ON THE OBSIDIAN TRAIL

With a papyrus craft in the Cyclades

This paper deals with an attempt at experimental archaeology concerning the construction and the voyages of a seacraft made of papyrus.

What led me to undertake this programme, were the archaeological excavations that started in 1967 at the Franchthi Cave in the bay of Koilada, Argolis.

The excavations under the direction of Professor Thomas Jacobsen continued through 1979 and brought to light important information on the life of the inhabitants of this region during the Paleolithic, Mesolithic and Neolithic periods.[1]

What, however, is of particular interest to scholars researching early maritime history is that in this cave, obsidian dated to circa 9000 BC was found.

The provenance of this obsidian is the island of Melos. Consequently, it can be assumed that some 11000 years ago people who lived in the South-Eastern Peloponnese travelled to the Cyclades or were in direct or indirect contact with "mariners" who had the ability to undertake such voyages in the open sea.

We are thus faced with the earliest tangible evidence in the world of an open-sea voyage.

In the mid 70's when I first became aware of this discovery, the question asked was: with what means of transport did the voyage from Melos to the mainland take place.

Having studied the little we know of the conditions prevailing in Mesolithic times, such as: the geographic area, the way of life of those primitive people, the tools they used, the possibilities that these tools afforded, and the climatological conditions, I was led to formulate the hypothesis that a craft made of papyrus was the likeliest to have been built and navigated in 11000 years BP.

A determining factor in my choice was certainly the fact that a small papyrus-made seacraft, locally known as a *papyrella* still "survived" on the island of Corfu.

This small craft was studied by the Corfiot Archaeologist and Ethnologist, Prof. Augustus Sordinas[2] and is reported by Paul Johnstone,[3] Thor Heyerdahl[4] and more recently by Captain A.I. Tzamtzis.[5]

I believe that the question of what type of craft were used to transport the obsidian found in the cave of Franchti will never be answered. We can however formulate an educated guess supported by a programme of experimental archaeology.

I started my quest in 1984, and in 1987 my work was placed under the auspices of the Hellenic Institute for the Preservation of Nautical Tradition.

The search led me to communicate with and meet the excavator of the Franchthi Cave, Prof. Thomas Jacobsen, who gave me invaluable information on the finds and encouraged me in proceeding with the programme. I also had the opportunity to gain information on stone tools from a specialist, Prof. Curtis Runnels and at a later stage I was fortunate in meeting Prof. Catherine Perlès the specialist on flint tools and obsidian, who has studied, dated and published the Franchthi Cave microlithic industry.

From the information obtained it became clear that the limitations imposed by stone tools did not allow people of the Late Paleolitic and Mesolithic to build complicated seacraft made with planks and frames. I believe that this type of advanced marine construction made its appearance in the Aegean at least 6000 - 7000 years later with the introduction of bronze tools.

Excluding the planked boats, however, did leave other possibilities: the dugout, the craft made of sewn hides, and rafts made of inflated hides or tree logs. The above constructions and their numerous derivations could have been built with the available tools and the technology of that time.

I eliminated the dugout as its seagoing capabilities would have made it, in my opinion, unsuitable to face the often rough sea conditions of the Aegean. For

the same reason I did not attempt to duplicate the small craft made of sewn hides of Messopotamia and Northern Europe, while Tim Severin's replica inspired by the Medieval voyage of St. Brendan[6] is too elaborate a craft for any stone age constructor.

That left the craft made of papyrus. It combines most of the positive features:

a) Papyrus can easily be cut with a stone tool.
b) It can easily be lashed together in bundles with vegetable fibers or leather strips.
c) It has great buoyancy.
d) There is wide proved evidence that such craft were built in Egypt and in other parts of the Mediterranean.
e) Two large papyrus craft, the RA I and RA II, sailed across the Atlantic.
f) Papyrus existed in Greece in Antiquity[7] and a specimen of papyrus still grows in North-Eastern Corfu in a lake called Kavourolimni in the Ghialinas property.[8]

I also investigated the construction of papyrus and reed craft that have survived until today in the Middle East, Southern Italy and South America, but as the intended construction had to be as "locally authentic" as possible, no foreign elements were "incorporated" and I confined myself strictly to the Corfiot *papyrella.*

While it was believed that the Corfiot *papyrella* was extinct and that the only known examples were the crafts made in the 1970's for the Museum of Exeter,[9] the Maritime Museum of Greece in Piraeus,[10] the Folklore Museum of Central Corfu[11], our persistent search in Corfu revealed the existence of the last *papyrella* still in use. We found it in Palaiokastritsa - a bay in North-Western Corfu - and it was used for lobster fishing. It had the advantage of unquestionable authenticity as it was built for everyday use and not as a museum exhibit[12].

The frame of the Palaiokastritsa *papyrella* was made in 1965, and the bundles of papyrus were replaced every 2 - 3 years.

Let me describe the very simple method of construction of the Corfiot *papyrella*:

The craft is composed of a frame made of six young cypresses cut and bent when still green. They are lashed together with a rope at their thinnest ends and are bent in a manner as to form a raised stern. The main part of the boat is composed of bundles of "papyrus" (the Corfiots call this diminutive papyrus *papyri*) cut from the nearby lake of Kavourolimni.

The length of each bundle is defined by the length of the papyrus, which reaches approximatively 2.50 metres. Thus the length of the *papyrella* is, in a way, limited by the length of the bundles. The framework made of cypresses keeps its curved shape at one end when dried, and the papyrus bundles, closely bound together between wooden planks, form the body of the craft. These roughly cut planks tightly hold the papyrus bundles lashed between the lower planks (bottom) and the upper planks (deck) in a sandwich manner. No nails, pegs or any fastenings are needed; only many metres of rope, firmly tied with numerous knots.

The local tradition, as recorded by Prof. Sordinas, refers to "double - ended *papyrellas*" made of two crafts joined stern to stern by means of *pountellia*. Neither Prof. Sordinas nor the local people had the slightest idea of how the joining was done, nor could they explain what the *pountellia* are[13].

I discussed my intention to build a double-ended *papyrella* that could undertake an open sea voyage in the Aegean with Prof. Sordinas, Captain A.I. Tzamtzis, Spyros Tsamis (Mihalas) son of the last *papyrella* builder from the village of Liapades (then aged 87) and Spyros Mihalas of Palaiokastritsa, owner of the last "papyrella" in use. All of them encouraged my attempt and promised to help with their knowledge.

A seaman from Liapades, Spyros Agathos-Gianitsellis agreed to undertake the construction of the proposed craft.

After explaining to Spyros the scope of the programme and after gathering locally the necessary first-hand information concerning the method of construction, he was left on his own to build a reduced model on a *1:2* scale of a double ended *papyrella*.

It took Spyros two weeks to build a 2.70 metre double-ended craft using the same technology as the traditional cut-stern craft.

During the Summer of 1987, I made brief sea-trials and paddled the scale model in a bay near the village of Liapades. Its stability, buoyancy and speed were satisfactory and the builder was asked to go ahead with the construction of the larger craft.

The construction started in Liapades in early November 1987 and took most of the 1987-88 winter.

Originally we thought that 30 days would suffice, but eventually three full months were needed. Only two or three days are required for the construction of

the traditional *papyrella*, but the time taken to build our double-ended craft was due to the following reasons:

1) The builder had never built a papyrus craft before.
2) He was working alone.
3) He had constantly to ask for advice from the old man in the village who was specialized in the construction, but was blind and had difficulty in moving.
4) The double-ended *papyrella* is twice the length of the traditional craft but its bulk is at least 6 times greater.
5) The traditional Corfiot *papyrella* is very light and can be easily lifted single-handed. Our craft weights over 100 Kg and is certainly a more complex construction, although it follows the same traditional design.

With the experience gained in building our papyrus craft, I believe that 12 days would suffice if we were to build a similar one today.

The method of construction of both craft is identical except for the following differences:

The single-ended *papyrella* is a craft with a cut stern of 2.50 metres in length, a beam of 1.10 metre at the stern and a total maximum thickness at the stern of 44 cm. Bundles forming the bulwarks have a hight of 13 cms. Our double-ended craft has a total length of 5.48 cm, the beam amidship is 1.50 metre. The thickness of the body averages 50 cm and the height of the bulwark-bundles is of 13 cm. To build it, 12 young cypresses were cut. Such cypresses grow among the large trees, in their shade, and in trying to reach the daylight their trunk remains very thin and slim. Each two cypresses were strongly lashed together at their thicker ends, to form a total length for the pair of approximately 6 metres.

The 6 pairs of cypresses were laid side by side and spaced approximately 25cm apart. A roughly cut plank of 110 cm long, 25 cm wide and 3.5 cm thick was placed under the cypresses at the point where they are lashed together in pairs. Holes were opened in such a way that a rope through them keeps the cradle thus formed in position. Both extremities were then lashed together and pulled in the direction of the center of the craft by a tension rope; thus forming a raised stern and stem. Day after day the pressure on the tension rope that held the two ends was increased, adding to the curvature. After two weeks, when the cypresses dried, the curved ends kept their raised shape.

The construction continued and 10 more planks were placed under the cypress frame -work, between the central plank and the ends of the craft (5+5). Each plank was pierced and lashed tightly with sisal rope to the stalks in the same manner as the central plank.

Now the "cradle" that formed the underbody of this flat bottomed craft was laid and bundles of papyrus were placed on it to build the body.

Eleven wooden planks similar in size to the ones forming the bottom were placed above the papyrus bundles. Holes were made in these planks too and a "sandwich" was formed with the *papyri* caught tightly between the wooden planks, squeezed by strong rope-lashing.

As for the Corfiot *papyrella*, the craft was completed by forming a "bulwark" around the edges, using bundles of papyrus to keep out the water in a choppy sea.

With the exception of the wooden planks, the whole of the craft was made of unprocessed materials:

a) cypress stalks, that could easily have been cut and cleared of their branches by using small stone adzes,
b) papyrus, that is easily cut with a flint tool or obsidian blade,
c) the sisal rope we used, although a vegetable fibre, is certainly a processed industrial product, but the lashing could without much difficulty have been achieved by stone age builders with vegetable fibre or by using strips of leather. Actually, if we were to repeat the trial, I would use leather-lashing, which is more resistant to damp than the vegetable rope.

The planks we used were made of pine, adzed to obtain a smoother surface. A bow drill was used to make a few holes, and then for practical reasons we used an electric drill. Having discussed the matter with specialists in stone-age tools, I am led to believe that such simple planks could be made using small stone adzes and flint scrapers, while making the holes with a bow drill is a much simpler matter.

One may be surprised by the strong resemblance of the completed craft to those depicted in Ancient Egypt. Our builder, however, was not influenced by such representations, of which he had no knowledge. But it would have been very difficult, if not impossible, to obtain a different form. The shape of the papyrus, which starts thick at the root and becomes extremely thin at the top-end, is what predetermines the shape of the boat. I believe that it is this primitive shape of the papyrus boats that influenced the profile of most of the later vessels in the Eastern Mediterranean. Some ships depicted on Minoan[14] seals are typical examples. I

also believe that the *aflasta* and *akrostolia* of historical times are relics of the "uncut" papyrus ends seen on the extremities of earlier craft. These "papyriform" decorations were probably passed from generation to generation, influencing even the *ἄφλαστον* of the *trieres*.

After the construction was completed, the craft was transported from Corfu to Lavrion in Attica, where it was decided that the trial voyages would take place.

At that stage I had to decide on the mode of propulsion of the craft and in my opinion it had to be moved solely with paddles.

A mast in the shape of a "Λ" for setting a square sail, could easily be stepped but this means of propulsion was not considered. The first known representation of a ship[15] with sail dates from circa 3200 BC and in my opinion it would have been arbitrary and unscientific to anticipate 5000/6000 years and place a sail on our craft. Placing a sail would require some sort of keel and a steering mechanism. And if we had used such "advanced" techniques for such a primitive craft, the experiment would have been artificial and have lost its scientific value.

Having studied the known representations of early boats and the methods of propulsion of primitive crafts used by people who lived or still live in similar conditions to those in the stone age, I decided to use solely paddles to move the *papyrella*. Paddles, however, also presented problems when we came to decide on their shape.

Then the problem arose of recruiting a proper crew to paddle such a heavy craft.

We started the first short sea-trials using a crew of five members of our Institute that had neither experience in paddling nor in seamanship.

It became apparent that our craft had great stability, excellent buoyancy and could easily take 5-6 paddlers, as well as a reasonable amount of fresh water - in goat-skin bags - provisions and a limited load, duplicating a possible ancient cargo of some 30 Kg in three straw baskets.

I was aware that the Corfiot *papyrellas*, at least in the recent past, were used not by "professional" seamen or fishermen, but by farmers. Influenced by this, I assumed that in the remote 9000 BC, hunters and fruit-gatherers occasionally became mariners. So I kept experimenting using different crew.

The first crew of non-seamen, who had no knowledge of rowing or paddling, although composed of strong young men, became exhausted after a distance of only one nautical mile.

We then experimented with well-trained, physically fit seamen, who knew how to row a boat using oars secured to tholepins. The performance improved, but it became obvious that to propel a craft with paddles requires a special training.

It was calculated that a one knot minimum speed had to be achieved. If this minimum speed could not be reached then the voyage to Melos would not be possible, because of the considerable distance separating the islands leading to Melos. That one knot speed limit was reached by the first paddlers we tried, but only for half an hour. Such a pace could not be maintained during extended crossings.

It is not at all surprising that our craft was so slow, as the method of construction duplicating the Corfiot *papyrella*, with the transversal boards under her flat bottom, goes against the laws of hydrodynamics. So the first trials were far from encouraging.

But still, I reasoned: "Obsidian was transported from Melos to the mainland during the Mesolithic period and our craft seems to have the capability of making such a voyage, therefore what we now need is an adequate crew, able to paddle over long distances: well-trained men who will be able to "conquer" the long crossings between the islands." So my main concern became to recruit proper "kayak" athletes to volunteer as crew for our project.

During other nautical attempts of Experimental Archaeology, (and I shall refer only to the most well-known: the KON-TIKI, the RA I and RA II, the medieval Scandinavian vessels, the voyage of the Brendan, the Kyrenia II), the method of propulsion was the wind. The most important piece of equipment on the ship was the sail. In the case of the *papyrella*, it was a totally different matter; the propelling force was man himself and the most important piece of equipment was the paddle.

It is worth stressing that from the moment the sail made its appearance in the Aegean, probably in the 2nd millennium BC and until the first half of the 20th c., people living in this area have not stopped using it. The skill for working a sail has been transmitted by the islanders from father to son without interruption.

For the paddle-propelled craft of the "kayak" or "canoe" type, the situation is totally different. With the appearance of the sail and with the acquisition of advanced shipbuilding techniques during the bronze age, this primitive way of propulsion, with paddles, came abruptly to an end and was lost for the Aegean[16].

Thus, it is not surprising that the words "paddle" and "paddling" have not survived, even in the oldest texts of the Greek language[17].

Wherever the sailing ship needed an alternative moving-force, say for manoeuvring, oars attached to tholepins were used. Such oars survived on small Greek sea craft until today.

On the Thera frescoes rowing and paddling co-exists together with ships carrying a sail. It is, however, believed that the depiction of the Thera paddlers - in their impossible position - is ceremonial and refers to a means of propulsion long out of use.

As the use of paddles in the Aegean has been interrupted for thousands of years, this hiatus means that we cannot expect to gain any help from local tradition. This may also lead to the conclusion that in the Early Bronze Age there was a boom in Aegean shipbuilding and seafaring, while in other parts of the world, where paddling has survived, the craft used have remained primitive and no evolution was achieved. Thus it can safely be said that wherever paddling has survived there has been no evolution in shipbuilding.

But one may ask: how is the Corfiot *papyrella* propelled? A long pole with a blade at each end called a *σταλίκη* is used by its single occupant, who stands in the style of the fishermen of the Messolonghi laguna. The pole has a total length of 2.30 metres including the two blades which have a length of 50 cm each. But as previously stated, the minuscule Corfiot *papyrella* is now only used for lobster catching in secluded bays and not in the open sea.

Putting together a crew of 5-6 paddlers proved quite difficult, as "kayak" athletes are scarce in Greece.

During the summer of 1988 twelve short sea-trials were performed. These voyages took place in the Lavrion area and the crew gained experience in moving our papyrus-craft under different weather conditions and with winds of various forces coming from different directions.

These voyages confirmed the original confidence I had in the sturdiness of the craft and her nautical capabilities.

Paddles with blades of different shapes were used and the paddlers sat and stood in various positions. We studied the scant evidence of types of prehistoric paddles that have been found in northern Europe[18], but I did not insist on making replicas of such paddles as I do not consider these cumbersome specimens as representative of what may have been the prehistoric Aegean paddles.

I concentrated on studying the iconography of ancient Egyptian paddles, and especially the shape of the paddle blades used by primitive tribes over the last two centuries in Africa, Asia, South and North America.

Finally, being pressed for time, I compromised for the ready available "Menzeler" "kayak" paddles - with a single blade to each paddle - whose design derives from primitive ones. The stern paddler used a paddle with double blades - one at each end; this mode of paddling helps in steering the craft and maintaining it on course.

The trials also proved that my original hypothesis that the "sea-going-travellers" of the Mesolithic age could have been non-specialized seamen, was erroneous. Such long and strenuous crossings could not have been undertaken by hunters and fruit-gatherers, who occasionally turned mariners.

In my opinion, it was proved, beyond doubt, that travelling in the open of the Aegean with a papyrus craft is not a simple matter suitable for amateurs. Specialized seamen with strong arms capable of exhausting paddling, coupled with nautical skills were required. Another of my assumptions, that had to be modified, after the knowledge gained from the first trials, was the route to be followed. Originally, when I envisaged the voyage to Melos I thought of a Franchti - Melos itinerary and vice-versa, via a circumnavigation of the Saronic gulf. Direct crossing from the Peloponnese to the Cyclades is probably beyond the capabilities of any paddlers, ancient or modern, and involves great risks[19]. I was also under the wrong impression that during that remote past, a voyage by sea would have been briefer and easier than a land voyage on foot. This reasoning, however, is correct only for much later years, when ship construction had evolved, the sail appeared and sea routes were opened, and such criteria are not applicable for the period of our quest.

A voyage from Franchthi to Melos via the coasts of the Argo-Saronic Gulf and Sounion would have been very arduous. It would have required much more time than the combination of a land voyage from the Argolis to Attica and a sea-crossing from Lavrion to Melos.

A sea route is advantageous when a large cargo has to be transported and when a "proper" sea craft is available. I believe that this was not the case during the Mesolithic period.

The fact that obsidian was found in the Franchti Cave, dated from circa 9000 BC (the earliest obsidian in Greece), does not necessarily mean that such early

obsidian exists only in that location. Actually, the extremely small quantities found at Franchti corresponding to that period may well be an indication that the obsidian did not reach this settlement directly from Melos. It is most probable that the dwellers in Mesolithic Franchthi had never been to Melos and may have been ignorant of the provenance of this mineral.

In contrast to Franchti, the Lavrion district is a most suitable location that could have been used very early as a transit center for obsidian.

The Lavrion district is the nearest mainland to Melos and Makronissos - an island today - was very probably in the Mesolithic period a peninsula, attached to Attica. The whole area is scattered with splinters of obsidian and although no such material found in Lavrion has been dated to the early Mesolithic, this wide scattering of obsidian should make us wonder as to the causes of this concentration.

Many caves used by early settlers that were near the coast may today be below the present sea level, concealing obsidian tools of the 8000 - 9000 BC or earlier. It is a fact that in many locations of the Aegean the sea has risen by 50 to 100 metres during the last 10000 years[20]. This however should not lead us to the erroneous conclusion that the geography of the Cyclades 11000 - 10000 years ago, was dramatically different from what it is today. That there was more land on the islands is a valid conclusion, but the changes affect only limited areas of the perimetre of each island and because of the great depth of the sea the difference in the sea level did not alter the land mass to such an extent as to influence the navigable distances between the islands. When I tried to investigate the possibility of drawing a chart of the Cyclades showing these islands approximately as they were 10000 - 11000 BP, I was dissuaded in my attempt by the scientists of the Institute of Geological and Metallurgical Researche of Athens. It was made clear that such a task would be impossible, as each area should be independently surveyed, because the geological changes are not only the result of the rise in the sea level, but also of tectonic phenomena and volcanic action.

At the end of the summer of 1988 we were ready to start the voyage from Lavrion to Melos.

After the repeated sea-trials the *papyrella* was still in very good condition and the paddlers sufficiently trained.

A date had to be set for the commencement of the voyage. It is known that a strong North-East wind, the *Meltemi*, blows in the Aegean from Mid July to Mid September and usually drops at the end of September; during October we have

calmer seas. So it was decided to start the voyage on the 8th of October.

We figured that 7 days would be needed to reach Melos stopping at one, two or three locations at each of the islands that link Lavrion to the island of the obsidian. Unfortunately, the weather conditions were unusually adverse and the little "Indian Summer" typical for the month of October did not occur.

The route followed by the *papyrella* was the following:

8 October: **LAVRION - BAY OF GAIDOUROMANDRA**
1½ n. miles - 1 hour paddling.

9 October: **GAIDOUROMANDRA - MAKRONISSOS (CAPE ANGALISTROS)**
3 n. miles + 1 n. mile drift - 3 hours 25 min. paddling.

10 October: **MAKRONISSOS - KEA (KOUNDOUROS BAY or BAY KAVADIA) - (CAPE TAMELOS)**
12½ n. miles + 1 n. mile drift - 8 hours 20 min. paddling.

11 October: **KEA (CAPE TAMELOS) - KYTHNOS (1½ N.M. SOUTH OF MERIHAS BAY)**
11½ n. miles + 2 n. miles drift - 7 hours paddling.

12 October: **KYTHNOS (S. OF MERIHAS BAY) - (CAPE AGHIOS DIMITRIOS) - SERIFOS (BAY AVESSALOS) - (BAY LIVADI)**
13½ n. miles + 1 n. mile drift - 7 hours 30 min. paddling.

Note: From the Bay of Avessalos the *papyrella* was transported to the Bay of Livadi as the weather was deteriorating and the escort vessel had to seek shelter in a protected area. Between the 13th and the 20th of October the *papyrella* remained immobilised in Serifos because of extremely bad weather. Winds of 7 and 8 Beaufort strength were blowing.

21 October: **SERIFOS (VOUS ISLET) - SERIFOS (KAMARES BAY)**
11n. miles + 3 n. miles drift - 10 hours 30 min. paddling.

22 October: **SIFNOS (KAMARES BAY) - KIMOLOS (CAPE KENTROS) - (STRAITS PIRYI)**
14 n. miles + 1 n. mile drift - 9½ hours paddling.

23 October: **KIMOLOS (STRAITS PIRYI) - (STRAITS KIMOLOS) - (CAPE LAKIDHA) - MELOS (ADAMAS BAY)**
5 n. miles - 4½ hours paddling.

Note: Because of very heavy rain the craft was transported from the straits of Kimolos to Cape Lakidha.

The *Papyrella* was paddled over a total distance of 72½ nautical miles for 51 hours 45 minutes, thus averaging a speed of 1,65 knots per hour. The total drift was calculated to be some 9 n. miles.

The distance was covered in 8 days, (in fact 7 days, as the first day's paddling was only for 1½ hours) while the craft remained immobilized in Serifos for another 8 days due to bad weather. I believe that our ancestors of the stone age, would have done the same in the case of adverse weather conditions. They would have waited for calmer sea.

The double-ended papyrus craft was paddled under very different weather conditions, from flat calm to 5-6 Beaufort. In some instances, the height of the waves was 1.20 m to 1.50 m. The prevailing winds were North-North East. A pronounced sea current from the North-East direction prevailed. This often resulted in driving the craft off-course.

Most of the voyage was made under a clear sky and in warm weather (16°C-27°C). Only on the last day was the craft paddled in the rain.

The crew consisted of 5 paddlers but there were times when a 6th paddler was used (four men and two women). The *papyrella* was paddled only in daytime except when starting, as she left Lavrion at night because of the delay in the departure ceremony.

Studying all the data of this voyage (which were meticulously noted in a log by the observers of the experiment that accompanied the *papyrella* on board the escort vessel), I believe that under more favourable weather conditions, by making slight modifications and reasonable "improvements" to the craft and after a better training of the paddlers, a voyage from Lavrion to Melos could be made in 4 or 5 days.

Some modifications, "improvements", to the *papyrella* could be envisaged should another similar craft be built in the future. Those modifications are described below:

1. The overall construction should be made lighter. Our builder's overcautiousness in producing a robust craft able to face the waves of the Aegean led him to build an unnecessarily heavy frame-work with an excessive weight, sturdiness and rigidity.
2. The flat bottom of the craft must certainly be maintained, but the thickness of the transversal lower exterior planks should be limited, as this acts negatively on the hydrodynamic and reduces the "hull speed". It also creates a problem in keeping the craft "on course" and increases its drift.

3. It would be preferable to use leather strips to lash the papyrus bundles and the other parts of the *papyrella* as the vegetable rope has proved weak and looses its strength when kept wet for long periods.

It should also be noted that the effort of the paddlers during this experiemental voyage was carefully monitored by a scientist of the Hellenic Sports Research Institute of Athens who accompanied the Archaeologists-Observers on the escort ship.

During all the voyage, the paddlers were equipped with electronic sensors that recorded their heart performance, and after each of the paddled stretches they were submitted to medical examinations. So their heart activity, blood pressure and general physical condition were closely monitored - from a computer installed on the escort vessel - during the effort produced and after their daily performance. The study of the data led the specialists to believe that each of the paddlers used only 50% to 60% of his/her physical capacity.

A further voyage with the *papyrella* should be made in the future to investigate the possibilities of a return voyage from Melos to Lavrion. The paddlers will have to move against the sea-currents and probably face headwinds. This will not however be an insurmontable obstacle as paddling under such conditions has already been experienced successfully during some of the trial voyages.

I do not consider this programme of Experimental Archaeology finished, but some thoughts - if not conclusions - can be advanced based on the Lavrion-Melos voyage:

Let me first emphasize once again, that it has certainly not been proved that man living in this area of the Aegean 10000 - 11000 years ago used papyrus craft to transport obsidian - raw or worked - from the island of Melos to the nearest mainland. There will never be proof of how our ancestors of that early age ventured on the open sea. What our experiment has indicated is that a voyage in the Cyclades with a simple papyrus craft is feasible.

Many may wonder: but can it be that Mesolithic man voyaged in such small craft? Why did they not build larger sea-crafts?

The answer is that firstly, the larger a craft is the more difficult it is to construct. Secondly, one should also bear in mind that the decisive factors in deciding on the size of a vessel are the necessities of transportation prevailing at that specific time. In the period that concerns us, in some 9000 BC, the articles that could be exchanged were extremely limited. What could be "traded" between communities

that did not yet have domesticated animals, had no control over the crops, had no basic agricultural economy and had not yet invented pottery? What could be available to be transported by sea by these fruit gatherers and hunters? Perhaps animal skins, salted fish and sea shells, stone tools, flint, obsidian, simple decorative artefacts made of shells and stone and eventually some passengers.

Several millennia later, larger sea-going craft certainly became necessary to transport bulky cargos: ceramic receptacles, agricultural products and domesticated animals.

The timid first steps that were taken in the Mesolithic period, or even earlier, started a process that later led to a dense sea-trade in the Aegean and all the Eastern Mediterranean.

But would it have been possible 10000 - 11000 years ago for primitive man to undertake, even occasionally, such voyages to Melos, if this island and the other islands *en route* were deserted and uninhabited? Should we not contemplate the possibility that these fishermen and early seafarers had established small settlements on the shores of these islands scattered on the "obsidian trail"? May it not be that these islands were inhabited much earlier than the 5th, 6th or even the 7th millennia BC? May it not be that the remains of early man's activities are today submerged in the sea, covered by deep strata of sediments, or waiting to be uncovered by the archaeologist's spade in other caves of similar or even greater importance than Franchhti? This is another question that may be answered by future land and/or underwater excavations.

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NOTES

1 A list of publications about to the excavations at Franchthi Cave is given at the end of the selected bibliography.

2. Sordinas (1970). Σορδίνας (1977).

3 Johnstone (1980).

4 Heyerdahl (1971).

Dr. Thor Heyerdahl in a letter of 9 May 1988 to the author states that "... the *papyrella* undoubtedly

represents a rudimentary survival of a kind of watercraft that was in common use in North African waters since the dawn of civilisation. In fact, whenever we encounter descendants of the ancient forms of reed boats today, they have two prototypes, the one, which like the *papyrella* has a tranversally cut off stern, and the other with both bow and stern pointed and curved up. Both forms are represented in the ancient art of Messopotamia as well as in the rock paintings of *Tassili* where I saw them a few weeks ago. And I have seen both types in present-day Ethiopia respectively on Lake Chad and Lake Zwai. Both forms were used well into the present century in Lixus on the Atlantic coast of Marocco, and the *papyrella* form is only now disappearing from Sardinia. Even in Peru and Bolivia, both forms have survived side by side until the present-day, and the same on Easter Island. I therefore consider your experiment with a *papyrella* with both ends pointed up to be fully valid as far as shape is concerned."

5 Tzamtzis (1990).

6 Severin (1976).

7 At Delos' Sacred Lake two grains of *Cyperaceas* pollen were found. Evans, Renfrew (1968) also Warren (1976). Rackham (1979). Diapoulis (1980).

8 Contrary to what was commonly believed, the papyrus of Lake Kavourolimni - locally called *papyri* - is not *Ferula Communis L* but *Scirpus lacustris L. ssp. lacustris* of the *Cyperaceae* family, as is the Egyptian *Cyperus* papyrus. The crafts of Lake Titicaca are made of similar papyrus, locally called *Totora. Scirpus Californicus.*

9 This craft was built in 1976 by Nicolas Tsamis. *Exeter Maritime Museum guide.*

10 This *papyrella* was also built by Nicolas Tsamis in 1986.

11 Nicolas Paktitis founder of the Folklore Museum of Sanaràdon and president of the Folk-Historical Society of Central Corfu undertook in the early 70's the task of having a genuine *papyrella* built for that Museum.

12 This *papyrella* built and used by Spyros Mihalas from the village of Kolombi, Lakonias, Corfu was still in use during the summer of 1987.

13 Some old inhabitants of the village of Liapades, N-W Corfu, told us the story of the construction of the last double-ended *papyrella* that was secretly built in 1942 during the Italian occupation of the island. The occupation forces seized and later destroyed the craft to avoid *clandestine* activities. According to the same sources, before 1940, some double-ended *papyrellas* undertook long crossings to the shores of Albania and sometimes even to Italy. The feasibility of such lengthy crossings was discussed with Prof. A. Sordinas who does not believe that such voyage to Italy could be undertaken (A. Sordinas letter of 23 February 1989 to the author). However, during the prolonged exodus of Albanian emigrants in the years 1991-94, several minuscule crafts made of scrappy materials, of much inferior construction than the double-ended *papyrella* succesfully made their way from Albania to the coasts of Italy.

14 See Basch (1987), pages 95 to 106; in particular figures. A7, A8, C15, F12, F14, F15.

15 It is not certain which is the earliest representation of a ship. There are four depictions of boats, all from Egypt, dated between 4000 and 3050 BC. The most ancient is a small ship model at the University College (University College, London no. 9024). Landstrom (1970). A graffito on a palette datable 3700 BC depicts a fishing boat. Basch (1987). These are other representations of ships on Egyptian vases of circa 3500 BC Vandier (1952). See also Casson (1971) Le Baron Bowen Fr. (1960).

16 Prof. L. Casson believes that paddling in the Aegean sea was no longer in use in 1500 BC Casson (1975).

17 S. Marinatos had to "invent" a word to render in Greek the English paddle and paddling and the French "pagaie" and "pagayer". He used the homeric terms *ταροοπλεῖν* derived from *ταρσός*

for blade of an oar. Marinatos (1971). Similarly C.N. Rados proposes to hellenise the French word by using *παγαίας*.

18 Part of a primitive paddle dated circa 7500 BC was found at Star Carr, Yorkshire.

19 A Franchthi - Melos voyage would not have been much longer if the route Franchthi - Spetses - Dokos - Hydra - Stavronissi - Parapola - Karavi - Falkonera - Antimelos - Melos was selected. As far as Stavronissi paddling would present no difficulty,but afterwards the distances between the islets is great and these minuscule rocks do not offer any reasonable shelter, but more importantly Parapola, Karavi, and Falkonera would present very poor visual landmarks for any ancient mariner.

20 Van Andel, Lianos

I would also like to acknowledge the assistance of persons not mentioned in the text of my communication. I am indebted to: Dr.Yannis Vichos and Andreas Politis for their investigative work in Corfu during the early part of our research. To Marilena Vavouri-Kastana and the late George Kastanas for supervising some early phases of the construction. To Spyros Karamalis, former Manager of Olympic Marine, Lavrion, for offering shelter and assistance to our craft during the sea trials. To Dr. Nicos Lianos and Yannis Pantzopoulos for accompanying and supervising the voyage. To the archaeologist Marilena Vavouri-Kastana and Tassia Ramou for keeping the voyage log. To Dr. Stathis Styros for advising on the geology of the Aegean. To Dr. Constantin Pavlou Sc. D. Director of Exercise Physiology at the Hellenic Sports Research Institute of Athens, for helping with the study of the physical condition of the paddlers and to his assistant Catherina Dimitrakaki, for handling the high-technology medical instruments on board the escort vessel and interpreting the records. And lastly to Captain Tony Dardaghanis and the crew of the escort ship "KYMA ALPHA".

Last but not least, my gratitude goes to the team of paddlers headed by Elias Mamounas, (in alphabetical order): H. Katsafados, A. Kondoskidis, L. Savidis, G. Stassinopoulos, A. Tsandoulas, P. Tsandoula, M. Valianou; to Theodor Troev who made most of the coloured transparencies and photographs and to the shipowner Constantin Lyras, Owner of the Ghialina property, who authorized the "harvesting" of the necessary *papyri* to build the *papyrella.*

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Abbreviations: *AAA*: Athens Annals of Archaeology.

AJA: American Journal of Archaeology.

IJNA: International Journal of Nautical Archaeology and Underwater Exploration.

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ILLUSTRATIONS

Fig. 1 The double ended *papyrella.* (Drawing by K. Damianidis).

Fig. 2 Map of the Cyclades showing the *papyrella* voyage. (Drawing by Y. Pantzopoulos).

Fig. 3 The *papyri* of lake Kavourolimni (photo by G. Kastanas).

Fig. 4a-d The Corfiot cut-stern *papyrella*.. (Photos by Y. Vichos).

Fig. 5a-e The double-ended *papyrella*.. Various phases of its construction. (Photos by M. Vavouri).

Fig. 6a,b The completed craft. (Photos by the author).

Fig. 7a,b Details of the lashing. (Photos by the author).

Fig. 8 During the first sea trials. (Photo by the author).

Fig. 9a,b Paddling to Melos.(Photos by Th. Troev).

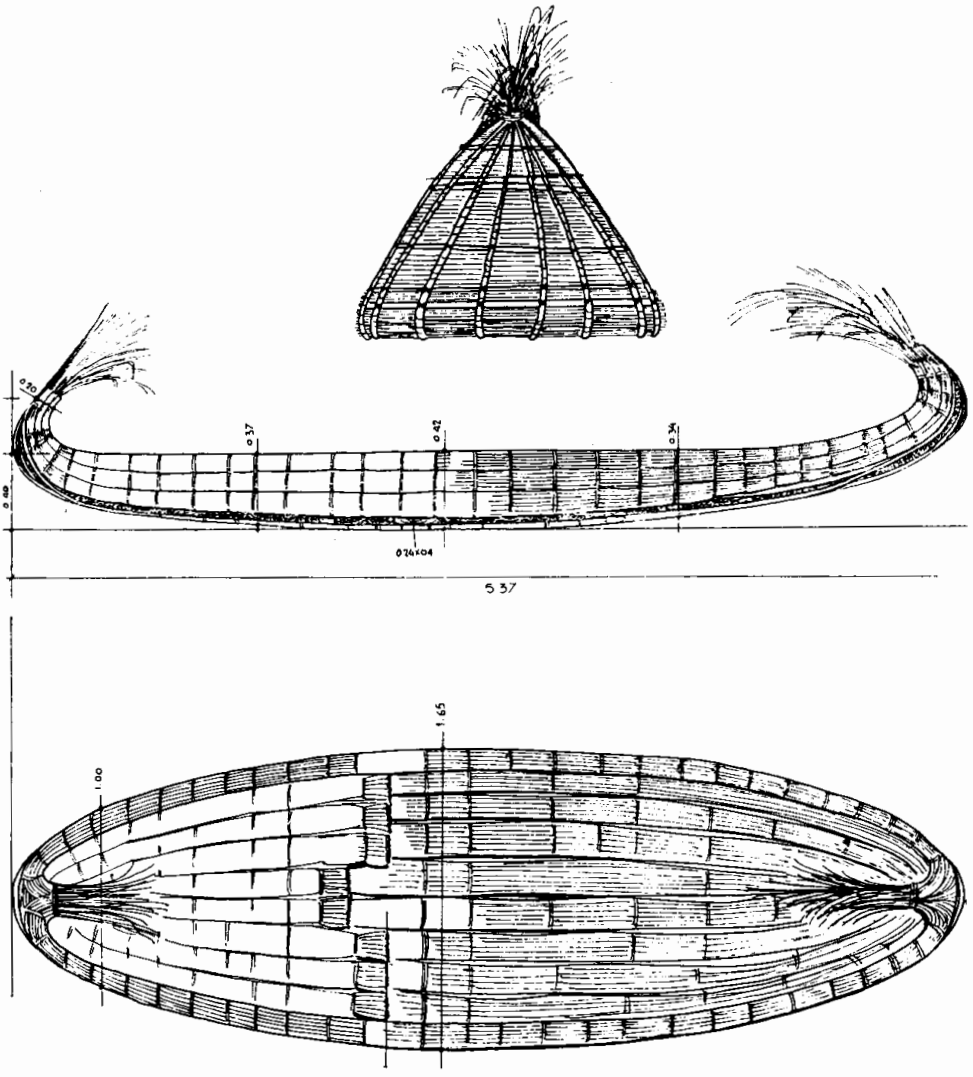
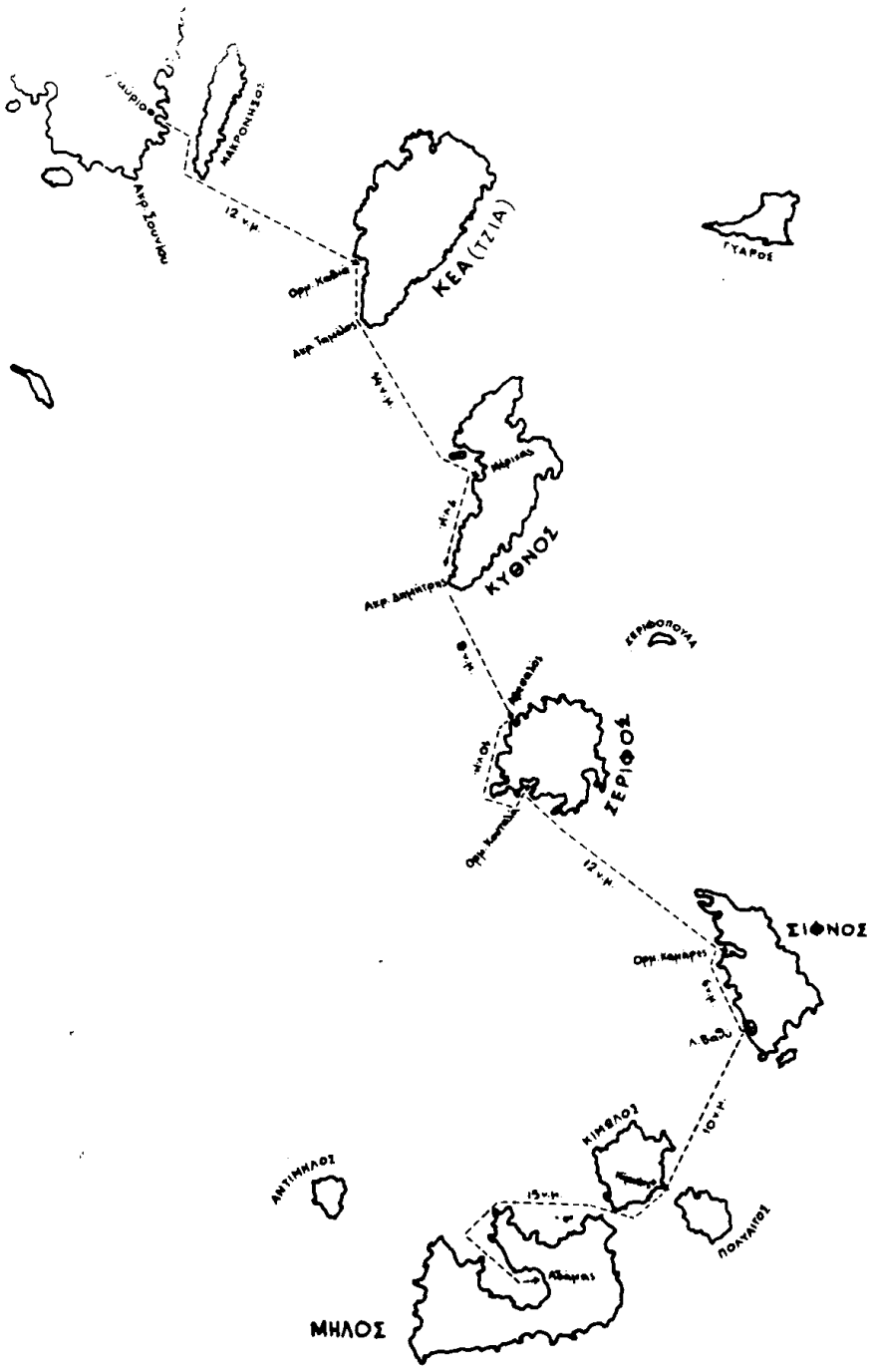


Fig. 1


ΚΕΑ (ΤΖΙΑ)
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14 ν.μ.
12 ν.μ.
10 ν.μ.
19 ν.μ.

Fig. 2

Fig. 3

Fig. 4a

Fig. 4b

Fig. 4c

Fig. 4d

Fig. 5a

Fig. 5b

Fig. 5

Fig. 5

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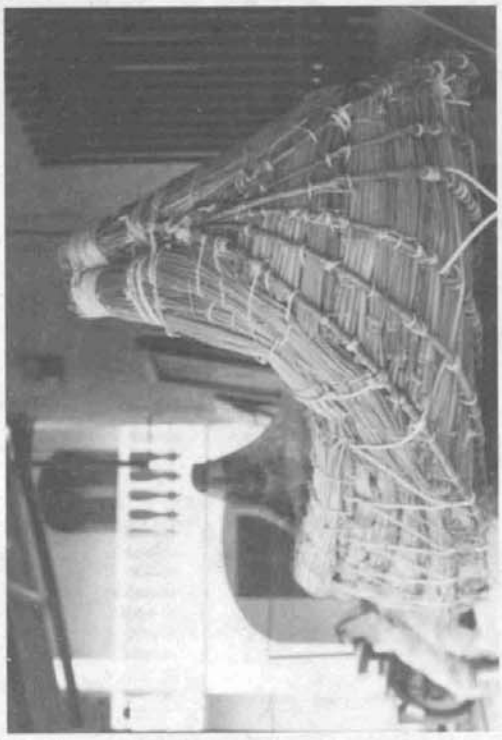

Fig. 6b

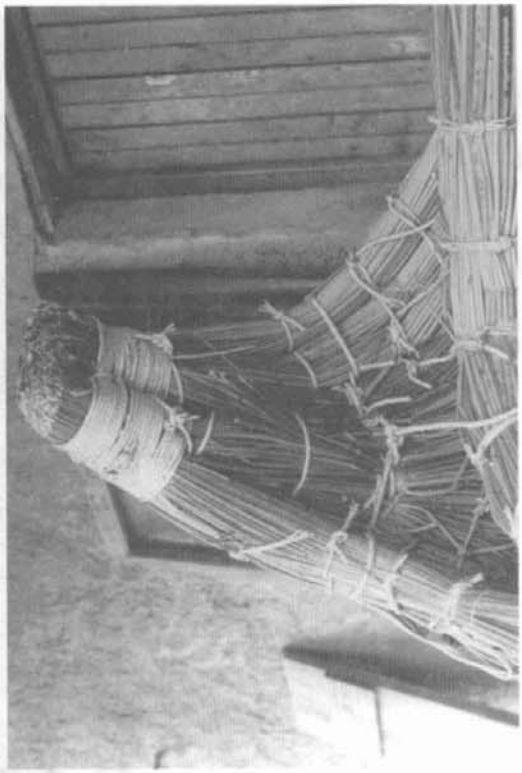

Fig. 7b

Fig. 6a

Fig. 7a