels are fit up with the strange "poop-device", reminding the similar "bifurcated" end of quite a lot of Middle Minoan gem-boats, or even the "keel projection" of the Early Bronze rowboats. Although several suggestions have been made, *the raison d'être* of this device remains obscure. Nevertheless, we might attempt to add one more clue possibly leading to some explanation:

On Middle and Late Bronze Age engraved seals two forms of ships seem to predominate: an asymmetrical one having a "bifurcated" end (fig. 7) and a symmetrical "crescent-shaped" one (fig. 8); the latter's rectangular sail is represented unfurled, high on top of the mast[36], and it has no poop-device, just like the only Theran sailing ship which is not paddled. On the contrary, the asymmetrical ships on the seals presumably have a poop-device (that is, a bifurcated lower end), but their sail is brailed up and only the triangular rigging (possibly also the roof of the passengers' cabin) is visible. We could then suggest the possibility they have been represented while rowed or paddled exactly as the correspondent Theran ones.

If this hypothesis is correct, when the sail is not represented, because there is no need to, since it is not being used at the moment, that is, when the ship is being propulsed by rowing or rather paddling, it would have been necessary to fit the stern with the poop device, or the other way round. As a matter of fact, on the second face of the above mentioned prism, on the first face of which three rowers (paddlers) are shown, two ships of the "bifurcated end" type are engraved, the sail brailed up (fig. 4).

It should be added though that some Late Bronze Age examples seem to contradict this hypothesis: the ship on the Tiryns finger ring[37] has its sail brailed up, but no poop device can be distinguished, unless we admit the ship is not being propulsed at that moment, but moored in the port. Another similar example is given by a cretan lenticular gem[38], unless the double stern oar is in fact the representation of this device, which is quite improbable. In any case, the point needs further study.

Paddling instead of rowing is an unusual practice for large boats. It is attested in the Near East as an additional method of propulsion, for instance on the reliefs dating of the time of the reign of Ashurnasirpal[39] on departure and arrival, but this would rather happen, although occasionally, in older periods[40]. If paddling was practiced occasionally on boats normally under sail, the high boat sides would not be especially suited for rowing, as it would be the case in normal rowboats, but the crew would have to paddle with their oars, too short for this ship, leaning over the gunwale the Theran way.

Little is known about the status of this Late Bronze rowing (paddling) crew from Linear B tablets recording *e-re-ta* lists[41]. On one tablet some female flax workers' and weavers' sons are becoming rowers[42]; the latter could belong to the same group coming to a total of thirty rowers sent to Pleuron according to another tablet. Several hundreds of rowers are recorded on a series of tablet fragments, recruited from various categories of the inhabitants, including (possibly) settlers, new settlers, refugees or immigrants[43], as well as others characterized by place indications, occupational designations or preceded by a personal name (in genitive singular). The latter names apparently belonged to important persons of the kingdom[44], since in most cases their patronymic is written too. These recruits "ought to row" *("ophelontes ereen")*.

Lists of absent rowers are also recorded[45] on a tablet containing on its *recto* a text many times erased and rewritten, and on its *verso* a ship graffito[46] sketched perpendicularly to the direction of the text lines. The big crew numbers on all these tablets would possibly be concerned with "a naval operation, not a peaceful mercantile venture"[47], since another tablet records the watchers who are guarding the costal areas, irregularly distributed[48], devided in local military units *(o-ka)*, under the command of a superior officer and his subordinates, and accompanied by an *e-q^{u}e-ta*[49]. The geographical locations of the rowers fill the gap of the coast watchers' stations guarding the coasts of the Hither and Further Provinces, whereas there is a concentration of sea-forces in the southern part of the Messenian Peninsula[50].

In any case, the crew had different origins, but it is not clear whether they were a temporary personnel[51], a permanent one[52] or both. It has been remarked that a navy based on rowing would recruit naval professionals[53], but would need to use as well other non competent groups of the population. It was anyway the central palace administration which recorded and managed the rowers and *o-ka* groups, as part of the personnel. The corresponding tablets were found in the central archives rooms in Pylos, and not elsewhere in the palace. The registration was probably made after communication with people coming from the outside[54].

The same remark can be made concerning the 45 noduli, all with the same ring impression, "goddess afloat in a boat" (fig. 12). They have not been found with the majority of the sealings (near and about the north-west portico of the villa of A. Triadha), but together in a small room with direct access to the exterior, in the south-west corner[55]. It could be possible that the owner of the ring was an overseer of a specialized activity, then why not mariners - rowers and rowing?[56]

The above mentioned *e-re-ta* constituted the crew of ships similar to the Tragana ship[57], belonging to a new type appearing during Late Bronze Age. To this type also belong the ships painted on the sarcophagus from Gazi[58] and on the Skyros[59], Asine[60] and Phylacopi[61] pottery. The stern is rather curvilinear and there is a kind of "keel-projection" on the bow, sometimes both sides. It would thus be possible to consider it as a structural ancestor of the Geometric ram, in which case an important break should be situated between Middle Bronze and Late Bronze periods in areas under Mycenaean influence.

This Late Bronze Age paddling or rowing crew would have a lower social status comparing to that of the Middle Bronze Aigina paddlers-warriors according to Basch[62]. Whether the ships they are aboard are merchantmen or not is another question. Distinction between cargo- and war-ships is quite difficult. Morisson[63] mentions the papyrus Harris according to which bowmen and soldiers were aboard merchant ships. On the other hand, Shaw[64] thinks painted *ikria* on Late Bronze ships were a naval power and authority symbol, and Laffineur[65] compares the mainland ships decoration of the hull to the pictorial ornaments on weapons, which shows a relationship between ships and warriors. We can of course imagine cargo ships had good reasons for being provided with warriors in case of attack, to protect their precious freight.

Concluding, we may remark an evolution of shipping propulsion techniques[66] during Early. Middle and Late Bronze Age in the Aegean. The long, oared ships of the Early Bronze Age with a possible trade and/or fishing control function adopt the sail from the Middle Bronze Age onwards. Sailing and rowing constitute alternative motive power then. Later, oars seem to be only occasionally used as time and sailing technique progresses. To a probable piratical function of ships during Early and Middle Bronze Age succeeds a possible centralized military use of ships and crews during Late Bronze Age. It seems a different boat type appears then in an area under Mycenaean influence, which could possibly lead to later geometric ship types. Trade would necessarily be a primary ship function, even before the invention of the sails, but it is mostly the variety of ships of different origins sailing in the end of the Bronze Age in the Eastern Mediterranean that attests of flagrant international relationships at the time. In addition to the traditional Theran type and the new Messenian (Tragana) type, cypriote ships -quite similar to the Syrian ones- are represented, for instance on Phaestos pottery[67] or on a decked ship model from Aghia Triadha[68]. We can be led to the conslucion the crew progressively lost its prestige and participation to the ship function (war or trade).

Trading routes, marked by anchors found in the sea[69], profound rounded cypriote models of merchantmen[70]; the "syrian type" shipwrecks from Cape Gelidonya[71] and Kas[72] and the egyptian sea going ships of the New Kingdom seem to corroborate the evidence about flourishing trade attested by the archeological finds in the Late Bronze Age Mediterranean. It is regrettable that the "people who lived in the islands in the middle of the Great Green Sea" put an end to these naval expeditions. Fortunately, these epic adventures survived in the common memory and some story-tellers sang them to the later generations[73].

Christina Marangou

University of Paris
(Panthéon-Sorbonne)
Aegean Protohistory

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ILLUSTRATIONS

Figure 1: Early Cycladic vessels incised on "frying pans" (Evans A. The Palace of Minos I (1921), fig. 138).
Figure 2: Platanos seal-stone (Evans A. The Palace of Minos I (1921), fig. 136 a).
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NOTES

1. According to this scheme, plank-, bark- and hide-boats could be built in shell or skeleton sequence, whereas logboats were shell construction (McGrail 1985:299-300). See also Pomey P. *"Principes et méthodes de construction en architecture navale antique"*, in *3èmes Journées d'archéologie navale*, Paris 1985, about conception and realisation.
2. McGrail 1981:15; see also Bass 1986. The construction of the Kas wreck was similar to the Kyrenia ship (McGrail 1985:275). See Gassend & Cuomo 1983 about alternative construction methods.
3. With sewn planking (Casson 1963).
4. McGrail 1981:15.
5. Pulak & Frey 1985, Bass 1986.
6. McGrail 1985:291-292.
7. McGrail 1981.
8. Small boats have not been included here. Small boat models are difficult to distinguish from ship models, since model sizes vary, not necessarily according to the prototypes dimensions. A preserved mast socket would prove a sailing boat prototype, but usual terracotta models, in most cases summary and fragmentary representations, could just as well represent fishing boats or "oared galleys". Cf. Gõtticher 1978 and Forsythe Johnston 1985 about classification difficulties of models. Cf. also Betancourt 1985 about what should be called rather boat-shaped vases than boat models and Basch 1981 about votive models.
9. Casson 1965.
10. MacCaslin 1980:102.
11. Torr 1964:1.
12. Marangou 1977:55.
13. Gil-Artagnan 1976:46-55.
14. Wachsmann 1981.
15. The Mochlos symmetrical model is quite exceptional and should be studied separately. Mr L.Basch believes though boat types were already quite differentiated in the Early Bronze Age (oral communication and Basch 1987).
16. Broodbank 1989:336, 337.
17. On the third face an "equine animal" - an ass? Evans 1921, 1:120, fig.89 and *idem* 1936, IV_2:520 and fig. 462.
18. Basch 1986.
19. Bass 1986. See also Renfew 1967.
20. 1982-83:81.
21. Sourvinou-Inwood 1973 gives to this asociation a ritual significance comparing the similar construction on the stolen Mochlos ring boat with eventual egyptian divine boat prototypes.
22. In the Late Bronze Age, a relatively great quantity of seals representing ships comes from the seal engraver's workshop, situated near the administrative buildings of the palace of Mallia. In any case, this shows an interest for the sea-fishing or trade? (Poursat 1984). As a matter of fact, three anchors from a total of five cretan anchors (Shaw and Blitzer 1983) have been discovered at Mallia: one of them in House Ea and the other two near the stone-cutter's workshop or Middle Minoan sanctuary. Quite a lot of votive anchors are known from the ancient Mediterranean; see for instance: Frost 1969, *idem* 1970, Shaw and Biltzer 1983, MacCaslin 1980, Davaras 1980. About amuletic anchors: Mc Caslin 1980:51-52. See also Kapitän 1984 and Frost 1986 for anchor types.
23. Onassoglou 1985.
24. Van Effenterre H. 1986.
25. 1978:596.
26. 1985.
27. Betts 1971.
28. Evans 1936, IV_2:521 and fig. 463.
29. But "none in good condition"; Hogarth 1902:79 and pl.IV,6.
30. The Zakro sealings had been used to seal objects made of leather (cf. "diptera" in Linear B texts): prints of their unsealed surface show marks of strips and cords which tied the documents (Weingarten 1982-83 and *idem* 1983); see also Pini 1983.
31. Evans 1936, IV_2:520.
32. Giesecke 1983.
33. Evans 1936, IV_2:521. In the Near East paddles have usually, but not necessarlily, broad blades; from 2000 BC onwards their blades are rarely seen, and in that case they have the same shape as the oarblades (Degraeve 1981:157).
34. See for example Alexiou 1976:206.

35. Cf. also to the fresco "canoē" the A. Triadha sealings (Levi 1925-26:126, fig. 134).
36. The Marinatos' (1933) "egyptian type". This seems to be a usual practice in the Aegean sea in case of calm (information given by local fishermen in summer 1977 - at the Myrina port, island of Lemmos).
37. Marinatos 1933, pl. XVI, 58.
38. Evans 1928, II_1:243, fig. 139.
39. De Graeve 1981:157, figs. 37 and 38.
40. See Amiet 1961, pl. 13bis E.
41. If the translation as "rower" is correct. Differing views: Deger-Jalkotzy (1978:53) thinks the word is related to the fleet either as rower or *"Kommandant"*. Chadwick (1976:173) notes that in Knossos tablets an e-re-ta is included in a list of local governors and could hardly have been a simple rower. A different interpretation is also given in Camera (1981:36-37), who thinks the tablet records workers and technical experts on occasion of a natural disaster. Göttlicher (1985) is not certain the "rower" etc. interpretation is correct.
42. Ventris & Chadwick 1973:161.
43. Ventris & Chadwick 1973:186.
44. Lindgren 1973:50.
45. Ventris & Chadwick 1973:161.
46. Perpillou 1968.
47. Ventris & Chadwick 1973:183.
48. Chadwick 1976:174.
49. Follower, "king's companion", "count" with probable religious functions (Palmer 1963:152) or charioteer (Chadwick 1958:4).
50. Van Effenterre H. 1985. The danger was to come from the sea. Raw material had been lacking for a long time since seas had become unsafe. Time was early spring, in the month of sailing, Plowistos *("po-ro-wi-to-jo"*; Chadwick 1976:90, 173, 174). The extraordinary rich gold offerings and human sacrifices to the gods written hastily on a tablet (Promponas 1983) didn't help to avoid the final catastrophe.
51. Since they also had other occupations; Lindgren 1973:50.
52. Perpillou 1968.
53. Perpillou 1968: $a_2$rie: "gens de mer".
54. Palaima & Wright 1985:258, t.2.
55. Weingarten 1986:11, 18.
56. Chadwick (1973:77) discusses an interesting text presumably dealing with ships, mentioning origin and two "mariners" (?) *(pontiloi, po-ti-ro)* for every ship(?) recorded.
57. Marinatos 1933, pl.XIII, 17; Marangou 1977:98; Korrès G. 1989. Cf. rowers on a Kos Late Bronge fragment (Benson 1970: Horse, Bird and Man, the origin of Greek painting. Massachusett, Amherst, pl. XXXIX 1).
58. Alexiou 1973, pl. I.
59. Gray D. Seewesen, C_{55}, fig. 15c, p. 53.
60. Frödin O. and Persson A.M. 1938: Asine, Excavation 1922-30, fig. 207, 2.
61. Marinatos 1933, XIII, 16.
62. Basch 1986:428.
63. 1980:10.
64. 1980.
65. 1984.
66. Only presumably of construction methods.
67. Laviosa 1969/70, fig. 3a-d.
68. Marinatos 1933, pl. XIV, 23; Laviosa 1969/70, fig.27.
69. Frost 1970; McCaslin 1980.
70. Westerberg 1983. They were sailing (cargo) ships, but could have been additionally oared; cf. for example ship number 5 in Westerberg (1983:55), where there is a mast-socket, as well as a "row of holes for rowing or fastening stays, sheet lines or lines for securing the cargo".
71. Bass 1967.
72. Bass, Frey & Pulak 1984; Pulak & Frey 1985; Bass 1986.
73. I am grateful to Mr. Lucien Basch for his most helpful comments on an earlier version of this communication. Remaining errors are mine.

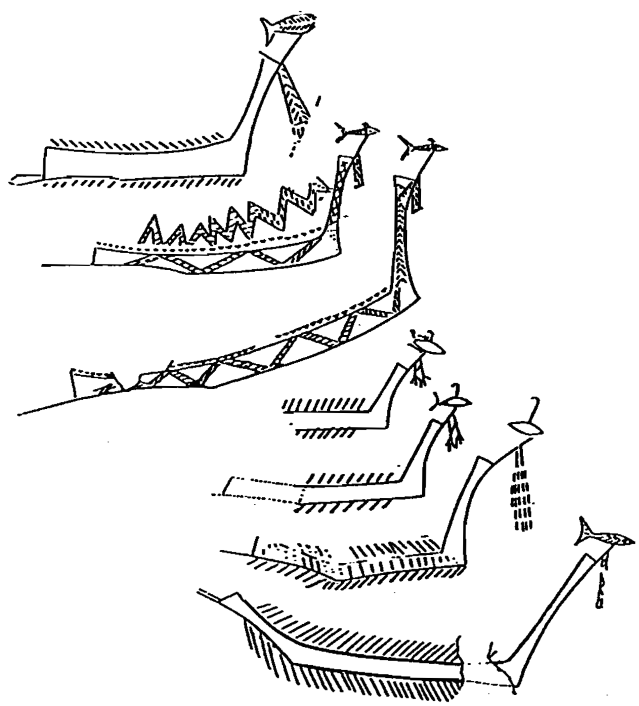
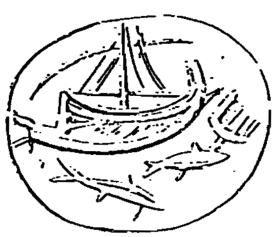


Figure 1



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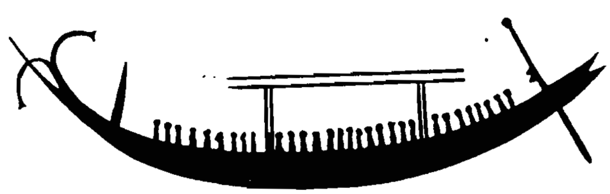

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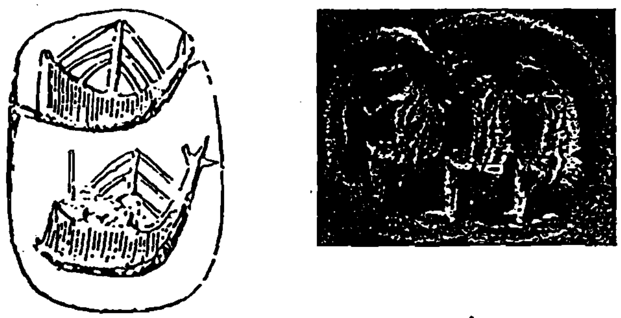

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Figure 4

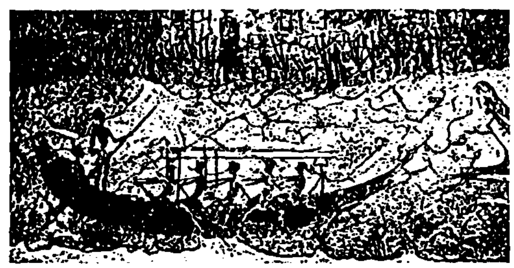
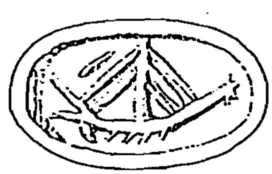


Figure 6

Figure 5



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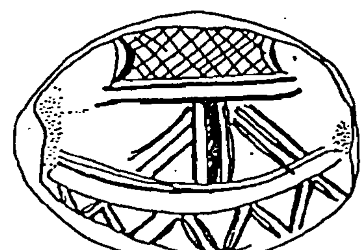

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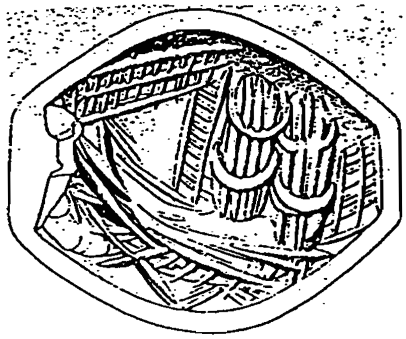

Figure 9

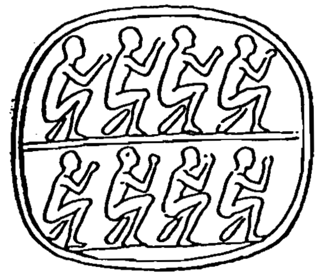

Figure 10

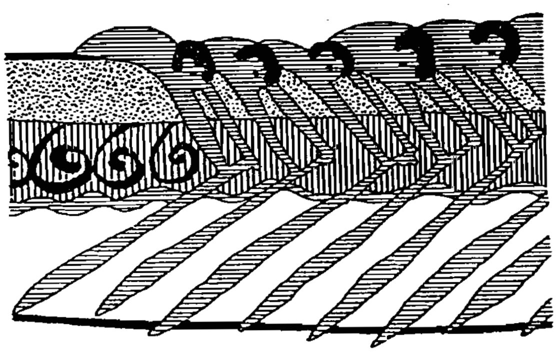

Figure 11

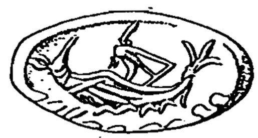

Figure 12

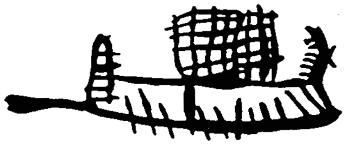

Figure 13

Dr. Eleni Paleologou made an oral presentation on "Ships on Argive geometric Pottery" but no written text was made available to the editor.

THE SHIPBUILDING WORK OF TRIERES - PROBLEMS FACED - LESSONS LEARNED*

The actual shipbuilding work perfomed-the problems faced and the solutions given will be described.

Datails of the experimental work in Athens Technical University concerning model towing tests to anticipate resistance in calm water and achievable speed will be given.

Deviations from authenticity which have been adapted in order to ensure the longer life of the ship and the safety of the crew will be explained.

A description of the materials used for the constructions will be made.

A description of the hypozoma tensioning gear related problems, the temporary solution given and the questions to be answered will be attempted.

The inclining experiment and the stability of the ship.

Questions to be answered in the future.

What would I do if I were to construct now another Trieres.

Cdr. Stavros Platis
Hellenic Navy

* Commander Stavros Platis made a verbal communication and no written version was made available to the editor. For a complete report of the 1988 sea trials see J.F. Coates, S.K. Platis, J.T. Shaw *"The Trireme Trials 1988"* Report on the Anglo-Hellenic Sea Trials of *Olympias.* Oxbow Books, 1990.

REMARQUES SUR LA CONSTRUCTION DU NAVIRE ROMAIN DE LA MADRAGUE DE GIENS*

A l'issue de l'étude de la partie centrale du navire, l'examen de la structure de la coque et notamment d'un important prélèvement intéressant la quille, les varangues et les premières virures du bordé, avait amené à proposer, en première hypothèse, des observations préliminaires sur la construction du navire, les observations conduisaient à accorder une large place aux procédés de construction mixtes en supposant l'implantation de varangues actives au cours du montage de la carène. La poursuite de l' étude de la coque et l'analyse de nombreux prélèvements complémentaires tant au centre qu'aux extrémités du navire, ont amené à modifier radicalement cette hypothèse. En effet, il est apparu que la coque avait subi en différents endroits d'importantes modifications ou réparations par le remplacement de nombreuses virures. De ce fait, les caractéristiques de ces modifications, alors insoupçonnées, avaient été interprétées à tort comme étant significatives des procédés de construction utilisés. Aujourd'hui, en tenant compte de ces phénomènes de réparation, l'examen de la structure du navire montre qu'aucune des membrures étudiées n'a été pré-érigée à un moment quelconque de la construction, alors qu'en revanche, l'ensemble des caractéristiques du chevillage du bordé indique que celui-ci a bien été mis en place avant la pose des membrures.

Si l'on analyse la coque du navire de la Madrague de Giens selon l'approche qui permet de distinguer les *principes* des *méthodes* de construction - les premiers se référant à la conception, notamment structurale du navire, les secondes à l'ensemble des divers procédés mis en oeuvre pour sa réalisation matérielle - on peut alors conclure que le principe de construction relève totalement d'une conception du type "sur bordé". Quant à la méthode de construction, tous les éléments analysés suggèrent un procédé de construction très proche de la méthode "sur bordé".

Patrice Pomey
Direction des Recherches
Archéologiques Sous-Marines
Fort Saint-Jean
13235 Marseille Cedex 2
France

* Resumé de la communication orale de Mr Patrice Pomey.

SUR L'APPARITION DU BATEAU A VOILE SUR LE LITTORAL THRACE DE LA MER NOIRE

Nous savons bien que les bateaux de la civilization créto-mycénienne se sont déplacés à l'aide d'une chiourme de nombreux rameurs et d'une voilure carrée[1]. A cette époque là, il n'y a pas de navire de guerre ou de commerce proprement dit, mais des navires pour tous usages.

Dans ce rapport je ne voudrais pas parler de l'apparition, de la voile comme moyen de propulsion. Ici, je voudrais poser la question de la chronologie de l'apparition, sur le littoral thrace de la Mer Noire, d'un nouveau type de bateau à voile sans rames. Cela ne signifie pas que les navires à rames aient disparu. Au contraire, ces bateaux naviguaient et pendant l'Antiquité ce sont les dières, trières etc. Mais ces bateaux étaient des bateaux de guerre. Les navires de commerce naviguaient seulement à la voile.

Du littoral thrace de la mer Noire le littoral bulgare est bien fouillé. Lors des expéditions et des recherches, nous avons constaté qu'il y avait de nombreux ports anciens. Ces ports ont pu être localisés grâce aux ANCRAGES d'ancres en pierre et des jas en pierre et en plomb. On compte plus de dix ancrages sur littoral bulgare[2]. Peu d'entre eux sont cependant bien fouillés. Aujourd'hui, ils portent les noms de cap Kaliakra, de Sozopol, et de cap Maslen nos.

Au fond de l'aquatoire:
autour du cap Kaliakra nous avons trouvé:
- 39 ancres en pierre percées
- 9 jas en pierre entiers et 4 demi-jas
- 10 jas en plomb et 2 bandes en plomb.

aux alentours de la ville de Sozopol:
- 54 ancres en pierre percées.
- 14 jas en pierre entiers et 1 démi-jas.
- 43 jas en plomb

autour du cap Maslen nos:
- 10 ancres en pierre percées
- 6 jas entiers en pierre
- 12 jas en plomb et 3 bandes en plomb.

Ces trois ports illustrent très bien la situation suivante (mais d'autres aussi):

RESQUE TOUTES LES ANCRES EN PIERRE ONT ETÉ TROUVÉES DANS AQUATOIRES À PROXIMITÉ DE LA CÔTE. CES AQUATOIRES ONT TRÈS BIEN PRESERVÉ LES BATEAUX DES VENTS MAUVAIS.

PRESQUE TOUS LES JAS EN PIERRE ET EN PLOMB ONT ETÉ TROUVÉS DANS D'AUTRES AQUATOIRES - AUX ENVIRON DES CAPS ET DES AQUATOIRES OUVERTES A TOUS LES VENTS.

Cette constatation montre la règle — les ancres en pierre et les jas (en pierre et en plomb) proviennent de deux régions différentes.

D'après cette règle nous pouvons dire:

a) Les ancres en pierre, ont servi probablement des navires à rames et à voile simple. Pour charger leurs marchandises, ces bateaux ont accosté grâce aux rames aux quais côtiers.

b) Les jas (en pierre et en plomb), ont servi probablement à des navires à voile qui n'avaient pas de rames. Leur voilure était plus perfectionnée que celle des bateaux à rames; leur construction, sans doute, aussi. Pour décharger leurs marchandises ces bateaux restaient aux aquatoires des caps, attendaient là pour avoir la possibilité de manoeuvrer à la voile quand les vents mauvais se levaient. Ils étaient probablement chargés et déchargés par des barques. Cela était encore pratiqué sur le littorale bulgare jusqu'au milieu de notre siècle.

Dans ce cas, l'apparition de l'ancre en bois avec jas en pierre ou en plomb montre l'apparition d'un nouveau type de navire: le bateau à voile. C'est pourquoi, nous devons traiter la question de la datation et de l'appartenance des ancres et des jas.

D'après la datation[3], la grande quantité des ancres en pierre percées de la Méditerranée Orientale et du littoral bulgare de la Mer Noire appartiennent à la deuxième moitié du IIème millénaire av.n.è.; une autre partie — probablement pendant la première moitié du IIème et IIIème millenaires av.n.è.; et une petite moindre pendant la première moitié du Ier millénaire av.n.è.

Les résultats[4] de l'analyse pétrographique de nos ancres ont démontré qu'environ 90% des ancres sont faites dans les roches du littoral bulgare de la Mer Noire; le reste provient de roches du littoral étranger, mais pour le moment nous ne les avons pas identifiées.

D'ailleurs, la situation des ancres en pierre sur le littoral bulgare, leur datation et l'analyse pétrographique montrent qu'elles sont les indices d'une grande navigation thrace qui a eu lieu pendant l'époque du Bronze (au moins du Bronze récent) et les premiers siècles de l'âge du Fer ancien. Il semble que cette tradition se soit prolongée jusqu'à l'apparition du bateau à voile.

Les savants croient que les ancres en bois alourdies par le jas (en pierre ou en plomb) sont apparues à la fin du VIIème s.av.n. ère. Cette date n'a pas été constatée lors de la table ronde sur les ancres anciennes, qui s'est tenue au cours du IIIème symposium international THRACIA PONTICA à Sozopol, Bulgarie, en 1985[5].

Dans ce cas, il semble que l'apparition du navire à voile sur le littoral occidental de la Mer Noire doit être fixé à la fin du VIIème s.av.n.è. D'ailleurs, cette date coïncide avec le commencement de la colonisation grecque du littoral.

Donc, pour l'instant on peut dire que l'apparition du bateau à voile sur les aquatoires thraces de le Mer Noire occidentale est due aux Grecs du VIIème s.av.n.è.

La date de l'apparition des jas en pierre et des jas en plomb demeure un important problème. On a parlé d'une époque allant du VIIème jusqu'au IVéme s.av.n.è. parce que pendant cette période on utilisait seulement des jas en pierre simultanement aux jas en plomb. Sans doute, les jas en pierre sont apparus avant les jas en plomb[6]. Mais, il y a une période où ils sont utilisés parallèlement pendant la propagation des nouvelles idées techniques — le jas en métal. Je crois que le changement des ancres en pierre avec des jas en pierre a eu aussi une période d'utilisation parallèle en deux types d'ancres, mais ceci quelques siècles plus tôt.

C'est ce qui nous donne la possibilité de penser qu'il existe une date hypothétique pour l'apparition des jas en pierre, respective aux bateaux à voile. Elle se base sur les problèmes de la datation des jas en pierre.

Le début de l'utilisation des jas en pierre correspond à la fin de la large utilisation des ancres en pierre. Comme nous avons vu plus haut c'est la période qui s'étend de la fin du IIème millénaire au début du Ier millénaire av.n.è. Cette date est probablement le terminus postquem de l'utilisation des jas en pierre.

Jusqu'à présent la datation des jas en pierre de Méditerranée est fixée à la fin du VIIème - IVème ss.av.n.é[7]. Cette datation est très bien argumentée par P. Gianfrotta. Malgré cela je voudrais soumettre quelques considérations pour une nouvelle datation, basées sur les différences entre les jas de la Méditerranée et les jas de la Mer Noire.

Les différences:

— Les jas de la Méditerranée dont parle P. Gianfrotta ne sont pas entiers. Ce sont des demi-jas. La plus grande partie des jas du littoral thrace de la Mer Noire sont entiers (45 entiers, 11 démi-jas).

— Presque tous les démi-jas mentionnés par P. Gianfrotta sont des offrandes provenant de temples, qui sont bien datés. Tous les jas et démi-jas du littoral bulgare ont été trouvés au fond de la mer sans contexte archéologique précis.

— Il y a des inscriptions en langue grecque sur la majeure partie des demi-jas de la Méditerranée. C'est un très fort argument pour une datation entre les VIIème-IVéme ss.av.n.è. Les jas et demi-jas du littoral bulgare n'ont pas d'inscriptions (pas même une seule lettre).

Il est évident que les demi-jas de la Méditerranée ne sont pas entiers parce qu'ils ont été placés comme offrandes dans les temples. Les inscriptions grecques sur les demi-jas sont très bien conservées. Il est clair qu'elles ont été faites avant que les démi-jas soient placés dans les temples. D'après moi, c'est la dernière phase de l'évolution des jas en pierre, quand les jas, d'objets utilitaires deviennent objets de culte. Cette phase coïncide avec la propagation de l'alphabet et de la langue grecque. De cette manière, la date VIIème-IVème ss.av.n.è. est le terminus ante quem de la fin de l'utilisation des jas en pierre.

Dans ce cas, on peut dire que, probablement, la nouvelle datation des jas en pierre, va de la fin du IIème-début du Ier millénaire av.n.è. jusqu'au VIIème-IVème ss.av.n.è. il y d'autres arguments pour soutenir cette datation.

Le nombre total des jas en pierre du littoral bulgare est de 45 exemplaires entiers et 11 démi-jas. Le nombre des ancres en pierre percées est de plus de 150. Le nombre des jas en pierre est inférieur aux autres. La grande quantité des ancres et des jas en plomb atteste un commerce régulier et paisible pendant la deuxième moitié du IIème millénaire av.n.è. et après la colonisation grecque, aux VIIème-Vème es.av.n.è. La petite quantité des jas en pierre montre qu'il s'agit d'une époque au cours de laquelle le commerce maritime n'était pas sûr. C'est la période entre la fin du IIème millènaire et les premiers siècles du Ier millenaire av.n.è.

Sur les jas et démi-jas en pierre du littoral bulgare il n'y a pas d'inscriptions. Evidement, les peuples qui ont utilisé ces jas n'avaient pas besoin de faire des inscriptions comme les Grecs. Si les jas étaient venus de Gréce, il aurait dû y avoir des lettres grecques au moins sur un des jas ou demi-jas comme il y en a sur quelques jas en plomb du littoral bulgare.

Les analyses pétrographiques[8] ont démontré qu'environ 10% des jas en pierre sont faits dans les roches de notre littoral; les 90% restant sont faits dans les roches du littoral étranger, mais nous ne les savons pas d'où. Evidement, l'apparition du bateau à voile du littoral thrace de la Mer Noire tient un peu au dévéloppement de la tradition thrace, mais surtout semble-t-il à d'autres traditions.

D'après Diodore de Sicile[9] après la Guerre de Troie, la mer d'Egée était sous la domination des:

— Lydiens et Meoniens	92 ans
— Pélasges	85 ans
— Thraces	79 ans
— Rhodiens	23 ans
— Phrygiens	25 ans
— Chypriotes	33 ans
— Phéniciens	45 ans
— Milétiens	18 ans
— Caryens	61 ans

On sait bien que les sources de Diodore sont très anciennes et encore que cet auteur ètait un assez bon copiste[10]. C'est pourquoi il nous fournit des données qui sont très importantes. Evidement, l'auteur annonce l'ordre des THALASSOCRATIES, qui avaient lieu entre la Guerre de Troie et la Grande colonisation grecque. Nous savons bien que la Guerre de Troie avait pour but la domination des détroits entre la Mer Noire et la mer Egée. La maîtrise des mers suivit. En fait, au début ce sont LES LYDIENS ET LES MEONIENS de l'Asie Mineure, ensuite ce sont LES PELASGES ET LES THRACES, suivis par LES HABITANTS DES ILES (RHODIENS, CHYPRIOTES) et après, d'autres peuples d'Asie Mineure, LES PHRYGIENS, MILETIENS, CARYENS.

A mon avis, il est très probable que ce soient les peuples venus ici avec des bateaux à voile qui avaient les ancres en bois avec des jas en pierre.

En conclusion, je voudrais dire, que l'apparition des jas en pierre, en relation avec l'apparition DU BATEAU à VOILE, peut être datée entre la fin de la guerre de Troie et la Grande colonisation grecque. Les inventeurs ont été LES THRACES, LES PELASGES, LES CARYENS et les autres HABITANTS DES ILES DU LITTORAL OCCIDENTAL DE L'ASIE MINEURE.

Avec la deuxième partie de mon rapport je veux démontrer que du point de vue historique l'apparition des jas en pierre et des bateaux à voile peut être datée à une époque plus ancienne que la période VIIème-IVème ss.av.n.è. Le plus vraisemblable, et le plus raisonable est de situer l'apparition du bateau à voile à la fin du IIème - début du Ier millénaire av.n.è. Ce bateau à voile a été crée par les contacts entre les civilizations de l'Europe du Sud-Est, des îles de l'Egée et de l'Asie Mineure.

Kalin Porojanov
Bulgarie

NOTES

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2. K. Porojanov, V. Popov. Les recherches archéologiques sous-marines conduites par le Centre d'histoire maritime et d'archéologie sous-marine à Sozopol. - *Thracia Pontica I,* premier symposium international à Sozopol 1979, Sofia, 1982, p. 311-316; K. Porogeanov. Navigation et commerce de la population du littoral européen de la mer Noire de la Thrace ancienne avec les peuples de la Méditerranée Orientale (XVI-XII ss.av.n.è.). - *Dritter internationaler thrakologischer Kongress,* Wien 1980. Sofia, 1984, p. 69-72;
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8. Ž. Ivanov et autres. op. cit.
9. Diod. VII, frg. 11 (Vogel).
10. RE, B. 5, Stuttgart, 1905, S. 663-705; R.Drews. Diodorus and his sources, *AJPh,* 83, 1962, p. 383 sqq.; Chr. Danov. Altthrakien in den mitographischen Büchern Diodors. - Acta Antiqua Philippopolitana. - In: *Studia historia et philologia,* Sofia, 1963, S. 81-86.

APHRODITE ET LES MARINS

Un jas d'ancre orné d'osselets que je remarquai au musée de Susa en Libye (antique Apollonia de Cyrénaïque) m'a permis de revenir sur l'importance, souvent méconnue, du rôle d'Aphrodite-Vénus comme protectrice de la navigation.[1] Je me propose d'examiner ici quelques-unes des manifestations de la dévotion des gens de mer pour la déesse. Les rapports entre Aphrodite et la mer s'observent en effet dans la légende, le culte et les coutumes, si l'on examine les sources textuelles, littéraires et épigraphiques, ainsi qu'iconographiques et archéologiques.

1. LEGENDE

Aphrodite est la déesse née de la mer, comme le content un hymne homérique. *Aphrodite* (II, v. 1-6, éd. Humbert) ou Hésiode dans la *Théogonie* (v. 188-206). L'iconographie de la déesse privilégie cet aspect marin de sa personnalité.[2] Le peintre Apelle, d'après Athénée (13, 590 F), avait représenté Aphrodite Anadyomène, sortant de l'onde, sur un tableau exposé dans l'Asclépieion de Cos.[3] Depuis la Cnidienne de Praxitèle, connue par de nombreuses répliques, les sculptures font souvent allusion au bain de la déesse, qui aime aussi à s'entourer d'animaux marins, dauphins ou Tritons[4]. La déesse serait encore sortie d'un coquillage, d'après quelques textes et certaines représentations figurées[5].

2. CULTE

Aphrodite, que la mythologie lie à la mer, apparaît comme une divinité marine qui protège la navigation.

1. Offrandes.

On offre à Aphrodite des produits de la mer:

— Callimaque, *(Epigrammes,* V) commémore l'offrande d'un nautile à Aphrodite, au cap Zéphyrion.

— Pline l'ancien mentionne des murex d'une forme particulière dans le temple de Vénus à Cnide: "En s'attachant au navire qui, pour le compte de Périandre, transportait des enfants de familles nobles, pour qu'ils fussent châtrés, ces murex l'arrêtèrent, alors qu'il voguait à pleines voiles; les coquillages, auteurs de cet exploit, seraient honorés dans le temple de Vénus à Cnide." *(Histoire naturelle,* IX, 80, trad. CUF-Budé; voir aussi XXXII, 5).

— L'épithète de "purpuréenne" donnée par Anacréon à la déesse (D. L. PAGE, *Poetae Melici Graeci,* 357, 3) est sans doute liée à la nature de ces offrandes.

2. Localisation des lieux de culte.

Aphrodite est très souvent honorée dans des sanctuaires côtiers ou portuaires, comme l'indiquent quelques exemples:

— La déesse est une divinité des caps, à laquelle fut assimilée la reine Arsinoé II, vénérée au cap Zéphyrion sous l'épiclèse de Zéphyritis et qualifiée d'Aphrodite Akraia dans une dédicace d'Hâdra[6].

— Elle a deux sanctuaires dans le port du Pirée[7].

— Pausanias mentionne à Hermionè un temple d'Aphrodite Pontia et Liménia (I, 1, 3).

— A Samothrace, dans le sanctuaire des Grands Dieux vénérés par les marins la déesse a son image sculptée par Scopas, d'après Pline l'ancien *(Histoire naturelle,* XXXVI, 25).

3. Expression de la croyance.

La déesse marine se range parmi les divinités qui protègent et sauvent les navigateurs.

— C'est Vénus qu'Horace invoque comme protectrice de la navigation *(Odes,* I, 3, 1-6).

— L'épiclèse d'Euploia signifie qu'elle accorde une navigation favorable, notamment à Cnide et au Pirée[8].

— A Délos, Aphrodite Euploia est assimilée à Isis souveraine des mers, dans une dédicace du IIe siècle av. J.C. *(Inscr. de Délos,* 2132)[9].

Aphrodite est en particulier remerciée pour des victoires navales.

— Après la victoire de Salamine, Thémistocle lui dédia au Pirée un sanctuaire, selon Ammonios, cité par le scholiaste d'Hermogénès *(Rhetores Graeci,* éd. Walz, V, p. 533)[10].

— Conon lui éleva également un sanctuaire au Pirée après la victoire de Cnide, en 394 avant J.C., selon Pausanias (I, 1, 3).

3. COUTUMES

1. Noms de bateaux.

Des bateaux prennent naturellement le nom d'Aphrodite marine. Au contraire des Athéniens du IVe siècle qui ne choisissaient pas de noms de divinités pour leurs navires, à partir de l'époque hellénistique on voit des vaisseaux de guerre désignés par le nom de divinités poliades: Asclépios à Cos,[11] Athéna à Athènes[12].

Les bateaux marchands se placent plutôt sous l'invocation de dieux sauveurs tels les Dioscures. Dans son étude pénétrante qui insiste sur les éléments de continuité entre les coutumes païennes et paléo-chrétiennes, F. J. Dölger a montré que le navire qui transportait l'apôtre Paul s'appelait "Dioscures", car sa proue était ornée de l'image ("parasème") de ces dieux sauveurs par excellence[13].

De même des bateaux s'appellent "Aphrodite":

— A Aquilée, une inscription d'époque impériale fait connaître Τίτος Φλάυιος, Εὔπορος Κορίνθιος, ναύκληρος πλοίου 'Αφροδείτης[15].

— La déesse, désignée comme Aphrodite Sôzousa, est représentée à la poupe d'un navire qui doit porter son nom, sur une peinture de Pompéi[16].

2. Le coup de Vénus.

Une dernière allusion, beaucoup plus modeste et obvie, à la personnalité protectrice et marine de la déesse est offerte par des jas d'ancre ornés de quatre osselets, chacun dans une position différente. M. G. Kapitän veut bien m'écrire que sur 113 jas d'ancre ornés de reliefs qu'il connaît, 79 sont ornés d'osselets,[17] ce qui indique la popularité de ce motif, même si certains jas ne présentent peut-être pas le nombre de quatre osselets. Après avoir analysé le motif dans une précédente publication, je reviens ici sur un jas d'ancre publié récemment par M. P. A. Gianfrotta[18]: un bras de ce jas porte les osselets dans la position du coup de Vénus, tandis que sur l'autre bras on voit quatre coquillages qui présentent tous leur face bombée; ces coquillages rappellent certainement un jeu, et, dans cette position, faisaient comme les osselets allusion à la chance dans la navigation; offerts aussi à Aphrodite, ils rappellent et appellent la protection de la déesse[19].

3. Jas inscrits.

La déesse est également directement nommée sur des jas d'ancre.

— Un jas trouvé au cap de Palos porte les inscriptions: Ζεύς Κάσιος Σώζων. Αφροδίτη Σώζουσα[20].

— Un autre conservé à Palerme est dédié aux mêmes divinités, sans épiclèses: *Veneri/Iovi*[21].

On peut se demander si le bateau qui avait de telles ancres portait le nom de l'une ou de ces deux divinités, ou bien si l'inscription ou l'allusion indirecte que présente le jas est simplement destinée à attirer la protection divine sur le navire et l'ancre[22].

Malgré les incertitudes et les lacunes de la documentation, nous pouvons constater que les témoignages archéologiques confirment l'importance du caractère marin d'Aphrodite-Vénus, qui paraît s'être surtout développé dans le monde gréco-romain.

François QUEYREL

NOTES

1. F. QUEYREL, "Le motif des quatre osselets figuré sur des jas d'ancre", *Archaeonautica* 7 (1987), p. 207-212.
2. Voir H. METZGER, *Les représentations dans la céramique attique du IVe siècle* (1951), p. 68-70; E. SIMON, *Die geburt der Aphrodite* (1959); A. DELIVORIAS, *Lexicon Iconographicum Mythologiae Classicae,* II (1984), *s.v.* "Aphrodite", p. 114-116.
3. Voir A. DELIVORIAS, art. cité, p. 54-55.
4. Voir A. DELIVORIAS, art. cité.
5. Voir A. DELIVORIAS, art. cité, p. 103-104.
6. Voir J.-L. TONDRIAU, «Les cultes "maritimes" royaux», *Aegyptus* 28 (1948), p. 172-175 et H. MATTINGLY, "Zephyritis", *American Journal of Archaeology* 54 (1950), p. 126-128.
7. Voir P. FOUCART, "Les fortifications du Pirée en 394-393", *Bulletin de Correspondance Hellénique* 11 (1887), p. 140-143.
8. Voir JESSEN, *RE,* VI.1, col. 1225-1226, *s.v.* "Euploia" et les corrections de L. ROBERT, *Collection Froehner,* I. *Inscriptions grecques* (1936), p. 2, n. 1.
9. Voir Ph. BRUNEAU, "Existe-t-il des statues d'Isis Pélagia?", *BCH* 98 (1974), p. 336 et n. 6.
10. Voir n. 7.
11. Voir le décret de Cos ordonnant, après la construction de navires aphractes, que τοὶ αἱρημένοι [ἐσπεμ?]ψάντω ἐπ' αὐτὰ ὁ μὲν τὸ πρ[ύμνας σαμεῖ?]ον 'Ηρακλεῦς, ὁ δὲ τὸ [πρώρας ἄγαλμα? 'Ασκ]λαπίου, avec le commentaire de M. SEGRE, ΚΡΗΤΙΚΟΣ ΠΟΛΕΜΟΣ, *Rivista di Filologia e d'istruzione classica* 1933, p. 365-374.
12. Voir la scholie à Aristophane, *Acharniens,* 545-548 (scholie II, 319, Rutherford) et le commentaire de F. J. DÖGLER, "«Dioskuroi», Das Reiseschiff des Apostels Paulus und seine Schutzgötter", dans *Antike und Christentum* 6 (1950), p. 281 et n. 27.
13. F. J. DÖGLER,, art. cité, p. 276-285.
14. Je ne prends pas ici en considération le bloc d'Egine qui porte l'inscription 'Αφροδίτα 'Επιλιμενία, dont on ne sait pas s'il s'agit bien d'une ancre, comme l'a proposé G.WELTER, *Archäologischer Anzeiger* 1938, col. 489-490.
15. G. BRUSIN, "Le epigrafi di Aquileia", *Rendiconti dell'Accademia dei Lincei* 1966, p. 31; voir J. et L. ROBERT, *Bulletin épigraphique* 1967, n° 683.
16. P. A. GIANFROTTA, "Ancore «romane». Nuovi materiali per lo studio dei traffici marittimi", dans *The Seaborne Commerce of Ancient Rome, Memoirs of the American Academy in Rome,* XXXVI (1980), p. 109 avec note 34 et fig. 19.
17. Lettre du 21 juin 1987; on consultera G. KAPITÄN, "Archeological evidence for rituals and customs in ancient ships", *Actes du congrès du Pirée. 1985, Ship Construction in Antiquity* (TROPIS 1).
18. Voir P. A. GIANFROTTA, "Rinvenimenti archeologici sottomarini", dans *Le isole pontine attraverso i tempi* (1986), p. 217-218, avec fig. 375-376.
19. Voir P. A. GIANFROTTA, art. cité, p. 108, n. 24.
20. P. CHUVIN, J. YOYOTTE, *Revue archéologique* 1986, p. 60, fig. 9.
21. P. A. GIANFROTTA, art. cité n. 16, p. 110, n. 36.
22. Voir, sur cette question, P. A. GIANFROTTA, art. cité, p. 109.

RIGGING THE ATHENIAN TRIREME

Interaction of Sail and Hull SLIDE NO:1

The starting point was to understand how and why the ancient Aegean sailor had used his sail. The control characteristics of a sailing boat depend on the indivisible relationships of sail distribution, immersed hull shape, rudder profile and position. It soon became clear that in the Mediterranean this interaction had been understood from the beginnings of sail. The iconographic evidence shows hulls with keels extended as rams, low broad square sails, masts stepped aft of or close to the centre of the waterline, and long narrow rudders hung from overhanging stems. It is possible to infer from the "above waterline" evidence that the seamen had to overcome a problem of directional stability when they took to using sail in the Aegean.

The clues to this are in the relative disposition of the sails and rudders and in the hull profile. Sailing skills of that age would be based on the developments made in vessels of, say, less than 20 metres but would continue to be applied to much larger galleys. The latter, because of their greater beam to length ratio would reduce the problem of directional stability while creating others.

Rudders - or adjustable leeboards?

Let us begin by considering the rudders of these smaller vessels. The rudders are of the balanced type and are long and narrow. Each blade has a high aspect ratio which would be most effective when hung from an easily turned hull but liable to be stalled if used in a deep drafted vessel. Since these rudders may be swung upwards when in use they would be deep, well below keel level. In that position not only would they be rudders but they would also function as lee boards too. The writer believes that in some cases only the lee rudder was used when sailing to relieve the fastenings of the weather rudder to the hull. Their position abaft the water line increases steering effectiveness but places the hydrodynamic lift created by water flowing obliquely across their surfaces an unusual distance from the sail's Centre of Effort. Two assumptions may be made because of the rudders:

a) The hulls of the smaller galleys are shallow and turn easily.

b) The hulls draw most water aft at a point probably just abaft the mast position.

Hull shape and Directional Stability

The usual profiles of the galleys would seem to support two assumptions. The vertical stems would influence the run of the planking and produce "Veed" hull sections below the waterline for some distance aft. A swept up stern post suggests that the garboard and second strake in that area would have had little deadrise, or that subsequent strakes would certainly be flattend out. Consequently the greatest waterline beam would be aft of the mast position. A ram just breaking the surface indicates least draft for'ard. A gently rockered keel leading into a curving stern post would seem logical and is to be seen in some illustrations. An obtuse angle between the keel and sternpost is likely also as in the Giglio wreck.

Whichever construction is used the form of hull described would attain its maximum speed easily when rowed and steer well. It would have its upright Longitudinal Centre of Buoyancy well aft of the mid waterline section, which is useful if at near maximum speed and on an even keel since it prevents the stern's squatting.

Sailing downwind stepping the mast in the fore part of the waterline would suffice. However, this would prevent the steering of a reaching course, ie, with the wind abeam.

In the Kyrenia wreck and subsequently in Kyrenia II the mast step seems to be in the forepart. It has been suggested that she may have been fore and aft rigged, inspite of the presence of lead brail rings (Katzev, 1972). Certainly when the writer sailed in a square sail rigged Kyrenia II that vessel would only sail downwind. Dare the writer propose a reassessment of that wreck's remains, beginning with the hypothesis that when the ancient hull was trimmed properly the mast step would have been close to the centre of the load water line?

A mast stepped at the centre of the waterline would return control to the helmsman who would then experience weather helm. In gentle breezes weatherhelm would be useful since in steering to correct it the combination of rudder angle and leeway would counteract the excessive leeway.

The Vikings and others in Northern Europe solved this problem in a similar fashion. Their hulls were symmetrical. On heeling the Longutudinal Centre of Buoyancy would barely move. The deep side rudder maintained control of the slightly increased weatherhelm. (Roberts, 1984).

The ancient Mediterranean galley, as suggested, had an altogether different form. Kept upright the sailing speed would be very fast. However, the least heel would create exceptional steering problems. The longitudinal Centre of Buoyancy would move aft creating overpowering weatherhelm. The rudders would stall and the vessel would gripe violently. Iconographic support for this scenario is obtained from three illustrations of galleys with the after half of their sails brailed up. The Centre of Effort of the sail is moved foreward to balance the griping action, thus letting the helmsman steer. Knowledge of this problem and how to control it is to be found in the fourth century work **Mechanica.**

This lucid explanation stops short of giving the causes of the needs for such actions which were embalmed in the centuries old traditional concepts of what constituted a proper form of hull. The writer is sure that the brails were never intended for this purpose but lent themselves effectively to being used as a practical solution to an alarming problem. To summarise: it is believed that the smaller Classical Mediterranean galley had a fast, shallow hull which would be considered unbalanced by modern sail boat theory. To counter this the sail not only propelled the hull but was essential for maintaining directional stability. The deep, narrow rudders not only steered, but acted as leeboards.

Two Masted Sailing Galleys

The form the two masted rig took in the large, narrow galleys seems to be different from that fitted in the beamy round ships. The latter had hull balance problems, when under sail, similar to those of the smaller galleys. Being larger a foremast or artemon was fitted over the bows where the small square sail would be most effective. The large galleys of narrow beam had a different problem. The practice was to send ashore all sailing gear before battle (Morrison and Williams, 1968). Therefore the practice of dividing a large sail area into manageable portions was established about this time. Also a single central sail might have had the same effect on steering as an unbalanced hull. The setting of main and boat sail when reaching would make steering easier. Brailing of the main would remain an extra option.

General Sail handling SLIDE NO:2

No reef points were needed as the sail could be partly brailed as required. Some drawings show the tacks hanging down while others were capable of being brailed up with the rest of the sail. What has been considered to be a two part brace is thought by the writer to be a single brace and leach brail together with their belay points adjacent. Under tension the leech brail would be functioning as a brace too. It has been suggested that there were buntlines. It is evident that the lee side of the sail is shown in a primitive perspective. The lines across the lee side of the sail are in fact its horizontal seams. The level way in which the sails are brailed is sufficient to indicate that no buntlines existed. Where no leech brails were fitted the sail area above the tack was lashed in a tight roll. Reefing by progressive brailing would not be detrimental to performance in free winds.

Furling the sail is an extension of reefing. In 1981 the writer had the opportunity to sail around Gotland in a Viking replica boat which set a broad square sail based on drawing found on the sixth century AD Gotland Stones, Dr Erik Nylen of the Gotlandsfornsal, Visby, had interpreted the web of lines drawn beneath each sail as controls necessary for the efficiency of a broad square sail (Nylen, 1983). Before the wind unless controlled, the tacks draw together as the foot curves forewards. Dr Nylen fitted lines beneath his sail for holding by the crew. This drew down the foot and pushed out the tacks. The writer fitted tell-tales over the sail and was able to demonstrate the changes in air flow which resulted (Roberts, 1984). In 1985 while in Kyrenia II the writer suggested tensioning the middle brails. This had the same result as the Viking sail. Some of the iconographic evidence shows sails in this attitude in Severin's "Argos" this point was missed and late Scandinavian middle-sheets were employed (Severin, 1984). For the two masted galleys the mid brailing of the main would ensure a better air flow for the boat sail.

Brails - Problems and Fittings SLIDE NO:3

A brail pulling up a sail pulls down on the yard. This would explain those drawings showing galleys with curving yards. Nowhere was there seen evidence of lifts to support the yards. Therefore in strong winds tensioned brails pulling against taut sheets and tacks must have produced curved yards. To compensate for these stresses fished yards were used. By having a quarter to one third of the yard fished the yard could effectively be made stiffer. The Athenian Trireme's mainyard is fished for a third of its length and the writer looks forward with interest to see how it curves during sailing trials in 1988.

As stated no evidence was found for there having been lifts even in the rig of third century AD Roman ships. The writer believes that those Roman ships displaying what seem to be multiple lifts really show the Roman answer to avoiding a bent yard. Instead of leading directly to the deck the brails are led to a series of fairleads higher up the mast, then down to the deck. This is particularly well illustrated in figs 2 and 12 in L. Foucher's **Navires et Bateaux** (Tunis, 1957) So far only one drawing shows a fairlead for the brail where it passed over the yard. It appears to be a forged staple with its legs bent outwards (Morrison and Williams, 1968), no doubt flattened, so that it may be lashed or nailed in place. This form and others were considered for the Athenian Trireme. To avoid the brails' jamming at the side and to prevent wear over the yard, a design with a totally closed fairlead hole was chosen. These were cast in bronze and nailed in place.

In wrecks where lead brail rings have been found one wonders what happened to the metal brail fairlead. Did the yards float away? The reason might be that wooden fairleads were commonly used. They would be perfectly adequate. The only metal fairleads in the iconography may suggest a limit on their use to the largest of rigs.

The bulk of the evidence shows brails passing over the yards. The Later Roman evidence, as in the Portus Relief and Herodotus' statement that nations "attach the rings and brails to their sails on the outside", ie., the lee side, "while the Egyptians attach them on the inside," support the general view that the Greek galleys used the leeside too.

It seems that having passed through the rings the brails were fastened to the foot of the sail. However the writer believes another an older method of brailing co-existed in the Aegean. It is to be seen in its earliest form in the ships of Ramses III and the Sea Peoples as depicted at Medinet Habu, Egypt dated about 1176 BC (Casson, 1959). These have their sails furled in a way that could only have been achieved by passing each brail under the foot of the sail, up the weather side and fastening the end to the yard, no brail rings being used. It is a logical method if furling is the only purpose of brailing and as such the technique has lasted to the present day. The later addition of brail rings enabled the brails to be used for reefing too.

The examples of this older method are in one of the merchant vessels on an Attic vase from 500 BC (Katzev, 1972) and in Odysseus' ship on another Attic vase. The brails in the former are heavily drawn around the sail and in the latter not so convincingly. Probably brail rings were used too since no billowing of the sails is evident. The benefit to a merchant vessel is the mechanical advantage to be obtained when sweating up the brails in strong winds with a small crew. The Kyrenia II uses this system, quite rightly in this writer's view. In a galley with plenty of manpower the one side brail is sufficient. It reduces the rope to be hauled by half and halves the time needed to brail.

Brail rings may have come into general use only about 700 BC since some vessels prior to that time are shown with tightly brailed sails on straight yards. Later the yards begin to be shown curved which indicated the use of brails for reefing and that action would be possible if brail rings were fitted.

Herodotus' claim that the Egyptians had brail rings on the weather side of the sail may be a misinterpretation of their use. In the Temple of Edfu on the Upper Nile, where Herodotus had travelled, is a relic from the 2nd century BC (Basch, 1978) showing a sailing boat with such rings but the writer has explained elsewhere that their purpose is to guide lines which trim the low broad sail before the wind (Roberts, 1987).

In the Athenian Trireme lead brail rings are sewn at intervals to the seams of the lee side of the sails. Those for the leech brails are of bronze because of the strains on the leach.

The Sails SLIDE NO:4

Sufficient information exists for many of the technical details of Classical sailmaking to be deduced. In literature reference is made to pieces of cloth needed for sailmaking (Morrison and Williams, 1968). Many drawings show seams in the leeside. In fact it is not so much a seam that is shown but the reinforcing strip sewn over it. This would explain the absence of seams on the weather side. Seams appear to be reinforced in a horizontal direction only to withstand shear in the vertical seams. Perhaps the reason for this is that the brails would support the sail vertically and relieve shear strain in the horizontal seams.

In the Athenian trireme No 6 R.N. flax canvas was used. Vertical seams are in fact false, the canvas being arranged in horizontal cloths. Straight seaming stitches were used throughout. Leather was used to reinforce the seams and as a tabling for all edges of the sail in accordance with the literary evidence and the later Portus Relief (Casson, 1971). In deference to doubts expressed a removable bolt rope has been fitted to the foot, unnecessarily in the writer's view.

The attachement of sheets is an obscure area. In only one case are tack rings in evidence. This method was adopted for the Athenian Trireme. In addition the leech brails are attached to them. These then pull directly against the tension in the sheets.

The head of the sail is bent on with a lanyard. The clews are lashed to the yard arms through sewn cringles.

Parrels SLIDE NO:4

While experimenting with a model trireme type sail the need for a strong parrel to link the yard to the mast became apparent. In the running position this was not necessary. When reaching the yard was displaced to leeward by a certain amount. This varied depending on how much drift was allowed to the halyards. The movement sideways was due to the tension in the brails and braces pulling at an acute angle.

Iconographic evidence shows this problem to have been cured by a simple rope tie. In those galleys whose masts were bound (in medieval terms, woldings), the rope parrel would probably have been loose fitting in order to slide over the woldings as there is no evidence of any crew climbing the mast to attend to it. In later forms of this rig seamen go aloft to set or hand the raffee-type top sails seen in Roman ships. Prior to the Aegean Galley it seems that the only people who went aloft were the Ancient Egyptian seamen. They fitted "crowsnests" to their masts not, the writer believes, for the well recorded military purpose, but as a very important navigational aid. A look out at say 10 metres above sea level would see the low featureless deltaic coastline long before anyone on deck, when making a landfall.

Halyards SLIDE NO:4

The sails of the Athenian Trireme are hoisted by pairs of halyards for which there is more than enough evidence. Indeed double halyards seem to be the norm in the Mediterranean long before the seafaring activities of the Greek galleys. For example the reliefs of Queen Hatshepsut's fleet from 1500 BC.

Reasons for doubled halyards are divers. Two halyards permit two groups to haul in a confined space. The weight on each halyard is halved. Should one part then the other would prevent the yard crashing onto the crew. Of course such advantages may have been apparent only later. Perhaps the real reason was that no one invented a smooth slot in the mast head.

In the Athenian Trireme, whereas all other rigging is of natural fibre rope, it was decided to use a polyester rope having the appearance of natural fibre for the halyards. The reliability of man made fibres was preferred in this case as the replica is inevitably to be exposed to weathering. Experimental archaeology should not include the possibility of killing people as a result of uncertain strength factors in vulnerable areas.

Mast Trucks SLIDE NO:5

Mast trucks were designed to be made of bronze for the Athenian Trireme. The curved fairlead slots were given the greatest possible radius so as to avoid nipping the rope. Trucks in the iconography vary from built up wooden structures to what quite obviously are metal casting. The latter form was chosen as being typical and also because it was easier to calculate the strength of the fitting.

Masting SLIDE NO:5

It was decided to conform with standard galley practice and make the Athenian trireme's masts free standing. After raising them in their tabernacles and wedging them in the only support given was a forestay and backstay. The mainmast is expected to bend slightly under sail. Without shrouds a substantial tabernacle is needed. Masts without shrouds suggest that ancient galleys may have had an easy motion, they heeled initially quite quickly in a gust. This would reduce the shock loading on the rig and thus enable the almost free standing mast to remain the norm for so long. Nevertheless all mast loads were transmitted into to the hull via the tabernacle. Consequently in any vessel this must have been a relatively massive. While sailing in Kyrenia II in 1985 a stream of bubbles was noticed emmananting from under the hull. This writer suggests it was able to trace it to air entrainment via a garboard seam which was being forced open at the keel tabernacle position. In her ballasted light condition air was sucked outwards. In the original Kyrenia ship, fully loaded, water would have come in. It is likely that these problems were quite common in lightly built galleys. In Roman times shrouds were used, certainly in their cargo vessels, which would be stiff from their deep laden condition. In this way the mast loads would be more evenly distributed into the hull.

Conclusion SLIDE NO:6

In conclusion it must be said that great pleasure and satisfaction was gained in researching and designing the rig for the Trireme Trust.

The evidence used in support of the writer's decisions when designing the rig for the Athenian Trireme are familiar to all. It is hoped that this interpretation will satisfy some of the experts and lead to a lively discussion. It is intended to record in future publications the practical problems of handling a rig from 2500 year ago.

Owain T.R. Roberts

Welsh Institute of Marine

Archaeology and History

Bangor

U.K.

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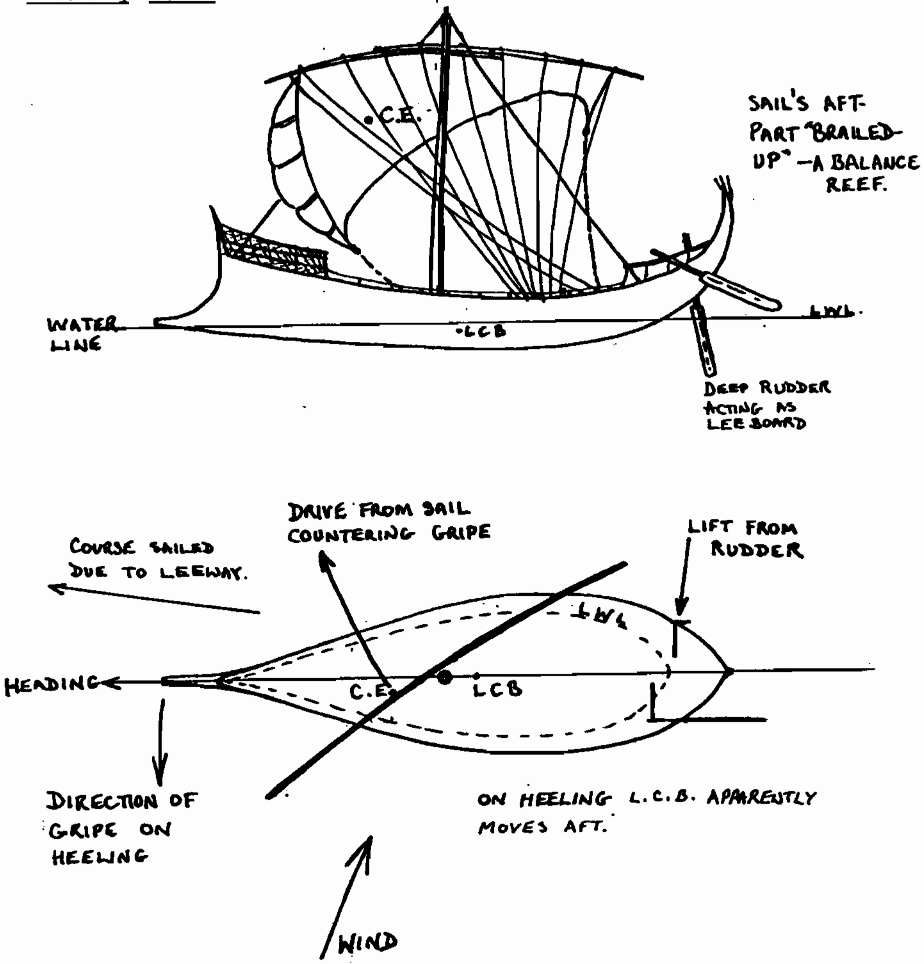
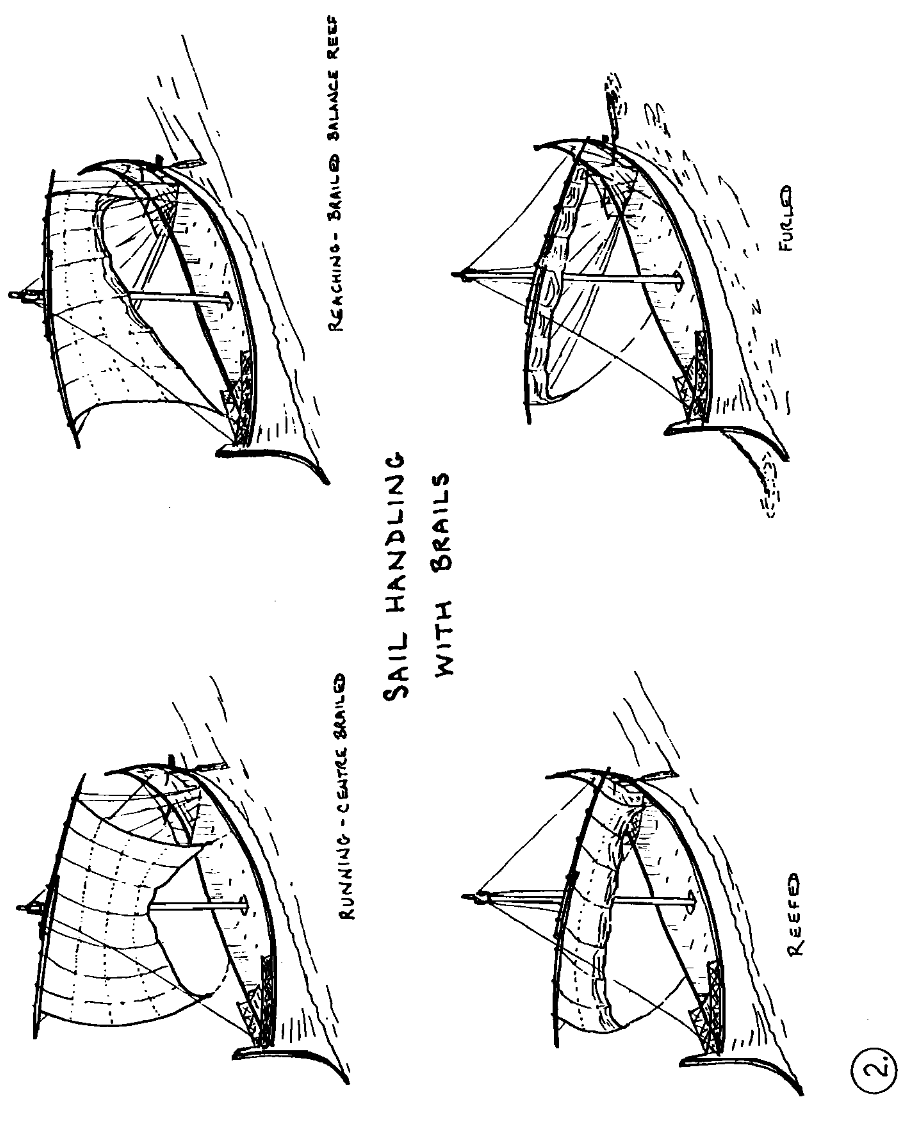
FORCES ACTING UPON A CLASSICAL GALLEY WHEN UNDER SAIL.

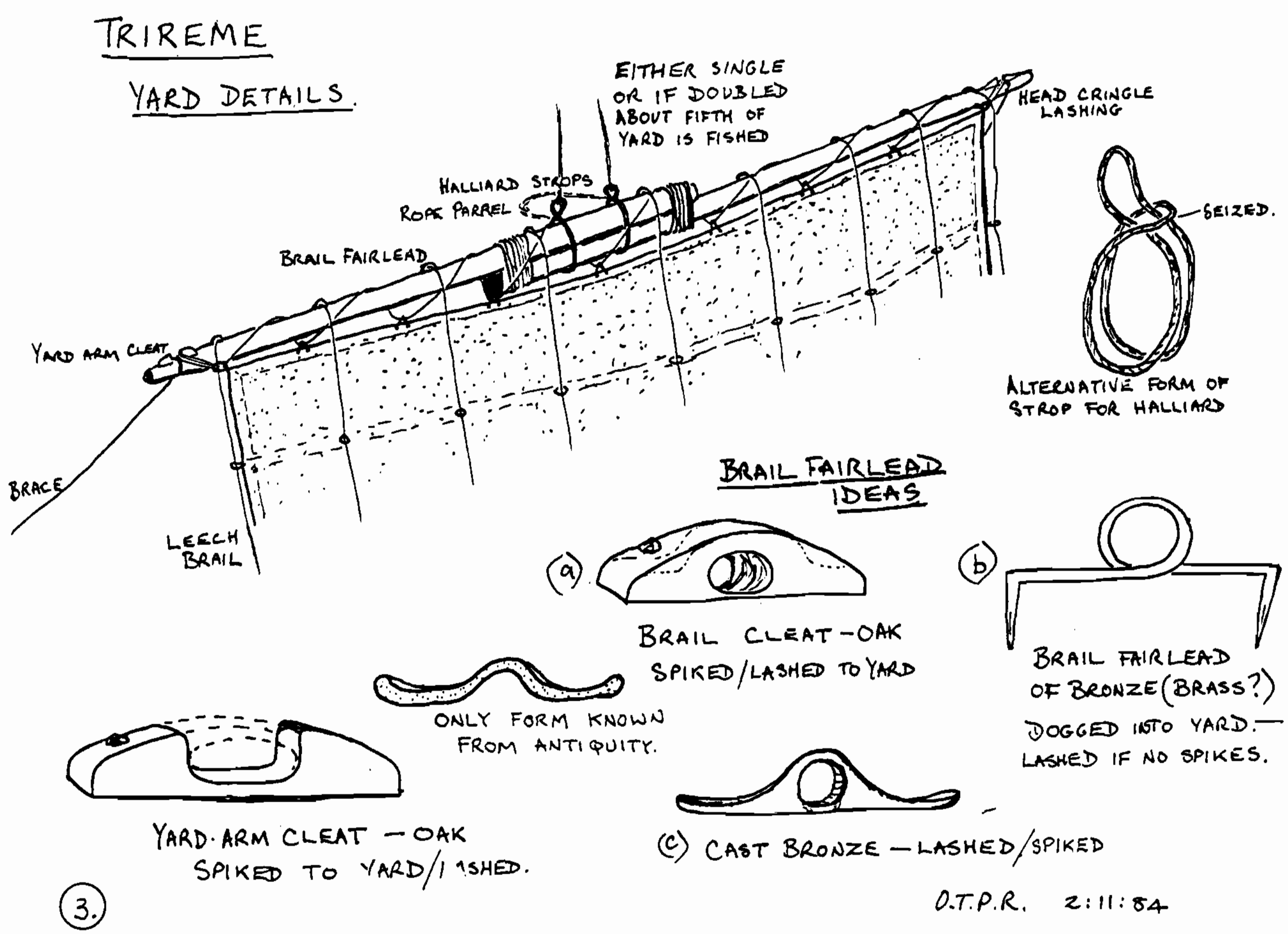


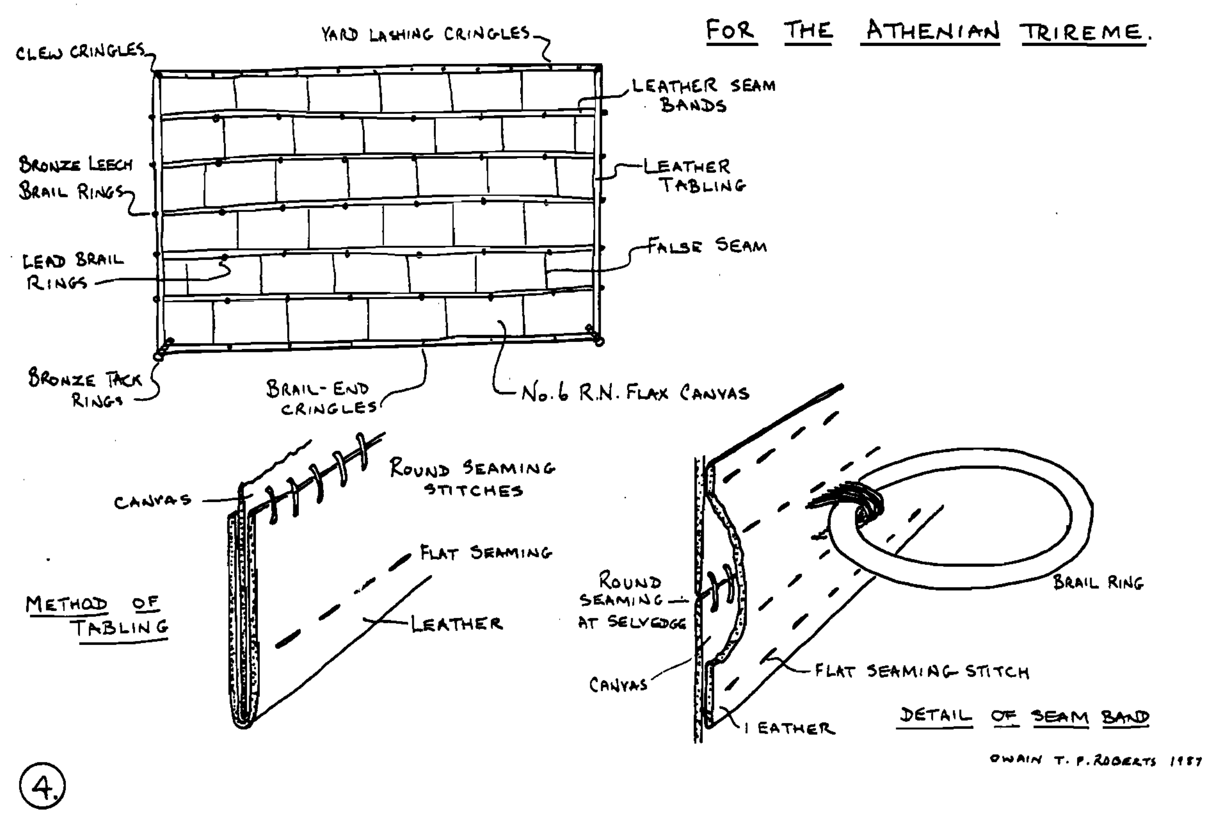
C.E. = CENTRE OF EFFORT.
L.C.B. = LONGITUDINAL CENTRE OF BUOYANCY
L.W.L. = LOAD WATER LINE

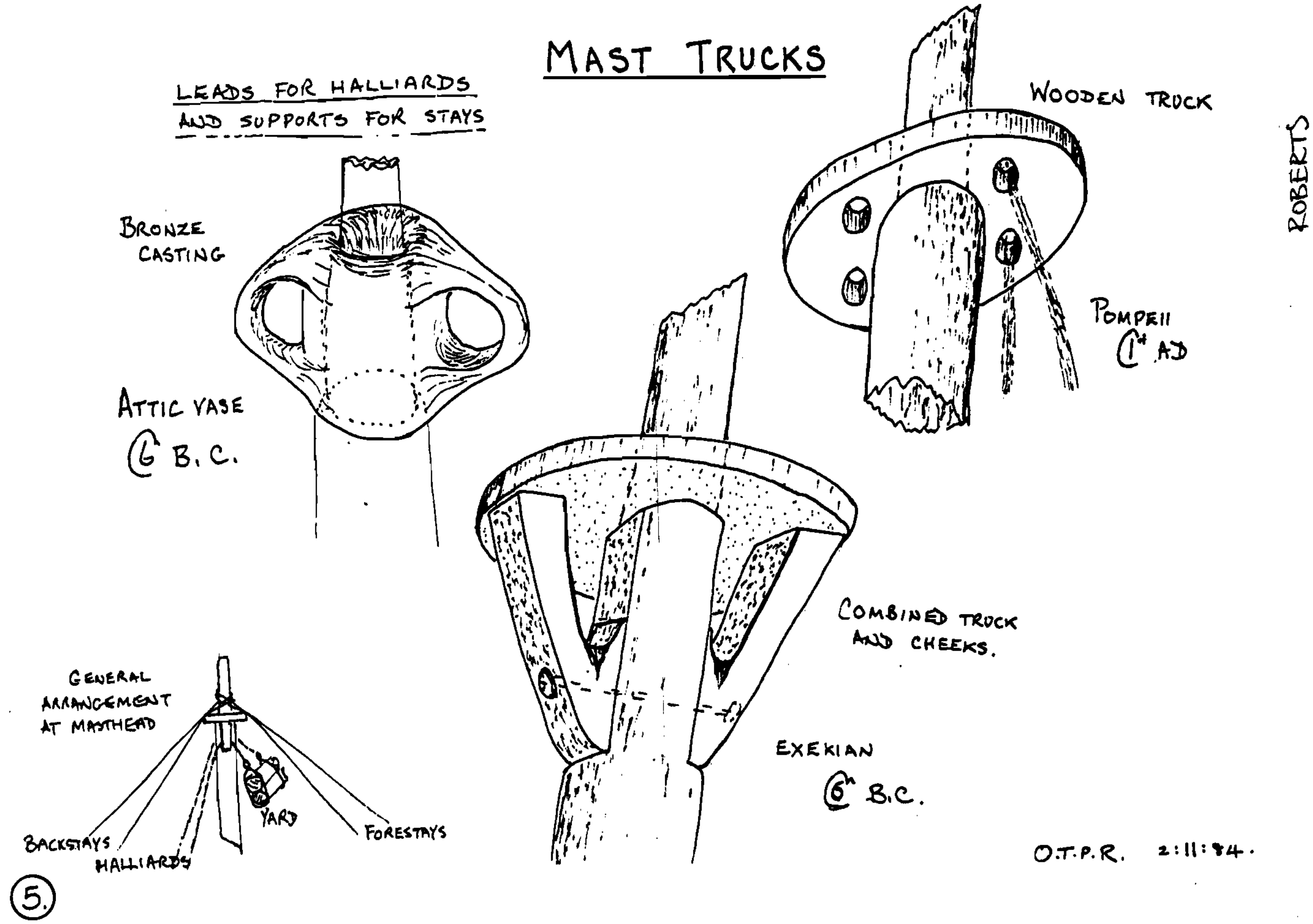
OWAIN T.P. ROBERTS 1997

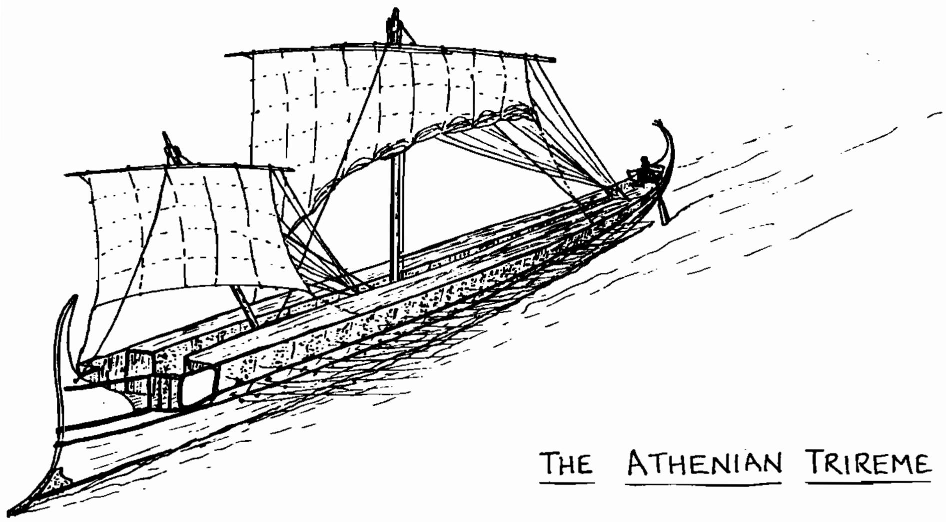
1.


SAIL HANDLING
WITH BRAILS
RUNNING - CENTRE BRAILED
REACHING - BRAILED BALANCE REEF
REEFED
FURLED
2.


TRIREME
YARD DETAILS.
EITHER SINGLE
OR IF DOUBLED
ABOUT FIFTH OF
YARD IS FISHED
HEAD CRINGLE
LASHING
HALLIARD STROPS
ROPE PARREL
BRAIL FAIRLEAD
YARD ARM CLEAT
BRACE
LEECH
BRAIL
SEIZED.
ALTERNATIVE FORM OF
STROP FOR HALLIARD
BRAIL FAIRLEAD
IDEAS
(a)
BRAIL CLEAT-OAK
SPIKED/LASHED TO YARD
(b)
BRAIL FAIRLEAD
OF BRONZE (BRASS?)
DOGGED INTO YARD.—
LASHED IF NO SPIKES.
ONLY FORM KNOWN
FROM ANTIQUITY.
YARD-ARM CLEAT — OAK
SPIKED TO YARD/LASHED.
(c) CAST BRONZE — LASHED/SPIKED
3.
O.T.P.R. 2:11:84


FOR THE ATHENIAN TRIREME.
CLEW CRINGLES
YARD LASHING CRINGLES
LEATHER SEAM BANDS
BRONZE LEECH BRAIL RINGS
LEATHER TABLING
LEAD BRAIL RINGS
FALSE SEAM
BRONZE TACK RINGS
BRAIL-END CRINGLES
No. 6 R.N. FLAX CANVAS
CANVAS
ROUND SEAMING STITCHES
FLAT SEAMING
LEATHER
METHOD OF TABLING
ROUND SEAMING AT SELVEDGE
BRAIL RING
CANVAS
FLAT SEAMING STITCH
LEATHER
DETAIL OF SEAM BAND
OWAIN T. P. ROBERTS 1987
4.


MAST TRUCKS
LEADS FOR HALLIARDS
AND SUPPORTS FOR STAYS
BRONZE
CASTING
ATTIC VASE
6 B.C.
WOODEN TRUCK
POMPEII
1st AD
COMBINED TRUCK
AND CHEEKS.
EXEKIAN
6th B.C.
GENERAL
ARRANGEMENT
AT MASTHEAD
BACKSTAYS
HALLIARDS
YARD
FORESTAYS
5.
O.T.P.R. 2:11:84.
ROBERTS



OWAIN T. P. ROBERTS
1997

(6.)

LE NAVIRE GÉANT DE HIÉRON DE SYRACUSE*

Le cargo à voiles de taille exceptionnelle, baptisé "Syracusia", construit par Hiéron II de Syracuse, avec la collaboration d'Archimède, est assez connu. Athénée (206d - 209b) nous en a laissé une description qu'il recopiait chez un auteur hellénistique, Moschion. Le passage a été traduit par L. Casson (*SSAW*, 190-199) qui s'est efforcé de montrer que ce bateau avait réellement existé. Beaucoup en ont douté, depuis C. Torr; récemment encore J. Rougé y voit un effet de la "légende d'Archimède" (*Archéonautica*, 4, 1984). Il apparaît cependant que la thèse de Casson, paradoxale encore au moment où son livre fut publié, est sans cesse confortée par les progrès de notre connaissance de l'architecture navale antique. Plusieurs traits, qui étaient jugés invraisemblables, sont établis comme véridiques: le type du bateau, un *eikosoros* à trois mâts, est mieux connu; certains détails techniques, comme le blindage de la coque au plomb (et aussi celui des bacs à plantes du pont supérieur, que l'on a mal compris jusqu'ici) n' étonne plus. Surtout les liaisons métalliques en bronze qui reliaient les éléments des membrures entre eux, à la quille et au bordé, sont maintenant bien identifiées sur les épaves: non seulement leur rencontre, avec les poids donnés pour ces "broches", n' est pas surprenante; mais elle explique les dimensions de la coque: nouvelle encore au III^{e} siècle av. J. C., cette technique assurant la solidité et permettant l' agrandissement des bateaux a conduit à des audaces sans précédent en charpenterie de marine, et au gigantisme des constructions navales ptolémaïques.

François SALVIAT
Université de Provence,
Aix en Provence.

* Resumé de la communication orale du Professeur Salviat, suivi par la traduction d'Athénée v, 206d-209f.

APPENDIX

TRADUCTION D' ATHÉNÉE V, 206 d - 209 b

Je ne puis passer sous silence le navire construit par Hiéron de Syracuse, sous la surveillance d' Archimède le géomètre; Moschion a écrit sur lui un traité, auquel j' ai donné récemment mon attention. Voici ce qu' écrit Moschion:

Hiéron avait à honneur de s'illustrer dans la construction navale, en construisant des cargos porteurs de grain; je rappellerai la construction de l' un d' eux. Pour les matériaux, il se procura du bois de l' Etna, de quoi fabriquer soixante quadrirèmes; il prépara des goujons, des éléments de varangues et de couples; pour les autres besoins, il fit venir des matériaux d'Italie et de Sicile, pour les câbles de l' alfa d' Ibérie, le chanvre et la poix de la vallée du Rhône; et pour tout le reste nécessaire, de beaucoup d' endroits. Il rassembla des charpentiers de marine et d' autres artisans; il mit à la tête de l' ouvrage entier Archias de Corinthe, architecte; il le pria de mettre tout son zèle à entreprendre cette construction; Hiéron lui-même apportait son appui quotidien. La moitié du navire fut construite en six mois. Et au fur et à mesure des progrès de la construction des "tuiles" de blindage en plomb enveloppaient la coque, tandis que trois cents ouvriers travaillaient au bois - sans compter leurs aides. Cette partie donc devait être irée à la mer, comme il était prescrit, la construction devant être achevée à flot: et pour ce ancement à la mer, on se posait beaucoup de problèmes. Archimède seul y procéda avec un personnel réduit; il construisit une vis et par ce moyen fit descendre ce vaisseau de si grande masse à la mer (c'est Archimède l'ingénieur qui le premier inventa et fabriqua la vis). Les autres parties du navire furent construites en six mois. Et tout le bateau fut assemblé avec des broches de bronze dont les unes étaient du poids de deux mines, les autres de quinze; ces broches, insérées dans des perforations faites au trépan, assuraient la cohésion de la membrure; l' étanchéité était assurée par des plaques de plomb appliquées sur le bois, par-dessus des toiles imprégnées de poix.

L'enveloppe extérieure achevée, on travailla à l' aménagement intérieur. Le navire était construit sur le modèle de l'*eikosoros,* mais il avait trois ponts *(parodoi)*: l' inférieur donnait sur la cargaison, où l' on descendait par de nombreuses échelles; le second était aménagé pour ceux qui voulaient accéder aux pièces de logement, le dernier était celui des gens d'armes. Il y avait sur le pont intermédiaire, sur chaque bord, des pièces à habiter de module de quatre lits pour l' équipage, trente en tout; la grand salle de l'armateur était du module de quinze lits, avec trois pièces de trois, dont l'une à la poupe faisait cuisine; toutes ces salles avaient des sols de mosaïque à tesselles de pierres variées, où étaient représenté de façon admirable tout le récit de l'*Iliade*; tout l'oeuvre, plafond portes, tout était travaillé. Au niveau supérieur, il y avait un gymnase et des promenades, établis en harmonie avec la grandeur du bateau, avec des jardins variés, aux merveilleuses plantations, et des bacs que des tuiles de plomb rendaient étanches; et aussi des berceaux de lierre blanc et de vigne, dont les racines puisaient leur nourriture dans des *pithoi* emplis de terre, arrosés par le même système que les bacs des jardins. Ces berceaux ombrageaient les promenades. Près d'elles était construit un temple d'Aphrodite, de "trois lits", au sol d' agate et d' autres pierres, les plus belles de l' île; murs et plafond en cyprès, portes d'ivoire et de thuya, et un mobilier très remarquable de statues et de vases. Tout près, une salle d' étude, de "cinq lits", aux murs et aux portes de buis, avec une bibliothèque à l'intérieur, et sur le toit une demi-sphère astronomique (polos) copiant le cadran solaire d'Achradine. Il y avait aussi un local de bains, de "trois lits", avec trois chaudrons à feu de bronze et une vasque pouvant recevoir cinq métrètes, en marbre de Tauroménion. Et plusieurs logements pour les *epibates* et les gardiens de la sentine. En plus, sur chaque bord, dix écuries: là était disposée la nourriture des chevaux, et le matériel des cavaliers et des soigneurs. Il y avait aussi une réserve d'eau de mer, avec de nombreux poissons. Et sur chaque bord du bateau faisaient saillie des poutres, convenablement espacées; sur elles étaient établis des réserves à bois, des fours à griller l'orge, des cuisines, des moulins, et plusieurs autres locaux de service. Et tout autour de la coque, à l'extrérieur, des atlantes hauts de six coudées, qui supportaient les masses supérieures et l' entablement (à triglyphes), chacun venant dans l'intervalle. Et tout le bateau était orné avec art des peintures appropriées.

Le bateau portait des tours d'une grandeur en harmonie avec ses masses; deux à la poupe, deux de mêmes dimensions à la proue, et les autres au milieu. Aux flancs de chacune étaient attachées deux vergues, sur lesquelles était établie une plate-forme, d' où l'on pouvait jeter des pierres sur les ennemis naviguant au-dessous; et sur chaque tour pouvaient monter quatre jeunes gens armés, et deux archers; l'intérieur des tours était garni de pierres et de traits. On avait construit aussi une courtine de défense avec son parapet et des passerelles établies d'un bord à l'autre, élevées sur des supports: là était installé un engin lithobole, capable de lancer des pierres de trois talents et des traits de douze coudées; cette machine était l'ouvrage d'Archimède; elle lançait l'un et l'autre projectile à un stade. Avec cela des écrans de protection assemblés en cuir épais (?), suspendus par des chaînes de bronze. A chacun des trois mâts étaient attachées deux vergues pierrières, d'où l'on lâchait sur les assaillants des grappins et des blocs de plomb. Et il y avait une palissade de fer tout autour du navire, contre ceux qui tenteraient de l'escalader, et des "corbeaux" de fer qui, lancés par des machines, accrochaient les vaisseaux des adversaires et les rapprochaient pour les exposer aux coups. Soixante jeunes soldats entièrement équipés étaient installés sur chaque bord, et un nombre égal autour des mâts et des vergues pierrières. Dans les hunes de bronze des mâts, il y avait trois hommes pour le grand mât, et deux, puis un pour les autres. Des esclaves hissaient avec des poulies, dans des paniers tressés, les munitions de pierres et de traits à ces nids cuirassés.

Il y avait cinq ancres de bois, huit de fer; pour les mâts, on avait pu les trouver, mais pour le grand, c'est avec beaucoup de peine qu'il avait été découvert dans les montagnes du Bruttium par un porcher (?); Philéas de Tauroménion, l'ingénieur, l'avait fait descendre à la mer. La sentine, bien que d'une profondeur considérable était vidée par un seul homme grâce à un *kochlion,* dont Archimède était l'inventeur. Le nom du bateau était "Syracusia"; lorsque Hiéron l'envoya (en Egypte) il prit celui d' "Alexandris". Pour sa remorque, il avait d'abord un *kerkouros* pouvant porter trente mille talents, avec un équipement complet de rames; avec lui, des *haliades* portant dix mille cinq cents talents, et plusieurs autres bateaux. Le nombre des personnes embarquées n' était pas moins en plus de ceux que l'on a déjà mentionnés, de six cents autres, aux ordres de la proue. Pour les délits commis á bord un tribunal était institué, comprenant le *naukléros,* le pilote et l'officier de proue ils jugeaient suivant les lois de Syracuse. On chargea le navire de 60.000 mesures de grain, 10.000 *kéramia* de salaisons de Sicile, 20.000 talents de laine et 20.000 talents de marchandises diverses; et en plus des vivres pour le personnel embarqué. Hiéron ayant appris que tous les ports étaient soit incapables d'accueillir le navire, soit dangereux, décida d'en faire don au roi Ptolémée et de l'envoyer à Alexandrie: on manquait en effet de grain en Egypte à cette époque. Ainsi fit-il; le bateau arriva à Alexandrie, et il fut tiré au sec.

THE OBELISK LIGHTER OF QUEEN HATSHEPSUT

Introduction

The Egyptian Queen Hatshepsut (c. 1490 - 1439 BC) had the transport of two obelisks by water depicted in her funerary temple at Deir el-Bahari. The obelisks were presumably identical to the two that she had had erected in the temple of Amon-ra at Karnak, between the fourth and the fifth pylons. The two temples face each other across the river Nile. One of the obelisks still stands *in situ*: it is a monolith of granite, 28.5 metres long, weighing 374 metric tons. Its provenance is the ancient quarry at Aswan, just below the first cataract, 200 kilometres upstream from Karnak.

Sølver[1] presented a thorough technological interpretation of the depiction of the barge carrying the two obelisks. This work, which incorporated results of earlier studies by Ballard[2] and Köster[3] is still the one currently accepted by such nautical researchers as Landström[4]. It is based on a well-known relief picture in the temple at Deir el-Bahari, and on considerations of shipbuilding and river navigation. In the present communication some corrections to Sølver's work are suggested.

The painted relief at Deir el-Bahari showing the obelisk barge (Fig. 1) was published by Naville[5]. It has been somewhat damaged but the portions now missing are supplemented without much trouble. The most important of these conjectural supplementary details concerns the five thick ropes arching over the obelisks. They are restored partly on the basis of other representations of water craft reinforced in this manner, and partly on the basis of mechanical considerations.

The artist depicted not only the barge, but also the oared "tugs" towing her. The barge merely functioned as a lighter, and so we refer to her under that name. The obelisks are shown lying on sledges on top of the lighter and pointing in opposite directions. If the two obelisks were identical to those erected by Hatshepsut in the temple of Amon-ra, and if the picture were true to scale, the barge would have been 93 to 95 metres long. To nautical experts it is at once clear that a wooden vessel of such great length would have lacked sufficient longitudinal stiffness. Ballard[6] rightly invoked the experience of builders of wooden ships of the 19th century. As these ships became progressively longer, from 70 to over 100 metres, iron braces had to be increasingly to be relied upon to maintain sufficient longitudinal rigidity. This method of construction was, of course, not available to the Egyptians of the 15th century BC.

The hieroglyphic text above the relief explicitly mentions that the two obelisks were carried at the same time by the lighter. Sølver assumed that they were transported lying side by side on a barge of 63 metres length with a beam of 21 metres. These dimensions are those of a similar vessel mentioned in a document of Inene, the senior state official and architect, during the reign of Tuthmosis I, c. 1500 BC, and they probably represent the maximum size that could be attained in building a wooden ship with the technology of the time.

Antiparallel

In view of the fact that this interpretation is widely accepted by nautical research workers, it is disturbing that it appears to be ignored by Egyptologists. In their recent work on the builders of Karnak, Golvin and Goyon[7] accept, in fact, that the length of the lighter did not exceed 70 metres, but in addition they assume that the two obelisks were placed as shown in the relief picture. They are evidently aware of the objections against interpreting the picture as if it were an engineering diagram. Of course it is entirely possible to design a barge of this length carrying two obelisks one behind the other. The difficulty is that such a vessel could not be made to resemble the one depicted in Deir el-Bahari. Golvin and Goyon in fact disregard implicitly, but no doubt unwittingly, this item of primary iconographic evidence.

The question must be asked why these two well-known Egyptologists appear to deliberately ignore Solver's work. Can it be that they do so because Sølver made one obvious error in his interpretation? He thought not only that the two obelisks were lying side by side, but also that they pointed in the same direction. He claimed that the manner they were shown in the picture was because "the primary object of an Egyptian artist was to be understood and what he wanted to do in this case was to show that there were *two* obelisks. If he had drawn what I believe to be the truth, the two obelisks lying side by side, only one of them would have been visible. Such treatment is common in Egyptian art and must be allowed for in studying the pictures".

The error in this reasoning resides in the fact that an Egyptian artist would simply have repeated the outline of the after parallel obelisk above and to the side of foremost one in the case supposed by Solver. In the adjoining diagram (Fig. 2) the result is schematically indicated. Heinrich Schäfer's handbook on the "Principles of Egyptian Art"[8] leaves no doubt that such a "layered" representation would have been chosen as a matter of course.

If the picture represented obelisks lying side by side, these were doubtlessly lying *antiparallel*, i.e. pointing in opposite directions. In that case a sideways projection of the obelisks would have resulted in a pictorial riddle, something which an Egyptian artist endeavoured to avoid. Putting one obelisk behind the other in the representation would have solved the problem in a manner which is entirely compatible with Egyptian stylistic convention. In what follows, we assume that the obelisks were in fact lying antiparallel, as a correction on Sølver's conclusions.

Another problem of interpretation concerns the five ropes which run fore and aft the length of the lighter. If the representation were taken literally, the two obelisks would have been caged in by the stanchions and ropes which would have had to be removed before loading and unloading. As we shall see, one of the purposes of the ropes was to strengthen the hull precisely when embarking or disembarking the obelisks, so once again the literal interpretation of the picture must be rejected. The one interpretation which seems most probable is that the artist wished to represent both obelisks in the same manner *vis à vis* the ropes and struts in order to avoid raising questions in the mind of the spectator. If the ropes and struts were aligned parallel and close to the midship line, flanked by the obelisks, one of these would have been in front of the struts, the other behind them. Placing them in a position in-between may have appeared a reasonable compromise to the artist. Accordingly, it is assumed here that obelisks were lying outside the struts and ropes, one to port, the other to starboard.

The question arises whether there was an overriding reason for the obelisks lying antiparallel.

If there was not, why did the artist bother representing them in this manner? As we saw, he was not above taking liberties with what we would regard as an exact representation.

In order to answer the question, we may begin by noting that the runners of the sledges were turned up only on the end where the apex of the obelisk was located. Apparently, the sledges were meant to be pulled only in that direction. If the sledges were standing near the sides, as assumed here, that would have been entirely feasible; the sledges were pulled in opposite directions which were the same during both embarkation and disembarkation.

The load of the lighter consisting of two obelisks instead of one possessed the disadvantage of a double load, but it also brought an important advantage. When embarking the first obelisk which weighed 374 tons it would have been extremely difficult to prevent the lighter's capsizing. The lighter's unladen displacement was estimated by Ballard and Sølver at 600 to 700 tons.

If there were two obelisks, and if the hull of the lighter was shaped more or less symmetrically fore and aft - the picture at Deir el-Bahari does not contradict that assumption - the danger of capsizing could be avoided entirely by pulling the sledges on board simultaneously at the same distance from the centre of buoyancy. The application of this simple principle during embarkation and disembarkation is illustrated in the diagram (Fig. 3) in which the positions of the obelisks during the voyage downstream are also given.

During loading and unloading it would have been necessary to keep the level of the deck beams carrying the sledges approximately level with the top of the "quay". Before embarkation the lighter had to be ballasted, probably with sand, to an amount displacing at least the same as the obelisks and sledges combined. When the obelisks had been pulled on board partly, the lighter would begin to bear part of their weight. Consequently, she would settle somewhat deeper in the water and the deck beams would sink relative to the top of the quay. That could be counteracted by unloading some of the ballast until they were level again. The sledges could now be pulled on board somewhat further, and so on. In this way the two obelisks were embarked carefully, step-by-step. When loading had been completed, they could be pulled to the positions for the voyage downstream, where they were secured to the deckbeams close to the centre of buoyancy. The inverse sequence was followed when unloading. The gradual loss of the weight of the obelisks carried by the lighter was compensated by ballasting.

The diagram shows that during embarkation and disembarkation it was necessary to moor the lighter diagonally in berths of a certain width, but their provision cannot have presented much of a problem. The whole operation must have been thought out carefully in advance, and its execution required close cooperation of all parties concerned. These are the same requirements posed by other technological feats of Egyptian Antiquity. Evidently, the ancient Egyptians were fully capable of meeting them.

Pre-Stressing

The heavy ropes running the length of the lighter are remarkable only because there are five of them instead of one. Vessels with a rope truss are attested by a number of models and pictures of Egyptian ships. The struts carrying the rope stood on floor timbers. We may assume that the same was true for the obelisk lighter. The earliest representation is probably a relief painting from the tomb of King Sahure, c. 2500 BC. Although it is generally recognized that the rope trusses were intended to counteract a hogging condition, it was far from obvious why they were present in the obelisk lighter. Ballard[6] wondered about the sagging conditions imposed upon the hull by the obelisks, against which the rope truss is useless. The method of loading and unloading which we deduced from details in the representation would have caused the hull to be temporarily subjected to a hogging condition, where a rope truss would have been most useful.

The question remains open why a sizable proportion of Egyptian ship models were equipped with these ropes while the majority were not. Moreover, we see such rope trusses in ships which were loaded in the customary fashion over gangways amidships. In other words, although the rope truss was undoubtedly useful in counteracting the sagging condition during embarkation and disembarkation of the obelisks, that does not appear to be the primary reason for their use.

If the ropes were pre-tensioned during construction of the ship, it would subject the bottom of the hull to a tensile stress in the for and aft direction. If such ships were caulked at this stage, any leakage during subsequent use would be less than that of a hull which had not been pre-stressed. That can be understood by considering the mechanical conditions prevailing in the bottom of the hull when the ship was fully loaded. The load would create a sagging condition, the ends of the hull would rise, thereby diminishing the forces set up by the pre-tensioning, because the ends of the ropes were attached at the ends. As a result, the variation in longitudinal tensile stress in the bottom of the hull upon loading would be less than in a ship which had not been pre-stressed in this manner. It would go to explain why the rope trusses were found in certain ships only, in others not. If the hull was constructed of long strakes, the rope truss would not have been necessary. We reproduce here a picture (Fig. 4) of a heavily loaded lighter from the tomb of the Fifth Dynasty King Unas, c. 2600 BC, of which the hull is clearly built of long strakes, while a rope truss is absent.

A silent assumption introduced in the preceding discussion is that the sides of the lighter were stiff in relation to the bottom and the rope truss. There is, in fact, an indication that the sides were exceptionally stiff. It lies in three rows of what must have been the heads of thwartships beams let into the planking. Solver concluded from the presence of these beams that the obelisks were really carried on the deck beams and not in the hold, as had been considered by Köster. He thought, in addition, that the beams "must have needed vertical struts between the rows and down to the bottom". This course, does not explain in any way why the heads of the beams had to penetrate the planking.

Some light can be thrown on the purpose of these beams by comparison with a relatively modern special-purpose prahu from the Indonesian island of Sumba, a quarter of the earth's circumference to the east, about which Sølver could not have known. This prahu was a *kora-kora equipped with thwartships beams (Fig. 5). It was used for carrying tombstones of c.5 tons* weight overseas from the village of Ruha, as described by the anthropologist Nooteboom[9]. From time immemorial it had been the tradition that the inhabitants of Tandulajangga would furnish the chiefs of Ruha with the large slabs of limestone against payment of goods and slaves. The latter were replaced in the course of the 19th century by buffaloes. The various stages of the transaction were circumscribed by ceremonial rules.

This special-purpose *kora-kora* has been discussed more recently by Horridge[10], who was of the opinion that the Sumbanese at "some point in their history... adopted the *kora-kora*, modified it to carry tombstones and presumably at some time more recently they must have inserted ribs and floors". This explanation seems realistic. The modification to which Horridge refers must be the introduction of the thwartships beams. Regarding these, he remarks that they "certainly redistribute the load from one side of the ship to the other when the ship is crushed or bent. They fail, however, to restrain twisting of the ship or shearing forces along the plank lines".

It would seem that Horridge, although generally correct, fails to take into account that the lashings between the beams must have been provided for the purpose of pulling the beams together. As a result, the strakes were strongly compressed between the heads of the beams. There were dowels distributed rather sparsely between the strakes, which by themselves probably would not have been able to prevent shearing between the strakes when the sides were subjected to a strong bending force. However, in combination with the strong pressure exerted by the heads of the beams they probably effectively prevented the strakes from sliding past each other when the tombstones were shipped.

The curious arrangement of the strakes relative to the ribs appears to confirm this explanation. The two lower strakes on each side and the hollowed-out keel were lashed onto solid floors, but those compressed between the beams were free to slide up and down on flexible rattan ribs. The latter arrangement makes good sense only if the primary purpose of the beams was actually to compress the strakes against one another.

That strakes which cannot slide relative to each other enhance the stiffness of the ship is illustrated by an elementary thought experiment in which we consider the behaviour of two identical beams lying on top of each other. Their deflection under a load P when they bend separately is 4 times that which results if they bend as one single beam. The latter situation may result from compressing the two beams together, as shown in the accompanying diagram (Fig. 6).

Both the special-purpose *kora-kora,* and the obelisk lighter were heavily loaded watercraft, in which this type of stiffening would not have been a luxury. The Egyptian vessel had a much higher beam-to-length ratio, which would have caused the beams to become impossibly long if they had to span the full beam of the lighter. It is permissible to think that there would have been a heavy stringer amidships running fore and aft, composed of timbers compressed in the same manner as the sides. Otherwise it appears that the Egyptian vessel emulated the *kora-kora* by having lashings drawing the beams together, thereby compressing the strakes between the heads of the beams. It is, in fact the only rational explanation which has been offered so far for the heads of the beams penetrating the shell. In the reconstructional diagram (Fig. 7) the resulting arrangement of beams and lashings is schematically shown.

It is probable that the main compressive force exerted of the strakes and the stringer was due to the weight of the obelisks. We do not know how much force was exerted by the lashings, but a reasonable estimate would put it at about 1000 kilograms. Between the three rows of beams there were two layers of 300 lashings. As a result, the total force exerted by the beams on the strakes and the central stringer was no more than some 300 tons, about half the compressive force exerted by the two obelisks. It was therefore essential that that force was distributed equally between the sides and the central stringer. In the reconstruction (Fig. 3 and Fig. 6) that condition is obtained by having the obelisks in a position on the deck beams which is on the average about one third of their length from the sides. The force carried by the central stringer was transmitted to the floors by pillars.

If this estimate of the magnitude of the forces caused by carrying the obelisks and by the lashings between the beams is correct, the function of the latter was mainly to prevent sliding between the strakes at the stage when the lighter began to carry the weight of the obelisks during loading. Once the obelisk sledges had been pulled to the positions they occupied during the voyage the greater part of the compressive force derived from to the weight of the obelisks themselves.

Draught

The earlier researchers thought that the draught of the obelisk lighter should not exceed two metres. That value was based on Egyptian ship building experience at the turn of the century, when this draught was considered the maximum which could be allowed for ships which should be able to navigate the Nile the year round. It would seem that the application of this maximum draught criterion to the obelisk lighter disregards the fact that she navigated the river only once, and that it is unlikely that she did so when the water level was at its minimum, i.e. in May or June.

Golvin and Goyon actually mention that the base of one of Hatshepsut's obelisks carries an inscription stating that work on the obelisks commenced "on the first day of the second month of winter", and that it was concluded seven months later "on the last day of the fourth month of summer" (spring was not one of the seasons known in Ancient Egypt). That would presumably imply that the obelisk lighter sailed down the Nile to Karnak sometime in August, when the river was in full flood. This natural phenomenon lasted until early November, as is evident from the accompanying diagram (Fig. 8) which gives water levels in the course of the year for a site about twenty kilometres downstream from Cairo. Since the construction of the large dam at Aswan the phenomenon no longer manifests itself in Egypt, and nowadays few people outside that country are aware of the large differences in water level which it created. The maximum difference at Cairo was 7.5 metres on the average, while at Aswan it was some 16 metres. The danger of running aground with a vessel with a draught between two and three metres cannot have caused a serious problem when the Nile was in flood.

As reconstructed by Sølver and Ballard their barges were rather lightly built, presumably in order to keep their draught under two metres, and they displaced between 600 and 700 tons. Assuming a somewhat sturdier build, a displacement of about 900 tons results, which would cause the vessel to draw about 2.4 metres of water, which is certainly not excessive.

In conclusion it may be said that the transportation of the obelisks as far as it can be deduced from the available data not only manifests a high degree of organising capability, but also bears witness to an extraordinary grasp of intuitive mechanics, which appears to have been handled with consummate skill and confidence.

André Wegener Sleeswyk
Laboratory of General Physics
Westersingel 34
NL 9718 CM Groningen

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ILLUSTRATIONS

Figure 1. Obelisk lighter as depicted in the funerary temple of Queen Hatshepsut at Deir el-Bahari.

Figure 2. Two obelisks on sledges as they would have been depicted by an Egyptian artist if they were lying parallel.

Figure 3. Antisymmetrical position of the obelisks on the lighter during: a: embarkation, b: navigation, c: disembarkation.

Figure 4. Lighter planked with long strakes carrying stone pillars. No rope truss. Picture from the tomb of King Unas.

Figure 5. *Kora-kora* equipped with twarthships beams from the Indonisian island of Sumba, which was used c. 1935 for transporting tombstones (After Nooteboom).

Figure 6. Showing the decrease in deflection under load of two beams when they bend as one compared with their bending individually.

Figure 7. Reconstructional drawing of the obelisk lighter equipped with lashings between the beams.

Figure 8. Variation of water level of Nile river during the year as it took place before construction of the dam at Aswan.

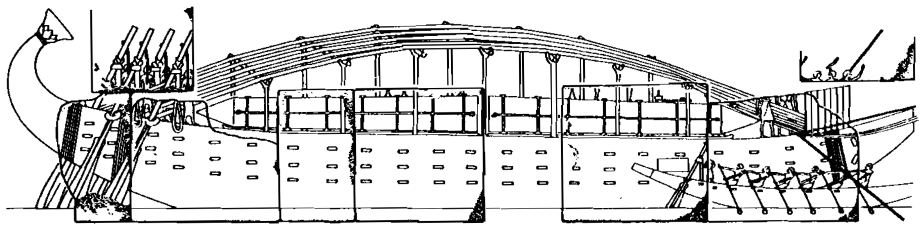


FIG. 1

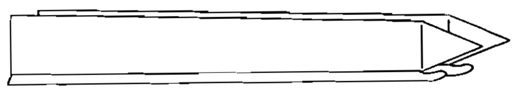


FIG. 2

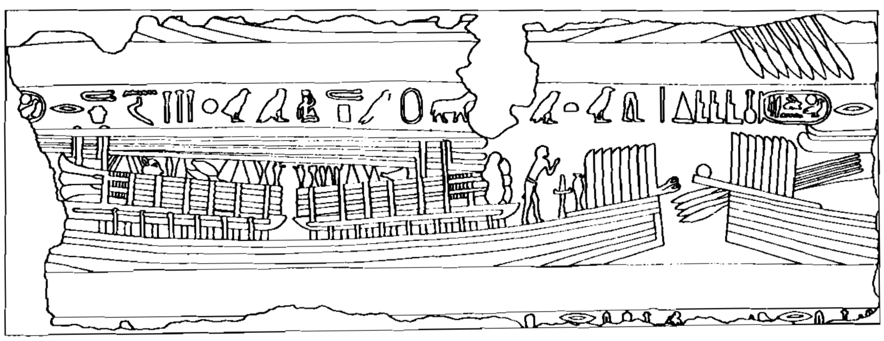


FIG. 4

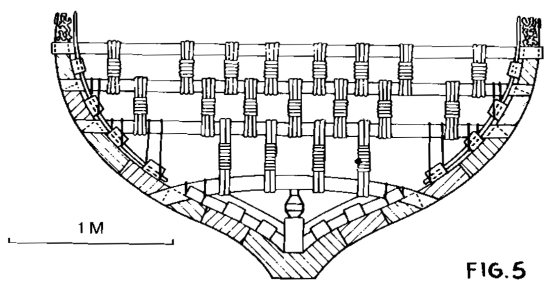


FIG. 5

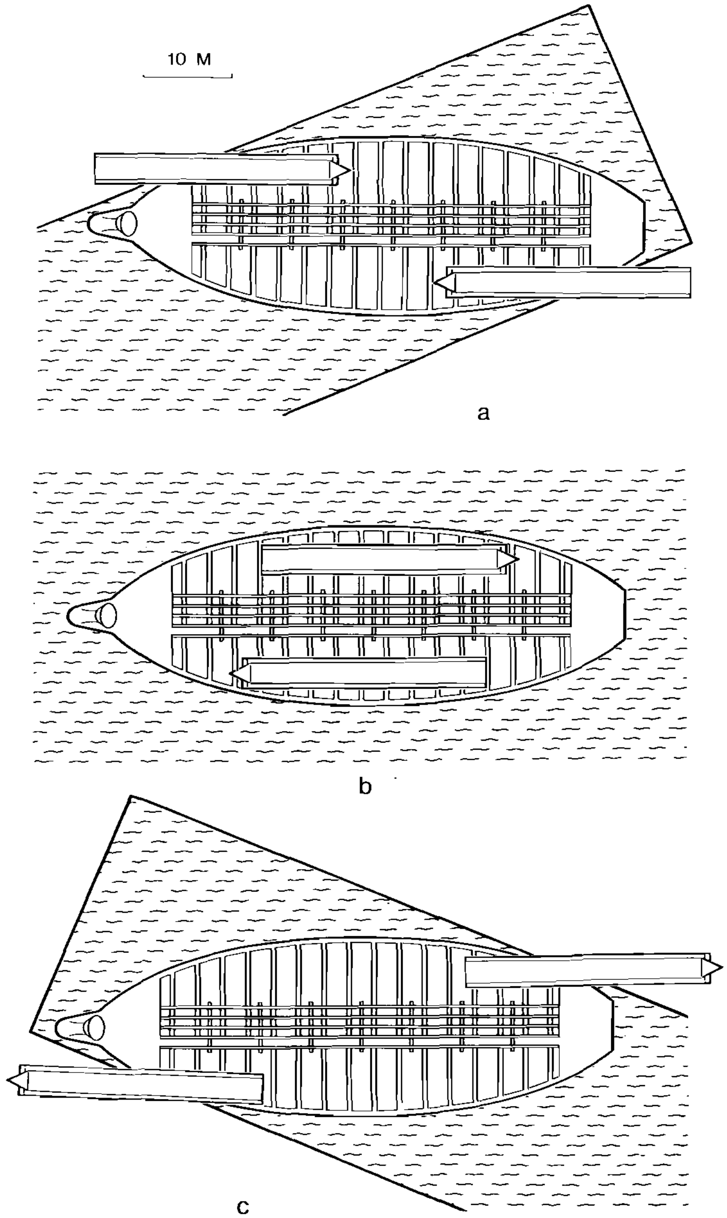


FIG.3

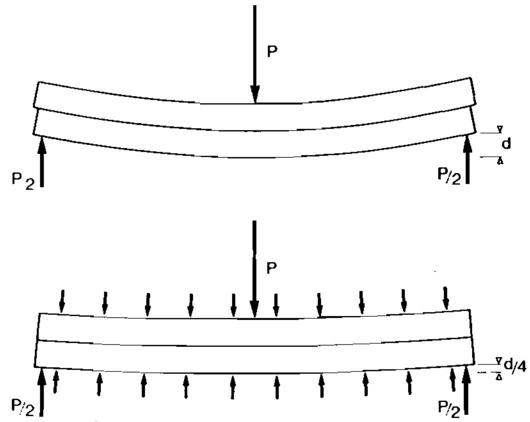


FIG. 6

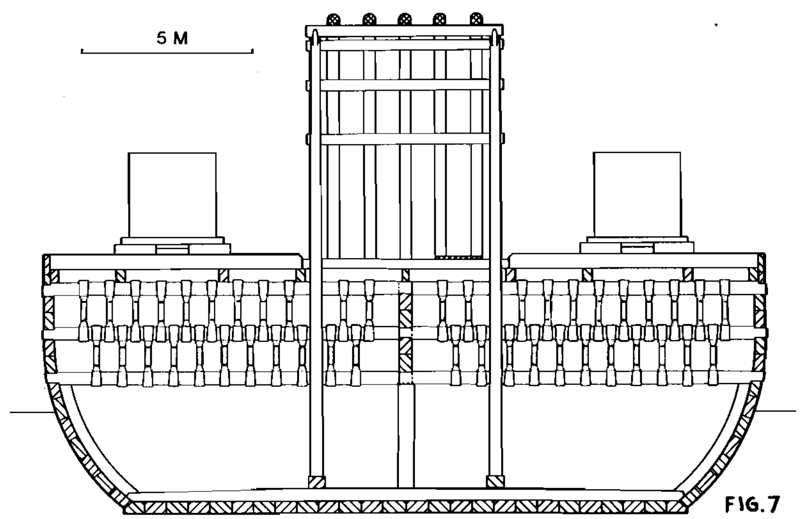


FIG. 7

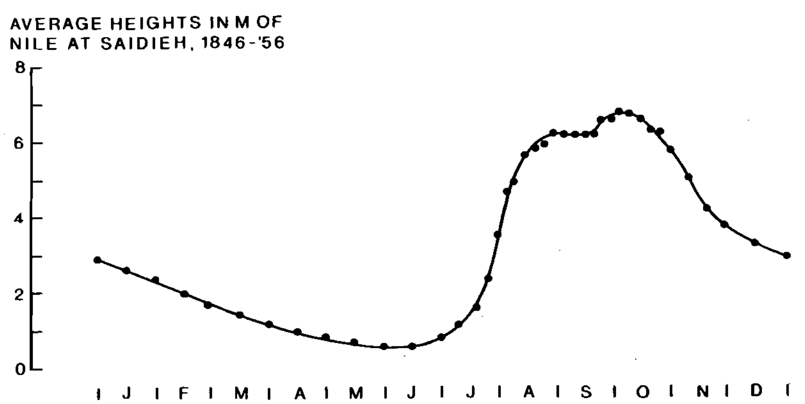


FIG. 8

PROBLEMS AND PROGRESS IN DATING ANCIENT VESSELS BY THEIR CONSTRUCTION FEATURES

When the Kinneret boat was uncovered and removed nearly intact from the Sea of Galilee (Lake Kinneret) in Israel last year, there were few artifacts in and around the boat and, at the time, it seemed unlikely that any of them could be related to the hull[1]. Consequently, I was asked by anxious associates to provide a date of construction based on a few hours of examination of the hull structure. This I did, reluctantly and conservatively, placing its origin to somewhere between the first century B.C. and the beginning of the second century A.D. New artifactual evidence and carbon-14 dating of the wood have since confirmed this range of dates, but there were three major reasons why I stated so many reservations when assigning a period. The first two were peculiar to the location. No other ancient watercraft have been excavated from Lake Kinneret, and identification without parallels is always risky. Techniques may have differed from, or existed longer than, Mediterranean methods. Secondly, there was a lively anticipation by religious and commercial interests that the vessel could somehow be connected to the Biblical accounts of Christ's presence on these waters. Such anticipation sometimes adopts fact where only possibility exists. But it was the third reason to which this paper is addressed; we are still in a primitive state when dating ancient hulls solely by their construction features.

The Kinneret boat appeared to be a classic example of Greco-Roman construction. A rockered keel was attached to a carved sternpost and a kneed, or blocked, stem by short scarfs. Planking was edge-joined by means of pegged mortise-and-tenon joints spaced at approximately 12 cm intervals. Diagonal scarfs formed planks into strakes. Frames were erratic in spacing and direction, and most of them were not fastened to the keel. They were arranged in the common pattern of floor timbers alternating with half-frames. There was no keelson. The stern was fuller than the bow, and the point of maximum breadth was well aft of the middle of the hull. Standard Greco-Roman construction, yes, but by what standards and precisely what period of time did it represent, even if it had been found along the shores of the Mediterranean? After all, many of these features were common on vessels spanning a period of more than a millennium.

Our colleagues in the field still look to coins and pottery as the most reliable forms of dating shipwrecks. They do so because those and other artifacts have been studied and documented long before scuba gear permitted the convenient examination of underwater sites and hence the frequent analysis of hull construction. The base of information for these artifacts is much greater than that of hulls, and thus their reliability is better established. But hulls are artifacts too, albeit big and complex ones, and we should be taking some hints from the older disciplines in order to establish more reliable dating standards.

My first impulse was to date the Kinneret boat to the first century because so many of its construction features were similar to those of the Herculaneum boat, a Roman vessel of nearly the same dimensions which was destroyed by the eruption of Mt. Vesuvius in A.D. 79[2]. They may indeed turn out to be the same age, but there are dangers in comparing such widely separated finds regardless of similarities in construction. Let's examine some important hull features to determine what sort of information can be used to date Classical Mediterranean hulls reliably. Since this paper is intended to evaluate the present state of shipwreck recording and publication, those features will be presented in abbreviated and generalized form. They are taken from a separate, more elaborate study of forty-four ancient wrecks spanning a period from the fourth century B.C. to the seventh century A.D. Details of that study will be published later.

Wood species does not seem to be a factor for dating ships and boats. The list of wood types for these vessels looks like the index of a forestry manual, although there is a predominance of pine for planking and oak for tenons. If one knew where these vessels were built, some orderly analysis might be developed between vessel types and sizes and the species of trees used in their construction. But many ships sank far from their points of origin and the forests that supplied their timber. Even small craft, which might be suspected of remaining in their areas of origin, are not reliable chronological indicators of wood types. For instance, the keel of the Kinneret boat is comprised of two types of wood. The after piece is made from an unlikely boatbuilding wood called jujube *(Ziziphus spinachristii)*, the forward section from a reworked piece of cedar *(Cedrus)* that probably saw prior service in a much larger vessel[3]. It is difficult to determine at this early stage whether the variety of wood used in the Kinneret boat represents standard building practice or scarcity of timber because of some natural or political circumstance.

The keel, sided 9.5 cm and molded 11.5 cm, had no rabbet and was rectangular in cross-section. There does seem to be a keel chronology for ancient vessels, although it is rather sparsely established at this time. For instance, the Kyrenia (4th B.C.)[4], Marsala (3rd B.C.)[5], Titan (1st B.C.)[6] and Dramont A (1st B.C.)[7] ships all had keels that were shaped like keystones. Their garboards, and therefore their garboard tenons, entered the rabbets at vertically oriented angles. The Madrague de Giens (1st B.C)[8] and Mahdia (1st B.C.)[9] wrecks had double-planked, double rabbeted versions of such keels, still essentially keystone-shaped but with extra rabbets cut in the sides for outer garboards. Grand Congloue's keel (2nd B.C.)[10] had chamfers instead of rabbets at its upper corners to accommodate the inner garboards, but it was far from a rectangular keel and the garboards and garboard tenons entered the keel at an appreciable upward angle. The garboard tenons on most of these hulls were locked by means of tenon pegs driven into the sides of the keels, although Grand Conloué and Titan, which were not as extensively recorded as some of the others, appear to have been exceptions to the latter feature. Therefore, it seems acceptable to say that, on the basis of existing evidence, most ships before the Christian era had keels whose sides sloped inward, their garboards rising at upward angles from the keel rabbets and their garboard tenons secured by pegs driven into the sides of the keels.

That was not the case for vessels built after the beginning of the Christian era. Like the Kinneret boat's keel, that of the fourth-century Yassi Ada Ship was a perfect rectangle;[11] the Herculaneum boat had a rectangular keel with chamfers in its upper edges to seat the garboards, and L'anse des Laurons (2nd A.D.) possessed a trapezoidal keel with upper chamfers[12]. In fact, most of the vessels dated to the first century and later, for which good evidence exists, had approximately rectangular keels, flatter bottoms or at least more nearly horizontal garboards, and keel tenons that were pegged from atop the keel.

While there are only about two dozen vessels recorded well enough from all of antiquity to form the above conclusions, it does seem that keels become more rectangular and garboards more horizontal in the last part of the Classical period. This may be due to the development of stronger internal structures, which in turn permitted flatter bottoms and more spacious holds. Vessels like the Kyrenia and Marsala ships lacked keelsons and stringers, and their keels merely joined the two sides of their planking shells and were not directly connected to the internal structure. Such vessels needed the extra vertical support provided by the garboards to insure sufficient backbone strength. As stronger internal construction was developed and frames were rigidly attached to the keel, planks were no longer needed to provide the vertical spinal support and hull bottoms could be designed to run almost horizontally from keel rabbets if desired.

The development of the keelson as a continuous, bow-to-stern intenal backbone seems to have occurred quite late, if the existing shipwrecks are to be considered as representative examples. Indeed, if the Madrague de Giens ship is demonstrative of large pre-Christian hulls in general, it would appear that the need for strong internal stringers was recognized everywhere except over the centerline of the hull. Even as early as the fourth century B.C. the Kyrenia builders understood the function of clamps, but these were the only longitudinal internal structural members. Although keelsons are attributed to some of the earlier hulls (Dramont A and Titan, for instance), few, if any, of them were preserved or recorded extensively enough to determine whether these members atop the frames are proper keelsons, elongated mast steps, or something else. At present, it seems that keelsons were not commonplace on Mediterranean ships until the second or third century A.D.

Even the rigid attachment of frames to keels does not seem to have been adopted until about the middle of the Classical period, since there are no examples of this practice until the first century B.C, after which the practice becomes commonplace. This is readily understood when one considers the rest of the hull structures in question. On the earlier vessels - Kyrenia, Marsala, and at least a suggestion from the limited remains of the Athlit vessel[13] - the planking shell is the predominant primary structure, with wales providing a major share of the longitudinal strength. As framing systems, keelsons, structural ceiling, and stronger athwarthships members were perfected, they shared more and more of the structural integrity of the hull. Hull planking, with its rigid edge-joinery, still played a major role in hull strength until the end of the Classical period, when it gradually became a mere skin over a rigid internal structure. This happened on examples as early as the fourth-century Yassi Ada hull; the process is seen to evolve further in the seventh-century Yassi Ada vessel, where tenons are no longer pegged and are small and insignificant[14]. By the time the eleventh-century Serçe Liman hull was constructed, planking was merely a skin over a strong internal framework[15].

Framing plans provide few clues for dating ships. Wherever sufficient evidence remained, Greco-Roman ships and boats had some sort of alternating framing plan, usually floor timbers alternating with paired half-frames; in most cases these timbers were extended by unattached futtocks. A surprising majority of these ancient framing plans had a room-and-space (center-to-center spacing) of approximately 25 cm, regardless of the size of the vessel.

Nor is the scarfing of planks a dating criterion. From the fourth century B.C. to the seventh century A.D., there seems to be a predominance of diagonal planking scarfs. There is further confusion, however. Kyrenia had diagonal scarfs, but her wales employed three-planed (Z) scarfs, a type still found on the medieval Serçe Liman wreck. The Marsala ship had long S-scarfs, as did the fourth-century Yassi Ada ship.

Nails clenched downward over frames in herringbone fashion may have been an earlier trend, while there seems to be a greater variety of frame fastening methods in the later centuries of the Classical period, although such assumptions are risky because there are so few examples before the first century B.C. Mortise-and-tenon joinery promises to show trends when there are many more hulls to compare, but presently it is of no help. Pegged mortise-and-tenon joints have been recorded on ships dating as early as the fourteenth century B.C.[16]; they continue through the Classical period. Joint size seems to depend more on planking thickness or relative hull strength than it does on the size of the vessels, and almost to the end of the Classical period there are a surprising number of hulls whose mortise-and-tenon joints have an average center-to-center spacing in the 12 to 14 cm range.

One could continue to compare various structural components, but the fact is that there are very few construction features in ancient vessels that can be considered *reliable* dating references, whether used individually or in combination. I was forced to date the Kinneret boat on the basis of its keel shape, the angle of its garboards and lack of a garboard rabbet, comparisons with nearby iconographic representations, and some logical conclusions based on workmanship, period technology, and historical accounts. Certainly that is far from a complete, scientific dating analysis. Aside from carbon-14 dating, which isn't always reliable, and dendrochronology, which cannot always be used, there seems to be no practical way at present by which one can closely date the hull remains of ancient watercraft.

This does not mean that we have been standing still, however. Ten years ago my comparative lists would have been too sparse to permit me to present this paper. It is encouraging to note that with the passing of time, ship construction reports generally have been more elaborate and precise, and that is progress. Nevertheless, the time has come for all of us who interpret shipwrecks to evaluate our methods of documentation. We can console ourselves with the fact that ours is a young discipline, that there are still few examples, that most wrecks contain datable items like coins and pottery, and that eventually there will be many more wrecks to compare. But even if we had twice as many wrecks documented at present, it is unlikely there would be a more reliable means of dating or a more convenient method of comparative analysis. Regardless of the age of our discipline or the number of wrecks available for study, we must admit to an unbridled confusion in the recording and publication of our vessels. Of the forty-four subjects considered for this study, little more than half of them have been reported formally. Of the eighteen categories I chose for comparison, only a few wrecks filled all of the columns, even though the information must have been available on many others. I am not criticizing the way in which anyone documents their shipwrecks, because we have differing priorities and varying opinions about what is and what is not important. But I do think that in the future we must take a clue from the older artifact disciplines and all record the same basic features where they survive.

Improved technology in diving gear, measuring, recording, and conservation suggests that there will be an increase in underwater excavations in the future. The number of ancient ships investigated may increase tenfold within the lifespan of some of the people attending this conference. When that point is reached there certainly should be an established list of priorities by which scholars can compare wrecks for any variety of reasons; indeed, the case of the Kinneret boat has just revealed that such a need already exists.

The following list is suggested as an absolute minimum set of categories for ancient Mediterranean ship recording and publication.

1. One or more scaled sectional drawings, either in reconstructed form or as found on the seabed, showing cross-sectional details of all structural components.

2. *keels* - wood type(s); number of pieces in keel; sided and molded dimensions, taken at various locations if dimensions are not constant; scarf and end details; rabbet dimensions; distance from rabbet to top of keel.

3. *false keels* - wood type; number of pieces;fore and aft limits; method of attachment to keel; composition, dimensions, and distribution of fastenings.

4. *stems* and *sternposts* - wood type; number of pieces; sided, molded, and other applicable dimensions (including cross-sectional sketches); method of attachment to keel, including scarf or mortise details; fastening types, composition, dimensions, and distribution of fastenings.

5. *planking* - wood type(s); thickness, each strake; applicable widths, especially at amidships and ends; scarf details, such as type, length of scarf, and width of plank at scarf; type, size, direction, and location of fastenings used to hold down scarf tips; fastening types, composition, dimensions, and distribution (should include treenails where nails are driven through them, clenching details, clenching details, treenail wedges or heads, etc.); hooding end details, including fastening patterns and planking shapes.

6. *mortise-and-tenon* joints - mortise dimensions (wide, deep, and thick) taken at numerous, widely scattered locations; tenon dimensions; average center-to-center spacing, also noting extreme variations from the average; wood types for tenons and pegs; average peg diameters at inner and outer planking surfaces; average distances between peg centers and seams; orientation of mortises at scarfs (perpendicular to scarf or seam?); method of cutting mortises, if discernable; slips and other mortise fillers; remains of tenon lubricants.

7. *frames* - wood type(s); number and arrangement of pieces in frames; room and space (center-to-center distance at keel); framing plan; frame curvatures, where known; sided and molded dimensions at keel, heels and heads of timbers, and intermediate dimensions as applicable; butt, scarf, or chock details; method of attachment to keels; locations and dimensions of limber holes; edge chamfering details.

8. *keelsons* - wood type; fore and aft limits; number of pieces; sided and molded dimensions; scarfs; steps, mortises, and other cuttings; method of attachment to keels and frames; description and dimensions of fastenings.

9. *ceiling* (includes common ceiling, limber boards, ledges, footwales, stringers, clamps, and shelf clamps) - wood types; thicknesses; widths, where applicable; scarfs or butts; fastening information; end details.

10. *lead sheathing* - thickness; sizes and shapes of sheets; sizes and directions of overlaps; fastening dimensions, composition, and distribution; composition and thickness of underlayment; methods of tucking around keels and posts.

11. *details* of mast steps, knees, beams, stanchions, bitts, decks, pumps and sumps, anchors, and rigging artifacts.

Few ships will be preserved sufficiently to supply information for all these categories, nor is this list meant to represent all that is to be recorded in a shipwreck excavation. Instead, it should be considered a check list to make certain that at least all of these basic factors have been investigated and reported for whatever hull members have survived. These categories were chosen because they represent the type of information needed for dating, design studies, comparative analyses, and a host of other research objectives. As such, they serve complete hulls and sparsely preserved wrecks equally well — in both cases important new information will be added to the bank of existing knowledge.

J. Richard Steffy
Institute of Nautical Archaeology
at Texas A & M University
August, 1987

NOTES

1. Articles on the Kinneret boat's excavation by S. Wachsmann and its construction by J. R. Steffy will be published in volume 16 of *The International Journal of Nautical Archaeology.* A complete preliminary report by various authors is also being prepared for publication by the Israel Department of Antiquities and Museums in *Atiqot* (English Language Series).
2. J. R. Steffy, "The Herculaneum boat: Preliminary notes on hull details", *American Journal of Archaeology* 89.3 (1985) 519-21.
3. Wood type identifications were made by Dr. Ella Werker of the Institute of Life Sciences, Hebrew University, Jerusalem.
4. J. R. Steffy, "The Kyrenia ship: An interim report on its hull construction", *American Journal of Archaeology* 89.1 (1985) 71-101.
5. H. Frost, *Lilybaeum,* Rome, 1981.
6. J. du Plat Taylor, *Marine Archaeology,* London (1965) 87-89.
7. F. Benoit, *L' épave du Grand Conglue a Marseille (Galia* Suppl. 14, 1961) 143-44.
8. P. Pomey, "La coque", in A.Tchernia et al., *L' épave Romaine de la Madrague de Giens (Gallia* Suppl. 34, 1978).
9. Taylor, *Marine Archaeology,* 48-50.
10. Benoit, *L' épave du Grand Congloué,* 149-52.
11. F. H. van Doorninck, Jr., "The 4th century wreck at Yassi Ada: An interim report on the hull", *International Journal of Nautical Archaeology* 5.2 (1976) 115-31.
12. J. M. Gassend, B. Liou, and S. Ximenes, "L' epave 2 de L' anse des Laurons", *Archaeonautica* 4 (1984) 75-105.
13. J. R. Steffy, "The Athlit ram: A preliminary investigation of its structure", *The Mariner's Mirror* 69.3 (1983) 229-47.
14. F. H. van Doorninck, Jr., "The hull remains", in Bass, van Doorninck, et al., *Yassi Ada: A seventh-century Byzantine shipwreck,* College Station (1982) 32-64.
15. J. R. Steffy, "The reconstruction of the 11th century Serçe Liman vessel: A preliminary report", *The International Journal of Nautical Archaeology* 11.1 (1982) 13-34.
16. C. M. Pulak, *A late Bronze Age shipwreck at Ulu Burun: preliminary analysis,* Master's thesis, Texas A&M University (1987) 129-32.

L'ARMEMENT D'UN NAVIRE, MOYEN D'ENRICHISSEMENT ET D'ASCENSION SOCIALE DANS L'ANTIQUITE ROMAINE*

Plusieurs textes mettent en évidence le rôle joué par l'image du Commerce Maritime dans les rêves d'enrichissement et d'ascension sociale à l' époque romaine. Deux sont bien connus: le *Navire ou les souhaits* de Lucien et le *Satiricon* de Pétrone. On peut y ajouter deux autres passages plus anciens et moins célèbres. Le premier est dans le *Brutus* de Cicéron; un des personnages mis en scène dit d'une accusation mal fondée qu'elle lui fait penser à l'histoire du jeune gandin qui, pour avoir trouvé un tolet sur la plage, se mettait à rêver de construire un navire. L'autre est de *Plaute* dans le *Rudens.* L'esclave Gripus a trouvé un coffre dans la mer, et suppose qu'il enferme un trésor: "Une fois libre, aussitôt j'acquerrai des terres, une maison, des esclaves. J'aurai de grands vaisseaux pour faire du commerce... Quand je serai devenu un illustre personnage, je bâtirai une vaste cité avec ses remparts.

On peut mettre ces textes en parallèle avec une série plus nombreuse d'autres passages, d' où il ressort que les quatre moyens les plus classiques de gagner de l'argent étaient l'agriculture, la location d'immeubles, le prêt à intérêt et le commerce maritime. Pourquoi estce ce dernier qui a fait rêver le plus?

D'abord parce qu'une entreprise de commerce maritime est une opération à risque, dans laquelle on peut gagner beaucoup en peu de temps ou tout perdre sur un seul coup. Mais aussi parce qu'on peut démontrer — et c'est là un point important d'histoire économique — que ce commerce était souvent financé par des prêts. Certaines catégories sociales peu fortunées pouvaient non sans raisons considérer que c' était pour elles la seule voie possible d'ascension sociale.

Cela conduit d'une part à souligner l'importance d'une distinction claire entre prêt et association, d'autre part à remarquer que, si la plupart des textes laissent l'impression de succès fréquents, les échecs devaient en réalité l' être tout autant: qu'on voit la-dessus une curieuse inscription de Rome (*CIL,* VI, 9659 = *ILS* 7519).

André Tchernia
Centre National de la
Recherche Scientifique,
15, Quai Anatole-France,
75700 Paris

* Resumé de la communication orale presentée par le Prof. A. Tchernia.

"KYRENIA" II IN THE FRESCO OF PEDOULA CHURCH, CYPRUS.

A COMPARISON WITH ANCIENT SHIP ICONOGRAPHY

Until a few decades ago, iconography and ancient texts were, with few exceptions, the only sources for our knowledge of how ancient ships looked.

Even today with the progress of underwater archaeology, that has made possible the excavation of portions of hulls and in a few instances of nearly complete one, we still greatly rely on the iconography to interpret ancient ships' rigging, steering mechanisms and details of their equipment in general.

As correctly stated by Jacques Thurneyssen in a note in the International Journal of Nautical Archaeology "Until we excavate a sunken vessel lying upside down on the sea bed, preserving in sand or mud most of the deck, we have to rely for our knowledge of the latter on vase painters, artist's representations and more surely on graffiti by sailors".

Although the importance of ancient iconography cannot be overemphasized, scolars have been, correctly cautious in the interpretation of such evidences. If a ship is represented by an artist the result may be a beautifully executed relief, a nicely painted vase or fresco, a colourful mosaîc, an impressive model or a delicately carved gem, seal or coin.

The ship may be nicely represented but how much can we rely on details depicted by a person who, in most cases, did not understand how the ship was built and how she sailed.

In the case of graffiti we are led to believe that most were the work of sailors who understood ships, but often lacked the necessary skill to depict same.

When I was last year in Cyprus on the occassion of the experimental voyage of Kyrenia II[1], I had the opportunity to experience a very interesting example of ships' representation.

In the church of the "Holy Cross" at Pedoulá, in the province of Nicosia an iconographer included Kyrenia II in the fresco decoration of the church. Above an arched door, sitting on a deep grey-blue sea, here she was proudly sailing between the austere figures of two Cypriot saints.

We can say that the presented case is, in my opinion, not only interesting but probably unique, because, although there have been comparisons drawn between modern depictions of ships and their ancestors of ancient times, in the fresco of Pedoulá we have an ancient merchantman painted by a today's artist.

We know the artist: Alkis Kepolas, a Cypriot iconogragher who paints icons and decorates churches with beautiful frescoes and mosaïcs.

We also know well the ship represented: the Kyrenia II, the replica of a ship built at the end of the Greek classical period.

Kepolas prepared meticulously the theme of his fresco without divulgating his intention. The Kyrenia II presence was made known only after the whole composition was completed.

So the depiction of the ship was unsolicited and in consequence the artist was in no way influenced in his work by anyone connected with the project of Kyrenia II.

Kepolas is also a keen and able photogragher. He did take numerous photographs of the ship on the slip in Perama and in port, during two visits he made to Greece. So the artist had the opportunity to study at length all the structure.

Based on the above we would tend to believe that he would have no difficulty in depicting the ship correctly in accordance with the original.

Well, this is not the case and there are numerous discrepancies between the ship on the wall of the church of Pedoula and Kyrenia II lying in Zea.

I believe the discrepancies can be divided in three different categories.

a) Errors made because of the lack of understanding of ships.
b) Intentional abstractions and simplifications which were considered necessary in order to incorporate the ship in the style of a Byzantinizing fresco.
c) Additions and ommissions which were considered indispensible for a ship of the "gentiles" to enter a Christian shrine.

Let me first enumerate the unintentional discrepancies:

— The topping lifts are shown as been lashed to the yard at its two extremities, while in fact the securing points are a-mid-distance between the extremities and the center of the yard.
— The yard is represented as made of a one piece log and absolutely straight. The present yard is made of 3 pieces. On the first sea trials however we had a yard made of one piece of timber and this may have influenced the artist, but even that yard was not straight but with a pronounced curvature.
— The proportions: mast, yard and hull length are incorrect. It may well be that the artist is trying to figure the ship at a 3/4 angle and this is difficult in the Byzantine style deprived of perspective.
— The tiller of the steering oar is turned in the wrong direction.
— The steering oar has no attachments to the body of the ship.
— The forestay and backstay, are shown with no attachment to the hull. The artist draws another stay in between, starting from the top of the mast and ending amidships on the port side cap rail. This stay is inexistant on Kyrenia II as its presence would interfere with the manoeuvers of the sail.
— The backstay is secured at the base of the stempost. This is another error as in fact it is attached much forward.
— Not a single block is depicted.
— The brace lines indispensable to manoeuver the yard are missing.
— However 5 lines are drawn aft of the sail as brails.
— 4 unshiplike nots are shown, made in a ribbon style, as never seen on a ship.
— The wale, an important structural part of the hull, is omitted.
— The curvature of the hull as shown through the transparence of the water is excessive.
— The sail area is disproportionaly large in comparison with the body of the ship.
— The ship sits too high on the water, an error too often found on ancient ship representations[2].

Now let's see the abstractions and simplifications which are, very probably intentional:

— The seams of the sail are not represented.
— The sail depiction is stylised to look like a drapery.
— Numerous essential lines of the standing and running rigging are omitted.

— Instead of passing through a clew cringle the sheet is secured directly to the sail.
— The number of strakes above the supposed water line is limited to 4.

But there are also additions and omissions due to religious reasons.

It is very probable that the iconographer had to obtain a preliminary permission from an eclesiastic, who had the overall responsibility of the project, to include a pagan ship representation in the holy circle of a church.

There are indeed strict rules as to what can be represented in a church iconography and how to represent it.

— The center of the sail area is occupied by the image of the holy Virgin with the monogram MP ΘV, Μήτηρ Θεού. Prokopios mentions painted sails in the 6th century A.D. But even earlier we see already decorated sails on the famous Roman merchantship on the Portus relief.(ca.200 AD)
— A cross stands at the highest point of the ship, the mast head, such a cross can be seen on a mosaïc from Ravenna (6th century) and on some other later icons representing ships.
— The side screen, made of canvas bears the monogram IC XC for *Iisous Christos*.
— I believe that the impossible knots shown at the end of some lines are a reminiscence of similar knots the painter has seen on icons.
— We are sure that ancient Greek warships had an *ophtalmos*, and we have many reasons to believe that it was also the case for merchant ships. But, in any case, it is certain that Kyrenia II has an *ophtalmos*, which is very conspicuous, since it is the only decoration of her hull. But this obviously pagan apotropaic symbol had no room in a religious Christian depiction and was willingly omitted. The sign of the cross, the image of the Virgin and the monogram of the Christ were, for the artist, sufficient symbols to protect the vessel.
— Perhaps for the same reasons the various flags and burgees that are usualy hoisted on Kyrenia II have been omitted.

Lastly to explain the presence of that unusual ship in this sanctuary, a verse from the *akathistos ymnos* to the Virgin is written in the space between the lower part of the ship and the door arch: ΧΑΙΡΕ ΟΛΚΑΣ ΤΩΝ ΘΕΛΟΝΤΩΝ ΣΩΘΗΝΑΙ. (Hail Olkas[3] of those seeking salvation).

This is the verse from the hymn to the Virgin of Romanos Melodos and the Virgin among other comparisons is called *olkas* Ship of salvation.

For those who are aware of the significance of the Kyrenia ship replica for the Cypriots because of the enslavement of the town of Kyrenia and of the ancient ship in its occupied castle, that sentence has an additional patriotic meaning, besides the religious.

Harry E. Tzalas,
Hellenic Institute for the Preservation
of Nautical Tradition,
Piraeus

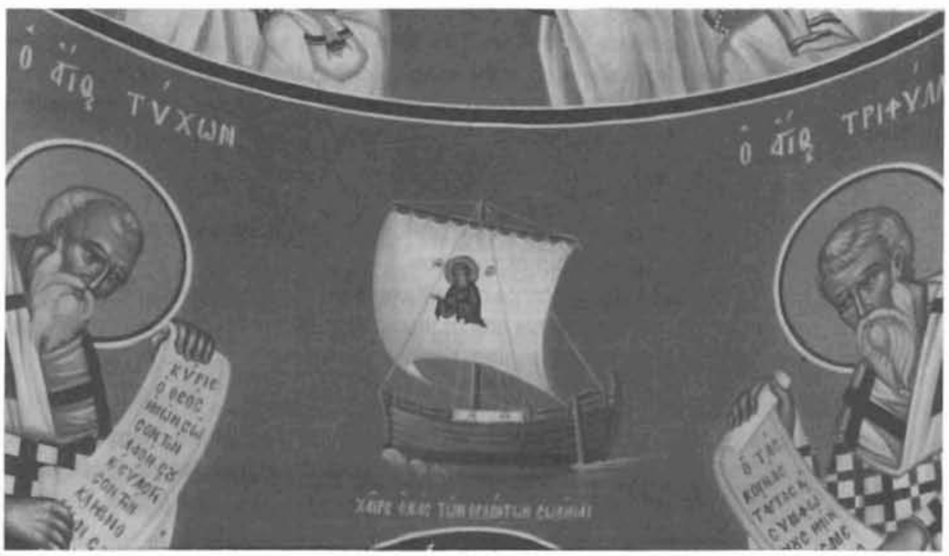
NOTES

1. Kyrenia II is the exact replica of the lvth c.B.C. merchantman that was excavated, preserved and reassembled by the Institute of Nautical Archaeology of Texas (I.N.A) under the direction of Prof. Michael Katzev. Between 1982 and 1985 the Hellenic Institute for the Preservation of Nautical Tradition, Piraeus in cooperation with the I.N.A. built in Perama, Greece the replica known as Kyrenia II.
2. L. Basch, *Marriners' Mirror*, 73, p.102.
3. Olkas: A Byzantine merchant vessel.

ILLUSTRATIONS

1. The frescoes in the church of the Virgin of Pedula, showing "Kyrenia II". Photo: A. Kepolas.
2. Linear representation of "Kyrenia II" from the fresco. Drawing: Y. Pantzopoulos.
3. "Kyrenia II" during her voyage to Cyprus (1986). Photo: Y. Vichos.

1



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PAPYRELLA: REMOTE DESCENDANT OF A MIDDLE STONE AGE CRAFT?

The Hellenic Maritime Museum has recently added to its exhibits a kind of primitive craft, a reed raft which is no longer in existence, now that modern technology has made unrestrained incursions on every sector of our life.

This floating device had disappeared today, and its method of construction has definitely been vanished. For this reason we believe that this now forgotten type of Greek vessel should be preserved. As we shall see later, this is a type that most probably existed for some ten thousand years in the waters of the Eastern Mediterranean provided that certain assumptions are proved correct. There are few extant illustrations or photographs, and as we have said, its method of construction has been forgotten. Characteristic of this is the fact that the last remaining builder with knowledge of its construction method, Nikolaos Michalas, a farmer and fisherman, is today eighty-eight years old practically blind.

As insignificant as it may seem by our standards of today, a more thorough observation of this device could, we believe, lead us to a notable extension of knowledge in this area of interest. However, before going any further, I shall give a description of the craft's, basic structure.

The reason that impelled primitive man to divise rafts or floating apparatuses using reeds is the same one that impelled him to divise vessels of leather - The lack of suitable tools for the construction of canoes or wooden rafts. Another reason was - and continues to be - the lack of suitable wood.

The first rafts made of reeds were divised by people who lived around swamps, lakes and river banks, where reeds thrive and the water is relatively calm.

We find them in Egypt, Mesopotamia, Africa, the Pacific, in Americas and in Central Europe (the Hungarian Lakes). In the Mediteranean area, we encounter them in southern France, in Corsica (Oristano Lake) in the Illyrian Coast, and finally, to come to Greece, we used to find them up to the pre-war years on the north-west coast of Corfu, under the name of "papyrella". This last type of raft, will be the subject of our today's paper.

The basic material used in the construction of the "papyrella" was "papyri". This is a type of thin reed (Ferula Communs L.) with a fleshy innercore, which from information that the President of the Folklore Society of Middle Corfu, Mr. Nikolaos Paktitis, was kind enough to give us, sprouts in the marshy spots of the Ropa Valley, in Kavourolimni, in the area of Fountana near the village of Liapades, in North West Corfu.

It is usually cut green towards the end of June, when it is in its greatest period of growth, and before it starts to "lose weight". The length of these cut reed is from 2 to 2.5 meters; their diameter at the base, form 2 to 3 centimeters, while at the top it is 0.5 centimeters. The cut reeds are spread out to dry. They must not be stepped on or torn because the core substance in the reed entraps air, which results in its acquiring good buoyancy. If the reed breaks water in sucked into the core; for this reason a "papyrella" had to be kept as dry as possible. When it was taken out of the water, it was always placed in an upright position in order to dry.

At this point, it should be noted that the "papyri" has nothing to do with the well-known papyrus of Egypt; however, the etymological relationship between these two terms is noteworthy, because it is difficult for one to believe that the inhabitants of Corfu gave this name to the plant without their having any knowledge of its counterpart in Egypt, where it was also used for the same purpose. It seems that some kind of contact must have existed, but how and why are questions that have yet to be answered.

The structure of the "papyrella" differs from that of other similar rafts which were-and are still being-constructed in other areas, and, as I have already pointed out, we come across rafts and vessels made of reeds almost everywhere in the world. In our case here, we have a kind of primitive frame-work. More specifically, the maker first formed a wooden framework consisted on the top of which he bound the papyri. The framework consisted of six to eight green cypress plants approximately 3 meters long and 2.5 to 3 centimeters thick at the base. The top parts of the plants were tied so that the cypresses would spread out like a kind of fan fastened in such a position on three planks 20-22 centimeters broad and 2.5 centimeters thick placed in transversal. In certain cases we have cypress branches instead of planks. The spacing out of the cypresses on the back end reached from 1.20 to 1.30 meters. We can say that this "threadwork" corresponds to the framework of wooden vessel. Sometimes, for greater durability, the spaces between the cypresses were filled with common reeds; this provided necessary reinforcement when a papyrella was pulled back onto land since it had, acquired a much more solid bottom given the fact that the "papyri" is an easily perishable material.

On this framework the primitive shipbuilder placed bundles of "papyri" which he bound tightly onto the cypresses and transverse planks, giving them a thickness of 45 to 50 centimeters at the base of the triangle which constituted the stern of the "papyrella", while at the top it reached about 30 centimeters, resulting in the formation of a prow-bound, downward sloping platform which made up the "deck" of the raft. On the deck transverse planks were placed which were like those of the bottom, and all of these-framework, papyri bundles and planks-were bound tightly together into a unified whole. One account tells us that 5 or 6 cypresses, of the same form as those in the lower side, were also placed on the deck under the planks. Finally, two cypresses were placed on the stern, and bound there from the bottom to around the top, thus completing the caging in of the papyri bundles. The stern was secured by knitting a makeshift net with string.

As a next step, bundles of papyri, 5 to 6 centimeters in diameter, were placed around the upper part of the raft, thus forming a kind of gunwale. Finally, the cypress tops on the framework were held and bound toward the back, thus taking on the form of a fairly familiar kind of stem on such crafts. The string which held the tops was tied over the framework of the papyrella, thereby taking on their definitive shape. The height of the topot the stern reached 65 to 70 centimeters from the base. The stern was "sheared" so that it took on the shape of a transom. There is an account that papyrellas with a rounded stern also existed. It was equipped with a paddle 2.40 to 2.50 meters long.

The Corfu "papyrella" was in general a small-sized sailing device. Its usual length was 2.5 meters and its greatest width 1.20 to 1.30 meters. Its travels were confined to lakes and bogs, rarely faring out to sea and far from the coast. However, as Professor A. Sordinas, who has studied this type of raft reports, there are local traditional references to the effect that in older times two papyrellas would be joined stern to stern by placing between them fibers of wooden pikes and tightly binding these; the result was the formation of a cigar-shaped sailing vessel of about 5 metrs' length. With these kinds of papyrellas local fishermen would go clear out into the sea to fish for lobster. We have here, namely, a case of a "papyro-boat" analogous to those of Egypt. .

Considering the foregoing information, one may pose the question. What broader significance could the presence of a relatively primitive sailing structure like the Corfu "papyrella" have on shipbuilding in general? In any case, a more careful observation leads us to some positive conclusions. First of all, it shows that there was a native tradition of building vessels with reeds on an East Mediteranean island, secondly, that all the prerequisites for the construction of sailing vessels of this type exist in the Greek flora; thirdly, that its method of construction lies within the competence of primitive man's endeavours; and fourthly, a fairly remarkable mesolithic settlement has been located in Sidari of North West Corfu in a geological layer which has been radio-carbon dated at 5870 B.C. ±340.

Comparative analysis of the archaeological and ethnographic material shows that from the end of the seventh millennium B.C., this mesolithic settlement of Sidari in Northern Corfu had seafaring contacts with distant lands and probably with eastern Italy. Later, in the early neolithic period of the sixth millennium, another settlement in the same place had direct contacts with Dalmatia. In the Diapontia islands situated to the north-west of Corfu, other researches have located settlements of the Bronze Age — the third millennium — with tools made of diorite stone which surely came from Pindus. In other words, we have definite signs of navigational activity in the Adriatic and Ionian Seas occuring up to the mesolithic period.

One other thoroughly proven instance of navigation, this time in the Aegean, is ascribed to the 8th millenium period of the transport of obsidiam of Milos to mainland Greece. The obsidian of Milos was discovered in the oldest pre-ceramic neolithic strata in Argissa, Sesklo and Soufli.

However, the most surprising fact is the discovery of obsidian in the Mesolithic strata of the Fraghthi cave in Argolida, which are chronologically placed around 8.000 B.C. The indication that obsidian was transported by sea from Milos is a most *intriguing* one. Milos is approx. 65 sea miles away by sea from the cave. Furthermore, these trips must have been made many times, for the obsidian of Milos, appears in successive strata. Today it is accepted that *the obsidian of Fraghthi can be regarded as the oldest positive proof of the transport of goods by sea from any other part of the world.*

The significance of this proven fact is enormous. That is, it is becomming evident that sailors crossed the Aegean and reached Milos to obtain the obsidian very long before 7.000 B.C., that is to say, before the advent of agricultural life.

The foregoing conclusions bring naval archaeologists face to face with a problem. What were the vessels in which obsidian was transport from the islands to mainland Greece by those first Aegean sailors like? What were they made of, or at least, what was their shape, or finally what did they look like? The answers to these questions are clear guesswork since we must go back to a period of time thousands of years, specifically from 2.000 to 1.500 B.C., in order to find the first depictions or the ship models which give us an idea of what these primitive vessels looked like.

A consideration of follow-up views on these subjects, and further study of the primitive vessels around the world, lead us to the conclusion that these vessels must have been dugouts or something similar. However, if we accept this another problem arises. The tools which are found there are typically microlithic, that is, it appears that it would have been difficult to build something like a dugout with these tools. The problem, then, of how easy or difficult it may be for someone to build a dugout with a collection of microlithic tools, does not seem to be one that has been solved.

However, there is another accepted belief, that these first sailors used a kind of vessel made from bundles of reeds. This type of boat is much easier to build than all other primitive vessels since it requires only simple tools to be constructed. The use of such crafts in Egypt and Mesopotamia, where reeds thrived and wood was lacking, is well known and needs no further statement here. However, vessels built in this manner have a limited capacity. If they were made longer, they would have broken in two in bad weather or under a heavy load. They have very little side, capsize easily in turbulent waters and drift helplessly in the wind. Consequently, they are basically no seagoing vessels. Nevertheless, there is very little doubt that these vessels were the most significant means of transports for valuable cargo in many places of the world.

All the above information brings us to the conclusion — a hypothetical one, of course — that the vessels which transported obsidian in the Middle and Late Stone Age period *may* have been made from reeds.

Unfortunately written sources from the Stone Age do not, of course, exist — at least as — of today. A reed is a perishable material of which we cannot expect to find any remains in Middle Stone Age strata. What remains is an analysis of the ashes from the excavation done in the Fraghthi cave, which, if it reveals the existance of a certain kind of reed in the Middle Stone Age strata, the above theory will be significantly reinforced.

Until then, our theories on reed vessels in the Middle Stone Age period will remain unproven.

Captain A. I. Tzamtzis
Akti Themistokleous 296
185 39 Piraeus - Greece

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CONTRIBUTION TO THE KNOWLEDGE OF 8th CENTURY B.C. SHIP REPRESENTATIONS

νέες ὠκεῖαι ὧς εἰ
πτερόν ηέ νόημα
(Ομηρος η. 36)

Dedicated to my husband
Evangelos Tzahos

The beginning of the 8th century B.C. saw some important changes in Greek life. The spirit of the age is expressed in the visual arts[1]. After three centuries of silence, following the downfall of the Mycenaean world, the first pictures with narrative figured scenes appear again. They are radically new and they are in accordance with Geometric visual and creative principles, and they are a purely Attic invention[2]. Pictures of ships are already found at the end of the 9th century B.C[3]. But figured scenes with ships appear in the first quarter of the 8th century B.C.[4]. They coincide with the great Greek colonization, which started early in the 8th century B.C. On the shores of three continents great Greek cities were built and they attained high levels of commercial, maritime, and cultural development. The Greeks sailed over seas in their strong vessels, which were now provided with a ram[5], an important new feature, which was to change naval warfare radically.

The number of representations of ships during that period is considerable[6]. We can distinguish two types of ships, the merchant ships and the warships. The merchant ships were broader and heavier, whereas, the warships were slim and light and correspond to Homer's description[7] of his heroes' ships as swift and hollow (undecked). Nevertheless, the interpretation of some important elements in the construction of the ship, as suggested by horizontal and vertical lines, is problematic. The pictorial conventions of Geometric art create ambiguity often critical for our understanding.

The representations of some more geometric ships can be added to the already published material. I believe that the new elements they offer, are useful and will give us an opportunity to reconsider some of the known representations. Among the evidence useful for the dating of these new pieces is the representation of the human figure on some of them[8].

During an excavation at Agioi Theodoroi in Corinthia at a site called Moulki, a number of Geometric tombs came to light[9]. This district is the site of the ancient Corinthian city of Cromyon.

Of special interest to us is an oenochoe (fig. 1), found in tomb 4, which also contained four other vases. The height of the vase is 0,34m. its max. diam. is 0,22m. and its base diam. is 0,135m. The clay is light orange; the surface is covered with black to brownish paint. Our oenochoe is of Attic fabric, according to the results of the atomic absorbsion analysis[10]. The oenochoe is of standard type, with a broad low ring foot, a tall body with a high straight neck, ending in a trefoil mouth, and a vertical handle, decorated with horizontal lines between two verticals; in a reserved band on the central lob of the mouth there are vertical strokes. In a reserved panel on the neck there is a hatched maeander running right, between three horizontal lines above and a dogtooth band underneath between two triple bands.

The body is decorated with five triple reserved bands. In a reserved panel between two mastoid knobs on the shoulder, we have a representation of a complete ship to the left (fig.2). Two painted Semicircles accentuate the knobs at each end of the panel. The form of the oenochoe and the system of body decoration with triple reserved bands present similarities to an oenochoe from the Kerameikos Cemetery from tomb 22 no.298[11], which is dated-to the middle geometric II period[12]. It also resembles another oenochoe no. 2145[13], which is dated to the middle geometric I period[14]. For our oenochoe, a dating at the end of the first quarter of the 8th cent. B.C., or at the beginning of the second is very probable.

Examining the representation of the ship on our oenochoe we observe the following. Its total length with the ram is 0,09m. The line of the stern continues along the lower part of the hull to the tip of the ram (έμβολο). The ram is long and pointed. The bow (η πρώρα) is a solid concave stem with two projections (τα προεμβόλια). Above, the high stem post inclines slightly forward, then backwards, parallel to the hull. The bow area lacks room for a bow device. The platform by the bow (το ίκριο) is surrounded by a protective palissade. The stern (η πρύμνη) is high, and curves well backward over the ikrion, which is an ample platform without railing. The lower part of the hull is solid. Above it is a thin line, probably representing the gunwale. The space between them is intersected by 19 verticals, which probably form a decorative band. Above the gunwale are 10 vertical posts, which may represent the tholepins (τους σκαλμούς) for the oars (τις κώπες). In the stern part there is a steering oar (το πηδάλιο). Amidship there is a mast (ο ιστός), which, as in all geometric representations, is shown no taller than the bow and stern or naments, the steira and the aphlaston. The yard (το κέρας) is raised up to the top of the mast. From the yard hangs a rectangular sail (το ιστίο), intersected by verticals, which denote the brails; two braces (ολκοί) start from the end of the yard.

If we accept, that the band intersected by verticals on the top of the hull is decorative, and the 10 vertical posts are the tholepins for the oars, then, this is a twenty oared ship, and it belongs to the one level type.

The idea that the 19 openings were oarports and not a decorative band, or the frames is less probable. Contemporary examples of the same type of ship, such as the one on the skyphos in the Eleusis museum no. 910[15], show the same band intersected by diagonals, which could not have been used as oarports. Furthermore, if the 19 openings were oarports, then the ship would have been a fifty oared vessel. However, the dimensions of our ship are more appropriate for twenty oars, a standard type known from Homer[16].

The evidence we have here is not decisive for the categorization of this ship as either a warship, or a merchant one. But taking into consideration the small number of ship representations during the M.G. period, their connections with sea battles and the importance of warfare in that period, I believe, that our ship is a warship, indicating probably at the same time the occupation of its owner[17].

A similar ship without a sail appears on a bronze fibula (fig. 3) from tomb 41 of the Kerameikos cemetery[18], dated to the Middle geometric I period, at the end of the 9th century B.C.

On the one handle skyphos in the Athens National Museum no. 18471 (fig. 4)[19], we have two ships that exhibit the characteristics we mentioned above in the description of the Agioi Theodoroi ship. In this case, however, the vertical hatching on the top of the hull may be interpreted as indicating the frames (τα εγκοίλια) of the hull; an interpretation appropriate for other examples too, even for the Agioi Theodoroi ship. The skyphos can be dated to the Middle Geometric II period.

The hydriskos[20], which was found in the same tomb, as the skyphos already described, remains unidentified; however, according to photographs, which appeared in the publications, it shows two ships with the same characteristics, as those mentioned above. Here we see the yard without sail, with fore and rear braces as on the Agioi Theodoroi ship, as well as a rare feature, the brailing ropes.

The skyphos in the Eleusis Museum no. 910 (fig. 5), which we have already mentioned[21], is the most important piece of the group, because here we have one of the earliest appearance of the human figure. It shows an attack on a beached ship of the same type. The human figure is shown in total silhouette. Even the eyes are not shown, in contrast to figures in Late Geometric pictures. Figures are hardly ever standing still, and they are not static in form. They are floating in the air. The painter did not have a pictorial prototype and he immitated nature[22].

The same type of ship can be found even later, on a krater in the Louvre no. A.525[23], which belongs to the Dipylon Master workshop, dated to the middle of the century, in the Late Geometric Ia phase.

But none of these ships is shown with a sail. On the ship of the Agioi Theodoroi oenochoe we have the earliest appearance of the sail in Geometric art.

The krater in the Metropolitan Museum of Art no. 34112[24], also of the Middle Geometric period, is of a later date than our oenochoe. Part of a sail is preserved on one of the two ships represented. Here the bird's eye view, shown on the Eleusis skyphos, has gone. The people fighting are shown as marching troops. The composition is more rigid, than the much freer composition on the Eleusis skyphos. The figures are silhouetted abstract forms. Heads are formless with pointed chin protruding. The human figure has begun to be geometrised.

Later, in the middle of the century, a good number of ships of the Dipylon group, have sails[25]. Now these sails resemble checkerboards. Here we have a fragment of krater in the Athens National Museum no. 802[26], with a representation of a ship with a sail (fig. 6). It is rectangular with squares. The horizontal lines denote the seams while the verticals denote the brails. With one hand the helmsman holds the sail and with the other the sailyard brace, which is tied to the balustrade in the bow compartment. Ropes forming the sheet are attached to the balustrade.

Concerning the context of the Agioi Theodoroi oenochoe, we have already mentioned above, that within the same tomb were found another four vases. The analysis of the samples taken from these vases have shown two of them to be Corinthian while one is Attic[27]. These vases are the following:

a) A hand made hydria (fig. 7); high 0,465m., max. diam. 0,352m; coarse corinthian clay, yellowish buff, surface stroke polish. Broken at the neck; a fragment from the flanged shape rim is missing. Two mastoid knobs on the shoulder; horizontal handles and the vertical one are cylindrical; ribbon base, flat underneath. We can compare it with the hydria of the tomb 16 of the North Cemetery at ancient Corinth[28].

b) A coarse aryballos (fig. 8); high 0,065m., max. diam. 0,062m., base diam. 0,032m.; fine orange attic clay. Broken on the shoulder; one piece from the flanged shape rim is missing. Cylindrical handle; flat base. It is comparable with the one from grave 97 of the Kerameikos Cemetery no. 358[29].

c) A skyphos (fig. 9); high 0,034m., max. diam. 0,226m., base diam. 0,135m.; fine yellow clay. Two small pieces missing. Paint dark brown to orange. Low ring base concave underneath; rolled handles; slightly flaring rim. Panels under the handles; the reserved panels in the handle zone front and back are decorated with chevrons; groups of small vertical lines inside the rim. It is identical with the skyphos from tomb 16 of the North Cemetery at ancient Corinth[30].
d) A trifoil-lipped oenochoe (fig. 10); high 0,11m., base diam. 0,063m.; fine yellow clay; complete and unbroken. Dark paint flaked off. ring base; rolled handle. Four stripes around the neck; groups of chevrons on the shoulder; four stripes around the belly; horizontal lines on the handle; mouth and lower body are covered with paint. Close to this vase is the oenochoe from tomb 17 of the North Cemetery at Ancient Corinth[31].
The dating of these vases is the second quarter of the 8th century[32]; this dating coincides with that given for the oenochoe bearing the ship representation,[33]. the fifth vase of the tomb 4 of the Agioi Theodoroi Cemetery.

The second document of our research is a gold band (fig. 11 a,b). It was found during an excavation in the city of Athens at nos. 23-24 Kriezi Square in the tomb 106[34]. Four skyphoi were found in the same tomb, which will be examined after the band.
Hammered out into a very thin sheet[35], with a whole at each end, the band is 0,41m. long and 0,018m. broad.

It is divided into metopes, which are separated by triglyphs. Each triglyph is composed of three vertical strips. two of the triglyphs are more elaborate, and are composed of a cross hatched band between vertical strips.

The central panel is the largest and is filled with two superimposed horizontal designs. The main one is a waved motif formed by semicircles in two rows, the other is a lozenge chain (fig. 12). The representations of the two ships are at either side of the central panel. The two panels next to the ships each contain a horse, one of which is represented upside down, possibly due to a mistake of the craftsman. The two terminal metopes are larger and are decorated with a row of four hoplites with round shields. From behind each shield two spears project above and below. Two of the soldiers have been left unfinished, probably because of the thinness fo the sheet. A row of dots borders the panel at the top and at the bottom.

The ship to the left (fig. 13) of the central panel shows the greatest interest. It is presented with its bow to the left, without a crew. The ram is long with a rectangular end. The bow has a screen; the sternpost inclines slightly forward, then curves aft, forming a horn. The stern is high and has a pronounced sheer. The hull is hatched with diagonals, which must be ornamental. Eight oars with spade-shaped blades emerge under the keel, suggesting that they were dipped into the sea over the farside. Sixteen vertical posts on the deck probably for the railing, which extends from bow to stern. In the stern part there are two steering oars, shown with a tiller. The mast has a forestay and a backstay. The yard is hoisted to the top of the mast, and the sail is reefed up to the yard. We should also note, that the masthead, the karchesion, is bisected. A bird with a long neck appears just before the ram, indicating the existence of a shore.

The lack of ship representations on gold bands does not permit any comparisons for the time being. The ships on gold, or bronze fibulae, differ in technique and in design.

We can compare the hatched hull of the ship and oars emerging under the keel, with those of the ship represented on the oenochoe in the National Museum in Copenhagen, no. 1628[36], dated to the third quarter of the century, the Late Geometric IIa phase. It bears the representation of a fight on and around a ship. The essential parts of stem and stern are missing. The curve of the post on the left suggests the stern. At this curve stand three spears, suggesting that the ship is a warship; in front sits a figure, who might be the helmsman, holding the steering oar. Below the line on which he is sitting, there is a strip decorated with diagonals. From the bottom of the hull there emerge six oars.

Two steering oars are represented on some of the items, we have already seen: On the one handled skyphos in the Athens National Museum no. 18471[37], or on the ships of the Dipylon group[38]. An interesting example too is the famous Attic krater in the British Museum no. 1899.2-19-1[39], dated to the third quarter of the century, the late Geometric IIa phase. The drawing follows the Dipylon master's archetype; but the painter of this original vase is more remarkable for his innovation, a ship with two superimposed rows of oarsmen, usually interpreted as a two bank type ship. Also the Corinthian krater in the Royal Ontario Museum no.C.199[40] has two steering oars.

Steering oars shown with a tiller can be found on some ships on bronze fibulae, dated to the Late Geometric II period, or even later. The engraved plate fibula in the Athens National Museum no. 11765[41], shows a ship to the right; the stern compartment has a rail and a steering oar with a tiller. On a second engraved plate fibula in the Athens National Museum no. 8199 (fig. 14)[42], we have a ship with steering oars shown with a tiller. Similarly on another fibula in the British museum no. 121[43]; on another at the National museum at Copenhagen no. 4803; and on the ship depicted on the fibula from Thisbe in the Berlin Antikenmuseum no. 8396[45].

A reefed sail on a yard occurs only on a fragment of a skyphos from Eretria[46], where below the yard hang brailing ropes; however, it is dated later, at the beginning of the 7th century B.C.[47].

The karchesion, represented as a bisected top is shown on a number of plate fibulae. The attic gold plate fibula from the Elgin Collection in the British Museum no. 1960.11-1-46[48], shows a careful engraving of a ship to left. The mast has a bisected top, and the backstay is attached to the rails in the stern compartment. A bisected top is shown on the bronze fibula in the Athens National Museum no. 8199[49]; on the one in the British museum no. 121[50]; on another in the same museum no. 3204[51]; on two fibulae at Oxford no. 1808.-624[52], and no. G.376[53]; and on one more in the National Museum of Copenhagen no. 4803[54] with a ship to the right. We can also discern a mast with a bisected top on some of the ships of the Dipylon group, as the one depicted on the fragment krater in the Athens National Museum no. 802[55]. A mast with bisected top is also to be seen on the Corinthian oenochoe in Berlin no. 3134.45[56] with a ship to the left.

Returning to our band, the second ship (fig. 15) to the right of the central motif is less impressive, than the one already described, but equally well designed. It is turned to the left. The bow with its long narrow ram has a screen; the stempost curves forward, then upward, and widens at the end. The stern post has a pronounced sheer. The hull is intersected by diagonals. Eight oars emerge under the keel; they are probably dipped into the sea over the far side, as on the first ship. Fourteen vertical posts on the deck form the railing; they could have also been interpreted as the tholepins. In the stern part there are two steering oars, shown with a tiller. The mast amidships has a forestay and a backstay. Here again the karchesion for raising the mast is shown, as a bisected top.

We have already said, that the two terminal metopes bare the depiction of four hoplites holding round shields (fig. 16,17). The shields, each decorated with a row of dots, cover the upper part of the bodies, with the thighs appearing below them. The legs are apart, bent at the knees. The heads are round with protruding nose and chin, while a dot denotes the eye.

Decisive for the dating of our band is the procession of hoplites with the round shields. It is in the late Geometric II period, that the procession of soldiers with round shields appear in vase painting[57]. At first the shield reaches down to the knees. Later the thighs apear below it. We can compare our hoplites with those depicted on two Attic amphorae. The one in the Ashmolean Museum at Oxford no. 1916.55[58], which follows the Dipylon workshop tradition, is dated in the Late Geometric IIa phase. The next one in the Athens National Museum no. 894 (fig. 18)[59], by the homonymous painter, working in the classical tradition, is dated in the Late Geometric IIb phase; and shows the Late Geometric version of the human figure, which here has reached its highest development; it is a characteristic example of a vigourous and progressive style of painting, looking ahead to the earliest orientalizing work of the Analatos Painter.

A date at the end of the third quarter of the 8th century B.C., or even at the beginning of the fourth quarter is appropriate for our gold band.

The gold band is unique both, for its technique and for its subject matter. The design is carefully incised with a blunt edge tool by an able artist directly on the gold sheet and not by impression. The sheet, as we have already said, is very thin. We can see the holes of the compass used for the central motive and for the shields. This method of incision is widely used even today in Greece for the production of small thin votives. The art and the style of the design on our band reflects the classical figure style. The purely geometric conception in the arrangement of the panel decoration, and the clarity of the line, point to an Attic workshop. We may say, that here we have the representation of a naval expedition[60], given in its essential elements, the hoplite, the ship, and the horse, framed in panels, in the style of the period. Diadems of gold foil with patterns impressed on them begin to reappear for the first time, after a long break, in graves of the 9th century B.C. A gold industry appears to have been established in Athens in the first half of the 8th century B.C., owing to her commercial activities and imports of various precious materials[61]. The Kriezi Street gold band gives us another example proving, that Athenian society at the end of the 8th century was richer and more refined than those of the other Greek states.

To the third quarter of the 8th century point the four vases, found in the same tomb with our band. These vases are now in the reserves of the 3rd Ephoria.

a) Skyphos no. 4052 (fig. 19); high 0,076m., lip diam. 0,113m., base diam. 0,06m. Light brown clay; restored from few pieces, a small bit missing. Black paint. Low ring base, concave underneath; wide body curving inward at the top; slightly flaring rim; rolled handles. The lower body and the interior are covered with paint. The handle zone is decorated with a large panel front and back filled by two sections of hatched meander running left; each panel is flanked by a triglyph, formed by three vertical lines. Over the edges of the handles there is a star. Three horizontal strips on the handles. Below the handle zone two horizontal lines. Around the rim three horizontal lines; on the reserved band inside the rim groups of 11 vertical lines. It resembles the group of the skyphoi, which were found during the excavation at Erechtheiou Street in the tomb Θ2[62].

b) Skyphos-pyxis no. 4053 (fig. 20); hight with lid 0,153m., hight without lid 0,093m., lip diam. 0,155m., base diam. 0,09m. Light brown clay; restored from a few pieces; bits and chips missing. Black paint. Low ring base with concave bottom; straight lip; strap horizontal handles. Conical lid with low cylindrical knob flanged shaped on top. The lower body and the interior are covered with paint. The handle zone is decorated front and back with a large panel filled by three sections of hatched meander running left; the ends of the panels are stopped by a column of chevrons between a pair of triple vertical lines; the handles are decorated on their outer faces with small vertical lines between two horizontals, at the middle two cross diagonals. Below the handle zone three horizontal lines, above another three, and on the reserved band of the rim a dotted line and another two lines. The decoration of the lip is as following; at the circumference on a reserved band there is a doted line between two couples of lines; furthermore there are another two reserved bands with three lines, around the handle three reserved lines, on the disk a star surrounded by concentric circles. The shape and decoration of the skyphos resembles the one in the Munich Museum of Staatliche Antiken sammlungen no. 8601[63].

c) Skyphos-pyxis no. 4088 (fig. 21); hight with lid 0,154m., hight without lid 0,095m., lip diam. 0,16m., base diam. 0,094m. Light brown clay; intact some chips missing. Black paint. Shape and decoration identical with no. 4053. The lid decoration instead of two sets of reserved bands has one and around the knob instead of three are five. This skyphos too is comparable with the one in Munich Museum of Staatliche Antikensammlungen no. 8601[64].

d) Skyphos-pyxis no.4087 (fig. 22); hight with lid 0,145m., hight without lid 0,097m. Yellow-red clay. Restored from two pieces; a small fragment missing. Black paint turned to orange. The shape and subsidiary decoration resembles the two previously described skyphoi; it differs in the panel decoration: here, we have the motif of the horizontal dotted wavy line and underneath two reserved lines; the panel is stopped at the ends by a triglyph of three vertical lines. Around the knob of the lid seven reserved lines. The dotted wavy line, which appears at the end of the Late Geometric Ib phase[65], dates the vase in that period.

The Late Geometric Ib phase is the terminus post quem for the dating of the vases of the tomb 106. But, even an early dating for this kind of vases, which were destined in life for every day use, does not prevent a later dating for the gold band. Taking into consideration, that the gold band is an object of purely funerary use, it could be the last of the offerings to the dead. And very probably it was a special command.

The last document of this study is the following. Among the pot sherds collected during an excavation in Argos at Danaou street no. 4 in the property of Katsaros[66], we found two sherds with a representation of a ship (fig. 23). The clay is yellow buff, its analysis has shown[67], that the sherds belong to a vase from an Argive workshop.

The whole piece is preserved to a length of 0,07m. and at a height of 0,049m. By its characteristic profile, curving at the top, I assume, that it belongs to the shoulder of an oenochoe. The picture of the ship would have been either part of a representation in a zone around the shoulder, or else the decoration in a panel on the shoulder under the spout of the vase, which is more probable.

Here, we have the middle section of a warship, sailing to the right. The hull is intersected by verticals, which probably represent the frames. The line of the deck is shown across the top of the frames. Through two of the openings, formed between the frames. on either side of the mast, we can see the mast-step system for securing the mast, by two pairs of superimposed horizontal supports. The yard is raised up to the top of the mast. From the yard hangs a trapezoidal sail hatched with diagonals, which denote the brails. On either side of the mast there is an oarsman. Each man sits on a rowing bench, facing towards the left, that is, away from the direction of the bow. Each rower holds a heavy oar with both hands. The oars apparently extend into the water over the far side. The bodies of the oarsmen are Y-shapd, the shoulders are rounded, the hands and the feet are not formed.

Behind the rower to the right of the mast we see the forepart of a horse. The animal is reduced to its simplest terms; the legs are short and denoted by single strokes; there are no fetlocks, and even the hoofs are omitted. The high carriage of the head, the protruding shoulder and the backward bend of the forelegs are local characteristics. The presence of the horse suggests, that the ship is a horse transporter. The two rosettes in front of the horse and below it are decorative. Over the animal's head and at the same level as the yard, we can see a small part of a horizontal line, which is easily recognized, as the ending of the steira; on geometric representations the mast is shown at the same height as the bow and steira ornaments.

Knowing that the mast is set amidships, we are able to calculate the length of the ship (fig. 24)[68]. The distance from the mast to the bow is 0,06m. (without the ram); thus, the length of the ship is 0,12m.; the height of the hull is 0,014m. - 0,017m., and with the mast 0,047m.. Here we have a ratio of about 1 to 8.

The style of the painting of our vase shows kinship with the miniature argive style, dated to the late geometric II phase, about the end of the third quarter of the 8th century, or at the beginning of the fourth[69]. We can see affinities in the rendering of the horses with those on the Argive oenochoe in the Athens National Museum no. 843, related to the Verdelis painter[70].

Useful for the dating of our fragment is an Attic pitcher, in the Athens National Museum no.18.542[71], dated to the Late Geometric II a-b phase. Here, we have a musical aspect of a funerary ritual[72]. We can see some similarities to our Argive oarsmen, such as the tendency to elongate the waist, or the concave curve for the upper outline of the shoulders, the rounded edges of the shoulders and the protruding chin and nose of the head; even one stool, on which one figure is seated, is hatched like the one on our Argive fragment.

I believe, that the Argos fragment belongs to the Late Geometric II phase, at the end of the third quarter, or at the beginning of the fourth quarter of the 8th century.

Argive examples with ship representations are rather rare, and the existing items do not resemble the one found in Danaou Street.

In her communication Mrs Palaiologou-Kourahani presented two new items found in the city of Argos. One is a pithos with a representation of two merchant ships, which seem to be the earliest surviving argive examples. The other ship is represented on an open vase partly preserved. It shows a one level type, and it seems to be a contemporary of the one from Danaou Street, or even slightly earlier.

The potsherd from the Argive Heraeum, now in the Athens National Museum no.25428. preserves the bow and forepart of a ship to the right (fig. 25)[73]. Inside we can see the back of a seated man. A helmeted archer is aiming towards the ship. The archer is still in the Dipylon painter tradition, although the figured scene is different from the Athenians. The Heraeum fragment must be earlier, than the one from Danaou Street.

A potsherd from Tiryns bears a representation of the middle section of a one level ship to the left[74]. Six oarsmen and part of two others are preserved. The arrangement of the oarsmen recalls that of the oarsmen on the Louvre' s krater no.522[75]; nevertheless the krater is dated in the Late Geometric Ia phase; while it seems to me, that the Tiryns fragment belongs to the Late Geometric II phase, judging from the Y-shaped bodies of the oarsmen, the rounded shoulders and the profile of the heads, showing a pronounced chin and nose.

To these examples should be added a pair of firedogs in the form of warships, from a warrior's grave in the Argos museum nos. F.10, F.11[76].

Concerning the hull of the ship from Danaou Street, it is interesting to note, that since the 12th century B.C. some vase painters depict the hull intersected by verticals, denoting thus the frames (τα εγκοίλια), as we can observe on the ship depicted on the pyxis from Pylos, now in the Athens National Museum no. 6098[77].

The ships of the Dipylon group very commonly depict a type of ship with two levels, with[78], or without[79] intersections; they could be thought, as depicting ships with a raised deck[80]. Those with intersections are rowed from the upper level[81]; while those without intersections are rowed from the lower[82], or even from both levels[83]. On the other hand there are ships, showing warriors fighting on the upper level[84], which proves the existence of a deck. On a ship of the same group we see the warriors standing on both levels[85]; furthermore, we have examples of ships with warriors standing on the lower level[86], thus proving, that the deck of these ships is not continuous; very probably the deck covers the middle section of the ship through out its length. But none of these ships can be interpreted with certainty, as depicting a bireme,the invention of which is assigned to the Phoenicians[87].

Morrison and Williams have pointed out, that the two krater fragments from the Acropolis, now in the Athens National Museum, with openings in the hull, show a two level ship, and they interpret the openings as oarports.

On the first piece no. Acr. 276[88], the middle section of a ship to the left is preserved. Along the hull are reserved squares, alternating with painted rectangles. In each square we see rowers' arms. Above them is the deck and the gunwale with three rowers, and between them part of the mast of the ship.

The second fragment no. 277[89] again shows the middle section of a ship to left. A band just below the gunwale is decorated with diagonal hatching. Another horizontal band above is decorated with a lozenge chain. The zone between these two horizontal bands is divided into alternating open and hatched rectangles. In each port there is one rower, and on the deck there are three more. The rowers of both ships are represented behind the front side of the hull, as it is suggested by the decorated bands, which cannot represent the farside of the hull, at it was maintained for the ships of the Dipylon group. To avoid confusion, the artist made use of the convention, to paint the oars of the oarsmen of both levels, as if they were dipped in the water from the farside. Furthermore, another argument for considering both these ships as two level ships, is their similarity to a ship depicted on a krater fragment in the Athens National Museum no. 15.992[90], and this ship is considered as a bire[91], because it is clearly rowed from two levels.

I believe, that the two krater fragments from the Acropolis cannot be later than the Late Geometric IIa period, judging from the figures of the rowers, which are in the Dipylon painter tradition.

On another fragment from the Acropolis, now in the Athens National Museum no. 259[92], we have the middle section of a ship to the right. Four large oval ports in the hull frame rowers, which are partially covered by Dipylon shields; but we cannot tell with certainty, that we have here a two level ship.

The protocorinthian bowl from Thebes, now in the Royal Ontario Museum at the University of Toronto no. C.119[93] bears another representation of a two level ship. It shows nineteen oarsmen sitting on the top of the ship with their oars attached to the tholepins, while at a lower level are depicted twenty oarports with a tholepin inside of each.

In the late Geometric II period we have some more representations of ships with large or narrow openings in the hull; their design is simpler and they cannot be interpreted as depicting two level ships. The hull of these ships show similarities with the ship from Danaou Street at Argos. In these cases I believe, that the intersections in the hull can be interpreted as the frames of the ship, and the ships belong to a one level type with a raised deck.

The oenochoe at Hobart in the University of Tasmania no 31[94] preserves an image of the after half of a ship to the right, whose hull is depicted by rectangles, similar to those on the ship from Danaou Street. In two of these apertures there seem to be seated figures, while another figure sits above the deck. The remains of three oars cross the hull. The vase is dated to the late geometric IIa period.

Another oeochoe at Munich no. 8696[95] shows a scene of a shipwreck with a similar ship. The hull has eight openings resembling those on our painting from Argos. The shipwrecked men have crosshatched chests; the big round eyes with staring pupils give a new impression. We cannot tell whether this representation illustrates Homer's description in Odyssey, or whether the capsized ship merely illustrates a typical shipwreck. Images of everyday life are usual during the Late Geometric IIb period, to which the vase is dated.

A third oenochoe, which we have already mentioned, attributed to a Corinthian workshop, now in Berlin Antikenmuseum no. 31.43.45[96], depicts in a panel on the shoulder a ship with its hull intersected by vertical lines, which extend above the deck.

The Late Geometric II fragment krater from the Agora no. P.26817[97] shows intersections on its hull and belongs to the same type.

To these large scale examples we can add some more representations of ships with intersections on the hull depicted on bronze fibulae: The fibula in the Athens National Museum no.8199[98] already mentioned, attributed to the Ship Master; the fibula in the British Museum no.121[99] almost identical with the one in Athens and a third fibula in Berlin Antikenmuseum no.8396[100].

The ship depicted on the pot fragment from Danaou Street at Argos is of great importance, not only because of the rarity of argive ship representations, but also for the useful details it shows.

The mast-step system for securing the mast with two pairs of superimposed horizontal supports, provides a unique insight of an important detail of ship construction in the Geometric period. Some bronze fibulae, dated to the Late Geometric II period, or even later, depict the mast-step as a rectangular box without details: the bronze fibula in the National Museum of Copenhagen no.4803[101], which we have already mentioned above; the two fibulae at Oxford no.1908.624[102] and no.1893.266[103]; the gold fibula from the Elgin Collection in the British Museum[104] and a fibula from Chaeronia in the Thebes Museum[105].

The mast-step as a rectangular box is also found in later pottery as the krater from Agrapidochori in Elis[106], and the fragment of a skyphos from Eretria[107], which we have already mentioned.

Returning to the Argos fragment, we observe, that the deck is not raised enough, to permit the insertion of rowers in the rectangular spaces, on the same scale as those on deck. The men are rowing over the farside, from deck level. Details of the near side are not shown. Our ship clearly belongs to the one level type with a raised deck. The artist was here trying to show a kind of cross section.

This representation of a ship carrying a horse is a rare one. Of course, horses are a favourite feature of argive iconography of the period, but not on a ship. Nevertheless we can find few examples on bronze fibulae: on the bronze fibula from Thisbe on the Berlin Antikenmuseum no.8396[108] the horse is shown in the bow compartment; and on a second fibula also from Thisbe in the same museum no.31013b[109] we see the same type of ship carrying a horse.

We learn from written sources, that horse-carrying ships were widely used. Herodotus mentions[110] horse-carrying ploia and nees in Darius's fleet and later in that of Xerxes.

Thucydides says[111], that Perikles during the expedition against the Peloponnese in 430 used ships as horse transporters for the cavalry. But it appears that the Greeks transported horses in their warships from at least as early as the Mycenaean Period[112].

As regards our representation, we can conclude, that our ship is a warship, as are most of the 8th century ship representations, which was occasionaly used as a horse transporter. We must not forget that local painters might have develop their own figured style; since Geometric Argive iconography is descriptive and at the same time depicts every day reality.

In conclusion, we may say the following:

The type of ship that appears at the end of the 9th century B.C. on the bronze fibula from Kermeikos Cemetery, remained unaltered in its general features, during the Middle Geometric period II until the appearance of the ship with a raised deck in the Late Geometric I Period, which was after the middle of the 8th century B.C. as seen on the ships of the Dipylon group. The ship on the Agioi Theodoroi oenochoe belongs to the first type, which is characterized by a low hull with a thin band on its top painted with vertical, or oblique lines; in the first case the lines may be interpreted as representing a decorative band, or the frames of the ship, while the band with the oblique lines could be interpreted only as a decorative. However the same type of ship continues down to the Late Geometric II Period; and the ships depicted on the gold band from Kriezi Street belongs to this one level type. Ships with a raised deck become common in the Late Geometric II Period. They, too, are of the one level type; such as the ship on the potsherd from Danaou Street. Some of these ships with a raised deck could be occasionally rowed from both levels alternatively, as the ships of the Dipylon group, but they are not real biremes. The interpretation of the ships, depicted on the Acropolis potsherds and the unique picture on the famous attic krater in the British Museum no.1899.2.19.1[113] remains problematic.

The representations of the narrative scenes with the splendid warships in Geometric art, with a few exceptions, are associated with the real world and probably depict events from the lifetime of the deceased persons, for whom the grave vases were made[114]. The great sea battles characteristic of the period about the middle of the century give way to images of every day life in the third quarter of the century. These changes in figures and compositions correspond to the new vision of the world, inticative of the period.

The frequency of 8th century B.C. ship representations and other nautical scenes in Attic vase painting provide useful evidence about the extent of Athenian trade at that time; their financial prosperity, and the role of navigation in their lives.

Olga Tzahou-Alexandri
Director of the Athens National
Archaeological Museum

NOTES

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1. J. L. Benson, Picture, Ornament, and Periodicity in Attic Geometric Vase-Painting, The Art Bulletin, 64, 1982, 542 ff.
2. J. N., Coldstream, Greek Geometric Pottery (1968), 26 ff.
3. The bronze fibula from tomb 41 in the Kerameikos Cemetery: K. Kübler, Kerameikos V 1, Die Necropole des 10 bis 8 Jahrhunderts (1954), p. 175, 195, 236, Pl. 160f. D., Gray, Seewesen, Archaeologia Homerica, Band I, Kapitel G, (1974), G 21 no. E1. The pyxis from Lefkandi: M., Popham, An Early Euboean Ship, Oxford Journal of Archaeology, VI, 1987, 353 ff.
4. See: G., Ahlberg, Fighting on land and Sea in Greek Geometric Art (1971), 25-38. Gray, Seewesen G.21 - G.25.
5. For the earliest ships see: L., Casson, Ships and Seamanship in the Ancient World (1971), p. 41 n.2 and p. 42 n. 4. For the geometric ships see: Casson, Seamanship, pp. 49-50, 52-53 and 58. See also Pindar, Pyth. 4, 191 and Herodot I, 166.
6. See: Gray, Seewesen, G.21 ff. For the epithets which the Homeric poet gives to his ships see: J. S., Morrison - R. T., Williams, Greek Oared Ships 900-322 B.C. (1968), 43 ff.
7. Casson, Seamanship, 43-48. Gray, Seewesen, G.92 - G.114, with bibliography G.158.
8. J. L., Benson, Horse, Bird and Man, The Origins of Greek Painting (1970), 77 ff.
9. G., Roux, Pausanias en Corinthie, (1958), 86-87. Δελτ. 17, 1961/62, Β' Χρονικά, σ. 52-54.
10. The sampling of the clay has been done by Mr Apostolos Voulgaris, conservator at the National Archaeological Museum of Athens, and the chemical analysis by Mrs Helen Mangou, chemist at the same museum. For the results see: Appendix, Table I, no.9 (vase 1).
11. Kerameikos V 1, 222-224, Pl. 75.
12. Coldstream, GGP, 26, Pl. 5b.
13. Kerameikos V 1, 236-238, Pl. 73.
14. Coldstream, GGP, 17, Pl. 3n.
15. Wrongly reffered in the bibliography as no.741. Kraiker, in Neue Beitrage zur Klassischen Altertumswissenschaft (Festschrift B. Schweitzer, 1954, 36 ff. Pl. 2). J. M., Davison, Attic Geometric Workshops, Yale Classical Studies, (1961), 106, fig. 137. F. Matz, Geschichte der Griechischen Kunst I. Die Geometrische und die früharchaische Form (1950), 36f. 39f., Pl. 7. K. Fittschen, Untersuchungen zum Begin der Sagendarstellungen bei den Griechen (1969), 46f. n.232,239. Ahlberg, Fighting, 26 and 34ff., no. B11, p. 36, fig. 42,43, p. 59,97, fig. 105. Casson, Seamanship, 32,52,71 fig. 30. Gray, Seewesen, G 21 no. E4.
16. This is the smallest mentioned ship; it seems to have been used for ordinary dispatch and transport work: Il 1. 309; Od. 1. 280; Od. 4. 669.
17. Schweitger, GGA, 37f.

18. S. Benton, The Dating of Horses on Stands and Spectacle Fibulae of Greece JHS, 70, 1950, 20 no.57. Kerameikos V 1, 175, 195, 236, Pl. 160f. Gray, Seewesen, G.21, no. E1. The design published here is executed by Mrs Theodora Kakarouga.
19. Davison, Workshops, 108f. P., Kahane, Die Entwicklungsphasen der attisch-geometrischen Keramik, AJA 44, 1940, Pl. 21,6. G. S., Kirk, Ships on Geometric Vases, BSA 44, 1949, 96, no. 1a, fig. 1. Morrison, GOS, 32, no. Geom. 26, Pl. 6c. Casson, Seamanship, 52 n.59. Gray, Seewesen, G.21, no. E2.
20. Kirk, Ships, 96, no. A2. Kahane, AJA 44, 1940, Pl. 22,1. Morisson, GOS, 32, no. Geom. 27. Gray, Seewesen, G.21, no. E3.
21. See above note 15.
22. Schweitzer, GGA, 35-37. Benson, HBM, 79f.
23. CVA France, 18, Pl. 4, 3.6.7. Kirk, Ships, 98, no. 5, and 105, no. 19. E. Kunze, Disiecta membra attischer Grabkratere, Αρχ. Εφημ. Εις Μνήμην Οικονόμου, 1953/54, I, 162ff., Pl. 1; 2, 1. 2; 4, 2. Kunze, AJA, 61, 1957, 307 goes with F3c. Davison, Workshops, 135 Dip. B4, fig. 15a-c. Morrison, GOS, 25, no. Geom. 17, Pl. 4a. Schweitzer, GGA 44f., Pl. 39. Fittschen, Untersuchungen, 48f. Casson, Seamanship, 44f., 49f., 75, no.2, fig. 62. Gray, Seewesen, G22, no. F4, Pl. G VII a.
24. Kirk, Ships, 99, no. A6. BMMA, 1934, 170, fig. 1. Marwitz, JDI, 74, 1959, 103f.
25. Kirk, Ships, 102f. no. 14-16 Pl. 40,1. E. Kunze, Disiecta Membra attischer Grabkratere, Αρχαιολογική Εφημερίς, Εις Μνήμην Γ. Π. Οικονόμου, 1953/54, I Pl. 5, 3 and 6, 1-2. Ahlberg, Fighting, 28 n.72. Davison, Workshops, 140 Dip. I F 18. Morrison, GOS, 22 no. Geom. 8, Pl. 2 c, d. Gray, Seewesen, G 22 no. F5 c, Pl. VII, b, d.
26. See note 25. Gray, Seewesen, G 22 no. 5 c, Pl. VII b. Here we publish a new photograph with the new piece.
27. See below p.351, Appendix, table I: no. 5 (vase 5) a skyphos, and no. 6 (vase 3) an oenochoe, which are corinthian; while no. 7 (vase 1) a coarse aryballos is Attic. The fifth vase of the tomb, the hand made hydria is corinthian.
28. Cf. Blegen, C. W., Palmer, H., Young, R. S., Corinth XIII, The North Cemetery (1964), p. 23 and 41, Pl. 6, no. 16-9.
29. Kerameikos V 1, Pl. 156. Comparable also to the aryballos from the grave V of the potters' Quarter at Ancient Corinth: Newhall Stillwell, A. and Benson, J. L., Corinth vol. XV part III, The Potters' Quarter, The Pottery (1984), p. 13-4 and 20, Pl. 3 no.32. It belongs to the Argive monochrome class. The most likely date for the tomb is the first half of the 8th century B. C.
30. Cf. Corinth XIII, 23, Pl. 6, no. 16 - 10
31. Cf. Corinth XIII, 24-26, Pl. 7, 17-1. Coldstream, GGP, 95, Pl. 18a. For tomb 4 and its content see: Δελτ. 17, 1961/2, Β' Χρονικά, 53.
32. Tomb 16 of the North Cemetery is dated in the MG II period; cf.: Coldstream GGP, 95ff. Also tomb V at the Potters' Quarter is dated in the 1st half of the 8th century B. C. cf.: Corinth XV III, 13-14.
33. See above p. 3 n.12.
34. Δελτ. 22, 1967, Χρονικά Β 1, 95.
35. The techniques of gold relief production have been fully explained by Kunze, Reichel and Ohly: E. Kunze, Kretische Bronzereliefs (1931), 265f. (app. I). W. Reichel, Griechische Goldrelief (1942). D. Ohly, Griechiesche Goldbleche d. 8 Jhs. v. Chr. (1953). Since the friezes on gold bands, or parts of them, have repeated identical images, matrices must have been used to make them. Matrices made of hard material have been found. Also the accuracy and the fineness of their design advocates for the use of this method. The representations would have been hammered in positive into the thin gold plate with a soft hammer. But the Kriezi street band is worked by the method of incision, as we will see below: see p. 12.
36. Kirk. Ships, 110ff., no. 36, fig. 3. CVA, Denmark II, Pl. 73 no. 4a. Davison, Workshops, Fig. 133. Morrison, GOS, 33, Geom. 29. Schweitzer, GGA, 49, Pl. 59. Ahlberg, Fighting, 25 and 29ff. no. B4, p. 29f., fig. 31-33. Gray, Seewesen, G.23, no. G6, Pl. G Xb.
37. See above note 19.
38. Krater fragment in the Louvre no. A 533. CVA, France 18, Pl. 6, 8. Kirk, Ships, 108 no. 28. Kunze, AJA, 61, 1957, 307. Davison, Workshops, 136, Dip. I B 15. Morrison, GOS, 23. no. Geom. 10, Pl. 3c. Casson, Seamanship, 55 n.73. Gray, Seewesen, G.22 no. F6, Pl. G VIIIc. - Krater fragment in Brussels Cinquantenaire museum (ex Louvre no. 531) Kirk, Ships, 105 no. 21. Matz, Gr. Kunst, Pl. 13b. Morrison, GOS, 23, no.Geom 11, Pl. 4a.Casson, Seamanship, 55 notes 73 and 75. Gray, Seewesen, G.22 no. F8, Pl. G VIIc. - Krater fragment in Athens National Museum no. 802. Morrison, GOS, 22, Geom. 8, Pl. 2d. Gray, Seewesen, G 22 no. F 5c, Pl. G VIId.
39. A. S., Murray, A new Vase of the Dipylon Class, JHS 19, 1899, 198ff., Pl. VIII. E. Pernice, Geometrische Vase mit Schiffsdarstellung, JdI, 15, 1900, 92ff. Pfuhl, MuZ. 72, fig. 15. R. Hampe, Frühe Griechische Sagenbilder iin Böotien (1936), 78f., Pl. 22. L. Curtius, Antike Kunst II, 1 (1938) 72, fig. 67. E. Buschor, Griechische Vasen (1969) 18, fig. 18. Matz, Gr. Kunst, 65, Pl 14 up. Hampe, Gleichnisse, 37, fig. 18b. F. Schachermeyr, Die Minoische Kultur des alten Kreta (1964). 314. fig. 164. Schefold, Sagenbilder, 22ff., Pl. 5c. G Neumann,

Gesten und Gebärden in der griechischen Kunst (1965), 18, fig. 6, p. 59f. D. Kallipolitis-Feytman, Les Louteria Attiques (1965), 29 no.2, Pl. 9. Morrison, GOS, 28 no. Geom 19, Pl. 4e. Fittschen, Untersuchungen, 51ff. (AA 2). Ahlberg, Fighting, 37 n. 97. Casson, Seamanship, 46, 49, 55, fig. 74. Gray, Seewesen, G 24 no. G15, Pl. G IX a.

40. Kirk, Ships, 113f. no. 38. Morrison, GOS, 36 no. Geom. 42, Pl. 7d. Schweitzer, GGA, 61, Pl. 76. Casson, 50, 75 no. 6. Gray, Seewesen, G 24 no. G 14, Pl. G XIc.
41. From Krete. It is the latest and best piece by the Swan Master. See: Schweitzer, GGA, 209, 213, Pl. 233. Gray, Seewesen, G 25 no. G 18, fig. 18i. Morisson, GOS, 78 no. Arch. 20, Pl. 8e.
42. From Thebes. Attributed to the Ship Master. P. Wolters, Βοιωτικές Αρχαιότητες, Αρχ. Εφ., 1892, 213f., Pl. 11,1. Blinkenberg, Fibules, 174 no. 3, fig. 206. Hampe, Sagenbilder, 98f. no. 13, Pl. 11. Schweitzer, GGA, 208, fig. 120. Morrison, GOS, 77 no.Arch.14. Gray, Seewesen, G 25, no. G 18, fig. 18g.
43. From Thebes. Attributed to the Ship Master. Hampe, Sagenbilder, no. 93, Pl. 11. Morrison, GOS, 77, no. Arch. 15.
44. Attributed to the Ship Master. Hampe, Sagenbilder, no. 83. Morrison, GOS, 77, no. Arch. 16, Pl. 8d.
45. A. Furtwängler, Erwerbungen der Antikensammlungen in Deutschland, AA, 1894, 115f. no. 1. Hampe, Sagenbilder, 98f. no. 60, p. 12 fig.1 H. L., Lorimer, The Hoplite Phalanx, BSA, 42, 1947, 117, fig. 11a. Schweitzer, GGA, 212, fig. 124.
46. Αγγελική Ανδρειωμένου, Γεωμετρική και Υπογεωμετρική Κεραμεική εξ Ερετρίας, V, Αρχ. Εφ. 1983, 185, εικ. 10, Πιν. 64, αρ. 224 (χάραγμα πλοίου).
47. In this case the mast support a main top, the Karchesion, girdled with a protective railing, the crows nest, which is a later feature, found on items, dated later than the 8th century B. C. Miss Andreiomenou interprets the crow's nest as a flag. For crow's nests see: the ship on the bronze bow fibula in the British Museum, no. 3204: H. B., Walters, Catalogue of the Bronzes in the British museum, 1899, 37, figs. 85, 86. Schweitzer, GGA, 213, fig. 125. Gray, Seewesen, G 18, fig. 18e. See also the ship on the bronze bow fibula in the Berlin Antiquarium no. 31013a: Hampe, Sagenbilder, no. 62a, Pl. 4. Morrison, GOS, 75 no. Arch. 8, Pl. 8c. Schweitzer, GGA, 215. Gray, Seewesen, G25 no. G18, p. G 61 fig. 18c.
48. Schweitzer GGA, 202, Pl. 231. Hampe, Sagenbilder, no. 88, 3, Pl. 7. Kirk, Ships, fig. 8. Matz, Pl. 38b. JHS, Archaeological Reports 1962-3, 53, fig. 3. Morrison, GOS, 78, no. Arch. 19.
49. See note 42.
50. See note 43.
51. Hampe, Sagenbilder, no. 100. Morrison, GOS, 76 no. Arch 10.
52. Hampe, Sagenbilder, no. 108. Morrison, GOS, 77 no. Arch. 17.
53. Hampe, Sagenbilder, no. 120. Morrison, GOS, 78 no. Arch. 18.
54. See note 44.
55. The Krater fragment in the Athens National Museum no. 802: Morrison, GOS, 22 Geom. 8(3), Pl. 2d. Gray, Seewesen, G 22 no. F5c, Pl. VIId.
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80. Casson, Seamanship, 55f., believes for some of these ships that they show a raised deck, and thus they can be oared from either level, or from both, and he considers them as the forerunners of the bireme, which is considered a Phoenician invension. See Gray, Seewesen, G 84 - G 90, where the author treats the whole subject.
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82. See note 79.
83. Cf. the fragment krater in the louvre no. A 532: (CVA France 18) Pl. 7, 2.3.5. Kirk, Ships, 106 ff. nos. 25, 29, 30, Pl. 39, 3, 4. Morrison, GOS, 24 Geom. 14. Fittschen, Untersuchungen, 46 n. 230. Casson, Seamanship, 49, 52, 55f., 71, fig. 77. Gray Seewesen, G 23 no. F 10, Pl. G VIII a.
84. See the krater fragment in the Athens National Museum, no. 802: Ahlberg, Fighting, p. 26 B 8, p. 34, fig. 39.
85. Cf. the fragment krater in the louvre no. A 528. CVA (France 18) Pl. 7, 7. Ahlberg, Fighting, 31, B 5, fig. 34. Morrison, GOS, 19 no. Geom. 4, Pl. 2 a. Coldstream, GGP, 31 no. 10. Schweitzer, GGA, 45, fig. 14. Gray, Seewesen, G 23 no. F 9. Seewesen, G 23 no. F9.
86. Cf. the ship on the krater fragment in the louvre, no. A 527: CVA (France 18), Pl. 2, 2 and 3, 7. Kirk, Ships, 100 no. 7 a, Pl. 38, 1. Kunze, I, Pl. 4, 1 down right. Morrison, GOS, 18 Geom. 2, Pl. 1 e. Ahlberg, Fighting, 25 and 33f. no. B 7, p. 32, fig. 36, 37, 38. Casson, Seamanship, 46 n. 22, p. 49, 51, 55, 71, fig. 68. Gray, Seewesen, G 22 no. F 3 a, Pl. G VI b. Compare also the ship on another fragment of the same krater: CVA (France 18), Pl. 3, 8. Kirk, Ships, 100 no. 8. Kunze, I, pl. 4, 1 (underneath left). Kunze, AJA, 61, 1957, 306 no. F 4. Davison, Workshops, 135 Dip. I B 3, fig. 13 a-c. Morrison, 18 Geom. 3. Schweitzer, GGA, 44f. Fittschen, Untersuchungen, 46 notes 230, 232. Ahlberg, Fighting, 26 and 37f. no. B 13, p. 37 fig. 45 and p. 41, 59. Gray, Seewesen, G 22, no. F 3c.
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92. Kirk, Ships, 109f. nos. 33, 34, Pl. 40,2. Morrison, GOS, 36 nos. Geom. 40, 41, pl. 7c. Gray, Seewesen, G 25 no. 17, Pl. G IX c.

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100. Hampe, Sagenbilder, no. 60, fig.1. Morrison, GOS, 77 no. Arch. 13.
101. See above note 44.
102. Hampe, Sagenbilder, no. 108. Morrison, GOS, 77f. no. Arch 17.
103. Hampe, Sagenbilder, no. 110. Morrison, GOS, 76 no. Arch. 11.
104. See note 48.
105. Hampe, Sagenbilder, no. 140, Pl. 6. Morrison, GOS, 76 Arch. 12. Schweitzer, GGA, 205, fig. 115.
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ILLUSTRATIONS

1. Oenochoe bearing a ship representation; Agioi Theodoroi, tomb 4. Ancient Corinth museum.
2. Detail of the Agioi Theodoroi oenochoe, the ship.
3. Bronze fibula, design. Kerameikos cemetery, tomb 41.
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5. Skyphos, Eleusis Museum no. 910.
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12. Gold band, central panel.
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15. Gold band, right panel with ship representation.
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20. Skyphos, 3rd Ephoria reserves no. 4053.
21. Skyphos, 3rd Ephoria reserves no. 4088.
22. Skyphos, 3rd Ephoria reserves no. 4087.
23. Oenochoe fragment with ship representation; Argos museum, from the excavation in the Katsaros properl
24. Oenochoe fragment from Katsaros property, design.
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APPENDIX

CHEMICAL ANALYSIS OF GEOMETRIC POTTERY BY ATOMIC ABSORPTION SPECTROSCOPY

Method: The samples selected for chemical analysis consisted of four Argive sherds and five Corinthian vases. They were obtained as a powder with a tungsten carbide drill.

The ceramic samples were prepared for analysis by the lithium metaborate fusion process and were chemically analysed by the atomic absorption spectroscopy technique (Hughes et al).

All the elements were determined by flame ionization except for titanium which was determined with a graphite furnace. The reference standards used were synthetically prepared in the laboratory with element concentrations which closely matched those of the clay matrices.

Results and discussion: The results of the chemical analysis, given in the table, indicate that the four Argive sherds and the Corinthian vases (No, 5,6) are similar in composition, especially eith respect to the origin-sensitive elements, magnesium, chromium and nickel. The three other Corinthian vases (No 7,8,9) and the two Attic sherds form a separate chemical group.

It is known that Attic pottery can be distinguished from Corinthian-Argive pottery on the basis of higher Mg. Cr and Ni contents in the former (eg, Jones 1986, Fig. 3.27, 202). In addition, Attic clays are usually less calcareous than those in the Corinthia - Argolid.

The two composition groups identified here have been compared with the published reference data for the two first group (No. 1-6) and the data for the Corinthia - Argolid, while the second group (7-11) matches the Attic reference data (see, for instance, Late Geometric and Protoattic craters from the Athenian Agora, Jones 1986, 156 and 683). No. 7,8,9 are therefore probably Attic imports.

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Helen Magou
Chemistry Laboratory
National Archaeological
Museum

Chemical composition in oxides

	Object No	Origin	Date	Si	Al	Fe	Na	K	Mn	Mg	Cr	Ni	Ti	Ca
1.	Sherd with ducks	Argos (Katsaros property)	730-720 B.C.	60.02	13.34	6.44	1.95	2.24	0.09	4.49	0.053	0.044	0.57	6.63
2.	Sherd with oval	"	"	63.27	13.23	6.15	1.99	2.52	0.10	4.58	0.051	0.032	0.74	8.21
3.	Sherd with ship	"	"	63.35	13.05	6.01	2.13	3.08	0.11	4.58	0.058	0.033	0.63	8.70
4.	Sherd with zig-zag	"	"	63.74	13.13	6.44	2.41	3.23	0.08	4.61	0.058	0.037	0.70	7.51
5.	Tomb 4 vase 5 Skyphos	Ancient Corinth (cemetery of Ag. Theodoroi)	775-760	57.00	13.60	7.01	1.59	3.30	0.09	5.32	0.054	0.038	0.68	10.21
6.	Tomb 4 vase 3 Oenochoe	"	"	63.25	12.47	6.29	1.65	3.21	0.11	4.66	0.052	0.037	0.71	10.34
7.	Tomb 4 vase 2 Aryballos	"	"	51.92	9.22	6.30	1.07	2.39	0.10	6.88	0.067	0.099	0.78	14.52
8.	Tomb 3 vase 9	"	"	57.47	13.74	7.01	1.47	3.31	0.07	6.18	0.111	0.104	0.85	5.35
9.	Tomb 4 vase 1 Oenochoe with ship	"	"	59.84	13.96	7.15	1.32	3.36	0.07	6.46	0.098	0.086	0.91	6.72
10.	National Museum sherd 802a	National Museum (Kerameikos cemetery)	740-730	57.36	12.58	6.44	1.54	2.87	0.09	6.25	0.086	0.064	0.89	8.72
11.	National Museum sherd 802b	"	"	55.14	11.66	6.15	1.68	2.40	0.08	6.02	0.083	0.070	0.81	8.08

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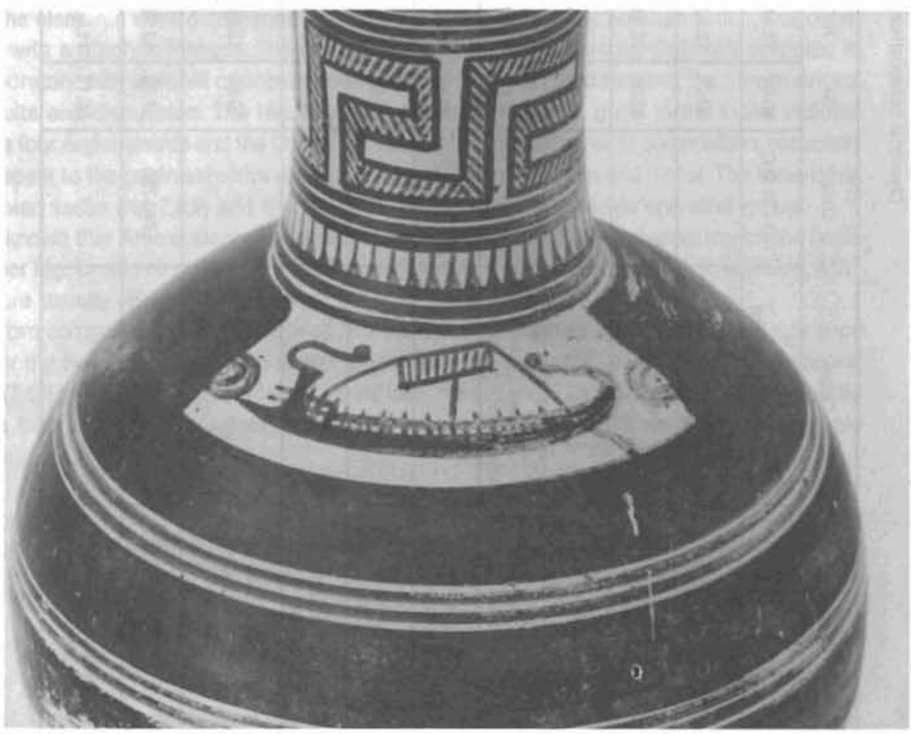

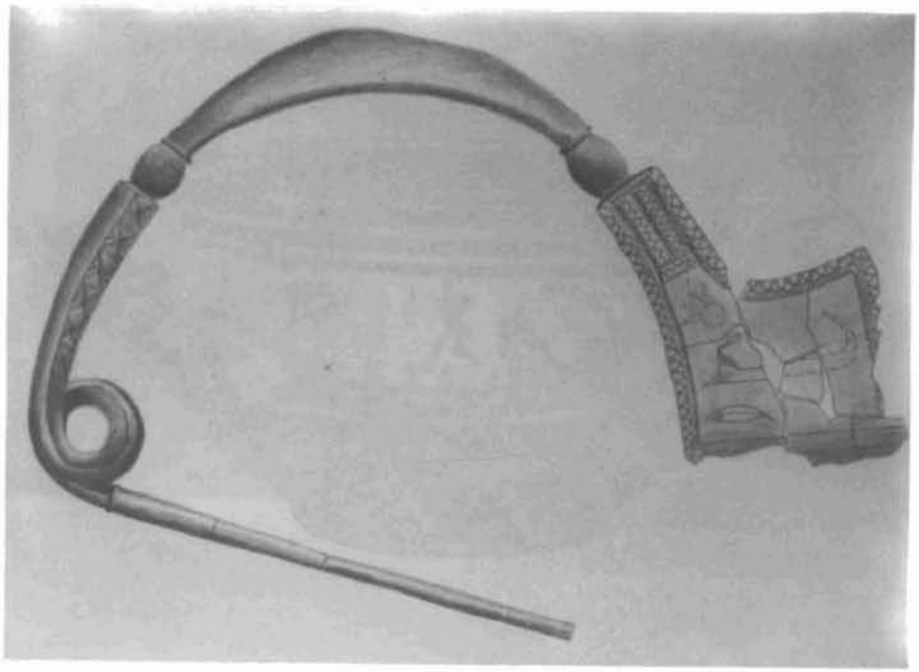

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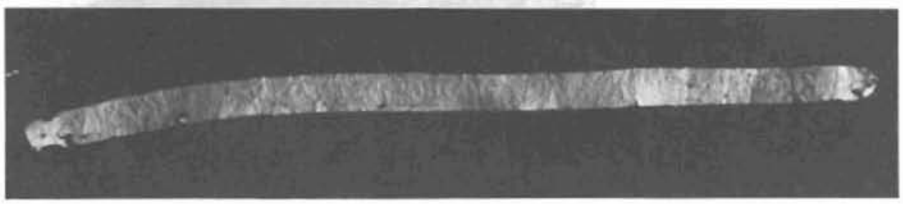
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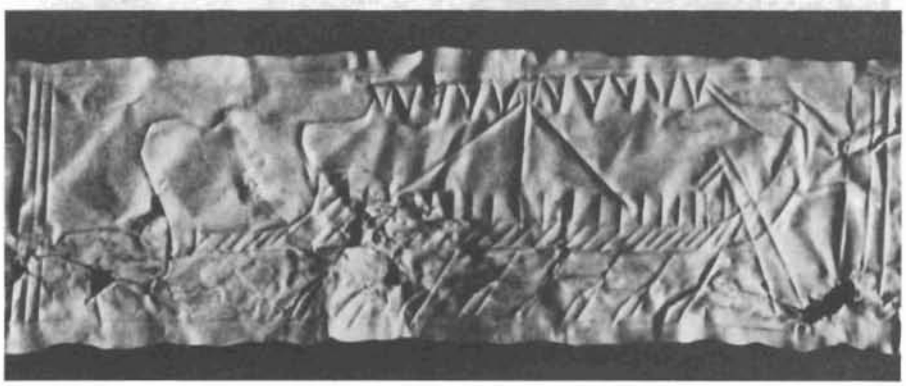
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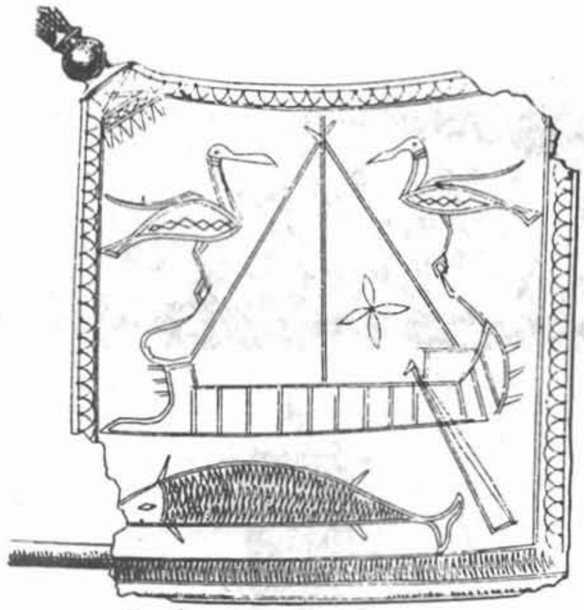

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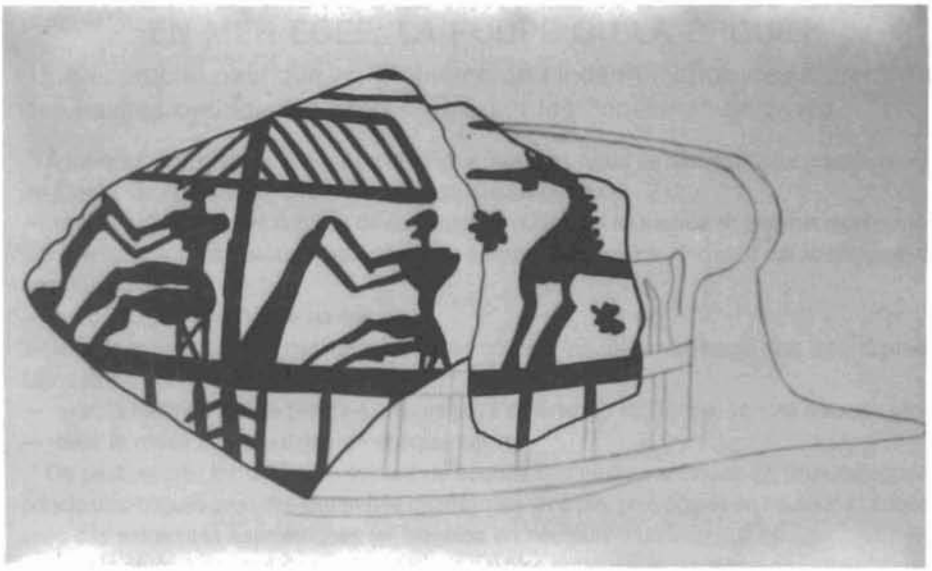

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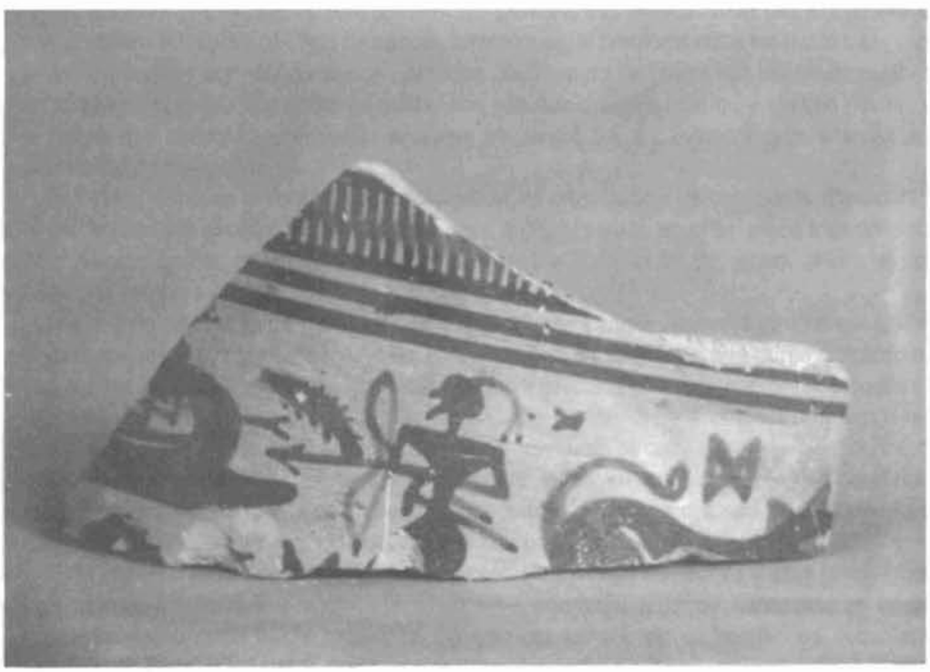

L'EXTREMITE HAUTE DES NAVIRES A L'AGE DU BRONZE EN MER EGEE: LA POUPE OU LA PROUE?

Une approche nautique au problème de l'indentification des extrémités des navires cycladiques représentés sur les "poëlons" de Syros

A travers l'iconographie antique on distingue plusieurs types de navires. Cette grande variété de formes de coques est en liaison avec plusieurs facteurs:

— avec les différentes techniques de construction utilisées. Les navires en papyrus représentés, par exemple, sur les sceaux minoens ont une forme particulière, imposée par le matériel de construction.

— avec l'emploi de chaque navire.

— avec le milieu d'activité des navires (régions côtières, navigation en haute mer, lacs, lagunes, fleuves).

— avec la tradition navale propre à chaque pays ou avec les influences venues d'autres pays.

— avec le mode de propulsion de chaque navire.

On peut répartir les difffentes formes de coques des navires antiques en deux catégories principales: coques avec des extrémités symétriques (et à peu près égales en hauteur) et coques avec des extrémités asymétriques (et inégales en hauteur).

Dans la plupart des cas de représentations navales antiques, le problème de l'identification de la proue et de la poupe est facilement résoluble: la représentation d'un gouvernail latéral ou d'une voile gonflée, indique la poupe sans aucun doute possible. Il reste, néanmoins, certains exemples iconographiques où tout élément qui permettrait l'identification des extrémités de navire est absent. Lorsqu'il s'agit de coques symétriques, le problème reste insoluble mais dans le cas de coques asymétriques, une approche nautique du problème est intéresasnte. Il est en effet très possible que cette asymétrie soit liée aux qualités nautiques de ces navires et à l'effort des constructeurs navals antiques de rendre leurs bâtiments plus adaptés aux problèmes de navigation.

Un navire, le moyen et l'outil de communication, de propagation, de commerce, d'imposition et de défense par excellence pendant plusieurs millénaires est, en effet, avant tout construit pour prendre la mer, arriver à sa destination et rentrer à son point de départ, même, si cela n'est pas toujours réalisé.

Les marins de l'antiquité n'étaient pas des aventuriers vaniteux. Avant tout ils essayaient d'accomplir des voyages en sécurité en accordant peu d'importance à la durée du parcours. Les marins du bassin méditerranéen et de la mer Égée plus précisément, ont toujours eu à affronter une mer difficile et souvent agitée et leurs navires étaient très souvent exposés à des vents violents et instables. Ainsi, les constructeurs navals de cette région devaient concevoir des navires avec des qualités nautiques exceptionnelles, en tenant compte des conditions maritimes propres à la mer Égée. L'évolution des formes de coques des navires de cette région est étroitement liée au besoin de dévolopper ces qualités nautiques.

Ici je limeterai mon discours aux navires cycladiques à l'âge du Bronze et plus précisément aux navires qui semblent appartenir à un type commun, répandu dans tout le bassin méditerranéen oriental au 3e millénaire. Ce type est attesté par un nombre de documents antiques et sa caractéristique principale est une extrémité basse et une extrémité haute de la coque.

Les exemples cycladiques

1. Les navires incisés sur les "poëlons" de Syros (fig. 1).

Ces objets en terre cuite et en forme de "poëlons" proviennent des tombes de Chalandriani de Syros, datées du Cycladique Ancien II, appartenant à la civilisation dite de Keros-Syros. Leur usage reste inconnu, malgré les diverses hypothèses avancées. Sur ces hypothèses j'aimerais en ajouter une nouvelle qui devrait être étudiée dans le cadre d'une recherche beaucoup plus approfondie: l'usage des "poëlons" de Syros est peut-être en relation avec l'alimentation des marins, à base de poisson, à bord des navires. Le fond plat des objets pourrait, dans ce cas, servir à leur plus grande stabilité à bord des navires[1].

A l'extérieur des surfaces plates des "poëlons" de Syros sont incisés des motifs en spirale, des poissons et très souvent aussi, des représentations de navires.

Depuis longtemps une controverse existe entre les chercheurs, concernant la définition de la poupe et de la proue de ces navires. Deux thèses principales sont exprimées à ce sujet. La première soutient l'hypothèse selon laquelle l'extrémité haute des navires, représente la proue et la deuxième soutient le contraire. Plusieurs arguments ont été prononcés en faveur de l'une ou de l'autre thèse. Ce n'est pas dans mes intentions de récapituler toutes les opinions exrpimées, ni de faire la synthèse des différents arguments. J'essayerai d'aborder le problème en faisant une approche purement nautique.

A première vue, les navires des "poëlons" de Syros ne semblent pas être des navires primitifs et l'analyse de leurs caractéristiques nous démontrera qu'il n'en est pas ainsi. Tout au contraire, ils semblent très évolués du point de vue de l'archicture navale. La technologie de l'époque et la tradition navale de la région, longue de plus de 6000 ans, permettraient une telle évolution.

Examinons d'abord les éléments principaux de ces navires (fig. 2). Il s'agit d'embarcations longues et effilées, propulsées par un nombre important de rames ou de pagaies. Le fond de leur carène est rectiligne et chaque changement de plan, est signalé par un angle. Une des extrémités de la coque, prolongée par un "éperon" *(P)* est basse, tandis que l'autre est haute et pourvue d'une hampe presque verticale *(H)*. Il est évident qu'un tel profil est, du point de vue géometrique, très asymétrique. Du point de vue de l'architecture navale, il n'en est pas de même. La pression verticale et les efforts latéraux que la hampe produit sur l'extrémité haute sont compensés par deux éléments se trouvant à l'autre extrémité: une projection horizontale *(P)* dans la partie inférieure et un changement d'angle au fond des navires *(V)*, à proximité de cette extrémité. Le rôle de ces deux éléments, par rapport à la hampe haute, n'a jamais été suffisament mis en valeur.

Quels sont les effets que la hampe haute produirait sur l'extrémité haute des navires? On observe que cette hampe est totalement icorporée dans les lignes des navires et sa largeur laisse supposer qu'elle fait partie intégrale de la coque; elle n'a donc pas de rôle décoratif, mais fonctionnel. Vu sa surface considérable, son volume et son poids devaient être assez importants, par rapport au volume et au déplacement totals des navires.

Le premier effet produit par le poids de cette hampe *(H)* serait une pression verticale sur cette extrémité des navires et l'enfoncement dans l'eau qui en résulte. Cet enfoncement, accentué par la forme angulaire de la partie inférieure de cette extrémité *(A)*, varirait durant la navigation et le tangage des navires (produit par les vagues). L'enfoncement de la partie angulaire *(A)* de cette extrémité serait déstiné à diminuer la dérive des navires, dans le cas où celle-ci serait la poupe du navire. La variation de l'enfoncement de cette partie du navire pourrait être diminuée grâce à la projection horizontale *(P)*, en forme d' "éperon" au prolongement de l'autre extrémité de la coque, à condition qu'elle soit placée au niveau de la ligne de flottaison ou même légèrement en dessous.

Le deuxième effet, produit par la surface latérale importante de la hampe *(H)*, est en rapport avec la pression du vent.

Lorsque la direction du vent était dans l'axe du navire, l'effet produit par sa pression contre la hampe devait être, soit défavorable à l'avancement du navire, l'extrémité haute était la proue du navire), soit favorable, l'extrémité se propulsant contre le vent (effet défavorable accentué, si l'extremité haute se propulsant alors dans la direction du vent (effet favorable accentué, si l'extrémité haute était la poupe du navire).

Lorsque la direction du vent était perpediculaire à l'axe du navire (vent de côté), la pression du vent contre la surface importante de la hampe devrait inciter le navire à se tourner dans le sens du vent *(fig. 2)*. Par conséquent, si l'extremité haute était la poupe du bâtiment, les navires cycladiques ne pourraient pas remonter au vent, malgré tous les efforts des rameurs ou pagayeurs. Par contre, si l'extremité haute était la proue du bâtiment, les navires cycladiques remonteraient facilement au vent. Dans les deux cas la tendance de l'extrémité haute de se mettre dans le sens du vent, empêcherait le navire à maintenir son cap. Compenser cette tendance par le simple effort constant des rameurs ou pagayeurs, devait être, extrêment difficile. La projection horizontale en forme d'"éperon" à l'extrémité basse des navires, pourrait en partie compenser cet effet, présentant une résistance latérale contre l'eau. Est-ce que l'angle au niveau de la carène et à proximité de cette extrémité signifit un enfoncement de la coque à cet endroit, une sorte de dérive fixe incorporée à la quille, ayant comme but de compenser encore plus la tendance de l'extrémité haute à se mettre dans les sens du vent? C'est possible, mais une autre hypothèse pourrait expliquer le changement de plan à ce niveau *(V)*: les artistes qui ont incisé les navires des "poëlons" de Syros ont peut-être voulu traduire en profil un réctrécissement des flancs et une forme en *V* des carènes des navires à ce niveau[2]. Si cela est vrai nous sommes en présence d'un effort supplémentaire des Cycladites destiné à compenser l'enfoncement de l'extrémité haute des navires, provoqué par la pression verticale de la hampe. Dans ce cas l'enfoncement de la carène à proximité de la partie basse équilibrerait en partie l'enfoncement de la carène à l'autre extrémité, dû à la forme angulaire *(A)* de sa partie inférieure. D'autre part, la forme en *V* de la carène des navires à ce niveau rendrait cette extrémité basse plus hydrodynamique, technique concernant surtout la poupe des navires. Dans le cas des navires cycladiques, elle serait accentuée par l'adjonction de la projection horizantale en guise de taille-mer.

Nous remarquons en cours d'analyse que les éléments de structure des navires cycladiques plaident en faveur de l'hypothèse selon laquelle l'extrémité basse est la proue et l'extrémité haute est la poupe. Essayons de mettre ces coques dans leur contexte maritime d'origine, celui de la mer Égée; essayons intellectuellement de les faire naviguer dans la région des Cyclades, en supposant d'abord, que l'extrémité haute soit la proue. Quels sont les problèmes auxquels une telle embarcation était confrontée? Nous avons vu qu'un navire pourvu d'une telle étrave naviguant contre le vent subissait une force défavorable assez considérable à sa progression, vue l'élévation de sa proue. Navigant par vent arrière, la force du vent serait, à première vue, favorable à la progression du navire, mais compte tenu de l'enfoncement de la proue sous l'eau, accentué par la poussée du vent arrière dans ce cas, on observerait un ralentissement de la vitesse du navire. Par vents de travers et de bout, une telle embarcation aurait une dérive importante et une grande difficulté à tenir son cap à cause de sa tendance à se retourner vent arrière, malgré la compensation de ces effets par la projection horizontale et la dérive fixe auprès de l'extrémité basse. Le fait qu'il agisse de navires à rames ou à pagaies, ne diminue pas considérablement ces effets négatifs. Confronter la mer Égée et ses vent violents et instables avec des embarcations mal adaptées à ces conditions, ne serait pas une tâche facile et sans doute les marins des Cyclades n'attendraient pas seulement les très rares moments d'accalmies de l'Égée pour prendre la mer.

Quel serait le comportement d'une telle embarcation face aux vagues de la mer Égée? Si les vents violents y sont très fréquents, la mer y est souvent agitée. Néanmoins, le creux entre deux des lames dépasse rarement les 2 mètres. Une hauteur de proue aussi élévée pour affronter les vagues en Égée serait, le moins qu'on puisse dire, exagérée, surtout que comme nous l'avons vu, un tel navire aurait tendance à se retourner vent arrière et, donc, aurait plutôt besoin d'une poupe élevée pour protéger le navire des vagues.

Supposons maintenant que l'extrémité haute soit la poupe. Une telle embarcation, navigant par vent arrière serait favorisée par la poussée du vent. Un léger enfoncement de la proue, s'équilibrerait par la résistance du taille-mer à l'avant du bateaux. Navigant par vents de travers et de bout, un tel navire aurait tendance à remonter au vent sans grande difficulté et à tenir son cap, grâce à la dérive fixe et à la force compensatoire des rameurs. Ce type de navire avec sa forme hydrodynamique, due à sa proue en *V* et à son taille-mer stabilisateur, pourrait affronter les vagues relativement réduites de la mer Égée, sans avoir à craindre trop le tangage.

L'acceptation du principe selon lequel cette hampe est fonctionnelle, nous permet de conclure que nous sommes en présence d'une première tentative de ce type en mer Égée ou d'une alternative de cette tentative, pour contrôler la force des vents égéens à l'époque cycladique. Cette tentative a pour but de capter le vent et de l'utiliser, plutôt comme force corrective dans l'allure des navires que comme force motrice.

L'adoption de la hampe haute a entraîné l'invention d'une série d'éléments de structure, à force de corriger les effets négatifs de cette adoption et d'améliorer l'hydronynamisme des navires.

Ces efforts ont abouti à une forme de coque complexe, très élaborée et adaptée aux conditions maritimes de la mer Égée.

Les succès de ces efforts est démontré par la diffusion du type de navire qui en résultent.

L'exemple crétois

Le modèle de Palaikastro *(fig. 3)*.

Ce modèle de navire en terre cuite daté au Minoen Ancien (3e millénaire) se trouve au Musée d'Héracleion. Sa forme générale rappelle fortement celle des navires des "poëlons" de Syros. Cette représentation tridimentionnelle confirme plusieurs caractéristiques des navires cycladiques. La projection de la proue est bien volumineuse et il en est de même pour la hampe de la poupe. Seul le changement d'angle sur le dessin de la partie avant du navire n'est pas apparent, ce qui doit être dû au fond plat du modèle, lui permettant de se tenir debout.

L'exemple helladique

Le tesson d'Orchoménos *(fig. 4).*

Sur ce tesson dy Musée de Chéronée, datant de l'Helladique Ancien, est incisé le profil d'un navire. On y retrouve les caractéristiques principales du type de "poëlons" de Syros, l'asymétrie de la coque, la poupe composée d'une hampe haute et la proue basse. Seuls, le changement d'angle sur le dessin de la partie avant du navire n'apparaît pas, non plus que le poisson sur la hampe. L'état fragmentaire de l'objet ne nous permet pas de dire si l'avant du navire est prolongé par un taille-mer.

Les exemples de Naxos

Les gravures rupestres de Korhi t'Aroniou *(fig. 5).*

Sur ces deux gravures rupestres du Musée d'Apeiranthos apparaissent également les caractéristiques principales rencontrées dans les exemples précedents.

Un élément très caractéristique des navires des "poëlons" de Syros, que l'on retrouve sur une série d'autres documents iconographiques du 3e millénaire, est la figure du poisson sur la hampe de la poupe. La direction du poisson a largement servi d'argument aux supporteurs de la thèse selon laquelle la proue de ces navires est l'extrémité haute. Sur ce point, nous rejoignons l'avis de l'éminent specialiste de l'iconographie navale antique, le Dr. Lucien Basch, selon lequel c'est de la vanité d'appliquer à la mentalité de peuples éloignés de nous de 5 millénaires la "logique" de notre époque. Le rapprochement possible, évoqué par ce même spécialiste, du poisson cycladique avec les girouettes en bois et en forme de poisson que l'on rencontre encore aujourd'hui sur les toits des maisons Mykoniates, me paraît très intéressant. Il me semble que le rôle d'emblème n'exclue pas un rôle également fonctionnel, celui de l'indicateur de la direction du vent. Tenant compte du fait que les marins, jusqu'à une date récente, lorsqu'ils ne possédaient ps de compas, "traçaient" la route de leurs bateaux suivant la direction du vent, par rapport à la position du soleil ou des étoiles, le poisson des navires cycladiques pourrait consister une sorte de girouette-boussole primitive.

En conclusion, l'approche nautique du problème de l'identification de la proue et de la poupe des navires du type des "poëlons" de Syros, nous démontre que des navires composés d'une proue basse et d'une poupe haute, pourraient naviguer infiniment mieux que dans le cas inverse. Toutefois, ce type de navires relativement légers et très élaborés, repésente l'aboutissement d'une longue évolution en architecture navale. Ses qualités nautiques, dues à un aérodynamisme et un hydrodynamisme très poussés, devaient être parfaitement adaptées aux conditions maritimes de la mer Égée et répondaient aux tâches auxquelles ces navires étaient destinés. La découverte de documents supplémentaires représentant ce type de "poëlons" de Syros, mais aussi et surtout l'apport de l'archéologie expérimentale, pourraient répondre définitivement à la question relative à l'identification de la proue et la poupe et pourraient nous révéler les qualités nautiques de ce type de coque dans toute son étendue. En ce qui conceme l'archéologie expérimentale, une réplique de ce type devait être construit pour naviguer en mer Égée, projet précédé par un congrès international avec la participation de tous les spécialistes de la question, pour définir les caractéristiques structurelles principales de ce type de navires.

NOTES

1. Le même usage pourrait avoir le vase en marbre de la collection Goulandris, dit "vase des pigeons", dont la forme rapelle celle des "poëlons" de Syros. L'appartenance à la civilisation de Keros-Syros de cet objet semble aujourd'hui certaine. On peut avancer l'hypothèse selon laquelle la bande des pigeons sculptée en relief au centre de l'assiette servait à la pose des arrêtes des poissons consommés par les Cycladites (voir Chr. Doumas, *Cycladic Art, The N.P. Goulandris Collection,* Londres 1983, p. 134 fig. 164).
2. L'angle prononcé à ce niveau semble pourtant exagéré, et doit être dû à une convention artistique propre aux artistites des Cyclades, attestée aussi dans les idoles en marbre.

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Yannis Vichos
56, Panepistimiou,
10678. ATHENES.

FIGURES

1. "Poëlon" de Syros du Cycladique Ancien II. Musée National Archéologique d'Athènes, No. 4974. Ph. Auteur.
2. Dessins d'un navire Cycladique. Vues en plan et de profil. Dessin: Auteur.
3. Modèle en terre cuite de Palaikastro. Musée Archéologique d'Héraklion. Ph. G. Xylouris.
4. Tesson de l'Helladique Ancien d'Orchomenós. Musée de Chéronée. D'après Kunze.
5. Gravure rupestre de Korphi t'Aronion (Naxos).

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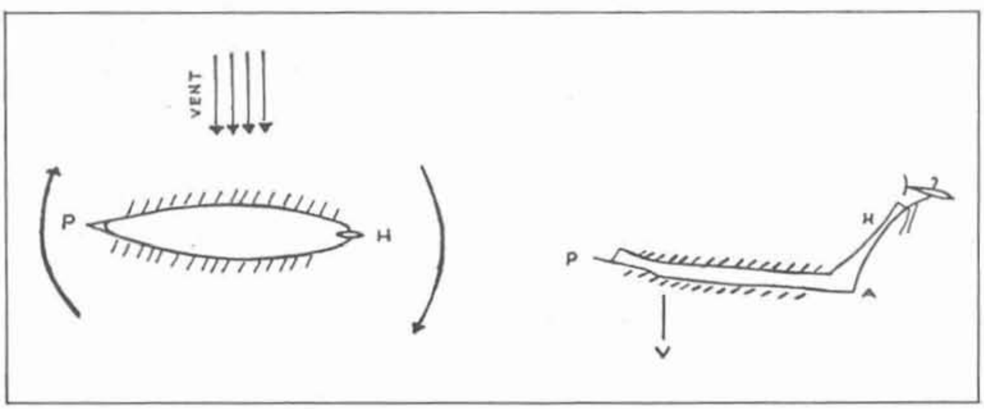

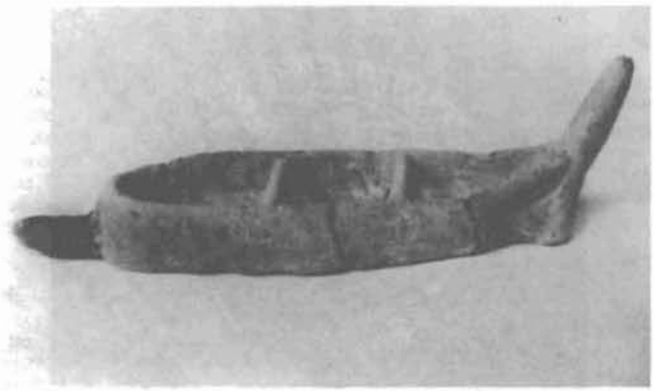

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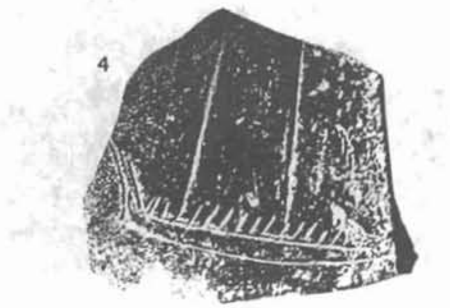

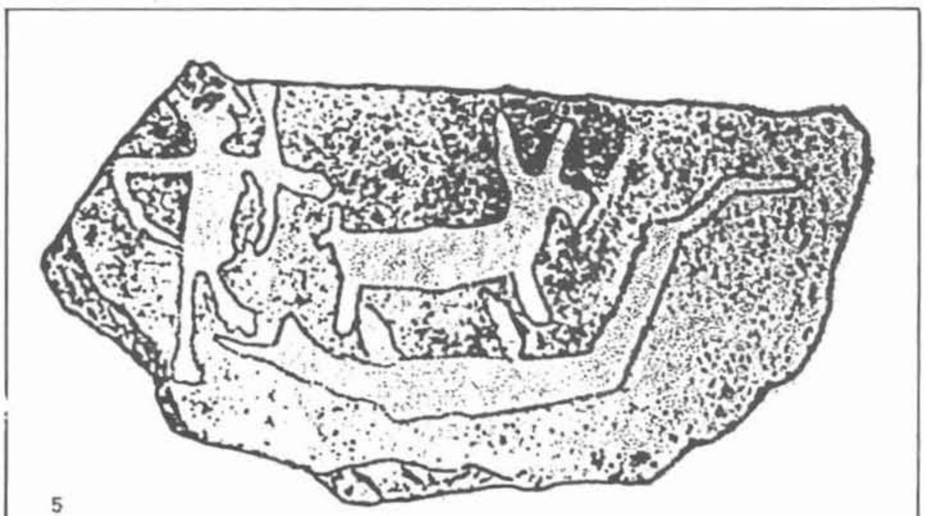

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THE KINNERET BOAT: THE DISCOVERY AND EXCAVATION

The Discovery

In 1985 and 1986 Israel was in the grip of a severe drought. Winter rain barely came. The drought caused the waters of the Sea of Galilee, or *Kinneret* as it is named in Hebrew, to recede exposing large stretches of lake bottom (Fig. 1). In January 1986 Moshe and Yuval Lufan, members of Kibbutz Ginosar and avid amateur archaeologists, decided to "look for an ancient boat" on the mud flats. They searched an area south of the kibbutz where the spinning tires of a tractor brought up coins and other artifacts (Fig. 2).

On closer inspection the brothers found iron nails, and then, the edge of a wooden plank buried in the mud. Was the boat ancient? The brothers contacted Mendel Nun of Kibbutz Ein Gev, a man who has dedicated his life to study of the Kinneret and is considered its leading expert. Nun quickly relayed the information of the discovery to the Israel Department of Antiquities and Museums.

As the Department's Inspector of Underwater Antiquities, news of the discovery of "a wreck — possibly ancient" reached my desk. The next day, Mendel Nun and the Lufan brothers, my colleague Kurt Raveh and I drove to the site. Opening a small section of the uppermost plank, we immediately found remains of "mortise-and-tenon" joinery. The wreck was indeed ancient.

Following standard procedure we carried out a short two day probe excavation (Figs. 3-4). A cooking pot and an oil lamp dating to the Early Roman Period were found, conceivably narrowing the wreck's dating (Figs. 5-6).

The probe was completed on Friday, February 7th. The discovery was to be kept secret until the rising waters of the Kinneret covered the site, protecting it from possible vandalism. We reburied the boat, taking additional steps to hide its location.

By Sunday, news of the discovery had leaked to the press, who immediately termed it the "Jesus Boat". The name fired public imagination even though it lacked any archaeological basis beyond the estimated date of the craft.

Rumors have abounded for years concerning a ship full of gold coins to pay the Turkish army that sank in the Kinneret during World War I. These rumors became associated with our wreck; treasure hunters began searching for the boat and its nonexistent "treasure".

Late that Tuesday night the Lufan brothers spotted searchers with flashlights near the boat. They contacted me; we carried out a nerve-wracking night vigil. No additional intruders were seen but it was now clear that the boat was in serious danger.

The history of archaeology throughout the world is studded with lamentable episodes of invaluable sites destroyed when looters preempted archaeologists. To prevent this happening to the boat, the Department's Director, Mr. Avraham Eitan, ordered its immediate excavation.

An excavation takes time to plan and organize; a staff must be found, materials and equipment have to be acquired. This normally takes months; the excavation was to begin on February 16th — three days hence. An excavation team was quickly assembled[1].

A most important member of the staff, however, was a ship reconstructionist to make sense of the wooden hull as it was uncovered. Professor J. Richard "Dick" Steffy, of the Institute of Nautical Archaeology, Texas A & M University was contacted. He agreed to study the boat; he could come during the dates February 20th-25th. This meant the hull had to be visible during his stay.

Funding Steffy's trip at such short notice was problematic. As the American Ambassador to Israel at that time, Mr. Thomas E. Pickering, has a deep interest in archaeology, I contacted the embassy. Within 14 hours (!) of receiving the request Howard Lane of the United States information Service had arranged the flight.

Meanwhile, back at the lake...

Receiving waters from recent rains, the Kinneret had started to advance toward the boat. When we first viewed the site, the lake had been thirty meters away — on the eve of the excavation it had advanced to within ten meters of the boat. The forecast was for more rain: the site would soon be inundated. Various proposals were studied — including lowering the level of the lake by pumping water into reservoirs. When the excavation began on the late afternoon of Sunday February 16th this problem remained unresolved.

The Excavation

The objectives of the excavation were to expose the boat and its surrounding area, to study the boat in situ and to remove it for conservation to the nearby Yigal Allon Museum at Kibbutz Ginosar. If possible the boat was to be removed intact; but at the outset this seemed unlikely.

As night fell we decided to work around the clock in a race against the rising waters. Gas fishing lamps lent a eerie atmosphere as the outline of the boat began to emerge (Fig. 7).

To check the state of hull preservation we cut a section at misdhip. The hull was indeed intact and well preserved.

During the evening, members of the Kinneret Authority, the governmental body in charge of the lake, visited the site. They proposed to save it from inundation by building a massive earthwork and sandbad dike, and promised to return the next morning with equipment, materials and workers.

By six AM the lake, whipped up by a strong easterly, was virtually touching the boat (Fig. 8). The Kinneret Authority arrived just in time and began work on the dike. Although the lake continued to rise it ceased to be a problem from that time. We continued carefully removing the mud cover (Fig. 9).

The excavation had an amazing effect on all involved. Kibbutziniks from Ginosar finished their own work and then joined us in the mud for another eight or ten hours a day (Fig. 10). People worked until they dropped. Volunteers from the neighboring Moshav of Migdal and from all over the country began to show up and to help. Despite the tremendous pressures on all of us, we worked as a team for a common purpose.

As the wood was revealed white plastic string was used to differentiate the planking; each wooden member was tagged (Fig. 11). As mud was removed it was necessary to build a hanging scaffolding on which excavators worked while lying on their stomaches (Fig. 12). The metal frame also supported a nylon tarpaulin which helped protect the wood from the harsh sun. By the time Steffy arrived, much of the boat's interior had been revealed.

While enlarging the pit around the boat, remains of two additional wrecks were found. These were examined recorded and reburied. To have done otherwise would have required more effort than we could afford and would have endangered the main objective.

The archaeological part of the excavation was completed by the eighth day of the dig (Fig. 13). The remaining days were devoted to the conservation and packaging of the boat for its removal to the Yigal Allon Museum in Kibbutz Ginosar, a distance of about 500 m.

The boat measures 8.2 meters by 2.3 meters; the wood looked sturdy, but was waterlogged and could not support its own weight. After consulting numerous experts, Orna Cohen, the excavation's conservationist, invented her own method for packaging the boat. She decided to strengthen the hull internally and externally with fiberglass frames and trusses and then cover the entire boat with a polyurethane "strait jacket".

Ginosar members, well versed in constructing and repairing the Kibbutz's fiberglass boats, went to work on the frames (Fig. 14). Once these were completed the entire interior of the hull was spray-filled with polyurethane. This took place at night under the light of the fishing lanterns. The chemical, sprayed on as a dark liquid, quickly foams and hardens; under the lamps it seemed to be a living substance engulfing the boat.

The following day we began to dig perpendicular tunnels beneath the boat; this revealed additional elements of the boat's construction. Fiberglass trusses were passed through these and secured around the hull's exterior. The tunnels were then filled with polyurethane foam which hardened into supportive external frames. Once braced, the remaining mud was excavated in sections and the process repeated until the entire boat was covered in a synthetic "cocoon" (Fig. 15).

On February 26th, eleven days after the excavation had begun, the pumps that had been used to keep the ground water form inundating the site were reversed and water was pumped into the excavation pit as a channel was dug to the lake through our precious dike (Fig. 16). The boat sailed the placid waters of the Kinneret for the first time in two millennia (Fig. 17). It was floated to the Allon Museum where it was placed on land by a huge crane (Fig. 18).

Within a record ten days, the museum built a reinforced concrete conservation pool. The boat was then lifted by crane and gently placed inside the pool (Fig. 19). Laboriously, the polyurethane was removed and the boat was submerged in water to prevent the wood from dehydrating until the conservation process begins.

The pool has been enclosed by a building which includes a glass encased viewers' gallery where the boat is now visited by thousands each month. PEG treatment of the boat has begun, thanks to a generous donation of 40 tons of PEG by Jacobson Agencies, Ltd., a subsidiary of DOW Chemicals (Fig. 20).

Shelley Wachsmann
Israel Antiquities Authority
Po. Box 586, Jerusalem
91004 Israel

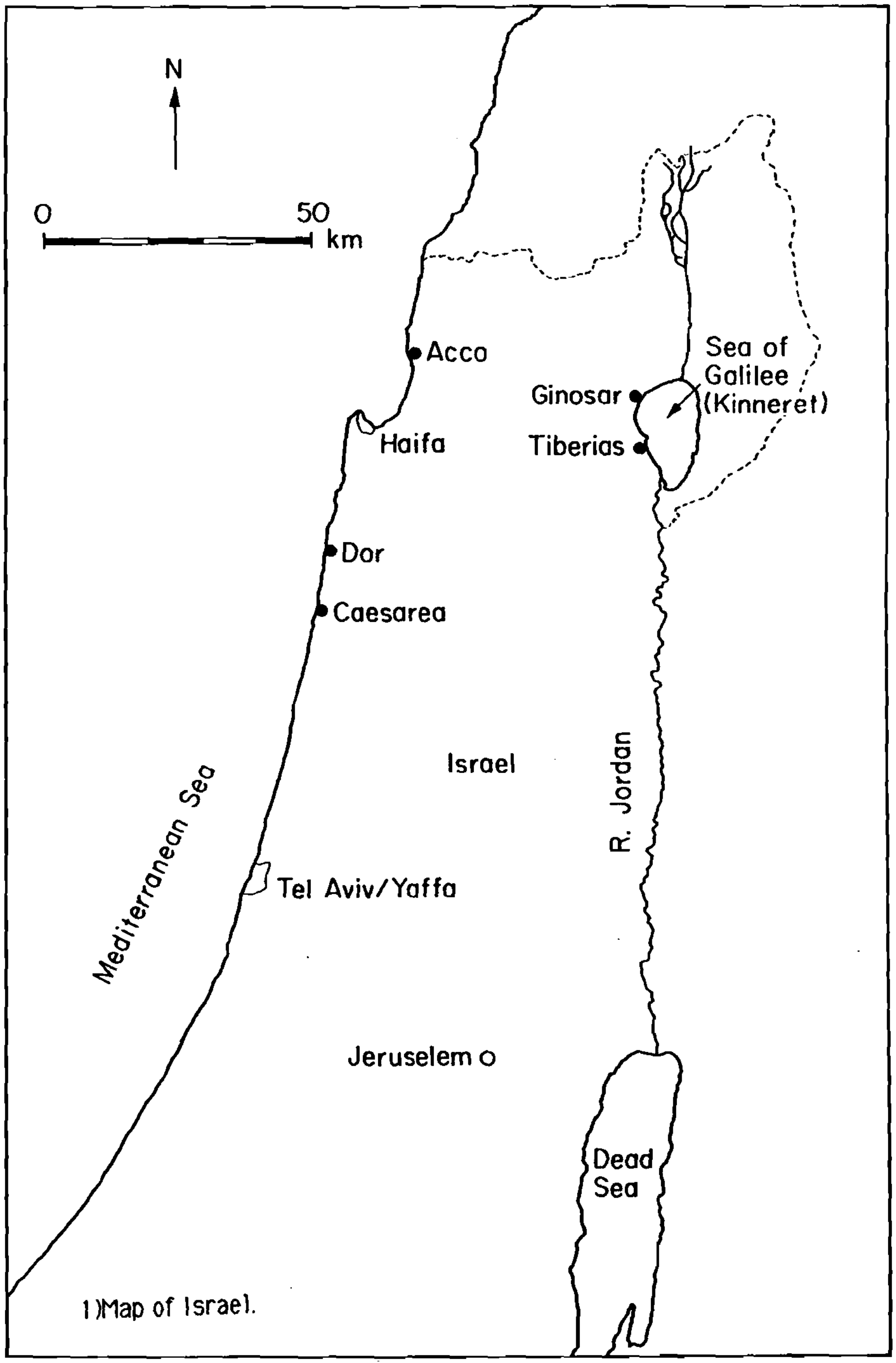
NOTES

1. The excavation staff included: Kurt Raveh, assistant excavtor; Orna Cohen, Conservationist; Danny Syon (Friedman), photographer; Edna Amos, Registrar; and Moshe and Yuval Lufan acted as liaisons with Kibbutz Ginosar.

ILLUSTRATIONS

All photos courtesy of Israel Antiquities Authority. Photos 3-4: S. Wachsmann: photos 7-20: D. Syon (Friedman).

1) Map of Israel.
2) Map of the Kinneret (Sea of Galilee) showing the discovery site of the boat.
3) View of the site during the probe excavation. The boat had been eroded to the height of the mud.
4) View of one of the sections cut on the southern side of the boat during the probe excavation. White plastic wire indicates the junction between planks; plastic dots indicate mortise-and-tenon peg heads.
5) The cooking pot.
6) The oil lamp.
7) The first night of excavation on the boat (Sunday, 16 February 1986).
8) The boat as it appeared on the second morning of excavation (17 February 1986).
9) Until the arrival of conservationist Orna Cohen, on the second day of excavation, care was taken to leave a protective layer of mud covering the hull while earth was removed from inside it.
10) Frames begin to appear in the stern from under the mud cover removed by a volunteer from Kibbutz Ginosar.
11) Each wooden part was numbered and white plastic tubing was placed between the planks to facilitate recording the hull.
12) Wooden planks provided a useful, albeit uncomfortable, perch for workers. The planks allowed workers to excavate inside the boat wihtout standing on the fragile, waterlogged timbers.
13) The boat in an advanced stage of excavation.
14) Internal fiberglass/polyester resin frames are laid between the wooden frames to strengthen the hull for removal.
15) At the conclusion of the packaging process the boat had been entirely encased in a polyurethane cocoon. Wooden boards gave the construction additional structural support.
16) Water was pumped into the excavation pit, floating the boat. When the water in the pool was at lake level a steam shovel excavated a channel between the pit and the lake.
17) The boat was floated out into the lake, sailing the Sea of Galilee for the first time in two millennia.
18) The boat was brought opposite the Allon Museum and lifted on to land by a huge crane.
19) Within a record ten days a reinforced concrete conservation pool was built by the museum. The boat was then placed inside the pool.
20) The boat in its conservation pool, prior to the introduction of PEG.



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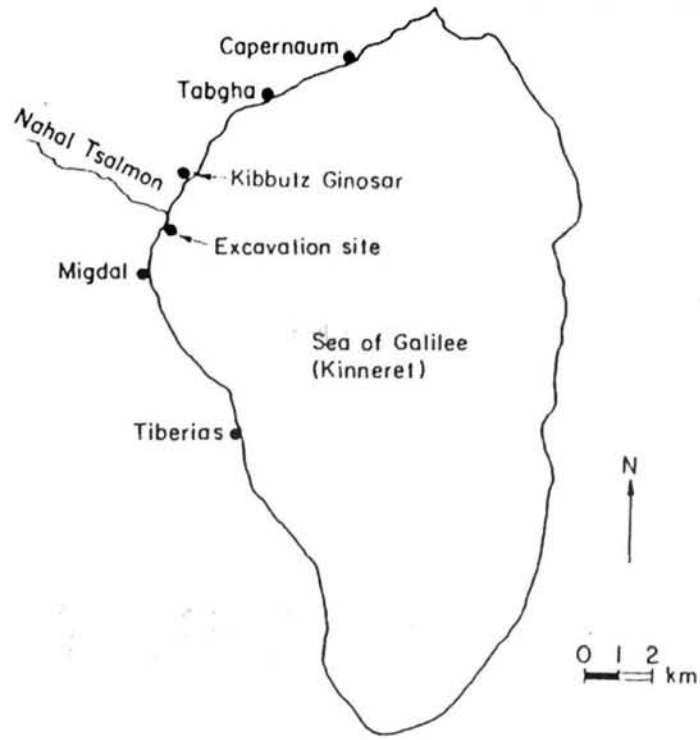

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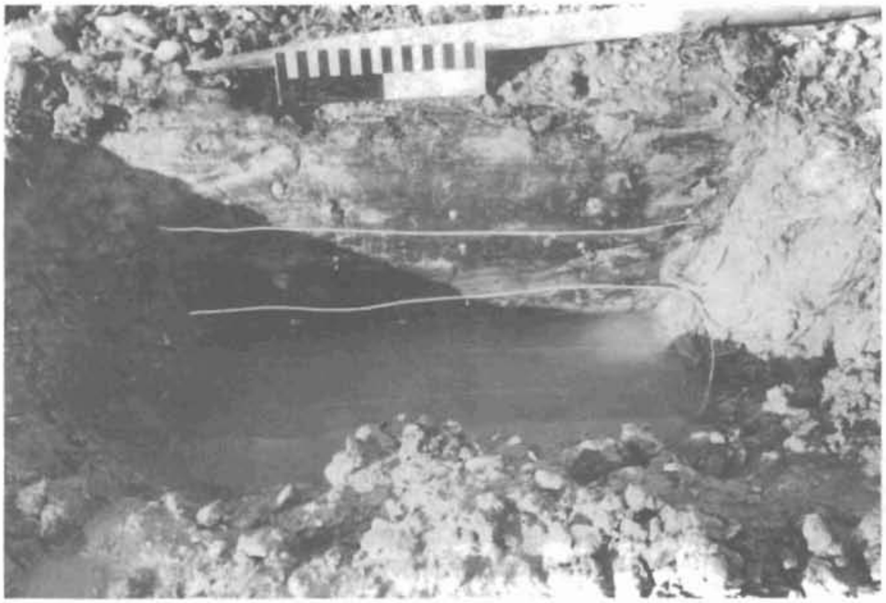
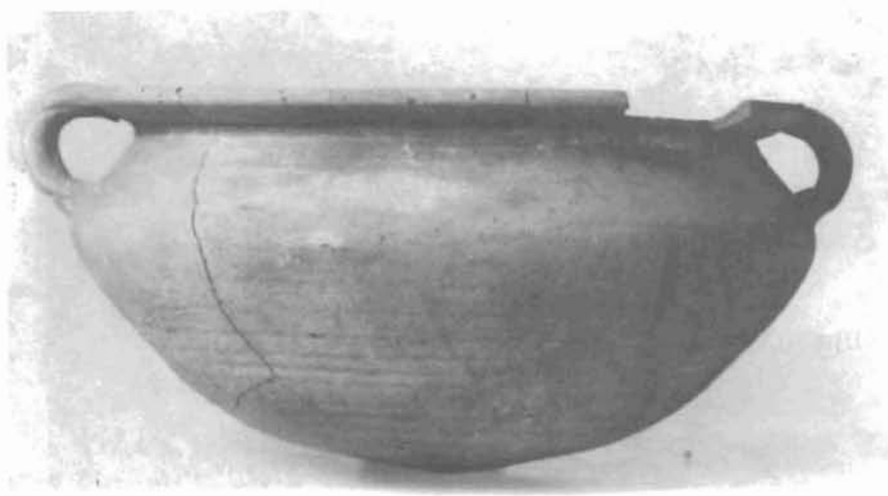


4)View of one of the sections cut on the southern side of the boat during the probe excavation. White plastic wire indicates the junction between planks; plastic dots indicate mortise-and-tenon peg heads. Courtesy Israel Antiquities Authority. Photo: S. Wachsmann.



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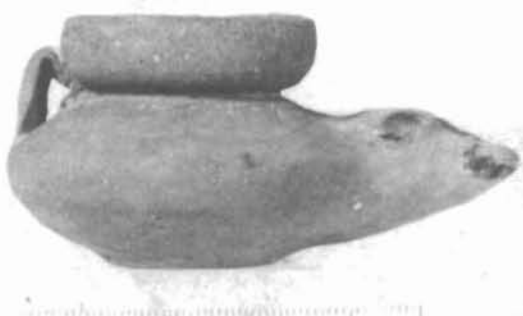

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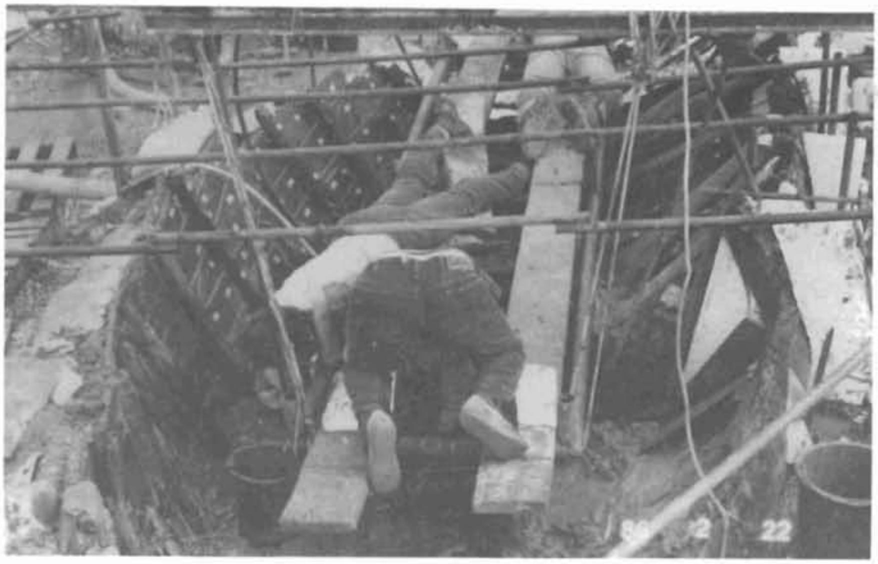
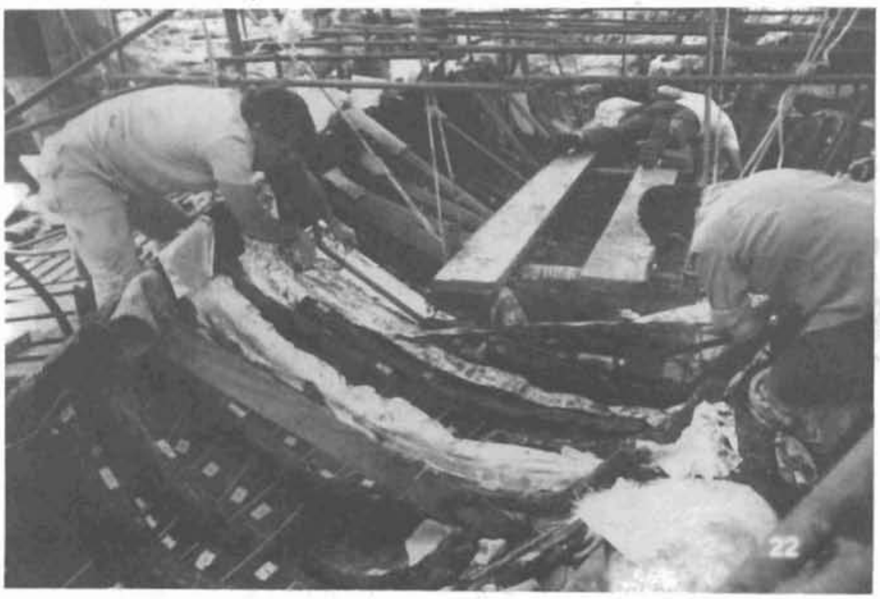


13)The boat in an advanced stage of excavation. Courtesy Israel Antiquities Authority. Photo: D. Syon (Friedman).



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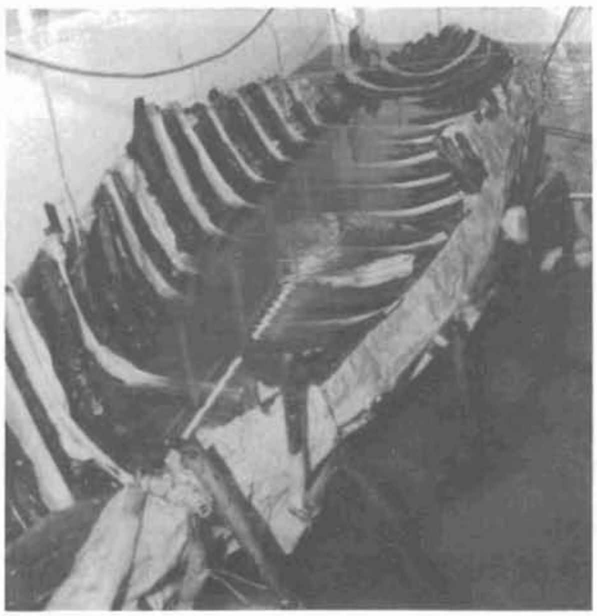

20)The boat in its conservation pool, prior to the introduction of PEG. Courtesy Israel Antiquities Authority. Photo: D. Syon (Friedman).