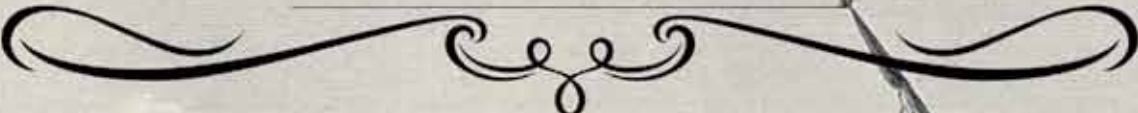




BETWEEN CONTINENTS

PROCEEDINGS OF THE TWELFTH SYMPOSIUM
ON BOAT AND SHIP ARCHAEOLOGY

ISTANBUL 2009



EDITED BY
NERGİS GÜNSENİN



ege

YAYINLARI

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*Proceedings of the Twelfth Symposium on Boat and Ship Archaeology
Istanbul 2009*

Edited by
Nergis Günsenin

ISBSA 12

Sponsored and Hosted by the
Istanbul Research Institute of the Suna and İnan Kiraç Foundation

Under the auspices of the Underwater Technology Program at Istanbul University's
Vocational School of Technical Sciences in partnership with
the Faculty of Letters, Department of Restoration and Conservation of Artefacts

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To the memory of

Ole Crumlin-Pedersen (1935-2011)
and
Claude Duthuit (1931-2011)

Crumlin-Pedersen founder of the Viking Ship Museum at Roskilde heralded a whole new area of archaeological fieldwork and remained a seminal and inspirational figure in nautical archaeology. Duthuit not only acted as director of the Institute of Nautical Archaeology (INA), but made lifelong contributions to the field. It is thanks to his dedication and his passion that several excavation efforts, including those at Cape Gelidonya, have come to life.

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Preface

The island of Tatihou in France was the site of the first ISBSA meeting I attended in 1994. Encircled by seminal figures in our field, it was the most inspiring event of my academic career. At the time, it became clear that the attendees were eager to hold one of their future meetings in Turkey. Their wish was the driving force that finally led me to this special day.

Positioned between two continents, Istanbul was the perfect place to hold the Symposium. Throughout history, the exchange of goods and cultures between east and west, as well as north and south, was realized in the waters off the Anatolian coast, with the Black Sea to the north, the Sea of Marmara to the north-west, the Aegean Sea to the west, and the Mediterranean Sea to the south. Given the vast area of interest, we invited participants to focus on the four seas and address their pivotal role not only for Turkey but also for the rest of the world.

The Turkish coastline had already been the site of pioneering underwater excavations since the 1960s. Indeed, nautical archaeology was initiated

in Turkey under G. F. Bass and further developed under the auspices of the Institute of Nautical Archaeology (INA). Today, the development of nautical archaeology and boat and ship archaeology on an international level far surpasses the initially limited field of underwater archaeology. Moreover, the discovery of the harbour of Theodosius, one of the most outstanding archaeological events of our era, has further enriched our field and added yet another dimension to our symposium.

The excavations in the harbour are still ongoing. Thirty-six shipwrecks dating from the 5th to the 11th centuries have been excavated. Their study will make an enormous contribution to our understanding of ship construction and the transition from shell-first to skeleton-first techniques. It will also allow us to re-examine Byzantine trade and the economy of the period. Furthermore, the remains revealing settlements dating back to 6500 BC, will shed new light on our understanding of the history of the ancient peninsula.



Fig. 1. Group photograph of the participants of ISBSA 12 (Photo: Engin Şengenç).



Fig. 2. Group photograph of the participants of the Amasra excursion.

The ISBSA 12 was held under the auspices of the Underwater Technology Program at Istanbul University's Vocational School of Technical Sciences in partnership with the Faculty of Letters, Department of Restoration and Conservation of Artefacts. It was sponsored and hosted by the Istanbul Research Institute of the Suna and İnan Kırac Foundation and was held at the Foundation's Pera Museum on 12-16 October, 2009.

More than 200 participants from 24 countries attended the Symposium where 50 papers, 25 posters, and various films were presented (Fig. 1). This also allowed numerous young scholars to present their work and contribute to ongoing debates in our field and even launch new areas of research based on recent discoveries. The papers for the symposium were selected by the ISBSA committee from among a multitude of excellent proposals. The mission of the ISBSA is focused on ship construction. While related subjects are welcome, the main thrust has traditionally been a discussion of the ship itself.

It is our hope that the conference theme which has helped bring together numerous scholars from around the world, will also bring together the two sub-fields of archaeology which have until recently

remained separate. It is believed that a genuine thematic and methodological dialogue between land and underwater archaeology can only enrich the field and uncover the mysteries of past civilizations. "Between Continents" will thus re-map our field and reset its intellectual boundaries.

Following the Symposium, an excursion to Amasra on 16-18 October offered the opportunity to visit workshops that still continue the traditional art of shipbuilding in *Tekkeönü* and *Kurucaşile* in the Black Sea Region. Participants learned methods of ship construction directly from the local shipbuilders. The Shipbuilding Program at the *Kurucaşile* Technical High School, the Amasra Castle, and the Amasra Archaeological Museum were among the local sites included in the itinerary (Fig. 2). Hüseyin Çoban was pivotal to the success of this excursion; his hospitality and his immense knowledge of traditional shipbuilding enriched our trip.

Like many other scholars in our field, I owe my presence here today to George Bass who not only accepted our invitation to attend the symposium but also graciously delivered the keynote address. Frederick van Doorninck, Jr., the late Claude Duthuit, Don Frey and Robin Piercy from the Institute of Nautical Archaeology further enriched

this symposium with their presence. It was a genuine honour to have them in our midst. As in all scholarly disciplines the master - apprentice relationship is central to our field. This was made amply clear during the course of this symposium.

However, our field is based not only on scholarly research. The constant interaction between nature and humans is an inextricable part of it: sailing on a fickle sea, working in the hostile underwater environment, and living in often difficult conditions are among the challenges that make our field so special.

May God save sailors and nautical archaeologists for future research and many more symposia!

Acknowledgments

I would like to express my sincere thanks to Suna, İnan and İpek Kır aç, founders of the Suna and İnan Kır aç Foundation, and  zalp Birol, General Director of the Suna and İnan Kır aç Foundation Culture and Art Enterprises; they made it possible for us to hold the meeting at the Pera Museum. The hospitality of the museum staff was also central to the success of this meeting.

My thanks also go to G lru Tanman of the Istanbul Research Institute whose help and friendship made it easier to navigate through a complexity of organisational issues. Erkan Bora, also of the Istanbul Research Institute, deserves special thanks for his assistance, not only during the Symposium, but also during the excursion to Amasra. Else Snitker welcomed everyone with her endless energy and friendly, familiar countenance.

I want to express my gratitude to Zeynep Kızıltan, directress of the Istanbul Archaeological Museums, who made it possible for us to visit the Yenikapı excavation site.

Commandant Ali Rıza İŐipek generously opened storerooms of the Istanbul Naval Museum, which is presently under construction. Thanks to him, participants had the opportunity to see the sultans' *kayıks* and the famous *kadırga*.

The *Setur* Travel Company team contributed to a remarkable organisation.

My heartfelt thanks also go to Carlo Beltrame, Ronald Bockius, Anton Englert, and Fred Hocker, who shared their invaluable experience as previous ISBSA organisers.

I would also like to acknowledge Ayy m Akyor for providing much needed editorial help with the English text.

Finally, my sincere thanks go to Rezan Benatar for her valuable intellectual and editorial contributions. She not only helped create a seamless text but also attempted to make rather complex material intelligible to the reader.

The success of a symposium is always determined by the contributions of its participants. I would like to sincerely thank each and every one of them for an intellectually stimulating exchange.

This volume is published by Ege Yayınları which has a long-standing commitment to archaeological research. I would like to thank its owner Ahmet Boratav for his interest in our work. My thanks also go to H lyya Tokmak for her patience with the layout of the manuscript.

20. Roman Ships Carrying Marble: Were These Vessels in Some Way Special?

Carlo Beltrame and Valeria Vittorio

Introduction

The widespread use of coloured marbles in both public and private architecture by the Romans since the late Republican period was the result of the influence of Greek culture, which assumed that each kind of marble had a particular symbolical meaning. The Romans used them both for public buildings and for decorating the houses of the rich. As these marbles were quarried mainly in the Eastern Mediterranean and in North Africa, the Romans began to import them by sea since the Augustan period (Pensabene 2002: 3-32; Lazzarini 2007: 21-28).

This kind of trade, which continued periodically into the following centuries, is well documented by about 50 wrecks located along the main routes. Most of the wrecks can be dated between the 1st and 4th centuries AD, but there is also evidence of wrecks dated earlier, in the Republican period -such as the Kızılburun (Carlson 2007), Carry-Le-Rouet (Kainic 1986) and Mahdia (Hellenkemper Salies, von Prittwitz und Gaffron & Bauchhensß eds 1994) wrecks -and later- the Byzantine wrecks of Marzamemi (Käpitan 1980) in Italy and Sapienza (Parker 1992: 386) in Greece and the modern wreck at Secca di Capo Bianco near Crotona, in Italy (Beltrame, Lazzarini & Medaglia 2012).

These wrecks carried both rough out form and unworked marble blocks. The stone elements were mainly columns and blocks, but some wrecks contained also capitals and sarcophagi. These elements could reach 8.5 m in length, like the columns of Capo Cimiti (Roghi 1961) and Methone (Throckmorton & Bullitt 1963: 21-23) wrecks. Sometimes the ships carried a secondary cargo, which could consist of amphoras or statues, as is documented by the selective archaeological evidence.

Considering that this kind of ships, which were composed of rigid shapes, had to carry very heavy cargos that could not be distributed on a large surface like -amphoras for example- we assumed that they rested on their backings, thus creating situations of instability in case of ship pitching or rolling. We would like to know if these ships were built in a special way or had a particular shape, as emphasized by some archaeological literature (Martino & Occelli 2009: 133), or if they were the same ships which carried amphoras and pottery and which are well documented by many hull remains and iconographical sources.

In order to answer this question, we first try to analyse what could be the technical characteristics of these vessels and the aspects.

The Evidence Coming from the Written and Iconographical Sources

Petronius and Plinius are the only ancient authors who made an explicit mention of ships carrying marbles. Petronius in the *Satyricon* (CXVII) let the servant *Corax* compare himself carrying luggage to a ship with a cargo of marbles (*iumentum me putatis esse aut lapidariam navem?*), while Plinius (N.H., XXXVI, 2) speaks more generically of *naves marmorum* when he mentions the transportation of stones.

The almost total lack of specific terms to indicate ships carrying marbles would suggest that they were not particularly 'special', at least not in the external aspects (Gianfrotta 2008: 86). As a matter of fact, it is the external aspect, i.e. the shipshape, which gave rise to the use of special terms.

The only iconographical source representing a 'marble ship' seems to be a quite well-known sculpture, which we now interpret for the first time



Fig. 20.1. Relief representing a ship on the arch of the Market of the Merchants of Leptis Magna (Photo: C. Beltrame).



Fig. 20.2. Relief representing a ship on the arch of the Market of the Merchants of Leptis Magna (Photo: C. Beltrame).

as a ship carrying marbles. It is one of the two side reliefs on a tetrahedral arch in the market of Leptis Magna. The arch was assembled in the 4th century with reused elements, which make it difficult to propose a dating for these decorations (Bandinelli 1964: 80). One of the two images shows a typical round ship with a square sail and two side rudders, the other shows a vessel without sail and rudders and with a particular cargo (Fig. 20.1). The cargo is represented over the sides of the ship, but this solution seems to be a simple artistic convention to better show the content of the load, as the relief of Villa de Medici at Rome showing lions in cages demonstrates (Pietrangeli 1948).

Because of their dimensions (they occupy almost the entire 'deck' of the ship); the four cylindrical elements carried by the ship could be interpreted as wooden beams or columns (Fig. 20.2). As Leptis Magna is a very rich city with thousands of marble columns still visible especially along the main street and in the theatre, it seems obvious to think that the merchants who worked there wanted to represent one of the numerous vessels, which allowed them to trade marble columns from the East Mediterranean to the North Africa Roman cities.

The Archaeological Evidence

Except for these poor documents, the main source to reconstruct a *lapidaria navis* is the archaeological source represented both by indirect evidence, that is the cargoes of marble objects, and by poor remains of hulls carrying stone elements.



Fig. 20.3. Carbon model of the marble cargo of the Isola delle Correnti wreck (Photo: V. Vittorio).

The analysis of the stone weight demonstrates that, although they could reach 350 tons, as documented by the wrecks coming from Isola delle Correnti (Käpitan 1971: 296-298), Mahdia (Hellenkemper Salies, von Prittwitz und Gaffron & Bauchhenß eds 1994) and now Punta Scifo D, the majority of the ships carried less than 100 tons. The biggest *onerariae* we know, that is the Madrague de Giens, carrying about 400 tons of amphoras (Pomey ed. 1997: 179), and the wreck of Albenga carrying perhaps 500 tons of amphoras (Lamboglia 1952), both dated to the late Republican period.

Starting from the published plans of some wrecks carrying marble and assuming that this kind of cargoes had to be disposed on the bilge, so as to improve

the metacentric height, and that their arrangement had to be rational to make good use of space and to balance the weight (Martino & Occelli 2009: 136), we have built simple carbon models in 1:20 scale to virtually recompose those cargos, which have not maintained, on the seabed, the original storage disposition (Fig. 20.3). The carbon models have then been used by the naval engineer Simone Parizzi to calculate, with naval engineering software, the minimum dimensions of the hulls carrying the cargos. Due to lack of important archaeological evidence of a *navis lapidaria* hull, as we shall see, he has used other shapes of well studied Roman ships for the calculations. Working together, we selected two different shipshape, i.e. a Nemi vessel, a very large and flat bottom 'ship', suited to carry large cargoes (Ucelli 1950), and the ship of Grado, a typical marine cargo vessel wrecked in the middle of the 2nd century off Aquileia (Beltrame & Gaddi 2007).

Parizzi's analysis of the shipshapes has demonstrated that the Nemi shape has got poor capacity of straightening up and so it would have worked better as a towed pontoon, while the Grado shape has got a good initial stability and so it could sail far from the coast.

Parizzi has adapted the sizes of these shipshapes to those belonging to the recomposed marble cargoes.

He has proceeded both with a transformation in similarity, that is keeping the shipshape proportion while changing the scale, and with a transformation for affinity, that is keeping only the requirements of buoyancy and stability while changing the proportions when necessary.

Parizzi's calculations according to a transformation in similarity has allowed to propose, for the ship of Capo Taormina, a length of 24 m and the shape of both Nemi ship and Grado vessel; for the Marzamemi a ship a length of 32.5 m with both the shapes. The results of the study of the vessels of Isola delle Correnti and Torre Sgarrata are more important because these ships carried the heaviest cargoes we know; both the ships of Isola della Correnti and Torre Sgarrata could have a length of no more than 42 m with both shapes (Figs 20.4, 5).

Parizzi's calculations according to a transformation for affinity that aims to optimize the results, would propose quite smaller ships. The Isola delle Correnti ship, in fact, could be only 30 m long according to Nemi's shipshape, and 33 m long according to Grado's shipshape. The Torre Sgarrata ship could be only 29 m long according to Nemi's

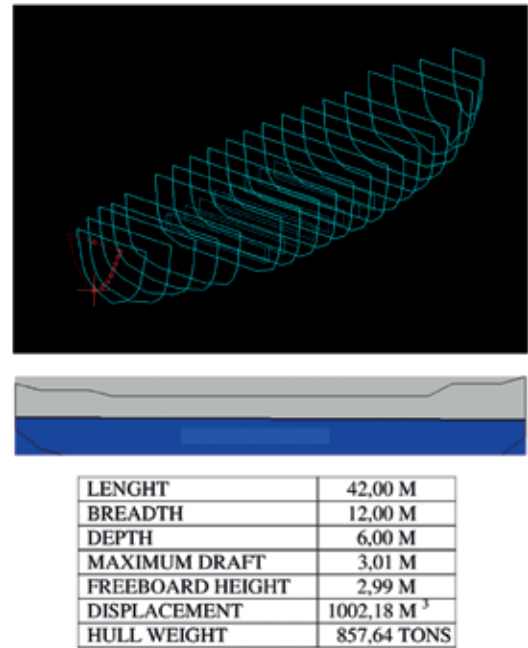


Fig. 20.4. Model of the hull of Torre Sgarrata wreck from the Nemi shipshape (S. Parizzi).

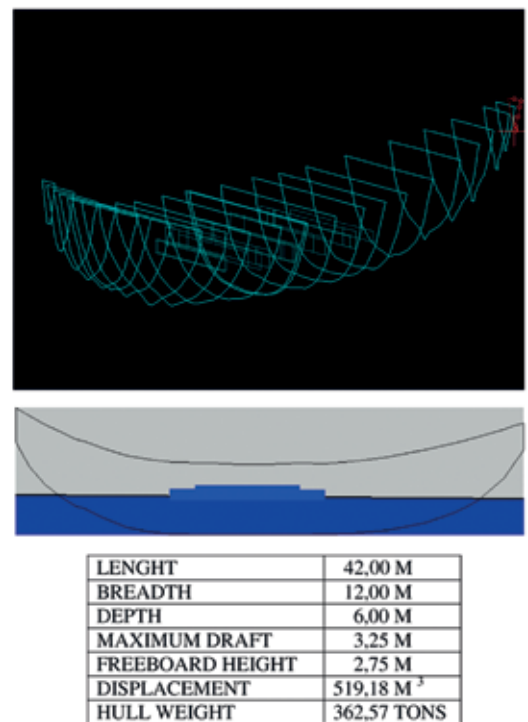


Fig. 20.5. Model of the hull of Torre Sgarrata wreck from the Grado shipshape (S. Parizzi).

shipshape and 33 m according to Grado's shipshape (Figs 20.6, 7).

These results show that all the ships we know that carried stones were not extraordinary in size, and that their length could be smaller than any *oneraria* carrying amphoras and belonging to the late Republican

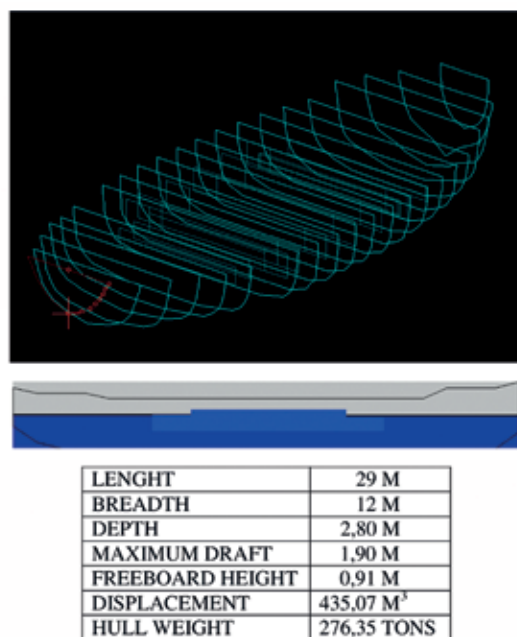


Fig. 20.6. Model of Torre Sgarata wreck from the Nemi shipshape after optimization (S. Parizzi).

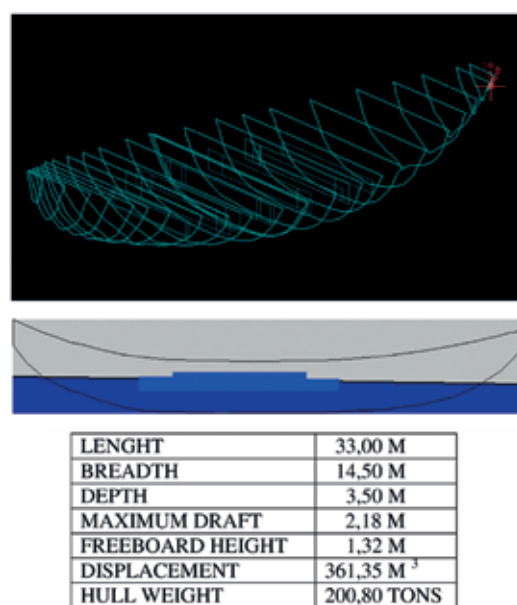


Fig. 20.7. Model of Torre Sgarata wreck from the Grado shipshape after optimization (S. Parizzi).

period, like the Madrague de Giens vessel which was 40 m long (Pomey ed. 1997: 179).

Obviously these calculations are only simple proposals based on not precise or direct data, so they will need to be confirmed by analysing a well preserved hull, but actually the archaeological evidence of these kind of hulls is still very poor. The few wood traces we know about have been preserved by the protection

of a marble cargo which, unfortunately, are hard to move and makes it difficult to investigate what lies beneath. This complex operation has been done only on the Kızılburun site (Carlson 2007).

The rare traces of hulls belonging to marble ships have been found in the following wrecks:

- The Dramont I wreck, which was found with an 8.5 m long side section and traces of preserved keel. The planking, jointed by mortise-and-tenons, was 5 cm thick, but the wales could reach 15 cm of thickness (Lopez 1993, 1994).
- The late Republican wreck of Kızılburun, where small evidence of planking, frames and a keel section have been found under the cargo. The possible thickness of the planking is 4.5 cm (Littlefield in this volume).
- The wreck of Mahdia, where sections of a keel, probably 26 m long, and part of the sides have been seen. The planking was 8.5 cm thick and was composed by two different layers; outside it was protected by a lead sheathing (Hoeckmann 1994).
- The wreck of Torre Sgarata, where a possible foremast step and other evidence of the hull have been documented by Peter Throckmorton. The planking was 7 cm thick (Throckmorton 1989).
- The wreck of Carry-le-Rouet, where traces of a 5 cm thick planking protected by lead sheathing is preserved (Kainic 1986).

The wrecks of Salakta (Parker 1992: 378) and Şile (Beykan 1988: 127-137) from which no hulls traces found by the excavators are still available. After this quite poor evidence, we want to draw attention to the wooden elements seen on the other three shipwrecks: the 'Column wreck' of Camarina (Parker 1976; Di Stefano 1991) and the Punta Scifo A and D wrecks near Crotona (Orsi 1921; Medaglia 2008: 105-108).

At Camarina, a hull section with 35 frames and the keelson have been documented with photos by Aquarius Company. As we can see from these images, the planking shows a characteristic: on its 5 cm thick edge, a 'false' double order of mortise-and-tenon joints are present (Fig. 20.8). The ship was no more than 20 m long.

The Punta Scifo A, was documented in the way. A hull portion with some planking and frames, measuring 3 by 3 m, has been seen. The planking, which is 8 cm thick, shows a 'partial' double order of tenon joints very similar to that of Camarina's one. In this case, the double order of the mortises is not 'false'



Fig. 20.8. Partial superimposed double order of mortise-and-tenon joints in the hull of the 'columns wreck' of Camarina (Courtesy Soprintendenza per i BB. CC. AA. di Ragusa).

because they are really partially superimposed and they have no space between them.

On the Punta Scifo D wreck, a portion of a presumed wale and copper alloy nails and bolts have been found. On the sides of the wale a double order of tenon joints have been documented by Alice Freschi in 1987. On the sides of this element about a 8 cm thick planking could be connected.

The archaeological evidence produced by these marble ships demonstrates that their hulls were built to become very strong although the Camarina cargo was quite light (20 tons). Their planking, connected by mortise-and-tenons, was in fact thicker than the average size. If planking average thickness of a Roman cargo ship was about 3-4 cm, the marble ships' planking was from at least 5 cm to the exceptional dimension of 8.5 cm. This solution is directly proportional to the ship size, but could be present on a relatively smaller ship, such as the one of Camarina. Sometimes the planking was composed by a double distinct layer (as on the Mahdia wreck) and sometimes it could be protected by a lead sheathing, as demonstrated by the Mahdia and Carry-le-Rouet ships, but also as suggested by some pieces of lead discovered near the cargos of Isola della Correnti (Käpitan 1971: 296-298) and Baia della Caletta (Martino & Ocelli 2009: 112-133). The wales on the sides, however, could be exceptionally thick as the Dramont I wreck shows.

On the Camarina and Punta Scifo D wrecks, the planking is very thick but in one layer. In these ships, the shipwright decided to make a sort of double layer of mortises. These mortises, and the relative tenons were disposed in a staggered position to

avoid two holes in the same zone and to reduce the breaking risk.

This technical solution of naval carpentry is present on great size Roman hulls, such as the Caesarea (Fitzgerald 1989: 4-9), Antikythera (Weinberg et al. 1967: 106), Madrague de Giens wrecks, but at least in one case also on a small ship such as the Saint Jordi 1 (Colls 1987) wreck. It aims to create a very strong connection between the planking of big ships and small ships.

After these considerations about the hull, we should ask ourselves if these ships had a sail like those other marine cargo ships had. Observing the marble cargos disposition on the seabed, we can note that there seems to be lack of space between the blocks. Surely in some of them there is no room to host a mast or a keelson (Fig. 20.3). This lack of space for hosting a main mast among the blocks could suggest that some of these ships had no sail. We can not exclude, however, the fact that they had a small sail towards prow.

Analysing the findings in the wrecks not related to the cargo, we can observe that there is no trace of rigging elements such as ropes, blocks and pulleys. Anchors and sounding leads are the only equipment found in these sites.

The possibility that some of these ships had no sail would be curiously confirmed by the relief of Leptis Magna, where we can see a ship without any sail and any side rudder (Figs 20.1, 2). If we can not exclude at all that this is an unfinished work and that these elements would have been simply engraved on the stone for a second time, we have to consider that the relief close to this one is complete and that it shows a sailing vessel with rudders. Maarleveld's welcome suggestion that the relief represented a ship momentary and not permanently without stern rudders -elements which had to be useful also for a towed ship- is in contradiction with the presence of the cargo aboard the ship. We think in-fact that it is hard to think that a ship could carry the cargo before being equipped with mast and rudders. It is also quite unusual in ship iconography to represent a ship which is not fully equipped, especially when it has to represent a subject as important as the icon of the traders of marble columns.

Without a main mast, these ships could be moved by a small prow sail and perhaps towed by other ships. A similar solution, that is an aft ship towing that carries two hulls, have been proposed also by Wirsching (2000, 2003) to explain the transportation

of great obelisks from Egypt to Rome. For these ships, the towing would have been a safer solution than sailing. The highly dangerous navigation of a vessel carrying such a heavy cargo with great problems of stability could be avoided by a towing navigation. Adopting this system in case of great danger, they could get rid of the towing ships transporting the marble cargo simply by cutting the ropes after the recovery of the crew.

The discovery of tiles on 10 wrecks¹ would suggest that some marble ships could have a roof cabin for the crew. The presence of sailors aboard would be demonstrated also by some lead weights for the nets, by pottery and lamps, other personal belongings and some human bones: the latest have been found in the Mahdia and Torre Sgarrata wrecks. But the presence of men aboard does not prove that these ships were moved by sails, because the crew could have had the task of controlling the mooring operations and protecting the ship, rather than moving a sail. These men in fact, as demonstrated by many wrecks², often had some weapons and similar elements, perhaps to defend the vessel from the pirates.

Some men could be on these ships also for other reasons, as the set of stone cutter's tools, which has been found on the Porto Nuovo wreck (Bernard et al. 1998), would prove. This is very precious evidence which tends to demonstrate that the artisans could move together with the cargo in order to work the marble blocks in the city of arrival. These had to be specialized artisans and could not be substituted by local craftsmen.

There are still very few direct sources such as traces of hulls to reconstruct the aspect and the technology of the marble ships of Roman age. Most of the information about these vessels must be obtained indirectly by analysing the cargos and the naval engineering calculations.

The hypothetical reconstruction of their dimension hulls would suggest they were not special ships because they did not exceed the length of the big *onerariae* used for transporting wine from Italy to Gallia in the late Republican period. Also the biggest *lapidariae*, carrying up to 350 tons of cargo, were not longer than the Republican *onerariae*.

It is possible that some ships were not moved by a big sail but only by a small one put aft. Some of them perhaps, could be towed by other ships: a solution that would have guaranteed the possibility of carrying a bigger cargo and a safer navigation especially

for the crew. This technique would be suggested by many elements, but of course it should be proved by more data or experimentation.

The shape of these ships could be very similar to the *onerariae* that carried amphoras, and to the Nemi ships with very flat hulls. This latest shape, however, which was a sort of pontoon, as demonstrated by Parizzi's calculations, would have been more appropriate for a towed ship.

A small crew was aboard, under a cabin, with the aim of following mooring or towing operations and of defending the ship. Some of them could be artisans embarked to escort the marble to destination where they would finish their work.

Looking at the technical details, we can say that these ships had been built by their shipwrights to be very strong and to overcome the stress caused by heavy cargoes with rigid shapes which could not be distributed homogeneously on the bilge. An important solution to guarantee solidity to the hull was the use of thick planking or double planking and, sometimes, the use of a sort of double order of mortises-and-tenons.

Conclusion

The information we have at disposal does not allow us to say that the *lapidariae naves* were special ships and that they were built only for the transportation of marbles, although they had some particular characteristics, such as a strong structure and perhaps the lack of the main mast.

It is possible to say that these ships were 'normal' strong ships which, perhaps after a partial transformation and a dismantlement of the equipment, were used for carrying heavy cargos marble blocks³.

Notes

- 1 Baia della Caletta (Martino & Ocelli 2009: 124), Margarina (Vrsalović 1974: 53, 240; Jurišić 2000: 40), Marzamemi A (Käpitan 1961: 290-300), Methone D (Throckmorton & Bullit 1963: 21-23), Punta del Francese (Galasso 1997: 129-132), Punta Scifo D, Riches de Dunes 5 (Bernard & Jèzègou 2005), San Pietro in Bevagna (Ward Perkins & Throckmorton 1965; Alessio & Zaccaria 1997), Torre Chianca (Borricelli & Zaccaria 1995), Torre Sgarrata.
- 2 The Porto Nuovo, San Pietro in Bevagna, Torre Sgarrata, Camarina A, Mahdia and perhaps Punta Scifo A wrecks.

3 Although this article is the result of a common research, the reconstruction of the cargos and the computer calculations have been followed by Vittorio while Beltrame is the author of the rest of the work.

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