

WERE HAVE ALL THE SAILS GONE?

This paper will deal with the following question: Why, in spite of the numerous wrecks that have been found in the Mediterranean, as far as I know, no sails or remnants of sails have ever been found at sea?

This is particularly surprising since we have found hulls, parts of rigging, ropes, anchors, jars and their contents, and remains of foodstuffs.

I will confine myself in this paper to the Mediterranean as a single entity and the wrecks of ships from ancient times through the classical period.

Figures 1 and 2 show the Mediterranean Sea with an indication of the number of wrecks from the ancient to the classical period that have been located. The squares indicate, with their respective numbers, the amount of wrecks that have been found in that specific area and, the dots, individual sites. It becomes immediately clear that there are a great number of wrecks throughout the Mediterranean where the climate, salinity, flora and fauna are relatively uniform.

It is for that reason that regions such as the North Sea, the Baltic, the greater oceans, etc., or more modern periods than the ancient and classical don't come into consideration within the context of this paper.

To return to the question, why sails or remnants of sails have never been found in the sea, one must first consider the materials from which sails were made.

The papyrus plant was an almost universal source of material in ancient Egypt. As we know from Theophrastus, who lived in Athens from 370-288 B.C., in his book, "Enquiry into plants"¹, " ... from the inner part of the papyrus they weave sails and also ropes". Herodotus, 484-424? B.C., mentions sails made of papyrus in a list of boat gear preserved on a document from that period². And Pliny the Elder, A.D. 23-79, in his book, "Natural History", wrote, " ... Papyrus grows in the swamps of Egypt or in the sluggish waters of the Nile ... and is plaited to make boats and the inner bark woven into sailcloth and ropes"³

These statements cover a time span of some 500 years. So we can be relatively certain that papyrus was used for at least this period of time. However, there is some discrepancy as to just how many Egyptian boats really did have sails of papyrus. There are some depictions of Nile boats, as in a mural painting at Kom el-Ahmar, where it is shown what seem to be separate sheets of papyrus which can be folded together, used as sails⁴.

Both Theophrastus and Pliny use the term, "weave", when describing the use of papyrus in the manufacture of sails. However, that is not correct in our present-day understanding of the terms, "weave" or "woven"⁵.

The following is the process by which papyrus is made into sheets. Strips were sliced from the inner part of the stalk, soaked and layed down edge to edge to make a flat, unbroken surface with a second layer placed on top of it with strips running perpendicularly across them, creating the same type of surface as the first layer. This "sheet" is then pressed or "tapped". This tapping crushes the plant cells and liberates the natural juices which cause the strips to stick together⁶.

So we can see why, as writing paper, papyrus might have been quite fine and, as a sail, opened, with wind hitting it, it may have performed rather well along the Nile. But it was very brittle and, after repeated folding, would tear and would have lost its ability to stand up against the wind.

Figure 3 shows the five fibers - in addition to papyrus - available to the ancient world. They are cotton, wool, silk, flax (linen), and jute: the oldest of these being flax. Linen was made from the flax plant, starting in Egypt, and spread throughout the Mediterranean as early as the second millennium, B.C. for making shrouds and sails⁷.

Linen became the fabric of choice for sails, gradually taking over from papyrus. It was sometimes painted and sometimes embroidered⁷ As it was written in the book of Ezekiel about 570 B.C., when describing the construction of ships sailing from the port city of Tyre, " ... fine linen with broidered work from Egypt was that which though spreadest forth to be thy sail ..."⁸

Linen was used for sails not only in Egypt but also the Eastern Mediterranean and in the Aegean. It is a much finer fabric than matted papyrus, and depictions of sails in the Aegean, (600 - 200 B.C.) show that they were not always of one piece but made up of patches sewn together probably for added strength⁷, and, of course, limited by the size of the looms. Much can be added about the decorations on sails. More may be said of the attempts that were made to make linen sails stronger, more durable, wind-proof and water-proof by the addition of various chemical treatments. But that is not the thrust of this paper.

It is true that authentic models of ancient Egyptian ships, with sails made of linen, have been found and are on display in museums all over the world (Fig. 4). But these have been preserved in the dry atmosphere of burial tombs. None have been found at sea.

It has been said that some sails were left ashore when ships went into battle⁹. If this is so, why have they not been found? Most probably, those ships that survived their battles would have retrieved their sails. If the ship did not survive the battle, the sails would have been used for other purposes such as making sacks, clothing or shrouds.

There is quite an interesting story of a most remarkable find, fairly recently reported by the late Professor Jean Rougé of the University Lumière at Lyon¹⁰.

Of the many mummies at the Museum of Natural History in Lyon, was one found in a temple at Edfu, Egypt, that had been wrapped in a large piece of linen. This particular piece has several horizontal reinforcing strips, 5 cm. wide, to one of which is attached a part of a wooden ring suggested to be a brail ring of a Greco-Roman sail, Carbon-14 dated to 150 B.C., ± 50 years (Fig. 5 and Fig.6).

Now, briefly, about the other materials.

In ancient times, wool was used for nomadic tents and clothing and never intended for sails, although Tacitus¹¹, in AD 70 reports that during the Batavian revolt in the estuary of the Rhine, "... they sewed their brightly coloured woollen war coats into sails". But that, and the story of the Vikings¹², who also used wool, takes us away from our original time frame and specific vicinity, making it part of another story.

As far as I know, silk was never used in the Mediterranean for sails neither in China nor Japan, and is also outside the scope of this paper. What remains is jute and cotton.

As time went on, other materials were introduced in combination with or in competition to linen such as hemp, from which canvas came, and jute¹³.

Parenthetically, cotton was a most interesting addition to our world of sails. Cotton began to be used for sails together with linen sails as soon as it was readily available, from about the middle ages. This is discussed in detail by John Pryor in *Mariner's Mirror*, August, 1990, in his article on Crusader Transport Ships when he suggests that on some ships, "... both cotton sails and linen were used for different purposes". Cotton became very popular after the America's Cup Race in 1851, when the yacht, America, using such sails defeated British yachts using linen sails. Of course, the major problem of cotton sails is their tendency to rot, due to mildew when damp¹³.

The question remains as to why sails have not been found under water. This is due to the hostile environment by which the fabric is surrounded at the bottom of the sea. Wool and silk apart, since they are proteins, all these fibers, as well as wood, are composed of two major families of molecules¹⁴; Celluloses, which are long chains of sugars, vulnerable to oxidation and microorganisms, and Lignins, their protective coating, tough and almost indestructible. (Table 1, below).

Table 1. Chemical Composition of Fibrous Plants and Trees
(Adapted from Refs. 14, 15, & 16)

	CELLULOSES AND HEMICELLULOSES (%)	LIGNIN (%)
<i>Cotton</i>	88.4	0
<i>Papyrus</i>	?	?
<i>Linen (flax)</i>	72-80%	2.0-2.5
<i>Hemp (canabis)</i>	83.1	3.3
<i>Sisal</i>	77.8	9.9
<i>Jute</i>	76.4	11.8
<i>Hardwoods (oak, etc.)</i>	~80.0	~20.0
<i>Softwoods (pine, etc.)</i>	~70.0	~30.0

Note: No figures on the chemical composition of papyrus are known. However the composition of various straws have been given (16) as celluloses and hemicelluloses about 80%, lignins 9-13%. Raw flax contains up to 5% lignin but the amount is reduced on "retting".

Wood contains 20-30% lignin and has, therefore, survived at the sea's bottom, almost intact when protected by, or buried in sand or mud. Jute and sisal, from which ropes were made, also have a high lignin content. As such, they have been found in situ, under the sea's bottom, attached to anchors, etc.

Linen, however, was another story¹⁶. The flax stalks were treated, or retted, before being woven. Retting is a process of hitting, or beating, the stalk in order to break down the tough, outer fibers of lignin and the inner pulp causing the protective coating and pulp to be stripped away.

All that is left is the exposed, pure cellulose fiber, completely vulnerable and at the mercy of the elements underwater (Fig. 7 & Fig. 8). This is the factor that destroys any possibility of finding sails or remnants of sails, *in situ*, in the sea.

The question still unanswered and still the subject of much searching is - what could be the possibility of finding a piece of sail impacted within the anaerobic environment of mud beneath the surface of the sea-bottom? Could modern-day techniques such as mud-penetrating sonar enable us to discover wrecks with their masts and sails somewhere aboard or, at least alongside? I would hope the answer is yes.

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ILLUSTRATIONS

- 1, 2. Maps of the Mediterranean showing submerged sites throughout the classical period. (From Anthony Parker in *Archaeology Under Water, an Atlas of the World's Submerged sites*; ed. Muckelroy, McGraw-Hill, 1980; 50-1).
3. Characteristic appearance of various fibers under the microscope. (From W. Scott-Taggart, "Cotton Spinning", Vol I, 9th Edition, McMillan & Co. 1935. Frontispiece.)
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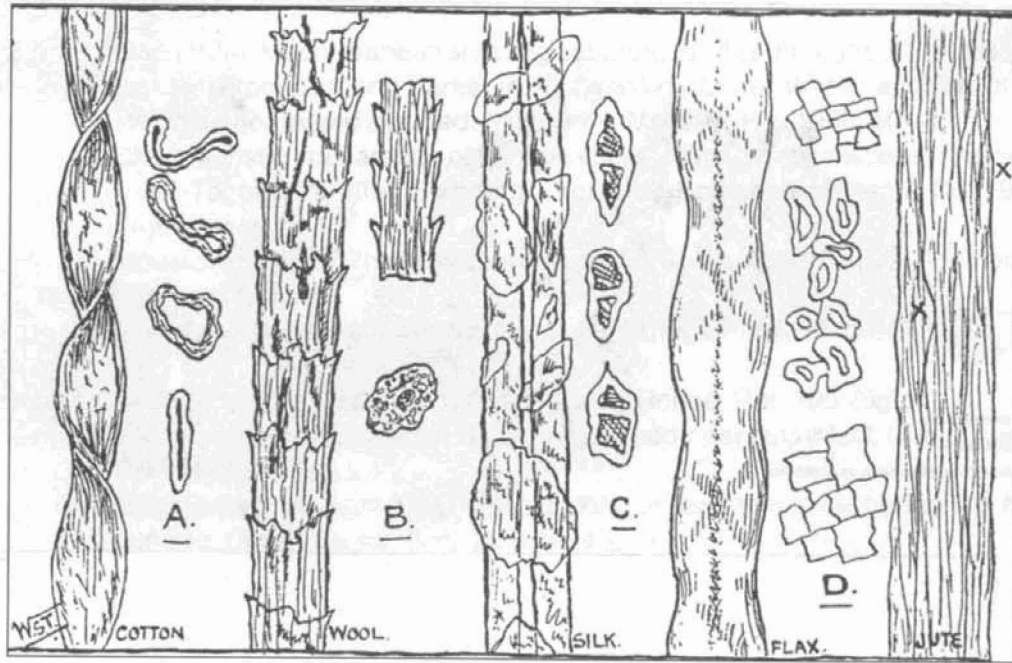
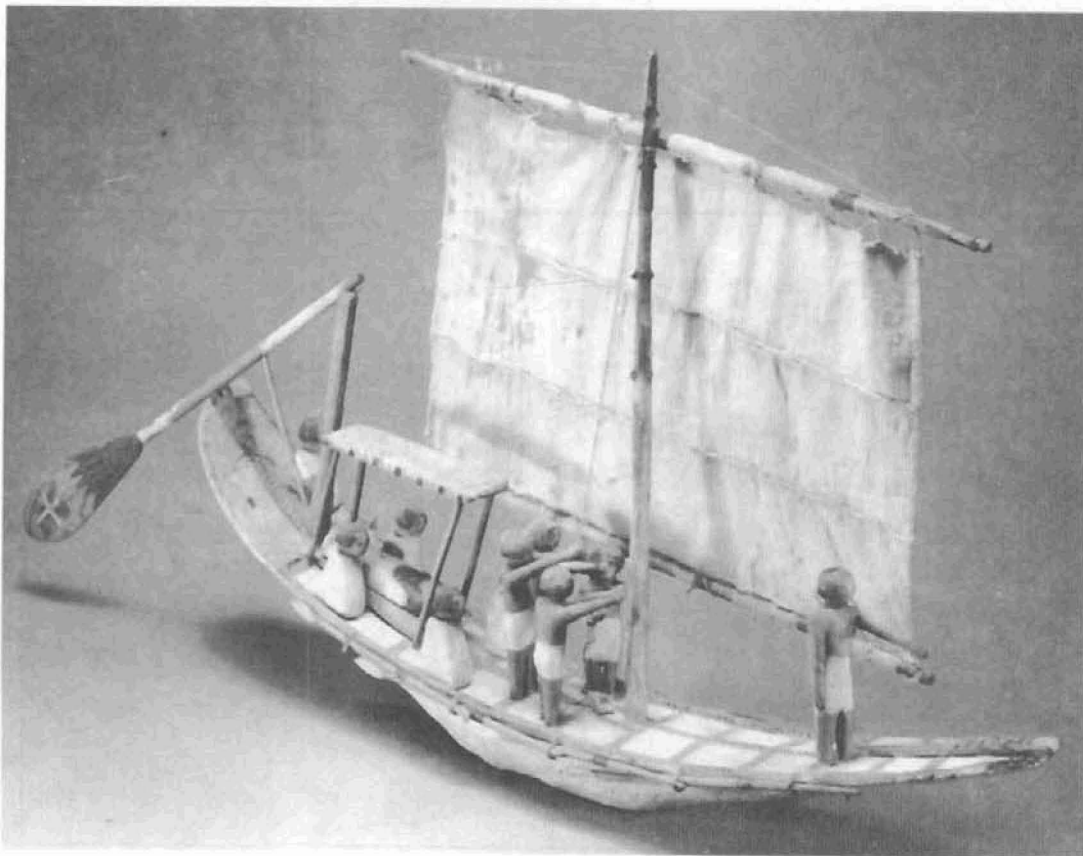


Fig. 3

Fig. 4



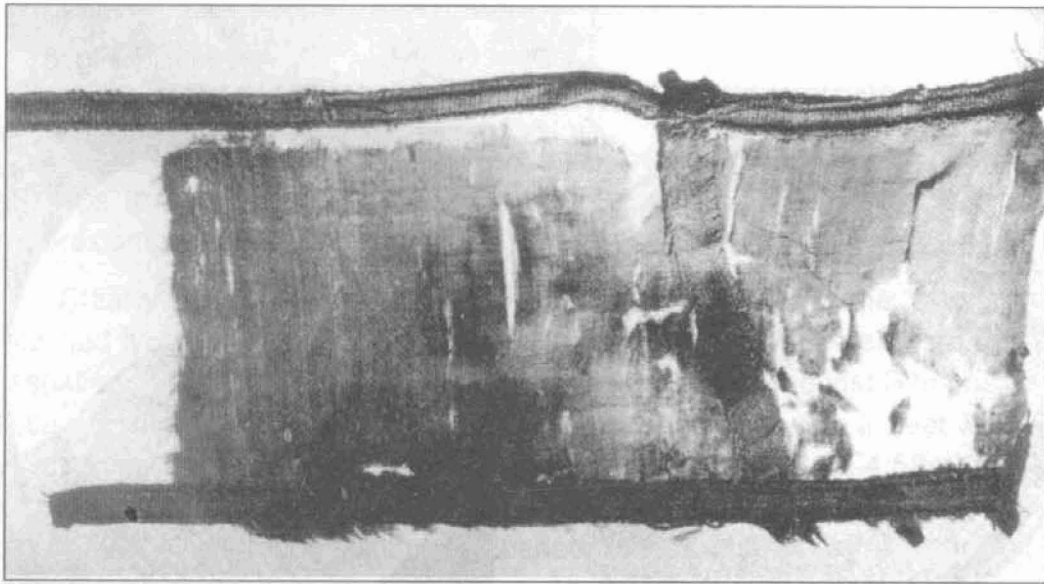


Fig. 5

The fragment shown in Fig. 5 is a piece of ancient fabric, possibly a sail, found at the site of the shipwreck of the *Ulu Burun* in the 14th century BC. It is made of a coarse, fibrous material, likely a type of wool or cotton, and shows significant wear and tear, including a large, irregular tear in the center. The fragment is rectangular and measures approximately 10 cm by 15 cm. It is a dark color, possibly due to the age and the material it is made of. The fragment is shown in a photograph, and the caption below it is 'Fig. 5'.

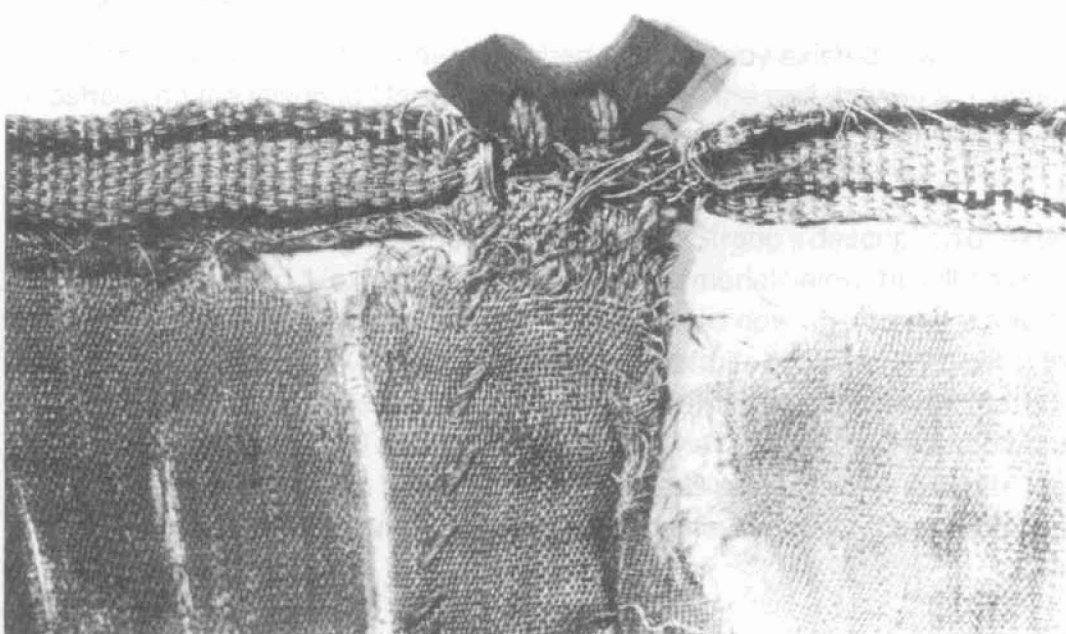


Fig. 6

Fig. 7

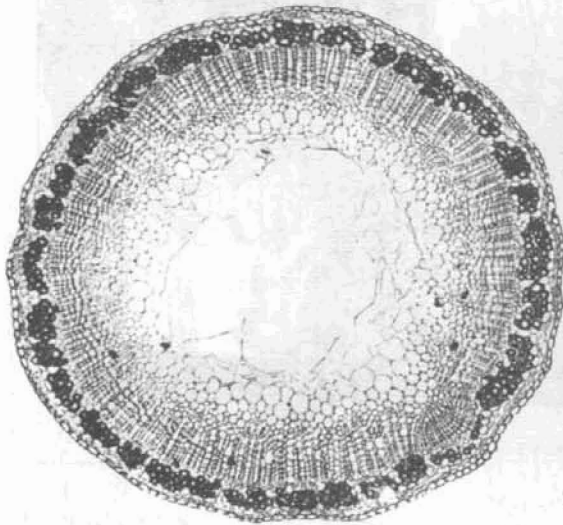


Fig. 8

