Anchoring the Kyrenia Ship:

An experimental project to reconstruct the ship's anchor

Dedicated to Honor Frost and her passion for the study of ancient anchors: "Ancore, the potsherds of marine archaeology" (Frost 1973: chapter title).

Introduction

Since its excavation in the late 1960s, the Kyrenia ship has become a seminal component of the corpus of archaeological evidence related to late-Classical and early-Hellenistic Period seafaring in the Eastern Mediterranean. The excavation recovered pieces of a single, one-armed wooden hook anchor fitted with a short, lead-filled wooden stock (van Duivenvoorde 2012) (Fig. 1). The remains include four heavy lead inserts of the stock, which provided the necessary weight to sink the anchor; the concretion formed around the anchor arm's iron tip; and some small wood fragments (Figs 2–4). The original anchor had a central wooden shank, carved from a crooked-grown oak timber, that terminated in a hook, or arm. The stock of the anchor was set perpendicular to the arm, which ensured that, when deployed, the anchor would always fall with its arm down and dig itself into the seabed. This poster discusses the anchor's hypothetical reconstruction and the archaeological experimentation with scale models and a full-scale replica of the anchor. In order to study physical aspects of its manufacture and gain a better understanding of anchor making in the ancient Mediterranean, the Kyrenia Ship Project built a full-scale reconstruction on Cyprus using authentic materials, tools, and methods. Following in-water testing with the scale models, the full-scale anchor was deployed from *Kyrenia Liberty* to experiment with its handling and stowage aboard the ship and to test its setting performance on the seabed. The study of the Kyrenia ship anchor is undertaken by the author under the auspices of the Kyrenia Ship Project with the on-going support of Susan Katzev and Laina Swiny. The full-size anchor reconstruction was made by Kleanthis Moustakas and resides now on *Kyrenia Liberty*.

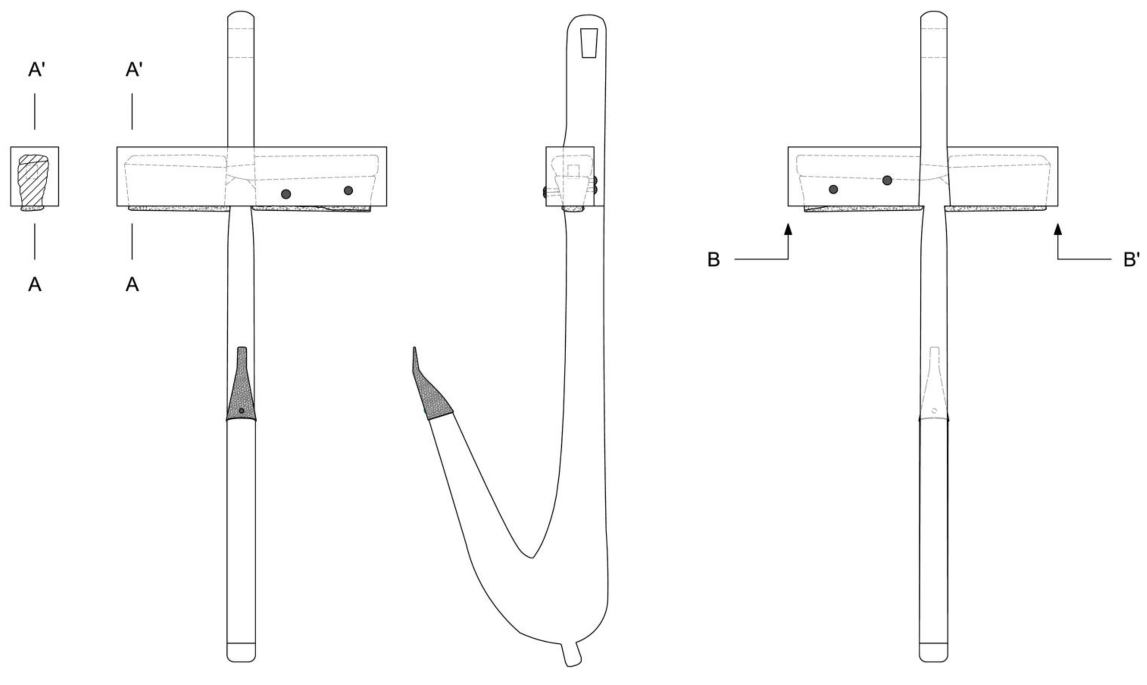

Figure 1. Reconstruction of the Kyrenia ship's anchor—based on its archaeological remains and those of the Ma'agan Mikhael anchor. Light grey lines are hidden or internal features (Wendy van Duivenvoorde)


Figure 2. Kyrenia Type IIb lead anchor-stock core made up of four separate lead pourings, originally seated in the carved mould openings of the wooden stock. Top left to bottom: Pb 19 and Pb 21, top right to bottom: Pb 20 and Pb22 (Mustafa Erkan and Kadir Kaba)


Figure 3. Two halves of the Kyrenia shipwreck's ferrous anchor-tooth concretion (Mustafa Erkan and Kadir Kaba)

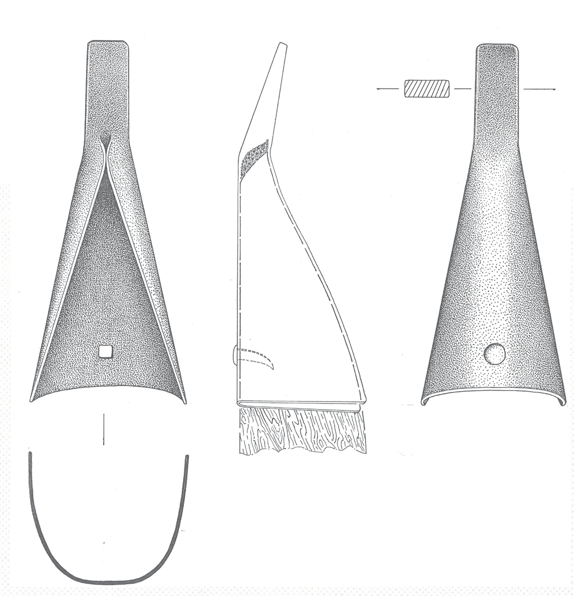
Figure 4. Reconstruction of the iron cone of the Kyrenia anchor-tooth (Susan W. Katzev)

The Kyrenia anchor is unique among all known wooden hook anchors in that it has a relatively high stock core consisting of two core fillings on either side of the shank. Anchor-stock fillings Pb 19 and Pb 21 formed one side of the stock core, while Pb 20 and Pb 22 formed the other side. The two halves of the stock core were joined through the wooden shank by a 9-cm-long lead connection (Figs 1–2). The four anchor-stock core-fillings have a maximum overall length of 720 mm, maximum height of 162 mm, and maximum width of 92 mm. The complete core weighs 67.4 kg, but the weight is distributed unevenly, 28.3 kg on one side of the anchor's shank and 39.1 kg on the other. The core-fillings are trapezoidal in section and the heavier side is marked by four pure copper nails (Fig. 1).

In addition to the lead-stock cores, archaeologists recovered the ferrous concretion of an anchor-tooth, or fluke-point (Figs 3–4).

Chisel marks impressed on the lead cores, the asymmetrical and irregular shapes of the cores, and the copper nails driven into core-filling Pb 22 all evince the Kyrenia anchor's construction technique.

The lead cores on either side of the wooden shank were connected and, therefore, can be assigned to Type IIb in Kapitän's typology for wooden anchors (1984:37, fig. 4.2b). The Kyrenia ship's anchor is the only example of its kind associated with a shipwreck; all other remains of this particular type of anchor come from undated contexts (van Duivenvoorde 2012:398).

From Scale to Full-Size Model

In January 2012 the author built a 1:5 scale model of the anchor with Glen Grieco in the J. Richard Steffy Ship Reconstruction Laboratory at Texas A&M University. The construction of this small-scale anchor was the first step in testing the proposed reconstruction of the Kyrenia ship's anchor as presented in Figure 1. It was taken to sea and cast in the water 50+ times and, in every single instance, fell on the seabed with the arm down, leaning on its heavier stock side (Fig. 5). The arm itself worked perfectly fine, i.e., it dug into the seabed well, and the joint between the arm and the shank as reconstructed seemed strong enough to hold.

The anchor was also placed purposely with the wrong side up—arm facing upwards—and then dragged over the seabed while giving it a slight vertical pull. Without exception, the anchor turned itself back onto its arm and instantly dug itself into the sand. The design of this type of anchor is thus practically fail proof and is engineered to consistently anchor properly.


Figure 5. Seabed trials with 1:5 scale model of the Kyrenia ship's anchor. The anchor cants properly and its arm digs into the sand after being cast from the surface (Patrick Baker, WA Museum)

With the experience of the small-scale model, the construction of a full-size anchor commenced in Cyprus in mid-2012; working on it part-time, Kleanthis completed the anchor almost a year later. He used only traditional hand tools to fashion and shape the oak tree branch into the anchor, and to make the copper nails, the iron tooth, and lead inserts.

The work commenced with the selection and sawing off a bifurcated branch from a local oak tree, with permission of the Cypriot forestry department. Once in Kleanthis' yard, he removed the bark with an adze (it is important to do this when the wood is green so the bark comes off easier) and cut the timber roughly to the dimension of the anchor (Figs 6–7).


Figure 6. Oak tree with branch used for the anchor reconstruction (Susan Harding)


Figure 7. Branch used for the anchor reconstuction (Susan Harding)


Figure 8. Kleanthis chiselling out the opening in the wooden anchor stock (Susan Harding)

Kleanthis used charcoal from his oven to mark the design and shape of the anchor on the wood, such as the opening in the stock. For the making of the wooden anchor, he used a hammer and chisel and an adze. He chiselled out an oblong cavity from a single timber, forming the mould for filling the core of the wooden stock with molten lead. He then cut out a central section from the side of the stock, just enough to create a tight fit onto the shank. Before connecting the two anchor parts, he chiselled out a small opening through the thickness of the shank, where the shank would be fitted into the stock (Fig. 1).

Kleanthis found that the anchor stock and shank/arm timbers had to be kept wet in order to prevent the wood from splitting, and to make their carving easier. Almost daily, he took the anchor parts into the sea for a soak. Additionally, he filled the holes carved into the anchor stock with water and covered the timbers with a wet cloth every night after work.

The four nails used to mark the heavy side of the stock and the single nail that fastened the iron anchor tooth were shaped with a hammer from copper bars (Fig. 11). The square sections of the nail shafts are a direct result of the hammering. If hammered excessively, copper becomes brittle, but this can be adjusted easily by heating the metal for a short time at about 500–700°C. Kleanthis used his wood oven to anneal the fasteners. The main issue proved to be acquiring pure copper as, today, it is hard to come by; the three bars (measuring 1m in length and 1cm in section) had to be imported from Greece.

The anchor's iron tooth was made by a local black smith and fashioned around the tip of the anchor arm before being nailed in place (Figs 9–10). Kleanthis pre-drilled all nail holes before driving the nails into the timber (Fig. 9).

Next Kleanthis and his assistant Phytos dug the anchor stock into the ground (placing the anchor upside down) and lined the inside of the stock with ashes and built a clay rim around the stock openings to prevent the wooden stock from burning (Fig. 13). The clay also served to guide the lead into the stock.


Figure 9. Kleanthis pre-drilling the nail hole for the copper fastener used to fix the iron anchor tooth in place (Susan Harding)


Figure 10. Driving in copper nail to fix the iron anchor tooth in place (Susan Harding)


Figure 11. Copper rods to fashion and shape the nails (Susan Harding)


Figure 12. Kleanthis and Phythos melting lead for the anchor stock cores (Susan Harding)


Figure 13. Kleanthis inspecting the clay rim around the mould opening prior to pouring the lead (Susan Harding)


Figure 14. Pouring lead into the anchor stock (Susan Harding)


Figure 15. The Kyrenia ship full-scale anchor reconstruction finished (Susan Harding)

He then poured the molten lead into two sides of the mould, overfilling each so that some spilled out over the top and solidified to form caps (Fig. 14). The stock cavities, and thus the cores, were trapezoidal in section, which is typical for Type II anchors. This shape secured the heavy lead cores in place and prevented them from breaking through the bottom of the wooden stock during use (Kapitän 1973:389–90). The caps also confirm that the anchor-stock core was cast with the stock upside down, so that the widest parts of the wooden mould was at the bottom. The lead heating and pouring was a two-person job: one put lead in a metal pot (perhaps iron), heated it over a fire, and then poured it into the mould while the other started heating the next pour of lead. It had to be done this way because the molten lead cools too quickly (in only 2 to 3 minutes). Once the pours were completed and the lead had cooled, Kleanthis and Phytos removed the clay (simply by breaking it) and extracted the anchor from the ground.

Splitting of the anchor wood became the main issue in the making of the full-size anchor. By the time Kleanthis finished the anchor and the wood had become dryer, cracks emerged. When delivered to *Kerynia Liberty*, the anchor was placed on the ship's foredeck and exposed to the elements, and quickly split lengthwise. Although most anchor wood to date has been identified as oak, Kleanthis suggests that wood species like ash (*Fraxinus ornus*) would be much better suited for the making of anchors. Ash does not split as easily and grows extensively in the Mediterranean. Homer mentions that king Nestor built his ships with ash sourced from the Manglavas Mountain in Pylos in the Peloponnese. It also was used for making furniture, tool handles, weapons, and flooring. This wood also is lighter than oak, which makes it easier to handle aboard the ship and would provide better buoyancy for lifting from the sea.

On *Kerynia Liberty*

The anchor was tested aboard *Kerynia Liberty* in Limassol harbour for two days. The use of the ship's mast derrick proved to be less beneficial for manoeuvring the anchor than simply man-handling (regardless of its weight). The application of goat tallow around the belaying pins also made it easier to lowering the anchor in and out of the water. Although more trials need to be undertaken at sea, the anchor was most easily affixed to the stem and stowed at the very bow of the ship (Fig. 16).

Discussion

The Kyrenia ship anchor reconstruction and its study are still preliminary, and more trials on *Kerynia Liberty* are planned for the near future. The research completed to date has allowed us to peer into the mind of the maker of the original Kyrenia ship's anchor and answer questions about material appropriation, tools usage, and methods of manufacture.


Figure 16. The Kyrenia ship anchor reconstruction fastened to the stem and ready to be cast (Susan Harding)

References

Frost, H., 1973. Ancore, the Potsherds of Marine Archaeology: On the Recording of Pierced Stones from the Eastern Mediterranean. In D.J. Blackman (ed.), *Marine Archaeology*, pp. 397–406. Colston papers, vol. 23. Hamden, Conn.: Archon Books.

Kapitän, G., 1984. Ancient Anchors—Technology and Classification, *IJNA* 13.1:33–44.

Kapitän, G. 1973. Greco-Roman Anchors and the Evidence for the One-Armed Wooden Anchor in Antiquity. In D.J. Blackman (ed.), *Marine Archaeology*, pp. 383–395. Colston papers, vol. 23. Hamden, Conn.: Archon Books.

Katzev, S.W., The Ancient Ship of Kyrenia, beneath Cyprus seas, in V. Petraklos (ed.), *Great Moments in Greek Archaeology*, Los Angeles, 286–299.

Van Duivenvoorde, W., 2012. The Anchor of the 3rd-Century-BC Ship from Kyrenia, Cyprus: A One-Armed Wooden Anchor with a Lead-Filled Stock. *IJNA* 41.2:397–407.

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