ROMAN CARGOES: UNDERWATER EVIDENCE FROM THE EASTERN MEDITERRANEAN

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By

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I, Elisabeth Julia Strauss, confirm that the work presented in this thesis is my own.

VOLUME I

ABSTRACT

The study of marine archaeology is fast becoming one of the more important primary sources in connection with the research into patterns of movements of goods during the Roman period; it can help shed light on a number of question regarding the use of simple and compound cargoes, for example, or the comparison between the distribution and location of wrecked cargoes and the finds on land in terms of production and consumption of goods and supplies. The main body of this work is the database of wrecks that were carrying products from the Eastern Mediterranean.

The time span I have used for the wrecks (300 BC-AD 250) covers the rise of the Roman Empire up to and including its height; few areas remained self-sufficient, and as cities grew, especially of course Rome with possibly one million inhabitants, demand also grew, not only for foodstuffs, but also for building materials and luxury goods. In the first two centuries AD, during which time the Romans ruled a fairly trouble-free and politically stable empire, the possibilities for long-distance transport of goods seemed limitless. Trading relationships developed too with regions as far east as India. The finds from the shipwrecks reflect this growth in the movement of commodities in terms of their contents and quantities; and analysis of the locations of these wrecks may shed light on patterns differing from those already known. Another aspect to be considered is the state's involvement in the movement of these goods – did the government actively promote transport of merchandise for their own fiscal benefit? The use of underwater archaeology may not only enhance, but possibly also challenge, what has already been learnt from archaeology on land and literary and epigraphic sources.

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Finally, I would like to thank my mother for her constant encouragement and for her help with the maps, and John, without whose patience, love and support I would not have been able to finish.

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ABBREVIATIONS

The abbreviations used in this work correspond to those used in the standard works in the field. Abbreviations for ancient works are those used in *The Oxford Classical Dictionary*; those for journals and periodicals are those used in *L'année philologique*. An abbreviation used that is not covered in these lists is:

PME *Periplus Maris Erythraei.*

JS numbers refer to the number given to each wreck in the database.

References for A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), refer to wreck numbers rather than page numbers.

Cross references within this work are given by chapter and sub-heading.

The terms 'ton' and 'tonne' have been left as cited in the primary sources since they are often approximate and conversions would result in fractions, giving a spurious impression of precision.

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GLOSSARY OF TECHNICAL TERMS

ceiling planks	planks laid fore and aft over frames to form a lining for the hold.
dowel	headless peg made of wood.
dunnage	brushwood stowed under the cargo to prevent wetting and chafing.
frame	important structural timbers covering the bottom and sides of the ship; a whole frame is a continuous piece of wood across the keel; a half frame covers only one side.
garboard strake	the first strake attached to the keel, often extra thick.
keelson	a line of timber placed inside the ship alongside the floor-timbers and parallel with the keel to which it is bolted, so as to fasten the floor timbers and the keel together.
mast-step	a heavy piece of timber on the keel in which the foot of the mast is slotted.
mortise and tenon	the joint used most frequently. Mortises (slots) are cut into the edge of planks to receive the tenons (tongue-shaped pieces of wood). These joints could be made extra firm with treenails.
rabbet	step-shaped channel cut along the edge of the keel into which another piece of timber with a tongue can be slotted.
scarf	joint by which two pieces of timber are connected longitudinally into a continuous piece, the ends being cut away so as to fit each other with mutual overlapping.
scantling	a small piece of wood.
stempost	the curved upright timber at the bow of the vessel into which the planks of the bow are scarfed.
sternpost	the external rear part of the ship's hull.
strake	longitudinal plank, part of the hull.
treenail	dowel or peg to fasten timbers.
wale	a thick strake part way up the hull to provide reinforcement.

1. INTRODUCTION

The ancient world relied on water transport for much of the long-distance movement of goods and unfortunately shipwrecks were probably fairly common occurrences. The database I have created aims to catalogue the wrecks that were carrying cargoes of goods from the Eastern Mediterranean and beyond, and I shall raise certain questions about the movement of these goods without necessarily being able to answer them.

The historical and political background of Roman expansion has been examined elsewhere by many eminent scholars, and is therefore not necessary here. An assessment of the ability of the ancient world to produce and distribute food and other goods will be made though, looking at aspects such as state and private involvement, taxes, and of course the products themselves. That the Romans had an effective transport system is undisputed when one looks at archaeological finds both on land and from the sea. Its success is reflected in the wide distribution of products throughout the Mediterranean with a variety of goods from the famous amphora, the so-called symbol of underwater archaeology, to marble sarcophagi. In the first two centuries AD, during which time the Romans ruled a trouble-free, politically-stable empire, the possibilities for long-distance trade seemed limitless. Thereafter, in the late third and fourth centuries, financial and political instabilities restricted the desire for and the movement of goods. The huge increase in the transport of goods during the early Empire is undeniable: the evidence showing this is overwhelming, from epigraphy to land archaeology to underwater archaeology. Literary sources range from Strabo and the *Periplus of the Red Sea* in the Augustan era, to the first-century *Natural History* of Pliny, to Greek and Aramaic inscriptions from Palmyra and honorific decrees. Although written later than the period here, Diocletian's Edict on Maximum Prices of AD 301 is also valuable. This is not to say that there is an even distribution of evidence topographically because there is not, as there is very little from Petra, Gaza or Tyre, places which we know from archaeology were important trade centres. In terms of marine archaeological facts, it is impossible to ignore the huge surge in the number of wrecked cargoes from 125 BC-AD 175, two to three times higher than in any surrounding period and not matched until the High Renaissance.[1] As K. Hopkins says, "the more sailings, the more wrecks and more wrecks because of more trade."[2]

Chapter 2 gives an overview of underwater archaeology, explaining its differences from land archaeology, and provides a background study for the database. Chapter 3 deals with Roman ports and harbours, especially the technological advances that were made in engineering, and the attempts that some emperors made to facilitate the process of the movement of goods, by building ports or canals, for example, not necessarily as a pro-active measure to help the economy, but probably more as a reactive one to satisfy the needs of trade that were already in place. Augustus expanded the port at Puteoli, and Claudius attempted a new port at Ostia that Trajan continued with Portus. Augustus also restored the canal that ran from the Nile to Arsinoe (Clysma) on the Red Sea and this may have facilitated Strabo's trip to India with a fleet of 120 ships in 25-24 BC.[3] Chapter 4 focuses on the ships themselves and what, if any, changes were made to them during the Roman period. It also looks at Mediterranean weather patterns and the problems of navigation in the ancient world, as well as some of the routes the Romans used.

By the Augustan era, Rome had control over a huge area of the Mediterranean and was able to make use of everything that it offered: not only agricultural resources, but mineral ones too. The diverse range of products included timber, clay, high quality wine and oil from Palestine and Syria, copper ore from Cyprus and Oman, silver from Anatolia and flax, grain, wine and dates from Egypt. Other minerals available for Roman use were iron from Cappadocia near the River Cerasus and in the hills above Pharnaceia; iron ore from near Andeira; and lead sulphide from near Zephyrum in Cilicia which was used for

[1] According to A. Parker's graph, there were more wrecks in the last two centuries BC, but this is not because there was more trading than in the first two centuries AD, but rather because piracy was still rife. What is more important is the definite decline in shipwrecks in the third and fourth centuries AD showing a decline in trade; A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992).
[2] K. Hopkins, 'Models, ships and staples', in P. Garnsey and C. Whittaker (eds.), *Trade and Famine in Classical Antiquity* (Cambridge, 1983), 98.
[3] Strabo II 5.12.

medical purposes.[4] As Cicero says, the Mediterranean had become Rome's port, *iamdiu mare videmus illud immensum ..... ab Oceano usque ad ultimum Pontum tamquam unum aliquem portum tutum et clausum teneri.*[5] Grain, oil and wine were the main goods associated with the Mediterranean and it is unfortunate that there is little archaeological evidence for grain and certainly none underwater in the Mediterranean as it was transported in perishable sacks.[6] Oil, wine and fish sauces, transported in amphorae, are the most common underwater finds and these form the subject matter of Chapter 5 along with other pottery such as fine tableware. Chapter 6 focuses on the production and transport of marble, looking especially at the three categories of its transport as booty, for imperially owned use and for private commercial use. Glass products and works of art in bronze will be studied in Chapter 7; although not many wrecks were carrying these as cargo, they are still an interesting addition to an overall picture of Roman shipping. Chapter 8 focuses on far eastern wares such as spices and raw textiles which were often manufactured in the eastern Mediterranean; unfortunately these highly perishable goods hardly feature in the shipwreck finds, but a combination of the use of the monsoons and Roman demand led to a huge increase in their importation into the Mediterranean. The movement of goods from the East in this category grew considerably in the first two centuries AD, as Rome's wealth expanded with, for example, the desire for live animals and birds, furs, kashmir wool, ivory, pearls and precious stones, incense, spices, pepper, cinnamon etc. These goods were subject to a 25 % customs duty as they crossed the frontier, as well as lesser taxes at local tolls such as at Palmyra: did the Roman state encourage these imports for financial gain? Did Hadrian build the Via Hadriana through the Eastern Desert from Arsinoe on the Nile across to the Red Sea and down to Berenike for the same reason?

The *pax Romana* should not be underestimated either. Prosperity and peace go hand in hand, whether it is peace through lack of warfare, or peaceful trading because piracy was wiped out. Merchants in Egypt were much safer with cohort security and this led to an enormous increase in the number of ships in the

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[4] Strabo XII and Pliny *HN* XXXIII and XXXIV for some of these resources; also M. Charlesworth, *Trade Routes and Commerce of the Roman Empire* (Cambridge, 1924), Ch. 5.
[5] Cicero *Prov. Cons.* 31.
[6] Only one ancient wreck has remnants of wheat which had solidified in melted pitch, St Peter Port off Guernsey, AD 280, A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 1007.

Red Sea sailing to and from India. Goods could move freely and the desire for luxury goods in particular increased.

Diverse factors then had a great impact on the economy of the Mediterranean under Roman rule: Roman taxation and the peace that Roman rule brought. Several regions clearly understood the advantages that could be reaped under the rule of an empire and specialised in large-scale production of food staples both for local use and export either as purchasable goods or in lieu of taxes: for example Tripolitania and Baetica specialised in oil, Egypt and Africa in wheat. For K. Hopkins, "...taxation was the driving force in the economy, and craftsmen became converters of high-bulk goods into transportable commodities",[7] whilst for J. Paterson, it was the fundamental nature of empire that led to the increased possibilities for the movement of goods: traders frequently went ahead of Roman armies and then set up permanently wherever there were garrisons, and in general, peace led to stability, security and prosperity, all of which were conducive to trade.[8] The debate also continues about how much involvement the Roman government had: obviously it was concerned with providing food supplies and paying for the army and it needed grain for the *annona* and therefore demanded it from the provinces, but that did not mean that it had any direct involvement in the handling of it. Much was left to private merchants, even in times of famine, as happened with the transport of other goods. If goods were being produced as a tax, how far was the state involved in their transport? Did military garrisons and troop movements have an effect on the transport of eastern Mediterranean products? Was there any conflict between the state and the private merchant? Augustus introduced a fleet as a permanent policy to keep piracy at bay, but there was no state merchant fleet so the state had to rely on private shippers.[9] The main questions are, therefore, what effect did Roman rule have on maritime matters, and were there significant changes in the

[7] As summarized by H. Parkins, 'Shaping the future of the ancient economy', in H. Parkins and C. Smith (eds.), *Trade, Traders and the Ancient City* (London; New York, 1998), 10.
[8] J. Paterson, 'Trade and traders in the Roman world: scale, structure, and organisation', in H. Parkins and C. Smith (eds.), *Trade, Traders and the Ancient City* (London; New York, 1998), 149-167. See also R. Duncan-Jones, *Structure and Scale in the Roman Economy* (Cambridge, 1990), 30-47.
[9] Suetonius, *Aug.* 98.2.

movement of goods from the Eastern Mediterranean between 300 BC and AD 250?

Thus there are a number of topics which, with the specific help of marine archaeology, will be addressed and answered, as far as possible without abandoning caution regarding partially preserved cargoes and incomplete recordings of finds. The final chapter will attempt to gather together all the threads linking the products to the database. Statistics show that the majority of wrecks carrying eastern Mediterranean goods are dated to the Imperial period. It also becomes apparent that it was normal for more than one product to be loaded onto a ship: there was a hierarchy of cargo, with the primary product being the most valuable as the stimulus for the whole journey, and the secondary one taking advantage of the route and exploiting the space left over. Long distance transport, as for grain, often generated short distance links because of the nature of coastal shipping in the ancient world. Ships carrying the *annona* were known to stray to take full advantage of tramp trading and in AD 409, well outside our period, a law was passed penalising such action especially in the eastern Mediterranean.[10] Therefore an attempt will be made to integrate archaeology on land and most importantly underwater, with epigraphical and literary evidence concerning the transport of Roman goods from the Eastern Mediterranean.

[10] In the Theodosian Code, shippers were warned not to overload grain ships with private goods, XIII 5.32.

2. THE TECHNIQUES AND METHODOLOGY OF UNDERWATER ARCHAEOLOGY

There has been interest in shipwrecks since ancient times, although, for the most part, this has been from the salvage point of view, of recovering specific objects for their intrinsic value. It is only during the last two generations, since the discovery of the Albenga shipwreck and its subsequent excavation in 1950, that interest has increasingly turned to archaeological research and the reconstruction of ships.[1] Thus archaeologists and divers, previously two groups with little contact, have come to work together. Nowadays, "Archaeological excavation might be defined as the disciplined dismantling of the contexts which form a site, with the aim of explaining the origin of each layer and its relationship to the rest of the site."[2] A shipwreck can be considered as a time capsule. Unlike dry sites where one investigates accumulated layers of information built up over a long period of time, an underwater wreck consists of a group of objects which went down at the same time, i.e. a closed group. The only comparisons on land might be a burial chamber, except that these objects were specifically chosen to be placed there, and a level of destruction as found in Pompeii. Many negative comments were made about underwater archaeology in the early days, but A. Merlin, the Director of the Bardo Museum in Carthage, made an accurate prediction in 1937, that "underwater archaeology, still in its infancy, would lead us to discover and find use again for the antique ships that went down with rich cargoes of works of art in the Eastern Mediterranean."[3]

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[1] For the Albenga wreck, see N. Lamboglia, 'La nave romana di Albenga', *RStudLig* 18 (1952), 131-213 and 'Il primo saggio di scavo sulla nave romana di Albenga', *RStudLig* 30 (1964), 219-229; P. Gianfrotta, 'Commerci e pirateria:prime testimonianze archeologiche sottomarine', *MEFRA* 93 (1981), 227-42; A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 28.
[2] M. Dean, B. Ferrari, I. Oxley, M. Redknap and K. Watson (eds.), *Archaeology Underwater: the NAS Guide to Principles and Practice* (NAS, 1992), 20.
[3] Quoted by J. Chabert, 'The archéonaute', in *Underwater Archaeology: a Nascent Discipline* (UNESCO Paris, 1972), 169.

What then, can a wreck offer? The basic feature is the structure of the vessel, and from that we can learn about the levels of technology and the methods of construction involved, as well as the types of raw materials used. We can learn about the reasons for a particular construction by looking at the design: was the ship built for transporting men or merchandise? Mediterranean shipwrecks mostly fall into the latter category.[4] Structural elements of ships can reveal a considerable amount about functional characteristics and performance, at what speed the ships sailed, their capacity, manoeuvrability etc. It is also important to look for any signs of faults or repairs, to give us clues about a ship's age, status and life history. This type of investigation might even explain why the ship actually sank. Obviously, the fact that the ship is there in the first place gives us an idea of sailing routes, although so far, we know little about ships that sank in open seas since most wrecks have been found by divers in relatively shallow waters. But any evidence of cargo, found on many Mediterranean wrecks, helps to form a pattern of sea-borne trade. Finally, the contents of the ship apart from the cargo, such as the crew's personal belongings, kitchen utensils and other amenities, reflect something about society on board. Until the development of underwater archaeology, very little was known about trade ships, and "of all underwater archaeological sites, wrecks would appear to be the most rewarding to study: in view of their numbers, the volume and variety of the cargo, their chronological spread and the novelty of the information they provide",[5] and it is for this reason that this section will concentrate on shipwrecks rather than other underwater work on, for example, ports and cities, which can be found in literature.

2.1 DEVELOPMENT OF DIVING

As early as the Roman period, salvage workers, *urinatores*, existed and they had a guild in the Roman port of Ostia.[6] Their work can even be seen at a

[4] For naval ships, see L. Casson, *Ships and Seafaring in Ancient Times* (BMP, 1994) or A. Guillerm, *La Marine de Guerre Antique* (Paris, 1993).
[5] F. Dumas, 'Ancient wrecks', in *Underwater Archaeology: A Nascent Discipline* (UNESCO Paris, 1972), 28.
[6] See R. Meiggs, *Roman Ostia* (Oxford, 1973), 279.

depth of 25m on the wreck of La Madrague de Giens in the South of France.[7] In 1446, a group of Genoese free divers found two Roman ships in Lake Nemi and unsuccessfully attempted to raise the hulls,[8] but it was not until the seventeenth and eighteenth centuries that science allowed people to move and breathe underwater. In 1691, Edmund Halley invented the diving bell which supplied air to the man in the bell via tubes from barrels of air on the surface. However since the air was compressed as it went down, the deeper the bell descended, the less air was available and what was available became stale very quickly. In 1715, two inventions allowed divers to go a little deeper: J. Lethbridge's rigid diving suit of a closed barrel with a glass viewport and arm holes sealed with leather cuffs which became famous worldwide for its ability to descend to 21m for about five minutes, and the French atmospheric suit, where the head and chest were enclosed in a copper suit and the legs and arms were tightly encapsulated. Air was fed to the diver through a tube from the surface into the headpiece and taken away via another tube. In the 1820s, the Deane brothers invented the diving helmet as we know it (and not Augustus Siebe as is commonly thought) and this was the start of salvage work on historical wrecks, including the Mary Rose and HMS Lutine, and even work such as recovering bodies from the Tay Bridge disaster in 1879.[9]

By the end of the nineteenth century, helmet diving was common throughout the Mediterranean especially for collecting sponges, which brought wealth to such places as Kalymnos and Syme in the Aegean.[10] Helmet diving involved compressed air passing through a hose from the surface to the diver, who used his head to work a valve in the helmet to control the inflow of air. However the effect of this system on the physiology of the human body was not really understood and half the men who tried it died in their first season. What we

[7] For La Madrague de Giens, see A. Tchernia, P. Pomey and A. Hesnard, *L'épave romaine de la Madrague de Giens (Var). Fouilles de l'Institut d'Archéologie Méditerranéenne* (*Gallia* Supp. 34 Paris, 1978).
[8] For Lake Nemi, see G. Bass, 'Eighteen Mediterranean wrecks investigated between 1900 and 1968', in *Underwater Archaeology: a Nascent Discipline* (UNESCO Paris, 1972), 35-53; A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992),732-5.
[9] See J. Bevan, The *infernal Diver* (London, 1995) and J. Broadwater, 'Timeline for deepwater technology and exploration', in C. Ruppé and J. Barstead (eds.), *International Handbook of Underwater Archaeology* (New York, 2002), 18-24.
[10] For sponge-diving, see the accounts of P. Throckmorton, *Diving for Treasure* (Pennsylvania, 1977), 66-77 and H. Frost, *Under the Mediterranean* (London, 1963), 197-225.

now understand as decompression sickness was then described as 'fatigue' and 'rheumatism'. It was for this reason that Turkey passed a law forbidding helmet diving but it was not strictly enforced and by the time that the first dive tables were introduced by the US Navy in 1907, there was already 'a trail of shallow graves from Tunisia to the Sea of Marmara'.[11]

Commandant Jacques-Yves Cousteau was the great innovator of SCUBA (Self-Contained Underwater Breathing Apparatus) during the 1940s and 1950s, a system which allowed the air supply to be attached to the diver. The idea was based on an early regulator invented by Commandant Yves le Prieur in 1926, and Cousteau and his friend, Emile Gagnan, an engineer, adapted it from wartime automobiles with their gas substitutes, to become an efficient and sensitive automatic pressure regulator. In scuba diving, the diver carries a tank of high pressure air on his back; the air then passes through the first stage of the regulator where it is reduced to an intermediate pressure; from there, it passes through a hose to the second stage of the regulator (the mouthpiece) where it drops to the ambient pressure of the surrounding water by the use of valves, springs and diaphragms.[12] The main difference from helmet diving is that scuba diving uses an open circuit system, i.e. the used air escapes into the water and is not re-used. This avoids a build-up of CO^2 by reducing the dead-air spaces; previously stale air had been kept in the helmet, so to avoid an excessive amount, the helmet had to be continuously purged or flushed out. It is also much easier to move around with a scuba unit, the only disadvantage being less available air. Advances in the mixing of gases in the 1990s have allowed longer times at shallow depths, while in 2001 a 45-day saturation diving mission was carried out by the U.S. Navy.[13] However, surface-supply diving is not totally obsolete and is still used on small sites where restricted movement does not matter too much.

2.2 PHYSIOLOGY OF DIVING

Underwater archaeology obviously involves certain changes to the body as a result of being in a different environment and it is essential that these

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[11] P. Throckmorton, *Diving for Treasure* (Pennsylvania, 1977), 70.
[12] For a detailed explanation of how regulators work, see *PADI Open Water Diver Manual* (California, 1991), 42-46.
[13] J. Broadwater, 'Timeline for deepwater technology and exploration', in C. Ruppé and J. Barstead (eds.), International *Handbook of Underwater Archaeology* (New York, 2002), 12-24.

physiological changes are understood and taken into consideration before embarking on any work underwater. There are a great many rules to follow to ensure the diver's safety against decompression sickness and lung expansion injuries. The air that we breathe is made up of 21% oxygen and 79% nitrogen, and nitrogen dissolves into the blood at depth. It is therefore very important to ascend slowly to give the nitrogen time to leave the body via normal respiration. Also, the body absorbs an increasing amount of nitrogen as the depth of the dive increases, so limits have been set restricting the time and depth of dives so that the nitrogen does come out.[14] If these limits are exceeded, nitrogen bubbles can form in tissues and blood vessels and they will eventually block veins and arteries. This can lead to a whole range of symptoms from difficulty in breathing to joint and limb pain and even paralysis. Even shallow dives to 15m, for example, are limited to 72mins. The time spent on the bottom can be increased by decompression diving, which involves stopping at various levels during the ascent.[15] If one is doing multiple dives over several days, there is also an increased risk of decompression sickness. Divers can also suffer from nitrogen narcosis, a condition that can start as shallow as only 20m below the surface and causes a feeling of euphoria and subsequent impaired function; as one archaeologist said, about the work on Antikythera, "It was as if the tomb of Tutankhamen had been excavated in five minute shifts by drunken stevedores who had never seen an Egyptian tomb, working in half darkness, dressed in American football pads with coal scuttles over their heads."![16] Diving is a dangerous activity and with the added equipment, lines and ropes involved in excavation, divers are at a greater risk of accidents. Care must be taken at all times, and if possible, there should be an extra diver in the water keeping an eye open for any problems. The effects of the underwater environment on the human body mean that marine archaeology is a more specialized field than that of archaeology on land. Not only do underwater archaeologists have to be trained as

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[14] For the history of diving tables, see Dr. R. Rodgers, 'The dive tables', in *The Undersea Journal* (PADI California,1984), 39-42 and 'Renovating Haldane', in *The Undersea Journal* (PADI California,1988), 15-17; Dr. M. Powell, 'Scientists test new dive tables for recreational divers', in *The Undersea Journal* (PADI California ,1987), 32-5.

[15] For instance, a dive to 55m for 17 minutes requires a 1 minute stop at 9m, a 9 minute stop at 6m and a 15 minute stop at 3m.

[16] P. Throckmorton, *Shipwrecks and Archaeology – the Unharvested Sea* (Pennsylvania, 1969), 145.

competent divers, but they also have to be much fitter than the average person, especially if diving at depth day after day. In addition, there has to be a huge amount of trust between the members of a team of marine archaeologists, since a mistake underwater can be a question of life or death.

Apart from these safety considerations, underwater archaeology also differs from land archaeology in other respects. The amount of time a diver is capable of working is much shorter than that of a land archaeologist. The reason is two-fold: firstly, the safety aspect mentioned above; secondly, water conducts heat away from the body twenty times faster than air, so divers get cold very quickly in comparison, especially as they are often motionless, and this leads to impaired function. Even in tropical waters, a diver can work for no more than 2½ hours in one stretch. The diver also experiences impaired visual function: light travels at a different speed in water than in air. When light enters the air in the mask from the water, the change in its speed causes the angle of travel to shift slightly. This causes a magnification effect that makes objects underwater appear 25 % larger and closer. Water has other effects on light. As one descends, there is less light because some light reflects off the water's surface, some is scattered by particles in the water and some is absorbed by the water itself. However, it is not absorbed uniformly; rather, colours disappear one by one as depth increases, red going first, followed by orange and yellow. Visibility can also be a problem in that it can be virtually non-existent, even in the Mediterranean, and this obviously reduces the archaeologist's ability to observe. To give a better idea of how this compares with land archaeology, here is an example of how much can be covered in one day: at a depth of 25-30m in a muddy area of the Mediterranean where the visibility is sometimes only 1-2m, less than 1km per hour can be covered for only a few hours a day. On land, this could be 3km per hour for five to six hours a day. During the excavation of the Mahdia wreck, comparisons were made with the timings of the investigations carried out in 1908; then, out of sixteen days, thirty-seven hours and forty-one minutes were spent in the water, of which only nine hours and twenty-five minutes were useful; in 1954, out of nineteen days, fifty-four hours were spent underwater, of which at least thirty-six to forty were spent on useful work.[17] Although this is a great increase in working time, due to the

[17] G. Bass, *Archaeology Underwater* (London, 1966), 24-6; JS 385.

advent of scuba diving, the comparison with land archaeology is still poor. The diving season is also more limited than land excavation, being a maximum of about four months.

2.3 THE UNDERWATER ENVIRONMENT

The geophysical conditions underwater have various impacts on wrecks, some advantageous, some disadvantageous. An early criticism of underwater archaeology was that nothing much could be preserved underwater, but actually the opposite is true and it is precisely because water preserves and protects clues not necessarily found elsewhere, that underwater archaeology can often give us more information than dry sites. The marine environment protects materials such as stone, wood and copper alloys twice as well as on land and it is therefore essential to arrange for conservation before excavation begins to keep these often unique pieces intact.

It is important to understand what is involved in wreck formation so that the most can be made of excavation opportunities and techniques. Some projects have unknowingly been left unfinished because only the immediately obvious has been examined and divers have failed to look around the site where in fact much of the wreck may lie. For example, the positioning of amphorae on the bottom, to use the most evident symbol of underwater archaeology, depends on the way in which the ship was transformed into the wreck it is today and this fact must be taken into account when surveying a site.

The ship may have sunk because it crashed into rocks, but it is often the composition of the bottom that is the first thing with which the ship has to contend after it has sunk. If the seabed is rocky, then the ship's hull will probably be broken, and its contents scattered. If the bottom is sandy or muddy, then the ship will sink into it in one piece and be covered up by seabed sediments, eventually to form a mound and resemble part of the natural landscape, like sand dunes in the desert.[18] The Mediterranean, fortunately, is quite sandy in parts and ships have been found almost intact, for example, La Madrague de Giens.[19] With

[18] See H. Frost, *Under the Mediterranean* (London, 1963), 124-6.
[19] For La Madrague de Giens, see A. Tchernia, P. Pomey and A. Hesnard, *L'épave romaine de la Madrague de Giens (Var). Fouilles de l'Institut d'Archéologie Méditerranéenne* (*Gallia* Supp. 34 Paris, 1978).

the gradual disintegration of the hull, the cargo will fill gaps in the planking and fan out over the seabed. Obviously, if the ship has fallen onto a slope, which is common at the foot of Mediterranean sea-cliffs, then the cargo will spill out down the side (Fig. 2.1).

The ship's preservation then depends on the aquatic environment: the deeper the water the better, since the ship will be protected from the destructive wave action, currents and swells associated with shallow water. The force of waves can be felt to a depth of more than five times their height, maybe 15m down, which is quite considerable, and although scattered cargo survives lodged into rocks, the likelihood of the ship itself surviving is minimal. Ships that have been found below 200m are in a much better condition because there is no oxygen at that depth and the renewal of all the bottom water would take about 2500 years. There, even normally perishable goods can survive. This retardation of decay due to lack of oxygen also explains why ships are better preserved if covered by mud or silt. In the Straits of Gibraltar, for example, at 400m, Cousteau's submarine, the Souçoupe, spotted a group of amphorae standing upright, stacked as if still on the ship.[20] This was only possible because the rate of the wood's disintegration was slow at that depth, giving the coralline limestone sea growth and shells enough time to develop and hold the group together, before the wood finally disappeared. The salinity of the sea also affects the rate of preservation: the less salty, the better, seen for example in differences between the Mediterranean and the Black Sea, which contains half the salt content of the former and preserves material to a greater extent. There are also differences due to the temperature of the water: the north-western Mediterranean is fairly cold and the degeneration slow, whereas the southern Mediterranean and the Red Sea are warmer with an increase in activity of marine life, where, for example, a sixteenth century wreck exists, covered in a coral forest over a metre thick.[21] Organisms, as well as the sea itself, can alter artefacts both physically and chemically, such as wood-boring molluscs, for example, shipworms, piddocks, teredo and gribble worms, which bore holes through the surface of the wood, making it more susceptible to degradation by other processes. Teredo worms are

[20] A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 447.
[21] E. Linder and A. Raban, *Marine Archaeology* (London, 1975), 21. As for many underwater sites, the location of this wreck has not been specified.

particularly destructive in the Mediterranean, where, within a few years, 'a piece of wood can look as if it has been riddled with buckshot'.[22] Larger animals such as lobsters and crabs can also be a problem by burrowing through or enlarging existing crevices and thus disturbing archaeological remains. On many sites, octopuses have stuffed the mouths of amphorae with all sorts of junk that is unfortunately common in the Mediterranean.

The rigging and sails are the first parts of any wrecked ship to disintegrate, probably during the first three to four months.[23] The wooden hull may last about seventy-five years as a recognisable ship, after which the wood turns soft and mushy. Parts that have remained in contact with the bottom and are protected from the water by the cargo are well preserved and can be brought up to the surface. As soon as they are exposed to air, they must be properly treated to prevent shrinkage as they are drying (see below for conservation).[24] Marble, like wood, is also attacked by sea worms and can be completely destroyed. The marble found on the Antikythera and Mahdia wrecks looks new on the buried side and pockmarked beyond recognition on the exposed side.[25] Some metals, particularly iron, form a concretion around themselves and become hollow casts once the metal inside has reacted with the chlorides and oxides in the salt water and disintegrated. Most metals only suffer surface corrosion, but other chemical reactions can occur, for example corrosion can affect silver very deeply, changing the outer layers into black silver chloride; or there is the case of the lead sheathing from the Grand Congloué wreck turning into sulphate of lead.[26] Glass is usually well preserved and it may be possible to date it by looking at the possible connection between the annual cycles of temperature and the formation of distinct layers. Again though, care must be taken when glass is brought up to the surface; some Phoenician beads of soft glass from the Cape Gelidonya wreck exploded into particles and dust in the sun.[27] Pottery is the best preserved of all materials, often found intact, and is the artefact most likely to be first noticed by

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[22] P. Throckmorton, *Shipwrecks and Archaeology – the Unharvested Sea* (Pennsylvania, 1969), 16.

[23] For an account of the effects of the sea on wrecks, see P. Throckmorton, *Shipwrecks and Archaeology – the Unharvested Sea* (Pennsylvania, 1969), 9-33.

[24] Oak tends to dry out fairly badly but pine and elm fare better.

[25] JS 36 and 385.

[26] JS 449.

[27] G. Bass, *Cape Gelidonya: a Bronze Age shipwreck* (*TAPhA* 57, 1967).

fishermen or amateur divers. Amphorae stoppers are affected, however, by the pressure of the water and might be pushed in, making the surrounding water oily or discoloured.

2.4 METHODS OF WRECK IDENTIFICATION

Underwater archaeological methods are based on land techniques with certain adaptations for the difference of environment, and, as with land archaeology, there are two ways in which wrecks are discovered: accidentally or by specifically investigating. Many Mediterranean wreck sites have been found by divers who have seen amphora necks protruding from the sand or local fishermen who have happened to catch objects in their nets, for example the statues from the Artemision wreck, or, quite commonly, sponge divers who have tripped over anchors.[28] Hopefully they might then tell the authorities or at least anyone who was asking (as many of the archaeologists were in the Mediterranean in the 1950s-60s).[29] Wrecks are also discovered by specifically looking through archives, although these only exist from about AD 1500 onwards, or searching particular locations; these may, for instance, be the site of a known battle, for example the Battle of Salamis, fought between the Athenians and Persians, or the site where it is known that a ship sank, for example the Mary Rose, or alternatively, a place where being shipwrecked is most likely, for example just under the surface of a busy channel near a reef, such as the Yassi Ada near Bodrum, or the south coast of Italy between Taranto and Capo Santo Maria di Leuca.[30]

There are two types of searches which the underwater archaeologist can use: a visual one or one that involves a remote sensing survey, usually with electronic equipment. Whichever is used, it is essential to know exactly where you are so that everything can be recorded accurately. This may sound ridiculous, but it is more difficult than often imagined to locate a particular site which could be small, with the added problems of handling a boat on rough seas, a distance from the dim coastline of the shore. Laying buoys and control lines is helpful,

[28] Roman anchors chopped up as diving weights is not an uncommon sight! JS 34.
[29] For example, Honor Frost, George Bass and Peter Throckmorton who made huge contributions to the early work of marine archaeology.
[30] G. Bass, *Archaeology Underwater* (London, 1966), 50-51.

but not infallible. To give an idea of the difficulties concerned, here is an example; at Porto Longo, a small harbour in Greece, a site that was researched in the late 1960s, numbered markers were used at close intervals right around the harbour, those on the east lining up with those on the west. In spite of this, running sonar back and forth by dinghy caused problems, since there were slight changes in the wind, an otherwise unnoticeable current, and difficulty seeing the white paint and flags on the markers.[31]

For successful visual searches, the necessary components are good eyes and training. It can be difficult to spot artefacts which are covered in sand or entangled in a thick growth of poseidonia or seaweed. Near the crusader castle of Atlit on a promontory south of Haifa in Israel, divers had been diving for years before it became clear that all the rocks and reefs were actually part of the jetties, moles and piers which made up the plan of the artificially built harbour.[32]

There are various ways the diver can travel underwater: for visual searches, the simplest method is by swimming, otherwise by being towed, either in the water or in a small submarine. For the most basic type of towing, a weighted line from the boat can be attached to the diver or he can lie on a vehicle that is being towed by the boat with moveable vanes, capable of changing attitude and elevation relative to the seabed. Another method is with a hydrodynamic cradle which has Perspex windows and can release marker buoys, since it is in communication with the driver, either by rope or telecommunication signals. Its speed can go up to three knots. Yet another is the towvane, a bell-shaped metal container with long vanes either side for one to two divers who stand inside it. It can either be closed like a submarine, or open like a diving bell, and again it can release buoys and has telephone links with the surface.[33]

Alternatively, the diver can be pulled along by an underwater vehicle. This allows the diver to control the speed and direction of the search and is therefore a more efficient method. It is also a safer process with regard to pressure-related illnesses, as the diver can control his own depth as well. These driver-propelled vehicles (DPVs) also vary in complexity from a simple motor, which the diver either holds in front of him or has attached to his tank, to

[31] P. Throckmorton, *Shipwrecks and Archaeology – the Unharvested Sea* (Pennsylvania, 1969).
[32] E. Linder, 'La Ville Phénicienne d'Athlit', *Archaeologia* 17 (1967), 25-9.
[33] E. Linder and A. Raban, *Marine Archaeology* (London, 1975), 22-29.

complicated submersibles such as Canada's 1997 *Deepworker* micro-sub that can descend to 610m. A cubmarine is a small submarine which can go down to 50-60 metres and is operated by 'rudders' or waterjets. It can also have claws or arms to pick up objects and at depth obviously needs strong lighting.[34] The effectiveness of any of these types of searches depends on the general visibility and the vehicle's speed. Much larger areas can be covered than if the diver were swimming, but if the speed is too fast, then sufficient and accurate observation will be impossible.[35]

There is a variety of methods used to toothcomb a specified area: a swimline or freeline search, comprising a string of divers spaced along a rope at regular and visible intervals, with their own set of differing-length tugs on the rope for communication; a jackstay or corridor search where ground lines are fixed and jackstays are moved along them in 2m to 8m corridors; a grid search, a more detailed version of the previous one where each individual square of the grid can be labelled; and a circular search, whereby there is a fixed point in the middle, around which the diver, attached by a rope, swims in ever increasing circles. Television monitors and metal detectors are also useful pieces of equipment in any of the above searches.

Developments during the last thirty years in remote-sensing equipment have enabled underwater archaeologists to survey areas which, for varying reasons, could not be searched using the above methods.[36] These may be areas which are too deep or where visibility is too poor for human divers. One major advantage of this new system is its ability to cover huge areas which can also be a distance away from the source. The basic principle behind remote-sensing is to record the shape of the seabed and in that way find out if there is anything lying on the bottom. The equipment can be divided into two groups, electronic and magnetic. The most commonly used in the former are the sidescan sonar, the echo-sounder and the sub-bottom profiler. All of these work by the process of sending pulses of energy to the bottom, and interpreting and recording the returning signal or echo. They work on varying frequencies and angles, the echo-

[34] See the *Titanic Exhibition Catalogue* (National Maritime Museum, 1995) for the work done from a submarine at 4000m.
[35] For all search methods, see M. Dean, B. Ferrari, I. Oxley, M. Redknap and K. Watson (eds.), *Archaeology Underwater: the NAS Guide to Principles and Practice* (NAS, 1992), 128-136.
[36] Ibid., 136-145.

sounder having quite a narrow field, the sidescan having a wide one with the added ability to look sideways from 100-200m and the profiler, also able to detect buried material. The magnetic-based group consists mainly of the magnetometer, which measures the strength of the Earth's magnetic field and detects variations in this field caused by the presence of ferrous materials or objects. This is less useful for the research for ancient ships than it is for post-mediaeval ships which were equipped with plenty of metal cannons, anchors etc.[37]

Deep water archaeology has dramatically expanded in the last few years due to advances in robotic remotely-operated vehicles (ROVs) and global positioning systems (GPS). Most of this technology has been developed for the oil industry or the military but the search for shipwrecks has been achieved too; with private funding, for example, the Titanic exploration and the Skerki Bank Project between Sicily and Carthage have been carried out, where, during the latter, five ancient wrecks have been found at depths of 800m (Fig. 2.5).[38]

2.5 UNDERWATER SURVEYS

Having found the wreck site and before beginning a survey, it is necessary to decide on the objectives of the excavation and thus tailor the survey accordingly. The reasons for the excavation may be archaeological or one of salvage, although it is hoped that anything even vaguely historical would fall into the former category. Within the archaeological context, there may also be varying aims: solely a survey or actual excavation. A projected timetable is useful at this point, before starting to organise the personnel (comprising technicians, draftsmen, photographers, electricians, mechanics and archaeologists), equipment, boat and finance.[39] Other aspects to consider might be the eventual conservation of the wreck, and publication and publicity.

After much trial and error in the 1950s and 1960s, modern ideas and practice try to encompass a complete range of aspects to do with an underwater

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[37] E.T. Hall, 'Wreck prospecting by magnetometer', in *Underwater Archaeology: a Nascent Discipline* (UNESCO Paris, 1972), 285-97.
[38] Japan has built a ROV that can descend to 11km. The Jason ROV used for Skerki Bank can reach 6500m. A. McCann and J. Oleson, *Deep water Shipwrecks off Skerki Bank: the 1997 Survey* (*JRA* Supp. 58, 2004), 16-23. The Ashkelon Project, run by MIT and WHOI, has researched areas off Israel and the Black Sea, ina.tamu.edu/fieldprojects99.htm. JS 364-67.
[39] For a description of the type of boat and equipment needed, see J. Chabert, 'The Archeonaute', in *Underwater Archaeology: a Nascent Discipline* (UNESCO Paris, 1972), 169-75.

site. This new attitude to the data means not only researching the cargo, but the ship itself, its positioning in a stratigraphical context and the environmental evidence. It is particularly important to conduct a full pre-disturbance survey, in which every visible clue's position is noted and the rest of the site beyond what may be visible, as established by the remote-sensing equipment. How much should be recorded? As much as possible, but the necessary information should be an accurate three-dimensional picture of the site, on computer if possible, or a two-dimensional plan with supporting descriptions and measurements. As will be shown below, early comments such as 'it is impossible to make proper plans underwater' can be disproved.

The most practical way to do a survey is to establish a framework, which can be in the form of site grid.[40] This is often a rigid structure made of metal tubing like scaffolding or gas pipes, particularly useful because divers can lean on it while they are working. Care must be taken to ensure its rigidity and accuracy against any movement from waves or currents. Datum points are then decided upon, as immovable reference points from which measurements are taken. These measurements need to be checked again and again to ensure absolute accuracy; the commonest and cheapest instruments are measuring tapes, rigid measuring rules or survey chains, but for long-distance measuring, the best are sonic-range meters or graduated tension wires which are expensive. Optical instruments, such as theodolites which are utilized by land archaeologists, are rarely used, due to the restricted visibility underwater. Each object that can be seen must be clearly labelled, then the process of drawing and recording the site can begin.

It is virtually impossible to expect a precise drawing of a site, partly because each person records only what they see, which might be different from what another person sees, and partly because drawing is two-dimensional and approximations of three-dimensional objects are inevitable. Even the thickness of the pencil line can be a problem on scale drawings. Photography is usually a better alternative with regard to speed and objectivity; however, there are also problems with this: again, limited visibility and insufficient light, reduced visual contrast, optical distortions inherent in the use of a lens and colour imbalance, all

[40] The first use of a site grid was on the Spargi wreck in 1958. See J. du Plat Taylor (ed.), *Marine Archaeology: developments during sixty years in the Mediterranean* (London, 1965), 103-18.

inhibit the survey's accuracy.[41] Ordinary photography is probably used less than it could be, due to lack of technique and knowledge (for example, the subject should be no further away than $^1/_3$ - $^1/_4$ of the visibility). Another option is the fairly new stereophotogrammetry, plan-making by computer from stereo-photographs of the site, which is more accurate than either of the above. The last possibility is the self-explanatory photomosaic, which can give a good overall view of the site, but used to suffer even more distortion. Recently, the use of photo-towers running up and down the rigid grid, with an overlap of 50% on each photo, has helped the technique to be more accurate (Fig. 2.2).[42] Finally, video systems are now employed, with an advantage over still photos in that they can record relationships between structures and objects, and three-dimensional relationships.

All of the above surveying procedures have a passive, non-touching role with the wreck. There is another method to survey and this has a potentially destructive effect on the site. This intrusive technique comprises probing with either a metal rod or tubing, through which low or high water pressure is pumped, to find sediments or structures beneath the surface layers and measure them by feel. This is obviously very useful for working out the dimensions and the lie of the ship and cutting down on guesswork. At this stage, before excavation proper, samples may also usefully be taken for dating purposes, particularly radio-carbon dating and dendrochronology. Moreover, this is the time to think about both temporary and long-term conservation, since artefacts can be lost forever if the correct treatment is not applied immediately after extraction.

2.6 EXCAVATION

After the various surveys and the decision to excavate has been made, it must be decided where to start and how much to do. This can extend from total excavation and reconstruction of the ship, to merely answering specific questions. And within the excavation category, the strategy has to be decided on, for

[41] Underwater photography was invented by Louis Boutan, a French marine engineer and zoologist in 1893, and was first used for archaeological purposes on the Grand Congloué wreck in 1952. For more on the early history, see D. Rebikoff, 'History of underwater photography', in *Underwater Archaeology: a Nascent Discipline* (UNESCO Paris, 1972), 193-205.

[42] Photomosaics are now of very high quality, for example the images taken of the Skerki Bank wrecks, in A. McCann and J. Oleson, *Deep water Shipwrecks off Skerki Bank: the 1997 Survey* (*JRA* Supp. 58 2004), 25-30.

example, whether all of one layer will be excavated or whether it would be better to dig one area down through all the levels. Partial excavation is avoided now as it is damaging to the site and can obviously give incomplete results, but is, on occasions, unavoidable. Time and continuity of excavation are vital since decay starts as soon as the natural stability of a site is altered. As a rule, it is recommended to work systematically around a particular object until it is free to be removed, as to pull it from the sediment may not only cause it to break, but also the failure to record its exact association with whatever is nearby. During the first attempts at excavation in the 1950s and 1960s, the top layers were taken off, only for a second and third layer to appear; airlifts (see below) were used, but these caused cavities and landslides, jumbling everything up and effectively destroying the site.

It is argued that it is easier to excavate in water than on land since the sea bottom is less compact and indeed the basic tool at the beginning of the excavation process is also the simplest: the hand. By using the density of the water and just by fanning the hand, a lot of sediment can be displaced, where the land archaeologist would have to use a brush or a trowel. The fine particles in the water drift away, albeit stirring up the sediment and reducing visibility, hopefully to leave the artefacts exposed. When the sediment is too thick or heavy, then a trowel can be used, and if there are larger objects, such as boulders, these can be lifted off. Usually peripheral trenches are dug into which the debris can be put.

After the sediment has been loosened, there are a number of devices by which it can be removed. Much work has been carried out in the last thirty years to improve these methods, especially to ensure that the archaeological evidence is not damaged in the process. The most successful are the air-lift and water dredge, both of which work on the principle of sucking up the waste sediment through pipes of about 5-20cm in diameter and emptying it away from the site.[43] They used to be utilized for bringing up artefacts amongst the sediment which was then sieved, but this practice is now frowned upon. The air-lift can be used for a range of tasks that on land would include a bulldozer, wheelbarrow, bucket and shovel, and its great advantage is that it is weightless and thus the diver can hover above the site. It consists of a rigid tube into the bottom end of which air is pumped

[43] For more information, see M. Dean, B. Ferrari, I. Oxley, M. Redknap and K. Watson (eds.), *Archaeology Underwater: the NAS Guide to Principles and Practice* (NAS, 1992), 208-213.

from the surface from a compressor. As the air ascends to the surface through the tube, it lifts it to a vertical angle, creating a suction effect at the bottom (Fig. 2.3). The main disadvantages of the air-lift for it to work effectively are a minimum current on site of 0.1-0.2 knots, a minimum depth of 5m and a compressor which is different from the one required to fill tanks. For the Mary Rose excavation, two huge pipes ran alongside the site, each with ten airlifts coming off them! The water dredge (or hydrolift) is similar to the air-lift except that the propulsive force is a jet of water which is pumped from the surface into the mouth of the tube and that it works horizontally, i.e. the water is pumped across the open end of a tube let into the side of the main tube and there suction develops, depending on the speed and volume of the pumped water (Fig. 2.4). The main advantage over the air-lift is that it can be used in shallow water, as it lies almost flat; its disadvantage is its negative buoyancy (although this can be easily corrected) and the fact that it is generally less efficient.

The removal of the artefacts from an underwater site to the surface needs more consideration than on a land site. Fragile, water-logged objects have to be carefully packed to ensure that they are not damaged in the rough water of currents or swells during any decompression stops on the way up and getting onto the boat. Often they can be raised in the medium that has surrounded them, such as sediment, to help reduce the potentially damaging environmental changes, although removing a large block of sediment may cause more damage to the surrounding stratigraphy; otherwise, they can be moved in purpose-built apparatus with a cushioning of water-filled plastic bags, bubble packs etc. Objects that are too heavy to be lifted normally by the diver have to be fastened to air-filled lifting bags, with extra padding at points where the ropes are attached to the object. Pieces of large timber may need to be cut, although underwater it can have the texture of soggy bread. It must be remembered that objects will be much heavier as they are lifted out, with their weight no longer supported by the water.[44]

It may be useful at this point to give a brief look at the way time is spent underwater doing archaeological work : the late Roman wreck of Yassi Ada in Cyprus was excavated by the University of Pennsylvania Museum in the 1960s

[44] For more information, see M. Dean, B. Ferrari, I. Oxley, M. Redknap and K. Watson (eds.), *Archaeology Underwater: the NAS Guide to Principles and Practice* (NAS, 1992), 226-7.

over four summers at a cost of about $100,000. Of 211 diving days, 1,243 hours were spent in the water, of which 64% was removing sediment by hand and air-lift, 19% making a plan of the site, 11% raising the cargo, 4% raising the hull pieces and 2% on miscellaneous activities. The team of the 1970s bettered this time by increasing the number of divers and the size of the diameter of the air-lift, by building a larger lifting bag to carry more than one amphora.[45]

2.7 CONSERVATION

Conservation is hopefully the aim of all excavations and this should include the preservation of what is left of the site on the bottom. The aim of conservation methods is to remove all the corrosive salts from the objects without harming them. Some materials are easier than others, for example, stone only needs washing to stop the salt crystals from forming, whereas wood and other organic substances need a lot of time and attention. Some of the processes involved are X-radiography, desalination and various types of drying out. The first of these is non-destructive and particularly useful for looking at objects within blocks of concretion and reckoning how much metal is left beneath a layer of corrosion products. Desalination is obviously a process to which all artefacts will be subjected, but it is especially important for ceramics, glass and stone. Fresh water cannot fully replace salt water straightaway, as this sudden osmotic pressure difference would alter the cell structures too quickly, but rather, gradually over a period of time that can last months, starting with a ratio of 1:1.[46]

The most complicated process of conservation is probably with regard to the hull. Waterlogged wood is wood without its natural juices and resins and if it were to dry like that, its cell structure would lose its internal support and eventually collapse.[47] Therefore the aim is to replace the sea water with a more stable substitute. There are three common ways of doing this: with polyethylene glycol (PEG), a water-soluble artificial wax whose concentration can be

[45] From the account by G. Bass, 'Improved techniques on a late Roman wreck', in K. Muckelroy (ed.), *Archaeology Underwater* (London, 1980), 32-40.
[46] For more information, see M. Dean, B. Ferrari, I. Oxley, M. Redknap and K. Watson (eds.), *Archaeology Underwater: the NAS Guide to Principles and Practice* (NAS, 1992), 229-30.
[47] As the French discovered with timbers of the Titan wreck that had been wrapped in newspaper and stored – the fragments shrank to half their former size, were green with rot and crumbling to dust! P. Throckmorton, *Shipwrecks and Archaeology - the Unharvested Sea* (Pennsylvania, 1969), 187.

gradually increased, so that the cell structures hold enough wax to tolerate the drying out process. The wax needs to be kept warm and the process can take years (the Wasa ship in Stockholm took more than ten years) so it can get expensive. The second method is to freeze dry the wood then impregnate it with vaporized wax, and the last, to replace the sea water with acetone, and then impregnate it with acetone-soluble resin. These methods are also suitable for other organic substances. For iron and other metals, the treatments vary from a chemical process (good for bronze), to electrolytic reduction (good for silver) to roasting the metal in an atmosphere of pure hydrogen at 1000°C.

2.8 CONCLUSION

As has been shown, great progress has been made in underwater archaeology in the last few decades, especially in the protection of artefacts and ship structures that are being brought onto land. However, less has been done in the past about the protection of these underwater sites before and after work is carried out. Nearly all Mediterranean countries have had serious antiquity problems since the birth of scuba diving, and in spite of regulations from governments, the armed forces and other groups, there are continuing difficulties. In countries that have a small coastline, such as Israel with only 117 miles, it is easier to control, since all the divers and archaeologists know each other. Whilst Yugoslavia was Communist, there was a virtual ban on diving, with yachts and diving equipment being sealed by Customs, so protection of the sites was also successful there. Greece and Turkey have a similar policy with regard to foreigners and they are not afraid to jail those they find in the water. In most countries, wrecks belong to the state and therefore any destruction, mutilation or theft is an offence; France has recently come down very hard on those who have indeed declared wrecks, but also happened to keep something for themselves - they are now in prison. Obviously there is growing concern and action is being taken which has to be a good thing. In the same vein, marine archaeological museums are being taken seriously and can be found even on small islands, which is vital, since research without communication is of limited use.[48]

This account of the techniques of underwater archaeology has hopefully

[48] Not all museums have publications though which is a shame.

made apparent which components are necessary to make a successful expedition. Clearly, important advances have been made and it is obvious that it is possible to organize an excavation underwater with the same deliberation and scientific accuracy as a land excavation. Collaboration between archaeologists and technicians in charge of diving is essential and becoming more usual, especially as the cultural gap between them narrows. The outlook for the future is therefore one of hope and anticipation at what still remains undiscovered at the bottom of the Mediterranean.

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Fig. 2.1 Schematic section showing a wreck formation.

Image removed due to third party copyright

Fig. 2.2 Photomosaic from the Skerki Bank D wreck.

Fig. 2.3 Diagram showing an airlifting operation.

Fig. 2.4 Diagram showing a water dredge operation.

Image removed due to third party copyright

Fig. 2.5 ROV Jason about to enter the sea.

3. PORTS AND HARBOURS IN THE ROMAN WORLD

The Mediterranean has a coastline that measures about 22,000km, which is equivalent to more than half the circumference of the world; it also has the highest density of ports of any of the Earth's seas, with more than a thousand recorded, most of them 30-40kms apart, and many of them on the highly indented northern shoreline. However, the requirements of an ancient port were often quite different to those of a modern one, since a harbour reflects and manifests the needs of the society that builds it, so only about one hundred and fifty of the old sites remain as commercial harbours today (Fig. 3.1).[1]

Roman harbours have until fairly recently been quite under-researched – older studies carried out before the invention of scuba diving relied on eye witness accounts of travellers who recorded what they could make out from land in brief, mostly un-illustrated, reports. The use of aerial photography and the advent of scuba diving has greatly increased our knowledge of what lies beneath the water; as G. Rickman says, "the amount of material is frightening — tumbled stone blocks underwater, remains of concrete wharves, timber revetments, ship sheds and slipways, ramps and steps, bollards and mooring rings, anti-siltation channels, lighthouse bases and store rooms quickly engulf one – and tend to obscure the view."[2] As purely archaeological finds, written up as reports of often difficult fieldwork, surveys are extremely valuable, but they need to be incorporated into the larger picture of the social and economic role of harbours to constitute a fully rounded study. As we shall see, there was a huge amount of Roman investment in ports and harbours, not only in Italy (Puteoli and Ostia) but also in the Eastern Mediterranean region (Alexandria, Tyre, Sidon), which must in turn have given a boost to the amount and variety of goods that could be transported. How the movement of these goods was affected will be discussed with regard to each commodity in further chapters.

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[1] S. Arenson, *The Encircled Sea: The Mediterranean Maritime Civilisation* (London, 1990), 59.
[2] G. Rickman, 'Towards a study of Roman ports', in A. Raban (ed.), *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 105.

3.1 DEFINITIONS

At this point, it would be useful to reflect on the definition of a port and of a harbour. According to A. de F. Quinn, "A harbour is an area of water partially enclosed, and so protected from storms as to provide safe and suitable accommodation for vessels seeking refuge, supplies, refuelling, repairs or the transfer of cargo... A port is a sheltered harbour where marine terminal facilities are provided, consisting of piers and wharves at which ships berth, while loading and unloading cargo, transit sheds and other storage areas where ships may discharge incoming cargo and warehouses where goods may be stored for longer periods while awaiting distribution or sailing. Thus, the terminal must be served by railroad, highway or inland waterway connections, and in this respect, the area of influence of the port reaches out for a considerable distance beyond the harbour. The tributary area of a port consists of that portion of the adjacent area for which freight transportation costs are lower than they are to competing ports. A harbour is merely a very important part of a comprehensive system of works and services which comprise a port." [3]

So in terms of a Roman port, we should be considering not only its geographical and physical features, but also its related structures and the relationship between them and the areas which produced raw materials, or were centres of manufacture, population and consumption. As G. Rickman asks, what decided whether a port was a success or not — natural factors, or human needs? And in the same vein, what brought about a port's decline — geographical variations or changes in society?[4]

3.2 FUNCTIONS

The most basic purpose of a harbour in any era is to provide a safe shelter for ships. But, for this study, we shall be looking at ports whose presence was intended to contribute to the commercial success of their region. With this in mind, there are two components to consider: the geographical one for the

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[3] A. De F. Quinn, *Design and Construction of Ports and Maritime Structures* (New York, 1961), 71 ff. quoted by G. Rickman, 'Towards a study of Roman ports', in A. Raban (ed.), *Harbour Archaeology, Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 105.
[4] G. Rickman, 'Towards a study of Roman ports', in A. Raban (ed.), *Harbour Archaeology, Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 105.

selection of the port's location in terms of size and trading possibilities, and the physical one which concerned the architects and engineers who had to take into account the local currents, waves and winds to suit the harbour's design or even to change the configuration of the coastline. The combination of these two factors means that very good natural harbours may never have been used if there was no economic reason to do so, and in other areas, which had no physical features that lent themselves to shelter, ports had to be created artificially to satisfy the economic needs of the region. Similarly, some excellent natural ports went into decline or were abandoned because of political and economic changes.

Y. Karmon talks about the hinterland and foreland as basic concepts of maritime trasportation.[5] The hinterland is the area that provides the port with exports, for example, raw materials, agricultural produce and industrial goods, or even simply those goods that are in transit. An efficient network of transport leading inland and not parallel to the sea is also vital (because moving goods by ship is cheaper). He specifies three types of hinterland; continental, which utilises gaps or passes through mountain barriers to reach inland plateaux or mountain valleys, for example, Ephesus, Aleppo and Damascus and Antioch (for the Anatolian routes to Mesopotamia and Persia); a regional hinterland found mainly in peninsulas and large islands of the northern sector of the Mediterranean – in Italy and Greece, nowhere is more than 100kms from the sea, therefore, the nearest port or the one with easiest access could be used; and a local hinterland which served small areas between regional ports every 20-30kms, usually situated in river mouths or small coves which need very little infrastructure, for example, the small islands of the Aegean, and to which small boats could come from the regional ports. The foreland is made up of the seas accessed from the ports. Large ports were often more attractive for traders because of their size, not only for the obvious economic reasons, but also on a practical level of available facilities to rest the crew and the ability to restock the ship with provisions or even repair the ship in dry dock.

The Phoenicians, Greeks and Romans adapted a wide variety of sites to their needs; according to Karl Lehmann-Hartleben's research there are three

[5] Y. Karmon, 'Geographical components in the study of ancient Mediterranean ports', in A Raban (ed.), *Harbour Archaeology, Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 1-6.

common patterns: the first is a partly enclosed bay, with sea-walls built to protect it from the open sea, for example, Misenum. The second is a headland or offshore island which provides several rather exposed harbours, each of which has to be protected by the joining of islands, reefs and the mainland with a series of sea-walls, for example, Apollonia; and the third is represented by artificially excavated harbours such as Ostia. [6]

3.3 ANCIENT EVIDENCE

Various sources are available when looking at Roman ports, none of which are very satisfactory on their own. They range from ancient texts on harbour construction to historical journeys and geographical treatises to underwater archaeology. The most comprehensive ancient text on harbour construction is book V, chapter 12 of Vitruvius' *De Architectura* of the first century BC; here he describes not only suitable places for harbours to be situated but also the composition and placing of the relatively new hydraulic concrete blocks that should be used to build moles and quays (see below).

There are several works that come under the heading of itinerary literature; the *Periplus Maris Interni* by Menippus of Pergamum (late first century BC) and the similarly dated anonymous *Stadiasmus* or *Periplus Maris Magni* and the slightly later (AD 40-70) anonymous *Periplus of the Red Sea* (*Maris Erythraei*) in Greek. In Latin, we have the *Itinerarium Antonini* dating from the third century AD and the illustrated map, the *Tabula Peutingeriana*, of the late Roman period. These works are comparable to the twentieth-century coastal pilots in terms of being handbooks, giving names of ports, distances between them in *stades*, details of harbours and other landmarks a sailor might find useful. Other literary evidence comes from writers who described particular ports, for example, Strabo about Alexandria, Herodotus about Samos, Josephus about Caesarea, and Suetonius about Ostia; but, although informative, these were not comprehensive reports, especially from the engineering and technical points of view. [7]

[6] K. Lehmann-Hartleben, 'Die Antike Hafenanlagen des Mittelmeeres', *Klio* 14 (1923). Also discussed by N. Flemming, 'Underwater adventure in Apollonia', *Geographic Magazine* 31 (1959), 497.
[7] Strabo XVII 1.6-10; Herodotus III 60; Josephus *BJ* I 408-14; Suetonius *Claud.* XX 3.

Ancient pictorial harbour scenes come in the form of coins, portraying, for example, Claudius' harbour, issued by Nero in AD 64 and the harbour of Pompeiopolis in Cilicia of AD 144, both of which feature a reclining deity holding a rudder (see Fig. 4.3 in Chapter 4); these are fairly accurate but others are not totally reliable, for example, Trajan's six-sided port at Ostia is represented with seven sides and late coins from Side show a circular harbour when in fact it was an irregular triangle shape.[8] Glassware has been found portraying harbours seemingly as souvenirs particularly from Baiae and Puteoli;[9] wall paintings mostly from Campania are not particularly good;[10] there are some mosaics, for example, from North Africa of the third century AD, or shop signs on the pavements in Ostia;[11] and finally there are sarcophagus reliefs that generally feature only ships but sometimes have harbour installations in the background – most are found at Ostia and are of Portus; the most famous is the Torlonia relief of two ships and the lighthouse of Portus (Figs. 3.2, 3.3 and 3.4).[12]

3.4 MODERN INVESTIGATIONS

In modern times, the first studies of ancient harbours were undertaken by a few engineers, notably Gaston Jondet in 1916 at the Pharos, Alexandria, and geologists who were interested in changes of sea level, for example, R. Gunther in 1903.[13] These studies were followed by Karl Lehmann-Hartleben's work in 1923 that was based more on literary evidence than archaeological work, including a catalogue of 300 sites based on travellers' reports and a few early excavations, for example, Delos. But, as N. Flemming points out, even he only mentions 184 out of more than 240 major ports in the Eastern Mediterranean.

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[8] Bronze sestertius of Trajan, *Coins of the Roman Empire in the British Museum* Vol. 3 (British Museum, London, 1936), Trajan no. 770A, 162; coin of Gallienus portraying Side, in G. Hill (ed.) *Catalogue of the Greek Coins of Lycia, Pamphylia, and Pisidia* (British Museum, London, 1897), Side no.112, 161. See D. Blackman, 'Ancient Harbours 1', *IJNA* 11.2 (1982), 81-82.

[9] Eight glass flasks are now known, see D. Blackman, 'Ancient harbours 1', *IJNA* 11.2 (1982), 83 and n.18.

[10] Detailed exceptions include a painting from the Temple of Isis at Pompeii on which two and three-storey arcaded piers can be seen; also a painting from Stabiae showing a possible lighthouse, a high arched breakwater and a jetty, both in D. Blackman, 'Ancient harbours 1', *IJNA* 11.2 (1982), 83-4 and n. 27.

[11] Mosaics from pavements in Ostia, see R. Meiggs, *Roman Ostia* (Oxford, 1973), Pl. XXIIId, XXIVb XXVa with commentary.

[12] Torlonia Relief, see R. Meiggs, *Roman Ostia* (Oxford, 1973), Pl. XX with commentary.

[13] G. Jondet, *Les Ports Submergés de l'Ancienne Ile de Pharos* (Cairo, 1916).
R. Gunther, 'Earth Movements in the Bay of Naples', *Geographical Journal* 22 (1903), 121-149, 269-80.

The first strictly archaeological study of a harbour was Tyre, undertaken by Antoine Poidebard in 1934-36 following his air survey of the Roman *limes* (frontier forts). Local sponge divers, the French and Lebanese authorities, and the Navy, Air Force and harbour engineers helped him.[14] Since then, major excavations have been, and are still being carried out in Portus, Leptis Magna, Marseille, Caesarea, Myos Hormos and Alexandria, with other smaller surveys all around the Mediterranean.[15] The main difficulty of harbours is dating them: rock cut harbours cannot be dated at all on their own and their dating depends on adjacent more datable remains. On the other hand, Roman concrete is distinctive and very useful for dating.

3.5 THE LOCATION OF PORTS

Studies of the great ports of the Mediterranean tend to overshadow the smaller ones and distort the view of the overall nature and level of trade and interest in ports. As pointed out in earlier chapters, a great deal of Roman maritime transportation consisted of coastal tramping for which small ports were more than sufficient; long distance transport did require ports with a large capacity and ample facilities for the larger size ships, but for the bulk of shipping, harbours did not need to be big or deep to be suitable. Even heavy cargo boats of 240 tons and above, with a beam of 10m and length of 30m, would have needed a depth of only 3m. What made things a great deal easier for the Romans is the fact that the Mediterranean is non-tidal.[16]

It seems that ancient ships could also do without a port altogether; the beaching of small ships or at least mooring off an unimproved open beach played an important role throughout antiquity. A mosaic from Tunisia shows this happening and it still occurs today in some areas of Greece and in Dubai (Fig. 3.5).[17] If mooring offshore, the cargo could be unloaded onto lighters.

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[14] A. Poidebard, *Un grand port disparu: Tyr. Recherches aériennes et sous-marines, 1934-36. Bibliothèque Archéologique et historique* 29 (Paris, 1939).

[15] For example, Marseille, under the direction of A. Hesnard; Caesarea under A. Raban; Myos Hormos under D. Peacock; Alexandria under J-Y Empereur.

[16] See the beginning of Chapter 4.

[17] Mosaic in the Museé du Bardo, Tunisia. For a discussion about beaching, see G. Houston, 'Ports in perspective: some comparative material on Roman merchant ships and ports', *AJA* 92 (1988), 560-61.

Some ports were developed purely for their geographical location as export points for specific local commodities: Melos for obsidian, Keos for red ochre, Aliki in Thasos and Proconessus for marble, the Black Sea ports for grain and fish, Apollonia in Cyrene for silphium and later corn, Alexandria, Utica, Thapsus, Sabratha and Leptis for grain, wild animals and ivory.[18] Then there were ports which became important purely due to their location on key trade routes, for example, Alexandria, Ephesus and Antioch were excellent midway points for luxury goods from the East. Cyprus was also in an advantageous position for goods in transit. As R. Hohlfelder says, "like Cyprus itself, the port city of Paphos seems to have thrived economically if not politically under the benign neglect that characterised Roman imperial rule."[19] According to *Stadiasmus* 271, Paphos had 'a triple harbour safe in all winds' which probably means that the enclosed basin was an all-weather facility, divided into three distinct anchorages, each with its own function: an international emporium, a facility for local trade and a shipyard.[20] It was badly damaged by an earthquake in 15 BC and Augustus sent personal help and money to repair it.[21] Other research in Cyprus testifies to the island's role as a coastal crossroad: one small natural anchorage was Kioni on the small northwest part of the island, not mentioned in any ancient text. There are poorly preserved foundations of a harbour structure with two columns marking the central channel, one of imported marble in situ and the other now submerged and also an extensive collection of pottery, with dense concentrations of Hellenistic Rhodian amphorae and mid-Roman pinch-handled amphorae of the first – fourth century AD.[22] Another haven was Kourion on the south coast, where remains of a single breakwater are preserved extending from beneath the sandy beach, and J. Leonard thinks it was a harbour of some importance.[23]

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[18] D. Blackman, 'Ancient Harbours 2', *IJNA* 11.3 (1982), 188.
[19] R. Hohlfelder, 'Ancient Paphos beneath the sea, a survey of submerged structures', in V. Karageorghis and D. Michaelides (eds.), *Proceedings of the International Symposium, Cyprus and the Sea: organized by the Archaeological Research Unit of the University of Cyprus and the Cyprus Port Authority, Nicosia, 25-26 September1993* (Nicosia,1995), 195.
[20] R. Hohlfelder, ibid.
[21] Cassius Dio LIV 23.7-8
[22] J. Leonard, 'Evidence for Roman ports, harbours and anchorages', in V. Karageorghis and D.Michaelides (eds.), *Proceedings of the International Symposium, Cyprus and the Sea: organized by the Archaeological Research Unit of the University of Cyprus and the Cyprus Port Authority, Nicosia, 25-26 September1993* (Nicosia,1995), 227-246.
[23] J. Leonard, ibid.

3.5.1 Physical Problems with Certain Locations

As mentioned above, the physical location of ports was an important factor not only for their creation per se but also for their continuing use. Unavoidable natural phenomena such as earthquakes caused destruction to various ancient ports. Caesarea, Kenchreae in Greece and ports in the Bay of Naples were constructed on unstable ground and became submerged. The variations in the Eastern Mediterranean of eustatic and tectonic components and their effect on sea levels are a study unto themselves but to give an example, of seventy archaeological sites surveyed on the coasts of the Peloponnese and South West Turkey during 1967–69, some showed a relative uplift of 3m and others a submergence of 5m.[24]

The opposite effect to submergence occurred in ports that were built at the mouths of rivers; siltation was one of the biggest problems ancient harbour engineers had to face.[25] Ephesus and Miletus were important gateways for the great valleys of Asia Minor but the silt from the Meander could not be overcome in Miletus's case; despite Ephesus being moved seawards by the late Roman period, even the newer harbour was soon out of use and is now 15km inland. The same thing happened at Ostia, which is now adjacent to the Fiumicino Airport. Alexandria was fortuitously, or cleverly, placed west of the Nile delta so the west-east current swept the silt away from the port.

The Emperors paid more attention to the River Orontes in Syria: its ports of Seleucia Pieria on the coast and Antioch inland were terminals for one of the major caravan routes going through Central Asia. Although the emperors dredged the port of Antioch a few times so that ships of light tonnage at least could unload there, large ships were unable to get all the way there, so Seleucia, formally a military port, became a trade port too; it was hollowed out at the foot of the mountain and was therefore protected from the alluvium of the river.[26]

3.6 ANCIENT PORT CONSTRUCTION

Generally speaking, once a site for a port has been chosen, its construction has to take into account long shore currents, winter spray, river deposits and the

[24] N. Flemming, 'Holocene eustatic changes and coastal tectonics in the northeast Mediterranean: implications for models of crustal consumption', *Phil. Trans. R. Soc. Lond. A289* (1978), 405-58.
[25] Vitruvius V 12, warning about ports on river mouths.
[26] J. Rougé, *Ships and Fleets of the Ancient Mediterranean* (Connecticut, 1981), 172-3.

direction of infrequent winds. Structures solid enough to bear all of these also have to be built on an unstable bottom composition of mud or sand. J. Oleson points out other adverse conditions; "Currents work at them (the ports) below the water line and the sun above, which draws to the surface of the stone and mortar insidious chlorides that percolate through the fabric and weaken it. The wind, made sharp with sand and salt, gnaws at every barrier and usually changes its direction 180° within each day as the morning offshore breeze becomes an onshore breeze in the afternoon."[27]

3.6.1 Concrete

The Phoenicians and the Greeks had created harbours by building breakwaters of ashlar blocks or rubble mounds with ashlar quays on top.[28] The Roman development was to use masonry bonded with mortar and then solid concrete for free standing structures. This discovery of hydraulic concrete in the second century BC gradually spread through the Mediterranean and allowed engineers to build ports from flat, sandy coastlines out into the open sea. The Greeks had originally used structural concrete within the limits of levelling courses of stone. The Romans then used lime-mortar for foundations within structural cores in walls, arches, vaults and domes.[29] Hydraulic concrete was made by using a pozzolana additive or substituting it for the relatively pure silica sand.[30] This additive was a sand-like volcanic ash, *pulvis puteolanus,* and causes the hydraulic mortar to set slowly, particularly underwater, and become extremely hard. This mortar bonds together added stone aggregate, *caementa,* which both adds compressive strength to the mix and reduces the amount of mortar needed. The Romans called this mix *opus caementicium* — concrete.[31] Vitruvius is very specific about the origins of the pozzolana — it had to come from the Vesuvius region[32] — and be mixed 2 parts pozzolana : 1 part lime. "When lime, *calx,* fired rubble, *caementicium,* and pozzolana meet in a single

[27] J. P. Oleson, 'The technology of ancient harbours', *IJNA* 17.2 (1988), 147.
[28] For example, the Phoenician port of 'Atlit; A. Raban, 'The Ancient harbours of Israel in biblical times', in A. Raban (ed.), *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 30-38.
[29] For example, the 43m diameter concrete dome of the Pantheon AD 120.
[30] References to pozzolana, Strabo V 4.6, Pliny *HN* XXXV 46.
[31] *CIL* I 1793.6
[32] Vitruvius V 12.2.

mixture, when this mixture is put into contact with water, the ingredients cling together as one, and stiffened by water, quickly solidify, neither waves nor the force of water can dissolve them."[33] This is certainly true archeologically of structures in Caesarea and Portus. This new concrete could replace arches and vaults that had previously been carved from stone and revolutionised the designs of bridge footings, harbours and aqueducts. And, out of that, came the crucial contribution to the economic activity of the Mediterranean, for there was an increase in the size of harbours themselves since the concrete was strong enough to support walls, wharves, lighthouses and warehouses.

Vitruvius continues his writings by explaining wherein the concrete could be placed underwater. It could be put into a flooded containment system (formwork, Fig. 3.6); or cast as blocks above the water at the end of a pier and settled in, to extend it; or placed within a watertight enclosure. The first and last suggestions were probably restricted to a depth of 2m whilst the second one could be deeper.[34] After two months a block would be ready for the addition of superstructures. ?

According to R. Yorke and D. Davidson, types of formwork include the use of natural features, such as reefs (Sabratha and Thapsus), the erection of pre-fabricated panels onto driven piles, and box sections that are either lowered into the water or completely made on land and then sunk.[35] Examples of formwork can be seen in the ports of Antium, Cosa and Portus and it is best suited to sandy bottoms for the piles and boards to be driven into, although it still would have been possible on top of rubble (Fig. 3.7). Timber frame remains or impressions are also still visible in Antium, Astura, Misenum, Puteoli and Pyrgi.[36]

There was a great variety in the design of formwork around the Mediterranean; the most accepted suggestion is that upright posts, *destinae*, were

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[33] Vitruvius II 6.1.
[34] Vitruvius V 12. 3-5.
[35] R. Yorke and D. Davidson, 'Survey of building techniques at the Roman harbour of Carthage and some other North African ports', in A. Raban (ed.), *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 157-64. And discussed by C. Brandon, 'Cements, concrete and settling barges at Sebastos: comparisons with other Roman harbour complexes and descriptions of Vitruvius', in A. Raban and K. Holum (eds.), *Caesarea Maritima: A Retrospective After Two Millennia* (Leiden, 1996), 28-29.
[36] C. Brandon, 'Cements, concrete and settling barges at Sebastos: comparisons with other Roman harbour complexes and descriptions of Vitruvius', in A. Raban and K. Holum (eds.), *Caesarea Maritima: A Retrospective After Two Millennia* (Leiden, 1996), 25-41.

driven into the bottom at close intervals to support horizontal planks, *tabulae*, and the whole thing reinforced by means of transverse tie beams, *catenae*. The concrete mix could not just be poured into the formwork — it had to be carried down to the bottom by baskets, otherwise the mix would separate and weaken. Divers certainly existed but the easiest method would surely have been to construct as much as possible on land. At Caesarea and Carthage, mortise and tenon joints were used as in ship building;[37] in Side in Pamphylia the north east mole shows concrete in formwork up to the water level and then ashlar above it, with imprints of horizontal planking and vertical piles.[38] The formwork was primarily intended simply to contain the mortar and aggregate while they were being placed and to protect the semi-liquid mass until it had set. Only occasionally would it have been intended to provide a longer-term protection. However, unless the construction was taking place somewhere particularly sheltered, only the summer would have been suitable for the works to be carried out, when the sea was calm. Evidence so far shows a wide variation in the size of the formwork – for example, Cosa pier 5 measures 4.8m x 4.3m; Caesarea area G 15m x 11.5m,[39] Antium east mole 8.5m x 6m. None are deeper than 5m, which suggests that below that depth it was too difficult to create a level surface on which the formwork could sit.[40]

The earliest datable and surviving example of a major structure built with hydraulic concrete is in the harbour at Cosa, originally thought to date from the second century BC but since recent C-14 work on carbonised wood, more likely to date from the mid-first century BC.[41] The pozzolana was imported from Puteoli, but then tuff aggregate was brought from quarries around Bolsena about 60-80kms to the northeast. The formwork used consisted of thin, narrow

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[37] Ibid., 34.

[38] D. Blackman, 'Use of concrete in ancient harbour construction', in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective After Two Millennia* (Leiden, 1996), 43-4.

[39] J. Oleson, 'Technology of Roman harbours', *IJNA* 17.2 (1988), 153.

[40] C. Brandon, 'Cements, concrete and settling barges at Sebastos: comparisons with other Roman harbour complexes and descriptions of Vitruvius', in A. Raban and K. Holum (eds.), *Caesarea Maritima: A Retrospective After Two Millennia* (Leiden, 1996), 29-30.

[41] Work has been carried out by the Cosa Port Excavations under the direction of A. McCann. For further information on building techniques, see E. Gazda, 'The port and fishery: description of the extant remains and sequence of construction', in A. McCann et al., *The Roman Port and Fishery of Cosa* (Princeton, 1987), 74-97. Also C. Brandon, 'Cements, concrete and settling barges at Sebastos: comparisons with other Roman harbour complexes and descriptions of Vitruvius', in A. Raban and K. Holum (eds.), *Caesarea Maritima: A Retrospective After Two Millennia* (Leiden, 1996), 25-41.

overlapping wood about 4m high laid on a bed of sand. The breakwater consists of a series of stout rectangular piers, typical of early Roman harbours along the Italian coast. These *pilae* broke the brunt of the seas' force but allowed the sediment from the longshore currents to pass through without causing siltation. Other examples of this design have been found in Puteoli and Misenum and possibly in Antium and Terracina, all dating to the end of the first century BC. So far, examples of Vitruvius' first type are a variation of this method and there are no known examples of his second type of allowing concrete blocks to drop into the sea off a jetty and settle into place.[42] Examples of the third system for concrete construction, where pre-fabricated, watertight, double walled frames that could float until sunk by the concrete, are seen in Caesarea (see below).

Much research has been carried out into the origins of the pozzolana found in different sites around the Mediterranean.[43] Although Vitruvius is adamant about its provenance of Puteoli, would core samples verify this? The startling conclusion is yes. Samples from Caesarea, Chersonesus in Crete and other Italian ports, all show the Bay of Naples to be its source. The Romans clearly did not realise that pozzolana also existed in Santorini and Melos and were happy to export thousands of tonnes from Puteoli. Its transport to Caesarea would have fitted in well with the route of the grain fleet of Alexandria on its return journey.[44] Instead of a commercially useless ballast of sand to fill the empty ships after their delivery of grain to Puteoli or Ostia, they could have taken on pozzolana and delivered it to Caesarea quite easily. A *collegium* of *saburrarii* is documented at Portus, labourers who dredged sand or gravel from the harbour basin to be used as ballast.[45] Surely, the same would have existed at Puteoli. This scheme works well for the construction of Caesarea but what about Chersonesus, a minor harbour? The Mediterranean system of tramping probably suited partial cargos of pozzolana quite well even over fairly long distances – several wrecks

[42] C. Brandon, 'Cements, concrete and settling barges at Sebastos: comparisons with other Roman harbour complexes and descriptions of Vitruvius', in A. Raban and K. Holum (eds.), *Caesarea Maritima: A Retrospective After Two Millennia* (Leiden, 1996), 25-41.
[43] The most recent and comprehensive research has been carried out by the ROMACONS Project; see J. P. Oleson et al 'An analysis of Roman maritime hydraulic concrete', *IJNA* 33.2 (2004), 199-230.
[44] '*navigia inania et vacua et similia redeuntibus*', Pliny the Younger *Panegyric* XXXI 4.
[45] *CIL* XIV 102; by the beginning of the third century AD it was up to the *praefectus annonae* to decide what areas the *saburrarii* could go and take the sand necessary for their operations, O. Testaguzza, *Portus: Illustrazione dei porti di Claudio e Traiano e della citta di Porto a Fiumincino* (Rome, 1970), 76. See chapter 4, 4.5.

found off the South of France were carrying pozzolana, such as La Madrague de Giens.[46]

Core samples of concrete have been taken from four different Italian sites to examine their compressive strengths and porosity.[47] The selection of sites was chosen to represent different structures: Cosa, an important Republican harbour, Portus, a major imperial harbour installation of the first century AD, Antium, another imperial harbour of Nero and Santa Liberata, a privately funded *piscina*. The results show that compared to modern concrete, the compressive strengths were quite low with a density of two thirds of modern concrete. Higher proportions of mortar to aggregate were also used and the porosity value in the Roman concrete was also several times greater. In spite of this, they were extraordinarily durable. The cores also showed identical measures of composition even if there was more variability within each sample, reflecting a less refined mixing process than today. The earlier concrete from Cosa showed that beach sand was included in the mix and in fact the end product is infinitely harder than that of Santa Liberata, for example, which was mixed without it.

3.6.2 Moles and Breakwaters

The chief purpose of moles and breakwaters was to provide protection against heavy seas. Their alignment was crucial in relation to the direction of the prevailing winds and currents and for the avoidance of siltation. Although earlier than our period, the most impressive breakwater is in Cnidus, constructed in the fourth century BC, of piled banks of stone and roughly cut blocks in 30m of water.[48] The height of breakwaters is hard to establish, some may have lost top stones or even a whole layer; for example, in Anthedon (north coast of Boeotia) the breakwater has two slots cut into its upper surface which probably held mortar for bedding the course above;[49] others that look complete may have

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[46] A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), no. 616; another wreck is the Chrétienne M, see A. Joncheray and J. Joncheray, 'Chrétienne M, trois épaves distinctes, entre le cinquième siècle avant et le premier siècle après Jésus-Christ', *Cahiers d'Archéologie Subaquatique* 14 (2002), 57-130.

[47] The most recent and comprehensive research has been carried out by the ROMACONS Project; see J. P. Oleson et al 'An analysis of Roman maritime hydraulic concrete', *IJNA* 33.2 (2004), 199-230.

[48] D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 198.

[49] D. Blackman, J. Schafer and H. Schlager, 1967, 'Un port de la basse époque romaine en Grèce centrale', *Archeologia* 17 (1967), 12-17.

subsided from underneath because they were built on unstable bottom compositions, for example, Cosa and the north mole of Cenchreae and the south harbour breakwater at Phaselis[50]; or the breakwater may be submerged because the sea level has risen for example, in Chersonesus by about 1m. Some moles were built up on the inside to provide quays and later buildings such as lighthouses and towers; some were very wide for warehouses, fish tanks and temples, for example, in Cenchreae and Leptis Magna; others were very narrow, for example, in Chersonesus or very long, for example, in Thapsus, with 1,000m of large blocks in order to reach deep water.[51]

Expert placing of breakwaters could deflect a silt-bearing current, as could arched moles that helped flush through sediment and low breakwaters that allowed the sea to wash over them. Another method to avoid siltation was to allow in controlled currents to pass through the harbour continuously. This was easy to achieve in a harbour that had two entrances, for example, the inner harbour of Tyre. Flushing channels 1.8m wide and lined with ashlar were cut into the main east mole of Mytilene at intervals of 38m; and two channels with sluice gates at Cosa were cut through the cliff face to bring in silt-free water from the outer end of the promontory where there was deep water with a rocky bottom. Other flushing methods include the use of tides with sluice gates: this was attempted at Seleucia in Syria but the tide range was too small. It worked better at Sidon (see below).[52]

3.6.3 Quays

Although the interior sides of moles were often used as quays, the main quays were usually on the shore about 1m above the water level. Sometimes, this was equal to the gunwale of the ships as shown on the Torlonia relief.[53] Other times the gangways were at a steep angle. Ancient ships usually moored stem or stern to, often at right angles to allow a maximum use of space on the quay.

[50] D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 198.
[51] See note 41 and D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 198-9.
[52] D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 196-202 and various authors, 'Ports, harbours and other submerged sites', in J. Taylor (ed.), *Marine Archaeology* (London, 1965), 162-167.
[53] Torlonia Relief, see R. Meiggs, *Roman Ostia* (Oxford, 1973), pl. XX with commentary.

Berths could be numbered, seen for example on columns of Trajan's Portus, and there was a variety of attachments to secure the ships.[54]

There seems to have been no standardisation in terms of methods for mooring ships.[55] The simplest form for mooring was a hole cut obliquely through the edge of the quay. However, most harbours had separate mooring stones or bollards. These stones were pierced blocks set into a quay face, usually with a horizontal or occasionally a vertical hole. At Teos, for example, a stretch of quay 87m long is preserved, with mooring stones projecting at intervals of 3.4 to 3.5m; in the port of Cnidus, the mooring stones were set into the back wall of the quay at a height of 75cms above the waterline, with the surface of a nearby quay 1.4m above present water level, thus showing little change since antiquity. At Leptis Magna, where there was a double-layered quay, the mooring stones are set into the upper quay.[56] There are strange rub marks on the outer edge of the east mole upper quay where it seems that ropes came away from the wall at a steep angle, which means that a gangplank would have been very steep. A possible explanation is that mooring was carried out by men in small boats therefore the rope marks could be from lifting goods from the lower to the upper quay. Mooring stones were decorative as well as functional — some in Rome are carved in the form of a lion's head and one from Terracina has the head and fore-paws of a lion.[57] The space between mooring stones varies from about 3m, as in Teos and Leptis Magna, to over 17m at Terracina, although there may have been bollards as well. There are reports of iron mooring rings from at least thirteen sites but none were definitely set into a quay. Several slipways have been found, for example, in Apollonia in Cyrene, they were 40m in length, 6m wide at a

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[54] O. Testaguzza, *Portus: Illustrazione dei porti di Claudio e Traiano e della citta di Porto a Fiumincino* (Rome, 1970), 163, 169 and 171.

[55] For mooring stones, see D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 203- 4 and P. de Coetlogon Williams, 'Roman harbours', *IJNA* 5.1 (1976), 73-79. For Teos and Leptis Magnis, see D. Blackman, 'Evidence of sea level change in ancient harbours and coastal installations', in D. Blackman (ed.), *Marine archaeology : proceedings of the twenty-third symposium of the Colston Research Society held in the University of Bristol, April 4th to 8th, 1971* (London, 1973), 115-39.

[56] Compare the banks of the river Tiber at Rome.

[57] D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 203 and fig. 2, with photo 286; R. Mengarelli, 'Terracina. Pietro di ormeggio, scolpita, rinvenuta press oil molo dell'antico porto', *Notizie degli Scavi di Antichita* (1900), 635-8 and fig. 2; P. de Coetlogon Williams, 'Roman harbours', *IJNA* 5.1 (1976), 75.

gradient of 4° and in Siteia in Crete, 30m long and 5.5m wide at a gradient of 15°.[58]

3.6.4 Lighthouses

The first known lighthouse of the ancient world is Pharos in Alexandria, built in the third century BC on the west side of the entrance to the east harbour, on the eastern tip of what was then an offshore island. With its three tapering stories (square, octagonal and round) and at over 130m high, it could be seen 50km away and was famous throughout antiquity, often being represented artistically.[59] The lighthouse at Portus was at the end of the west mole, four stories high of decreasing height in both cylinder and square form (Fig. 3.8).[60] Not every harbour had a lighthouse, but it seems that many of them did have towers that could have shown light. Other sources come from a mosaic from Praeneste and a painting probably from Herculaneum showing a fire lit on top of a column standing in a prominent place — this was certainly simpler and cheaper than a tower.[61] Another suggestion is that colossal statues were used with a fire lit in the crown on the head, for example, on top of the small island in the bay of Porto Raphti, Attica and two from Crete.[62] The function of all of these lit structures was as an aid to navigation in terms of attraction rather than as a warning of danger. All are found at the end of a harbour site, for example, Leptis Magna, or on an island, for example, Pharos, or at the entrance to the harbour, for example, Portus and Centumcellae.[63]

[58] D. Blackman, 'Evidence of sea level change in ancient harbours and coastal installations', in D. Blackman (ed.), *Marine archaeology : proceedings of the twenty-third symposium of the Colston Research Society held in the University of Bristol, April 4th to 8th, 1971* (London, 1973), 115-39.
[59] Particularly common are coins dating to the reign of Antoninus Pius, see S. Handler, 'Architecture on the Roman coins of Alexandria', *AJA* 75 (1971), 58-61. Also D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 207.
[60] D. Blackman, 'Ancient harbours 2', *IJNA* 11.3 (1982), 198.
[61] Mosaic from Praeneste in O. Marucchi, 'Nuovi studi della Fortuna in Praeneste e sopra i suoi mosaici', *Bullettino della Commissione Archeologica Communale di Roma* 32 (1904), 233-83, pl. VI-VII.
Painting from Herculaneum in Pitture d'Ercolano, *Le PittureAntiche d'Ercolano e contorni* (Naples, 1757), I: 75.
[62] Examples from Crete, see T. Spratt, *Travels and Research in Crete* (London, 1865), I 210-11, 242.
[63] For further discussion on lighthouses, see P. de Coetlogon Williams, 'Roman harbours', *IJNA* 5.1 (1976), 73-79.

3.7 THE PORTS

3.7.1 New Technology in Established Ports

A typical feature of the Romans' civilisation was the ability to incorporate what had evolved before them with their own innovations and this is also true of their dealings with ports. The Romans added technological expertise to existing harbours and this led to a greater flexibility of design and therefore success. Several well-established ports benefited from this new technology: Tyre, Sidon, Apollonia and Alexandria.

The very ancient port of Tyre was originally an island with two harbours until Alexander the Great created a huge mole from the mainland of Syria that became a thick stretch of land. Substantial quays were added by the Romans to the two basins; these were enclosed by moles that were constructed of large blocks; anchorage space of 1,200m long was created outside the harbour by enclosing the natural bay with breakwaters following the line of the reef and protecting it from winds and swells from the south and the south-west.[64] Thus not only had Tyre's mooring space been increased but it was also safer.

Sidon, north of Tyre, had been built on the same featureless coastline.[65] A rocky offshore island to the north provided adequate anchorage to ships that could unload goods onto lighters, which then put in at the huge landing quays, on the beach north of the town, constructed under the Romans. Flushing methods were put in place by allowing water to filter over the west side of the inner harbour into two rock cut tanks, with floors sloping towards the basin and sluice gates at the inner end; when they were opened, silt-free water could be shot through. Extra moles at the Cyrenaica harbour of Apollonia seemed to have been constructed by the Romans to add shelter to the site which was exposed to the north-west wind: rubble and *opus pilarum,* formed by blocks of stone or concrete joined by arches, have been found along the east of the site.[66]

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[64] A. Poidebard, 'Un grand port disparu: Tyr', *Bibliothèque Archéologique et historique* 29 (1939). Also, various authors of 'Ports, harbours and submerged sites', in J. Taylor (ed.), *Marine Archaeology* (London, 1965), 162-4.

[65] A. Poidebard and J. Lauffray, 'Sidon. Aménagements antiques du port de Saida', *Etudes anciennes au sol et sous marines 1946-50* (Beirut, 1951).

[66] N. Flemming, 'Ports, harbours and submerged sites', in J. Taylor (ed.), *Marine Archaeology* (London, 1965), 168-174. Note the similarity in shape between the ports of Apollonia and Alexandria.

Alexandria, built on the south shore of the Mediterranean, west of the Nile Delta and backing onto Lake Maeotis, became one of the greatest harbour cities in the ancient world (Fig. 3.9).[67] It was created by building an eastern and western harbour on either side of an artificial mole (the Heptastadion, about 1300m long) which ran out to the offshore island of Pharos on which the lighthouse stood (see above). The eastern harbour, or Magnus Portus, had a basin of 600 hectares and measured 2.5 x 1.5km and offered a variety of sheltered harbour areas to ships, depending on the direction of the wind. The Romans contributed to Alexandria in several ways: they constructed extra canals, for example, the Augustan canal which ran from west to east through the city to Iuliopolis, a civilian settlement and customs post; this provided a more secure access route than going via Lake Maeotis and made the checks that ensured that grain was not tampered with a lot easier too. Three other canals in Alexandria itself came off this one, the Rhakotis, Nepharotis and the Canopus canal, which was mostly for passengers.[68] The *horrea* of Magnus Portus were greatly developed under the Romans and an administration centre was built on the old palace of the kings and where Alexander was buried. Many other first century buildings have been found around the harbour in 4-5m of water; their wooden posts remain, all of which date to the first century as well as limestone blocks, red granite columns and pavement. Traces of formwork have been found surrounding large mortar blocks including Area N1 at the end of the Poseidium and in the north west part of the port and on the west side Tika area.[69] It is thought that the port did have several entrances as mentioned by Strabo and Josephus, since the prevailing north/north-west winds would have made it difficult to exit through the Pharos entrance, so ships may have sailed through the Heptastadion and out through the west harbour.[70]

[67] Strabo XVII 1. 13. All information regarding Alexandria comes from the excavation work carried out under the direction of Frank Goddio of the Institut Européen d'Archéologie Sous-Marine, who read a paper 'The Topography of Magnus Portus: Interpreting the excavations (1992-2000)' at 'City and Harbour: The Archaeology of Ancient Alexandria'. International Archaeology Conference, University of Oxford, 18-19 December 2004.

[68] M. Clauss, 'Claustra Aegypti – Alexandria and its surrounding harbours'. Paper read at 'City and Harbour: The Archaeology of Ancient Alexandria'. International Archaeology Conference, University of Oxford, 18-19 December 2004.

[69] Excavation areas as detailed by F. Goddio, n. 67.

[70] Strabo XVII 1.6-10; Josephus *BJ* IV 615.

The Pharos itself, thought at one stage to have been on Fort Qait Bey, seems to have stood on a rock or island between the main entrances. The Pharos was white, made of limestone, and since limestone remains are extremely rare, as they are eroded underwater, it is for this reason that there are no ruins of it to be seen. The whole area suffered slumps over the centuries, partly due to the heavy weight of the buildings on quays that were built on sediment and partly because the area is prone to earthquakes.[71] There was also a tsunami in AD 365 which may have been the reason that all the buildings in the Magnus Portus collapsed to the south west.

3.7.2 Caesarea Maritima

Although many Roman goods passed through ports that were relatively simple and small, the great Roman-built harbours of the Mediterranean had a huge impact on the economy. The first century BC port of Caesarea Maritima has been the focus of the most extensive harbour excavation so far, and as R. Hohlfelder says, "Herod's port was the harbinger of a new era of construction."[72] Its design and enormous scale certainly made an impression on ancient authors particularly Josephus who wrote about it in great detail.[73] According to him, there was a total absence of existing anchorages along this part of the Levant and certainly no natural shelter on the site Herod picked. "For the whole shore from Dora to Joppa, midway between which the city lies, was without a harbour, so that vessels bound for Egypt along the coast of Phoenicia had to ride at anchor in the open when threatened by the south-west wind; for even a moderate breeze from this quarter dashes the waves to such a height against the rocks, that the backwash spreads a wild commotion far out to sea."[74] In reality though, the port of Dor, described by Josephus as a poor harbour, was a thriving maritime community even through the Roman period. Issues of coinage were struck from the first century BC and under Trajan in AD 111-12 it was given the rare title of

[71] During the twentieth century, the building of docks in the west harbour was difficult because of sediment – the engineers had to dig down to 6m to hit rock on which to build.
[72] R. Hohlfelder, 'The building of the Roman harbour at Cenchreae: old technology in a new era', in A. Raban (ed.), *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 81.
[73] Josephus *BJ* I 404 - 414 and *AJ* XV 330-342.
[74] Josephus *BJ* I 409.

'ruler of the sea' normally reserved for large ports such as Sidon.[75] Archaeological remains include three de-silting channels corresponding to three sea-level changes, shallow tanks for the purple dye industry, mooring stones and a 30-40m inner harbour made of ashlar masonry.[76]

Heavy seas and a strong long shore current carried a huge quantity of sand from Africa and the Sinai. Herod chose the site of Caesarea because it was near the northern frontier with Roman territory, in a region where only a coastal station, Strato's Tower, had previously existed. Not only would Herod be seen to be honouring Augustus by naming a magnificent town after him, but he also hoped to supplant Alexandria as a commercial gateway between the East and the Mediterranean. Herod's building programme in general was ambitious (he also rebuilt the second temple in Jerusalem at the same time, similarly to gain favour, this time with the Jews) and the town of Caesarea Maritima with its extensive port was intended to be his most impressive structure. An all-weather harbour that could be amenable to units of the Roman fleet might also have won support from Augustus; it would also have had the facility to station his own fleet. And in the tradition of earlier Hellenistic kings, "He desired to leave behind to posterity still greater monuments of his reign."[77]

Practicality obviously did not come high on Herod's list of priorities regarding Caesarea.[78] As well as the natural obstacles mentioned above, the bottom of the site was composed of sand, which was inherently unstable and prone to shifting under weight. Built between 22 BC and 10 BC were two enormous breakwaters reaching 600m and 300m (with a width of 50m) out to sea to enclose an area of 20 hectares. There was an intermediate basin and an inner basin as well, which was possibly the military or royal harbour (Figs. 3.10 and 3.11). His plan was to extend the city out into the harbour and that meant building a series of warehouses and other buildings on the breakwaters themselves (and

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[75] Between 64-3 BC and AD 210-11, sets of coins were struck depicting Doros, son of Poseidon; one coin of AD 66-7 features a murex shell on the reverse side, acknowledging the purple dye industry. See S. Kingsley and K. Raveh (eds.), *The Ancient Harbour and Anchorage at Dor, Israel: results of the underwater surveys 1976-1991* (Oxford: BAR International Series 626, 1996), 10 and 13.
[76] Ibid., 12-13.
[77] Josephus *AJ* XV 330.
[78] For more information on building techniques used in Caesarea, see R. Hohlfelder, 'Caesarea's master harbour builder: lessons learnt, lessons applied?' in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective after Two Millennia* (Leiden, 1996), 77-104. All mentions of excavation work refer to the Caesarea Ancient Harbour Excavation Project (CAHEP).

thus increasing the overall weight in the process). The breakwaters were built on a foundation or apron of rubble on the sandy bottom, with enormous concrete blocks, 15m x 12m x 2m placed on top. Uniquely the foundation was wider than the blocks, so that waves and currents could not break too hard on it or undercut the breakwater.[79]

Traces of formwork into which the concrete was placed still exist, and the pozzolana is definitely from the Puteoli area. It was the discovery of these concrete blocks which shows that Italian engineers and builders were involved — the use of hydraulic concrete had only been used in Italy up to this point. Remains of the wooden formwork were found in situ; some were large, flawless double-walled caissons, 11.5m x 15.2m built on land, floated into place, then submerged by filling the double wall with special mortar. The hydraulic concrete was then placed in the middle. One block was riddled with holes left by horizontal tie beams and vertical interior supports. Another kind of formwork is also seen in area K (northern end of the south breakwater, Fig. 10) - a watertight enclosure with a bottom, comparable to ship construction, 14m x 7m x 4m, built like the barges on the nearby beach. It was floated out, anchored in place and filled with concrete layer by layer, some hydraulic and some not.[80] Although Vitruvius only mentions double-walled formwork for use when the interior section needed to be dry and waterproof for normal concrete, these techniques at Caesarea seem to be an adaptation of Vitruvius's forms, maybe because total exposure to open sea and the character of the sandy bottom made it difficult to attach a pre-fabricated single walled caisson, that had no bottom, to the sea floor just with pilings.

In order to minimise the damage of waves, especially in heavy winter storms, and especially on the loading and storing areas of the inner quay, a

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[79] R. Hohlfelder, 'The building of the Roman harbour at Kenchreae: old techniques in a new era', in A. Raban (ed.), *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 81-87.

[80] C. Brandon, 'Cements, concrete and settling barges at Sebastos: comparisons with other Roman harbour complexes and descriptions of Vitruvius', in A. Raban and K. Holum (eds.), *Caesarea Maritima: A Retrospective After Two Millennia* (Leiden, 1996), 25-41. Compare finds from Les Laurons on the Bay of Fos, near Marseille. Built in the C3rd BC and expanded in the C1st AD, its timber formwork included a floor of fitted planks nailed to a horizontal frame of beams, 22.9 x 2.2m. D. Blackman, 'Further evidence for use of concrete in ancient harbour construction', in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective After Two Millennia* (Leiden, 1996), 41-49.

second or subsidiary breakwater was built, where the mole was most vulnerable as it turned north, running parallel to the south break water. This was lower, only just reaching the surface to break the force of the waves, and built with gaps to allow an easy reflux through the openings in its course. A revetted wall along portions of the outer face was another important design feature of the breakwater to give strength to the main structure. The engineers took advantage of the sand brought in during the winter months to fill up holes left in the construction of the north breakwater. They left rectangular compartments between each set of four blocks of concrete, knowing that any sand that got in there could not escape through the bottom since the rubble floor was already in place. Next spring, this sand was then packed and capped with another layer of rubble and then the whole breakwater could be paved. This construction technique was unknown until the area was excavated. The age-old problem of siltation was also dealt with. The south to north current brought in silt so at least one sluice channel, possibly more, was cut through the breakwater to allow sand-free water from the open sea to flow into the enclosed basin. An artificially induced current also flushed the outer basin and swept debris and sediment out through the entrance mouth to the open sea.

As mentioned above, Augustus sent help to Paphos to rebuild its port after an earthquake in 15 BC.[81] The apparent repairs may have been undertaken by some of the builders who were working on Caesarea Maritima at the time. There is no literary evidence for this but some of the design features are identical. Another strong connection with Cyprus is the use of Cypriot pine for the formwork to hold the concrete blocks in Caesarea. This adds to the international quality of Herod's harbour; engineers from Rome, wood from Cyprus and pozzolana from the bay of Naples, all encapsulated in Josephus's comment that Herod "got no material suitable for so great a work from the place itself but completed it with materials brought from outside at great expense."[82]

Once all the structural work was completed, then the usual buildings associated with the port were erected – customs house, workshops and *horrea.* Although no *horrea* have actually been found on the moles, four types on the

[81] Cassius Dio LIV 23.7-8 and R. Hohlfelder, 'Caesarea's master harbour builder: lessons learnt, lessons applied?', in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective after Two Millennia* (Leiden, 1996), 92.
[82] Josephus *AJ* XV 332.

adjacent land have: the vaulted type of Mithraeum *horrea* and inner harbour *horrea* – four parallel vaults about 300m long, 5m wide and 5m high opening to the west; courtyard *horrea* in area KK (250m to the south-east off the port) with plastered walls and white mosaic floors with lots of *dolia* fragments; corridor *horrea* 15.5m by 9m wide on the east side of the corridors is a *dolia* hall 15.9m long x 4.5m wide and on the west side three simple store rooms 5.8 x 5m; composite *horrea*, a mix of corridors, storage rooms and a hall and three underground granaries.[83]

Bar charts showing imported amphorae to Caesarea give by far the highest percentage from various quantified deposits as coming from AD50 in C8 vault and AD125 in the Hippodrome. Local amphorae also show the highest percentage in AD50.[84] With regard to the hinterland and transport network, seven major roads from Caesarea were built by the Romans and Herod, including one going north to Ptolemais, part of the Alexandria-Antioch road, the most important one of the Near East. Unfortunately the economic boom of the area experienced a downturn after Herod's death, but nature also played a part in Caesarea's demise. Unknown to the engineers of the port of Caesarea Maritima was the fact that two fault lines run parallel to the coast only 200m and 400m west of the land and these caused subsidence of 5-6m.[85]

3.7.3 The Ports of Rome

Rome itself was served by two ports until the mid first century AD, neither of them suitable for the vast amount of imported goods that the city of Rome required. Puteoli was too far away and goods had to be transferred onto smaller ships that would make it all the way to Rome, while the river port of Ostia had only a single quay which was inadequate and unsuitable for large ships. Rome suffered severe shortages during winter seasons because of a problematic

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[83] See the site map and excavations in A. Raban and K. Holum (eds.), *Caesarea Maritima: A Retrospective after Two Millennia* (Leiden, 1996), xxiii. Area KK has been excavated by the Combined Caesarea Expedition; J. Patrich, 'Warehouses and Granaries in Caesarea Maritima', ibid. 146-176.
[84] J. Blakely, 'Towards the study of economics at Caesarea Maritima', in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective after Two Millennia* (Leiden, 1996), 327-346.
[85] S. Arenson, *The Encircled Sea: the Mediterranean Maritime Civilisation* (London, 1990), 68; Y. Mart and I. Perecman, 'Caesarea: unique evidence for faulting patterns and sea level fluctuations in the Late Holocene', in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective after Two Millennia* (Leiden, 1996), 3-24.

food supply.[86] Julius Caesar had drawn up plans to change the course of the River Tiber to increase its navigability and Augustus considered a solution regarding the river mouth but nothing came of either plan.

Finally, with a threat of famine at the time of his succession, Claudius took a long term view and began the creation of the greatest man-made harbour of antiquity, Portus, in spite of his architects' attempts to change his mind (Fig. 3.12).[87] They were only too aware of the problems of siltation and the huge costs involved in the project. The selected site was established 3km north of the river Tiber and construction started in AD42. What is most surprising about this is the fact that it must have been known that there was an anti-clockwise current working in that area, i.e. being north of the river it would be likely to silt up.[88] Half the basin was excavated in dry land and lined with retaining walls before the sea was let in; then two huge 700m long moles were built into the sea to form a more or less circular shape, 10,000m sq. with an entrance 200m wide. The circular part of the northern breakwater was constructed on arches with the intention that debris would pass through, whilst the southern mole was solid to prevent the silt drifting in. The inner basin was separated from the main one by another island mole. Traces of wooden formwork can be seen on the concrete jetties, as can the pilings which anchored the formwork to the bottom (Fig. 3.7). Travertine blocks also formed part of the mole.[89]

The famous ship on which Caligula had imported an obelisk was thought to have been sunk to form an island on which the famous lighthouse was built; the lighthouse was four storeys of decreasing height, in both cylindrical and square form.[90] However, recent excavation shows that the lighthouse was actually near the end of the left mole and not on a separate island, although traces of the ship can definitely be seen in the solid concrete.[91] The other strange phenomenon was that the main entrance faces north, the direction from which 40 knot winds

[86] Cassius Dio LX 11.1-5, about the lack of suitable harbours and the need for continuing supplies during winter.

[87] The architects tried to dissuade Claudius by exaggerating the expense of the project, Cassius Dio LX 11.3.

[88] Unlike Alexandria, which sensibly had been built to the west of the Delta to avoid exactly this problem.

[89] Information about Portus from the Soprintendenza per I Beni Archeologici di Ostia.

[90] According to Suetonius *Claud.* XX 3.and Cassius Dio LX 11.4.

[91] R. Meiggs, *Roman Ostia* (Oxford, 1973), 149-60; D. Blackman, 'Ancient harbours 2' *IJNA* 11.3 (1982), 198.

blow. It now seems likely that there was another entrance to the south. No doubt this also explains how two hundred ships sank inside the port in AD 62.[92] The interior of the whole port was ringed with quays made of concrete with hundreds of mooring stones to which the boats could be attached.

In AD 46 Claudius also had built two canals running parallel to each other, connecting the harbour with the sea and with the Tiber, and an attempt was also made to reduce the risk of flooding by artificially connecting the last loop of the Tiber with the sea. The whole port was only finished in AD 64 under Nero, who had commemorative coins minted for the occasion.

Trajan improved Portus between AD 100 and 112 with the construction of a hexagonal basin 700m wide and 4m deep, dug out of solid ground.[93] As N. Purcell points out, 'this was a serious attempt to centralize the commerce of the capital' as it provided another 78 acres of anchorage;[94] Trajan restructured one of Claudius' canals to create the dock (It. *darsena*) and he used the other to connect to the Tiber (Fig. 3.13). He then dug a new canal which has since become the mouth of the Tiber. Again, this harbour was extremely well equipped with a dry dock, stronger quays and *horrea,* many tiled in marble (Figs. 3.14 and 3.15). The forces of nature were still against these harbours at Ostia and this must have become apparent even to Trajan, since he took measures to build another new harbour for Rome 60km further north, Centumcellae (still Rome's principal harbour, Civita Vecchia).[95] It was built on the same principles as those used at Ostia except that the island mole overlapped the ends of the main breakwaters instead of just lying between them. To the south of Rome, Nero built Antium, another large-scale work, straight after Portus had been finished, as well as Astura.[96] Trajan built yet another big port, Tarracina, to the south of Antium.

3.7.4 Other Italian Ports

As mentioned above, the ports in the bay of Naples or Phlegraean fields served Rome during the Republican period and continued to be an integral part of

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[92] Tacitus *Ann.* XV 18.3.

[93] There are no clear literary references to Trajan's work, only a restricted issue of coins from AD 112 that reproduced the harbour with the title 'Portus Traiani'; see p. 49 above for artistic licence in representations of ports.

[94] G. Rickman, 'Mare Nostrum', in E. Rice (ed.), *The Sea and History* (Oxford, 1996), 10.

[95] Pliny *Letters* VI 31.15-17.

[96] Suetonius *Nero* IX.

the Roman port system in imperial times. Puteoli was already an important harbour for Rome's imports but Augustus extensively developed the whole area and made use of the recently discovered concrete.[97] These large shipyard facilities were publicly owned and operated for government purposes, even if they were built with the aid of private money. Puteoli was extended under Augustus with 372m of arched breakwater, set on a row of at least fifteen *pilae*, to allow a certain amount of water circulation to prevent siltation (Figs. 3.2 and 3.3).[98] A long broad walkway was built on top of these arches and this was restored under Hadrian and Antoninus Pius.

The harbour of Misenum was built in AD 10 for the military fleet; this was likewise built on *pilae* and remains of the formwork are very clear in large sections of what is left. Formed from two natural basins, the inner one, now Mare Morto, was where repair work and the armament of ships was carried out, while the outer basin, now the Bay of Misenum, was the actual port. A canal spanned by a very high wooden bridge connected the two. The longer south pier was supported by a double line of *pilae* arranged so that the *pilae* of one was opposite the spaces between those of the other, in order to break the force of the waves better. Mooring stones are also visible. A shipyard on the little island of Nisida was also built. Later on Nero had an idea to build a canal linking Ostia to the coastal Lake Averno near Puteoli which had had a harbour, Portus Iulius, since 37 BC and traces of that effort (18m wide, 4m deep with quays and roads) still exist at Circeii.[99] All of these ports were in a great position strategically and their importance was reflected in a variety of literature from Horace and Virgil to Strabo. [100] Even now, the NATO base for southern Europe and the Sixth Fleet of the US Navy is here — but unfortunately the whole area is unstable and many of the ports subsided as a result of bradyseism.[101]

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[97] Private harbours for the so called 'villa society' also existed here. See J.H. D'Arms, *Romans on the Bay of Naples – A Social and Cultural Study of the Villas and Their Owners from 150 BC to AD 444* (Cambridge, Mass., 1970).
[98] Cf. Cosa, above. P. Gianfrotta, 'Harbour structures of the Augustan age in Italy', in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective After Two Millennia* (Leiden, 1996), 65-76.
[99] G. Rickman, 'Mare Nostrum', in E. Rice (ed.), The Sea and History (Oxford, 1996), 10.
[100] Horace, *Odes* II 18.20-22, III 1.33-35, Virgil *Aeneid* IX 710-716, Strabo V 4.6.
[101] Puteoli suffered from an uplift. Even in a small area such as the Bay of Naples, volcanic activity and tectonic shifts had different effects. See P. Gianfrotta, 'Harbour structures of the Augustan age in Italy', in A. Raban and K. Holum (eds.), *Caesarea Maritima: a Retrospective after Two Millennia* (Leiden, 1996), 65-76.

3.7.5 Old Technology in New Ports

An example of a port that was built during the Roman period without any new technology is Cenchreae, Corinth's eastern port.[102] Probably started in the 40s BC, its construction was completed by 10 BC and it served as a simple, traditional, international port with no imperial help for at least 500 years until it became submerged. This was a small natural bay with two promontories that were extended as breakwaters, built with rubble on a sand floor, 100m out, 20m high and 40m wide. The south mole and pier supported the various facilities such as *horrea*, *tabernae*, inter-connecting tanks and loading quays; it had no silting problems and very little current, although it did not actually offer much added shelter to ships, as its entrance was 150m wide. Compared to the port of Caesarea Maritima it was quite small, about one seventh of its size.[103] As R. Hohlfelder says, "As with so many facets of the heterogeneous Roman world, the old and the new, the local and the imperial, and the traditional and the innovative could co-exist."[104]

Leptis Magna in Tripolitania is an example of a slightly later, medium sized Roman port active under Nero but renovated by Septimius Severus who was born there. The harbour basin measures 25.2 acres and is enclosed by two moles with an entrance passage of 80m. The western mole extends 100m to the sea and has a lighthouse on the end. The inside of the harbour was rimmed with quays made up of big limestone blocks into which mooring stones were set. Great *horrea* stand behind a portico on the eastern quay as well as a small temple and the harbour control tower. Unfortunately this beautiful harbour enjoyed prosperity for only a short time as yet again, siltation problems could not be overcome, this time caused by the Labda Wadi which engineers had diverted.

[102] R. Hohlfelder, 'The building of the Roman harbour at Kenchreae: old techniques in a new era', in A. Raban (ed.), *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 81-86.
[103] According to J. Shaw, 'The harborage', in R. Scranton, J. Shaw and L. Ibrahim, *Kenchreai Eastern Port of Corinth, Volume I: Topography and Architecture* (Leiden, 1978), 14.
[104] R. Hohlfelder, 'The building of the Roman harbour at Kenchreae: old techniques in a new era', in A. Raban (ed.), *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours – Caesarea 24th -28th June 1983* (Oxford: BAR International Series 257, 1985), 85.

3.7.6 Red Sea Ports

In contrast to the Mediterranean that was non-tidal and had a good number of natural shelters, the Red Sea was extremely difficult for sailors. It had a huge tidal range especially in the two northern gulfs of Suez and Eilat; there were no rivers emptying into it that could offer protection in their mouths and because of varying wind direction and strength, often reduced to none at all in the middle section, oars had to be used. The coasts were barren and arid and inhospitable; there was no short distance tramping trade as in the Mediterranean.

However the amount and variety of long distance trade that did pass through the Red Sea was remarkable and the two ports that existed in Roman times must have been extremely busy. Strabo writes that Myos Hormos was the main port for trade from India, without mentioning a port at Berenice, but by the middle of the first century AD, both Pliny and the Periplus Maris Erythraei mention Berenice's harbour as being a more convenient port.[105] Here goods from India and the East were unloaded for their overland journey to the Nile, longer than if they had continued sailing to Myos Hormos, but easier than trying to sail against the north wind for another 230 nautical miles.

The archaeological evidence suggests that the prosperity of Berenice waxed and waned over several centuries, with the first century AD being the most successful.[106] We know from epigraphic evidence that at least eleven different languages were written there and at least nine different religious cults were practised; archaeological remains include artefacts from India and Sri Lanka, pottery from India, textiles, large quantities of black peppercorns also from India, and floral and fauna remains from such diverse regions as eastern Java, Thailand or Vietnam, the Persian Gulf, southern Arabia, Aksum, the Near East and the Mediterranean.

3.8 ADMINISTRATION OF PORTS AND HARBOURS

Having looked at the archaeological evidence for the construction and developments of ports under the Romans, it is time to examine their administration. Disappointingly though, sources are scarce both in literature,

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[105] Strabo II 5.12, Pliny *HN* VI 26.

[106] Annual excavation reports of Berenice have been published in a series, the latest of which is S. Sidebotham and W. Wendrich (eds.), *Berenike 1998* (Leiden, 2000). For more on the Red Sea ports, see Chapter 8, 8.7.

epigraphy and archaeology with regard to repairs, maintenance and officials. Out of the whole of *CIL* IX and X which covers southern Italy, Sardinia and Sicily, there are only two inscriptions which report any kind of port construction: 1640 and 1641 about the restoration of *opus pilarum* at Puteoli by Antoninus Pius.[107] Another inscription from Ephesus of AD 146-47 was a decree issued by the governor of the province of Asia, L. Antonius Albus, in response to damage done by traders of building materials: no one was allowed to store wood or saw marble on the quayside, since the first was too heavy for the pillars supporting the quay and the latter caused too much sediment that blocked up the channels.[108] Without constant maintenance work, even the best constructed port would not function — we know that the maintenance of the canals in Alexandria, for example, was under the charge of the *praefectus*.

A huge number of workers would have been required to run a port smoothly. Apart from stevedores to load and unload ships, there would have been men to operate cranes and other mechanical aids for unloading heavy cargoes. Vitruvius describes simple cranes[109] but as yet, there is no archaeological evidence and the pictorial evidence is suspect (a mosaic from the *Foro delle corporazione* at Ostia appears to show a tower with a horizontal arm, but this may be a yard from one of the ships; a graffito from Sabratha has been restored and looks implausible[110]). Then there must have been shipbuilders who could do repairs, men in charge of pump houses to supply fresh water and some in charge of keeping the fire lit in the lighthouses,[111] as well as divers and dredgers.[112]

Harbour rules must also have existed: was there a right way and wrong way to enter and exit a port? Or was it dependent on the direction of the wind? Surely in order to avoid traffic chaos, there must have been some kind of traffic flow: numismatic and sculptural evidence suggest that there was a division of inbound and outbound lanes; in particular, iconographic evidence from several

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[107] G. Houston, 'Ports in perspective: some comparative material on Roman merchant ships and ports', *AJA* 92 (1988), 563 – 64.
[108] *SEG* XIX 684.
[109] Vitruvius X 2.10.
[110] L. Turba, 'Graffiti con figure di navi nelle pareti di un fornice del teatro di Sabratha', *Quaderni di Archeologia della Libia* 3 (1954), 109-12; P. de Coetlogon Williams, 'Roman harbours', *IJNA* 5.1 (1976), 77.
[111] Cosa became a successful port mainly because it was the only one in the area that had freshwater from its many springs.
[112] These dredgers may have been the same as *saburrarii* (see above) since what was dredged from the harbour basin would also have been suitable as ballast.

ports reveals that a statue of Neptune stood on a pedestal in the mid-channel of the harbour's mouth as a day beacon and a channel marker; furthermore, it is probable that the ships passed it on their left-hand sides, i.e. observing an anti-clockwise flow.[113] Also, there must have been some kind of order as to which ship docked where and how long they were given to unload and reload. After all, there was room for 250 ships in Claudius' port at Ostia and for another 200 in the Trajanic harbour, surely a logistical nightmare unless well organised.

There is clear evidence that the ports of Ostia and Puteoli were under imperial administration. Claudius replaced *quaestors* who had previously taken charge of the ports with *procuratores portus* of freedman rank. Trajan then replaced them with equestrian ranked officials and in turn Hadrian split this one position into two: a *procurator annonae* of equestrian rank and a *procurator portus utriusque* of freedman rank.[114] We can only assume from honorific inscriptions in Ostia that the procurator dealt with all the administrative points mentioned above.[115] G. Houston has found no evidence that other Italian ports were run by imperial officials, which points to the use of local administration or private initiative for ports other than Ostia and Puteoli, which therefore appear to be anomalous.[116]

3.9 CONCLUSION

The greatest contribution the Romans made to harbours was their technological advance in the area of materials, and how they used them. Their development of concrete was crucial in building bigger and better-planned ports all over the Mediterranean; and they perfected the designs of secondary structures such as lighthouses, canals and water-supply installations. The huge ports of the Roman Empire, Portus and Caesarea, emerge as extraordinary creations, made all the more impressive considering how unusual they were.

Who paid for these works and why? The answer is those who had an interest in imports and exports. In the case of Caesarea this was King Herod who

[113] Cf. the hypothesis of E. Poehler about road traffic in Pompei, *AJA* 105 (2001), 264.
[114] G. Houston, 'The administration of Italian seaports during the first three centuries of the Roman Empire', *MAAR* 36 (1980), 157-70.
[115] Inscriptions erected by *collegia* such as that of builders (*CIL* XIV 160), grain measurers (*CIL* XIV 161) and river transporters (*CIL* XIV 4459).
[116] G. Houston, 'The administration of Italian seaports during the first three centuries of the Roman Empire', *MAAR* 36 (1980), 166.

clearly understood many aspects of the international exchange system; he realised that he could alter regional patterns by constructing an immense port that would dominate the Eastern Mediterranean. In the case of Ostia, it was obviously the various emperors who intended to gain from the port's commercial success, whether financially or by popularity with the people of Rome, whose food supplies would become more stable. In general, the more goods being moved from place to place for private consumption, the more the state earned from *portoria*; and, presumably, the better the facilities, the easier the passage for the *annona* goods that were an essential part of the Roman system.

As noted above, though, it was not simply in the construction of important ports that we can see the imperial attitude at work. Most ancient maritime transport was still conducted through small or medium-sized ports all over the eastern Mediterranean; the correspondence between Trajan and Pliny sheds light on what the emperors were prepared to offer. It seems that a group of engineers and surveyors existed whose help could be enlisted — Pliny's requests for aid in local projects such as in Prusa, Bithynia were turned down, but he was more successful regarding the construction of a canal to join a lake to the sea at Nicomedia, a port of considerable magnitude and glory, at least in the Emperor's eyes.[117] The importance that the imperial administration gave to maintenance work around the Empire was crucial for a port's survival against the constant ravages of nature, whether in the form of winds, currents, siltation or natural disasters: emperors such as Antoninus organised the dredging of Seleucia Pieria for its continued existence; the port of Luna in Italy was insignificant except for the fact that it was the export outlet for the nearby quarry of Luna marble, a commercially valuable commodity, whose port was therefore worth keeping silt-free;[118] Augustus sent help to Paphos after earthquake damage. Imperial negligence, in contrast, could be the downfall of a port, such as Leptis Magna, that could not continue diverting the Wadi by itself.

As C. Delano Smith so rightly sums up, "In the last analysis a port is a man-made feature, and it is on human factors that its survival must depend. The physical changes and problems brought by siltation, or erosion, should be measured in terms of cost and effort ... For a better understanding of the decline

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[117] Pliny *Letters* X 17 and X 41 and 42.
[118] Strabo V 2.5

and abandonment of so many port-cities around the shores of Mediterranean Europe, the focus should be turned to the fortunes of commerce, of urban administration and of national, economic and political organisation."[119] The Romans, with their technical expertise and investment in the construction of ports and harbours, responded magnificently to the expansion of the long-distance movement of goods, so necessary for the organisation of a vast empire.

[119] C. Delano Smith, *Western Mediterranean Europe*, (London, 1979), 368.

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Fig. 3.1 Map of the Eastern Mediterranean ports mentioned in this chapter.

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Fig. 3.2 Drawing of an etched souvenir glass representing the port of Puteoli C3rd-4th AD.

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Fig. 3.3 Idealised view of Puteoli, wall painting from Stabiae, C1st BC.

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Fig. 3.4 The Torlonia Marble Relief.

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Fig. 3.5 Mosaic from Tunisia showing a boat drawn onto the beach.

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Fig. 3.6 Diagram of Vitruvius' formwork for hydraulic concrete.

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Fig. 3.7 Formwork seen in Portus.

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Fig. 3.8 Mosaic of merchant ships in front of the lighthouse of Ostia C2nd AD.

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Fig. 3.9 Map of the port layout of Alexandria.

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Fig. 3.10 Excavation map of Caesarea Maritima.

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Fig. 3.11 Aerial view of Caesarea Maritima.

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Fig. 3.12 Map of Portus.

Fig. 3.13 The Darsena in Portus.

Fig. 3.14 Warehouses in Portus.

Fig. 3.15 Air vents underneath a granary store, Portus.

4. ROMAN SHIPS AND SEAFARING

Having examined the role that the Romans played in creating and renovating ports in Chapter 3, it is necessary to look at the ships that they were using and the routes that were being taken. Is the investment made by the Romans into harbours matched in terms of their treatment of ships? The Mediterranean was Rome's *mare nostrum*, or *mare internum*, and control of it allowed Rome to have the free access necessary for its imperial expansion, rule and way of life. Not only was the transport of goods made possible by sea, but also the transport of people: soldiers, officials, craftsmen and slaves. "Ease of transport and communication by sea in some degree compensated for low technology and low productivity. In that sense, the Roman Empire was built on water."[1]

This chapter aims to show what kind of ships the Romans travelled in, whether the Romans brought any innovation to naval architecture, and what conditions they faced when sailing in the Mediterranean. The Mediterranean Sea has been compared to a giant lake as it is the world's biggest inland sea; it measures 3,800km from east to west with a surface area of 2.96 million km^2, and has nearly no tide and few currents. Its basins are as deep as 2,700m and much of the shoreline is indented; islands dot the open sea, particularly in the eastern basin.[2] The continental shelf around the Mediterranean is very varied – along the south coast there are wide, sandy, featureless beaches which slope gradually, whilst the northern shores drop off more sharply (Fig. 4.1). Topography and meteorology were significant factors in the distribution of products in the ancient world; the ancient seafaring peoples were far more dependent on nature than we are in the modern world. Weather and seasons affected maritime travel in terms of speed and sailing times and therefore the cost and availability of products was

[1] K. Hopkins, 'Roman trade, industry and labour', in M. Grant and R. Kitzinger (eds.), *Civilization of the Ancient Mediterranean* (New York, 1988), 755-77; G. Rickman, 'Mare nostrum', in E. Rice (ed.), *The Sea and History* (Oxford, 1996), 1-14.
[2] S. Arenson, *The Encircled Sea: the Mediterranean Maritime Civilisation* (London, 1992), 59.

affected too. We take it for granted that things can be sent around the world anytime and anywhere, but earlier eras were severely limited in both aspects.

4.1 ANCIENT EVIDENCE OF SHIPS

The literary and artistic evidence about Roman transport, although quite abundant, provides a series of insights rather than a more general understanding. Vessels are mentioned in ancient literature and epigraphy with some frequency, but unfortunately details about construction and even sailing and navigation techniques are missing. Literary evidence comes mainly from Strabo and Pliny the Elder about seasons and sailing times, whilst inscriptions reveal the activities of individual sailors and merchants. Maritime matters were alluded to by elegiac poets in the context of love, especially during the first century AD;[3] accounts of particular sea journeys are famous, such as that of St Paul from Sidon to Puteoli in the Acts of Apostles or Lucian's account of the Isis,[4] the description of which may or may not have included a reliable analysis of technical and nautical details, while Diocletian's Edict on Maximum Prices shows the comparison of costs between sea and land transportation.[5] On the whole there was little interest in boat structures. Theophrastus' treatise on various woods, *Historia Plantarum*, however, is of great importance for the study of shipbuilding, as are passages of Pliny's *Naturalis Historia*, since they show us what qualities were considered important by the shipwrights.

Representations of merchant ships were rare before the first century AD, but from the reign of Nero, they became common subjects on sarcophagi and tombs, mosaics and wall-paintings, reflecting the far-flung commerce of the Roman Empire. Presumably most artists only saw boats when they were already in the water and thus the shape of the keels et cetera was hidden from sight and they were forced to guess the rest. It is possible to make a generalization on these lines i.e. that most art forms can be considered inaccurate, whether by virtue of ignorance on the part of the artist or his right to artistic licence (Fig. 4.2). There was an inclination to make quite sizeable cargo ships look like dinghies, as on

[3] For instance, Catullus IV or Tibullus II 4 and 5.
[4] *Acts of Apostles*, 27. Lucian, *Navigium*. G. Houston, 'Lucian's *Navigium* and the dimensions of the *Isis*', *AJP* 108 (1987), 444-450.
[5] Diocletian's Edict on Maximum Prices XXXVII 8, 20 and 39 (ed. S. Lauffer, Berlin, 1971); see 4.9 below.

Trajan's Column, and to include much larger-than-life people, as on the Neumagen ship monument.[6] Three-dimensional scenes on sarcophagi and coins showed usually only the prow of the ship and this often not in perspective, thus there are serious distortions. The first coin showing Claudius' port near Ostia, issued under Nero, does, however, show quite a detailed ship: it is a round-hulled vessel with a huge mainsail and a slanted foremast on which an *artemon* (foresail) hangs; the sternpost is in the shape of a goosehead while the stempost is a massive block (Fig. 4.3). This type of illustration continued through to the third century AD. An amusing coin is one issued by Tarsus in the reign of Caracalla of a merchant ship with its sail billowing the wrong way![7]

4.2 REMAINS OF SHIPS

In sum, then, neither literature nor art are accurate enough to help us analyze the structures of sea-going vessels. Instead, we have to turn to what remains of the ships themselves and this has proved to be the most trustworthy means of discovering how ancient ships were constructed. It must be stressed though that underwater archaeology is not without its limitations; as mentioned earlier in Chapter 2, there are inherent difficulties involved in the sites where the remains are found, for the hulls did not often land upright on the seabed. Because many sank due to bad weather, the hull would often have broken up on rocks or landed on a slope so that the cargo spilt out or may even have been superimposed on others, as in the case of the Grand Congloué wrecks.[8] The evidence that comes from wrecks with regard to the ships' structure is mainly in the form of the keel, the bottom part of the hull and occasionally the mast-step. Regrettably, the sides of the hull and the deck are usually lost, as is the rigging, which was made of perishable materials, although we know from mosaics that Roman ships relied on a large rectangular mainsail, with a smaller sail on a slanted mast (the *artemon*) when necessary on bigger ships.[9] Thanks to the underwater excavations of ships

[6] The original sculpture is in the Landesmuseum in Trier, with a copy in the town of Neumagen, Germany.
[7] The coin commemorates a grant of Egyptian wheat to Tarsus by Caracalla; G. Hill (ed.), *The British Museum Catalogue of Greek Coins: Lycaonia* vol. 21 (1900), no. 198, pl. xxxvi.1
[8] Wreck A is overlain by wreck B, see L. Long, 'Les épaves du Grand Congloué. Etude du journal de fouille de Fernand Benoit', *Archaeonautica* 7 (1987), 9-36; JS 451.
[9] The wreck of Albenga is an exception to the rule - the main mast is still in place, square-shaped up to the main beam and then circular, A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580,) 1992, 28. The recently discovered

such as the Madrague de Giens wreck (mid-first century BC) and La Bourse wreck in the south of France and the conservation of the Kyrenia wreck in Cyprus, we now know much more about the construction of Roman ships (Fig. 4.4).[10] What can be gathered is extremely useful in itself and also for working out the dimensions, and thus hopefully the tonnage, of the ship.

4.3 ROMAN SHIP CONSTRUCTION

4.3.1 Types of Wood

The first thing to be considered when examining the structure of a ship has to be the types of wood with which it was built.[11] Here, literary sources are fairly informative, notably Theophrastus and Pliny, as mentioned above: conifers, especially pine, cedar and cypress, were the most popular materials, and amongst the evergreens, oak (especially for military keels), and elm were favoured.[12] According to Theophrastus, pine was the most favoured type of wood for merchant ships because of its resistance to decay, even for the keel. This is because they were almost always left in the water, unlike galleys which were likely to be hauled up onto beaches and therefore needed extra strength on the keel. Theophrastus also explains how it is best to use green wood for its ability to be bent easily.[13]

For shipbuilding, the qualities needed of the wood were a certain density (between quite light and medium heavy), and a good elasticity. One of the

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Black Sea wreck has also preserved its mast, JS 101; C. Ward and R. Ballard, 'Deep water Archaeology Survey in the Black Sea', *IJNA* 33 2004, 2-13. A mast has recently been found in Olbia, see E. Riccardi, 'A ship's mast discovered during excavations of the Roman port at Olbia, Sardinia', *IJNA* 31 (2002), 268-9.

[10] For La Madrague de Giens, see A. Tchernia et al, *L'épave romaine de la Madrague de Giens (Var). Fouilles de l'Institut d'Archéologie Méditerranéenne* (*Gallia* Suppl. 34, Paris, 1978); M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991), 147-244 ; A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992) 616. For La Bourse, see M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991), 245-266. For Kyrenia, see R. Steffy, 'The Kyrenia ship: an interim report on its hull construction', *AJA* 89 (1985), 71-101; P. Throckmorton *History from the Sea* (London, 1987); A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 563; JS 200.

[11] The most comprehensive work on Roman shipbuilding is M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991).

[12] NB *pinus* as a synonym for a ship in Horace *Epodes* XVI 57 and Virgil *Aeneid* X 206. For example, the Antikythera ship was made of elm and oak, JS 36, the Torre Sgarrata ship was made of Aleppo pine JS 349, the Punta Scifo ship of oak and fir JS 350 and Skerki Bank B of pine JS 367.

[13] Theophrastus, *Hist. Pl.* V 7.1-3. See Appendix for the third century AD document recording the payments to shipwrights and sawyers and the types of wood they were working with.

dominating factors which determined which timber was used was provenance: around the Mediterranean, there are abundant areas of conifers and hardwoods. Indeed the provenance of the wood is the only possibility we have of guessing the origin of the ships, since the cargo on board, the crew and the supplies are usually diverse. River boats are easier to localize as they moved little from their building yards, but there are several cases where the provenance of sea-going merchant ships can be identified, based on the diagnosis of rare species of wood: for example, the Pantano Longarini wreck's tenons were made of pistachio, which was only grown in the Aegean and the Cyclades, thus it is pretty safe to assume that it was constructed in these islands, and Apollonia A was constructed from fir and Aleppo pine, also grown locally in North Africa.[14] However one must be cautious since foreign woods were also imported for shipbuilding purposes: the Egyptian use of Lebanese cedarwood is famous and Hiero imported wood from Italy and elsewhere for the frames and tenons of his Syracusia ship.[15]

There is a huge variety of pines throughout the region: *pinus negra, pinus pinaster* and *pinus halepensis*, as well as spruces: *abies numidica, abies maroccana, abies cephalonica* and *abies cilicica*, found in Africa, the Balkans and Asia Minor respectively. All these conifers are known to be quite durable because of their resin content and resistance to attacks from destructive organisms, and pine and cypress were the ones used most often for maritime purposes: cypress can be seen for example in the keel of the wreck of La Bourse, Marseille,[16] and in many mortise and tenon joints. Pine was the most celebrated of the conifers; Theophrastus wrote in detail about its many varieties, including the *pinus halepensis* which he described as τὸ δε ξύλον ἰσχυρότερον τὸ τῆς παραλίας, the most typical of the Mediterranean species, especially in Spain, France, parts of mainland Greece and North Africa although not particularly abundant in Italy.[17] Vitruvius and Pliny attribute to pinewood the properties of flexibility and durability, essential for shipbuilding but doubtless its popularity was aided by its geographical location, for instance in Cyprus, οἱ δ'ἐν Κύπρῳ

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[14] P. and J. Throckmorton, 'The Roman wreck at Pantano Longarini', *IJNA* 2 (1973), 243-66; Apollonia A, JS 241.
[15] Athenaeus V 206f; L. Basch, 'The archaeology of ships', *IJNA* 1 (1972), 51.
[16] For La Bourse, see M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991), 245-266.
[17] Theophrastus *Hist Pl.* III 9. 2-3.

πίτυος·ταύτην γὰρ ἡ νῆσος ἔχει...[18] The *pinus sylvester* also had the advantage of height, i.e. it could be cut lengthways and used as a whole mast, whereas with other types, such as the maritime pine, which as well as being quite knotty, tends to taper, the pieces are not very long although they form good planking material. It is surprising that certain woods were not used more often, such as the larch, whose qualities are mentioned by both Pliny and Vitruvius, since it wears well and is impermeable to water, but presumably it was due to its difficult mountainous location that it is only found in the La Bourse wreck, the Les Laurons B wreck and the Grado wreck.[19] Cedar was likewise under-exploited and has only been found in boats that were built in Cyprus and parts of North Africa and Asia Minor.[20] Fir trees, on the other hand, which grow all around the Mediterranean basin, were used accordingly, still to be seen in very good condition in the La Madrague de Giens wreck, and the Cavalière wreck.[21]

Thus ancient shipbuilders preferred to use conifers for the shells of their ships, but for the skeleton which needed to be absolutely rigid, unbending and fairly heavy, they preferred hardwoods. Certain types of oak were suitable, as was elm, and both these are found in the skeletal structures of, for example, the La Madrague de Giens wreck (Fig. 4.5) and for the dowels of many others.[22] It is considered an oddity when a keel is made of pine rather than a hardwood, for example in the La Roche Fouras wreck, since it is regarded as fragile.[23]

Once the timber has been cut, it has to go through a complicated process of conservation to prepare it for its life at sea, a careful process since wood is always susceptible to decomposition, due to air, humidity and heat. This job was done by the *lignariii* and *fabri navales*.[24] The wood was immersed in water to stop it drying out: salt water was usually considered better than soft water since it rid the wood of insects and allowed the wood to retain its resistance, although salt water took longer to rid the timber of its sap. The wood was therefore floated in

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[18] Theophrastus *Hist. Pl.* V 7.1.
[19] Pliny *HN* XVI 43, Vitruvius II 9 53. M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991), 31-33 ; the Grado wreck JS 337.
[20] M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991), 34-36.
[21] Ibid., 36-42. G. Charlin, J-M. Gassend and R. Lequément, ' L'épave antique de la baie de Cavalière', *Archaeonautica* 2 (1978), 77-8 and JS 451.
[22] Pliny *HN* XIII and XVI passim ; M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991), 203ff.
[23] A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 992.
[24] *CIL* XIV 278 for *corpus naviculariorum lignariorum.*

water for three months and then aired for three-four weeks. This was always a problem for the shipyards as Theophrastus and Palladius, writing four centuries later, say, describing how some woods needed to be soaked at different depths; this method continued until recently in dockyards such as Toulon and Cherbourg.[25] The number of trees needed for one ship was phenomenal: the estimate for the wreck of La Bourse which is approximately 23m long is between eighty-five and ninety trees!

4.3.2 Hull Shapes

There were many types of Roman merchant ships, from enormous grain-carriers to smaller coastal hopping boats.[26] Their names reflect the diversity of provenance – *corbita, gaulus, ponto, cladivata* - and it was primarily in terms of hull shape that they differed, though they all had a basic ratio of length to breadth of 6:1 (as opposed to 10:1 for war galleys). The popular merchant ship was the distinctive low-prowed, high-sterned one which has been excavated most frequently, but as the mosaic of Althiburus shows (Fig. 4.6), many types existed, especially ones used for towing ships into port.[27] A general feature of ships used for fast cross-Mediterranean sailing was a deep keel, as opposed to the slightly flatter-bottomed hulls hauled up on beaches for coastal trading. Although every ship was different in the ancient world (since it seems that moulds were not used), it is possible to describe the basic construction of a *navis oneraria*, in necessarily simplified terms, as, on the whole, the principles of boat construction remained essentially unchanged.

4.3.3 Construction Techniques

There are two elementary ways to build a boat - the so-called skeleton-first technique or the shell-first technique (for technical terms, refer to the glossary on page 16).[28] The first has been used especially in the West from the basic/

[25] Theophrastus, *Hist. Pl.* V 4.8 ; Palladius, *de Re Rustica* XII 15. M. Rival, *La Charpenterie Navale Romaine* (Marseille, 1991), 108-09.
[26] P. Pomey, *La Navigation dans l'Antiquité* (Aix-en-Provence, 1997), 84-86.
[27] Catalogue of ships from the mosaic of Althiburus, Tunisia, third century AD, P. Duval, 'La forme des navires romains d'après le mosaïque d'Althiburos', *Ecole Française de Rome, Mélanges d'Archéologie et d'Histoire 61* (1949), 119-49.
[28] The most comprehensive accounts of shipbuilding are by L. Basch, 'The archaeology of ships', *IJNA* 1 (1972), 1-58 and L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore;

sixteenth century onwards, involving the setting up of the skeleton of the boat, i.e. the keel and the frames, followed by covering it with a smooth skin of planking to form the whole hull. The other method, widely used in southern Asia and parts of Northern Europe, shapes the boat first in the form of the planking of the hull and then inserting into this any frames necessary to ensure its sturdiness. Thus in the first method, the frames decide the shape of the ship, while in the second, their function is only as a support. L. Basch sees these in terms of active and passive roles: with the active frames, the planking has to be particularly strong to adapt to the frames' resistance, while with a passive framework, the shell can be quite thin, as in many of the Roman wrecks.[29] These definitions are perhaps too clear-cut, for when a boat has been completed, it can be difficult to tell which technique was used. Towards the end of the Roman period (fifth century AD onwards), there seems to have been a movement away from the shell-first to the skeleton-first technique.

It has been convincingly argued that the Romans only used the shell-first technique; L. Casson noticed by 1963 that all the wrecks found up to that point were constructed with mortise and tenons (see below, 4.3.4).[30] He points to other evidence such as the representation of a frame being inserted into the completed hull on the tomb stele of Longidienus (Fig. 4.7),[31] the inner surface marks made with a blunt point on the Chrétienne A wreck as guides for the positioning of the frames[32] and also the fact that the nail which attaches the side planking to the frames often impales the tenon which joins the strakes to each other. Thus this has to be before the frames are inserted as it just would not be possible afterwards. With the same reasoning, one can tell whether the hull was assembled first by looking at the direction in which the pegs were driven, since they were fortunately not always cylindrical, for example, the pegs of the Grand Congloué

London, 1995) chapter 10. See also P. Pomey, *La Navigation dans l'Antiquité* (Aix-en-Provence, 1997), 89-100.

[29] L. Basch, 'Ancient wrecks and the archaeology of ships', *IJNA* 1 (1972), 16.

[30] L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore; London, 1995), 203-06 and Chapter 10, Appendix I.

[31] Stele of P. Longidienus, a *faber navalis*, from the late 2nd-early 3rd century AD, National Museum of Ravenna, as n. 30 above, 206.

[32] F. Dumas, *Epaves Antiques. Introduction à l'Archéologie sous-marine méditerranéenne* (Paris, 1964), 159.

wreck, and the Le Titan wreck are definitely tapering and so can only have come from one way.[33]

Roman practices actually differed little from her Greek predecessors in that the construction began with the keel, to which was added the sternpost and stempost and probably a few temporary frames for the guidance of the shell. The planking began obviously next to the keel with the garboard strakes being fixed directly onto the keel, and from there the rest of the planking began. The planks were joined together edge to edge, so-called carvel building, typical of the Mediterranean (as opposed to clinker planking in which the planks were overlapped like tiles on a roof and smoothed out to form an even hull, especially popular in Scandinavia, China and Japan). Only after the hull was formed were the frames inserted, and then the deck added.

4.3.4 Hull-first Technique

This type of hull-first method needs to be studied in more detail. The keel, made of hardwood, was normally made up of at least two pieces about 4-5m long and joined together by scarfing and trenails to form a total length of 10m, a complex feature requiring a lot of skill.[34] The fact that many keels were of too light a construction and were insufficient to perform their stiffening function led to movement and leakage in the hulls and the subsequent downfall of many ships; the Port Vendres A wreck is an exception with a strong keel of 35cm x 28cm.[35] This appears to be the reason why keelsons were introduced, for example in the Monaco wreck, where a sectional area of the keel was about twice that of the keelson; in the Titan and Dramont A wrecks, the keelsons were of heavier dimension than that of the keel itself, about 30% and 120% respectively.[36] Ancient keels normally lacked rabbet lines so the keels had to be cut obliquely along the top part to accommodate the garboard strake at its proper angle. Very robust tenons were needed to lock it into position securely but the method was improved as is seen in the wrecks of Le Titan and Mahdia: the garboard strakes

[33] L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore; London, 1995), 206-08; Grand Congloué JS 451.
[34] L. Basch, 'The archaeology of ships', *IJNA* 1 (1972), 46ff.
[35] L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore; London, 1995), chapter 10, Appendix I ; A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 874.
[36] J. du Plat Taylor, *Marine Archaeology* (London, 1965), 87-89 and 98-99.

were chiselled into the keel timber so that the first strakes of the planking could be secured to the keel itself by nails.[37] The Monaco wreck was even more advanced with a rabbet line in the keel, akin to the construction of modern wooden hulls.[38]

The strakes of the planking (Latin *tabulae*) differed in thickness quite considerably, normally from 3.5 to 10 cm (but they could be even as thin as 2 cm), which meant that the mortises took up more than half the available thickness. Ancient writers liked to emphasize the narrowness of the wood which separated sailors from the perils of the sea, only three fingers wide sometimes or four and only occasionally as thick as seven.[39] In underwater archaeology this thinness is borne out in the wrecks, for example, the Porquerolles, La Jaumegarde B and Monaco wrecks, all with 2cm thick hulls.[40] Some parts of the planking were specifically made thicker in places, for example on the Kyrenia wreck where some of the planking was as much as 7-8cm. The probable construction of the La Madrague de Giens ship is unusual in that the frames seem to have been inserted early on, after only the third strake of planking. Hulls could be double-planked, i.e. a second layer of planking was nailed onto the shell to act as a reinforcement, without being attached to the keel. Normally, fabric soaked in pitch was placed between the two layers of wood, as, for example, with the Dramont A wreck.[41]

The number of frames needed depended on the purpose of the vessel as well as the tradition of the shipwrights. For the placing of the frames, the inside of the shell was sometimes scored to mark the exact positioning of each piece of wood (as on the wreck of Chrétienne A, above). On merchant ships, they were not usually more than ca. 0.25m apart and in many boats they were often closer, for example, on the Titan and Dramont A wrecks, they were only 0.08- 0.1 m apart, so the nails crossed a large number of tenons. The spacing even between the close frames was far from regular and it is hard to know whether this was

[37] Mahdia, JS 385.
[38] L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore; London, 1995), 207-08.
[39] Three fingers wide, Dio Chrysotom, *Orat.* 64.10; four fingers and seven fingers wide, ... *digitis a morte remotus / quattuor aut septem...* Juvenal XII 58-59.
[40] L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore; London, 1995), chapter 10, Appendix I and for la Jaumegarde B, see A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 531.
[41] A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 371.

planned or part of a bad construction. The frames did not need to be attached to the keel: half frames were not uncommon, for example, on the wrecks of the Chrétienne A and Grand Congloué, but then floor timbers were needed to cover the keel.[42] Full frames, as on the Nemi, Planier 3 and Le Titan wrecks, thus also acted as floors and proved to be quite a strong structure.[43] Some ships used both types of frames alternately, for example, Dramont A, Cavalière and the La Madrague de Giens wrecks, in which the half frames finished about 7-10cm from the keel;[44] another possibility was to have single frames throughout until the narrow end of the hull where they would alternate with half frames, for example the Chrétienne A wreck.[45] These frames were transfixed with trenails (Latin *pali*) and bronze spikes. Over the inside of the frames was laid a lining and the floor timbers to protect the cargo from any leaks and the bilge; the mast-step was built at this point. Underwater discoveries have shown how deeply the mast was stepped into the keel and the good-luck coin placed there at the time of construction has sometimes been found. Bilge-water pumps and their accompanying lead pipes have also been found, shedding light on a branch of technology hitherto unknown.[46]

The edge to edge joining of the planks can be made in a variety of ways: by diagonal nails as in modern Egypt, China and Japan, by tying as in Arabia, or by mortise and tenon (very similar to the groove and tongue method) as in ancient Egypt, Greece and Rome.[47] This last method was fairly complicated but used by the Romans with extravagance, not only for the shell planking, but also for fixing the rudder to its mainspiece and the fitting of the deck (Fig. 4.8). Once the mortises and tenons were in place, treenails of oak were inserted, for example in the wrecks of Grand Ribaud A and Chrétienne C, and these could be further reinforced with metal piercing, for example, iron-nailed in the Punta Scifo wreck,

[42] L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore; London, 1995), chapter 10, Appendix I. Grand Congloué JS 449; Cavalière JS 451.
[43] L. Casson, *Ships and Seamanship in the Ancient World* (Baltimore; London, 1995), 207.
[44] Ibid. For a detailed description of Cavalière, see G. Charlin, J-M Gassend and R. Lequément, 'L'épave antique de la baie de Cavalière', *Archaeonautica* 2 (1978), 60-89; JS 451.
[45] A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 302.
[46] The Grado wreck, JS 340.
[47] See L. Basch, 'Archaeology of ships', *IJNA* 1 (1972), 15; L. Casson above and individual wrecks in Parker, as above.

or copper-nailed as in the Giardini Naxos wreck.[48] It was certainly a very strong way of joining but often unnecessary; the obvious familiarity that the builders had with the technique meant that they cut the mortise slots into the planks before assembly, probably at great speed.[49] The spacing of the tenons was usually regular, for example less than 0.05m on the Grand Congloué wreck, and exactly 0.05m on the Albenga wreck, which also points to the cutting of the slots en masse.[50] But mortise and tenon work could be quite sloppy as on the La Roche Fouras wreck, whose mortises are peculiarly shaped where they have been chiselled out roughly and thus do not fit the tenons very well, allowing a certain amount of lateral movement.

4.3.5 Water-proofing and Strengthening of Hulls

If ships were double-planked, the natural swelling of the wood ought to have produced a good seal, but hulls were not always completely watertight so many ships were caulked on the inside and out (and occasionally between the joints, as La Jaumegarde B wreck) with pitch, resin or tar to protect the cargo from the damp, especially important with a cargo of grain which could spoil easily. Otherwise they were expensively sheathed or patched, particularly in the first centuries BC and AD, most often with a thin layer of lead or copper over a layer of tarred fabric, held in place by many large-headed copper nails.[51] It can be seen from the evidence of wrecks that this sheathing was replaced with extra strips when it had worn too thin and amongst the shipboard items of the Pozzino wreck and the Vulpiglia wreck were rolls of lead sheeting for this purpose.[52] The lead sheathing was also referred to as a stabilizing element in times of bad weather in the first century AD. Ancient shipwrights however did not realise that lead sheathing was only necessary for ships that were going to be sailing in salt

[48] Punta Scifo JS 350 and Giardini Naxos JS 374. The latter had copper nails as well, and both types were all twisted, reflecting the impact of hitting the bottom.
[49] There is literary evidence that the tenons were greased before being slotted into the mortices, Plutarch *Mor.* 321d.
[50] A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580,) 1992, 28; JS 451. Very close mortise and tenons have been found on the Vulpiglia wreck, JS 359.
[51] Many examples of wrecks with lead sheathing include the Serce Limani JS 4, the Antikythera JS 36, the Grado JS 340, the Skerki Bank D JS 364, the Isole delle Correnti JS 375, La Tradalière JS 456 and Porto Novo JS 432. The Spargi wreck shows copper sheathing that had been crumpled JS 420.
[52] The Pozzino wreck, JS 406; the Vulpiglia wreck, JS 359.

water, as destructive mites and shipworms are not found in fresh water; thus the ships in Lake Nemi were sheathed unnecessarily, although it has proved a useful study for modern naval archaeologists.

4.3.6 Rigging and Steering

Unfortunately, there is little archaeological evidence about the rigging of merchant ships, although a perfectly preserved wreck with a thirty-five foot mast has recently been discovered in the Black Sea.[53] It is from literature and art, such as the House of Europa graffito from Pompeii, that we know that most ships had one mast with a large, rectangular sail that could be raised and lowered (Fig. 4.9).[54] Sometimes a second mast was attached to the bow at an angle with a small, square sail or a triangular lateen. This second mast, due to its weak dimensions, must have been used mostly to balance the ship and help in changes of direction. Occasionally, three-masted ships were built, such as the Syracusia and the Isis. A topsail was added to the big sea-crossing ships for extra power in open water. Rigging followed Greek systems except for the re-introduction in the first century BC, even on small boats, of ropes that attached the top of the mast to the highest yard to help balance the yard and tilt it. Ancient ships could sail into the wind in spite of previous, modern arguments to the contrary, as has been proven by the replica ship, Kyrenia II (Fig. 4.10).[55] However, they did prefer to sail with the wind behind them, especially as, with their relatively shallow keels, they would have experienced a sideways drift.

Uniquely for the ancient world, remains of sails have been preserved in Berenice, Egypt, in the same location as teak planks and brailing rings. The larger proportion of the sails is made of cotton "a situation without parallel in the Roman world."[56] The cotton comes in two forms – an S/S type that is spun anti-clockwise, or the Z/Z type spun clockwise. The first is traditionally Egyptian, the

[53] Un-named wreck in the Black Sea, JS 101; for rigging, see L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), 229 ff.; C. Ericsson, *Navis Oneraria* (Abo, 1984), 84-91.
[54] The graffito is scratched on the front wall of a house on the Via dell'Abbondanza, Regola. I, Insula 17, Nr.3 Pompeii.
[55] M. Katzev and S. Katzev, 'Kyrenia II: building a replica of an ancient Greek merchantman', in H. Tzalas, (ed.), *Tropis I. First International Symposium on Ship Construction in Antiquity 1985* (Piraeus, 1989), 163-75. .
[56] F.C. Wild and J.P. Wild, 'Sails from the Roman port of Berenice, Egypt', *IJNA* 30 (2001), 211-20.

second Indian, and thus imported. It appears that these are remnants of sails that have been made in a non-Mediterranean place, even down to the repairs with patches and webbing. Mediterranean sails were made of linen from Egypt, but a high number of these from Berenice are the Z/Z type from India, but in the shape of the Mediterranean sail, i.e. a large square sail with a grid pattern of reinforcements for the main mast, and not at all like Indian sails. The suggestion is then that ports in India had to carry out repairs on Mediterranean ships, arriving from Egypt on the rough south west monsoon before heading back on the gentler northeast monsoon in December/January.[57]

There was a wide variety of pulleys and tackles as one would expect, although very little is known from archaeology. The Grado is an important wreck as six pulleys have been preserved.[58] Also, these ships carried a large number of anchors.[59] Ancient anchors worked in the opposite way to the ones that we know, i.e. they had their weight in the stock with the arms and shanks made of wood. Thousands of these lead and iron stocks have been found and most ships would have carried a variety of weights, for example the 230ton Mahdia ship had five anchors, one of which was 2.35m long and weighed 695kg, and the Lake Nemi ship carried one of 417kg.[60]

Steering of these ancient ships comprised two oars situated at each side of the stern, attached to each other by a bar, the *clavus.* This was an effective way of steering and not at all inferior to later medieval rudders which were fixed to vertical stern-posts (Fig. 4.11).[61] Also at the stern post end, there was some kind of protection or even a cabin for the crew, where they could cook and shelter from bad weather.

Included in the database is a category for shipboard paraphernalia. Much of what has been found on the wrecks is cooking ware, but there are several other interesting items: unspecified weapons were found in the Grand Congloué A wreck and in the Camarina A wreck was a lead box containing thirty-four lead

[57] Pliny *HN* VI 26.106. For monsoons and trade with India, see Chapter 8.
[58] The Grado wreck JS 340.
[59] For anchors, see L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), 250-58.
[60] Mahdia JS 385; for Lake Nemi anchors, see C. Ericsson, *Navis Oneraria* (Abo, 1984), 76-8.
[61] For steering, see L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), 224-28.

sling shots;[62] one hundred and ten fishing weights were found in the Porto Novo wreck, while surgical equipment was discovered in the Le Groticelle wreck;[63] a small altar has been found only on the Spargi wreck, although most ships would presumably have carried this, and finally, ivory dice were found in the Straton's Tower wreck.[64]

4.4 THE SIZE OF ROMAN SHIPS

The size and tonnage of merchant ships varied enormously, depending on their different needs.[65] 'Tramp' ships which coasted from one port to another were clearly going to be much smaller than the sea-crossing grain freighters and could be as small as 15m long, 10-20 tons or up to 20m long with a capacity of 50-60 tons, while probably nothing smaller than a 70 ton ship would have sailed to Rome from the East (fifty tons worked out at approximately 1000 amphorae). Most merchant ships were small at less than 100 tons; although it is difficult to establish an average size, one can make comparisons with other pre-industrial empires to give an indication as to what was normal. It is evident that there is always a large percentage of small vessels included in figures of coastal and short-to-medium length trade, and that the percentage in a fleet of the largest ships is quite low at a maximum of 5-10%; for example, at the port of London, during October and November 1567 and May to August 1568, 339 ships docked and were registered — 56% were 40 tons or less, 82% were 60 tons or less and only 4.7% were over 100 tons. Lloyds register of 1812 shows a similar result — 65% were under 200 tons and only 11.5% were 300 tons and over. In 1910 of British merchant vessels 42% were 1,000-3,000 tons, 44% were 3,000-5,000 tons with only 5.7% at 7,000 tons or more. So, clearly, in spite of the overall increase in size over the centuries and whatever the composition of the fleet, the overwhelming majority belong to the smaller size category with few being in the

[62] JS 449, JS 368.
[63] JS 432, JS 407.
[64] JS 420, JS 217.
[65] For size of merchant ships, see L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), 170-173 and 183-200. For tonnage, see P. Pomey and A. Tchernia, 'Le tonnage maximum des navires de commerce romaines', *Archaeonautica* 2 (1978), 233-251 ; J. Rougé, *Recherches sur l'Organisation du Commerce Maritime en Méditerranée sous l'Empire Romaine* (Paris, 1966), ch. 7.

largest. Therefore, we can assume that the Roman situation was similar in that the number of vessels over 100 tons was limited.[66]

This is borne out by Roman epigraphic and literary evidence; however much the Roman government wanted only large ships for its grain fleet, this clearly was not the case. Claudius offered concessions to ships of over 70 tons that promised to serve for six years or more;[67] a century later exemptions from liturgies were offered to those who built and placed in the *annona* service either one ship of 350 tons (50,000 *modii*) or several of 70 tons (10,000 *modii*).[68] Hero of Alexandria's *Stereometrica* contains formulae for calculating the capacity of merchant ships in terms of amphorae and modii with three examples, 58 tons, 95 tons and 144 tons, i.e. not that big.[69] The Lex Claudia of 218 BC prohibited senators and their sons from owning ships with the capacity of more than 300 amphorae (150 tons) and Cicero implies that a ship of 200 amphorae or 100 tons was considered large.[70]

Several large ships have been found such as the Skerki Bank B which was 40m long, the Isole delle Corrrenti which was 40-48 m long and 10-11m wide, and other marble-carrying ships (see below, 4.6).[71] The size of ships such as the supposed second century Isis would have been exceptional with a length of 53m, a width of 14m and a depth of 13m with a capacity of about 1200 tons. Lucian describes it with awe, when it took shelter in Piraeus on the way to Rome,

"…. What a huge ship! A hundred and twenty cubits long, the shipwright said and well over a quarter as wide, and from deck to bottom, where it is deepest, in the bilge, twenty-nine. Then, what a tall mast, what a yard to carry! What a forestay to hold it up. How gently the poop curves up, with a little golden goose below! And correspondingly at the opposite end, the prow juts right out in the front, with figures of the goddess Isis, after whom the ship is named, on either side. And the other decorations, the paintings and the topsail blazing like fire, anchors in front of them and capstans, and windlasses, and the cabins on the poop

[66] G. Houston, 'Ports in perspective: some comparative material on Roman merchant ships and ports', *AJA* 92 (1988), 553 – 64.
[67] Gaius *Institutes* 1.32C
[68] *Digest* L 5.3.
[69] Hero of Alexandria *Stereometrica* II 50 - 52
[70] Lex Claudia, Livy 21.63, 3-4, although it was disregarded in the first century BC; Cicero *Fam.* XII 15.2. For discussion, see G. Houston, 'Ports in perspective: some comparative material on Roman merchant ships and ports', *AJA* 92 (1988), 559.
[71] Skerki Bank B JS 367; Isole delle Correnti JS 375.

– all very wonderful to me. You could put the number of sailors at an army of soldiers. She was said to carry corn enough to feed the whole of Attica for a year. And all this a little old man, a wee fellow, has kept from harm by turning the huge rudders with a tiny tiller."[72] Lucian's description of the ship needs to be regarded as something of a monstrous curiosity to fit into the context of the whole work, [73] but it is true that the size of some of the larger merchant ships was not exceeded until the fifteenth century.[74]

4.5 TONNAGE AND PACKING OF GOODS

The amount of goods being moved around the Mediterranean was obviously reflected in the tonnage of the shipping and the easiest way of estimating the tonnage is by looking at the way the goods were stowed in the ships. Amphorae were surely the easiest and cleanest cargo to stow in the hold of a ship since they were of standardized volumes and weights and could be stacked either one on top of another or in a quincunx, the base of one fitting between the shoulders of two others (Fig. 4.12) — even so, it was a specialized job to stack them - there were *collegia* at Rome specifically for the stackers of amphorae.[75] They could be transported in anything from one layer, as in the wreck of Cavalière, to two, as in Le Titan wreck, to five or even nine as in the Albenga wreck, in other words there were a possible 13,500 amphorae or 500-600 tonnes on board.[76] Amphorae carried the greatest variety of goods: oil, wine, garum, olives, nuts and pitch. Grain could be transported in sacks as was certainly normal in Egypt: papyri attest the presence of σῖτομετροσακκοφόροι "grain-measurers and sack-carriers", or else emptied loose into the hold, in which case it may have been compartmented off into separate areas if there were various

[72] Lucian, *Navig.* 437 (translated by L. Casson, 'The Isis and her voyage', *TAPhA* 81 (1950), 43-56).
[73] G. Houston, 'Lucian's *Navigium* and the dimensions of the *Isis*,' *AJP* 108 (1987), 444-450.
[74] P. Pomey and A. Tchernia, 'Le tonnage maximum des navires de commerce romaines', *Archaeonautica* 2 (1978), 250-251.
[75] P. Pomey, *La Navigation dans l'Antiquité* (Aix-en-Provence, 1997), 149.
[76] Cavalière, see G. Charlin, J-M Gassend and R. Lequément, 'L'épave antique de la baie de Cavalière', *Archaeonautica* 2 (1978), 87-89 ; JS 451; for Le Titan and Albenga (including doubts), see A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 1149 and 28 respectively.

shippers.[77] If left completely loose, it had to fill the whole hold, since if the ship tilted, so could the grain and set the boat off balance enough to put it in a very dangerous situation. Lighter goods, such as pottery, were either stowed in layers on top of other heavier goods, as in the ship of La Madrague de Giens, or to the fore and aft of them, as in La Tradelière ship.[78] Packing material, such as brushwood, was not always essential, but has been discovered in a number of sites; perhaps the most interesting is that of La Madrague de Giens, with pine cones and twigs wedging the amphorae into place.[79]

Heavy goods such as tiles were stacked on edge in layers, so carefully in fact that apparently a minimum of dunnage was needed.[80] Pieces of stone, sarcophagi and columns et cetera, must have been stowed with great care (see specialist ships, 4.6). Ingots were presumably stacked up in much the same way as tiles, and concretions of layers of ingots have been found intact, for example, tin ingots in the Bagaud wreck off the French coast and Spanish copper in the Agde J wreck.[81] These heavy goods would have been stowed at the bottom of the hold, if part of a mixed cargo, and thus acted as ballast. Forty-four wrecks have produced ballast, usually in the form of pebbles, boulders, or clay, for example, river-worn pebbles measuring between 10 and 16mm in the Kyrenia ship or the three heaps of ballast stones found at the Matala wreck site.[82] There is much debate about the Latin term for ballast, *saburra*, which has been thought to mean sand, but even this is surrounded by uncertainty as is the assumption that sand was used as ballast, for instance, in the wrecks of La Madrague de Giens and Procchio.[83] It has been pointed out though that moist sand would rot the wood of

[77] *P. Berol. Frisk* I, col. 22.3-4 (J. Frisk, *Bankakten aus dem Faijûm nebst anderen Berliner Papyri* (Göteborg, 1931)); *Digest* XIX 2.31 *quod si separatim tabulis aut heronibus aut in alia cupa clusum uniuscuiusque triticum fuisset, ita ut internosci posset ....*
[78] For La Madrague de Giens, see A. Tchernia et al., *L'épave romaine de Giens (Var). Fouilles de l'Institut d'Archéologie Méditerranéenne* (*Gallia* Suppl. 34, 1978), 19-27. For La Tradalière, see A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 1174; JS 456.
[79] The Torre Sgarrata weck was wedged with twigs of tamarisk, JS 349.
[80] The Cape Andreas F wreck shows the tiles still in position, JS 206.
[81] The Bagaud wreck seen by the author; Agde J in A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 16.
[82] A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 563 and 681, JS 200 and JS 250. Other wreck sites with ballast stones include one 200 miles of Cyprus JS 208, Methone D JS 309, and Cape Akritas JS 312.
[83] A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 616 and 906. *CIL* XIV 102 attests the presence of a *collegium* of "sandmen", *corpus saburrariorum*, as does an inscription dated to AD 210 referring to the orders

the hull and that dry sand would run through any holes and slits and block the bilge, so if it were used as ballast, it may have been as a last resort, for instance if there were no stones available as, for example, near the ports of Alexandria and near the mouth of the River Guadalquivir.[84] In the Kyrenia wreck, the ballast was placed along one side of the ship's central line to compensate for the asymmetry of the hull.

Larger containers, *dolia*, were developed for liquid products and have been found in several wrecks, such as Straton's Tower and the Rhône Delta.[85] They remained in the ship and were therefore unsuitable for tramping ships as they were restricted to being filled with the same product each time. The use of dolia as huge containers of wine and possibly oil was short-lived in the history of Roman trade, existing as far as we know, only in the first century AD. Dolia which have been excavated on land have also contained grain, for instance in warehouses at ports, but they must have contained liquid in ships for a number of reasons: the only way of emptying the dolia was by pump - this also therefore rules out the possibility of garum, since it comprised too many bits of fish; the measurements written on the sides of the dolia are *cullei*, units of liquid; all known dolia from wrecks have contained wine from the big-producing wine regions, namely Campania and Tarraconensis, and a graffito on the lead seal of a dolium found in the Port-Vendres D wreck reads ΔΙΨΩ (I am thirsty).[86]

At first glance, they seem to have been an economically advantageous idea, for they could hold between 55 and 98 amphorae worth of liquid, i.e. between 1,436 and 2,550 litres. In other words, in the same amount of space, dolia could hold ca. 21,000 litres compared to 12,400 litres in amphorae. There were dolia of two sizes, 1m and 1.65m, and of two shapes, bulbous and cylindrical. An interesting feature is the fact that they could be repaired: those in the Petit Congloué wreck, had been extensively patched up with lead.[87] Of course the advantages depend on how many layers of amphorae the dolia would be replacing: if there were two layers, then dolia would hold up to seven times more,

of the *praefectus annonae* showing from what point to what point the *saburrarii* can dig sand, O. Testaguzza, *Portus* (Roma, 1970), 76.

[84] F. Foerster Laures, 'Roman maritime trades', *IJNA* 15 (1986), 166-7.

[85] Straton's Tower, JS 217, Rhône Delta, JS 455.

[86] A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 877.

[87] Ibid., 806.

but if the amphorae were stacked in three layers, then the amount would only be twice, if that. Thus the advantages must have been carefully weighed up by the ship-owners. The dolia themselves could have numbered up to twenty in the hold, for example in the Ladispoli A wreck.[88] At least, though, dolia ships were small, less than 20m long and of average tonnage, compared to the more cumbersome ships stocked entirely with amphorae (Fig. 4.13).

4.6 ROME'S EFFECT ON SHIP CONSTRUCTION AND SIZE

The increase in the number of goods being imported and exported during the early Empire was naturally reflected in the amount of shipping around the Mediterranean. There were two ways in which this could have been increased: either by a greater number of ships, or the making of ships that were bigger and which could therefore carry more. Both of these seem to have happened. More ships were wrecked during the first and second centuries AD in the Mediterranean than in any other century while many of those of the first centuries BC and AD appear to be larger than those found in any other period, with a slight decrease in the average size during the later Roman period, although this is of course a gross generalisation.[89] The shortness of the safe sailing season must have made extra cargo space very valuable, and added to the need to increase tonnage. The effect of greater loads in the ships can be seen in a variety of aspects, each of which deserves careful consideration. The most obvious is that some ships increased in size and usually therefore tonnage, a general trait of Roman as opposed to Greek shipping (although there was no fixed ratio between dimension and tonnage- a stone carrier would be smaller than a grain carrier but probably had the same, if not more, tonnage); also, heavier cargoes were loaded into normal size ships that were built with stronger planking; other ships came to be adapted to carry specialist cargo, for example marble or tiles, for which ships were often made with flatter bottoms than usual (the La Luque A wreck[90]); and special containers were invented, notably dolia, and arguably, these had to be built into the ship at the time of its construction.

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[88] Ibid., 565.
[89] See chapter 9 on distribution patterns.
[90] A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 610.

The length of many ships can be calculated from the dimensions of what remains of the main structures, namely the keel and the frames. It is certainly true that some ships were long: examples include ships of the 1st century BC, Albenga (40m) and the second century AD, Torre Sgarrata (30m) - the Nemi boats are the most exceptional at 73 and 71m but are of a different nature since used probably only as pleasure boats on Lake Nemi.[91] If Lucian's Isis was a real ship, with a length of 55m, a beam of ca. 13.75m and hold of 13.25m, then the tonnage of a ship this large could have ranged from 1000 to 6400 tonnes, the most commonly accepted being 1200 tonnes; but without the length of the keel, which could have been a lot shorter than the overall length of the ship if there were fore and aft overhangs, it is difficult to be exact.[92] Clearly this would have been an exception, but what is most notable about the ships just mentioned in general is the fact that they were structurally weak in relation to their size, doubtless the cause of their destruction. Ancient shipwrights appear not to have realised the significance of doubling the breadth of the keel, for example, to be able to withstand the enormous pressures exerted on it, not only in terms of the weight of the cargo but also of the rest of the ship's structure.[93]

However, several wrecks do show a tendency towards the doubling of the planks around the keel area, presumably because the cargo the ship was going to be carrying was heavier than normal. The La Madrague de Giens ship had extra reinforcements around the keel area with especially wide mortise and tenons that were driven perpendicularly into the garboard strakes both inside and out.[94] The tonnage of the La Madrague de Giens ship has been estimated based on the layers of amphorae which are clearly visible: it is uncertain whether there were three or four layers, but if one takes the length of the ship to be 30m, then it was carrying 4500-5000 or 6000-6500 amphorae respectively, i.e. a tonnage of 225-250 or 300-325 tonnes. If the ship was 35m long, then the figures are increased to 5800

[91] L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), Chapter 10 Appendix I; Torre Sgarrata JS 349.
[92] See above, 4.4 and 4.5, and P. Pomey and A. Tchernia, 'Le tonnage maximum des navires de commerce romaines', *Archaeonautica* 2 (1978), 233-251.
[93] The technique of 'frapping' a ship is known from the 1st century AD onwards, i.e., passing heavy cables under the keel in bad weather, the most famous example being during the journey of St. Paul, L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), 91 n. 71 and 73.
[94] A. Tchernia et al., *L'épave romaine de Giens (Var). Fouilles de l'Institut d'Archéologie Méditerranéenne* (*Gallia* Suppl. 34, 1978), 75-99.

or 7800 amphorae and 320 or 390 tonnes. These are quite sizeable numbers even if only the lower ones are correct and they are certainly larger than the estimates made of some of the tonnages of earlier ships such as Mahdia (230-250 tonnes).[95] A different method perhaps of strengthening the hull is seen in the wreck of Mal di Ventre which carried lead ingots: a thick layer of lead sheeting without fixing holes was found lying under the ingots on the inside of the hull, although it may have been lain there simply to protect the wood.[96]

Ships from the eastern Mediterranean from which area stone and marble originated would have been constructed with the transportation of these goods in mind.[97] These *lapidariae naves* were generally quite large, for example, the wreck of the Isole delle Correnti is 40-48m long, the wrecks of the Torre Sgarrata, the Punta Scifo and the Mahdia are 30m long, but the main consideration must have been for their strength and thus they were also double-planked for the most part.[98] They would also have needed to be easily manageable, and perhaps this was reflected in their rigging, about which we have very little information. Because they were slower than other ships, it was essential that they were non-perishable, with lead sheathing to prevent shipworm. The hold of a ship of this type was doubtlessly different from one that was to carry amphorae, for example. More equipment for manoeuvring the cargo was necessary, although the hatch may not have been much larger than others since not all the columns were huge, for example, those on the Mahdia wreck were only 1.85m and 4.4m long.[99] The ship which brought Caligula's obelisk from Alexandria was exceptionally large: the obelisk weighed 322 tonnes and the pedestal another 174, but because the obelisk itself had to be carried on deck, the ship also needed a lot of ballast and this was made up of 800-900 tonnes of lentils! This means a total tonnage of about 1300 tonnes. The ship turned out to be impractically big, however, and was afterwards filled with concrete and sunk to form part of a mole of Claudius's new harbour at Portus. Excavations have

[95] Mahdia JS 385.
[96] A.J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 637.
[97] See chapter 6 on marble transport.
[98] Isole delle Correnti JS 375; Torre Sgarrata JS 349; Punta Scifo JS 350; Mahdia JS 385.
[99] Mahdia JS 385.

been made and on the basis of the identification of the sides, a possible 104m has been suggested as the length, but this is questionable.[100]

4.7 THE PHYSICAL ENVIRONMENT

Having looked at the construction of Roman ships and how they were used for commercial purposes, it is time to turn to the environment in which they were sailing. Travelling by ship is obviously dependent on the state of the sea and weather conditions and until the advent of steamships in the nineteenth century, those involved in maritime commerce were obliged to respect the natural conditions of the sea and its coast; ancient ships were particularly vulnerable to sudden changes in the weather (see below for some examples).

4.7.1 The Seasons and Weather

Meteorological factors have not changed since antiquity according to William Murray, who has studied modern weather conditions saying, "We are fully justified in applying modern wind data to the problems of classical antiquity."[101] Two external forces are at work in the Mediterranean – the Atlantic Ocean's cloud, rain and moist air and the Sahara Desert's dry, clear skies. Between the September equinox and the March equinox, the Atlantic is the predominant influence from the west, bringing a number of depressions that cause unsettled, unstable weather with strong winds. During the spring equinox, there is a sudden change with a swing from the Sahara from the south, bringing calm seas with regular and well-established winds, i.e. the sunny weather for which the Mediterranean is famous.[102] Ancient mariners were well aware of this distinction, hence the Roman term *mare clausum* in reference to winter when it was too difficult to sail safely because of storms and too difficult to navigate because the stars were hidden by clouds etc, as opposed to the summer season "*nam mare adhuc iustis cursibus patet*",[103] the beginning of which was marked by a religious ceremony *navigium Isidis* described by Apuleius.[104] Vegetius in the

[100] See chapter 6 on marble.
[101] W. Murray, 'Do modern winds equal ancient winds?' *Mediterranean Historical Review* 2.2 (1987), 156.
[102] S. Arenson, *The Encircled Sea: the Mediterranean Maritime Civilisation* (London, 1991), 91-93.
[103] Symmachus *Letters* IV 54
[104] Apuleius *Metamorphoses* XI 5 and 16.

fourth century AD describes the four periods of sailing, as May 27th -September 14th as open to all, March 10th – May 27th and September 14th – November 11th as dangerous and November 11th – March 10th as closed.[105] Only under very special circumstances did ships sail in winter, for example, during the winter of AD 51, there remained only two weeks' supply of grain in Rome and Claudius was forced to order extra from Alexandria; Tacitus says that it was only possible "thanks to a mild winter", and stresses how Rome depended on such imports.[106] For St John Chrysostom of Antioch in the fourth century AD, the winter was a season of rest, a time when all sailors stayed at home.[107] A tough time though, not just for sailors but also for dockers who had no loading or unloading to do and were therefore not earning money.

On the other hand, E. de Saint-Denis argued against the traditional idea of *mare clausum* saying that the Romans could not possibly stop everything like messenger services and military expeditions, "La circulation maritime n'était pas obligatoirement suspendue, mais seulement ralentie."[108] Coastal sailing was probably possible on a small scale because little ships, *naves orariae*, would have been able to pull in anywhere for protection in case of sudden bad weather, whereas the *naves onerariae*, used to sailing across the open seas, would have been too big to stop at many ports. While Pliny admits "*ver aperit navigantibus maria*", he also mentions that it was open to abuse from greedy sailors.[109]

Similarly, according to J. Beresford, while the winter probably saw something of a downturn in sailings, winter sailing was still not uncommon for normal commerce. He thinks Vegetius seems to have been referring to oared warships, while legal texts were referring to state cargoes – and while the state might have an interest in limiting the risk on its own cargoes by prohibiting their carriage in winter except in emergencies, merchants carrying private cargoes were more likely to take the added risk of winter sailing and benefit from higher

[105] Vegetius *Mil.* IV 32.
[106] Tacitus *Ann.* XII 43 '*modestia hiemis rebus extremis subventum*' and '*navibus et casibus vita populi Romani permissa est*'.
[107] St. John of Chrysostom, *Ninth Homily on the Statues* = PG 49, 107.
[108] E. de Saint-Denis, '*Mare clausum*', *REL* 25 (1947), 200.
[109] Pliny *HN* II 47.

sale prices. There is abundant evidence for ships sailing in the winter (including evidence that they did so because it was easier to escape pirates).[110]

4.7.2 Winds

The topography of much of the Mediterranean's coastline creates conditions which give rise to several regional and local winds. Aristotle and Theophrastus both wrote coherent observations about the wind direction and time of occurrence in *Meteorologica* II and *De Ventis* respectively. During the summer months, regular winds determine maritime routes for good or for bad. The chart attached (Fig. 4.14) shows some of the common winds and currents. The ancient Etesian (modern Meltem) blows through the Sea of Marmara and Aegean predominantly from the north, curving around the coast of Turkey to come from the west; it starts in May and is at full strength by July/August, dying off in September/October, sometimes strong enough to penetrate as far as Egypt and Libya. The promontories off the west coast of Asia Minor, which have a predominantly east-west orientation, form barriers against these prevailing northerlies, but can still create heavy swells off the south coast of Turkey especially in the afternoons, making sailing "always difficult and sometimes murderous", according to R. Heikell, thus making the passage from west to east easy and the reverse tricky.[111] This may explain the fairly large number of ships that were wrecked in this area during the whole period. The Scirocco (Arabic Khamsin, Chili in the Magreb and Ghibli in Libya) is a hot, dry wind blowing from the south or south-east and is most prevalent in spring and autumn, helping sailors to go west. However the Scirocco also contributed to the fierce weather experienced along the west coast of the Peloponnese which suffered from its high, straight coastline with few indentations. The Gulf of Patras and the Gulf of Corinth both have prevailing winds from the west in the summer, gusting up to Force 5-6 because of the tunnel effect through the mountains. There are also coastal breezes, caused by the difference of temperature between the land and the sea, blowing from the sea during the day and from the land during the night. The latter breezes were used in antiquity for departures, for example, the ship on

[110] J. Beresford, *A reassessment of the ancient sailing season: the case for wintertime seafaring in the Graeco-Roman Mediterranean* (unpublished D. Phil, Oxford, 2005).
[111] R. Heikell, *Turkish Waters and Cyprus Pilot* (London, 2001), 35.

which St Augustine was sailing waited until the evening to set sail for Rome. These breezes were also important for navigation since they could be felt about twenty kilometres out at sea.[112] Winds in the Adriatic can be tricky, especially the Bora which blows in bursts from the north to north-east and is associated with stormy weather. On the west side of Italy, winds are a little calmer; the southern coast of France is hit by the Mistral which comes from the Rhône and which is certainly responsible for many of the wrecks in the region.

4.7.3 Currents

In general, Mediterranean currents run in an anti-clockwise direction: their circulation is dependent on the overall influx of water from the Atlantic Ocean, the Black Sea and river mouths.[113] The high level of evaporation in the Mediterranean means a huge loss of water and only a little over a quarter is replaced by rivers.[114] This means that the two channels connecting the Mediterranean to the Atlantic Ocean in the west and the Black Sea in the east, the Gibraltar Straits and the Hellespont respectively, deal with a huge influx of water and a much smaller outflow of water; this new water is fresher and lighter than the dense saline water of the Mediterranean, thus creating a surface current of about three knots that follows a relatively unobstructed path eastwards across the southern part of the Mediterranean along the shores of North Africa.[115] From Egypt, it turns northwards along the east coast of the Mediterranean before turning westwards along the south coast of Asia Minor. In the eastern Mediterranean the current is usually quite weak, sometimes even weak enough to be reversed by a contrary wind. As it turns up into the Aegean, it is hit by the 5-6 knot outflow from the Hellespont and this creates a current strong enough to cover the length of the Aegean. This then meets the westward moving current from the Ionian Sea that did not flow up the Aegean and creates the currents

[112] St. Augustine *Confessions* V 8.15. J. Morton, *The Role of the Physical Environment in Ancient Greek Seafaring* (Leiden, 2001), 51.
[113] The amount of water flowing from rivers into the Mediterranean has probably decreased since ancient times due to heavier demands now put on rivers before they reach the sea, J. Pryor, *Geography, technology and war: studies in the maritime history of the Mediterranean, 649-1571* (Cambridge, 1988), 12 ff.
[114] 115,400m^3 of water evaporates per second, D. Walker, *The Mediterranean Lands*, (2nd edition, London, 1962), 10.
[115] J. Morton, *The Role of the Physical Environment in Ancient Greek Seafaring* (Leiden, 2001), 37.

around Cape Malea and Cape Matapan; these capes were, and are still, renowned as being dangerous, especially when combined with the severe gusts that regularly occur in those areas, thus possibly explaining the demise of the two ships that sunk at Methone.[116] The currents continue to be strong all the way up the Adriatic before proceeding southwards down the east coast of Italy.

The Straits of Messina, where many ships have been wrecked, is a turbulent area due to the tunnel effect of a 17 km passage narrowing to a 3 km one. The depth also diminishes from 2000 metres in the Ionian Sea to only 80 metres in the northern sector.[117] Thereafter, the currents continue in a northwards direction up the coast of Italy. Another notoriously difficult area for sailing is the Straits of Bonifacio between Sardinia and Corsica, only 11 km across and still claiming ships and lives.

Because the Mediterranean is land-locked, tides are weak and are only really felt along the north coast of Africa where there are extensive shallows, and where there are very deep, narrow bays and straits such as in the Gulf of Corinth and the Northern Adriatic.[118]

Visibility is hugely affected by the weather. Nowadays, morning mist around southern Turkey in the summer leads to a visibility of less than a mile, and likewise around the south coast of Cyprus to less than a quarter of a mile. However visibility was probably better in ancient times before pollution and it is important to remember that in the Aegean, one is never more than forty miles from land, and that Italy is only forty-five miles away from Corcyra.[119]

4.8 NAVIGATION

According to F. Braudel, even in the sixteenth century, man's efforts had only conquered a few coastal margins and direct routes in the Mediterranean.[120]

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[116] Strabo VIII 6.20; S. Arenson, *The Encircled Sea: the Mediterranean Maritime Civilisation* (London, 1990) 93. There was great pride amongst ancient sailors if they managed to sail around Cape Malea safely; an epitaph on the tomb of a merchant from Hieropolis in Caria reads, "Flavius Zeuxis, merchant who travelled round Cape Malea seventy-two times to Italy" (*SIG*[3] III 1229); JS 309 and 310.

[117] http://home.um.edu.mt/medinst/mmhn/vivia_bruni.pdf#search=%22sea%20Currents%20straits%20of%20messina%22.

[118] J. Morton, *The Role of the Physical Environment in Ancient Greek Seafaring* (Leiden, 2001), 45-51.

[119] T. Severin, 'Early navigation: the human factor', *Mariner's Mirror* 40 (1954), 15.

[120] F. Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II* (London, 1975), Vol. 1, 103-08.

Vast stretches of sea were empty with shipping routes following the coastline moving "from promontories to islands and from islands to promontories."[121] The ancient concept of 'tramping' was still the predominant method of travelling in the Mediterranean, sixteen centuries after St Paul.

Was this because navigational techniques were still too undeveloped for sailors to feel secure without land in sight, or was it because it made good commercial sense in that boats were like travelling bazaars, at the same time benefiting from the daily renewal of essential onboard supplies such as food and water?[122] Navigation in the ancient world was pretty basic, and for the most part, relied on good visibility and observations of the wind direction, currents and the nature of the sea bottom. Sounding leads that were filled with tallow or grease to pick up samples of the sea floor have been found in many shipwrecks.[123] There were charts listing ports, rivers and promontories with the distances between them, such as *Periplus Maris Interni* by Menippus of Pergamum, or the anonymous *Stadiasmus* or *Periplus Maris Magni* but land is and always has been man's best compass.[124] Almost all of the Mediterranean's islands can be seen from other islands or the mainland and could be used as stepping stones, hence the popularity of tramping.[125] Sailors also made use of navigational techniques, such as watching birds fly[126] and astronomy; this science was already well developed, evidence for which can be seen by the discovery of an astronomical device on the first century wreck of Antikythera.[127] There were also advantages in staying close to land for protection against the weather if suddenly needed and for the use of coastal breezes; but where the coast offered no protection, then it

[121] Peter Martyr to the Court of Tendilla and the Archbishop of Granada, 8th January, 1502, letter 231 (re-edited by L. Garcia y Garcia, *Un Embajada de los Reyes Catolicos a Egipto* (Vallodolid, 1947), 55.
[122] F. Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II* (London, 1975), Vol. 1, 103-08; P. Horden and N. Purcell, *The Corrupting Sea* (Oxford, 2000), 145-46.
[123] Sounding leads found in the Spargi wreck JS 420, the Capo Taormino wreck JS 376 and the Fondana Amorosa wreck JS 207. J. Oleson, 'Testing the waters: sounding weights and the history of navigation and maritime trade', from 'The Maritime World of Ancient Rome', a conference at the American Academy in Rome, 27-29th March, 2003, publication forthcoming.
[124] See Chapter 3.3.
[125] S. Arenson, *The Encircled Sea: the Mediterranean Maritime Civilisation* (London, 1990), 91ff.
[126] A sailor caught in a storm in the Black Sea managed to find land again by following a swan, Pomponius Mela *De Chronographia* Book 3 (C. Frick, Leipzig, 1880).
[127] G. Weinberg et al, 'The Antikythera wreck reconsidered', *TAPA* 55.3 (1965); P. Throckmorton *Shipwrecks and Archaeology* (Gollancz ,1969); A.J. Parker *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 44; www.abyssoblu.com; S. Arenson, *The Encircled Sea: the Mediterranean Maritime Civilisation* (London, 1990) 96-7; JS 30.

would be dangerous to be too close to shore in case of storms and also rain is more likely near the coast, especially on the east coast of the Adriatic.[128] Winds were more regular over the open sea but it could be calm for days at a time. J. Morton has suggested that it is possible that small boats existed to tow ships in these circumstances; although totally absent from any shipwrecks found so far, they may be absent precisely because they were used to escape from a sinking ship.[129] I think this unlikely as merchant ships seem not to have sailed with enough crew on board to tow a ship, let alone one carrying cargo. Heavily laden ships were less buoyant, less manoeuvrable and slower than empty ships and therefore less suitable to voyages through the rougher conditions of open sea.[130]

4.9 ROUTES AND JOURNEY TIMES

Shipping routes are mentioned in various written and epigraphical sources and for the most part worked on an east-west line rather than a north-south one. Importantly, a ship's crew had to be flexible about the route they were planning to follow since constant reassessment was necessary depending on the weather conditions at the time.[131] About the only direct route that existed was that of the grain trade from Alexandria to Rome through the Straits of Messina. These ships, which often sailed in convoy, were occasionally blown off course (the Isis which pulled in at Athens, most famously) or had to loop up the coast of the Levant before heading west. They went to Rome fully loaded and returned to Egypt virtually empty.[132] In spite of the necessity for speed in transporting the grain to Rome (see below for duration of voyages), it seems there was a tendency amongst the *annona* ships to stray from the direct route in order to deliver

[128] J. Morton, *The Role of the Physical Environment in Ancient Greek Seafaring* (Leiden, 2001), 143-50.
[129] Ibid., 280ff. There is literary evidence that ships did tow dinghies e.g. *Digest* XXXIII 7.9 *scapha navis non est instrumentum navis;* Statius *Silvae* 3.2.31 *secuturam religent post terga phaselon.*
[130] J. Morrison and J. Coates, *The Athenian Trireme: the history and reconstruction of an ancient Greek warship*, (Cambridge, 1986), 132 and 161ff.
[131] See Synesius's description of a journey from Alexandria along the east coast of North Africa when the captain suddenly had to head for open sea in the face of a storm and northerly winds, Synesius *Letters* 4.
[132] Strabo XVII 1.7. Egypt imported amber and tin from the West and some wines from Italy and Greece.

unrelated cargos; a law was issued in AD 409 penalising such behaviour, particularly conducted by Eastern Mediterranean ships.[133]

Most other routes between major ports stopped at islands along the way, picking up and depositing cargos in the numerous ports which dotted the coasts of Anatolia and Greece.[134] For example, a ship from Antioch going to Rome would have sailed via Cyprus, Lycia, Rhodes, Cape Malea and Messina; similarly the route to the western Mediterranean that would have cut across through the Balearics to reach Spain or via Corsica for Gaul. That there was traffic between Arles and Syria is indicated in a decree from Beirut favouring shipping merchants from Arles[135] and between Egypt and Cadiz, according to Aelius Aristides in AD 117.[136] Smaller ships travelling west, unable to follow the grain freighters' non-stop route, would have followed the coast up the Levant, over to Cyprus and then across to make use of favourable winds. Cyprus was clearly an important trading centre in antiquity for this reason; its goods, such as pottery and bronze, have been found through the whole eastern region of the Mediterranean and everything about Cypriot culture reveals that it was the crossroads for many eastern Mediterranean cultures.[137]

Routes from Asia Minor to Rome wound their way through the islands of the Aegean as the exported goods from this region were not principal cargo material, but rather luxury goods. The popularity of these increased enormously during Roman rule, creating a constant stream of traffic. Little apart from marble was exported from Greece itself but clearly the area enjoyed a lot of passing trade due to its geographical position. A. J. Parker has recently argued that less shipping than previously thought hugged the coast, and that regular straight-line crossings of the Mediterranean were made, possibly as much as 12% of total shipping.[138] However the fact remains that deep sea underwater discoveries are

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[133] *Cod. Theod.* XIII 5.32.
[134] Anatolian ports included Amastris, Heraclea, Parium, Lampsacus and Cyzicus on the north coast, Myrina, Chios, Ephesus and Smyrna along the west coast and Myra, Attalea, Side and Tarsus along the south coast.
[135] *CIL* III 14165.8.
[136] Aelius Aristides *Discourses* XXXVI 91.
[137] V. Karageorghis and D. Michaelides (eds.), *Proceedings of the International Symposium, Cyprus and the Sea: organized by the Archaeological Research Unit of the University of Cyprus and the Cyprus Port Authority, Nicosia, 25-26 September1993* (Nicosia,1995).
[138] A. J. Parker, 'Artefact distributions and wreck locations: the archaeology of Roman maritime commerce', from 'The Maritime World of Ancient Rome', a conference at the American Academy in Rome, 27-29th March, 2003, publication forthcoming.

still relatively rare and until the whole of the Mediterranean has been mapped, we are unable to verify his claim.

Journey times varied enormously because they were completely dependent on the weather. L. Casson has worked out the average sailing speed to be about 5 knots in good conditions, slower than modern equivalents due to their use of a single mainsail which was safe but slow.[139] Literary records probably recall the exception rather than the rule, but there is information about the Alexandria-Rome route: one to two months to sail to Rome because the prevailing winds blew towards Egypt and therefore ships had to head north before going west, but only a possible nine days to return (more usually 18-19 days).[140] This meant that ships starting from Alexandria at the beginning of the season could squeeze in no more than two round trips, since in mid-July the Etesians started blowing from the north-west and they could only sail at night or via the Levantine coast.[141] And those starting from Rome would only have fitted in one and a half round trips, being forced to spend the winter in Alexandria. Even at a push, only three trips could be made per season (see weather conditions above, 4.7.1); there is a description in Oxyrrhyncus Papyri 1763 of the journey of a fleet of grain ships from Alexandria to Rome:[142] they loaded up in spring, departing probably in April and arrived in Rome 30 June. The ships were unloaded by 12 July, but were still waiting for clearance on 2 August. Strabo describes how the ships leave Rome in April, reach Alexandria in May, return to Rome by August and if possible, return to Egypt ready for the next year's sailing. The only exception during the winter was the route between Rhodes and Alexandria which could be used continuously throughout the year.[143]

Lucian gives a description of the route the Isis was forced to take,

"When they left the Pharos, he said, the wind was not very strong and they sighted Acamas (western tip of Cyprus) in seven days. Then it blew against them from the west and they were driven abeam to Sidon. After Sidon a severe storm broke and carried them through Aulon (the passage between Cyprus and

[139] L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), 281-296.
[140] Pliny *HN* 19.3
[141] For difficulty sailing westwards due to the Etesian winds, see Caesar *B. Civ.* III 107, Tacitus *Hist.* II 98; for night sailing, Pliny *HN* 2.27.
[142] B. Grenfell, A. Hunt et al., *Oxyrhynchus Papyri* (London 1898-). See L. Casson, *Ships and Seamanship in the Ancient World*, (Baltimore; London, 1995), chapter 12 Appendix.
[143] Strabo 17??

Turkey) to reach the Chelidonenses (off Lycia) on the tenth day ... I know the size of the waves there, especially in a south-westerly gale with a touch of the south; this, you see, happens to be where the Pamphylian and Lycian seas divide. The swell is driven by numerous currents and is split on the headland – the rocks are knife-edged, razor-sharp at the sea's edge. So the breakers are terrifying and make a great din, and the wave is often as high as the cliff itself. This is what the captain said they found when it was still night and pitch black. But the gods were moved by their lamentations and showed fire from Lycia, so that they knew their place. One of the Dioscuri put a bright star on the masthead and guided the ship in a turn to port into the sea, just as it was driving onto the cliff. Then, having lost their course, they sailed across the Aegean beating up with the trade winds against them and yesterday, seventy days after leaving Egypt, they anchored in Piraeus, after being driven so far downwind. They should have kept Crete to starboard and sailed beyond Malea so as to be in Italy now."[144]

According to Cicero, fifty days was a good time to travel from Rome to Syria but the average time was more like 100 days.[145]

In spite of the difficulties and dangers of sea travel (see below), it was the most favourable mode of transport, cost-wise. Modern scholars infer from Diocletian's Edict on Maximum Prices that the relative cost of shipping to transport overland, looking at the average of three routes from Alexandria, Syria and Nicomedia to Ephesus, was 1:31.[146] This compares to R. Duncan-Jones' calculations of the ratio of sea : river : land costs at 1 : 5: 28, i.e. it was over 20 times cheaper by boat.[147] Other scholars have worked out that it was cheaper to move a cargo of grain from one end of the Mediterranean to the other than to move it 120 km on land.[148]

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[144] Lucian *Navig.* 439- 441, translated by L. Casson, 'The Isis and her voyage', *TAPhA* 81 (1950), 43-56.
[145] Cicero *Fam.* XII 12, *Att.* XIV 9.
[146] Diocletian's Edict on Maximum Prices chapter XXXVII 8, 20 and 39 (ed. S. Lauffer, Berlin, 1971).
[147] R. Duncan-Jones, *Economy of the Roman Empire* (Cambridge, 1974), Appendix 17.
[148] C. Yeo, 'Land and sea transport in imperial Italy', *TAPhA* 77 (1946), 221-44, looking at Diocletian's Edict on Maximum Prices and Cato *Agr.* XXII 3; R. Laurence, *Roads of Roman Italy* (London, 1999), 95-100.

4.10 REASONS FOR SHIPWRECK

The vast majority of wrecks occurred on established trade routes with a good proportion of those being near harbours or anchorages. There are only three possible reasons for shipwreck – faulty ship design, natural causes such as bad weather or submerged rocks, or deliberate wrecking from piracy. It seems that little could be done in a storm except jettison cargo that was on deck and throw in anchors if too close to rocks. Jettisoning large amounts of cargo was an accepted practice in bad weather; the value of cargo lost in such circumstances did not have to be repaid to creditors by debtors according to Athenian maritime laws.[149] Evidence for throwing anchors overboard can be seen in many wreck sites, such as the Taranto C, where a line of anchor stocks leads up to a wreck, but these attempts were usually ineffectual.[150] If storms in the open sea were bad, then those near the coast were worse, especially if the captain was unfamiliar with the shoreline. However there was at least more chance of the crew jumping overboard and swimming to land and cargo could be recovered later by *urinatores*, professional divers (Fig. 4.15).[151]

Piracy was the other danger on the sea, especially prevalent during the second and first centuries BC until Pompey supposedly out wiped the pirates.[152] These Cilician pirates were highly organised with many ports and observation posts at their disposal from which to send out their light, quick ships. Their intimate knowledge of the coast and its inlets allowed them to escape punishment for decades until the Roman state finally realised what a threat they could be to the food supply of the ever-expanding Rome. Evidence that ships were wrecked because of pirate attack can be seen in the Kyrenia wreck, whose timbers have spearheads lodged in them.[153] Also, the discovery of bronze helmets on wrecks such as La Madrague de Giens and Spargi show that an attack must have taken place just before the ship sank and that the crew members were trying to defend

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[149] Demosthenes *Private Orations* XXXV 11.
[150] Taranto C, JS 347; H. Frost, 'Stone anchors: a reassessment reassessed', *Mariner's Mirror* 79 (1993), 449.
[151] Archaeological evidence from the Madrague de Giens wreck in A. Tchernia et al., *L'épave romaine de Giens (Var). Fouilles de l'Institut d'Archéologie Méditerranéenne* (*Gallia* Suppl. 34, 1978), 29-31; literary evidence from *Digest* XIV 2; guilds known in Ostia or Portus, *CIL* XIV 303 and suppl. 4620.
[152] P. de Souza, 'The Roman invention of piracy', from 'The Maritime World of Ancient Rome', a conference at the American Academy in Rome, 27-29th March, 2003, publication forthcoming.
[153] A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 563; JS 200.

themselves.[154] Lumps of melted lead that were used as fire bombs have been found too.

4.11 CONCLUSION

For the first and last time, the whole Mediterranean coastline was under the control of one power. Long-distance movement of goods indisputably increased with the creation of the Roman Empire that had led to peaceful and prosperous conditions, but transport success was still dependent on factors outside Rome's control. The topography, meteorology and oceanography of the Mediterranean had a significant effect on seafaring; navigation was dependent on recognition of headlands and other coastal features as well as the ability of sailors to identify the night sky. The weather governed the timing and routes of journeys and sailors had to be ready to adapt to sudden changes in the conditions. Although it now seems likely that there was limited sailing during the winter, at least by private merchants if not by the state, it was clearly more hazardous and riskier than in fine weather. The relatively weak currents and tides of the Mediterranean acted in the sailors' favour, but mariners still required "a detailed understanding and careful interpretation of a great variety of aspects of their physical environment."[155] However, this knowledge was clearly not enough, considering the number of wrecks that occurred around headlands and near ports (see maps, pages 304-09). The Romans are not known for their innovative naval technology; rather they made certain adaptations to suit their requirements, namely in terms of size. Their attempt to develop larger ships in order to transport a greater quantity of goods on each journey failed to take into account the technical problems associated with naval architecture. Many of the changes affected the seaworthiness of the ships to the extent that a great number met with a disastrous end precisely because their keels, for example, were too weak to withstand the length of the ships. Overloading by greedy merchants must also have been a factor in some wrecks. In face of these adverse conditions, it is impressive that so many goods were transported safely around the Mediterranean. Roman success was therefore somewhat limited in comparison to what they

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[154] A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 616 and 1108; JS 420.

[155] J. Morton, *The Role of the Physical Environment in Ancient Greek Seafaring* (Leiden, 2001), 253.

achieved in building harbours, possibly because shipbuilding was not under state supervision as far as we know. As ships were owned and hired out privately, there was no obvious way to exchange ideas about naval architecture. The risks involved in maritime transport may have been considered to be insurmountable, a question of luck as much as shipbuilding skill, so the Romans may not have realized that they were raising the stakes by building bigger ships.

APPENDIX - P. FLOR. I 69[151]

A record of payments made to shipwrights and sawyers working on a boat in the autumn months of Phaophi and Hathyr in an unspecified year in the middle of the third century AD.

(Phaophi)(day)17 : to six shipwrights for work on the aforementioned boat, at 7 drachmas each, 42 drachmas
to two sawyers for cutting persea wood, at 8 drachmas each, 16 drachmas
(day) 18 : to five shipwrights for work etc., at 7 drachmas each, 35 drachmas
to two sawyers for cutting persea wood, at 8 drachmas each, 16 drachmas
(day) 19 : to four shipwrights for work etc., at 7 drachmas each, 28 drachmas
to two sawyers for cutting persea wood, at 8 drachmas each, 16 drachmas
(day) 21 : to five shipwrights for work etc., at 7 drachmas each,35 drachmas
(day) 22 : to four shipwrights for work etc., at 7 drachmas each, 28 drachma
(day) 23 : to six shipwrights for work etc., at 7 drachmas each, 42 drachmas
(day) 24 : to four shipwrights for work etc., at 7 drachmas each, 28 drachmas
(day) 27 : to seven shipwrights for work etc., at 7 drachmas each, 49 drachmas
Hathyr (day)1 : to four shipwrights for work etc., at 7 drachmas each, 28 drachmas
to two sawyers for cutting persea wood, at 8 drachmas each, 16 drachmas
(day) 2 : to five shipwrights for work etc., at 7 drachmas each, 35 drachmas
to two sawyers for cutting the frames of acacia, at 8 drachmas each, 16 drachmas
(day) 3 : to four shipwrights for work etc., at 7 drachmas each, 28 drachmas
to two sawyers for cutting frames of acacia, at 8 drachmas each, 16 drachmas
(day) 4 : to four shipwrights for work etc., at 7 drachmas each, 28 drachmas
to two sawyers for cutting frames of acacia, at 8 drachmas each, 16 drachms
(day) 5 : to three shipwrights for work etc., at 7 drachmas each, 21 drachmas
(day) 7 : to four shipwrights for dismantling the planks of the scaffold on one side of the aforementioned boat, at 7 drachmas each, 28 drachmas
to two sawyers for cutting frames of acacia, at 8 drachmas each, 16 drachmas
(day) 8 : to four shipwrights for dismantling the planks on the other side of the aforementioned boat, at 7 drachmas each, 28 drachmas.

[156] G. Vitelli and D. Comparetti, Papiri fiorentini (Milan 1906-1915). Published and translated by L. Casson, 'Documentary evidence for Graeco-Roman shipbuilding P. Flor. I 69', *BASP* 27 (1990), 17

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Fig. 4.1 Map of the Mediterranean showing the depths of the sea in relief.

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Fig. 4.2 Mosaic of a freighter with rounded bow and standard rig and another with a three-master rig, ca. AD 200, Ostia.

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Fig. 4.3 Bronze *sestertius* of Nero showing ships and Portus ca. AD 64.

Fig. 4.4 Reconstructed hull of the Kyrenia wreck, Cyprus.

Fig. 4.5 Diagram showing the use of elm and pine in the La Madrague de Giens wreck.

Fig. 4.6 P. Duval's drawings of ship mosaics from Althiburus, Tunisia, 3rd century AD.

Fig. 4.7 Tomb stele of Longidienus, a *faber navalis*, 2nd AD.

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Fig. 4.8 Diagram showing mortise and tenon joints.

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Fig. 4.9 Graffito of a Roman ship from the house of Europa, Pompeii showing valuable information about the shape of the keel and the rigging.

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Fig. 4.10 Replica of the Kyrenia ship at sea.

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Fig. 4.11 Marble relief of a sailing vessel entering port, Pompeii, ca. AD 50.

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Fig. 4.12 Theoretical diagram showing the stacking positions of amphorae on the La Madrague de Giens wreck.

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Fig. 4.13 Hypothetical diagram showing the *dolia* and amphorae placement in the Grand Ribaud D wreck.

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Fig. 4.14 Map showing the currents and winds around Asia Minor.

The Meltem →

Afternoon summer breeze →

Summer currents →

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Fig. 4.15 Stele of the *corpus urinatorium* of Ostia, 2[nd] AD.

5. POTTERY FROM THE EASTERN MEDITERRANEAN

As mentioned above in Chapter 2, the amphora is the most obvious sign pointing to the existence of a shipwreck and pottery is also one of the most significant pieces of evidence about the Roman economy. Although the study of ceramics on its own may seem to be a dull subject,[1] pottery's existence was an essential part of Roman daily life, since its role concerned a primary human need, food. Unlike the modern world which is full of plastic and metals, the ancient world used pottery as its main container material and its durability as evidence furnishes proof of commercial integration throughout the Roman world. The three broad divisions of pottery are easily distinguishable: amphorae (coarse ware, functional containers) for storing and transporting food, cooking ware for preparing it and fine ware (mass produced, slipped ware) from which to eat it. As B. Ward-Perkins says, "The Romans produced goods, including mundane items, to a high quality and in large quantities, and then spread them widely, through all levels of society."[2] It is the last phrase which is important; unlike luxury goods from the East, and marble, both of which were mainly only affordable by the wealthy, pottery was a functional product for the lower, as well as the upper, end of the market.

The last few decades have seen a huge increase in research into amphorae, especially the scientific analysis of the clay from which they were made.[3] Millions of sherds of pottery have been collected and studied all around the Mediterranean, allowing classifications of types to be made along with regional and long-distance distribution patterns.[4] Unfortunately, less work has been done

[1] B. Ward-Perkins, *The Fall of Rome* (Oxford, 2005), 88.
[2] Ibid., 87.
[3] Thin-section petrology and neutron activation analysis on Aegean forms has recently shown that some amphorae had wider ranges of areas of production than previously thought: I. Whitbread, *Greek Transport Amphorae. A Petrological and Archaeological Study* (BSA Occasional Papers 4, 1995).
[4] For example, the conference 'Transport Amphorae and Trade in the Eastern Mediterranean' held at the Danish Institute at Athens, September 26-29th 2002. Also, the Ephorate of Underwater Antiquities in Athens is working hard to systematize the way shipwrecks are recorded and to

on what they contained which is, after all, what they were being traded for. This is important for economic historians since the exportation of agricultural products gives information about a region's surplus production rather than simply what a region was able to produce to be self-sufficient. With reference to the products transported in amphorae, perhaps largely wine, oil and fish, it is worth noting, as K. Hopkins does, that "Because most regions of the Mediterranean basin have a similar climate, in Roman times they grew the same produce."[5] He goes on to argue, however, that there was no large-scale inter-regional trade of staples except to the large cities, which were too big to be fed from their local areas, or of manufactured goods. I think that a slightly less austere approach will be taken once the shipwreck evidence is reviewed, since wrecks have been found transporting exactly those products, such as staples and manufactured goods, into areas where there were no large cities, for example on the eastern coast of the Adriatic and along the coast of southern France.

Knowing the typology and origin of an amphora should be the easiest and most foolproof way of identifying a cargo's provenance and within broad limits its date. In general, eastern Mediterranean amphorae especially of the Roman period have not been as thoroughly studied as those from the western Mediterranean, however petrological analyses can at least determine an Aegean origin, for example. There are also various ways to determine amphora contents; by using gas chromatograph-mass spectrometry to analyse the residue and the coating of the interiors, by looking at finds made inside sealed amphorae from shipwrecks and by interpreting the graffiti, *tituli picti* and stamps.[6] The majority of eastern amphorae were not stamped but had *tituli picti*, most of which are illegible or problematic, according to J. Hayes.[7] Most amphorae from the Aegean area have traditionally been considered to have been wine carriers and indeed this

categorize amphora finds, see the abstract of P. Micha, 'Amphora wrecks in the Aegean' *Poseidons Reich* XI, 17-19. February 2006, 29.

[5] K. Hopkins, 'Economic growth and towns in classical antiquity', in P. Abrams and E. Wrigley (eds.), *Towns and Societies* (Cambridge, 1978), 35-77.

[6] For the various scientific techniques used, see M. Rothschild-Boros, 'The determination of amphora contents', in G. Barker and R. Hodges (eds.), *Archaeology and Italian Society-Prehistory, Roman and Medieval Studies* (Oxford: BAR International Series 102, 1981) 79-89.

[7] J. Hayes, 'From Rome to Beirut and beyond: Asia Minor and eastern Mediterranean trade connections', *RCRF Acta* 36 (2000), 285-297.

does seem to be the case.[8] Luckily for us, ancient wine often contained pips and bits of skin that had to be filtered out at the time of consumption, and these remnants verify wine as the content. All the other commodities mentioned below would have left some evidence too.

The re-use of amphorae has been suggested by scholars, which would mean that using them as evidence for a ship's origin would be invalid. I would argue that re-use may have been a common practice by individuals but re-use en masse for trading purposes seems to have been quite rare, judging by the numbers of each amphora type found on underwater sites.[9] There are only two examples of amphora re-use found from shipwreck evidence: the Maïre A wreck, Marseilles (mid-second to end of the first century BC) where the amphorae were found full of pozzolana and their stamps erased and the Grado wreck (AD 200), all of whose amphorae that had originally contained wine and oil had been re-filled with fish.[10] Monte Testaccio in Rome also points to Roman disdain for re-use; the remains of an estimated fifty-three million amphora, mainly from Baetica of the second and third centuries AD, have been found, presumably broken on purpose to ensure quality control, in this case, of oil.[11] Some amphora shapes were so recognized that their contents were accepted without question, so if they were not made unusable, inferior quality products could have been sold in them for higher prices.

A drawback to be taken into account when dealing with underwater finds is the difference between the wrecks in terms of investigation, research and

[8] Analyses currently being carried out on Samian amphorae from the classical Greek wreck of Tektaş Burnu by Cheryl Ward (Florida State University) show that so far nearly all of the 120 amphorae were lined with pitch and the occasional intact grape seed can be seen, D. Carlson, 'The Classical Greek wreck at Tektaş Burnu', *AJA* 107 (2003), 583, note 9.

[9] Inscriptions from classical Athens document the selling of empty amphorae at public auction, although they reflect a special case; the amphorae formed part of the properties that had been confiscated from men who had been exiled for profaning the mysteries in 415 BC, therefore the amphorae had to be auctioned so as not to incur charges of corruption (D. Amyx, 'The Attic stelai, Part III. Vases and other containers', *Hesperia* 27 (1958), 174-78); they were not normally recycled for long-distance trade: P. Dupont, 'Trafics méditerranéens archaïques: quelques aspects', in R. Eichmann and H. Parzinger (eds.), *Migration und Kulturtransfer* (Bonn, 2001), 454.

[10] Discussion at the end of A. Parker, 'Evidence provided by underwater archaeology for Roman trade in the Western Mediterranean', in D. Blackman (ed.), *Marine Archaeology: proceedings of the twenty- third symposium of the Colston Research Society held in the University of Bristol, April 4th to 8th, 1971* (London, 1973), 380; A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 631. Grado wreck, JS 340, see below. Also, the abstract of A. Tonioli, 'The Cargo of the Grado wreck: re-use and recycling in Roman Imperial times', *Poseidons Reich* XI 17-19 February 2006, 37.

[11] B. Ward-Perkins, *The Fall of Rome* (Oxford, 2005), 90-92.

cataloguing, which is not immediately evident when looking at the data. Of the one hundred and fifty wrecks carrying amphorae, the precise cargo size is known for very few of them while descriptions of the rest vary from 'large quantities' to 'hundreds' to 'a number' to 'one'. On the whole I have discounted those with only one or two amphorae in relatively untouched sites as being shipboard items; in looted sites, small numbers may still represent the remains of cargo.

I also think that the term trade can be applied to the movement of amphorae in the Mediterranean more than to any other product. C. Whittaker argues that amphorae were transported by rich families from their own estates around the Mediterranean to feed them and their slaves and that the number of these slaves was enormous;[12] some wealthy families may have been able to use their own produce, but the diversity of the cargoes found underwater does not really back up this argument. Similarly, I do not believe that military garrisons and troop movements had an effect on the transport of eastern Mediterranean products examined in this chapter. It seems clear that wine was the main content of eastern amphorae and certainly few of the wrecked ships were heading towards areas where the military was based. Wine and oil from other Mediterranean regions such as Spain were used for the military, judging by the finds of Spanish amphora sherds in German limes regions, but as far as I know, there are few examples of Aegean or Eastern amphorae.[13]

5.1 AMPHORAE

5.1.1 Fabrication

There is no need here to examine how amphorae were made; D. Peacock and D. Williams, for example, describe the technical aspects of amphora production from forming and firing to stoppers.[14] What may be of interest is the material used to seal the amphorae. Because amphorae are made of terracotta and are unglazed, they are porous so they had to be made impermeable before being

[12] C. Whittaker, 'Trade and aristocracy in the Roman Empire', in *Amphores Romaines et Histoire Economique: Dix Ans de Recherche* Actes du colloque de Sienne (24-26 mai 1986) Collection de l'Ecole Française de Rome 114 (1989), 537-9. The slave population of Rome approached 500,000 on its own, probably half of which were owned by the 600 men of the Senate.
[13] J. Rodriguez, 'Baetica and Germania. Notes on the concept of provincial interdependence in the Roman Empire', in P. Erdkamp (ed.), *The Roman Amry and the Economy* (Amsterdam, 2002), 293-308.
[14] D. Peacock and D. Williams, *Amphorae and the Roman Economy: an introductory guide* (London and New York, 1986), chapter 4.

filled. The only exception when it was in fact beneficial to leave them unlined was when they contained water; in this instance, by allowing the water to seep out slowly and evaporate, the amphora was kept cool. Otherwise, unlined amphorae can lose a substantial part of their contents in just a few days.[15] These interior linings can often disappear but there is enough evidence, even underwater, that points to the use of a kind of rosin (the solid residue of resin from pine trees), at least for wine amphorae. In all of the larger Rhodian amphorae and some of the smaller ones found on the Kyrenia wreck, for example, one to two millimetres of pitch has been found as a lining agent.[16] Literary references also allude to the lining of amphorae, as do epigraphical texts, such as the Hellenistic papyri of commercial records referring to pitched containers being more valuable than unpitched ones.[17] No definite linings have been found for oil amphorae but they may simply have disappeared or be impossible to distinguish from the oily contents.[18] Columella mentions that oil lees or gum, with additional wax, was used to seal porous amphorae intended for oil transportation.[19] This type of sealant may have been used for fish too.[20]

Amphorae were closed at their mouths with stoppers made of skin, cork, wood or terracotta.[21] Unfortunately these are rare finds underwater and so far, there is only one recorded for a ship carrying goods from the Eastern Mediterranean.[22] Experiments have been carried out on amphorae in connection with the Kyrenia ship; the aim was to test different sealing methods of amphorae

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[15] C. Koehler, 'Handling of Greek transport amphoras', in J.-Y. Empereur and Y. Garlan (eds.), *Recherches sur les Amphores Grecs* (*BCH* Supp. 13, 1986), 50.

[16] References from M. Katzev in note 8 of C. Koehler, 'Handling of Greek Transport Amphoras', in J.-Y. Empereur and Y. Garlan (eds.), *Recherches sur les Amphores Grecs* (*BCH* Supp. 13, 1986), 51.

[17] Literary references, such as Plutarch *Mor.* 676a about the pine tree being sacred to Dionysus since its resin as a sealant for wine amphorae; *PCairZen* 59271.9, 59741.26.

[18] See the discussion after A. Parker, 'Evidence provided by underwater archaeology for Roman trade in the Western Mediterranean', in D. Blackman (ed.), *Marine Archaeology: proceedings of the twenty- third symposium of the Colston Research Society held in the University of Bristol, April 4th to 8th, 1971* (London, 1973), 380.

[19] Columella *De Re Rustica* XII 52.14-17.

[20] For instance, on Lamboglia 2 amphorae in the Cavalière wreck: G. Charlin, J.-M. Gassend and R. Lequément, 'L'Epave antique de la baie de Cavalière', *Archaeonautica* 2 (1978), 23

[21] B. Liou, 'Direction des recherches archéologiques sous-marines', *Gallia* 31 (1973), 557, 601, figs. 9, 34.

[22] Cakil Burnu, JS 22; terracotta stoppers have been found with Spanish amphorae, for example, in the wrecks of Lavezzi B, Cala Rossano and Port-Vendres B or with Lamboglia 2 amphorae in the wreck of Stori Stoni, A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), nos. 585, 153, 875 and 1114 respectively.

and how they would react under water pressure at the same depth as the Kyrenia wreck was found (35m).[23] The results showed that the amphora with the cork stopper opened at a depth of 15m, the fresh skin stopper at 20m and the sun-dried plaster-plugged sealed amphora remained intact![24]

5.1.2 Products transported in amphorae

There are many literary references to the variety of goods transported in amphorae and indeed many of these goods often produced by-products. Grapes produced several types of wine apart from the normal varieties such as *lora* and *passum* and several by-products, such as *defrutum, mulsum* and vinegar. *Lora* was a secondary wine given to workers in winter instead of proper wine[25], while *passum* or γλύκύς was a very sweet wine made from dried grapes and resin in Crete.[26] The exact nature of *defrutum* has been much discussed, but it seems to be a condiment made from reduced grape must that was useful for wine-making, preserving (of olives, for example, in the Port-Vendres B and Sud-Lavezzi 2 wrecks), cooking and sweetening.[27] *Mulsum,* a sort of honeyed wine, was likewise a kitchen requisite rather than a drink, as was vinegar. Vinegar had many uses, mainly as a conserver of food like vegetables, lentils and fruits, but also for medicinal purposes; Juvenal specifically mentions Egyptian vinegar being imported to Ostia and Pompeii, but Cnidian vinegar was also popular.[28]

5.1.3 Wine

Grapes were grown widely throughout the Aegean, both for local use and for export. It seems that Greek wine was present in the western Mediterranean, albeit in small quantities (compared to Italian wine), throughout the Hellenistic and Roman periods. In literature, many wines are noted for their excellence in taste and for their usefulness as remedies. The wines from the islands just off the Aegean coast were the best, Chios, Lesbos and Thasos, while those from Cos,

[23] JS 200.
[24] http://www.aquatec-innerspace.com/aiokyrenia1.htm.
[25] Varro *Rust.* I 56.3; Cato *Agr.*25.
[26] *CIL* IV 6324, Pliny *HN* XIV 81, Juvenal *Sat.* XIV 270.
[27] J. van der Werff, 'Old and new evidence on the contents of Haltern 70 amphoras', in L. Rivet and M. Sciallano (eds.), *Vivre, produire et échanger: reflets méditerranéens* (Montagnac, 2002), 446-7; J.-P. Brun, *Le Vin et l'huile dans le Méditerranée antique* (Paris, 2003), 108.
[28] Juvenal *Sat.* XIII 85.

Cnidus and Rhodes were considered to be average, followed by those from Lydia and Caria.[29] The Romans even attempted to transplant some of the vines, for example, from Chios.[30] Wealthy Romans appreciated the variety of foreign wines;[31] their cellars may have been filled with their own Italian wine, but luxury is always to do with choice and they attempted to complete their cellars with foreign wines such as these.[32] Even the Taverna of Hedonius in Pompeii had a choice of wines, with ordinary wine for sale at 1 *as*, superior at 2 ~~*as*~~ and grands crus, such as Falernum and Setian, at 4 ~~*as*~~.[33] During the second century AD in Ostia, there were two corporations of wine merchants, those of Ostia and those of Rome, who had their place in the *Forum Vinarium* where auctions were held.[34] In Rome itself, from AD 68 a *Portus Vinarius* is attested and *cellae vinariae* were built under Trajan, to be moved to Trastevere later in the second century. These better quality wines were perfectly suited for storage in amphorae, according to A. Tchernia who divides wines into three parts: local wine, high quality wine "aged in amphorae for consumption in due course by persons of appropriately elegant status", and mass-produced wine for a ready market.[35]

asses /

There has been much debate about the amounts of wine consumed in Rome, but J.-P. Brun believes that there was an average daily consumption of two setiers (1.08 litres), i.e. seven million amphorae a year would have to be imported. This is much more than the number of oil amphorae found at Monte Testaccio which leads him to think that most wine must have been transported in bulk, in skins and then barrels.[36] Certainly skins were used for transporting oil overland; a second century AD inscription from Palmyra records skins filled with oil being carried by camel (two or four skins per animal) or by donkey (two

[29] According to Horace, wine from Chios was up with the top three Italian wines of Falernum, Caecuban and Albanum (*Sat.* II 8. 15-17). Pliny's top three Aegean wines were from Chios, Lesbos and Thasos (*HN* XIV 73). For other references, see A. Tchernia, *Le vin d'Italie romaine* (Rome, 1986), 100-102. Seawater was sometimes added as a conserving element to wines from Cos, Cnidus and Rhodes.

[30] Pliny *HN* XIV 25.

[31] Not only in ancient times; in the C16th, sixty different types of wine arrived in Rome by sea, even though Italy was still producing plenty of its own wine (A. Tchernia, *Le vin d'Italie romaine* (Ecole Française de Rome, 1986), 104)

[32] Seneca *Epistles* 114.26 mentions that the sign of a good house was a cellar in which the wine was arranged by provenance and year.

[33] J.-P. Brun, *Le Vin et l'huile dans le Méditerranée antique* (Paris, 2003), 108-119.

[34] *CIL* XIV 318.

[35] A. Tchernia, *Le Vin d'Italie romaine* (Ecole Française de Rome, 1986), quote by A. Parker, 'The Wines of Roman Italy', *JRA* 3 (1990), 325-331.

[36] J.-P. Brun, *Le Vin et l'huile dans le Méditerranée antique* (Paris, 2003), 120-21.

skins).[37] Skins seem to have been more expensive than amphorae[38] but the real problem lies in the fact that not many have been preserved. The only examples have been found in waterlogged conditions in Northern Europe or in the very dry conditions of Egypt and Syria.[39] At least we know the capacities of these skins from an ostrakon from Carthage of AD 373: half of the state oil collected there was delivered in skins containing 26 litres or larger ones containing 182.7 litres.[40] We can only presume that skins could have contained either oil or wine so these figures are applicable to wine transportation as well. Wooden barrels were first reported by Caesar in Gaul, and were also prevalent on the Rhine and the Danube.[41] There are eighteen sites where they have been found, all in those areas and never in Italy, again probably due to the climate.[42] Representations of them have been found in Italy from about the third century AD: for example, in Aquileia the tomb of a vine-grower, L. Cantius Acutus, was decorated with a barrel and a *falx vinitoria* and on the sarcophagus of a wine merchant in Ancona (second half of the third century AD), two people are shown with two barrels, the merchant with a tasting pipette and a ladle, and the buyer with a purse of money.[43] So far, no remains of barrels have been found in any shipwreck in the Mediterranean except the seventh century AD wreck of St. Gervais, which leads to the supposition that they were not utilised until the late Roman Empire, as A. Tchernia suggests.[44] Very large pottery vessels were used as containers for liquid at specific times in both Hellenistic and Roman periods. *Pithoi* have been found in shipwrecks from the fourth-third centuries BC within mixed Aegean cargoes, while *dolia* were used for the transportation of wine from western Italy from the first century BC to the second century AD.[45] The capacity of *dolia* was anything from 1500 to 3000 litres and up to twenty could be permanently in place in a ship; Dr.2-4 amphorae were often part of the cargo at the same time. The only

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[37] *OGIS* 629 l. 49-58 Portoria Palmyrenorum dated 18th April AD 137.
[38] Diocletian's Edict on Maximum Prices taxes *uter olearius primae formae* at 100 *denarii*, X 14 and XV 98.
[39] J.-P. Brun, *Le Vin et l'huile dans le Méditerranée antique* (Paris, 2003), 165.
[40] J. Peña, 'The mobilization of state olive oil in Roman Africa: the evidence of late 4th-c. *ostraca* from Carthage', *JRA* Supp. 28 (1998), 171.
[41] Caesar *B. Gall.* VIII 42 and *B.Civ.* II 11.2.
[42] G. Ulbert, 'Römische Holzfässer aus Regensburg', *Bayerische Vorgeschichtblätter* 24 (1959), 6-29.
[43] A. Tchernia, *Le Vin d'Italie romaine* (Ecole Française de Rome, 1986), 285 ff.
[44] Ibid.
[45] See Chapter 4.5.

ship in the eastern Mediterranean found with dolia onboard is Straton's Tower.[46] *Dolia* may not have survived past the first century AD because of the risk of the ship being swamped from inside if a *dolium* was to burst, although obviously the aim would have been to repair them as quickly as possible with molten lead.[47]

J. Hayes has clarified what questions historians should be asking, such as "what are the percentages of local vs. imported amphorae? ... and how much is arriving from north, south, east and west in each major period?"[48] Quantitative research on amphorae from different Mediterranean sites, such as coastal Etruria, systematically show that there was a steady trickle of so-called luxury Eastern wines from the Republic onwards, but that there was a definite increase of some types, such as Cretan wine in AC 4 amphorae, during the third century AD.[49] Study of amphorae in the Adriatic has also shown some interesting results for the early and middle Imperial periods: in the northern Adriatic (Trieste), 25% of the amphorae are of an eastern provenance while in three sites in and around Brindisi the figure is much higher at about 65%. Unfortunately, many of these are unidentified but of those that are, general Aegean area amphorae, Käpitan 2, Zemer 57, Knossos A 53 and Dr. 24 (oil) stand out.[50] Pompeii serves as a useful area for quantitative research for a particular period, i.e. the first century AD. Excavations of House 11 and 12 in Insula 9, Regio I by Reading University have shown that these were not domestic residences but commercial buildings from which wine was served.[51] Although Italian amphorae dominate, Cretan wine is extremely well represented with 178 AC 1 amphorae and 173 AC 2 amongst others, the Aegean area being the third most significant supplier of

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[46] JS 217.

[47] Dicussed by A. Hesnard, M.-B. Carre, M. Rival and B. Dangreaux in 'L'epave romaine Grand Ribaud D', *Archaeonautica* 8 (1988), 149-154.

[48] J. Hayes, 'From Rome to Beirut and beyond: Asia Minor and eastern Mediterranean trade connections', *RCRF Acta* 36 (2000), 289.

[49] A. Del Rio, S. Menchelli, C. Capelli and G. Puppo, 'Anfore orientali nell'Etruria settentrionale costiera (II A.C.-VII Sec. DC)', *RCRF Acta* 36 (2000), 449-457.

[50] R. Auriemma and E. Quiri, 'Importazioni di anfore orientali nell'Adriatico tra primo e medio impero', in J. Ering and J. Lund (eds.), *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, September 26-29th 2002*, Monograph of the Danish Institute, Athens vol. 5 (2004), 43-55.

[51] J. Timby, 'Amphorae from excavations at Pompeii by the University of Reading', in J. Ering and J. Lund (eds.), *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, September 26-29th 2002*, Monograph of the Danish Institute, Athens vol. 5 (2004), 383-392.

commodities.[52] With a capacity of 20-25 litres each, this comes to an impressive stock of 2,150 litres of Cretan wine.

Another interesting angle is to look at amphora studies from inland sites such as Lyon; research here for the beginning of the third century AD shows that eastern amphorae represent only 5% of the total amphora finds, but of that 5% there are fifteen eastern types, and Rhodian make up 21%, AC 4 11%, Agora F65/F66 20% and Käpitan 2 5%.[53]

The question I shall be asking is whether this long distance transport of wine amphorae is reflected in finds from underwater sites.

5.1.4 Oil

Oil was the other main commodity traditionally contained in amphorae and like wine was considered to be less of a luxury and more of a staple product in the ancient world. Different types of oil were produced: *oleum viride* from young olives, *omphacium* from white (green) olives and *oleum maturum* from very ripe olives[54] with a variety of uses from cooking to body care, to perfume, to pharmacy, to religious and lighting purposes.[55] A by-product of oil was *amurca*, a black, watery, oily leftover liquid which was used for all sorts of things like greasing leather, insecticide, conserving fruits and even waterproofing amphorae.[56]

It is difficult to estimate the amount of oil used by the Romans. The only piece of evidence in Italy is a daily account from Pompeii showing the expenses of a household of three adults (including one slave) for a period of nine days: 225 ~~as was~~ spent in total, of which oil was twenty per cent, bread also twenty per cent asses were and wine ten per cent.[57] According to D. Mattingly, the average consumption of oil as a food product per person would have been twenty litres a year and may have accounted for up to one third of an individual's annual calorific intake;

[52] Compare the results from similar excavations in Carthage and Berenice, where the local amphorae dominate but Aegean ones are the third most represented, J. Timby, as above, note 47.
[53] S. Lemaître, 'Les importations d'amphores de Méditerranée orientale à Lyon au IIIième siècle ap. J-C', *RCRF Acta* 36 (2000), 467- 476.
[54] Pliny *HN* XII 12 and 130; Pliny *HN* XV 23.
[55] Juvenal *Sat,* V 86-88 explains how first pressings were used for food and last pressings for lamps.
[56] J.-P. Brun, *Le Vin et l'huile dans le Méditerranée antique* (Paris, 2003), 182. For waterproofing of amphorae, see above, 5.1.1.
[57] *CIL* IV 5380.

when oil's other uses are added, this could easily amount to fifty litres per person a year.[58] Oil for lighting is an underestimated area of consumption; according to M. Amouretti, one litre of oil would supply 250-300 hours of light, so using her reckoning, the city of Rome would therefore need a million litres of oil purely for lighting purposes per year.[59]

Excellent oil was produced in the Aegean and must have been widely transported within the region but none seems to have been imported to Rome as Spanish and then Tripolitanian oils were favoured and indeed these areas received am impressive amount of Roman investment, in terms of planting and processing equipment such as large presses. D. Mattingly says, "Olive oil production and trade was a significant source of elite wealth in certain regions."[60] These regions were clearly not the eastern Mediterranean and evidence for regional trade in the east is also slim from an archaeological point of view. *Unguentaria* were small vessels used for scented oils and perfumes, produced in Cnidus or Cyprus and these were certainly common throughout the eastern Mediterranean. However they only contained small quantities, so C. Koehler has suggested that other containers, such as *pithoi*, the older, Aegean version of dolia, may have been used.[61] The Black Sea has certainly thrown up evidence of these on land, but they have never been found in wrecks in the eastern Mediterranean.[62] Olives themselves are also a rare cargo although they too must have been

[58] D. Mattingly, 'Oil for export? Comparison of Libyan, Spanish and Tunisian olive oil production in the Roman Empire', *JRA* 1 (1988), 34.
[59] M. Amouretti, *Le Pain et l'huile dans la Grèce antique: de l'araire au moulin* (Paris, 1986), 190 ff.
[60] D. Mattingly, 'The olive in the Roman world', in G. Shipley and J. Salmon (eds.), *Human Landscapes in Classical Antiquity* (London and New York, 1996), 247. For Spanish oil amphora types, see A Parker, 'Evidence provided by underwater archaeology for Roman trade in the Western Mediterranean', in D. Blackman (ed.), *Marine Archaeology: proceedings of the twenty-third symposium of the Colston Research Society held in the University of Bristol, April 4th to 8th, 1971* (London, 1973), 361-381. For the growth of the oil trade, see R. Hitchner, 'Olive production and the Roman economy: the case for intensive growth in the Roman Empire', *BCH* Supp. 26 (1993), 499-508.
[61] C. Koehler, 'Oil on the water? Reflections on the contents of Hellenistic transport amphorae from the Aegean', in J. Ering and J. Lund (eds.), *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, September 26-29th 2002,* Monograph of the Danish Institute, Athens vol. 5 (2004), 214-15.
[62] The only example of a wreck carrying *pithoi* is the Istanbul wreck of the fourth century BC in A. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Oxford: BAR International Series 580, 1992), 527

transported in amphorae.[63] More commonly, they are found in small quantities as a shipboard item.

5.1.5 Fish and Other Foods

Fish was another commodity transported in amphorae throughout the Mediterranean. *Garum,* an aromatic and spicy sauce prepared from the innards of small fish seems to have been a Spanish speciality, but *muria* and salted fish were produced widely. *Muria* was an inferior and cheaper variety of fish sauce than garum and is mentioned as a preservative for vegetables, while mackerel and tunny fish were the most commonly salted fish. Fish products traditionally brought success to the Aegean region, especially the islands along the west coast of Asia Minor, and indeed this success was reflected on the coins of Lesbos, Chios and Samos with their images of the tunny fish. The most famous fisheries and salting industries were on the Pontic coast, the Bosphorus and the Propontis. The best fresh fish was from Pontus according to Galen and their pickled fish was second only to those from Spain and Sardinia;[64] oysters came from Ephesus and shellfish was good from the Troad; Sinope was famed for its mullets, Parion on the south coast of the Hellespont for salted mackerel. Trade in *garum* and *salsamenta* was well established in the Eastern Mediterranean by Roman times, with the Black Sea region being particularly dominant and there is much evidence for its continuation in inscriptions, in Strabo and from the region's coins.[65] The long-standing trade in processing fish products seems to have been improved upon technically by the Romans, with better equipped *piscinae*, for example, at Kenchreae, the eastern port of Corinth, where six of them from the first century

[63] Black olives were often conserved in *defrutum,* see above.
[64] Galen *De Alim. Fac.* III 24.6.
[65] Pontus, with its ports of Sinope and Trapezus, was famed for its fishing, particularly pickled tuna and mullet. Panium on the southern coast of the Hellespont was known for its salted mackerel. Ovid praised the variety of fish in *Halieutica* which was allegedly written while he was in Tomis on the western shore of the Black Sea.
Lucian describes how Phoenicians sailed to Pontus Euxinus as far as Lake Maeotis and around other Greek waters before heading back home in late autumn, *Tox.* IV.
Coins from Methymna on Lesbos, from Chios, Samos, Clazomenae and Teos bore images of tunny, as did those from Byzantium, still in the reign of Tiberius.
An inscription from Alabanda in Caria on a sarcophagus of a merchant who imported fish inland reads τᾰρειχόπώλης.
A first century AD inscription from Histria in Moesia Inferior shows that much of the city's revenue came from fishing and its products. A Roman tax on its profits is strongly implied from other inscriptions in which imperial legates granted exemptions from tax including τάρῑχος.

AD were inter-connected and linked to the sea by channels.[66] The apparent lack of archaeological remains of salting establishments in the Eastern Mediterranean in general, however, is surprising, and may be due partly to a lack of research, or possibly the fact that these regions carried out small-scale garum production in *pithoi* or *dolia*, without the need for large built vats.[67] Connected with the salting plants in many places, this production and trade was mostly in private hands and certainly increased during the first century AD.[68] In Egypt, salting was an extensive industry, with salt lakes near Memphis, Mount Casius and Paraetonium, and mines between Egypt and the Sinai, but here the Roman government held the monopoly over salt products. There are numerous references to processed fish products regarding production and commerce which show that it was an integral part of life. Almost a half of the one hundred and eighteen published papyri (up to 1991) date to the second and third centuries AD.[69] Approved dealers existed who leased the right from the state to sell salt in particular regions at a fixed price as well as paying rent, φόρος. There is evidence of commerce between Alexandria and Athens with ships from Egypt bringing pickled fish together with a cargo of perfume from Canopus.[70] Garum was also exported to Syria and Africa[71], but probably not to Rome as the Spanish industry was very strong.

A variety of fruits and nuts were also transported in amphorae from the Aegean. Most regions of Asia Minor grew this type of produce; hardy fruits, such as apples, pears and cherries grew well in the north, whilst figs and melons did well in the mild climate and alluvial soil of the west and south-west and the least hardy, such as palms, grew in Pamphylia and Cilicia. Nuts most often mentioned were almonds and hazelnuts, but others, such as chestnuts also did well. Strabo

[66] Other large, undivided basins serving as fish tanks have been found on Aegina, in Lapithos in Cyprus and Caesarea in Israel.

[67] Cf. the so-called 'garum shop' at Pompeii; A. Wilson, 'Fishy business: Roman exploitation of marine resources', *JRA* 19 (2006) forthcoming.

[68]Strabo VI 4-6.

Salting installations have been found in the Straits of Kerch (Cimerian Bosphorous) with well-preserved vats, 59 of which measured c. 460m². Over 90 vats have been found in Chersonesus dating from the C1st AD. They are of a similar style to those found in Spain, in that they are sunk into the ground with a waterproof lining of mortar of lime and crushed ceramic, but these Eastern Mediterranean ones are missing a hole in the bottom.

[69] R. Curtis, *Garum and Salsamenta* (Leiden, 1991), 131-141.

[70] Lucian *Navigum* 15

[71] Jewish *Talmud* (BT Makshirin 6.3). Also references in the Talmud about Akko in Judea as being famous for its fish.

particularly mentions the north for this type of produce, saying, "The country along the mountains (above the Pontic coast) yields so much fruit, self-grown and wild, grapes and pears and apples and nuts, that those who go out to the forest at any time of the year get an abundant supply .....".[72] Lucullus even transplanted the cherry from Pontus to grow in Italy.[73] Figs though were commercially the most important exports, especially dried ones from Caria and Chios.[74] Other contents of amphorae include honey and wax from Bithynia and Pontus,[75] and resinous plants and gums, such as styrax and iris-gum from Pisidia and Cilicia. Some perfumes and ointments were produced too, for example, rose perfume from Phaselis, and although Campania led the way in this industry, Asia had been the foremost producer early on and remained an important exporter. Nuts have only been found on two wrecks, the Kyrenia and the La Tradalière, dated to ca. 300 BC and 20-10 BC respectively.[76] Discovered in the Kyrenia wreck, which was carrying a variety of Aegean amphorae, were ten thousand almonds, lying in clusters, indicating that they were carried in sacks. Tens of thousands of hazelnuts, which formed a layer up to a metre thick, were found in the La Tradalière wreck.

5.1.6 Types of Amphorae Found in Wrecks

The review of the amphorae from the Eastern Mediterranean that follows discusses the most important ones found on shipwrecks dating from about 300 BC to AD 250. The typological terms used are currently valid in literature, derived from an entire series of typologies such as Dressel 1899 and quantified results from excavations such as those from Berenice (Riley 1979), Carthage (Hayes 1976), Knossos (Hayes 1983) and Ostia (Panella 1973).[77] I have tried to simplify the amphora categories but have used several typologies for the same amphora when they have been mentioned as such in wreck reports. One hundred and fifty wrecks of the two hundred and ten in my database were carrying

[72] Strabo XII 3.15.
[73] Pliny *HN* XV 102.
[74] Cypriot figs were sent to Jerusalem in AD 70 to relieve famine, Josephus *Ant.* XX 2.5, although they were considered to be of a poor quality.
[75] Pliny *HN* XI 59.
[76] Kyrenia, JS 200; La Tradalière, JS 456.
[77] For a full list of typologies, see C. Panella, 'Oriente ed occidente: considerazioni su alcune anfore Egee de eta imperiale a Ostia', in J.-Y. Empereur and Y. Garlan (eds.), *Recherches sur les Amphores Grecs* (*BCH* Supp. 13, 1986), 635.

eastern-made amphorae (71%). Of those, fifty-two (34%) were found in the Aegean, twenty in the Eastern Mediterranean (13%), forty-six in the central Mediterranean (30%), and twenty-five in the Tyrrhenian Sea (16%) with nearly negligible amounts in the Black Sea and Red Sea. An interesting and unique find was made in the La Tradalière wreck of some miniature amphorae, possibly a merchant's samples (cf. the marble samples of the Punta Scifo wreck, JS 350). If this is the case, it is the first evidence of wines being tasted in distant regions before presumably a bulk order is placed.[78]

Corinthian A and B

These are predominantly fourth to third century amphorae probably containing wine.[79] All five wrecks carrying Corinthian A or B forms (and sometimes together) date to the third century BC; two of these are in the Aegean (Seriphos, the latest wreck 250-225 BC, and Preveza B), the Savelletri wreck of 280-250 BC is off the coast of Bari while the others were found off the eastern coast of Sicily (Vulpiglia and Stentinello).[80] In the case of the Savalletri and Stentinello wrecks there was another type of amphora which has not yet been identified.

Dressel 2-4 Greek variant and Egyptian variant

The Greek variant of Dr. 2-4 (which I consider to derive from an earlier Coan form, as J. Freed, n. 74) was made on the islands of Rhodes and Cos and was widely exported throughout the Mediterranean from the end of the Roman Republic through to the end of the first century AD.[81] The overlap between this form and actual Coan amphorae on which all the western forms were based (see below) has led to confusion; recent analysis of over six hundred amphorae from the amphora walls in Carthage has found thirty distinguishable types of Dressel

[78] JS 456 and Pomey and F. Guibal, *Bilan scientifique du Département des recherches archéologiques sous-marines* 1999, 66-67.
[79] Although C. Williams and J. Fisher consider the contents to be oil, 'Corinth, 1972', *Hesperia* 42 (1973), 25.
[80] Seriphos, JS 79 ; Preveza B, JS 300 ; Savelletri, JS 337 ; Vulpiglia, JS 350 ; Stentinello JS 351.
[81] J.-Y. Empereur and M. Picon believe that the neighbouring cities of Rhodes and Cos were also producing these amphorae, J.-Y. Empereur and M. Picon, 'Les régions de production d'amphores impériales', in *Amphores Romaines et Histoire Economique: Dix Ans de Recherche* Actes du colloque de Sienne (24-26 mai 1986) *Collection de l'Ecole Française de Rome* 114 (1989), 223-248.

2-4 forms.[82] Of these, several are definitely Coan in fabric and it is possible to trace their development chronologically within this series, specifically by looking at the increasing angularity of their design (they increase in height while narrowing in their body). By the mid first century AD, all the Dr. 2-4 types are over a metre tall with a maximum body diameter of 30cm. Although the content most usually associated with Dressel 2-4 amphorae is wine, amphorae of the Greek variant from two wrecks in the south of France were found to contain the remains of dates (La Tradelière and Dramont D).[83] In another scattered wreck from the western Mediterranean, the Maratea A, an Italian form of Dressel 2-4 was also found along with the Greek variant.[84] However the Coan variant is the dominant type of Dr.2-4 in the Adriatic (Valle Ponti, Plavac, Mlin Reef, Cape Glavat etc.) and is often found with Rhodian amphorae.[85]

Wine was produced in centres near Lake Mareotis thirty miles south-west of Alexandria and shipped out in bitronconique Dressel 4 amphorae from Hellenistic times right through the Roman Imperial period. Marean wine was Mareotic praised by Virgil, Horace and Strabo and amphorae have been found in the royal tombs of Meroe in southern Egypt and also all over the Aegean, Rome and northern Italy.[86] Evidence for its export as far as southern France comes from a wreck in the Gulf of Fos from which at least thirty amphorae have been raised and are now in the museums of Istres and Martigues.[87]

Rhodian (Camulodonum 184)

Rhodian amphorae began to appear in Italy from the second century BC and continued through to the Late Roman Empire with several modifications in form. The early stage amphora had an egg-shaped body, cylindrical neck, a short beaded rim and short cylindrical solid base. From the late first century BC, the handles become narrower and sharper, eventually to become horned, while average capacities dropped from 28-29 litres to 26 litres to 23 litres, and some

[82] J. Freed, 'Adoption of the form of the Koan amphora to the production of Dressel 2-4 amphora in Italy and north-eastern Spain', *RCRF Acta* 36 (2000), 459-463.
[83] JS 456 and JS 458.
[84] JS 410
[85] Valle Ponti, JS 338; Plavac, JS 322; Mlin Reef, JS 330; Cape Glavat, JS 320.
[86] Virgil *Georgics* II 91; Horace *Odes* I 37; Strabo 17; Athenaeus I 33.
[87] J.-Y. Empereur, 'La production viticole dans L'Egypte ptolémaïque et romaine', *BCH* Supp. 26 (1993), 40-47.

half-size ones were also manufactured, at least in the first century AD, as found in the wrecks of Akandia A and Mlin Reef.[88] The most common content was wine but these amphorae could also contain other items such as figs, as in the Dramont D wreck.[89]

Early Rhodian amphorae were stamped on each handle, until the last quarter of the first century BC, with eponyms and months on one and the name of the potter on the other, and are thus easily recognisable, as, for example, in the Antikythera A, Qaitbay 2, Apollonia B, Pozzino, Sanguinaires and Le Grand Congloué wrecks, all of which have been dated between 210 BC and 80 BC.[90] In Alexandria and Palestine, for example, they are the commonest of the stamped amphorae.[91] However Imperial Rhodian amphorae from the first century AD onwards are largely unstamped, and can be variable in both weight and form, and there has been much debate as to whether these amphorae really were produced on the island of Rhodes.[92] They did not come solely from the island of Rhodes, according to J.-Y. Empereur and M. Picon, but from Rhodian territory which at varying times including parts of coastal Asia Minor and several other small islands.[93] This would explain why the good quality wines of Symi, Carpathos and Nisyros are not mentioned in any text – buyers simply considered them to be Rhodian. Another suggestion by P. Fraser, certainly for the case of Alexandrian finds from the second and first centuries BC, is that the amphorae were exported empty to Laodicea, Syria, where they were then filled with Laodicaean wine. He argues this based on the lack of written evidence about Rhodian products in Alexandria as compared to the enormous volume of the stamped handles, the

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[88] J. Riley, 'Typology of the Hellenistic and Roman coarse pottery of Berenice', in J. Lloyd (ed.), *Excavations at Sidi Khrebish Benghazi* (Tripoli, 1979), 122. JS 52 and 330.
[89] JS 458.
[90] The stamp on the Antikythera A wreck is the name Lysistratus (JS 30), the ones on the Apollonia B wreck are the names Drakontas and Ariston (JS 240), while that of Pozzino reads as [Epi Pith]ogeneus Yakinthiou (JS 406). A rose motif also occurs on some stamps, e.g. those on the Sanguinaires wreck (JS 431); Le Grand Congloué, JS 449.
[91] There are now over 100,000 stamped Rhodian amphora handles on file, according to C. Habicht, 'Rhodian amphora stamps and Rhodian eponyms', *REA* 105 (2003), 541-578, but under 1000 whole vessels, according to C. Barker, 'Three new eponym-fabricant combinations on Rhodian amphorae from the 'Tomb of the Kings' at Nea Pafos', *RDAC* (2002), 189-200.
[92] A. Hesnard, 'Imitations et raisonnement archéologique: a propos des amphores de Rhodes et de Cos', in J.-Y. Empereur and Y. Garlan (eds.), *Recherches sur les Amphores Grecs* (*BCH* Supp. 13, 1986), 69-79.
[93] J.-Y. Empereur and M. Picon, 'Les régions de production d'amphores impériales', in *Amphores Romaines et Histoire Economique: Dix Ans de Recherche* Actes du colloque de Sienne (24-26 mai 1986) Collection de l'Ecole Française de Rome 114 (1989), 223-248.

high tariffs on foreign wines even for mediocre wines such as Rhodian when the local wine was of a similar quality and the fact that there were many Laodiceans living in Alexandria at this time.[94] However, the fact that Rhodian amphorae were the only ones to be stamped should not be used in judgement against them and possibly far larger numbers of Coan and Chian wine amphorae were arriving in Alexandria at the same time. In fact, J.-Y. Empereur has used a coefficient derived from elsewhere to suggest that Coan amphorae are more numerous than Rhodian.[95] Many of these unstamped amphorae are found in the western Mediterranean, in Italy, France, Germany and Britain, while few have been found in the Aegean, although this may simply be because only the stamped ones have been published. It is now beyond doubt that these unstamped amphorae were indeed made on Rhodes.

Rhodian amphorae are numerous throughout the Mediterranean both on land and in the sea (Figs. 5.1 and 5.2). They are by far the most common amphora found in wrecks, featuring in forty-two of my total, of which fifteen are in the Aegean, four are around Cyprus, another four from the coasts of Egypt and Libya, six off the coast of Croatia, four from the south-eastern coast of Italy, a couple in Italian waters in the Tyrrhenian and four from France.

Cnidian (Pompeii 38)

Cnidian amphorae were stamped until the first century BC and represent 65% of the total stamped amphorae in Delos and Athens,[96] with a wide, though infrequent, distribution ranging from the Black Sea to Palestine to the western Mediterranean (Fig. 5.3). This is also evident from underwater sites: only five wrecks have been found with Cnidian amphorae, but there are three from the Aegean, one from the Adriatic and one off the coast of France with dates ranging from 300-270 BC (Serçe Limani B) to ca. 200 BC (Le Grand Congloué) to the first century BC (Çökertme B) to the first –second centuries AD (Mlin Reef).[97] Six hundred amphorae of the same form in two different sizes have been raised from the Serçe Limani B wreck; all are stamped on one handle with the name

[94] P. Fraser, *Ptolemaic Alexandria* (Oxford, 1972) 162-71.
[95] J.-Y. Empereur, 'Les anses d'amphores timbrées et les amphores: aspects quantitatifs', *BCH* 106 (1982), 219-33.
[96] V. Grace and M. Petropoulakou, 'Les timbres amphoriques grecs', in P. Bruneau et al, *Exploration Archéologique de Délos* 27 (Paris, 1970), 277-382.
[97] Serçe Limani B, JS 4; Le Grand Congloué, JS 449; Çökertme B, JS 15; Mlin, JS 330.

ZHN/PHILA and with NTH[ ] on the other. This is the largest collection of stamps of the so-called Zenon group which was originally thought to have been associated with Zenon of Kaunos, an agent of Apollonius who was the finance minister of Ptolemy II Philadelphus, and whose activities are well known from papyri.[98] However ceramic analysis has shown that these amphorae were made on the Datça Peninsula near Cnidus rather than in Egypt and this wreck is also earlier than Zenon of Kaunos's activities by about twenty years. It is also known, by the by, that the ship sank in early summer as the amphorae were packed with freshly-cut brushwood.

Coan (Dressel 5)

In a similar case to the Rhodian amphorae, the origin of those from Cos has also been doubted, the thought being that they were Italian copies of the original Hellenistic Coan amphora. Morphological and petrological analysis has again proved that they were indeed made on the island of Cos and were exported to the same areas as the Rhodian ones (Fig. 5.4). This is borne out by the evidence underwater; almost every wreck which was carrying Coan amphorae was also carrying Rhodian ones, for example, the Antikythera A, Dhia A, Taranto C and Dramont D wrecks.[99] This is an important indicator that Aegean wine was being transported vast distances during the Roman Empire. Its sudden appearance in the first century BC came from a change in drinking habits that now appreciated Coan wine varieties that were made with seawater and were therefore very different to Italian wines.[100] Not all were stamped but those from the Antikythera A wreck had double-barrelled handles stamped with the same symbols as Coan coins, namely a crab and a club. A less obvious picture comes from the six Coan amphorae, with double-rolled handles, that have been found in the deep wreck of Skerki Bank D, which is dated to the first half of the first century BC.[101] They form part of a very mixed cargo for which it is difficult to guess the route: areas from which the thirteen types of amphorae come include Italy, Gaul, North Africa and Greece. Coan amphorae were also exported further

[98] I. Whitbread, *Greek Transport Amphorae. A Petrological and Archaeological Study* (BSA Occasional Papers 4, 1995), 117-121.
[99] Antikythera A, JS 30; Dhia A, JS 90; Taranto C, JS 341; Dramont D, JS 458.
[100] Pliny *HN* XIV 79.
[101] A. McCann, 'Amphoras from the deep sea: ancient shipwrecks between Carthage and Rome', *RCRF Acta* 36 (2000), 443-448; JS 354.

afield, as the wreck at Shab Rumi off the coast of Sudan shows.[102] It is usually assumed that Coan amphorae contained wine, but some may have contained oil, as the report on the wreck of Astypalaea suggests, regarding what are described as "exceptionally fine Coan amphorae".[103]

The overlap with Dressel 2-4 causes complications, since they were arriving in the west at the same time as the Coan, and as Antoinette Hesnard points out, there is a need to publish not only all the unstamped amphorae but also those found with Latin stamps in the eastern Mediterranean.[104]

Cretan Amphorae

Cretan amphorae presumably containing wine were being exported during the Hellenistic and Republican periods (as found in the Kyrenia and Qaitbay 1 wrecks, ca. 300 BC and mid first century BC respectively), but there was a massive export production from Augustan times onwards from at least sixteen amphora production centres.[105] Crete was in unique position geographically, standing on the maritime route to Egypt, the Red Sea and the Levant. Many Romans lived in Crete and they no doubt played an important role in the exportation of Cretan wine to the western Mediterranean. The wine was sweet, a *passum*, and was considered to be of cru quality;[106] there were also less good white wines produced that, according to Galen, were used for medicinal purposes but did not travel well.[107] Cretan amphorae represent about 15% of all amphorae found in three different Rome locations in AD 64, 80-90 and 110 and in Ostia they represent approximately 30% of all Aegean imports during the second century AD (Figs. 5.5 and 5.6).[108] Unfortunately, wrecks containing these amphorae are rare (only eight) and there are only definite cargoes for AC 4 amphorae and not the other three types. The Skerki Bank B wreck, dated to the second half of the first century AD, was carrying unspecified Cretan wine

[102] Shab Rumi, JS 501.
[103] Astypalaea, JS 60.
[104] A. Hesnard, 'Imitations et raisonnement archéologique: a propos des amphores de Rhodes et de Cos', in J.-Y. Empereur and Y. Garlan (eds.), *Recherches sur les Amphores Grecs* (*BCH* Supp. 13, 1986), 69-79.
[105] A. Marangou, 'Le vin de Crète de l'epoque classique a l'epoque impériale: un premier bilan', *BCH* Supp. 26 (1993), 177-182. Kyrenia, JS 200 and Qaitbay 1, JS 222.
[106] Clement of Alexandria *The Pedagogue* II. 30.2; Martial *Ep.* XIII 106.
[107] Galen *Hipp.* XV 648.
[108] A. Marangou-Lerat, *Le Vin et les Amphores de Crète* Etudes Crétoises 30 (1995), pl. 33and 34.

amphorae as well as wine amphorae from Campania and Egypt and oil amphorae from Tripolitania, while the Punta Mazza wreck of the third century was carrying two sizes of Knossos 18 amphorae.[109]

Cretan AC 1 (Knossos 2, MR 2, Agora G 197, Pompeii 10)

About 60cm high dating from the middle of the first century AD to the fifth century, these have been found in the Aegean and in Pompeii and Rome and are known to have contained *passum*.[110] This was a standard Greek amphora holding about 20 litres and the only stamped type (πασσον) from Crete. The most exported of the Cretan ones, they formed 27% of eastern amphorae found in the Baths of the Nuotatore in Ostia from the mid to late second century AD.[111] Disappointingly, there are no recorded finds of AC1 from the sea.

Cretan AC 2 (Dressel 36, Pompeii 8 and 10, ER 1)

Also about 60 cm tall, these have been found in sites from Alexandria to Marseille, with so-called wrecks at Fos and at Pyrgi;[112] these amphorae copy the Coan type of amphora.

Cretan AC 3 (Knossos 1)

Dated to the first to third centuries AD, these have only been found in Athens and Pompeii. According to *tituli picti*, they contained wine that had not been cut with seawater, αθαλασσιος.

Cretan AC 4 (Cretan horn-handled, Dressel 43, Knossos 4-5, Pompeii 36)

Similar in looks to Rhodian amphorae, but with a smaller capacity, these amphorae date to the first to the third centuries AD. The one found in the

[109] Skerki Bank B, JS 357; Punta Mazza JS 400.
[110] St. Markoulaki, J.-Y. Empereur and A. Marangou, 'Recherches sur les centres de fabrication d'amphores de Crète occidentale', *BCH* 113 (1989), 551-580.
[111] C. Panella, 'Oriente ed occidente: considerazioni su alcune anfore Egee di eta imperiale a Ostia', in J.-Y. Empereur and Y. Garlan (eds.), *Recherches sur les Amphores Grecs* (*BCH* Supp. 13, 1986), 609-636.
[112] Only one amphora and the neck of an amphora have been found in Fos and Pyrgi respectively, therefore not necessarily representing the cargo of a shipwreck: Musée of Istres, unpublished, and P. Gianfrotta, 'Archeologia sott'acqua: rinvenimenti sottomarini in Etruria meridionale', *Bollettino dell'Arte* 10 (1981), 71-72.

Chrétienne H wreck had a capacity of 12 litres and a weight of 5.9kg.[113] One of the twelve amphorae from the Gulf of Fos has a dipinto of *Cret(icum vinum).*[114] A variation of AC 4 with exaggerated handles and a bulging neck is also common. The Alberti Panarea wreck was carrying at least a hundred of these, along with Dr. 2-4 amphorae. Similarly, the wreck of Koromašno was also carrying more than a hundred as well as other Aegean mixed cargo. The Torre Chianca is the most recent wreck, dating to the third century AD, and is the only one to have been carrying a commodity other than amphorae, namely cipollino marble columns.[115]

Chian

Chian wine was one of the most famous Aegean wines but the island was also famous for its figs which it exported to Italy, so some amphorae may well have contained figs rather than wine. [116] There are disappointingly few wrecks carrying Chian amphorae (only four) and surprisingly, only one has been found in the Aegean, Moudros Bay, which is dated to the Hellenistic period and which carried a mixed Aegean and southern Italian cargo.[117] The earliest wreck in the west is Le Grand Congloué of ca. 200 BC. The latest date for Chian amphorae comes from the La Tradelière wreck of the early first century AD, where again they were part of a mixed cargo of Aegean amphorae containing wine and dates.[118]

Käpitan 1 (Agora K 113) and Käpitan 2 (MR 7)

Käpitan 1 amphorae have their origins in the Aegean and were distributed only to Greece, Italy and southern France during the late second to third centuries AD. Käpitan 2 amphorae, on the other hand, measuring about 70 cm in height, have a wide distribution from Iraq to the Black Sea to Britain (although never in Spain and rare in France and North Africa) with a distribution peak in the early third century AD – origins are various Aegean sites but definitely not Rhodes

[113] C. Santamaria, 'L'épave H de la Chrétienne a Saint-Raphaël (Var)', *Archaeonautica* 4 (1984), 41.
[114] B. Liou, 'Inscriptions peints sur amphores', *Archaeonautica* 7 (1987), 91 n. F32.
[115] Alberti Panarea , JS 408 ; Koromašno, JS 323; Torre Chianca JS 346.
[116] Varro *Rust.* II 1.3
[117] Moudros Bay, JS 72.
[118] Le Grand Congloué, JS 449 ; La Tradelière, JS 456.

(Fig. 5.7).[119] The contents are unclear. Of seven wrecks in total, once again, what is surprising considering their distribution on land is the fact that neither type has been found on any wrecks in the Aegean (except the Methone C wreck on the western tip of the Peloponnese) and although they are said to be rare in France, there are two wrecks carrying them in that region: the Porticcio wreck off the coast of Corsica, which was carrying Käpitan 1 and 2 as well as nine other types of amphorae including Spanish, Gaulish and African, and the Bagaud A wreck off the south of France.[120] Although the Grado wreck was carrying Käpitan 1 amphorae, these had been recycled and, like the other amphorae on board, had been filled with fish (see above, Ch. 5 beginning). More numerous are wrecks off eastern Sicily; the Ognina A wreck with Käpitan 1 and 2, the Terrauzza with a badly smashed cargo also of both forms, Marzamemi A, also with both types and Capo Granitola A with Käpitan 2 amphorae. The last two wrecks were each carrying a large cargo of Attic and Proconnesian marble blocks and columns respectively, so the amphorae were clearly the secondary cargo, as was the case for the Methone C with a cargo of Egyptian or Greek granite columns and at least ten Käpitan 2 amphorae.

Other Aegean Forms

Kingsholm 117 is a small cylindrical amphora, presumably from the Aegean, with a distribution as far as Britain. [121] It dates to the first three centuries AD and has been found as cargo (four amphorae, one filled with dates) in the La Tradelière wreck and probably as a shipboard item (five amphorae) in the Dramont D wreck.[122]

Samian, Parian and Thasian amphorae feature in several wrecks such as the Kyrenia, Kuçük Keramit Adasi and Callatis B.[123]

[119] J.-Y. Empereur and M. Picon, 'Les régions de production d'amphores impériales', in *Amphores Romaines et Histoire Economique: Dix Ans de Recherche* Actes du colloque de Sienne (24-26 mai 1986) Collection de l'Ecole Française de Rome 114 (1989), 233.

[120] Porticcio, JS 433; Bagaud A, JS 468; Grado, JS 344; Ognina A, JS 362; Terrauzza, JS 360; Marzamemi A, JS 361; Capo Granitola A, JS 363; Methone C, JS 310.

[121] F. Vilvorder, R. Symonds and S. Rekk, 'Les amphores orientales en Gaule septentrionale et au sud-est de la Grande Bretagne', *RCRF Acta* 36 (2000), 477-486.

[122] La Tradelière, JS 456; Dramont D, JS 458.

[123] Kyrenia, JS 200; Kuçük Keramit Adasi, JS 2; Callatis B, JS 103.

Asia Minor Forms

Several types of amphorae exist that were produced in the Asia Minor region, including Agora F65/F66, Dressel 30 and Agora G199. Agora F65/F66 are relatively small, one-handled amphorae (6.5 litres) made in the Meander valley and Ephesus during the first few centuries AD. They contained wine judging by their resin lining and their distribution was widespread, even to London and Colchester.[124] Dr.30 amphorae were made in Cilicia, and Agora G 199 in both Cilicia and Cyprus. They are thought to have contained wine also.

Only two wrecks feature Agora F65/66 amphorae, the Punta Mazza and Ouest Embiez 1; the Punta Mazza wreck carried seven types of amphorae including the three mentioned above as well as the Cretan Knossos 18 amphorae and some from Palestine (Fig. 5.8). The Ouest Embiez's main cargo was glass but as a secondary cargo it was carrying a mixed group of amphorae, a small number of which have been identified, including six Agora F65/ 66.[125]

A recently discovered ship in deep water off Cyprus went down in ca. 100 BC with over two thousand Pamphylian amphorae. This is a unique find and as yet, no comprehensive study has been made on the amphorae.[126]

Black Sea

Only one amphora type from the Black Sea has been found as cargo on wrecks, the Sinope type. These amphorae are typically long and carrot-shaped and seem to have contained a variety of products.[127] In an unnamed wreck off the coast of Bulgaria, dated to the third century BC, amphorae of this type held fish, with evidence coming from the bones of freshwater catfish, as well as olives, judging by the olive stones, and wine, judging by the resin used as a lining. Three Roman wrecks off the coast of Turkey that lie close together had large cargoes of amphorae, some of which are thought to be Sinopian.[128]

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[124] F. Vilvorder, R. Symonds and S. Rekk, 'Les amphores orientales en Gaule septentrionale et au sud-est de la Grande Bretagne', *RCRF Acta* 36 (2000), 477-486.
[125] Punta Mazza, JS 400; Ouest Embiez 1, JS 466.
[126] JS 208; see the abstract of M. Lawall, 'Deep water survey and amphoras: a terrestrial ceramicist's point of view', *Poseidons Reich* XI 17-19 February 2006, 25.
[127] C. Abadie-Reynal, 'Les amphores romaines en Mer Noire (I^{er}- IV^{e} s.)', in Y. Garlan (ed.), *Production et Commerce des Amphores Anciennes en Mer Noire* (Aix-en-Provence, 1999), 255-264.
[128] No name Bulgaria, JS 102; three wrecks not named Turkey, JS 101.

Palestinian and Egyptian

Two wrecks were carrying Egyptian amphorae amongst their cargo which seem not to have been of the Dressel 2-4 type. The Skerki Bank B wreck was transporting Egyptian amphorae in the second half of the first century AD when it sank off the western coast of Sicily with other amphorae of Tripolitanian oil and Cretan wine. The Komiža wreck of the first to second century AD has been completely looted, but amongst the remains are many sherds of Egyptian, possibly Somalian, amphorae.[129]

The early Kyrenia wreck was carrying Palestinian amphorae suggesting a regional trade, while the third century Punta Mazza wreck had a varied cargo from the Aegean and Levant which included Zemer 57 amphorae from Palestine which were being circulated between the second and fourth centuries AD.[130]

Another thirty-four shipwrecks were carrying other pottery finds from the Eastern Mediterranean with a mixture of fine ware, coarse ware and some unidentified pottery.

5.2 FINE WARE

Ceramic fine ware appears in large quantities all over the Mediterranean in all sorts of contexts, from Imperial palaces and villas of the wealthy to dwellings of ordinary people.[131] Thus fine ware was a functional product that covered the whole spectrum of society, and can be expected to form 10% of all pottery finds, according to J. Hayes.[132] The pre-requisites for making fine ware are different from those of amphora production, since the necessary components are simply availability of good clay and fuel. However these are not enough to allow fine ware production to flourish, since even areas which had excellent clay, such as Greece, did not exploit the situation in the Roman period. Fine ware exportation had to depend on already active routes along which other goods, such as amphorae, were being transported and to which they could attach as a secondary product. This does not mean to say that fine ware exportation was not

[129] Skerki Bank B, JS 357; Komiža, JS 331.
[130] Kyrenia, JS 200; Punta Mazza, JS 400.
[131] For example, I. Schrunk, *Late Roman Red Slipped Wares from Diocletian's Palace at Split, Yugoslavia* (PhD dissertation, University of Minnesota 1984).
[132] J. Hayes, 'From Rome to Beirut and beyond: Asia Minor and eastern Mediterranean trade connections', *RCRF Acta* 36 (2000), 285-297.

an organized business especially when one considers the amount of fine ware found on archaeological sites around the Mediterranean. For the obviously high levels of exchange and the amount of modern literature written about fine ware, it is disappointing that only sixteen out of my two hundred and ten shipwrecks seem to have been carrying any.

One of the most successful eastern exports to the western part of the Mediterranean was the good quality, red-slipped, eastern sigillata fine ware, which may be surprising when one remembers that Italy and then Gaul made very good fine ware of their own which had a wide distribution. Between AD 75 and 125, Italian sigillata still made up over 50% of all sigillata at Ostia, but eastern fine wares being imported to the west came in the form of Eastern Sigillata A, Eastern Sigillata B, Eastern Sigillata C, Pontic Sigillata and Cypriot Sigillata. African red-slip ware was later to take over the market completely from the mid-second century AD. These eastern Mediterranean red-gloss wares seem to have been part of a sophisticated industry much like that of Italian Sigillata, as characterized by P. Kenrick.[133]

Production of Eastern Sigillata A began around the middle of the second century BC in the hinterland area behind Antioch, Seleucia Pieria, Apamea and Laodicea and continued through to the second century AD. With notable concentrations in the eastern Mediterranean,[134] Eastern Sigillata A is mainly found in three regions of the central Mediterranean: in the southern Adriatic coastal region (Brindisi etc), the eastern coast of Sicily and Campania with relatively high amounts in Pompeii and Puteoli. Its presence is lacking in Ostia which points to Puteoli being its port of arrival for Italy, although it obviously travelled north as there are at least thirty pieces found in a *domus* in Pisa.[135] The main types that were being imported date to the late Hellenistic and early Roman periods and may well have been the impetus for Arretine fine ware that began in

[133] P. Kenrick, 'Italian Terra Sigillata: a sophisticated Roman industry', *OJA* 12 (1993), 235-242.
[134] Paphos (where Eastern Sigillata A constitutes about 60% of fine ware between 100 BC and AD 200, J. Hayes, *The Hellenistic and Roman Pottery. Paphos III* (Nicosia, 1991)), Tarsus (F. Jones, 'The pottery' in H. Goldman (ed.), *The Hellenistic and Roman Periods. Excavations at Gözlü Kule, Tarsus I* (Princeton, 1950), 149-296), Antioch (F. Waagé, *Ceramics and Islamic Coins. Antioch on-the-OrontesIV.1* (Princeton, 1948)), and Tel Anafa (where more than 23,000 Eastern Sigillata A sherds have been found, K. Slane, 'The Fine Wares', in S. Herbert (ed.), *Tel Anafa 2.1. The Hellenistic and Roman Pottery JRA* Supp. 10.2 (1997), 247-406).
[135] S. Menchelli and M. Pasquinucci, 'Ceramiche orientali nell'Etruria settentrionale costiera (II Sec. A.C.-VI Sec. D.C.)', *RCRF Acta* 36 (2000), 371-378.

the middle of the first century BC, although the shapes are very different.[136] Cicero's reply to his friend Atticus in 50 BC about his request for some tableware from Rhosos, an area inland from those mentioned above which may or may not have produced Eastern Sigillata A, points to the fact that this type of tableware at least was considered to be a fashionable commodity.[137] Many pieces of Eastern Sigillata A and B have been found on land along the eastern coast of Sicily but no wrecks carrying this as cargo have been found there so far. The designs of Eastern Sigillata A underwent a change during the early Imperial period as potters started to copy Italian sigillata as a direct result of the latter's importation to the eastern Mediterranean (in particular to the Roman colony that included the towns of Knossos, Corinth, and Ephesus, and into the Bosphorus, and even as far as Arikamedu in India, but only for about fifty to sixty years in the first century AD).[138] As J. Poblome and M. Zelle say, "the new Eastern Sigillata A production line basically interpreted the Italian concept of design to an eastern taste"[139] and these changes can be seen in the higher feet, new ornamental forms and stamps. Only two wrecks were carrying Eastern Sigillata A as cargo and both are dated to the Republican period, before the design changes of the first century AD. In the Aegean is the Cape Gelidonya B wreck with about 300 pieces of Eastern Sigillata A plates, cups and bowls, and at the other end of the Mediterranean, off the coast of France, is the Cap Camarat 2 wreck which was also carrying Arretine ware and Greek amphorae.[140]

Eastern Sigillata B was produced in the Phocaea region/Meander Valley from the early Imperial period in two phases (10 BC – AD 75, then AD 75 – ca. AD 150) as the closest eastern imitation of the undecorated, plain Arretine sigillata; it was mainly concentrated around the Aegean but became important in quantitative terms in its later phase in Italian areas such as Istria.[141] Italian potters

[136] D. Malfitana, J. Poblome and J. Lund, 'Eastern Sigillata A in Italy: a socio-economic evaluation', *BABesch* 80 (2005), 199-212.
[137] Cicero *Att.* VI 1.13.
[138] S. Menchelli and M. Pasquinucci, 'Ceramiche orientali nell'Etruria settentrionale costiera (II Sec. A.C.-VI Sec. D.C.)', *RCRF Acta* 36 (2000), 371-378.
[139] J. Poblome and M. Zelle, 'The table ware boom. A socio-economic perspective from western Asia Minor', in C. Berns, H. von Hesberg, L. Vandeput and M. Waelkens (eds.), *Patris und Imperium*: kulturelle und politische Identität in den Städten der römischen Provinzen Kleinasiens in der frühen Kaiserzeit: Kolloquium Köln, November 1998 (Leuven, 2002), 276.
[140] Cape Gelidonya B, JS 16; Cap Camarat 2, JS 454.
[141] P. Maggi and A. Starac, 'Rinvenimenti di Terra Sigillata e di altre ceramiche fini de produzione orientale in Istria', *RCRF Acta* 36 (2000), 348-357.

seem to have been involved with its production in the beginning since some of the potters' stamps appear with Latin names, such as C. Sentius, an active potter from Arezzo, or Q. Pompeius Serenus, a known potter from Puteoli.[142] Stamping seems to disappear on all eastern sigillata by about AD 75, the same time that Italian imports ceased, although the table ware itself remained important, although marked by a decline in quality. The only wreck found so far carrying Eastern Sigillata B as cargo is the Pakleni/Cape Izmetište, off Croatia, dated to AD 100-150. With about 2,500 pieces of pottery, half of which are Eastern Sigillata B, there is a huge variety of forms, from flat based plates to deep bowls to shallow bowls to plates with a rounded base. Many are stamped with at least twenty-eight different motifs, including one with Greek letters CΠΟ/ΡΟΥ, presumably pointing to a potter called Sporos (Fig. 5.9).[143]

Eastern Sigillata C, also known as Çandarli ware, from the area around Pergamon, began to appear at the same time as Eastern Sigillata A, but was only ever a regional ware and seems not to have been exported even within the Aegean until the second century AD.[144]

Export of Cypriot Sigillata or Eastern Sigillata D began early in the first century BC but was mainly restricted to Cyprus, Egypt, Palestine and Rough Cilicia, where it formed over 50% of all fine ware. The exact location of its production in Cyprus is still unsure, although south-west Cyprus is now preferred to the northern region. This area also produced the MR 4 (Riley) wine amphora whose distribution is identical to that of Cypriot Sigillata, thus enhancing the idea of fine ware exportation going hand in hand with other products.[145] The determining factor for the relationship between these areas for these products was presumably the sea routes connecting the Levant and the Aegean via the north-west and south- east coasts of Cyprus.

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[142] J. Poblome and M. Zelle, 'The table ware boom. A socio-economic perspective from western Asia Minor', in C. Berns, H. von Hesberg, L. Vandeput and M. Waelkens (eds.), *Patris und Imperium*: kulturelle und politische Identität in den Städten der römischen Provinzen Kleinasiens in der frühen Kaiserzeit: Kolloquium Köln, November 1998 (Leuven, 2002), 277ff.

[143] M. Jurišić, *Ancient Shipwrecks of the Adriatic* (Oxford: BAR International Series 828, 2000), 30-34 and figs.15-20. Pakleni/Cape Izmetište, JS 333.

[144] J. Poblome and M. Zelle, 'The table ware boom. A socio-economic perspective from western Asia Minor', in C. Berns, H. von Hesberg, L. Vandeput and M. Waelkens (eds.), *Patris und Imperium*: kulturelle und politische Identität in den Städten der römischen Provinzen Kleinasiens in der frühen Kaiserzeit: Kolloquium Köln, November 1998 (Leuven, 2002), 275-287.

[145] J. Lund, 'Trade patterns in the Levant from ca. 100 BC to AD 200 as reflected by the distribution of ceramic fine wares from Cyprus', *Münstersche Beiträge zur antiken Handelsgeschichte* 18 (1999), 1-22.

Results are also disappointing in terms of wreck finds for Corinthian and Cnidian relief fine ware which has been excavated from various sites on land; at Ostia, for example, this type of fine ware is attested from AD 150 to AD 300.[146] Also prevalent in Istria, these plates and bowls were decorated with typical scenes of the labours of Hercules, battle scenes between the Greeks and the Barbarians and scenes of Dionysus, yet only discovered underwater in the Punta Mazza wreck off the north-eastern coast of Sicily AD 200-250.[147]

Megarian ware dates from third century BC and was made in the Aegean/Ionic-Ephesus region; of the pieces found in Sicily of the second to first centuries BC, five are from Attica, two from the Peloponnese, and one hundred and sixty-one from the Ephesus area. It is scarce but quite widely distributed in Italy from Pompeii to Cosa, and can also be found along the French coast and in the Balearics. The wrecks of Pozzino (140-120 BC) and Spargi (120-100 BC) that carried Megarian ware, amongst other pottery products, probably shared a port of embarkation at Delos – a free port since 167 BC, and where goods arrived from diverse eastern regions to be re-distributed on ships heading west. The same may be true of the Apollonia B wreck (180-150 BC) whose main cargo was Megarian ware. Trade in this product was probably quite well organized but limited as these were considered items of luxury.[148]

Unspecified black gloss pottery features in seven other wrecks with dates and locations ranging from 300-270 BC Serçe Limani B off the coast of Turkey to the second century AD Camarina A off the coast of Sicily.[149]

5.3 COARSE WARE

Most of the large Roman settlements around the Mediterranean would have been able to manufacture at least some pottery within their own territories,

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146 C. Pavolini, 'Ceramica Corinzia a rilievo di eta imperiale ad Ostia (1)', *Riv. Studi Lig.* (1980), 241-258.

147 D. Malfitana, 'Anfore e ceramiche fini da mensa orientali nella Sicilia tardo-ellenistica a romana: merci e genti tra Orients ed Occidente', in J. Ering and J. Lund (eds.), *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, September 26-29th 2002,* Monograph of the Danish Institute, Athens vol. 5 (2004), 239-250. Punta Mazza, JS 400.

148 S. Menchelli and M. Pasquinucci, 'Ceramiche orientali nell'Etruria settentrionale costiera (II Sec. A.C.-VI Sec. D.C.)', *RCRF Acta* 36 (2000), 371-378; G. Falco, 'La Sicilia ed il Mediterraneo orientale in eta tardo ellenistica: la testimonianza della ceramica Megarese', *RCRF Acta* 36 (2000), 379-386. Pozzino, JS 406; Spargi, JS 420; Apollonia B, JS 240.

149 Serçe Limani B, JS 4; Camarina A, JS 358.

at the very least their own cooking ware, so it is surprising that any coarse ware was transported between regions at all. Various types of cooking ware have been found at Ostia, for example, that were not manufactured locally. Among these is Aegean cooking ware, occurring in the first and second centuries AD, and making up about 10% of the total wares (in the later empire, African wares become the most popular). Aegean cooking ware has been found on land all around the Mediterranean coast from north-west Africa to southern France and the west coast of Italy. The place of manufacture of Eastern Coarse Ware has been confirmed as the same production region as Eastern Sigillata B, i.e. Phocaea in western Asia Minor,[150] but there may well have been other Aegean production centres, as two different fabrics have been analysed. Phocaean coarse ware seems to have monopolized the market, certainly in the eastern Mediterranean, as Athens, which had been producing its own cooking pots up to AD 100, only used imported cooking ware, specifically from Phocaea in the second and third centuries.[151]

There are twelve wrecks where coarse ware pottery has been found with a pretty even spread around the Mediterranean. However, wrecks along the eastern Adriatic coast date only to the second century AD, and Eastern Coarse Ware is the most common pottery found as cargo – ten forms including casseroles, cooking-jars, mugs and pinch-mouthed jugs were found in the Pakleni/Izmetište wreck (an estimated 1,500 pieces of pottery), and an estimated 50,000 pieces including platters, frying pans, and braziers of Aegean origin were being transported in the much looted Viganj wreck; this was the main cargo of both these ships.[152] The Nerezine site on the island of Lošinj may also have been a shipwreck full of pottery, while coarse ware as part cargoes of wrecks have been found off Cape Maharac and Veliki Školj.[153]

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[150] For references, see J. Istenič and G. Schneider, 'Aegean cooking ware in the Eastern Adriatic', *RCRF Acta* 36 (2000), 343, n.42.
[151] J. Hayes, 'From Rome to Beirut and beyond: Asia Minor and Eastern Mediterranean trade connections', *RCRF Acta* 36 (2000), 285-297.
[152] Pakleni/Izmetište, JS 333; Viganj, JS 334.
[153] M. Jurišić, *Ancient Shipwrecks of the Adriatic* (Oxford: BAR International Series 828, 2000), 34-38 and figs.21-36. Cape Maharac, JS 329; Veliki Školj, JS 332.

5.4 CONCLUSION

To answer the question posed in 5.1.3, whether underwater finds match the distribution patterns established on land, the outcome is somewhat mixed. Some products share similar quantitative results, whilst others are very different. Clearly the availability of data can skew distribution maps and as D. Peacock says, "It is all too easy to chart the intensity of archaeological work rather than an ancient phenomenon",[154] but for once, shipwreck evidence has the upper hand since this problem is flattened out, certainly when one is looking at a large number of wrecks in a well dived area such as the south of France. Results are disappointing for some products such as Cretan wine, especially in AC 1, 2 and 3 and also for oil and fish products. Underwater finds for some types of fine ware are also rarer than hoped, although it is interesting to note that a couple of the wrecks were carrying pottery seemingly as main cargo rather than simply being space-fillers. The significant picture that comes out is of relatively modest cargoes of mixed types of amphorae and other products that point to varied itineraries.[155] 'Tramping' continued to be normal practice, although wrecks such as the Punta Mazza with seven types of amphorae and the Skerki Bank D with thirteen types seem to be extreme. By the continued examination of the pottery found in wrecks, there will be better understanding of east-west interactions in general. The demand in Rome and the west for certain products was clearly there, not only amongst the wealthy but also for more ordinary people who enjoyed the variety of goods that the Roman Empire made available to them.

[154] D. Peacock, *Pottery in the Roman World* (London and New York, 1982), 166.
[155] See Chapter 4.9 for routes.

Fig. 5.1 Map showing Hellenistic Rhodian amphorae distribution.

Fig. 5.2 Map showing Imperial Rhodian amphorae distribution.

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Fig. 5.3 Map showing Cnidian amphorae distribution.

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Fig. 5.4 Map showing Coan amphorae distribution.

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Fig. 5.5 Pie charts showing amphora distributions in Rome.

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Fig. 5.6 Map showing Cretan amphorae distribution.

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Fig. 5.7 Map showing Kapitän 2 amphorae distribution.

Fig. 5.8 Map showing amphora distributions in Sicily.

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Fig. 5.9 Drawings of Eastern Sigillata B stamps from the Pakleni/Izmetište wreck.

6. THE PRODUCTION AND TRANSPORT OF ROMAN MARBLE

This chapter about marble aims to show the technological, social and economic circumstances that led to the huge increase in its production and transport during the Roman period. As I have pointed out throughout this study of the transport of goods, the *pax Romana* that allowed peaceful and prosperous conditions throughout the Mediterranean had a huge influence on the movement of commodities. But unlike the trade in foodstuffs, which was necessary to feed the growing population of Rome, marble was a luxury which became one of the symbols of wealth. It is unique as such, to qualify as both a product of an imperially-owned organisation for imperial use and as a commodity for the open market. Whereas the Romans completely transformed the industry of gold in north-west Spain solely for government purposes, one can see a difference in the exploitation of marble in the Eastern Mediterranean between imperial and private use. This chapter aims to demonstrate, by looking at the wrecks, the patterns arising from distinguishing between the concepts of trade versus simple transport of goods, and to distinguish between the three categories into which the transport of marble falls: its movement as part of a cargo of booty or tribute, the transport of imperially owned products for imperial use, and the trade in goods that were made available to the general public. The body of evidence for ships carrying booty is meagre but is important as a reminder for understanding distribution by unspecified means, namely the theory of 'theft' and 'gift', as categorized by Philip Grierson.[1]

As is the case for many other products, during the early Empire, marble was exported mainly to Rome, and there were two periods of great demand; from Augustus onwards there was a huge requirement for columns as part of the Imperial building programme; large blocks of marble were still available from

[1] P. Grierson, 'Commerce in the Dark Ages: a critique of the evidence', *Transactions of the Royal Historical Society* (1958), 123-140.

Luna during the first century AD and so Aegean marble blocks were not yet required from the East; during the second century, however, problems with the silting of the harbour at Luna may have severely restricted the export of its marble. Therafter, Eastern Mediterranean marble became more fashionable for Imperial buildings in both Rome and the provinces, such as Tripolitania, and there was a huge surge from Trajan onwards in the demand for marble building blocks and decorative pieces.[2] At the same time the private market emerged on a large scale, namely in the form of sarcophagi, architectural pieces for residential use and statuary. This increase in production coincided with the re-organisation of marble under Hadrian, possibly as a result of commercial decisions, aiming at specific geographical and economic markets. Figure 1, the map of marble wrecks, clearly reflects these trends; Luna marble features in wrecks heading towards Gaul that are datable to the early Empire, and eastern marble wrecks dominate the second and third centuries, and are mainly found off southern Italy and Sicily, presumably heading for Rome.

Any study of marble needs to consider the material itself, its provenance and geological characteristics and the method by which it was quarried, for these are determining factors for the way the marble was to be exploited as a finished product. But I shall not go into too many details on the technological side as it is the product that ended up in shipwrecks which is of most interest to this particular study. It is enough to give a summary of the major quarry sites and the basic technique used to extract the marble.[3]

6.1 MARBLE-CARRYING WRECKS

Fifty wrecks of ships carrying marble have been found in the Mediterranean so far; most are datable to the first to third centuries AD and only eleven are located to the west of Italy (Fig. 6.1).[4] Marble is one of the few commodities from the ancient world that was non-perishable, so it may seem

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[2] The cultural interests of the emperors such as Hadrian and the Antonines may have influenced taste in marble too. See S. Walker, 'From west to east: evidence for a shift in the balance of trade in white marbles', in N. Herz and M. Waelkens (eds.) *Classical Marble : Geochemistry, Technology, Trade* (Dordrecht, 1988), 187-95.

[3] J.B. Ward-Perkins made a huge contribution to the study of ancient marble. Much of his work has been collected in Dodge, H. and Ward-Perkins B., (eds.) *Marble in Antiquity: Collected Papers of J.B. Ward-Perkins* (BSR London, 1992).

[4] Please refer to the attached map of marble wrecks and the database for each wreck.

surprising that even more wrecks have not been found. Clearly the transport of marble was not a small business, since we can look at any archaeological site on land to see that the amount of marble used for buildings and statues is enormous; instead, we must assume that by far the majority made it to their destination without mishap.

Only four wrecks are dated to the first century BC, the Mahdia, the Antikythera, the Kizil Burun Column and the Tremiti Islands wrecks and the first two of these fall into the theft/gift category.[5] Sixteen ships sank in the first century AD, and another sixteen were wrecked in the second to third centuries AD.[6] The other fourteen are dated only to the Roman period. The problem with marble is that it is un-datable by itself, unlike wood that can be dated through dendrochronology. This means that the thirty-six wrecks that are dated were not carrying marble exclusively but were carrying other cargoes as well, such as amphorae, which can be dated, or other artefacts, such as coins. This corresponds to the theory that compound cargoes were prevalent in the ancient world, although specialized ships did exist too.[7]

There is no doubt that the location of the majority of the wrecks relates in a very significant way to both the origins of the product and its final destination. Obviously ships could sink anywhere, but the fact that so few carrying Aegean marble have been found west of Rome, where scuba diving has been so popular in the last fifty years emphasizes the Roman bias of this eastern Mediterranean commodity. There was a definite change in the contents of the wrecks over time, reflecting exactly what is known about marble from other sources such as literature, epigraphy and land-based archaeology.

6.2 PROVENANCE AND EXTRACTION

The majority of marbles exploited by the Romans came from the Eastern Mediterranean, with only a few from the western part of the Empire: the latter include the famous white marble of Luna and the yellow *giallo antico* from

[5] Mahdia, JS 385; Antikythera A, JS 36; Kizil Burun Column JS 12; Tremiti Islands, JS 346.
[6] First century AD: JS 321, 332, 365, 409, 411, 412, 421, 422, 432, 455, 459, 460, 461, 464, 469, 470; second-third centuries: JS 85, 100, 309, 310, 349, 350, 350, 351, 352, 368, 371, 373, 374, 375, 376, 377, 465.
[7] For a more detailed discussion on compound vs. simple cargoes, see Chapter 9.

Simitthus in Numidia.[8] Coloured marble came from the Pyrénées as well as from Marseille and Glanum in the south of France.[9] In Asia Minor, a large number of quarries were in operation; as many as forty have been found in the area around Ephesus, thirty-eight in the area around Laodicea ad Lycum and fifteen around Aphrodisias.[10] Also in Asia Minor were the important quarries of the Troas, Teos, Docimium and the island of Proconnesus. Teos produced the confusingly named africano and Docimium produced both white marble and the white, purple-veined pavonazzetto.[11] The most famous white marbles in Greece and the Aegean were the white Pentelic marble from Attica, already famous for its use by Pericles for the Parthenon in the fifth century BC, and the white marble from the islands of Thasos and Paros; famous coloured marbles were green cipollino from Carystus near Euboea, verde antico from Thessaly and pastel breccias from the island of Chios.[12] Egypt produced purple porphyry, red granite and white/grey granite from Mons Porphyrites, Syene and Mons Claudianus respectively, and clearly the annexation of Egypt allowed these to become available to a much wider clientele (Figs. 6.2, 6.3 and 6.4).[13] Diocletian's Edict on Maximum Prices of AD 301

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[8] For Luna marble, see E. Dolci, *Carrara: cave antichi* (Carrara, 1980) and 'La localizzazione ed il rilavamento delle cave lunensi', *Quaderni del Centro di Studi Lunensi* 6-7 (1981-2), 47-62; L. Mannoni and T. Mannoni, *Marble. The History of a Culture* (New York; Oxford, 1985). For giallo antico, see H.G. Horn 'Die antiken steinbrüche von Chemtou/Simitthus', in H.G. Horn and C. Rüger (eds.), *Die Numider* (Cologne; Bonn, 1979), 173-80 and G. Röder 'Numidian marble and some of its specialities', in N. Herz and and M Waelkens, (eds.) *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 91-6. *Giallo antico* was one of the first coloured marbles to be imported to Rome: Pliny *HN* XXXVI 8.49 mentions its use as door sills in the house of Marcus Lepidus, 78 BC. In public buildings, one of its first uses was as columns in the late C1st BC portico adjacent to the Temple of Apollo Palatinus (J.B. Ward-Perkins, *Roman Imperial Architecture* (Yale, 1981), 36).

[9] F. Braemer, *Le Marbre des Pyrénées dans la sculpture antique* (Paris, 1973); R. Bedon, *Les Carrières et les carriers de la Gaule Romaine* (Paris 1984), 64-7.

[10] For Ephesus, see H. Vetters, *Ephesus: Vorläufiger Grabungsbericht* 1971, ÖA, CIX 1972, 92. For Laodicea and Aphrodisias, see D. Monna and P. Pensabene, *Marmi dell'Asia Minore* (Rome, 1977), 91.

[11] For Teos and Docimium, see R. Gnoli, *Marmora romana* (Rome 1971), 147-51 and 142 and J. Fant, *Cavum Antrum Phrygiae. The Organization and Operations of the Roman Imperial Marble Quarries in Phrygia* (Oxford, 1989).

[12] For Pentelic marble, see G. Lepsius, *Griechische Marmorstudien* (Berlin, 1890), 13-23 and G. Borghini (ed.) *Marmi Antichi* (Rome, 1989) 251; for Paros, see G. Lepsius, *Griechische Marmorstudien* (Berlin, 1890), 43-52 and G. Borghini (ed.) *Marmi Antichi* (Rome, 1989) 250. For Carystos, see G. Borghini (ed.) *Marmi Antichi* (Rome, 1989), 202-3, for Thessaly, see G. Lepsius, *Griechische Marmorstudien* (Berlin, 1890), 37-40 and R. Gnoli, *Marmora romana* (Rome 1971), 136-8; for Chios, see R. Gnoli, *Marmora romana* (Rome, 1971), 145-6 and G. Borghini (ed. *Marmi Antichi* (Rome, 1989), 264-5.

[13] See R. Gnoli, *Marmora romana* (Rome, 1971), 98-111, 119-122 and 122-4; G. Borghini (ed.) *Marmi Antichi* (Rome, 1989), 274, 225-6.

mentions only nineteen marbles but this list reflects the range of goods available for military purchase rather than that of imperial ownership.[14]

The nature of some types of marble meant that it was difficult to extract large blocks in quantity. Pentelic marble contains large bands of micaceous material leading to difficulty in extracting fault-free blocks so it was often easier to split it off according to naturally occurring beds or planes. Green porphyry from Croceae in the Peloponnese was also hard to extract in anything more than 60cm lengths because its veins of porphyry only emerge on the surface in narrow strips, so it was used mostly for veneering and opus sectile work (Fig. 6.5). The expensive price of 250 *denarii* per square foot in the Diocletian's Edict on Maximum Prices must reflect this difficulty in extraction.[15] Nevertheless, what was needed for high-grade statuary was fault-free stone, an even texture and large enough blocks to produce life-size figures. Therefore it was a rare commodity. The main sources for this were Paros, Mount Pentelicum, Docimium and Luna.

Quarrying methods remained virtually unchanged from Egyptian times to the nineteenth century, when a Belgian engineer, Eugène Chevalier, used a running metal wire and abrasive sand to cut through the marble.[16] Knowledge about the characteristics of marble is still significant today; the skill of the workmen is as important as the development of tools, so even now most quarrymen in Turkey are natives of Marmara (ancient Proconnesus).[17] Some quarries were above ground, some underground, or both, as at Teos and Paros, where its two underground quarries, the Grotto of the Nymphs and the Grotto of Pan, produced the highest quality marble for sculpture. This so-called lychnites, named from the Greek λύχνος meaning lamp,[18] or λυχνίτης meaning a precious stone emitting light, i.e. translucent, is extremely pure, with light being

[14] Chapter 32 deals with stones and marble in M. Giacchero (ed.), *Edictum Diocletiani et Collegarum de pretiis rerum venalium* I, (Genoa, 1974). Also see the Aphrodisias copy of the Edict in K. Erim and J. Reynolds, 'The copy of Diocletian's Edict on Maximum Prices from Aphrodisias in Caria', *JRS* 60 (1970), 120-136.

[15] Chapter 32, lines 11-12 of the Aphrodisias copy of the Edict in K. Erim and J. Reynolds, 'The copy of Diocletian's Edict on Maximum Prices from Aphrodisias in Caria', *JRS* 60 (1970), 120-136. The Edict probably does not take transport costs into account, so these prices must simply refer to the quarry cost. Also H. Dodge, 'Ancient marble studies: recent research', *JRA* 4 (1991), 28-50.

[16] L. Mannoni and T. Mannoni, *Marble. The History of a Culture* (New York; Oxford, 1985), 82.

[17] According to M. Waelkens, R. de Paepe and L. Moens, 'Patterns of extraction and production in white marble quarries of the Mediterranean – history, present problems and prospects' in J.C. Fant (ed.), *Ancient Marble Quarrying and Trade* (Oxford, 1988), 81-116.

[18] According to Pliny, citing Varro, *HN* XXXVI 4.14.

transmitted through it to 35mm, compared to 15mm for Pentelic marble and 25mm for Luna marble.[19] There are two fallacies regarding this marble: it does not come only from underground (Paros-3 quarries above ground also produced some lychnites) and it was not only quarried in small blocks of $1m^3$. New advanced tests on the statue of Augustus from Prima Porta (now in the Vatican) show that this statue of nearly $2m^3$ is indeed carved from lychnites and is not marble from Luna, Docimium or Pentelicum as previously assumed; indeed the shafts at both grottoes are 3m across, an ample width to quarry blocks of this size.[20]

The normal quarrying technique in Roman times was to drive straight into a slope or hillside to form a block shape by producing a square or elongated cut around the edges and behind it. The stone was then split by joints at intervals of no more than 1.5m, either by narrow separation trenches of about 1m deep being laboriously cut around each block, or preferably using iron or wooden wedges along the horizontal bottom edge to split it off. Pointillé was another technique, which involved cutting cylindrical holes closely spaced at the base of separation trenches cut on three sides with a point. Then pressure could be applied from one corner to split it off from the bedrock. This method worked particularly well where stones had a fairly predictable splitting line. Occasionally, both the wedge and the pointillé method were used together, as at Aliki on Thasos. As each horizontal row of blocks was removed, the now sloping face behind it was cut back to the vertical before work on the next row began.[21]

Evidently, there were no great technological advances in the method of extraction, so the huge increase in marble production arose from a two-fold development: a change of ownership of the quarries and an increase in clientele with an insatiable demand for marble and all that it represented.

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[19] According to analysis by G.R. Lepsius, *Griechische Marmorstudien* (Berlin, 1890), 13-23.
[20] N. Herz, 'The classical marble quarries of Paros', and J. Pollini, 'The marble type of the statue of Augustus from Prima Porta: facts and fallacies, lithic powers and ideology, colour and colour symbolism in Roman art', both in D.U. Schilardi and D. Katsonopoulou (eds.), *Paria Lithos – Parian Quarries, Marble and Workshops of Sculpture – Proceedings of the First International Conference of Archaeology of Paros and the Cyclades, Paros 2-5 Oct. 1997* (Athens, 2000), 27-35 and 237-253.
[21] 'Materials, quarries and transportation', (*First Shuffrey Lecture* 1976) in H. Dodge and B. Ward-Perkins (eds.), *Marble in Antiquity: Collected Papers of J.B. Ward-Perkins* (BSR London, 1992), 13-22.

6.3 QUARRY OWNERSHIP

Very little is known about the ownership of Eastern Mediterranean quarries before the first century AD except that they were owned and organised privately, for example, Julius Caesar owned the whetstone quarries in Crete.[22] The green lapis Lacedaemonius quarry at Croceae was also owned privately;[23] while some may have continued to be private property throughout, more often others became imperial owned and it was only in the fourth century AD that private persons were once again granted the right to own quarries, first in Africa, then in Macedonia and Illyricum.[24] Some of the western European quarries were run by the military, particularly in Britain and the Rhine Valley.[25] Others were municipal property: Mylasa in Asia Minor and probably Ephesus and Aphrodisias.[26]

The famous quote of Suetonius about Tiberius taking over the principal quarries and mines of the Roman world may not necessarily be accurate, "*plurimis etiam civitatibus et privatis veteres immunitates et ius metallorum ac vectigalium adempta*".[27] Such a sweeping statement does not reflect the much more gradual acquisition of the quarries; certainly the stimulus behind it was the requirement of marble for imperial building projects (see below for details) but little is known about quarry workings during the first half of the first century AD compared to the high production activity later on in the century. Although it seems that most of the Eastern Mediterranean quarries became imperial property, judging from quarry marks and inscriptions (see below), the whole discussion on quarry ownership is all very uncertain. There is little evidence about Tiberius's motives for expropriating the quarries and in fact, there were some that retained their private status: Herodes Atticus owned the quarry on Mount Pentelicum in the second century AD and exploited it so indiscriminately for his adornment of public buildings, including a race course, that he used up the existing rock

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[22] *Digest* XXXIX 4.15.

[23] Strabo VIII 5.7

[24] *Cod. Theod.* 10.19 *De Metallis et metallariis.* A. Dworakowska, *Quarries in Roman Provinces* (Warsaw, 1983), 25-26; C. Dubois, *Etude sur l'administration et l'exploitation des carrières dans le monde romain* (Paris, 1908), 15ff.

[25] H. von Petrikovits, 'Die Spazialgebäude römischer Legionslager', in *Legio VII Gemina* (Lyon, 1970), 246 f.

[26] Strabo XIV 2.23. See J. Ward-Perkins 'Uso e Commercio in Roma', in *Enciclopedia dell'arte antica classica e orientale IV* (Rome, 1961), 866.

[27] Suetonius *Tiberius* 49.

sources.[28] Certainly some quarries in Asia Minor remained in the ownership of cities, such as Sardis.[29] This fact probably explains why marble from there was not exported very much, being retained instead for local use.

Overall, the main change came in the relationship between the quarry and the client; whereas it had been a direct one in Hellenistic times, it was now routed through officials who organised bulk production of items to be stored in marble yards on site or after shipment. The personnel involved in the operation of quarries were considerable, numbering anything between five hundred and a thousand, if one can believe Christian sources.[30] A *procurator marmorum* was in charge of each quarry and he was probably a freedman or from the military.[31] Army officials often acted as works managers and, being mobile by nature, their experience could be carried from one region to another. The various clerical posts included a *dispensarius*, a *tabularius, commentarii* and other assistants.[32] Lower military personnel were used for engineering purposes, as in Docimium, but the hard labour was carried out by slaves.[33]

Quarry takeovers may or may not have happened at the same time but probably by the end of the first century AD, most of the major quarries were the property of the imperial patrimony and would have been worked by the emperors' officials or leased by them to contractors: the idea of contracting out the work was not mutually exclusive from commercial motivation.[34] The system of outright leasing was standard Roman practice with the formula "*ex ratione*" on early inscriptions form Teos, Docimium, Carystos, Paros and Chios.[35] These accounting records inscribed onto the blocks themselves are the main but limited

[28] Pausanias I 19.7.

[29] D. Monna and P. Pensabene, *Marmi dell'Asia Minore* (Rome, 1977).

[30] According to *Passio IV Coronatorum*, there was a staff of 622 skilled slaves at a quarry near Sirmium. See J.C. Fant, 'The Roman emperors in the marble business: capitalists, middlemen or philanthropists?', in N. Herz, and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 153.

[31] For evidence of procurators, see C. Dubois, *Etude sur l'administration et l'exploitation des carrières dans le monde romain* (Paris, 1908), 174 ff and *CIL* III Suppl.1, 7146, lines 11 f.

[32] See J.C. Fant, 'The Roman emperors in the marble business: capitalists, middlemen or philanthropists?', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 147-158.

[33] See A. Dworakowska, *Quarries in Roman Provinces* (Warsaw, 1983), 99-114.

[34] Compare the practice by the state of contracting out such things as the provision of essential supplies in the Republic.

[35] See J.C. Fant, 'The Roman emperors in the marble business: capitalists, middlemen or philanthropists?', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 147-158.

evidence for imperial ownership from the mid-1st century AD to the mid-2nd century AD. [36] Two types exist; more abbreviated ones that must have been for internal accounting and longer ones which give names of consuls/ *ratio* of x/ block number/ name of *officina*.

The earliest of these occur under Nero, one on a block of africano from Teos, the other on a block of giallo antico from Numidia, both dated to AD 64; there is a possibility of one tentatively dated to AD 17 on some cipollino from Euboea but it is very uncertain.[37] The latest dated mark comes from a block in Docimium of AD 236 and the latest inscription, away from a quarry, is on a Greek marble statue from the Baths of Caracalla dated to AD 206. In Simitthus however, after AD 118, the formula changes to emperor as owner/ block number/ name of *officina*/ names of consuls/ name of procurator (*sub cura*). This may coincide with the Hadrianic re-organisation of the quarry system in the Eastern Mediterranean when white marble, in particular Proconnesian and Thasian, began to replace Luna marble in the architecture of Rome; the first major use of Proconnesian marble in Rome was in the Hadrianic Temple of Venus and Rome, AD 135.[38]

Most inscriptions occur on coloured marbles and Parian marble seems to be the only white one to be inscribed. There are none on marbles from Proconnesus, Luna, Hymettus, or on Troad granite or green porphyry from Lacedaemonia (marks found on blocks from Mons Claudianus were probably only for internal use), nor on verde antico from Thessaly, rosso antico from the Mani peninsula or on pink breccia corallina from North West Turkey. Possibly marble that was part of a more complex trade was not marked in this way at all and had a completely different system; or maybe the marks, especially painted ones, have simply rubbed off. It seems fortunate that any exist at all. From the mid-second century AD, marble was marked with lead seals. Two drums of

[36] See A. Dworakowska, *Quarries in Roman Provinces* (Warsaw, 1983), 27-8.

[37] See J.B. Sard-Perkins, 'The Roman system in operation', *Second Shuffrey Lecture* 1976 in H. Dodge and B. Ward-Perkins (eds.), Marble *in Antiquity: Collected Papers of J.B. Ward-Perkins* (BSR London, 1992), 25, n.16.

[38] See J.B. Ward-Perkins, *Roman Imperial Architecture* (2nd edition Yale, 1994), 123. It seems that the workmen were imported too; the profiles of the order and the decorative mouldings and the manner of the carving all betray the direct influence of Asia Minor.

imported onyx marble recovered in Ostia still bear small circular impressed seals of lead.[39]

6.4 CHANGES IN THE SYSTEM

The *ratio marmorum* certainly facilitated the emperors' building programmes in Rome and was also the single most important factor in creating a truly Mediterranean-wide movement of marble. The increase in production and stockpiling in the quarries and at Rome made the accounting system essential to track what was where at any given point. As J. B. Ward-Perkins points out, the relationship between the customer and the quarry changed in such a way that the customer could now place an order at any of the 'agencies' which must have been in business in all the large importing centres. Inscriptions show that such was the popularity of some of the coloured marble that a number of subsidiary quarries in the Upper Tembris Valley at Altintaş, Çakirsaz and Obruk Tepe were opened up as part of the imperial system.[40]

J.C. Fant puts forward the theory that by the second century AD the quarry system began to be more obviously commercial, not necessarily because of high demand but rather because of a general imperial attitude towards money; he believes that the re-organisation arose partly from what had been learned during the stressful decades of high requirement and partly from a new mentality which looked for a way to re-direct government output into commercial channels.[41] Certainly it is true that there was a great increase in production in the late Flavian/early Antonine period when both the Proconnesian and Docimium quarries became business enterprises with specifically designed products aimed at particular markets, rather than just providing the emperors with the marble they owned anyway.[42] Indeed Proconnesian marble had supplanted the local white

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[39] A number of such seals are recorded by L. Bruzza, 'Iscrizioni dei marmi grezzi', *Annali dell'Instito di Correspondenza Archeologica* 42 (1870), 106-24. Also see P. Baccini Leotardi, *Nuove Testimonianze sul commercio dei marmi in eta imperiale* (Rome,1989), 109-14.

[40] J.C. Fant, *Cavum Antrum Phrygiae: the Organization and Operations of the Imperial Marble Quarries at Docimium in Phrygia* (Oxford: BAR International Series 482, 1989).

[41] J.C. Fant, *Ancient Marble Quarrying and Trade*, (Oxford: BAR International Series 453, 1988) and 'The Roman emperors in the marble business: capitalists, middlemen or philanthropists?', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 147-158.

[42] For products designed for and aimed at specific geographic markets, see N Asgari, 'Roman and Early Byzantine marble quarries of Proconessus', in *Proceedings of the Xth International Congress of Classical Archaeology, Ankara* (1973), 467-480 for Proconnesus; for Docimium, see

marble of Luna by the second century and was used in the great public buildings of the Temple of Venus and Rome (AD 135), whose decorative work is clearly eastern influenced,[43] likewise the Hadrianeum (AD 139-145), the Arch of Septimius Severus (AD 203) and in the Hadrianic Capitolium in Ostia (AD 120).[44]

Another aspect of this so-called commercialisation of the marble trade was an apparent standardisation of the products. Blocks of veneer were produced in standard form so that sheets could be sawn off without waste. A certain number of standard lengths for columns were introduced and are attested by inscriptions as well as by the high percentage of actual columns that are exact multiples of the Roman foot: for example, the columns of the pronaos of the Pantheon were made of two types of Egyptian granite, red from Aswan and grey from Mons Claudianus, all of which are 40 Roman feet in length instead of 50 feet which was the original plan. Other examples include columns of 16, 20 and 24 Roman feet as standard features in Leptis Magna. The cipollino columns of the Temple of Antoninus and Faustina in the Roman Forum are 39 Roman feet, maybe because one had a fault and the rest had to be adjusted accordingly. It would certainly have been easier and cheaper for the quarries to work to specific lengths for which there was an assured market rather than offering a made-to-measure service.[45] Also architects would have been able to plan dimensions more easily knowing that standard lengths not only existed but were also readily available.

Who wanted marble? And how do the wrecks reflect this? The three categories mentioned above will be examined in turn with the corresponding underwater evidence starting with those dating from the first century BC.

J.C. Fant, *Cavum Antrum Phrygiae: the Organization and Operations of the Roman Imperial Marble Quarries in Phrygia* (Oxford: BAR International Series 482, 1989)and M. Waelkens 'Production patterns of sarcophagi in Phrygia', N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 139-44.

[43] See note 26.

[44] See S. Walker, 'From west to east: evidence for a shift in the balance of trade in white marbles', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 187-95; '*Dignam congruentique slendori patriae*. Aspects of urban renewal under the Severi' in M. Henig (ed.), *Architecture and the Architectural Sculpture in the Roman Empire* (Oxford, 1990), 139.

[45] Marble being worked into sarcophagi shapes in Thasos were of two sizes: the ones for export used dimensions based on the Roman foot, 29.42cm, while those for local use used the local foot measurement of 32.53cm, T. Stefanidou-Tiveriou, 'Thasian marble: a connection between Thasos and Thessaloniki', in *Abstracts from ASMOSIA VII, Conference September 2003 in Thasos* (Thasos, 2004), 1-13.

6.5 MARBLE IN THE REPUBLIC – PRIVATE USE AND BOOTY

Already by the late Republic, marble was associated with luxury and this in turn was the most obvious show of wealth and power that there was. As J. Fant points out, "marble made a particularly appropriate symbol of wealth and power because it was expensive, imported and unnecessary (especially in a land endowed with great building stones like piperno and travertine)."[46] Rome's role as the controlling force of the Mediterranean world needed to be expressed visually as well as politically and there was no better way than to build monuments that could rival the glory of the previous Hellenistic rulers. Rome's annexation of Greece in 146 BC would have opened up access to Greek marble quarries, especially the Pentelic ones near Athens: evidence of this can be seen in Rome in the Round Temple of the Forum Boarium, and the Temple of Jupiter Stator in the Circus Flaminius of 146 BC, built for Quintus Caecilius Metellus Macedonicus by the architect Hermodorus of Salamis.[47] Pliny accuses Lucius Crassus of being the first private person to install foreign marble in his house on the Palatine, although the columns were merely made from Hymettus marble from Athens (common?) and were only six in number and 12 (Roman) feet long.[48] He also accuses Lucullus of being amongst the first politicians to import marble (africano from Teos) to Rome in 74 BC; this may have been the result of looting or gifts from the time he spent in charge of Asia.[49]

The study of mosaic pavements with marble inserts from two private houses in Rome shows the extent to which the eastern market was opening up in terms of type and quantities of marbles. From the late Republican house, the Domus below the Ludus Magnus, 115 fragments of marble (more than ⅔ of the total) have been examined: they are made of alabaster and giallo antico predominantly, followed by africano and porta santa from Chios, then lumachella orientale, pavonazzetto and bardiglio, with a total absence of white marble; the second study is of the enormous pavement of the peristyle in the Villa Volusi at -iorum

[46] J.C. Fant, 'The Roman emperors in the marble business: capitalists, middlemen or philanthropists?', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology and Trade* (Dordrecht 1988), 147-158. Even Strabo sounds vaguely critical of the import of marble, describing the opening up of a large quarry in Taygetus as being supported by the extravagance of the Romans, τὴν τῶν 'Ρωμαίων πολυτέλειαν VIII 5.7.

[47] Velleius I, 11,5 *hic idem primus omnium Romae aedem ex marmore in iis ipsis monumentis molitus, vel magnificentiae vel luxuriae princeps fuit.*

[48] Pliny *HN* XXXVI 3.

[49] Pliny *HN* XXXVI 8.

Lucus Feroniae of 10 BC-AD 20 where more than a thousand fragments were examined. Porta santa dominates, while alabaster is absent, with plenty of giallo antico and fine white marble in large quantity (15%). Interestingly there are many more types of coloured eastern marble than in the first house, albeit in sometimes small quantities (pavonazzetto, bardiglio, cipollino, rosso antico, breccia di Aleppo, green Greek porphyry and coloured limestone)[50]. However, larger sheets of marble were still beyond the reach of private people during the Republic and early imperial age, in spite of their great wealth: even the owners of the great villa of Oplontis, rather than using sheets of veneer, had to make do with finto marmo walls and dados of breccia coralline as signs of their power and position. By the late Empire, when marble had fallen into decline but was still a symbol of wealth, private houses often had walls painted to give the effect of marble opus sectile, (compare the Pompeian First style wall paintings in the second century BC). Although demand must have been great for these decorative marbles from the East, they were just not readily available to the public, however rich. Marble statuary was obtainable, however, as can be seen from the following wrecks.

Two wrecks in particular are relevant at this point, both falling into Grierson's theft/gift category. The Mahdia wreck found at the turn of the twentieth century by sponge divers lies in 40m of water off Tunisia and is dated to 110-90 BC.[51] It contained a large cargo of seventy Attic columns, bases and capitals weighing in total about 205 tons. The columns are rough and not yet fluted but a number of the capitals and bases are completely finished; these are considered to be the ship's main cargo. Also found amongst the marble were full size and miniature sized bronze figures, marble candelabra and craters and other decorative pieces, altogether a fantastic collection of treasures. It is thought to have been the property of a senatorial collector who, possibly like Lucullus, had spent some time in the Eastern Mediterranean gathering these artefacts, either honestly or as seems more likely, by looting. Several inscriptions refer to the sanctuary of the *paraloi* in the Piraeus, and the bronze statue of a winged youth showed traces of having been removed from its marble base, suggesting a

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[50] See F. Guidobaldi and A. Salvatori, 'The introduction of polychrome marble in late Republican Rome: the evidence from mosaic pavements with marble insertions', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology and Trade* (Dordrecht, 1988), 171-5.

[51] JS 385.

connection with the plundering of Athens by Sulla's army.[52] A series of seven life-sized marble busts, originally thought to have been the heads of statues, are now regarded as tondi, i.e. busts to be fixed in round niches that must have been removed from a sanctuary. Most of the other decorative marble pieces seem to be products of the neo-Attic workshops in Athens, for example, the four statues of a group of boys intended to decorate a fountain; copies of the same prototype have been found in the grotto of Sperlonga, indicating mass production. Although the ship was wrecked off Tunisia, one can only assume that it was blown off course from its final destination of Italy.[53]

The other wreck in this group is the Antikythera which sank in 80 BC or later, in 50m off the south-western coast of Greece.[54] As well as between seventy and eighty Rhodian, Coan and Lamboglia 2 amphorae, the ship was carrying a huge consignment of works of art; many of the thirty-six marble statues are copies of bronze originals of the fourth to second centuries BC, most of which are unknown.[55] There were also contemporary works of art, fine and coarse pottery, a bronze bed, glass vessels, jewellery, and ingots. The wreck has been dated by an astronomical computer and coins. The piles of coins from Pergamum of 88-86 BC indicate that the cargo probably formed part of the booty which Pergamum sent to Rome after the Mithridatic War.[56]

6.6 MARBLE IN THE EMPIRE

The majority of marble was transported by the emperors for their vast building programmes in Rome and the provinces. This was facilitated by the imperial takeover of the quarries enabling an increase in production.[57] It is evident from the architecture in Rome (and distribution maps[58]) that there was a flood of most types of Eastern Mediterranean marble to Rome; the first architectural evidence for marble from Docimium in Phrygia comes from the

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[52] See Chapter 7.4.
[53] The most comprehensive report is G. Salies (ed.), *Das Wrack: Der Antike Schiffsfund von Mahdia* (Cologne, 1994).
[54] JS 36 and Chapter 7.2 and 7.4.
[55] Compare the works of art cargo of the Artemision wreck, JS 34 and Chapter 7.4.
[56] See G. Weinberg et al, 'The Antikythera wreck reconsidered' *TAPhA* 55 (1965), part 3.
[57] See pages 6-7.
[58] See Fig. 6 and the map attached to this chapter, as well as maps in J.B. Ward-Perkins, 'Nicomedia and the marble trade', *PBSR* 48 (1980), 23-69 and in H. Dodge, 'Ancient marble studies: recent research', *JRA* 4 (1991), 28-50.

Forum of Augustus for the paving of the Temple of Mars Ultor completed in 2 BC; Pliny singled out the Basilica Aemilia, which includes columns of Phrygian marble, as one of the wonders of the world, built either as part of restoration after a fire in 14 BC or as part of the renovation of AD 22.[59] He also praised the floor of the Basilica Julia and Vespasian's Templum Pacis. Egyptian marble was first seen in Rome under Claudius when his official agent, Vitrasius Pollio, following large scale quarrying, brought statues of imperial porphyry to Rome "an innovation that did not meet with much approval."[60] Indeed, Pliny himself did not approve of any marble;[61] as one of the materials of '*luxuria*', he associated it with the moral decline of the Republic. Augustus's boast that he had found Rome a city of bricks and left it as one of marble is not an empty one[62]: nearly all the known uses of marble in this period were precisely for imperial buildings. For example, the Temple of Concord in the Forum used five types of marble: on the threshold of the cella were two blocks of porta santa 7.32m wide, and slabs of pavonazzetto, cipollino, africano and giallo antico were used for veneering.[63]

Sixteen wrecks can be firmly dated in the first century AD but of these, ten were carrying marble from the Italian quarry of Luna presumably to Gaul, rather than eastern marble to Rome. The Porto Novo wreck, in 10m of water off Corsica, is dated to AD 27 by a coin of Tiberius.[64] The interesting aspect of this wreck was the discovery of sets of stone-working tools (Fig. 6.7); feminine personal items such as three mirrors and a bronze strigil were also found along with a decorated sword and buckle. Some slabs of badly-finished coloured veneer from a variety of sources (Chemtou, Teos, Chios and Carystos), as well as black and white quartz from Egypt, may have been left over from previous journeys,

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[59] Pliny *HN* XXXVI 24.102.
[60] Pliny *HN* XXXVI 11.58.
Small quantities were known earlier when Caligula used some for the pavements of the barges in Lake Nemi.
[61] Judging by his remarks, Pliny *HN* XXXIX 1-9.
[62] Suet. *Augustus* XXVIII 3.
[63] H. Rebert and H. Marceau, 'The Temple of Concord in the Roman Forum', *MAAR* 5 (1925), 53-79.
[64] JS 432. Another is the St. Tropez wreck which contained 12 large pieces of column drums, bases etc, with a total estimated weight of 200-300 tons, JS 464. The only wreck off the south of France carrying marble that was not from Luna is the Dramont I; three blocks of africano marble were found with a total weight of only 23 tons, but there was also a cargo of several hundred kilos of corundum, a very hard and heavy mineral probably from the island of Naxos, JS 459.

which suggests that the ship could have been a specifically designated marble carrier, with military and female personnel on board.[65]

Two other wrecks of the first century are interesting in that they too, seem not to have been heading towards Rome. The very deep Skerki Bank wreck F off Sicily was carrying such a variety of items, from Spanish, African and Pompeian amphorae to North African ceramics, together with two layers of marble building stones and monolithic columns, that it is impossible to guess the final destination of the ship or even the origin; the stone may be red granite from Aswan, or grey granite from the western Mediterranean (Fig. 6.8).[66] The other is the Margarina wreck, Croatia, carrying unfinished blocks and twenty white columns, presumably heading to somewhere in the Adriatic; at over 30 tons, this is largest stone cargo found on the eastern Adriatic.[67] It is surprising that there are not more column wrecks in the vicinity of Italy although the Capo Taormina wreck off Sicily with thirty-seven columns and the Capo Cimiti wreck off Italy with five possibly cipollino columns, are assigned simply to the Roman period, so may well have been carrying columns to Rome.[68]

Imperial construction projects still dominated quarry exports throughout the second and third centuries AD; Rome was not only importing columns but blocks and architectural pieces too. The wrecks reflect this increase with many of them loaded with heavy cargoes of marble. The changes in the marble trade that led to bulk production meant that many objects were produced to a so-called quarry state, i.e. a partly finished product that could be completed by the client or at least at the centre to which it was being imported (Fig. 6.9). Fully finished products were seldom shipped out from quarries in the first two centuries AD, although there was a slight change in the third century with fully finished columns and bases. These part-finished products included columns, sarcophagi, slabs of veneer, furniture and statues which could be stock-piled at both the producing and receiving ends (see below, 6.8). Skilled craftsmen and sculptors travelled widely throughout the Mediterranean from the East, settling in areas which imported marble. Aphrodisian sculptors are known to have lived in

[65] H. Bernard et al. 'L'épave romaine de marbre de Porto Novo', *JRA* 11(1998), 53-81
[66] JS 365; A. McCann and J. Oleson, *Deep water Shipwrecks off Skerki Bank: the 1997 Survey* (*JRA* Supp. 58, 2004), 90-117.
[67] JS 321; M. Jurišić, *Ancient Shipwrecks of the Adriatic* (Oxford: BAR International Series 828, 2005), p 69.
[68] Capo Taormina, JS 376; Capo Cimiti, JS 354.

Greece, Sicily and Crete, with a colony established in Rome.[69] Tripolitania was relatively late in importing marble in the second century, but even here marble traders arrived in earnest and we find a statue of Artemis near the amphitheatre of Leptis Magna remarkably similar to that in the Temple of Artemis in Ephesus. These travelling artisans were responsible for the widespread distribution of designs such as the medallions featuring a gorgon's head that are found in Didyma and Leptis.[70] Several inscriptions attest the presence of Bithynian and Phrygian marble workers in the provinces of Tripolitania and Thracia.[71] An inscription exists in Leptis Magna written by Asclepiades, a marble worker from Nicomedia.[72] Marks of individual masons found on other stones in Leptis, invariably in Greek, and specifically on lotus and acanthus leaf capitals of the Severan period, show the presence of Greek sculptors too.

6.6.1 Columns

Columns were exported in first and second processing stages with projecting collars at either end, seen for example in the Punta Scifo wreck and at Simitthus, Carystos and Mons Claudianus[73]. These collars protected the stone during the journey which might otherwise have led to the column being unusable on arrival. Egyptian granite and porphyry seem to have left quarries in a more advanced stage, doubtless because they were a harder material and less likely to break. A Republican wreck of the second to first centuries BC, to be set alongside the material above, is the Kizil Burun wreck off the coast of Asia Minor; it was carrying eight Proconnesian marble column drums averaging about 1m tall and ranging in diameter from 1.5 to 1.7 metres.[74] This incremental graduation suggests that the eight drums and one capital comprise a single column over 9

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[69] For Aphrodisian sculptors in Greece, Sicily and Crete, see D. Monna and P. Pensabene, *Marmi dell'Asia Minore* (Rome, 1977), 94-8; for the Aphrodisian colony in Rome, see M. Squarciapino, *La Scuola di Afrodisia*, (Rome, 1943); for overseas craftsmen in Leptis Magna, see J.B. Ward-Perkins, 'Tripolitania and the marble trade', in *JRS* 41 (1951), 89-104.

[70] See M. Ballance and O. Brogan, 'Roman marble – a link between Asia Minor and Libya', in A.S. Campbell (ed.), *Geology and History of Turkey* (Libya, 1971), 33-38.

[71] See J.B. Ward-Perkins, 'Nicomedia and the marble trade', *PBSR* 48 (1980), 23-69 and in H. Dodge and B. Ward-Perkins (eds.), *Marble in Antiquity: Collected Papers of J.B. Ward-Perkins* (BSR London, 1992), 61-105

[72] *IRT* 264 in J.B. Ward-Perkins and J. Reynolds, *Inscriptions of Roman Tripolitania* (London, 1952).

[73] According to P. Pensabene, 'A cargo of marble shipwrecked at Punta Scifo near Crotone', in *IJNA* 7.2 (1978), 105-118. Punta Scifo, JS 350.

[74] Kizil Burun, JS 12.

metres tall. The stone was newly quarried as the drums are not fluted and still preserve traces of corkscrew-shaped hoisting grooves. A group of large rectangular marble blocks which probably represent architectural elements associated with the column were also found. The area around this wreck also yielded an interesting array of newly-quarried, roughly-finished marble objects such as a small hand basin, the pedestal for one of two larger basins, and an uninscribed grave stone or stele. Other wrecks containing columns include the already mentioned Capo Cimiti with five columns 8m long or less, lying parallel, of green, white or cipollino of uncertain provenance;[75] the Torre Chianca with five cipollino 9m columns weighing about 120 tons[76] and the Methone C, AD 200, with nearly thirty fragments of pink Egyptian granite columns, some still in the stacked position as they would have been on the ship (Fig. 6.10).[77] It is thought that the columns of the Methone C wreck came from a ruined building, not straight from the quarry, as they all have irregular breaks and were probably broken when the building collapsed. Other column wrecks include the Camarina A with two 20 foot giallo antico columns AD 175-200;[78] Capo Taormina with not only thirty-seven columns but also two blocks of green marble;[79] Paros with two hundred and seven marble objects, including unfluted columns and architectural blocks, as well as cinerary urns, some complete and inscribed, a pediment crowning a funerary stele, a lion's foot, sarcophagus lids, two Doric capitals, the head of a marble statue and the torso of a small statue of Artemis;[80] and also Sidi Ahmad with two long columns of white marble with green veins.[81] The Giardini Naxos wreck of the third century AD contained twenty-four columns of cipollino, blocks of cipollino and thirteen rectangular blocks of white/grey Aegean marble. Interestingly, they too must have been loaded all at the same time as they are regularly aligned and stacked randomly on two levels. The grounding must have been fairly rough though as two of the columns are broken (Fig. 6.11).[82]

[75] Capo Cimiti, JS 354.
[76] Torre Chianca, JS 351.
[77] Methone C, JS 310.
[78] Camarina A, JS 368.
[79] Capo Taormina, JS 376.
[80] Paros, JS 85.
[81] Sidi Ahmed, JS 386.
[82] Giardini Naxos, JS 374.

6.6.2 Blocks and Architectural Pieces

Ships that were carrying other marble products include the Marzamemi A, AD 200-250. Its main cargo was Attic grey/white marble of fifteen blocks, some partly shaped as columns or architraves with one block weighing a huge 40 tons and a total weight of 172 tons.[83] Even more impressive is the 350 ton find at Isole delle Correnti containing white marble with blue streaks, possibly Proconnesian or other Asiatic.[84] Another large wreck, Sapientza, had a 300 ton cargo of slabs;[85] one of the two wrecks at Capo Granitola of ca. AD 225 carried over 60 blocks, measuring approximately 3m x 1m x 1m in 8 files and weighing about 350 tons.[86] Some of the Proconnesian marble was in trapezoidal form and between the blocks were chips of verde antico, Parian and other Asiatic marble, presumably the remains of previous voyages, which like the Porto Novo wreck, could point to a system of specialized stone transport. Some salvage work seems to have taken place in antiquity. The other wreck at Capo Granitola carried a cargo of Corinthian and Ionic capitals and plinths, also of white marble with blue veins.[87]

Architectural decorative pieces were also pre-fabricated to a certain extent before export, mainly because of a need to reduce the weight from a starting block of about 40 tons for a Doric capital, to something nearer the final 12-ton figure. Partially carved distribution of this kind is clear from looking at architraves with friezes in Palestine, an area which had no marble quarries of its own, and comparing them with finds from Ephesus and Side in Asia Minor and Leptis Magna.[88] In the same way, carved and moulded fragments of cornices from Caesarea and Scythopolis have almost identical designs and decorations to those from Side, Perge and Leptis Magna. Local artisans could then go on to copy the designs in the local stone, as they did for sarcophagi that have been found in Qedesh, Upper Galilee.[89] The same applies to column capitals, mostly Corinthian, found all over the eastern Mediterranean, that again were created in central workshops in Asia Minor. These came to represent the imperial side of official

[83] Marzamemi A, JS 371.
[84] Isole delle Correnti, JS 375.
[85] Sapientza, JS 311.
[86] Capo Granitola A, JS 373.
[87] Capo Granitola D, JS 377.
[88] See M. Fischer, 'Marble imports and local stone in the architectural decoration of Roman Palestine: marble trade, techniques and artistical taste', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology and Trade* (Dordrecht 1988), 161-70.
[89] Ibid., 163.

architecture, since they must have been ordered by the provincial or municipal administration to decorate important monuments, for example the Hadrianeum of Caesarea, and the Basilica of the forum of Askalon. For less important locations, local artisans could copy and incorporate their own designs on to local stone, for example, the use of the Syrian acanthus leaf in Palestine, or they could complete semi-finished imported marble in their own style. In spite of the fact that some provincial inland centres were using marble extensively, others, Palmyra for instance, used it mostly for veneer, either because it was too hard to transport safely overland and/or because of the expense involved. Similarly, London, Colchester and even Fishbourne also limited their use of marble to veneer.

Other objects that were exported partially or fully finished include tables and stands, fountain basins, and mortars and bowls from Egypt and Docimium: for example, a partially finished bowl found in Portus (Fig. 6.12) and two baths of Egyptian granite found in the Baths of Caracalla, which are now fountain basins in the Piazza Farnese in Rome. In Simitthus, a sort of production line for bowls and dishes has been found, where the rough blocks came out as finished pieces at the other end. There is no doubt as to the important role which marble architecture, imported from certain workshops, played in the creation of these provincial centres. Centralized art was an instant show of Roman rule; whether it was intended or not, the transport of marble developed in such a way that this was the outcome.

6.7 PRIVATE USE

The re-organisation of the quarry system in the second century opened up the market to the private sector, the evidence for which is considerable and varied. The use by individuals of marble that had formerly been restricted to Imperial building projects was also a way of expressing favoured status and a close relationship with the Imperial family, and there was symbolic meaning even in the types of marble used (see below, the Casa dei Vettii).

Many wrecks contain marble pieces that must have been exported for private purchase rather than as imperially-owned objects intended for imperial buildings. Sarcophagi are seen in wrecks for the first time from the second century AD, and these can only have been considered as objects for sale to the public. Six ships were carrying sarcophagi and they all date to this period, although again, it is surprising that more have not been discovered.

Two of these wrecks are the Methone D off the Peloponnese and San Pietro off Italy. Methone D dates to the second to third century and contains four unfinished garland sarcophagi made of volcanic Assos stone, decorated with a simple motif (Fig. 6.13). Their lids lie underneath them in a heap.[90] Compare others found on land in Ravenna, Beirut, Alexandria and Nicopolis in Epirus. The San Pietro wreck at a depth 3-6m dated to AD 200-225, contains twenty-three sarcophagi, some left double, and some with lids, of fine crystalline white stone from Aphrodisias or Proconnesus.[91] Some are just hollowed out, some are rectangular, some are oval on the inside and rectangular on the outside and some are oval both inside and outside, with a likely weight of 150 tons. It is interesting that there are only two mixed cargo wrecks containing sarcophagi, the Torre Sgarrata, and Şile: the Torre Sgarrata, found in only 6m of water, dates from AD 180-205 and had on board eighteen roughed out sarcophagi filled with marble veneer sheets, alabaster from Asia Minor, twenty-three huge white marble blocks, one big column and sarcophagi from Thasos; the ship was very sturdily built because, in spite of the weight of cargo, approximately 250 tons, the hull was well preserved.[92] The Şile wreck of AD 100-125 held a huge amount of marble: two 10 foot long breccia columns in a finished state, a large block of green possibly verde antico marble from Thessaly, and in Proconnesian five Ionic capitals half finished, column bases, two large blocks and a plaque.[93] Some are roughly quarried, some are semi-finished. There was also a half-finished colossal statue of a cuirassed emperor 4.5m high, a large female bust, a sarcophagus lid, stele and two bowls. It is not certain that the columns, capitals and bases are supposed to go together, as they do not fit each other but there may be other pieces still buried in the sand.[94]

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[90] Methone D, JS 306.
[91] San Pietro, JS 352.
[92] Torre Sgarrata, JS 349.
[93] Şile, JS 100.
[94] For the Şile wreck, see M. Beykan, 'The marble architectural elements in export-form from the Şile shipwreck', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology and Trade* (Dordrecht 1988), 127-137.

6.7.1 Sarcophagi

Sarcophagi and other architectural elements were usually exported hollowed out and with some kind of design already blocked out and carved in low relief, as the wrecks verify. Those from Docimium were often in a more finished state, probably to reduce the weight and therefore the expense of overland travel.[95] Proconnesus exported three types of sarcophagi to suit particular markets: the massive gabled form exported to the Danube, Adriatic, western Italy and Provence, which was hollowed out, shaped and roughly dressed, then finished in a variety of styles on arrival; the pedimental gable, found almost exclusively in Syria, which was taller and more elegantly shaped, although rather plain except for the gabled ends with pedimental panels decorated with rosettes or Medusa heads; the last type was the Proconnesian garland sarcophagus, again for Syria and also Alexandria, with a design of three garlands supported by *putti* or animal heads along the two long sides, and a single garland at each end. Rosettes or heads decorated the area above the garlands and hanging below them were bunches of grapes.

Other centres also produced sarcophagi: from Assos came the volcanic stone *lapis sarcophagus*, that was unattractive but presumable popular due to the belief in the flesh-eating quality of the stone, found in northern Italy and particularly in Alexandria (as found on the Methone D wreck, above). Pentelic white marble from Attica was used too in varying states of finish; it was the only marble that Aquileia, parts of Greece south of Thessalonica and Cyrenaica imported, and was part of a shared market of marbles exported to Syria, Asia Minor and the rest of Italy (Fig. 6.4). Many of these designs were copied by local craftsmen in stone that was available in the vicinity as a cheaper option. For example, in Arles, where five sarcophagi of imported stone have been found, one is of Pentelic marble and another Proconnesian with twisted columns and a Medusa head. The others show that locals worked their own designs on the imported marble, as the execution is heavy and geometric designs were used.[96] The designs of these sarcophagi indicate an existence of an efficient commercial

[95] Sarcophagi lids were also roughed out; see J.C. Fant, 'Four unfinished sarcophagus lids at Docimium and the imperial quarry system in Phrygia', *AJA* 89 (1985), 655-662.
[96] V. Gaggadis-Robin, D. Kavoussanaki, E. Dostika, Y. Maniatis, 'Provenance investigations of some marble sarcophagi from Arles', abstract from *ASMOSIA VII, Proceedings of the Seventh International Conference of the Association for the Study of Marble and Other Stones in Antiquity, September 2003 in Thasos* (2004), 13.

network operated through agencies; how else would Alexandria have exclusively imported Proconnesian types and Cyrenaica exclusively Attic ones?[97] There are no imperial epigraphic records concerning sarcophagi or architectural decorations, therefore it is safe to assume that their transport remained in private hands and that Alexandrians and Cyrenaicans were given no choice for their sarcophagi. It is interesting to note that sarcophagus lids were often made of Luna marble, at least when found in Italy, presumably to reduce their overall cost.

A more unusual display of wealth can be seen in the choice of garden furniture of the Vettii family in Pompeii. An analysis of twenty samples taken from basins, tables and supports has found that there was a wide variety and a large quantity of marbles, chosen with the implicit assumption that other cultivated Romans would be able to recognize them. Seven pieces of Pentelic marble were placed at axial points in the courtyard, highlighted by a large table; eleven pieces of Paros-2 were also exhibited prominently, including a line of basins extending into the garden from the north side. Other marbles came from Luna, Thasos and Proconnesus in the form of round basins and large circular tables.[98]

6.7.2 Statuary

Several wrecks contained marble statues, some of which have already been mentioned, and most of them relate in date to the trade that commenced in the second century. There was a huge increase in the demand for life-size statues across the whole Mediterranean region during the Roman period, as more people wanted to show off their wealth. Marble was a cheaper medium than bronze in which to make statues: statuary that had previously been reserved only for images of gods and emperors due to the high price of bronze was now expanded, so that local dignitaries and the wealthy could be immortalized in marble; also, regions which did not have ready access to bronze were now able to participate in this phenomenon. However, the use of marble was a compromise in that it lacked the

[97] See J.B. Ward-Perkins for monopolies in 'Nicomedia and the marble trade', *PBSR* 48 (1980), 23-69 and in H. Dodge and B. Ward-Perkins (eds.), *Marble in Antiquity: Collected Papers of J.B. Ward-Perkins* (BSR London, 1992), 61-105.

[98] J.C.Fant, S. Cancelliare, L. Lazzarini, M. Martinez and B. Turi, 'White Marble at Pompeii: Sampling the Casa dei Vettii', in L. Lazzarini (ed.), *ASMOSIA VI – Proceedings of the Sixth International Conference of the Association for the Study of Marble and Other Stones in Antiquity', June 15-18, 2000* (Venice, 2003), 309-317.

well-defined style and detail to be found in bronze. Although marble was at the lower end of the luxury market, high grade marble was needed for statuary as it had to be evenly textured, without fault lines and large in size, all in all a rare piece of marble indeed. The quarries that could produce this were Paros, Mount Pentelicum, Docimium and Luna; purple and cream pavonazzetto from Docimium was well suited to draped statues while purple porphyry from Egypt was popular for imperial statues and rosso antico from Cape Taenarus for satyr statues. Secondary sources, from which only adequate grade marble could be extracted, included Thasos, Naxos, Ephesus, Aphrodisias and possibly Filfila in Algeria. Due to the fact that demand for large blocks was greater than its availability, sculptors usually had to use two pieces of marble and join them up: this could be two halves or separate heads, arms or front parts of feet. It was a difficult process to do, due to the weight distribution and the attempt to keep the joins hidden, and few ancient add-ons remain intact. However it did allow the sculptor to tailor the pose to suit the client. It was also cheaper if they used poorer quality marble for the body, which probably would have been painted, saving the good quality marble for the face, hands and feet, as, for example, the female statue from Magnesia on the Meander or the head of a young man, made of Parian marble but coloured and gilded from the Horti Laniani, Rome (Fig. 6.14).[99] A common practice was also to wax marble in order to protect its surface and give a smoother, more translucent finish.

The development and growth of the marble market had an effect on the production of statues: early on in the Empire semi-draped heroic nudes had to be made in two halves, but from the end of the first century AD, full nudes made from one piece were being sculpted, i.e. the production caught up with the demands of the market. During the first century, about 90% of statues had attached heads and this figure dropped to about 55% in the second century: the size and quality of available blocks improved dramatically and statues could now be carved to include elaborate plinths.[100] Not only could they be much larger, but an open-legged stance with a sense of movement was now possible, rather than the tightly contained pose of earlier times. The weight of the arms continued to be

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[99] A. Claridge, 'Roman statuary and the supply of statuary marble', in J.C. Fant (ed.), *Ancient Marble Quarrying and Trade* (Oxford: BAR International Series 453, 1988), 139-52.
[100] Ibid.

a problem though and struts began to appear to hold them up. It seems that 'mail-order' statues were also known. Arrian's letter to Hadrian, written when he was governor of Cappadocia in AD 131-2, shows how the local work in Trapezus was not up to scratch and that he was requesting replacement statues.[101]

The wreck at Lixouri off Cephalonia contained six marble statues including three male nudes, a draped female and a seated male, all headless, and six architectural fragments of two Ionic capitals and four column bases.[102] We cannot tell whether the statues were carved headless to start with, or whether the heads came off during the ship's landing on the bottom.

The Punta Scifo A wreck discovered near Crotone in the early twentieth century dates to about AD 200, and went down with an example of almost all the products mentioned.[103] The marbles lay in an area 50m x 50m and seemed divided into two groups 'almost as if the ship were broken into two, which is not rare in shipwrecks'.[104] It held a mixed cargo of pavonazzetto and white marble from Docimium and some grey/white marble from Proconnesus in the form of eleven columns, five basins, five altars, blocks, capitals, bases, tables including a complete one measuring 2.1m x 1.05m, and a statuary group of Cupid and Psyche, in roughed out, semi-finished and finished pieces. The statue of Psyche, for example, has a cloak and hands that are not fully carved and Cupid's legs have been left thick to avoid breakage. The columns have been cut to standard lengths of 20 Roman feet and 12 feet with protective collars; basins and stands are very nearly finished except for the a final polishing (and a little extra carving for a stand with lion paws). Only one of the blocks is from Docimium, but the other four are Proconnesian, measuring 60 and 69 Roman cubic feet There were also inscriptions on the columns and blocks, for example, "the fiftieth block quarried from sector I of bracchium II in the year of the consuls Severus and Victorinus by the officina Commodiana under the direction of Julius Gayrus

[101] Arrian *Periplus* 1-2 "The altars are already in place, but the stone is coarse and in consequence the inscriptions are hard to read. What is more, the Greek text contains mistakes, because it was carved by barbaroi ....As for the statue of yourself it is fine as regards the pose – it is pointing to the sea – but it is a poor likeness and not good work. Please send a statue worthy of yourself in this same pose ..... If you think fit, send a fresh Hermes too about 5 feet".
[102] Lixouri, JS 314.
[103] Punta Scifo, JS 350.
[104] P. Orsi, 'Crotone. Scoperte subacquee di marmi in parti scritti a Punta Scifo', *Notizie degli Scavi* 1921, 493-94.

where the quarries were administered by Escopius."[105] This consular date (found on several of the columns) is the most recent recorded, AD 200, while a reference is made on the blocks to the consuls of AD 197, Lateranus and Rufinus. This means that the blocks must have been kept for three years before being loaded onto the ship. It seems possible that all of this was loaded in one port which may mean that Ward-Perkins' theory (now discredited, see below) that Nicomedia acted as a loading port for both Proconnesian and Docimium marble is correct — or that Proconnesian marble was unloaded in one port, for example Ephesus, and loaded straight away onto another ship carrying other products.[106] The other interesting feature of the Punta Scifo wreck is the find of plaques of slate and marble that may have been samples to help with ordering. This suggests that there were travelling salesmen who could show the quality of the marble from the quarries they were representing and take made to measure orders. This initiative presumably came from the quarries themselves.

6.8 TRANSPORT AND STORAGE

The weight and size of marble meant that the further inland the quarry site, the more expensive the total transport cost. The Egyptians and Greeks only transported stone if necessary and economically viable. The Romans had a different mentality about luxury goods and often imported them precisely because they were exotic and expensive.[107] Nevertheless, quarries which were close to the sea or near a river were favoured over those that were inland, and without easy access. In the second century, the island of Proconnesus, whose quarry floor was at only 90-100 metres above sea level and close to the coast, therefore gave relatively easy access to ships, and became the most important exporter of marble

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105 ///LBSECOM SEVEROEVI
CTORINOCOSOFFCOMODIANA
CAESIVLIGAYRI SVB CVRA on the column end, and

///GRES//
/AVGGER// TORIVLII
GAYRI ///
OPH
EEPICTET on the shaft.

P. Orsi, 'Crotone, scoperti subacquee di marminpresso l'Heraeum', *Notizie degli Scavi,* Supp. (1911), 118-124.

106 For the Punta Scifo wreck, see P. Pensabene, 'A cargo of marble shipwrecked at Punta Scifo near Crotone (Italy)', *IJNA* 7 (1978), 105-18 and 233-4.

107 Pliny *HN* XXIV 125, Seneca *Ep.* 86.6.

for general architectural purposes throughout the eastern Mediterranean as well as being popular in Rome. The sea access at Aliki may explain similar popularity for marble from Thasos. Although it now seems probable that the prices in Diocletian's Edict on Maximum Prices did not include transport costs (see above), Synnadic marble from Docimium, shown at the expensive price of 200 *denarii*, has previously been discussed because of the idea that the more expensive cost of overland travel affected the price overall (compare the price of Thessalian marble at 150 *denarii*). It has similarly been argued that cheap water transport down the Nile contributed to the cheaper price of 100 *denarii* for Aswan granite, although the boats seem to have been state-owned anyway; a letter dated 28th January AD 300 from Aurelius Is~~o~~dorus, Diocletian's Procurator of the Lower Thebaid, refers to ten state-owned ships going to Aswan to pick up columns.[108]

The machinery used to transport marble does not seem to have developed to any great extent under the Romans. Sleds or carts with large wheels of 2m diameter, into which the ends of columns could be enclosed, as if acting as the axis, were pulled by oxen or mules, to drag the material down to the coast where it would be hoisted on board ships by lifting machines.[109] As mentioned above, river transport was essential for the export of Aswan red granite columns, each an average length of 10m. The weight of individual stone varies but 1m^3 of marble weighs about 2.7 tons, while granite is about 15% heavier. No doubt because of this weight problem and transport difficulties, these columns were often combined with bases and capitals made from stone found at the final destination: for example, the tetrapylon at Palmyra. In Asia Minor, columns of Troad granite were mixed with Proconnesian capitals and bases (compare what has been found at Umm Qais (Gadara) and Caesarea Maritima).[110]

The other quarry site that had previously thought to have probably depended on river transport for its export was Docimium, 200 miles inland, and

[108] T.C.Skeat, *Papyri from Panopolis in the Chester Beatty Library, Dublin* (Dublin, 1964), 62.
[109] A Greek epitaph from Dorylaeum attests the presence of a *collegium* of muleteers in imperial service at Synnada where they would certainly have been involved in bringing marble from the quarry to Synnada if not all the way to the coast as well. Oxen, however, were favoured for their strength. Apparently, 30 pairs were needed to transport a single column drum (?)
[110] M. Fischer, 'Marble imports and local stone in the architectural decoration of Roman Palestine: marble trade, techniques and artistical taste', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology and Trade* (Dordrecht 1988), 161-70

the route has been much disputed; J.B. Ward-Perkins suggested a route down the River Sangarius which rises to the north-east of Docimium and flows circuitously into the Black Sea (but its course is now un-navigable) for loading at Nicomedia.[111] Another suggestion is a way down the River Maeander to either Miletus or Ephesus; yet another is by a gently descending road to Antalya. It is doubtful whether either of the rivers was truly navigable, especially all year round, as the marble industry must have required. Since the administrative centre for Docimium was Synnada to the south west, the first route seems unlikely, and the present scholarly consensus is that the route taken was the overland one to Antalya.[112]

Marble had to be of very high quality to justify overland costs from Docimium and conversely this explains the relative cheapness and popularity of Proconnesian marble. The fact that Docimium marble was already appreciated in the time of Augustus and thought worthy of the transport difficulties can be seen in Strabo: "on account of the present extravagance of the Romans, great monolithic pillars are taken from them ....Although the transportation of such heavy burdens to the sea is difficult, still both pillars and slabs, remarkable for their size and beauty, are conveyed to Rome."[113]

Marble yards existed at both ends of the marble transport system and some ports, such as Alexandria, would have used them for both imports and exports; stock-piling was known at quarry sites, whether for specific commissions or for more general purposes. A number of column shafts and column bases have been found around the town of Saraylar in the north part of the island of Marmara where Proconnesian marble originated.[114] Four shafts are completely finished, while thirty-seven have been quarry-picked into rough cylindrical form with lines incised at both ends to separate the protective collars from the body. They are not standard dimensions so may have been for

[111] Pliny the Younger's letter to Trajan proposing the cutting of a canal to join Nicomedia to Lake Sophon which the Sangarius passes to the East seems persuasive but the marble he mentions as being helped by such an idea need not refer to Docimium marble. Pliny, *Ep.* X.41. It could just as easily be Bithynian marble such as a lumachella 'occhio di pavone rosso'. See J.B. Ward-Perkins, 'Nicomedia and the marble trade', *PBSR* 48 (1980), 23-69 and in H. Dodge and B. Ward-Perkins (eds.), *Marble in Antiquity: Collected Papers of J.B. Ward-Perkins* (BSR London, 1992), 61-105.
[112] Personal information from M. Waelkens.
[113] Strabo XII 8.14.
[114] N. Asgari, 'Observations on two types of quarry items from Proconnesus – column shafts and column bases', in M. Waelkens, N. Herz and L. Moens (eds.), *Ancient Stones: Quarrying, Trade and Provenance* (Leuven, 1992), 73-81.

something specific. Column bases were a more popular export item than column shafts which were considered to be at risk of damage during travel. For this, the stronger Troad granite may have been preferred for column shafts, at least within Asia Minor.[115] The bases are found in various worked states. The commonest is a square plinth with a cylinder and various levels and steps above. A considerable number were exported in this state; two here are definitely dated with Roman control markings.[116] They were also very large, with handles still attached to ease manoeuvrability as well as to protect them.[117] Some quarries still have pieces of stone only partially detached from the rock face, for example, at Miletus, Aliki on Thasos, Euboea, Mons Claudianus and Simitthus.[118] For some reason they were abandoned in situ, possibly as part of a trial production or as part of a cancelled order or simply because of a flaw.

There were storage yards and workshops at the other end of the market too, where marble imports arrived. In Ostia there were early storage facilities on the south mole of Claudius' harbour and in Trajan's hexagonal harbour, there seem to have been active workshops that not only completed the cutting and rounding of columns that had arrived as a solid mass of three or four fused together for transport safety (Fig. 6.16), but also undertook repairs.[119] The rate of breakage during shipment was probably quite high as marble is such a fragile material, so it was a logical step to provide a repair service to save whatever was possible. Reinforcements can be seen on columns with lead-coated iron clamps holding together cracks, or clamps and dowels re-attaching completely broken columns (Fig. 6.15). Some were just too substandard to be used and remained abandoned, for example some Teos columns that had started to develop high iron-oxide content and large quartz veins. The canal that connected Portus to the Tiber, the Fossa Traiana, contains a lot of marble that must represent a good cross-section of imports lost overboard whilst being loaded onto Tiber barges for the trip up to the Emporium. Some of these are newly quarried blocks and it is surprising that they were not salvaged at the time. There has been a recent re-

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115 Ibid.
116 Ibid.
117 As found in the Şile wreck, see above, 6.6.1.
118 See A. Dworakowska, *Quarries in Roman Provinces* (Warsaw, 1983), 64-5.
119 Compare groups of 3 or 4 still fused together in the Docimium quarry, see J.C. Fant, 'The Roman Imperial marble yards at Portus', in M. Waelkens, N. Herz and L. Moens (eds.), *Ancient Stones: Quarrying, Trade and Provenance* (Leuven, 1992), 115-120 and from Portus (Fig. 6.16).

arrangement of these three hundred and eighteen blocks into different stone qualities; of the three platforms of white marble, the variety includes four blocks of Pentelic, four of Thasian and Proconnesian, three of Luna and five of Phrygian. Blocks from Paros number twenty-three, of which thirteen are Paros-1 (i.e. lychnites) and five are Paros-2. The Paros-1 blocks are irregularly shaped and three of them are inscribed with the name "Hermo" and "Loc(us)" which corresponds to inscriptions engraved on the quarry face at the Grotto of the Nymphs and on four other blocks in the quarry. The Paros blocks are datable to the mid-second century and were probably too small ever to have been used as single piece statues.[120] There was also a dumping ground next to the canal, containing fifty large blocks of africano, cipollino and white marble dating from AD 82 and into the second century.[121]

In the Portus marble yard, 63.5% of finds are polychrome marbles: africano, cipollino, giallo antico, pavonazzetto and porta santa. If we add the Parian white marble examples, then this rises to 75%. It is surprising that there is not more Proconnesian marble as we know that large amounts of it were imported. Guilds existed and it is probable that the *corpus traiecti marmororum* was active in the transportation of decorative stones from Ostia to Rome itself.[122]

In Rome, there was a huge stockyard in the Emporium still known as Marmorata in the middle ages. This may have outgrown itself, as further up the Tiber, a dock of heavy construction has been identified as a pier for the *statio marmorum,* possibly from the late second century onwards, although this is questioned by J.C. Fant.[123] There are many inscriptions from these yards. Some blocks of marble were kept for centuries: two blocks of giallo antico in Ostia were first used for building in AD 394 having been quarried under Domitian three hundred years earlier.[124] Likewise the red granite Column of Antoninus

[120] P. Pensabene, L. Lazzarini, M. Soligo, M. Bruno and B. Turi, 'Parian marble blocks of Fossa Traiana', in D.U.Schilardi and D. Katsonopoulou (eds.), *Paria Lithos – Parian Quarries, Marble and Workshops of Sculpture – Proceedings of the First International Conference of Archaeology of Paros and the Cyclades, Paros 2-5 Oct. 1997* (Athens, 2000), 527-537.
[121] G. Melchiorri, *Guida Metodica di Roma e suoi contorni* (Rome, 1936), 153-4.
[122] See M.L. Anderson and L. Nista (eds.), *Radiance in Coloured Marble from the Museo Nazionale Rome,* (Rome, 1989), 36, n.12.
[123] See J.C. Fant, 'The Roman Emperors in the marble business: capitalists, middlemen or philanthropists?', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 147-158.
[124] G. Becatti, *Edificio con opus sectile fuori Porta Marina (Scavi di Ostia VI* Rome, 1969), 22-5; J.B. Ward-Perkins 'Columna Divi Antonini', in *Melanges d'histoire ancienne et d'archéologie*

Pius, one of two 50 foot columns, erected in AD 161 had been quarried in Egypt in AD 105.[125]

6.9 THE MARBLE-CARRYING SHIPS

The wrecks give us some idea about the size of the ships that sank: the smaller ones of 25m in length and carrying a cargo of 90 to 100 tons are the Capo Taormino and Giardini Naxos wrecks, while larger ones of 35m carried over 300 tons as the Punta Scifo, Capo Granitola, Isole delle Correnti and Sapien~~t~~za wrecks. In these cases, it seems likely that the heavier ones sank precisely because of the weight of an unsteady cargo in the hold. If there was rough weather and the cargo shifted, the ship could easily capsize.

Who owned the ships that transported this marble? It seem likely that the ships themselves were privately owned, especially when one thinks that the *annona* fleets were entrusted to private ships and not state ownership, when wheat was such a crucial commodity to the people of Rome and therefore to the emperors. Marble after all was always a luxurious import. The exception seems to be river transport: the Nile barges of Egypt were evidently state-owned, an no
arrangement which may have been inherited from the Ptolemies or even the Pharaohs. Similarly, state ownership may have been operating on the Tiber. Were there specially designed ships, operating regularly from the ports of Nicomedia, Antalya or Alexandria? From the evidence of these fifty wrecks, apart from Capo Granitola A and possibly Porto Novo, I would say that there were not. The dimensions of the hull remains are in accordance with other Roman merchant ships carrying different products throughout the Mediterranean – indeed many of these wrecks were not carrying marble exclusively. Their other cargoes, from amphorae to works of art, show that multiple pick-ups were normal.

There is an exception though. There seems to be pretty strong evidence that the Romans constructed specially built ships for one particular marble product, obelisks. The Egyptians had been transporting obelisks down the Nile to Alexandria for centuries until the Roman takeover, but none had gone overseas

offerts a Paul Collart (Lausanne,1976), 345-53 and in , H. Dodge and B. Ward-Perkins (eds.), *Marble in Antiquity: Collected Papers of J.B. Ward-Perkins* (BSR London, 1992), 107-114.
[125] *IGR* I, 529. There is a difficulty with the reading of "in the ninth year of Trajan", and it is more likely to refer to the Egyptian royal year. See J.B. Ward-Perkins, 'Columna Divi Antonini', as above, n. 125.

until the time of Augustus. As a practice run, the Romans transported two obelisks down the Nile from Heliopolis to Alexandria in 13-12 BC[126] and then brought another two all the way to Rome in 10 BC. One weighed 230 tons and was for the Campus Martius and the other 260 tons for the Circus Maximus, now in Monte Citorio and Piazza del Popolo in Rome respectively. The ship carrying the first obelisk was put in permanent dock in Puteoli by Augustus to celebrate the achievement, but later burnt;[127] the other famous obelisk ship, used to transport a 330-ton stone under Caligula, was used as part of the building works for the new harbour at Ostia by Claudius. How big did such a ship have to be? According to investigations by O. Testaguzza in Ostia in 1970, a ship would have to measure 104m in length (90m in the water) with a possible load of 1300 tons.[128] But this is just not possible or necessary for an obelisk whose length was only 25m. The Roman development in all things nautical was not exceptional, so they must have continued, or adapted, what they learnt from the Egyptian Nile technique.

The Egyptian transport technology was based on hanging an obelisk below the water line between two ships. It could be loaded easily then towed by oared boats for directional help. If it was particularly heavy, then a double doubled-ship could be used, i.e. four boats attached to each other with the obelisk hanging in the middle: with four ships with a length of 30m, and beam of 4.2m and a draft of 1m, there would be enough displacement to carry an obelisk of 300 tons. Obviously, the technique would have to be adapted for an overseas journey since, without the river current to help the ships' hydrodynamics, they would need to be more stream-lined. The Romans therefore added a single slim trireme-like ship in front of the two boats which had a central mast and could be rowed (Fig. 6.17). It also explains the figure of 300 rowers mentioned in ancient texts: there would be sufficient room on the two boats so that half of them could rest at any given time. This also explains Pliny's comments about the ship taking up a large part of the left side of the harbour in Ostia, because it was in fact the length

[126] In the nineteenth century, these two obelisks were taken to London (1877) and New York (1879); see A. Wirsching, 'How the Obelisks Reached Rome' *IJNA* 29.2 (2000), 273-284.
[127] Pliny *HN* XXXVI 14.70.
[128] O. Testaguzza, *Portus: Illustrazione dei porti di Claudio e Traiano e della citta di porto a fiumincino* (Rome, 1970), 105-109.

of two ships.[129] Added to that, his comment about three moles of Puteoli as high as towers now makes sense: it was not that they were as high as three towers, but rather that there were three moles because they were created on top of each of the three ships.[130]

6.10 CONCLUSION

During the Roman period, marble was being transported to an extent that had never been seen before. As J.C. Fant says, "Long distance trade in stone is an improbable phenomenon. Stone is dense, voluminous and very expensive to transport."[131] Cicero facetiously remarked to the Chians who were taking pride in displaying their walls of Chian marble, "I would be more impressed if you had made them of travertine!"[132] showing that he too suffered from the snob value of only being impressed by what was exotic and therefore expensive. The use of decorated marble extended from one side of the Empire to the other and this was mainly due to the fact that the Romans were the first to direct mass production of marble to the market at large, rather than solely quarrying for the specific commissions of individuals. They were also the first to practise the concept of pre-fabrication and, to some extent, the principle of standardization of products. This is clear from many of the shipwreck finds that carried semi-finished and nearly finished products and columns of specific lengths. But it seems clear from the shipwreck evidence too, that the private commercial side of marble production took some time to get going as most of the wrecks carrying artefacts for private use are dated during the second century through to the third century AD. There is no doubt as to the important role that the emperors played; apart from a few wealthy Republicans, it was the desire for luxury as a sign of power for the imperial family that initiated the great flood of eastern marble towards the capital for its grand building projects and this in turn spurred on the private trade i.e. an imperial-organised industry that led to an open market industry. The cultural aspect is also significant: there was Hellenisation of architectural taste

129 Pliny *HN* XVI 76.201-2.
130 For a detailed discussion, see A. Wirsching, 'How the obelisks reached Rome: evidence or Roman double ships', *IJNA* 29.2 (2000), 273-283.
131 J.C. Fant, 'The Roman Emperors in the marble business: capitalists, middlemen or philanthropists?', in N. Herz and M. Waelkens (eds.), *Classical Marble: Geochemistry, Technology, Trade* (Dordrecht, 1988), 147.
132 Pliny *HN* XXXVI 5.19

through the decorated marble that was arriving along with the artisans who finished it, while there was a Romanisation of tastes in other provinces. Without a sufficient shipping system, the marble trade could not have existed, as overland transport was extremely difficult, and, apart from the transport of obelisks, this system, as for other products, seems to have remained in private hands even if the *ratio marmorum* itself was imperial. What should impress us the most is not the number of shipwrecks that have been found carrying marble but the sheer quantity of marble that reached its destination.

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Fig. 6.1 Map of the marble wrecks.

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Fig. 6.2 Porphyries, granites and coloured marbles from specimens in the Corsi Collection (University Museum, Oxford).

Fig. 6.3 Coloured marbles from specimens in the Corsi Collection (University Museum, Oxford).

Fig. 6.4 Map showing the major quarries of decorative stones in the Roman world.

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Fig. 6.5 Opus sectile work from the Domus Tiberiana, Palatine Museum, Rome.

Image removed due to third party copyright

Fig. 6.6 Map showing the distribution of Attic sarcophagi.

Fig. 6.7 Drawing of the marble-working tools from the Porto Novo wreck.

Fig. 6.8 Photomosaic of the Skerki Bank F wreck.

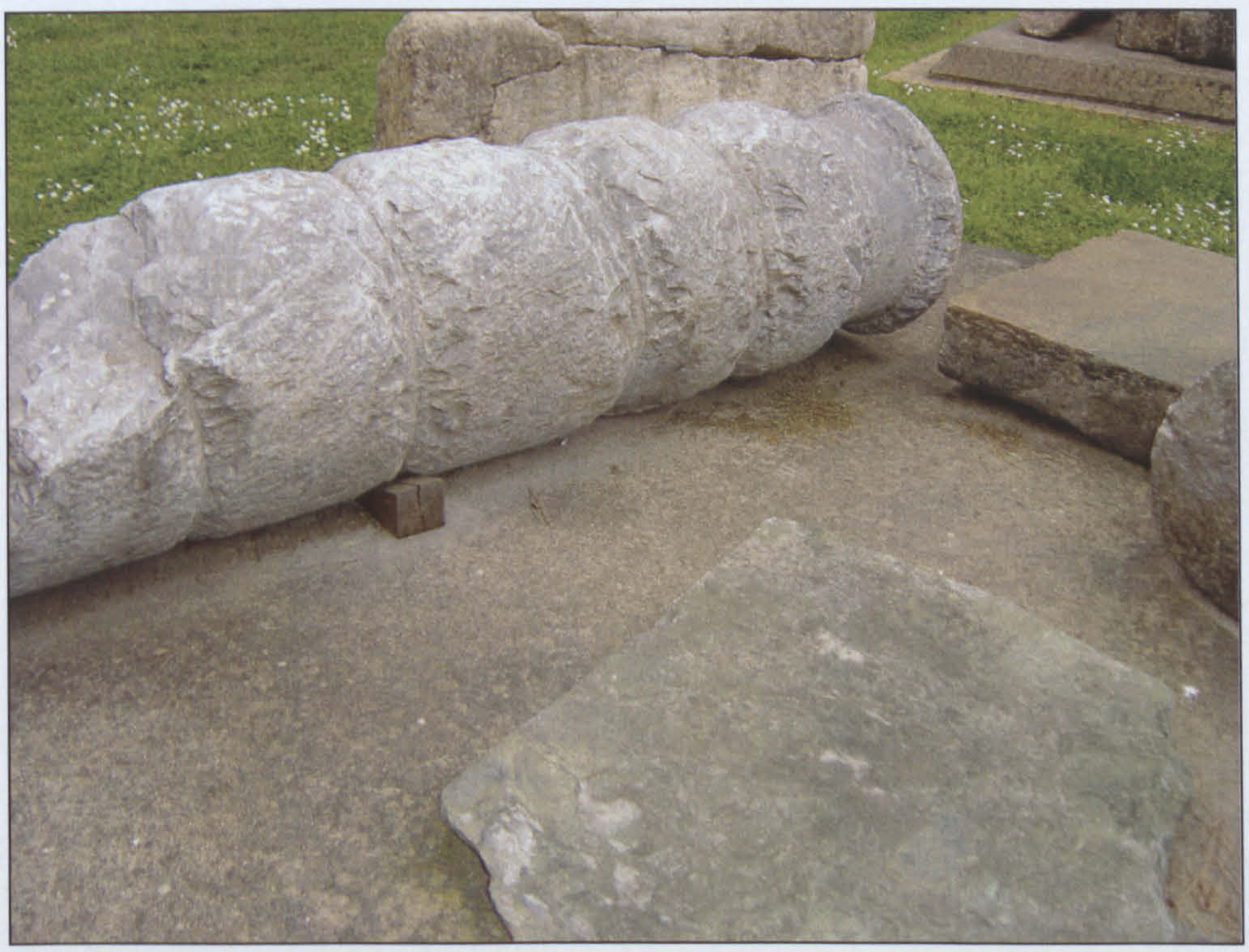

Fig. 6.9 Half-worked column from Portus.

Fig. 6.10 Columns from the Methone C wreck.

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Fig. 6.11 Diagram of the location of the columns from the Giardini Naxos wreck.


Fig. 6.12 Half-finished basin of portasanta marble from Chios, Portus.

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Fig. 6.13 Sarcophagi from the Methone D wreck.

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Fig. 6.14 Head of a young man from the Horti Laniani, Museo del Centro Montemartini, Rome.

Fig. 6.15 Lead clamping in a block of marble from Portus.

Fig. 6.16 Marble columns still fused together from Portus.

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Fig. 6.17 General sketch of the Roman double-ship.

7. SHIPWRECKS OF GLASS AND BRONZE ARTEFACTS

Although the number of wrecks that have been found with glass and works of art in bronze is relatively small in comparison to those carrying amphorae, these items are still worthy of examination, particularly as they were very much products of the Eastern Mediterranean. Seven glass wrecks have been discovered so far, which is disappointing, however they do illustrate a trade not only in raw glass and finished glass products but also a trade in recycling. Twenty-six ships were carrying bronze artefacts when they sank and these ships point more to the private transport of goods (stolen or purchased) than to trade. What stands out is the quality of the workmanship and the variety of goods from statues to decorative pieces to whole couches. Because of the high monetary value of bronze, these works of art rarely survive on land as they may have been melted down, so these underwater finds are exceptional.

7.1 GLASS

The invention of glass occurred around 2200 BC in north-western Iran. Coloration of glass was already in place during the reign of Tutankhamen in Egypt (ca. 1330 BC), and coloured glass was heavily exploited for furniture and architectural inlay during the next few centuries.[1] Most of the major sites of manufacture during the early days of glassmaking were located near the eastern Mediterranean coast and various techniques had been developed by the Hellenistic period.[2] Naturally coloured glass is composed of 72% silica, 15% soda, 10% lime, and 3% impurities. Beach sand, the main ingredient in glass, contains silica and lime, the latter component coming from crushed shells, which is why so many centres of production were close to the sea. There are two steps to producing naturally coloured glass: by melting the ingredients at a relatively low temperature (circa 750° C) to obtain a white, granular substance (*frit*) that

[1] D. Grose, *Early Ancient Glass*, (New York, 1989), 45-57 and 73-84.
[2] The coast between Acre and Haifa was famous for its glass production; see Pliny *HN* XXXVI 45; Josephus *BJ* XI 188; Strabo XVI 758.

could easily be stored for later use, and by re-melting the frit in a far hotter furnace (ca. 1150° C), thereby transforming it into fluid glass. However, glass is not naturally colourless. Beach sand invariably contains black particles of iron oxides scattered through it. When fired in a usual, oxygen-rich environment (i.e. with the furnace in an oxidizing state), these impurities give the glass a natural aqua blue to light green tinge. The typical amount of iron in beach sand is 0.3%: the intensity of the colour increases as the amount of iron increases.[3] All the raw glass used in western workshops was imported from the eastern end of the Mediterranean and is indeed mentioned in ancient literature, for example, Pliny talks about nitron from Egypt and also from Macedonia.[4]

Early techniques to create glass vessels included the coiling of glass threads around a core shape before rolling it smooth and heating it, and, in the Hellenistic period, adapting the then new potter's technique for mould-shaped bowls, but in reverse: glass was cast by laying a disc of hot glass over a conical-shaped clay mould, pressing it down so as to create a smooth rim and lifting it off before it cooled completely to prevent cracking and breaking.[5]

Although the Romans clearly had nothing to do with the invention of glass, during the first century AD they did play a primary role in the industrialization of the glassmaking process in the Mediterranean world. The discovery of glass blowing in Jerusalem coincided with Roman expansion in the eastern Mediterranean, and key to the growth of glass working in the West was the displacement (and enslavement) of skilled eastern craftsmen. They brought with them the traditional Eastern Mediterranean technique of glass moulding and the relatively new technique of much cheaper glass blowing. The blow pipe's invention had far-reaching consequences. It allowed the craftsman to gather a sizeable chunk of hot glass from a small furnace and expand it into larger, sometimes more complex forms. Many changes in the glassworkers' repertoire soon followed. Casting could be used only for glass vessels with an open form—platters, bowls, and cups—whereas free-blowing could be used both for those and for vessels with a closed form, such as the narrow-necked jugs, bottles, and food storage jars which previously had been the marketplace prerogative of pottery-

[3] J. Henderson, 'The raw materials of early glass production', *OJA* 4 (1985), 267-291.
[4] Pliny *HN* XXXVI 191, XXXI 110-11 and XXXI 107.
[5] S. Fleming, *Roman Glass: Reflections on Cultural Change* (Pennsylvania, 1999), 6-10.

makers. Experimentation with the two techniques during the first centuries BC and AD in the Syro-Palestine region led to mould-blowing, which then spread to the western coast of Asia Minor before migrating to Italy. By the beginning of the second century AD, every glass working technique we use today had been fully developed by the Romans, and it has been estimated that close to one hundred million vessels were then being produced every year to satisfy the Empire's domestic demands.

Other decorative techniques also began in the eastern Mediterranean and became popular in the west.[6] A thin-walled glass beaker could be mounted on a lathe and its surface scored with the edge of a wheel or a scribing point to create delicate patterns of lines spaced in any rhythm the glass-cutter chose, while a thick-walled glass vessel could be decorated with grooves with all sorts of depth of cut, width and spacing. Patterning of this kind ranged from the very simple to the extremely complex. Because of the versatility of this means of design, lathe-cutting remained a popular technique for glass working all the way through to the early fifth century AD.

While some poets enthused about glass's transparency, most Romans praised it just for its practical everyday value.[7] Pliny the Younger commented on glass as window panes, while Martial talks about its use as wine beakers.[8] The presence of glass in only seven of my two hundred and eleven shipwrecks clearly does not reflect its enormous importance in daily life; however its widespread distribution is apparent with wrecks discovered in areas from Greece to southern France. These wrecks also show the variety in the use of glass, from sheets to lumps of glass to fine goblets.

7.2 THE GLASS WRECKS

Looking at the wrecks in geographical order from east to west, the Antikythera wreck of 80 BC is the only one so far found in the Aegean. It carried a dozen glass vessels, possibly Alexandrian, amongst its cargo of works of art (see below). Some of these are intact and are luxury glasses of the highest

[6] C. Lightfoot, 'From east to west: the early Roman glass industry', in D. Foy and M.-D. Nenna (eds.), *Echanges et commerce de verre dans le monde antique: actes du colloque de l'AFAV, Aix-en-Provence et Marseille 7-9 juin 2001* (Montagnac, 2003), 341-347.

[7] Horace *Odes* I 18, IV 2; Seneca *Naturales Quaestiones* I 6.

[8] Pliny the Younger *Letters* II 17; Martial *Epigrams* IV. 85, "We drink out of a glass, you from a murrhine, Ponticus. Why? Lest a transparent goblet reveal you are serving two kinds of wine."

quality.[9] In the Adriatic Sea, there is the Grado wreck of AD 150-200 in which a partially disintegrated barrel stored towards the prow was found full of glass; much of it was waste glass, including fragments of plates, bowls, trays, drinking glasses and bottles as well as some square bottles with the base mark of C SALVI GRATI. Presumably these were destined to be melted down in a glass workshop to obtain the vitreous mass needed to produce new objects. The glass fragments show from their quality that they came from at least three different areas of the Mediterranean and this is the first archaeological evidence underwater we have of glass being recycled.[10]

The Pozzino wreck dated to 140-120 BC was carrying three glass cups typical of the Syrio-Palestine region amongst its cargo of Rhodian amphorae and Megarian bowls.[11] The Sanguinaires wreck of 250-200 BC was transporting at least 550kg of blue frit glass, both manufactured and un-manufactured in the form of ingots, as well as amphorae and fine and coarse ware pottery. This is the earliest of the glass wrecks and shows that eastern Mediterranean glass was being exported to the west even at this early stage.[12] The Porticcio wreck, also found off Corsica, had sheets of glass and glass objects with a total weight of about 100kg. It is dated to the third century AD by its African amphorae (Fig. 7.1).[13]

Along the southern coast of France are two wrecks carrying glass. The La Tradelière wreck of 20-10 BC was carrying glass cups, stacked in piles of 8 or 10, in six different colours along with a huge variety of amphorae and pottery, together with tens of thousands of hazelnuts in a layer up to a metre thick.[14] The Ouest Embiez 1 wreck of the late second century AD is unique since its principal cargo was made up of colourless glass: irregular blocks of very good quality raw glass up to 25kg each with a total of at least 10 tons stacked in the centre of the boat; more than fifteen fragments of sheet glass, all rectangular except one circular piece with a diameter of 43cm (very rare) and at least two thousand pieces of glassware, the majority of which are cylindrical goblets, with different types of bases, stacked together in lots of five. The sheets of glass were definitely made on the Syrian-Palestinian coast between Acre and Haifa which was famous

[9] G. Weinberg et al., 'The Antikythera shipwreck', *TAPhA* 55 1965. JS 36.
[10] Martial testifies to the practice of recycling of glass, *Epigrams* I 41. JS 340.
[11] JS 406.
[12] JS 431.
[13] JS 433.
[14] JS 456.

for its glass production. The other glass could have come from any Mediterranean area. The excavation of this wreck is on-going and hopefully further research will reveal the origins of the rest of the glass (Fig. 7.2).[15]

7.3 BRONZE ARTEFACTS

Works of art and other artefacts made from bronze were highly prized from the time of their inception right through to the present day. Bronze is an alloy of copper with 10% tin (and a very small percentage of lead too if required) and was used not only for expensive statues and furniture but also for mundane things like nail heads, hundreds of which have been found in shipwreck sites all over the Mediterranean, and clamps, for use in marble columns, for example. Greek bronze sculptures were created in thousands; according to Pliny, for example, there were three thousand bronzes in Rhodes by the end of the Hellenistic period, and three hundred statues were taken to Rome from the town of Ambracia by M. Fulvius Nobilior after its capture in 189 BC.[16] Bronze beds, *fulcra*, seem to have been part of an organized trade throughout the Mediterranean and Pliny especially mentions Delos as a producer of bronze furniture and decorations.[17]

7.31 Casting of Bronze

There were several methods for casting bronze. Initially, small bronze objects and tools were solid cast in two-piece clay moulds, then from 1,500 BC onwards, larger items were being hollow-cast in bronze using the *cire perdue* (lost wax) method. For this direct method type of casting, a clay core was formed in the basic shape of an object. This core was then covered with wax and the details of the statue or object were moulded in the wax. Wax sprues and gates were attached to the model to provide pathways for the wax to evacuate the mould and for the molten metal to enter it. Wax vents were also added through which hot gases could rise while the liquid bronze was being poured. The wax model with its vents and gates was first painted with very thin clay in order to

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[15] JS 466. D. Foy and M.-P. Jézégou, 'Commerce et technologie du verre antique. Le témoignage de l'épave Ouest Embiez 1', in E. Rieth (ed.) *Méditerranée Antique: Pêche, navigation, commerce* (Paris, 1998), 121-134.
[16] Pliny *HN* XXXIV 37; Livy XXXIX.5.
[17] Pliny *HN* XXXIII 144; XXXIV 9 and 14-15. C. Rolley, *Greek Bronzes* (Fribourg, 1986), 193.

pick up the finely sculpted and carved details. Then it was covered completely with a coarser clay mantle. The mantle was attached to the inner core by iron or bronze pins called chaplets. The clay mould was then baked slowly so the wax would melt out and then it was fired at a higher temperature so it would harden. The space left by the wax was filled with molten bronze. When the bronze had cooled for a couple of days (or perhaps more), the clay mantle was broken open and the bronze object was removed. The chaplets, vents, and gates, now in bronze, were removed, and the surface of the statue was finished by various cold-working techniques. The limitation of this direct method of hollow-casting bronze is that the mould can only be used once. This was a method used during the Archaic Greek and Early Classical (480 - 450 BC) periods to make small objects or statues.[18]

The majority of the large-scale bronze statues produced by the Greeks and Romans were made using the indirect method of hollow-casting. In this process, the clay core is finished more completely and a cast is taken of it. This is called a master mould. When the master mould has dried, wax is painted into the negative impression. This then becomes the working model, which is sculpted and cast as before.[19] The benefit of this additional step is that the master mould can be reused. The large-scale statues made by the Greeks and Romans were often cast in series using this master mould procedure. Large-scale bronze statues were usually cast in pieces of a maximum dimension of about one metre. There are several reasons for this. First, about the most two men could handle was a crucible holding about seven and a half litres of molten bronze weighing sixty-eight kilos. Second, bronze must be poured fairly rapidly or it will begin to cool and it will not pour uniformly. If the bronze is not at just the right temperature and state of fluidity, the casting may fail resulting in the bronze cracking and becoming deformed as it cools. The ancient founders understood these constraints. One of the reasons for adding some lead to a copper-tin bronze is that

[18] S. Hemingway, *How Bronze Statues Were Made in Classical Antiquity*, Harvard University Art Museums Gallery Series, No. 19, (Cambridge, Mass: the Harvard Art Museums, 1996), 4-5; D. Brown, 'Bronze and pewter', in D. Strong and D. Brown (eds.), *Roman Crafts* (London, 1976), 27-29.

[19] S. Hemingway, *How Bronze Statues Were Made in Classical Antiquity*, Harvard University Art Museums Gallery Series, No. 19, (Cambridge, Mass: the Harvard Art Museums, 1996), 5-7; C. Mattusch, 'The preferred medium: the many lives of classical bronzes', in *The Fire of Hephaistos: Large Classical Bronzes from North American Collections*, (Cambridge, Mass: the Harvard Art Museums, 1996), 20-25.

the lead both lowers the melting point of the resulting alloy and makes the molten metal less viscous so it pours more easily. The separately cast parts were then joined together by metallurgical and mechanical means. The skill with which these joins were made in antiquity is one of the greatest technical achievements of Greek and Roman bronze working. In the finishing process, decorative details such as hair and other surface design may be emphasized by means of cold working with a chisel. The ancient Greeks and Romans frequently added eyes inset with glass or stones, teeth and fingernails inlaid with silver, and lips and nipples inlaid with copper, all of which contributed to a bronze statue's astonishingly lifelike appearance.

Because bronze could be melted down and reused, very few bronze sculptures have survived from ancient times. Greek artists melted down older statues to create new, more naturalistic ones, while the Romans and other invaders melted the bronze to create weapons, shields and armour. Fortunately, the Romans also admired the Greek statues and often made marble or terracotta copies if they had to destroy the original. Greek workshops continued to be extremely active even through the Roman period when Italy was producing its own bronzes, and, under Nero, there was a renewed appreciation for the sculpture of Pergamum.[20] The bronze statues that have survived have often been found in shipwrecks.

7.4 THE BRONZE WRECKS

Twenty-six of my shipwrecks were carrying bronze artefacts when they sank and some of them have become very famous for their magnificent cargoes, for example, the Artemision, the Antikythera, the Riace and the La Fourmigue C wrecks. Wrecks could also contain bronzes of different dates such as the Artemision wreck with one sculpture of the fifth century and another of the second century BC which has led scholars to believe that many of these wrecks represent plunder of some kind.[21] Many reports of bronze finds are unfortunately rather short on detail, for instance, the Pserimos wreck with a statue of a bronze

[20] C. Rolley, *Greek Bronzes* (Fribourg, 1986), 224-226.
[21] Consideration of several late Hellenistic shipwrecks such as the Antikythera, the Mahdia and the Artemision has led S. Hemingway to conclude that they were all victims of plunder; S. Hemingway, *The Horse and Jockey from Artemision: A Bronze Equestrian Monument of the Hellenistic Period*, (Berkeley, 2004).

woman 1.98m high, whose head was broken off during lifting (!).[22] However those that have been researched fully have also received the most restoration and these are the ones I shall concentrate on. It is interesting to note that nearly all the sculpture finds come from the Aegean and central Mediterranean while nearly all the furniture and decorative finds are from the west coast of Italy and the southern coast of France. However because there are no significant dating patterns, I think this may just be chance rather than an important factor for the bronze trade.

Two important finds come from sites relatively near each other off the coast of mainland Greece, the Artemision wreck and the Marathon wreck. Two bronze statues have been raised from the Artemision wreck: the first represents Poseidon, or Zeus, brandishing a trident with his raised right hand and is an original work of a great sculptor, possibly of Kalamis, dated to ca. 460 BC (Fig. 7.3). The other is the "jockey" of Artemision. The statue represents a young man riding a horse. He probably held the reins in his left hand and a whip in the right. It was found in pieces, and is dated to ca. 140 BC (Fig. 7.4). The jockey's physiognomy and original black skin are those of an Ethiopian, but his hairstyle is Greek, which implies that he is of mixed race. He is most likely a professional or trained jockey. After considering three likely contexts for the original function of the Horse and Jockey (funerary, decorative, or dedicatory), S. Hemingway argues that the best interpretation is that the group was set up in a sanctuary to honour one or more victories in horse races. The large size of the monument and the high quality of the sculpture suggest commission by royalty or a wealthy Greek aristocrat. He goes on further to build a strong circumstantial case for its having been plundered from Corinth in 146 BC by Mummius, who then gave it to Attalus, who was shipping it to Pergamum when the ship was wrecked in the Trikiri channel north of Euboia.[23] With a *terminus ante quem* of 146 BC and a stylistic analysis placing the statue in the second half of the second century BC, the group is given a date of the mid-first century BC.[24]

The wreck found at Marathon contained a statue representing a youth, perhaps the god Hermes. It is the work of the school of Praxiteles and is dated to

[22] JS 58.
[23] Pausanius VII 16.8-9.
[24] S. Hemingway, *The Horse and Jockey from Artemision: a Bronze Equestrian Monument of the Hellenistic Period* (Berkeley, 2004). JS 34.

325-300 BC (Fig. 7.5).[25] Another wreck that contained two superb bronze statues, that had probably been plundered, is the Antikythera wreck, dated to about 80 BC. A statue of a young man, a god or a hero who held a spherical object in his right hand (possibly Paris with the apple) is one of the most brilliant products of Peloponnesian bronze sculpture, perhaps the work of the famous sculptor Euphranor, and is dated to 340 BC (Fig. 7.6). The other sculpture is the portrait head of a bearded, elderly man, perhaps a philosopher of the Hellenistic period, dated to 250-200 BC (Fig. 7.7). A pair of statuettes and a bronze bed were the other bronze artefacts amongst a mixed cargo of amphorae, marble statues, jewellery and fine and coarse pottery.[26]

Another Hellenistic/Roman find was made off Mazara del Vallo in south western Sicily by fishermen. First, in 1997, a leg appeared in their nets, then a year later, the head and torso came up. Though still missing both arms and his right leg, the statue was in amazingly good condition. It represents a larger-than-life Satyr more than two metres tall, and the work may be an original of the Hellenistic period, dating to the fourth century BC, or a later reproduction made between the second and the end of the first century BC. Experts think it may be a Roman copy, noting the satyr has a high percentage of lead and shows other signs of Roman bronze-casting methods. So far, technical analysis yields a date for it anywhere from the 4th to the 1st centuries BC. The overall weight of the preserved parts is around 108 kilograms (96 for the body, 12 the detached leg). The young Satyr is caught in the act of dancing, with his arms outspread, possibly holding a cup and a thyrsus, the left leg slightly raised and the head turned to one side with hair flowing around. His semi-feral nature is shown by his pointed ears (Fig. 7.8).[27]

An important find was made in the area between Euboea and the island of Aghios Eustratios. It is a statue of the first Roman emperor riding a horse and this is the only preserved life-size equestrian statue of Augustus. He wears a heavy chiton and a mantle and he holds the reins with his left hand. It is dated to the end of the 1st century BC (Fig. 7.9).[28]

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[25] JS 31.
[26] JS 36.
[27] JS 362.
[28] JS 72.

The Riace bronzes, found together by divers in 1972 at Riace Marina near Reggio Calabria, provide an example of the serial production made possible by the indirect method mentioned above. These two large male statues, probably of the fifth century BC, have similar body styles but different details. Analysis indicates that they were probably made from the same master mould but cast at different times. Tenons of lead show that they have been taken from their bases and are therefore probably spolia. Other statue fragments including a shield-grip were also found from this site thought to date from the first century AD (Figs. 7.10, 7.11 and 7.12).[29]

Many other large fragments of bronze statues have been found in wrecks: the Megadim A and the Hof Hacarmel wrecks off Israel contained statues and statuettes; the third century AD Punta del Serrone wreck off Brindisi was carrying one hundred and fifty bronze fragments including a foot and seven heads, spanning four centuries (possibly for recasting?) to name but a few.[30] Two other bronze wrecks stand out, both carrying furniture, the Mahdia and the La Fourmigue C. The Mahdia wreck, dated to ca. 80 BC, was carrying full-size and miniature bronze sculptures, including a 1.4m statue of a winged youth (Eros?) and a herm of Dionysus with the signature of Boethus of Chalchedon, both of which show traces of having been removed from their marble bases. Vases and candelabra were also found, and other decorative pieces such as a hinged lamp in the shape of a shell, as well as bronze couches. The couches are inscribed with Greek numbers, showing that the ship was carrying at least twenty-two of them. The cargo strongly suggests the private collection of a Roman senator returning from Athens, possibly L. Licinius Crassus (Fig. 7.13).[31]

The La Fourmigue C wreck discovered near Cannes dates to the late Roman Republic and was full of a fine collection of furniture and sculptural appliqués, mostly belonging to bronze couches inlaid with silver and copper; an inscription indicated Greek manufacture. Also found were a large dish, a bucket, decorated with a fine Bacchic mask, a candelabrum foot and other pieces of

[29] C. Mattusch, *The Fire of Hephaistos: Large Classical Bronzes from North American Collections* (Harvard University Art Museums, 1996), 29-30.
[30] Megadim A, JS 216; Hof Hacarmel, JS 219; Punta del Serrone, JS 353.
[31] JS 485; Ch. 6.5.

bronze furniture of magnificent workmanship in the Hellenistic style of the first century BC (Figs. 7.14 and 7.15).[32]

7.5 CONCLUSION

The amphora may be the symbol of underwater archaeology but other commodities such as glass and bronze are also important finds in the marine world. Glass was not a luxury item judging by the comments made by ancient authors but it has been treated as such, presumably because of its fragility. The fact that any has survived underwater after the impact of a shipwreck is even more impressive. The finds from the wrecks demonstrate how raw glass from the eastern Mediterranean was transported in ingot form and in manufactured form as (window?) panes and finished items such as tableware. The barrel of glass fragments from the Grado wreck is a unique find and illustrates an interesting Roman attitude towards recycling. The number of wrecks carrying glass is not representative of finds from land sites, but at least they provide a wide-ranging view both geographically and chronologically.

The looting of works of art from Greece by Romans has long been acknowledged and some of these underwater finds confirm that this was the case. Not all would have been spolia, and surely some of these cargoes represent the property of private collectors who would have bought these items. The variety of some of the cargoes is remarkable as is the intricate detail given to some of the decorative pieces and statues. The number of bronze statues from the Aegean Sea is high (eleven) but because of the nature of the finds, often caught in fishing nets, no other items of cargo or pieces of the hull have been found with them, giving a frustratingly incomplete picture. Maybe the new deep sea exploration projects will be able to survey these areas and discover more than just isolated statues. Wrecks from the Italian and French coasts are much more complete and, as mentioned above, contain more decorative furnishings than those from the Aegean, albeit spanning the same periods from the Hellenistic to the Roman Imperial eras. It seems clear that bronze works remained collectible in the Mediterranean under the Romans, even if many statues were melted down for other uses.

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[32] See C. Baudoin, B. Liou and L. Long, 'Une cargaison de bronzes hellénistiques: l'épave Fourmigue C à Golfe-Juan', *Archaeonautica* 12 (1994); JS 453.

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Fig. 7.1 Glass from the Porticcio wreck.

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Fig. 7.2 Goblet from the Ouest Embiez wreck.

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Fig. 7.3 Poseidon, or Zeus, from the Artemision wreck.

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Fig. 7.4 The Horse and Jockey from the Artemision wreck.

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Fig. 7.5 The boy from the Marathon wreck.

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Fig. 7.6 The youth of the Antikythera wreck.

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Fig. 7.7 The philosopher of the Antikythera wreck.

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Fig. 7.8 The satyr from the Mazara del Vallo wreck.

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Fig. 7.9 Augustus from the Aghios Eustratios wreck.

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Fig. 7.10 Riace A

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Fig 7.11 Riace B

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Fig. 7.12 The Head of Riace A

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Fig. 7.13 Herm of Dionysus from the Mahdia wreck.

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Fig. 7.14 A bronze piece from the arm rest of a "fulcrum" bed from the La Fourmigue C wreck.

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Fig. 7.15 Head of Silenus. Bronze appliqué of a large bronze vase from the La Fourmigue C wreck.

8. ROMAN MARITIME DEALINGS WITH THE EAST

Although this chapter geographically falls beyond the frontiers of the Roman Empire and therefore my thesis, so many goods from the East passed through Egypt and the Eastern Mediterranean, that they nevertheless merit investigation. The ancient use of the term "Red Sea", *Erythra Thalassa,* encompassed not just the modern Red Sea but also the western section of the Indian Ocean, the Persian Gulf and even the Bay of Bengal. Previous studies have looked at items traded, routes, the volume and cost of goods, and the Roman government's involvement, all of which are essential points for this study, whose emphasis is more on the maritime aspects of the Red Sea trade and its effect on the pattern of Roman trade in general.

The two regions of the East which I will be looking at are Arabia and India, set in a time frame of about 31 BC to about AD 200, which is the best documented era of Roman involvement there, presumably since it was the most active. The Roman pursuit of goods from beyond the eastern borders of the empire is a common subject in Roman literature (see below); epigraphy has also helped to shed some light on this trade. But, its importance is now being confirmed by archaeological remains not only in the Red Sea ports themselves but also further afield in India both on land and underwater.

8.1 EARLY DEALINGS WITH THE EAST

Ancient literature regarded all goods that came from the East to be luxury ones and this misconception has continued until recently. However, many of the goods being transported were staples and would have been regarded as such by many in the Roman world and not only by the rich. Unfortunately episodes such as the reception of Roman officials led by Scipio at the court of Ptolemy Physcon in 129 BC, gave the eastern products a reputation as being frivolous and decadent. Ptolemy's desire to impress these austere Romans did little to banish this reputation and manifested itself by him greeting them in the harbour of

Alexandria dressed in a long, transparent silk tunic, putting on elaborate banquets and organising guided tours of his palace and other royal monuments filled with eastern extravagances. Scipio and his group were unimpressed and even quarrelled with the King.[1] His plans had certainly backfired but many other Romans were eager to acquire these so called luxury goods at very high prices and Egypt was to benefit. I shall look at how much help the Romans gave to the passage of these imports, whether by direct or indirect means.

Although there has been a tendency to exaggerate the Roman involvement in helping the East to thrive, it must be remembered that until AD 1000 only three great trading networks existed in the Western Indian Ocean and one of them was Rome. The other two were Sassania in the sixth century AD and Siraf in the Persia? ninth and tenth centuries. If one compares Rome to Sirafi, in both cases the elite accumulated extraordinary wealth and the consumer undertook the considerable risk of sending ships to collect the goods. J.W Eadie also thinks we need to be less Romano-centr~~o~~ in evaluating evidence, pointing out that the Red Sea's ic location between east and west was unique and the Ptolemies had already realised its significance during the Hellenistic period.[2] After all, by the third century BC, Egypt had already begun to found colonies on the east coast of Africa and was obtaining ivory, slaves and elephants for military purposes. They then expanded their trade to include aromatics and other goods from South Arabia. We do not know how they paid for these goods: either it was by barter or if by coinage, then these coins were melted down for their gold and silver content as very few Ptolemaic coins have been found east of the Red Sea.

However, although the Ptolemies restored the old canal from the eastern branch of the Nile delta to the northern end of the Red Sea at Clysma and prepared roads between Coptus and Berenice, the canal silted up and the roads were beset by bandits and the seas by pirates; by the first century BC there was little being traded with the East. It took the Romans, with the discovery of the full use of the monsoons, to rejuvenate and increase trade through these Eastern areas,

[1] Diodorus Siculus XXXIII 28b.1-2.
[2] J.W. Eadie, 'Strategies of Economic Development in the Roman East: the Red Sea Trade Revisited', in French and Lightfoot (eds.) *The Eastern Frontier of the Roman Empire: proceedings of a colloquium held at Ankara in September 1988* (Oxford: BAR International Series 553, 1989), 116.

not only for themselves but for other peoples too.[3] Indians from Barygaza and Palmyrenes sailed in the Persian Gulf in the first two centuries AD and the Arabs of Muza were also good voyagers.

The Romans were surprisingly ignorant about the origins of certain goods (see below) which according to W. Ball suggests that the Romans neither controlled nor even knew about the sea routes as much as we think.[4] But, the undisputed fact remains that goods from the East flowed into the Mediterranean from Augustan times onwards.

This influx was partly due to the monsoons and partly to the *pax Romana.* As G. Young says, "... there was a strong upsurge in the volume of the commerce almost immediately upon the Roman takeover of the whole Mediterranean basin in 31 BC. The establishment of peace after the disruption of the previous centuries appears to have had a dramatic and immediate effect on the demand for spices, aromatics and so forth."[5] The Romans and Ptolemies shared a common goal; to enrich their states by levying duties, tolls etc. without the actual responsibility of transporting the goods: this, as we shall see, they left to private entrepreneurs who had to undertake dangerous journeys to South Arabia and India themselves.

8.2 ANCIENT EVIDENCE

The single most important piece of evidence for Red Sea trade is the *Periplus Maris Erythraei*, the only literary source whose prime subject is the luxury trade from the East (Fig. 8.1). It is dated to the mid first century AD on the basis of a list of Nabataean kings. Rather than being simply a coastal pilot like other *periploi*, this is unique as a guide for merchants, full of useful information about routes from the Red Sea ports, south towards Africa or east towards Arabia and India, favourable times for sailing by taking advantage of "the good wind", and distances between ports, all of which are listed; there is also trading information about imported and exported goods, their origins and methods of purchase by barter cash, local government monopolies on trade, and information

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[3] E. H. Warmington, *Commerce between the Roman Empire and India* (2nd ed. London; New York, 1974), 80.
[4] W. Ball, *Rome in the East: the Transformation of an Empire* (London, 2000), 132-133
[5] G. Young, *Rome's Eastern Trade: International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 25.

about ruling kings. It is a very descriptive piece of anthropological writing about people, places, plants and animals although it offers no information about religion. Clearly the author was a merchant himself, and writing for other Egyptians, since the work is written in Greek and the start and end points of journeys are Egyptian Red Sea ports. It is divided into sections for Africa and Arabia, a quarter each with the other half for India; although goods from the Persian Gulf are mentioned, the author does not give a coastal pilot for the area, presumably because the goods were of little interest to Roman traders: low quality pearls, purple garments, wine, dates and gold.

Another guide to these Eastern areas is the *Tabula Peutingeriana*, probably a medieval copy of a fourth century AD map (at the earliest), which in turn may be linked to the great map of the world of the Augustan age, the *Orbis Pictus*.[6] The section showing India also points to the existence of a temple of Augustus in Muziris (Fig. 8.2). Another less useful source is the work of Cosmas Indicopleustes, a sixth century native of Alexandria, who was a sea-faring merchant. His only surviving work is Christian Topography, which describes his travels through the Mediterranean, Nile Valley, Persian Gulf, the Levant and Ethiopia. Book Nine, about Sri Lanka and India, may have been written only from second-hand knowledge.

Both Strabo (63 BC to AD 24) and Pliny (AD 23 to 79) write abundantly about products from the East, sometimes historically and sometimes with contempt. Strabo describes first hand the expedition of his friend Aelius Gallus to Arabia Felix. Otherwise their records are generally secondary. Other peripheral information comes from historians such as Diodorus Siculus and Josephus and Latin poets such as Juvenal and Horace.

There are references in Tamil literature too: the principal Tamil sources are the poets of the Third Śangam (academy). They wrote the 'Eight Anthologies', *Eṭṭutokai,* which together with over two hundred poems made up a larger body of literature. None of these is precisely dated but some can be dated to the second and third centuries AD. The word for foreigners, *Yavanas,* is seen from the third century BC onwards, initially referring to Greeks, then to any

[6] The whole parchment, measuring 6.752m x 6.37m, consists of eleven segments, the most westerly of which, Spain, has been lost; B. Salway, 'Sea and river travel in the Roman itinerary literature' in R. Talbert and K. Brodersen (eds.), *Space in the Roman World: Its Perception and Presentation* (Munster, 2004), 43-97.

westerner, and there are references to Yavana ships arriving with gold and leaving with pepper (see below, in reference to pepper) although Ball argues that Yavanas could easily be Arabs or Ethiopians, in this case, rather than Romans.[7]

Other evidence comes in the form of papyri and ostraka mainly from Egypt, primarily because of its arid conditions that are perfect for preserving such data. The most important collection of ostraka, known as the archive of Nicanor, comes from Coptus, the records of a family involved in trade between Coptus and the Red Sea ports (see below,8.9). Many other papyri have been discovered that refer to goods, the merchants etc. (for example, the Muziris Papyrus, see below, 8.8.3). Inscriptions from the Eastern Desert also shed light on road maintenance and military activity.

Field surveys and excavations along the Red Sea coast and in India have confirmed what is already known about the trade. Unfortunately there are few remains of the items themselves, because of their delicate nature, but more archaeological evidence is constantly being found. So far, three shipwrecks have given definite evidence about transport of goods from the East and doubtless more will follow. Notable land sites include Berenice in Egypt and Arikamedu in India, where thousands of Roman coins and numerous ceramics have been unearthed (see below, 8.7 and 8.9). Thus the Eastern trade of the Roman Empire is evident through a variety of sources – literary, epigraphic and archaeological.

8.3 ROUTES AND THE MONSOON

Goods could be transported between east and west by land or by sea. Palmyra was an important trade centre as it funnelled goods from India and China into the Roman Empire. The most common route involved goods being shipped into the Persian Gulf and unloaded around Spasinou Charax; from there, they went a short way up the River Tigris or Euphrates before crossing the desert to Palmyra, thence to the Mediterranean on the Syrian coast or to Petra and its port Aelata. Antioch in Syria had already been an important trading centre but its prosperity increased greatly during the Empire. The Roman relationship with Parthia had been less than amicable before 20 BC and thus the above route avoided crossing any of their land, but Chinese silk in particular passed through

[7] W. Ball, *Rome in the East: the Transformation of an Empire* (London, 2000), 126.

Parthia in increasing quantities, even if not accompanied by Roman merchants. Other routes that could be taken were the Central Asian silk route from China which interconnected with the Bactrian routes to India via North Bactria, down the River Oxus, across the Caspian Sea and along the river valleys of the Caucasian country to the Black Sea; and the Persian route through Susa and Persepolis. Little was known about the Bactrian route and the Parthian route continued to be difficult so it was the maritime route that offered the safe way to Arabia and India via the Red Sea and Indian Ocean.

Until the middle of the first century AD, ships hugged the southern tip of the Arab peninsula insuring the wealth of towns such as Ocelis and areas such as Arabia Eudaimon where cargo was usually trans-shipped. It seems that few ships made the entire journey, rather "Eudaimon Arabia was called 'fortunate', being once a city, when, because ships neither came from India to Egypt nor did those from Egypt dare to go further but only came as far as this place, it received the cargoes from both, just as Alexandria receives goods brought from outside and from Egypt."[8] Once direct sailings were common place, these south Arabian ports became little more than watering holes, even if they continued to trade with India for their own imports of textiles, foods and raw materials.

The observations of a certain sea captain Hippalus changed all of that in the first century BC, when he studied the seasons of the monsoons. From that time, direct voyages could be made across the Arabian Sea to India.[9] (The theory pertaining to the origins and regular alternations of the monsoons, formulated in the seventeenth and eighteenth centuries by E. Halley and G. Hadley, is still valid. The causes of the monsoons are chiefly attributed to the diverse capacity of the heating and cooling of the atmosphere over the continents and over the oceans. This phenomenon provokes differences in pressure that generates potential energy, the winds are set in motion by the transformation of part of the potential energy from the atmospheric system into kinetic energy. The rotation of

[8] *PME* XXVI.

[9] There has been much debate about the date of the discovery of the monsoons, see M. Raschke, *New studies in Roman Commerce with the East* (*ANRW* II 9.2, 1978). Dates range from the first crossing by Eudoxus in 116BC (see below) to mid-first century AD. M.P. Charlesworth puts forward a date of 20-10BC, *Trade Routes and Commerce of the Roman Empire* (Cambridge, 1924), 57-75, while G. Young suggests that the monsoon was known and used around the time of the annexation of Egypt i.e. prior to 30 BC, *Rome's Eastern Trade: International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 19-20.

the earth then determines the wind's direction, while the humidity factor causes a series of storms characterizing the phases of the monsoons. At the beginning of winter, both the land and sea of the Northern Hemisphere lose heat which radiates into space. This loss is somewhat mitigated by the clouds, which are usually more extensive over the oceans, having a greater thermal capacity. This creates an imbalance in temperature and therefore a potential energy. Cold air from North Asia moves towards the Equator in order to restore equilibrium, which in turn is diverted towards the right by the movement of the earth. The winter NE monsoon maintains a stationary state, similar to the south west monsoon, until spring's solar heating dissipates the potential energy which feeds the winter monsoon. When the land's temperature again surpasses that of the ocean's surface, potential energy is formed, thus giving the new cycle.)[10]

This was an important move for Roman shippers in terms of speed: they could now leave Egypt in July and reach India by the end of September with the south west monsoon, staying there for two months before heading back with the north east monsoon to be in Alexandria by February. The first known voyage by a westerner to India using the monsoons had actually occurred in 116 BC and was made by Eudoxus of Cyzicus but it was only after Hippalus that it became more popular with westerners.[11] According to Strabo, the increase in shipping between Egypt and the east was phenomenal, even before the Romans' use of the monsoons – from less than twenty ships a year to one hundred and twenty ships.[12] "Formerly not twenty ships dared to cross the Arabian Gulf far enough to look outside the Straits. Now large fleets are sent as far as India and to the furthest ends of Ethiopia, from which the most valuable cargoes are carried to Egypt."[13]

The exact trip involved goods being taken up the Nile to Coptus, being transported by caravan across the Eastern Desert to one of the Red Sea ports, Myos Hormos or Berenice being the most popular. Ships would then sail down the Red Sea, using the summer northerly winds in July, through the Gulf of Aden using the south west monsoon and from there across the Arabian Sea to northern India or across the west Indian Ocean to south India (Fig. 8.3). Alternatively, if

[10] Taken from R.M. Cimino, 'Eurasia – one continent', in *Ancient Rome and India* (New Delhi, 1994), 1-2.
[11] Strabo II 98-99.
[12] Strabo II 12.
[13] Strabo XVII 1.13.

their destination was Rhapta on the African coast, they could simply head south west. This area provided traders with ivory, tortoise shell, frankincense, and myrrh, as well as cassia that had been imported from India and the Far East (see below, 8.5).[14]

This south west monsoon is still dangerous – it is stormy and according to the US Hydrographic Centre's *Sailing Directions to the West Coast of India* "may well be the strongest and most persistent wind over any water area of the globe." In fact, sailing conditions are so dangerous that even now nearly all maritime activity stops. Maritime insurance rates rise from about 1.5% to 20% between May and August. According to the *Periplus,* a ship could reach the open waters of the Arabian and Indian Oceans when the monsoon was at its height with an average wind of 22-23 knots and often gale force winds of 34-47 knots. Therefore, they would arrive in India by late September or early October. There were two points in India that merchants sailed to: the north-west coast using the monsoon astern, to the port of Barbarike at the mouth of the River Indus, or the more important port of Barygaza. The other area was the south-west coast of India leaving from Kane on the south coast of Arabia or Cape Guardafui on the African coast and sailing with the monsoon on the starboard side to the port of Muziris.

The return journey could be started any time after the beginning of November when the north-east monsoon gave favourable winds in clear, balmy conditions, right up to the entrance of the Red Sea.

In the fifteenth and sixteenth centuries, the Arabs used a slightly different timetable, leaving the Gulf of Aden at the end of August, so that the monsoon was not so fierce. In the twentieth century they avoided it completely, simply using the north-east monsoon both ways. Arab sewn ships were probably less sturdy than Greek or Roman ones but the Roman merchants knew their limitations too: shipments from the Malabar coast to the east coast of India, the Coromandel Coast, were not made by Roman ships but rather were transferred to Indian vessels. The distances travelled by western shippers were impressive.

[14] The *Periplus* author inserted notes at appropriate points advising on the correct time to leave Egypt for key destinations, e.g. the 'far-side' ports between Avalites and Opone – between January and September, preferably September (*PME* VI 3.6-7) for Barygaza – around July (*PME* XLIX 16.31-32).

Warmington lists some of these such as Ostia to Alexandria = 1220miles, from Myos Hormos to Barygaza = 2820 miles.[15]

Clearly, the discovery of the monsoons had an impact on the quality and perhaps variety of goods being transported between the Mediterranean and the east. Westerners came flowing into the Indian Ocean but in contrast, Indians did not come through to the Mediterranean although a few more came to Egypt. The southern Indians may have improved their local shipping but did not venture much more frequently to the Persian or Arabian Gulfs.

8.4 SHIPS

There has been some debate about the types of ships Roman merchants used to cross the Indian Ocean. Were they specially fitted out ships "large in size and lashing the sea into foam" according to Tamil literature?[16] Or, even, "now equipped with seven sails", as a Chinese record apparently states? W. Ball suggests on the other hand that Roman merchant ships would not have been capable of withstanding the force of the monsoon and that their square rigs were too primitive for the sophisticated navigation required by deep ocean sailing. He argues that the Indians were famous as ship builders (see below for export of masts and yard arms), with a long tradition of producing ocean going boats in Gujerat from the second century BC (Figs. 8.4 and 8.5). These may have been large enough to accommodate 500 -700 passengers, according to Indian sources. Were these huge ships the predecessors of those that became famous in the Mediterranean for their size, for example, in the time of Lucian, a ship 60 metres long by 15metres wide and 14 metres deep with a crew like an army, passengers of both sexes and corn sufficient to supply Attica for a year? L. Casson believes that Greek and Roman shipwrights built vessels especially fitted out for these ocean requirements, i.e. they were constructed in the very strong mortise and tenon way as compared to the stitched Arab vessels (see chapter 4 above).[17] The ships need not be that big since the goods being transported were not, except for

[15] E.H. Warmington, *Commerce between the Roman Empire and India* (2nd ed. London; New York, 1974), 73.
[16] *PME* LVI.
[17] Also their square rigs were designed for safety rather than for speed. L. Casson, Ships and Seamnaship in the Ancient World (Baltimore; London, 1995), 239-245.

amphorae, bulky. A monumental investment could be contained in a small amount of luxury goods, so I am inclined to agree with Casson.

8.5 GOODS FROM THE EAST

What is interesting about the exotic goods from the East is that many of them were processed once they were in the Empire. An area in Capua called Seplasia, for example, was frequented by the *ungentarii* who bought raw materials and manufactured them into perfumes[18] and Pliny was amazed at the tight security surrounding the processing of Arabian incenses in Alexandria.[19] So what were the goods that so enticed merchants to risk their money and indeed their lives to procure?

8.5.1 Herbs and Spices

From southern Arabia came frankincense and myrrh, pearls, bdellium (for religious rituals), sardonyx, salted lizards (as a food and aphrodisiac), cinnabar, sugar and cardamom. These were not considered to be luxury goods in the ancient world since they were used primarily for religious, funerary, culinary or medicinal purposes. For the wealthy at least they were necessities that had long been used, with literary references going back to Plautus.[20] Frankincense and myrrh are included for example, in a cream to cure backache that also included wax, mistletoe and sycamore resin – 4g each; round pepper and long pepper, ammonia salt, bdellium, Illyrian iris, cardamom, balsam wood, male frankincense, myrrh and dry resin – 40g each; pyretrum, Cnidian berries, wild cucumber root, Cretan aristolochia, liquid turpentine and resin – 80g each. To this was added a quantity of irinum which was needed to give the right density to the final product.[21]

Frankincense was thought to be the best of the incenses and correspondingly, its price was high. It comes from trees of the genus Boswellia, with various forms found in Arabia and East Africa. There was a mistaken belief

[18] *CIL* I 1594, X 3968, 3974.
[19] "At, Hercules, Alexandriae, ubi tura interpoantur, nulla satis custodit diligentia officinas! Subligaria signantur opfici, persona additur capiti densuse reticulus, nudi emmittuntur." Pliny *HN* XII 32.
[20] Plautus *Poenulus* Act II.3.
[21] Celsus V 18.7.

that it could only grow above 600m, although it is true that gum taken from trees on the coastal plains may have been of inferior quality.

Myrrh is still grown today all over Arabia as well as in Somalia and Ethiopia. Less popular than frankincense, only 450-460 tonnes of myrrh were produced annually, compared to 2,500 – 3,000 tonnes of frankincense according to Pliny. Collected by ships from the south Arabic port of Kane it was transferred to Myos Hormos and from there to Alexandria to be processed; otherwise it went via the incense route from south Arabia through Medina and Petra to Gaza on the eastern Mediterranean coast.

Although these were the only goods exported from Arabia that were actually Arabic, cinnamon and cassia were mistakenly attributed to Arabia and/or Ethiopia due to these being places of trans-shipment between India and the west. Strabo was the first to acknowledge that they came from India but he and other writers continued to believe that these plants grew mainly in Arabia and East Africa.[22] This is the most impressive cover-up in ancient trading history and the Arabs were not about to give up the monopoly on these spices; they may have lost out on other products once the Romans found their own way to India but cinnamon and cassia were too profitable to give up. Not only were these used as condiments, for example, with wine but also in perfumes, incense and medicines.[23] How the Arabs kept this monopoly going is uncertain but they presumably encouraged the assumption of westerners that what was purchased in their country was grown there too.[24]

They occasionally appear alone in doctors' prescriptions but more often are compounded with other ingredients. But it was not for medicinal purposes that they were so expensive: rather as components for perfumes, for the living or the dead.[25] A pound of the very cheapest cost 5 *denarii* while the best cassia was 300 *denarii* and the best cinnamon during times of shortage 1,500 *denarii* a pound.[26] Cinnamon comes from the bark of a tree native to Sri Lanka but is also found in south India, and cassia comes from a tree native to India, China and mainland South East Asia but both originate in China. The difference between

[22] Strabo XVI 782, XV 695 or Pliny *HN* XII 86.
[23] Pliny *HN* XIV 19.
[24] L. Casson, *Ancient Trade and Society* (Detroit, 1984), 225- 245.
[25] Martial XI 54.3.
[26] Pliny *HN* XII 91, 93, 97 and 98.

the two is quality. Cinnamon is generally finer than cassia. Various grades of both products are mentioned in the *Periplus* as being available in Avalites and Opone on the African coast. The products were shipped as pieces as peeled bark as we now get it and also in the form of twigs, branches or even whole trees.

Ginger was also thought to have originated in Arabia when in fact it comes from the Far East.[27] It is not mentioned at all in the *Periplus* and only during the second century AD did the Romans find out it came from further east, although Ptolemy says it came from Sri Lanka.[28] It was commonly used in cooking, especially with dried fish. Other products from Arabia such as precious stones, pearls and ostriches were considered to be luxury goods.

Roman imports from India are more abundantly documented than those from Arabia. M. Wheeler differentiates between two types of goods that left India for the Roman Empire: those produced by India itself (terminal trade) and those which came to India from further afield, for example, from China and central Asia (transit trade).[29] Trade from central and southern India mostly comprised terminal trade - spices, muslins, pearls and stones – along with some transit trade such as silk from China. More of these Indian goods do come under the heading of luxuries. As a general rule the imports of pearls, special stones, ivory and animals were luxury goods whereas plants and plant products used for basic religious, medicinal and culinary reasons were necessary imports.

The Pozzino wreck off the north-west coast of Italy of the first century BC is so far the only one that has definite evidence about the spice trade.[30] Collyrum and spices smelling of cinnamon, vanilla and cumin were found, packed in small wooden cylinders with wooden lids. These were fitted in groups of three into tin (or pewter) and wood containers and in rectangular wooden boxes, perhaps with sliding lids. One hundred and thirty-six cylinders have been found, of two varieties of boxwood. A left hand of an ivory and wood statue was also found.

[27] See Dioscurides, II 190, who says it was produced chiefly in Trogodytica and Arabia. Cf. Pliny *HN* XII 14, who gives it a value of 6 *denarii* a pound.
[28] Ptolemy VII 4.1.
[29] R.E.M. Wheeler, *Rome Beyond the Imperial Frontiers* (London, 1954), 137.
[30] Pozzino wreck JS 406.

8.5.2 Luxury Goods

Luxury goods included pearls, tortoise shell, precious and semi-precious stones, Iranian or Afghani turquoise and lapis lazuli; exotic animals included tigers, one-horned rhinos, parrots, peacocks and other pet birds, hounds, panthers, leopards and snakes.[31] As noted above, pearls were also being exported from Arabia and although the Red Sea continued to be a regular source during the empire, those of India were considered to be of a better quality. Barygaza may well have imported some too from the Persian Gulf.[32]

According to Pliny, tortoise shell was already being used as an inlay from the first century BC, imported from India but probably sourced from Malaya and the East Indies.[33] Precious stones, with exotic names that cannot now be identified were exported to Alexandria where they were cut and polished: this led the Chinese to believe that the Roman Empire was the home of all precious stones.[34] The money involved in this trade must have been phenomenal, huge if we are to believe that Augustus donated the equivalent of 500,000 *aurei* in pearls and precious stones to the Temple of Jupiter Capitolinus.[35]

Ivory originated in Africa and India and was known in Egypt from pre-dynastic times but it was from Augustus onwards that Indian ivory became much more popular to the point of being prevalent: Horace implied it was used to decorate ceilings; Cynthia asked Propertius for ivory dice, but its commonest use continued to be as inlay for furniture and statuary.[36] The find of an ivory statuette of Lakşmi, the Indian goddess of good luck and prosperity, in Pompeii, may be part of an organized art trade or a single example of an objet d'art bought by a collector or simply an item of curiosity (Fig. 8.6).[37]

India also produced specialised woods such as ebony, teak and sandalwood and they were certainly for sale through north Arabia. They were shipped from Barygaza to the ports of Apologos and Ommana on the Persian

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[31] For tigers, see Pliny *HN* VIII 25.65-6

[32] Ovid *Ars Am* III 129, Strabo XV 1.67

[33] Pliny *HN* IX 39, *PME* LVI. 63

[34] Propertius mentions *smaragdus* (emerald?), *chrysolithos* (topaz?) II 16.43-44. J. Thorley, 'The silk trade between China and the Roman Empire at its height, ca. AD 90-130', *Greece and Rome* 18 (1971), 78-9.

[35] Suetonius *Aug.* 30

[36] Horace *Odes* I 31.6, II 18.1, Propertius II 24, Strabo II 1.14.

[37] S. Sidebotham, *Roman Economic Policy in the Erythra Thalassa 30 BC- AD 217* (*Mnemosyne* Supp. 91, 1986), 23.

Gulf and transferred overland from there to Petra. This monopoly at least was not a secret – the *Periplus* author knew the origins of these timbers even if he was unable to buy them himself at Barygaza.

Parrots seemed to be the only birds regularly exported from India to the Mediterranean: a famous poem of Ovid is about the death of a pet parrot.[38] By the Late Empire, they were considered a delicacy to eat: rumour had it that Elagabalus had enough to feed his guests and his lions on them![39]

Various textiles made their way from India to the Roman Empire, namely silk and cotton. Silk came originally from China and was exported as a quite heavy material from India to avoid crossing hostile Parthia.[40] According to Diocletian's Edict on Maximum Prices, the trade in textiles was large and the centres renowned for their production and export were Tyre, Sidon, Berytus, Laodicea, Hierapolis and Aphrodisias. Once the these goods reached the Mediterranean textile centres, they were unravelled and re-woven into lighter transparent gauze, often with other materials, such as linen or wool, woven into it and then dyed.[41] The Chinese and others then bought it back, not realising it was their own material.[42] Indian cottons and muslins were also exported to the Roman Empire. Diocletian's Edict on Maximum Prices shows how much profit could be made from turning raw silk into re-processed silk, 12,000 *denarii* a pound compared to 150,000 a pound[43]

8.5.3 Other goods from India

Other goods from India included all sorts of herbs and spices including pepper, sesame seeds, cumin seeds, sugar cane, rice, ship masts and yard arms and slaves, specifically cup-bearers and litter-bearers. Juvenal criticises eastern slaves, describing one as 'expensive, handsome and supercilious too, refusing to serve his master's more humble guests'.[44] All things Eastern seem to have been

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[38] Ovid *Am.* II 6.

[39] Lampridius *SHA Elagabalus* 20-21.

[40] *PME* XLIX. References to 'Seres' and silk are rare pre-Augustan, but much more common during the first century AD especially with the poets, e.g. Ovid *Am.* I 14.5-6.

[41] Syria must have enjoyed the economic benefits of this industry, so at least trade with the East was combined with industry within the Empire.

[42] J. Thorley, 'The silk trade between China and the Roman Empire at its height, ca. AD 90-130', *Greece and Rome* 18 (1971), 77; J. Ferguson, 'China and Rome', *ANRW* 9.2 (1978), 590-91.

[43] Diocletian's Edict on Maximum Prices XXIII 1-2

[44] Juvenal V 56-65. For slaves, see Horace *Sat.* II 8.14ff.

regarded as exotic: Indian influences are seen in Roman art, for example, the marble bust of a man with an Indian hairstyle (Fig. 8.7).[45]

Pepper, which had started out as a luxury, soon became part of daily life in every respectable household in Rome. It is included in nearly every recipe of Apicius's ten books but it was also an important ingredient of medicine. The famous quote about trade from India comes from a Tamil poem, written about the port of Muziris, "They arrive with gold and depart with pepper...."[46] Both black and white peppers were expensive but clearly not prohibitively so. According to Pliny, one had to pay 4 *denarii* a pound for black, 7 for white and 15 for long pepper. (However, it may still have been too expensive for some people; Martial describes how he was given a wild boar that he intended to serve at a dinner party but the cook wanted to empty floods of Falernum, garum and tons of pepper for the marinade; as he found it all too expensive, he gave up the whole idea.[47])

Pepper arrived in great quantities from Muziris and Nelcynda in sacks either ground or as unground 'caunia' and was stored in Rome from AD 92 in the *Horrea Piperataria* near the Via Sacra. The first literary reference is in Horace and implies that it was becoming quite easily obtainable.[48]

Cardamom was another important herb grown in India, used mainly in medicine and perfume but it must have been transported to the Roman Empire over land at least at the beginning of the empire as there is no mention of it in the *Periplus*. By the second century AD it must have been shipped as it is included in the list of goods liable to *vectigalia* in the *Digest*.[49] It was expensive, the best being 60 *denarii* a pound.[50]

Another herb widely used by the Romans who were ignorant about its origins is malabathrum. They knew it came from the Far East and that it was available in India but didn't realise it was actually cinnamon leaf, even though they used a great deal of it in perfumes and as a spice for cooking, for example, in a sauce for grilled lobster. [51]

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[45] Now in the Galeria Borghese, Rome.
[46] Āgam 149, lines 7-11
[47] Martial *Epigram* VII and XXVIII
[48] Horace *Ep.* II 1.270
[49] *Digest* XXXIX 4.16.6-8.
[50] Cardamom was used for example in a prescription to cure headaches along with rush flowers, costum, bay berries, ammonia salt, myrrh, wax and balm wood. Celsus V 24.1-2
[51] Apicius IX 1.3

Rice may have been exported from India occasionally but it was known as a medicinal gruel rather than as a food staple.[52] But it was also grown in Syria according to Strabo which is the more likely source for the Roman market.[53]

What seems to be confusing is that there was a certain amount of agricultural information being swapped and transplanting of botanical species being carried out between India, South Arabia and Ethiopia. This means that foreign plants were being grown in areas that were not their natural habitat, but it goes some way to explain the misnomers 'Indian myrrh', 'Ethiopian ebony' and 'Arabian ginger'.[54] Some plants were also cultivated within the Roman Empire, for example, the Romans started to produce their own silks, incense and spices such as pepper in the '60s and '70s AD, frankincense in Syria, even saffron, cassia, galbanum and possibly cinnamon and rice.[55] Exotic animals began to be bred too, for example, Claudius owned an elephant farm in southern Italy. All this begs the question – why did the Romans continue to import these goods if they were now becoming available in their own Mediterranean region? Three reasons are likely. The snob value of exotic imports was typical of Roman society; the quality within the Roman Empire may have been inferior to the products coming from their original location and the domestic supply may not have been sufficient to meet the growing demand.

8.6 EXPORTS FROM THE MEDITERRANEAN

Goods from the east far outweighed those coming from the west but there was a similar variety of luxury and staple products. Staples that Arabia imported include clothing, textiles, grain, olive and sesame oil, wine, copper and tin. Luxuries included expensive drugs, horses, silver and gold and statuary. The variety of Roman ceramics, glass and bronze statues may have been souvenirs rather than imports or even the property of Romans living there. What is strange is that there is no archaeological or literary evidence for Roman coinage in Arabia 11 BC to AD 96, despite the fact that the Arabs clearly admired the coins as they copied Mediterranean types and weights. Either they melted them down

[52] Horace *Sat.* II 3.155.
[53] Strabo XV 1.13
[54] Columella *De Arboribus* I and Pliny *HN* XXVIII 10.33 about cultivation; *HN* XII 34.71, *HN* XII 14.28, Pausanius I 42.5.
[55] Pliny *HN* XII 14.29.

or they simply traded in gold and silver bullion.[56] A papyrus of AD 117 deals with the price of silver bullion at Coptus, no doubt for use in the eastern trade.[57] Similar products were sent to the African coast of the Red Sea: olive oil and Laodicean and Italian wine were imported by Adulis, other staples and silverware, glass ware and drinking vessels to Avalites.

India also imported wine, glass, Arretine ware and coral from the Mediterranean which was as highly valued to the Indians as pearls were to the Romans.[58] Many types of metals were imported to India, including lead, tin and copper, even though for some parts of India there were sources much closer than the Mediterranean. Pliny says that India had no lead but that is not true: Galena was a lead-bearing ore but it may have been used solely for its silver extract. Tin, which was popular as it became bronze when alloyed with copper, has been found in Avalites and the 'far-side' ports of Kane and in India. This is odd as there are very rich deposits in Burma, Thailand and Malay that were already being exploited in ancient times and trade contacts were already in place between these regions and India.[59] Copper is a similar case in that India had copper resources in Rajasthan and Madras which it exported to the Persian Gulf, yet they imported it for themselves.[60] Glass features quite prominently in exports from the west to the east and is one of the few commodities that has actually survived. According to the *Periplus*, it was shipped in large quantities to various ports along the east coast of Africa and to India. They imported several sorts of coloured glass, glass vessels and unworked glass.[61] There is a lot of evidence about glass reaching the west coast of India, but actually more has been excavated on the east coast, particularly in Arikamedu where finished objects have been found. Arikamedu seems to have been a centre for the bead industry too in the first centuries BC and AD as much raw glass and waste from glass making has been found there, as well as glass beads themselves.[62]

[56] Diod. Sic. III 47.5, Strabo XVI 4.19 and 22, *PME* XXVIII.
[57] *P. Giss* 47, G. Young, *Rome's Eastern Trade. International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 50-51.
[58] Pliny *HN* XXXII 11.21-23
[59] For tin and copper, see M. Raschke, *New studies in Roman Commerce with the East* (*ANRW* 9.2, 1978), notes 1769 and 1770.
[60] Pliny *HN* XXXIV 163
[61] *PME* VI 7 and 17; *PME* XXXIX; *PME* XLIX and LVI.
[62] Glass would have been very convenient as ballast for the outward journey to the east.

Many amphorae have been found in India from the foothills of the Himalayas to the Coromandel coast in the south (for amphorae featuring in Indian art, see Fig. 8.8). Arikamedu is an important site where one hundred and sixteen fragments were found by Mortimer in 1945 and a further three hundred have been found since then (see below, 8.9), but other sites south of Madras are now beginning to show that there were import centres there too. Amphorae of oil and garum are far outnumbered by those of wine and these are of Coan and pseudo-Coan form. The wine was no doubt Italian on the whole as some Coan amphorae are covered in patches of pozzolana and even pseudo Coan amphorae were being made in Pompeii from 50 BC.[63] Because oil and garum amphorae are fewer in number, it is difficult to tell whether they were part of an import trade or simply for Roman merchants' private use.

A shipwreck has been found off Quseir al-Quadim in the Red Sea which was carrying Campanian (presumably Dr. 2-4) amphorae dating to the late first century BC to first century AD. At a depth of 65m, it has only so far been surveyed.[64]

Another wreck off Bet Dwarka on the west coast of India has also been found: it consists of Roman amphora sherds (not yet identified), lead ingots and lead anchors, as well as fragments of the hull itself.[65]

8.7 GROWTH OF THE RED SEA PORTS

Let us turn to some of the ports on the Red Sea coasts and see how they were affected by the increase of movement of goods. According to ancient sources, there were six ports on the Egyptian side: Arsinoe, Myos Hormos, Philoteras, Leukos Limen, Nechesia and Berenice, with Leuke Kome on the Nabataean side.[66]

Leuke Kome is modern Ayunah and in ancient times was a surprisingly prosperous town. In 26 BC when Aelius Gallus's expedition spent the summer and winter there, it could clearly accommodate a sizeable fleet and provide food for the troops too. It was connected by caravan with the Nabataean capital Petra, which as noted above was a midway point to the Mediterranean. It seems to have

[63] See chapter 5 on pottery.
[64] JS 500.
[65] JS 502.
[66] Ptolemy *Geog.* IV 5.

benefited from Roman involvement in the area for the *Periplus* says that it had developed significantly by AD 40-70 with a customs official, a centurion and a garrison. This was not necessarily a result of direct Roman support but almost the opposite. The Nabataeans may have been trying to retain a grasp on commerce in this area in the face of growing Roman competition and Leuke Kome was the only port facility through which goods from south Arabia and further east could be trans-shipped with a much shorter caravan route to the Mediterranean.[67]

Rome's annexation of Nabataea in AD 106 to create the province of Arabia led to the decline of Leuke Kome: the Via Nova was built to Aila (modern Aquaba) which then took over the commerce in aromatics and spices that had brought wealth to the Nabataean region for 1,000 years.

There is a certain amount of confusion about the six Egyptian ports since neither Strabo nor Pliny agrees with the locations of the *Periplus*. Some excavations have now taken place which may shed light on which is which, but there is no doubt that Myos Hormos and Berenice were the most important ports of the area, not only for commerce but for military purposes too.[68] Aelius Gallus's expedition returned to Myos Hormos from Arabia in 25 BC and Strabo says it possessed a naval station for sailors.[69]

The location of Myos Hormos has been difficult to fix with a number of possibilities being put forward: Abu Sha'ar, Ras Abu, Soma, Safaga and Quseir al-Quadim. Based on ancient sources, the first of these was the most popular choice previously but recent excavations by S. Sidebotham have shown that only a third to fourth century AD fort exists, hardly representative of an important trading city. It now seems likely according to D. Peacock that, based on satellite images, modern Quseir is our Myos Hormos.[70] The problem lay in the description of it being a natural harbour with offshore islands, even if it does fit with being 800 stades from Berenice. Today, the site is a small bay in a coral reef but the view from space shows that there has been a huge coastal change and the port is now in a silted inland lagoon. Also, the routes to Coptus from here are the most

[67] G. Young, *Rome's Eastern Trade. International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 94-96.
[68] *PME* I 19 and 21; Strabo II 5.12 and XVI 4.24; Pliny *HN* VI 26.102-3.
[69] Strabo XVII 1.45.
[70] D. Peacock, 'The site of Myos Hormos: a view from space', *JRS* (1993), 226-232; the most recent research is D. Peacock and L. Blue (eds.), *Myos Hormos - Quseir al-Quadim: Roman and Islamic Ports on the Red Sea*, Volume I (Oxford, 2006).

fortified and signed (see below) and there is indeed, a 'red mountain' of red granite.[71] The upper town above the port lacked the monumental buildings seen in other Roman harbours but this was clearly a busy, working port.[72]

Berenice, the other significant port on the Egyptian side, has been located at the ruins near Ras Banas, but the ports of Philoteras and Nechesia are not certain. The archive of Nicanor named Berenice thirty times and Myos Hormos twenty-eight times, suggesting that they were of equal importance.[73] According to Strabo, "Berenice has convenient landing places and now all Indian and Arabian merchandise and Ethiopian goods brought via the Arabic Gulf are transported to Coptus, the emporium on the Nile for such cargoes".[74] This suggests that Berenice was not a great port in his time and it is certain that the Romans carried out a large renovation programme there in the early first century AD. Excavation works from the 1990s have shown Berenice's peak to be the first century to early second century AD and also fourth to fifth century AD. The Romans built further east and south than the Ptolemies had, partly to expand the area as a whole and possibly also because of silting problems. Not many indications of actual harbour facilities have been found yet, only a one metre wall dated to the first century AD with marine sediments attached to it near Trench 1 with a few remnants of wharves and loading ramps. But building activity can be seen in the form of a building constructed on top of a dump made up of pottery and faunal remains of the first century AD: of these, 85-90% were amphorae fragments from diverse areas of the Mediterranean and Egypt. Other Mediterranean evidence comes in the form of amphorae originating from Spain to Palestine and there is fine ware including Terra Sigillata from Italy and the eastern Mediterranean. Evidence from the Indian Ocean includes a Tamil-Brahmi graffito recording the name Korra, a Chera king[75]; there are also peppercorns, rice, sorghum, glass beads, conch shell bangles and coconut shells. Other archaeobotanical remains from the Mediterranean include various nuts and olives that were easy to preserve – the remains of a single peach is puzzling – and from the Nile valley came cereals and

[71] Strabo XVI 4.5.
[72] As note 70, 176.
[73] Of the thirty mentions of Berenice, twelve of them can be dated to reign of Tiberius.
[74] Strabo XVII 1.45.
[75] I. Mahadeva 'Tamil-Brahmi Graffito', in S. Sidebotham (ed.), *Berenike '95: Preliminary Report of the 1995 Excavations at Berenike (Egyptian Red Sea Coast) and Survey of the Eastern Desert* (Leiden, 1996), 205-208.

pulses, watermelon and coriander seeds; dates, palm sugar dates and Christ's Thorn come from the Eastern Desert. Animal remains have been found too, with pork being dominant for the first two centuries AD: these drop to about 7% in the later period. A lot of chicken and seafood was also consumed.

Considering the arid climate of all the Red Sea ports it is not surprising that Berenice was not self sufficient and had to import its food. Maybe even drinking water had to be brought in too; at Leukos Limen the nearest wells were at Bir Karem, 25km away.

A good amount of coinage has also been found; all was minted in Alexandria but was not legal tender throughout the empire until the late third century AD. As one would expect these coins were *aes,* the kind of small change you would expect to find in a port and which the owner did not consider worth retrieving. 62% of the finds date to first century AD and it is surprising that there seems to be a lack of second century AD coins, despite the fact that Berenice was still flourishing then.

It seems certain that Berenice was also a manufacturing centre, converting raw goods into finished products. The metal production especially was on quite a large scale and included cold working as well as smelting of copper and iron. Beads, glass and possibly basketry were also produced. Other ports probably also produced some light industry too. At Leukos Limen, a lot of murex, conch shells and clams have been found, suggesting a dyed textile industry. A small glass manufacturing industry is also as shown by the excavation of glass slag. Large quantities of finished glass, some very good quality, have also been found - maybe they were sent for export to India and south Arabia. A more flourishing centre than the Red Sea ports was Alexandria where many of the goods that had passed through the Red Sea were converted into finished products. Incense and textiles were the main products.[76] Note that Myos Hormos means 'mussel harbour' although this might refer to the fact that mussel shells were a good source of lime, which was used to line and waterproof carefully built wells and cisterns in the Eastern Desert.

It is probable that these Red Sea ports were quite squalid, according to Sidebotham. Buildings were badly constructed from sun dried bricks, field stones

[76] Pliny *HN* XII 32 and VIII 74.

and chunks of coral; some may not even have been roofed, for example, in Leukos Limen.[77] Town planning, however, seems well organised; Sidebotham suggests that they were probably only occupied at certain times of year when goods were passing through: the inhabitants may have returned to the more fertile Nile valley when no ships were expected.

8.8 ROMAN INVOLVEMENT

It is well established that the quantity of goods increased enormously through the Red Sea during the first and second century AD, the two main reasons being the *pax Romana* and the discovery of the monsoons but, how much did the Roman government actively encourage these imports? One thing becomes clear quite quickly, that the involvement concerning monitoring of taxes, protection of merchants and facilitating the actual journeys all stemmed from the realisation that doing all of the above ensured that the Roman government made huge financial gains from relatively small expenditure.

8.8.1 Rebuilding

The Roman government encouraged the movement of goods by improving existing facilities, such as rebuilding the port of Berenice (as above, 8.7). Trajan also rebuilt the canal from the Nile at Bab, near Cairo, to Arsinoe (Clysma) on the Red Sea, which had long since silted up.[78] This meant that it was possible, even if not desirable, to sail from the Mediterranean all the way to India in the same ship (it was not desirable because it was difficult to sail up the last section of the Red Sea against the north winds). Lucian refers to the connection between the two seas in AD 170 "when the young man had sailed into Egypt as far as Clysma (Arsinoe) and a ship was then departing, he was persuaded to sail to India".[79] Although getting to this canal from the Red Sea may not have been popular with sailors, it was surely cost effective, being cheaper to transport goods by water rather than overland. S. Sidebotham has suggested that Arsinoe was used as an exit point for bulky goods such as grain and textiles which would explain how this port and the other two, Myos Hormos and Berenice, continued

[77] S. Sidebotham, 'Ports of the Red Sea and the Arabia-India Trade', in Begley, V. and de Puma, R. (eds.), *Rome and India: the Ancient Sea Trade* (Madison, 1991), 12-39
[78] The *Amnis Traianus.*
[79] Lucian *Alexander the False Prophet* 44.

to enjoy such traffic. The only explanation for Trajan rebuilding this canal is a commercial one, although G. Young suggests that it may not have been a deliberate attempt to foster Red Sea trade, rather an act of euergetism, or even for military purposes.[80]

The Via Hadriana may have been another effort by the emperors to encourage Red Sea trade. Hadrian built this new road through the Eastern Desert from Antinoe to the north of Myos Hormos and continuing south along the coast to Berenice. Like the roads from Coptus to the Red Sea, it was equipped at intervals with plentiful wells, stations and guard posts. Rather than having a purely commercial or even administrative purpose, its construction may have been simply to connect Hadrian's newly founded town of Antinoe with the rest of the region. Neither of these second century developments can be obviously described as part of a pro-active Roman economic policy to expand the Red Sea trade.

The Roman government also turned its attention to the roads from Coptus to the Red Sea ports. Cairns often marked out the roads which were sometimes little more than cleared desert tracks; *hydreumata* were forts placed at fairly regular intervals along the roads which were supplied with wells and provided accommodation for travellers and pack animals. These *hydreumata* were sited along the valley floor and not on defensible high ground thus indicating that their role was to protect and control the route rather than to defend it. The Coptus-Myos Hormos road also had a system of sixty-five watch towers used for signalling as well as for security purposes.[81]

8.8.2 Protection and Military Involvement

The Roman army and auxiliary units provided protection for travellers along these roads from the threat of robbers. Surely the caravans loaded with expensive, exotic goods would have been an easy target and indeed groups of bandits are known, not just the nomads such as Trogodytes and Blemmyes but villagers in Egypt, especially from the late second century onwards, who were being crippled by high taxes. Military units were also stationed at the Red Sea

[80] G. Young, *Rome's Eastern Trade: International commerce and imperial policy, 31 BC – AD 305* (London; New York 2001), 75-78.
[81] An ostrakon relating to a roster system to man the towers: *O. Amst* 8-14; as note above, p. 70.

ports, possibly acting as coast guards to protect ships from piracy. The Egyptians had a fleet installed in the Red Sea to offer protection for commercial ships so the idea was well established.[82] We know little about any Roman provisions regarding the safety of merchant vessels either against piracy or natural disasters, but maybe the idea of the Roman classis is not so strange. A fleet may well have been formed from the leftovers of Aelius Gallus's expedition to Arabia, especially as we know that Myos Hormos had a naval station. According to Pliny, merchant ships were equipped with archers but we do not know if they were supplied by the Roman military or hired privately by the merchants themselves. The Arab side of the Red Sea was considered to be dangerous both from the lack of good anchorages and infestation of savage tribes.[83] The Nabataeans had previously lived peacefully but the emergence of piracy was probably due to concern that their overland route from the east would be relegated in favour of sea-borne commerce. As it turned out, they were right to be worried, especially after the discovery of the monsoons when trade through Petra was reduced. If there was a Roman fleet, surely it would have remained in the Red Sea and not ventured out into the Indian Ocean.

If a general policy to give security to merchants is emerging, then the Roman efforts to gain control of areas which were not already under Roman rule fits in well. Three powerful peoples also shared the Red Sea with Egypt. The Ethiopians on the southern frontier of Egypt were put down by 21 BC after Augustus fixed a boundary at Hierosycaminos in an agreement with their queen Candace. The Axumites had a large port at Adulis and although we have no evidence of any aggression between them and Rome, they cannot have been too pleased with Roman expansion in their area either. The tribes of the southern tip of Arabia who rebelled because of their loss of revenue were suppressed by Claudius.

Augustus's attack on Arabia Felix was similarly unprompted by political or military threat but by a desire to control an area which was wealthy from the trade that passed through it. The expedition led by Aelius Gallus, a friend of Strabo, in 26 BC included an auxiliary support of 1000 Nabataeans and 500 Jews. At this point, the Romans were not interested in Nabataea, only presumably in the

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[82] M. Raschke, *New studies in Roman Commerce with the East* (*ANRW* 9.2, 1978), note 960.
[83] *PME* XX, Pliny *HN* VI 101.

profits from the incense and spice trade that passed through or were produced in areas such as Eudaimon Arabia and Muza in the Sabaean kingdom. The Roman aim was either to compel the Sabaeans to become Rome's allies or to conquer their country outright.[84] Strabo did not want to blame his friend for the failure of the expedition so he blamed Syllaeus who had been given the job of guide but had chosen a long and difficult route that meant the army was exhausted before getting to Arabia. Augustus did not blame the Nabataeans and he had no plans to control them. In spite of the expedition being a military failure, diplomatic ties had been forged and thereafter embassies from various Arab states and India came to Rome (see below).

Tiberius had intended to convert the client kingdom of Nabataea into a province, presumably to control the overland route from Leuke Kome and Aila to Petra and Gaza, but he died. Trajan carried it out 75 years later. Otherwise, there was no political or military advantage to warrant the expenditure needed to control the area. This could explain Augustus's reluctance to control Judea which didn't even offer commercial advantages.

8.8.3 Administration and Taxation

An aspect of Roman involvement which surely had less to do with safety for the merchants and more to do with financial gain was the tightening up of entry and exit points. These were more strictly controlled in Egypt than in any other Roman province. Even a Roman citizen needed a *grammaton*, a pass to leave Egypt. An *apostolos* was a pass required by a person who was travelling with goods[85] and an *anapostolos* may have been a pass for a foreign national with or without goods. These passes were acquired through the procurator or a Prefect of Egypt and there were heavy fines if you were found without any pass at all. An inscription recording a tariff dated AD 90 found at Coptus shows that even within Egypt a pass was required. Various passes were sold through the military to individuals and groups using the Eastern Desert roads, with different rates depending on numbers and types of vehicles and animals. Prostitutes had to pay

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[84] Strabo XVI 4.22.
[85] *Gnomon of the Idios Logos*, a second century fiscal document.

very high rates indeed although they may have been considered as a commodity thus *portoria* were being paid.[86]

But, the most profitable and direct gain that the Romans got from the Red Sea trade was in the form of taxation. In the course of a journey from a Red Sea port to Alexandria, a merchant would have several points of contact with Roman officials, administratively as above, to do with correct passes, and fiscally as soon as a ship docked, since they were immediately then in territory under the jurisdiction of the *Praefectus Montis Berenicidae.* The first official to deal with was the *arabarch,* whose duty was to collect duties and tolls of various types. His first duty was to remove small portions of the goods arriving as payment for a kind of road tax. Possibly, heavy goods were taxed more for wear and tear of the Red Sea to Coptus road. The reverse of the Muziris papyrus *P. Vindob* G 40822 (see below,) states that small quantities of ivory and fabric were removed: ivory tusks to the value of 1175 *mnai* out of a total shipment of 76 *talents* 5,675 *drachmae*, which equals 0.25% and fabric to a value of 1,592 *drachmae*, 3 *obols*, out of total shipment value of 8 *talents* 5,882 *drachmae*, 3 *obols* or 2.88%. Sixty containers of Gangetic nard are mentioned but presumably their tax was straight forward. Just six parcels from this particular shipment had a value of 1,155 *talents* – almost as much as it cost to build the aqueduct at Alexandria Troas. The parcels of ivory and fabric together weighed 92 *talents*, only 11% of the cargo, so if we take L. Casson to be correct about the size of ships sailing to the East i.e. with an average capacity of 300 tons then we are looking at enormously expensive cargoes returning from the East.[87] The other duty of the *arabarch* may have been to organise passes as above.

The final major taxation was that of a customs levy on goods that were both entering and exiting the Roman Empire. This *tetarte* was carried out in Alexandria and, unlike the other two levies, was not exacted by government officials but farmed out to publicans. Goods were impounded again in a public warehouse so that the 25% tax could be paid. The fact that goods were only taxed when they reached Alexandria may also explain the high level of security on the

[86] *OGIS* 674, l. 2-5 and l. 18 about the prostitutes, 'Women for the purposes of prostitution, 108 drachmas; women arriving by ship, 20 drachmas'. See M. Raschke, *New studies in Roman Commerce with the East* (*ANRW* II 9.2, 1978), note 990; G. Young, *Rome's Eastern Trade. International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 48-50.
[87] L. Casson, 'New light on maritime loans: *P. Vindob* G 40822', *ZPE* 84 (1990), 205 n.29. However, this figure seems too high, cf. Ch. 4.4 and this chapter, 8.4.

Red Sea to Coptus road. The government did not want any trade to go astray before tax was paid in Alexandria. But, Sidebotham argues that tax farmers would surely have been stationed at each of the Red Sea ports or at least at Coptus through which everything had to pass. This would mean that there was double tax to pay in Egypt – import and export.

Very high taxes had been introduced by the Ptolemies of 20%, 25%, 33⅓% and even 50% on goods received at Pelusium before their transfer to Alexandria.[88] So Roman taxation, although seemingly high to us, may not have been so much of a shock to ancient traders. The same 25% tax was in place at Leuke Kome in Nabataea which suggests that it may have been under some kind of Roman government regulation too, even before its annexation in AD 106. As soon as the tax was paid, merchants could do whatever they wanted with the goods, sell them there or continue to transport them across the Mediterranean. The recto of *P. Vindob* G 40822 also records this aspect of bureaucracy. This is a mid-second century AD papyrus from the Vienna collection showing an agreement between two shippers (see Appendix for full text).[89] One of them contracts to serve as an agent for the cargo belonging to the other, which had just arrived in the Red Sea at the port of Myos Hormos or Berenice. The text also refers to the provisions of a loan "for a voyage to" or "at Muziris." This may have been a maritime loan that allowed the purchase of the goods by the agent. It sheds light on the actual conveyance of goods from the Red Sea to Alexandria. A parcel with a weight of 20 talents will be given to the camel driver, 50 drachmae will be paid for road use to Coptus; it mentions that the goods will be under guard for receiving revenues at Coptus, where the agent will register them under the owners' names; the goods will be then placed "on a riverboat that is sound" to go to Alexandria where the 25% tax will be paid. If the debtor failed to pay off the loan then the creditor could seize the goods.

There has been some debate about when this agreement was drawn up. G. Thür's view is that it was made along with the loan contract at Alexandria before

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[88] *P. Cairo Zenon* 59012 of May-June 259 BC.

[89] See L. Casson, '*P. Vindob* G 40822 and the shipping of goods from India', *BASP* 23 (1986), 73-9; L. Casson, 'New light on maritime loans: *P. Vindob* G 40822', *ZPE* 84 (1990), 195-206; G. Thür, 'Zum Seedarlehen *kata Mouzeirin* P. Vindob. G 40822', *Tyche* 3 (1988), 229-33; D. Rathbone, 'The Muziris papyrus (SB XVIII 13167): financing Roman trade with India', *BSAA* 46 (2000), 39-50; G. Young, *Rome's Eastern Trade. International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 56-7.

the voyage to India started. L. Casson's reading is that it was drawn up at a port on the Red Sea upon the safe arrival of goods from India as such details could hardly have been planned six months earlier. Both G. Thür and L. Casson compare this text to the only other complete maritime loan in Demosthenes' *Against Lacritus* where a merchant also takes out a loan, pledging as security the goods they will purchase with the borrowed money.[90] In the Demosthenes case, the borrowers had twenty days to sell the goods and pay back the creditor; during those twenty days the creditor was the legal owner of the cargo. This compares favourably with the terms "hold title to" and "under the name and seal of" in the Muziris document. But, clearly, the time frame would have to be a lot longer since the goods were not being sold at a Red Sea port. The merchant was obliged to take them all the way to Alexandria. So Casson sees this agreement as supplementary, referring to what would happen within Egypt once the goods were safely there.

D. Rathbone suggests that this was a generic agreement used by the administrators of the creditor, a kind of master contract with standardised operational terms, for no names, time scales or amounts of money are specified.[91] He also points out that the creditor for the Muziris document must have been extremely wealthy and that he often lent money to trips to India as he had his own set of agents at a Red Sea port, Coptus, and Alexandria. This agreement safeguarded both him and the merchant: the goods being registered in his name meant that the merchant could not steal them, whilst at the same time, the financier could not run off with them and leave the merchant accountable for the *tetarte*. The merchant may have intended to sell the goods and pay back the creditor within a time limit or, what would have been easier, to sell most or all of the shipment to the creditor at a mutually agreed price. According to D. Rathbone, this contract seems to show the reverse of what would be expected in trading operations: instead of a merchant planning a journey and looking for a backer, here is an investor wanting to trade in goods from the east enlisting a merchant to carry it out for him.[92]

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[90] Demosthenes *Against Lacritus* XXXV10-13.
[91] D. Rathbone, 'The Muziris papyrus (SB XVIII 13167): financing Roman trade with India', *BSAA* 46 (2000), 39-50.
[92] Compare third century AD contracts of large private estates in Egypt leasing out flocks of sheep, ibid., 43.

8.9 EFFECT ON THE EAST

What effect did this increase in the movement of commodities have on the peoples and places of the East? We have seen so far that there was an adverse balance in terms of goods being exchanged. Arabia and India imported far less from the Roman Empire than they exported. But that did not mean that they were adverse to advertising themselves and doing their own publicity. Augustus declared that Indian embassies came to him frequently. At least four are known, for example, at Antioch, where the Indians were received by Nicolaus of Damascus, sent by Poxus, 'king of kings' probably in the Punjab who was "anxious to be a friend to Caesar and not only to allow him a passage through his country wherever he wished to go but also to co-operate with him in anything that was honourable."[93] Other vague references are made about embassies bringing elephants, precious stones and pearls as gifts to Augustus. According to Pliny, four envoys came from the king of Sri Lanka to see Claudius, their mission seemingly of curiosity value after meeting the Roman castaway freedman Plocamus. Embassies, including one from India, went to see Trajan in AD107[94] and embassies from India, Bactria and the Hyrcani went to see Antoninus Pius.[95]

The Romans would have wanted to keep the southern Indians sweet since western merchants did not sail past Sri Lanka as the waters between India and Sri Lanka were very shallow. It was best trusted to local vessels to transport the products that the Romans were interested in, namely Gangetic nard and malabathrum from the east coast, to ports like Muziris and Nelcynda.[96] The first westerners who made it further east, through the Straits of Malacca, suddenly found themselves in communication with China. According to Chinese Annals, Rome had always wanted to trade directly with China but was prevented by the Parthians' wish to control the silk trade. In a reversal of roles, it was Marcus Aurelius who sent an embassy to the Chinese king, offering ivory, rhino horns and tortoise shells. "From that time dates the direct intercourse with this

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[93] Strabo XV 1.73 Also Strabo XV1.4 about an embassy from King Pandon, probably of the Pandya, the southern most kingdom of India.
[94] Cassius Dio *Historia Romana* LVIII.15.
[95] Aurelius Victor *Liber di Caesaribus* XV 4.
[96] *PME* LVI 18.25

country."[97] Thereafter there are frequent mentions in the Chinese records of the country Ta-tsin (Syria) and an appreciation of the honesty and integrity of Roman merchants. It was unfortunate timing that Roman trade was just beginning its decline at this time.

Alexandria became a melting pot of nationalities as a direct result of the transit of eastern wares. Its attraction was clear: "You also receive goods from the whole Mediterranean sea because of the beauty of your harbours, the greatness of your fleet and by the abundance and selling of the goods of every place; and you also have the power over the outer seas, both the Red Sea and the Indian, whose name was rarely to be heard formerly, so that trade not only of islands or ports or some straits or isthmuses but virtually the whole world comes to you."[98] According to Dio Chrysostom, large numbers of Arabs and Indians were to be seen in the audiences of shows.[99] Xenophon of Ephesus mentions an Indian raj who had come to Alexandria to sightsee and to do business.[100] ah Similarly, natives of Arabia moved to Egypt for trade purposes: the evidence is epigraphic rather than literary, for example, a temple dedication in Coptus in which a citizen of Eudaimon Arabia made an offering to Isis and Hera. Clearly Roman trade was not restricted to Roman citizens: the Roman government did not attempt to exclude these middlemen, as far as we can tell, it was open to everyone.

It seems clear, particularly from archaeological evidence that Romans settled in areas of India. In the southern area of the west coast, in Muziris, there are unmistakable indications of a foreign colony.[101] According to the *Periplus*, Muziris imported grain "sufficient for those involved in shipping because the merchants do not use it",[102] meaning that the local merchants eat rice but that westerners preferred grain that they were used to, even if it involved shipping it thousands of miles.[103] These also were not merchants just passing through, but a

[97] *Hou-han-shu* ch. 88
[98] Dio Chrysostom XXXII 36.
[99] Dio Chrysostom XXXII 40.
[100] Xenophon of Ephesus III.
[101] Coin hoards, G. Young, *Rome's Eastern Trade. International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 204 and there must have been a Temple of Augustus, as marked on the *Tabula Peutingeriana.*
[102] *PME* LVI 18.21-2.
[103] Grain was produced in North India, e.g. in the province of Aiakê and shipped overseas, but it would not have been economically viable to send such a small amount to southern India.

fixed colony of them. The *Tabula Peutingeriana* mentioned earlier features a building called the Temple of Augustus at Muziris: such a building would only have been put up by subjects of the Roman Empire and, presumably, ones who were living there too.

Arikamedu, on the east coast of India, is the town that so far has shown the most evidence of inhabitation by foreign merchants in the early centuries AD. M. Wheeler excavated there extensively in the 1940s and said "This village, like its modern equivalent in the neighbourhood, doubtless consisted of simple fisher-folk who caught the gullible fish of the region from the shore or from small outriggers, gathered the fruits and juices of the palms, cultivated rice patches and lived in a leisurely and unenterprising fashion just above subsistence level. To it suddenly, from unthought of lands 5,000 miles away, came strange wines, table-wares far beyond the local skill, lamps of a strange sort, glass, cut gems ...... A small foreign quarter like that of Puhar came into being, and finally the village was replaced by a brick-built town, spreading northwards to the sea."[104]

The Roman finds from here may suggest a colony of Romans but W. Ball thinks the inhabitants were just as likely to have been Syrians or Egyptians. Finds include pottery, wine (particularly Coan and Dr. 2-4) and garum amphorae, most being datable to the first centuries BC and AD.[105] The probable explanation of the colony at Arikamedu is that western merchants there were involved in forwarding eastern goods to the west coast where foreign ships could pick them up. Surprisingly, no coin hoards have been found here, where one would definitely expect some.[106]

Many people within Egypt benefited from the increase of merchandise passing through their region, from people who were involved in the transportation of goods at the ports, the shipwrights and sailors themselves and the goods transporters to camel drivers of the Eastern Desert. Ostraka, inscriptions, graffiti

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104 M. Wheeler, *Rome beyond the Imperial Frontiers* (London, 1954), 174-5; More recent excavations took place between 1989 and 1992, V. Begley et al., *The Ancient Port of Arikamedu. New Excavations and Researches 1989-92* (Pondicherry, 1996).

105 E. Will, 'Mediterranean amphorae in India', in J. Ering and J. Lund (eds.), *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, September 26-29th 2002,* Monograph of the Danish Institute, Athens vol. 5 (2004), 433-40.

106 Many coin hoards have been found in southern India, especially dating to the first and second centuries AD; L. Casson, *The Periplus Maris Erythraei: Text, Translation and Commentary.* (Princeton, 1989), 31 and 296.

and impressions made in plaster plugs used to seal jars tell us about some of the people involved. They were male and female, Egyptian, Greek and Roman, Indians and Arabs. Important plaster plugs from Leukos Limen record the business activities of imperial freedmen: one is unnamed but worked in the wine trade, another is a freedman dating to AD 69-96 (Fig. 8.9). These imperial freedmen and slaves may have facilitated the sale of products from imperial estates and their transportation to Rome.[107]

The most important information about the organisation of goods comes from the Archive of Nicanor.[108] It consists of 90 ostraka from Coptus dated from 18 BC to AD 69, which are clearly the records of a transport company that hauled provisions for the use of merchants and their agents, who were resident in Myos Hormos or Berenice. Many of them refer to food and drink (wheat is mentioned 38 times, wine 18 times) and other everyday low value staples like mats, medicine, clothing and rope. This archive shows a group of family members who founded a business with friends: there is Nicanor, son of Panes, his two brothers Philostratos and Apollus, his two sons Miresis and Peteharpocrates and one female non-family member, Isidoar, daughter of Menodorus.[109] It is unlikely but not impossible, that the Nicanor family just dealt with these kinds of supplies; other ostraka surely record their transactions in reverse, i.e. regarding their transportation of trade goods from the Red Sea to Coptus. Otherwise the information from the Muziris papyrus concerning investors/merchants employing their own camel drivers, guards etc., may have been what was normal for this region.

8.10 CONCLUSION

If the Romans can be said to have had a general policy with regard to trade, to provide security to trade routes and improve existing facilities, then their involvement in the Red Sea fits into it well. As always, the Roman government cannot be described as deliberately stimulating, yet it did react to what was already in place. The East was considered by the Romans to be a source of luxury and corruption: eastern goods replaced simple Italian items, loose morals

[107] D. Whitcomb and J. Johnson (eds.), *Quseir Al-Qadim 1978 Preliminary Report* (Cairo, 1979).
[108] J. Tait, *Greek Ostraca in the Bodleian Library Oxford,* nos. 220-304.
[109] *Petrie Ostraca* passim 220-291.

replaced traditional values and frenzied religious cults replaced safe Roman religion and yet there was a huge demand for these so-called luxury goods. The government certainly did not discourage trade with East, for in fact, as we have seen, most of these goods were not actually luxurious, but rather normal for everyday life. Expensive, yes, but not so much so that most of the population was excluded.

So how much help did the Roman government provide? The most significant factor that increased the imports of eastern merchandise actually had nothing to do with the Romans at all – it just happened to coincide with their era – namely the discovery of the monsoons. This allowed westerners to trade directly with peoples from the East and to maximise their financial gains from this overseas trade by having a quick turnaround. Indirectly, the Roman government helped by improving ports and routes and making them safer places on which to travel. Directly, they took control of those areas which were not already in their domain and which could have impeded their trade.

Any involvement that the Romans had was driven by financial gain. The money raised from taxes on goods and indeed people passing through Egypt was enormous and it can only be expected that they were keen to maintain at least some control over the trade, even if they were unwilling to contribute a huge amount to it.

APPENDIX: *P. VINDOB* G 40822

Recto

.... of your other agents or managers, and I will weigh and give to your camel-driver twenty other talents to be loaded for the road up to Coptus, and I will take (them) through the mountains under guard and security to the public customs-house at Coptus, and I will place (them) under the authority and seal of you or your agents or whoever of them is present until the loading on the river, and I will load (them) at an opportune time on the river on a safe boat, and I will convey (them) to the customs-house for receiving the *tetarte* in Alexandria and I will likewise place (them) under the authority and seal of you or your agents, assuming all future expenses from now until the reckoning of the *tetarte*, both the passage of the mountains and the boatmen and other expenses according to (my) portion. If, at the appointed time for repayment in the loan agreement at Muziris, I do not then rightly pay off the loan in my name, then there will be to you and to your agents or managers the option and full authority to exact the amount without notification or summons, to seize and control the aforementioned security and to pay the *tetarte* and to transfer the other three-quarters to wherever you wish and to sell, transfer the security or to give to someone else, as you wish, and dispose of the goods themselves in whatever manner you wish, and to cause them to be bought at the price current at the time, and to remove and reckon expenses arising from the aforementioned loan, good faith for those expenses being to you and to your agents or managers, there being no legal action of any sort against us. Concerning your investment, shortfall or excess shall be to me, being the borrower and offerer of security.[105]

[110] Translation G. Young, *Rome's Eastern Trade: International Commerce and Imperial Policy 31 BC- AD 305* (London; New York, 2001), 56-7.

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Fig. 8.1 Map of the Indian Ocean in ancient times

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Fig. 8.2 The *Tabula Peutingeriana*: Rome and India sections.

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Fig. 8.3 Map of the Indian Ocean in Roman times showing the major routes as described by the *Periplus.*

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Fig. 8.4 Various representations of Indian ships.

Fig. 8.5 Representation of an Indian ship in a fresco of Ajanta (painting in cave II).

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Fig. 8.6 Ivory female statue found in Pompeii.

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Fig. 8.7 Male bust with hair dressed in Indian style, Galleria Borghese Rome.

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Fig. 8.8 Roman amphorae represented in a marble relief from Nagarjunkonda, Government Museum Madras.

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Fig. 8.9 Drawing of the plaster plugs from Leukos Limen.

9. PRODUCTION AND DISTRIBUTION PATTERNS IN THE EASTERN MEDITERRANEAN

This study of shipwreck evidence, put together for analysis in this way for the first time, aims to contribute to the understanding of production and distribution patterns of goods from the Eastern Mediterranean. As one would expect from a database of 212 shipwrecks carrying goods from the eastern half of the Mediterranean, the majority of the wrecks have been found in the Aegean (74) and the Eastern Mediterranean Sea (28). However, what is interesting is that the assumption of all goods heading west, with Rome as the final destination, is not totally backed up by the underwater finds: certainly Rome was the place of the greatest demand for what were, on the whole, luxury goods, but the number of wrecks in the Adriatic Sea (24) is significant, as are the wrecks off the south coast of France (18). The number of wrecks off Sicily is also quite high (19), although more than half are located on the east side of the island and may well have been heading north to Rome.

The evidence from these marine finds demonstrates activity in the Mediterranean throughout the whole period of 300 BC to AD 250 but illustrates a clear-cut increase in the movement of goods over the centuries. Few wrecks have been found with eastern goods between 300 and 200 BC (8), while there is a steady increase through the third to second centuries (24) to the late Roman Republic (42). The majority of the wrecks date to the Roman Empire (85, albeit over a longer time span than the previous categories) while there are 22 non-specific Roman wrecks. Within these time frames, several interesting features have appeared. Nearly all the wrecks off the coast of Croatia are early Imperial (15 out of 18), which possibly reflects the development of the area under the Empire, while all those off the east coast of Sicily are either third to second centuries BC or from AD 200 onwards, i.e. there are few wrecks datable to the time when Sicily is considered to have been a backwater. In a similar vein, the dating of the wrecks off the south coast of France is restricted on the whole to the late Republic and early Imperial era.

The database provides a unique record of the variety of goods being shipped, although obviously written records can never be supplanted. Certain aspects about the transport of goods can only be inferred from literature and epigraphy, since some commodities do not survive in the water; there is no underwater evidence about the grain trade, for example. The cargoes of the wrecks are diverse but they share a common factor, in my opinion, in that they cannot be considered to be state-orientated; by this I mean that they did not either form any part of the *annona* or belong to the group of goods that had to be sent to the army on the frontiers. Eastern Mediterranean amphorae have been found in 150 wrecks (71%) with an even spread through the Aegean and the central Mediterranean, petering out in the Tyrrhenian Sea. In spite of the confusing typologies surrounding the study of amphorae, it is possible to show that the distribution of types underwater does not always match what is known from land archaeology; disappointingly, few amphorae seem to have contained anything apart from wine, even within the Aegean where the regional transport of oil and fish products is attested by other sources, and, specifically, Cretan wine amphorae are poorly represented in comparison to their distribution in land sites. Fine ware is similarly sparse underwater.

Marble has been found in fifty wrecks with a heavy distribution around Italy and Sicily. Although many wrecks cannot be attributed to a specific Roman period, it is clear that the system of marble production, standardisation, stockpiling and distribution was a well-developed network. The database does bring to the fore some interesting statistics: nearly all the wrecks off the southern coast of France (7 of 8) were carrying marble from Luna but have a very short dating span during the early Empire. Clearly there was a desire for marble goods in Gaul but why did it seem to stop during the second century AD? The only reasonable explanation for this would be that the advent of the Roman Empire allowed better organisation of Gaul's own marble quarries. Another clear-cut distribution pattern occurs around Sicily, where nearly all the marble wrecks (6 of 8) date to AD 200 onwards. Looking at the increased tonnage sizes, this suggests that the ships were *naves lapidariae* and built too large to be strong enough to cope with difficult conditions around the toe of Italy and Sicily. Eastern marble is much better represented from the second century AD, as one would expect, with its increased use in Rome for both public architecture and private domestic use. Pre-fabricated goods are evident in the form of columns, architectural pieces and sarcophagi, which corresponds with the remains seen in quarries throughout the Aegean and in the marble yards of Portus and Rome. The possibility that there were 'salesmen' on board ships travelling with small samples of marble to show to potential clients is a an exciting idea and one which will hopefully be further attested in future finds.

The glass and bronze wrecks add an interesting dimension to the sometimes dry reports of amphora finds. The fact that any glass has survived a rough landing underwater is impressive in itself, and the evidence in the form of raw glass as well as sheets, nearly all with a provenance of the Levant, is exceptional. Glass may not have been regarded as a luxury item, however the bronze works of art found underwater certainly were. Some of the finest examples of bronze statuary have been found on the sea floor, especially in the Aegean, where fishing nets rather than scuba diving have played a large part in their discovery. These are important finds for artistic reasons, since so many bronzes were apparently melted down during and after the Roman period. Unfortunately, the perishable nature of most of the products from the East means that very few items have been found on shipwrecks, a fact which makes the Pozzino wreck with its spices a unique find. We simply have to accept literary evidence for the importance of this trade from the east and the manufacturing of raw products into finished goods along the eastern coasts of the Mediterranean.

To answer some of the questions asked at the beginning, the database shows that Roman rule had a huge effect on the Eastern Mediterranean in terms of movement of goods but it was not through direct intervention in trading patterns. The demands to feed the army and Rome itself have been shown elsewhere to have changed trade even on a local level and every farmer must have felt their effect. There was an uneven distribution of natural resources in the Eastern Mediterranean so even without the demands of Rome, trade was important in this region. The fact that Roman rule regulated local government at various levels and to varying degrees meant that distribution must have been organised in a more coherent way than in earlier eras under different rulers. However, the database has not shown that the needs of the Roman army had any effect on the goods that have been examined in this work. But the fact that the Mediterranean was ruled peacefully by one power allowed a huge increase not only in the variety of goods, as shown here, but also in their quality, quantity and distribution. As Pliny wrote, "Everyone is aware that as a result of the world being united under the majesty of the Roman Empire, life has improved thanks to trade and the sharing of the blessings of peace."[1] There was a constant movement of commodities, and the great expanse of the Mediterranean Sea was unified and bound together by lines of communication and connectivity; micro-regions had now become part of the big picture of the Roman exchange of goods.

The transportation of these goods was in the hands of private merchants with some state supervision only from the Severi onwards, although incentives were offered to merchants at various times.[2] Roman input came in the form of investment in ports and harbours, especially in Italy, and providing security along recognised transport routes, particularly in Egypt, the gateway for eastern products. Their encouragement must have stemmed from the need to ensure ease of movement for their *annona* and other goods for the army, and the desire for revenue that could be raised from *portoria*. The actual transport of the goods was left to private merchants who must have developed their own network of contacts. What the database cannot show are the logistics involved in organising the ships that were arriving in huge numbers, not only in the ports of Rome but also in relatively remote areas such as the Red Sea region, and this in itself was an extraordinary achievement.

The evidence from the shipwrecks points overwhelmingly to the fact that mixed cargoes were the norm and that goods continued to be picked up in various ports along the way. The notion of 'tramping', at least for most of the goods from the eastern Mediterranean, was a convenient way to convey goods and there was clearly a complex network linking the Eastern and Western Mediterranean, India and the Red Sea. The database has raised some interesting points and shows that the Roman demand for these products increased especially during the early Empire. However, one must not lose sight of the fact that this data simply reflects what was wrecked and indeed what has been found so far; possibly more impressive is the fact that so many more ships reached their final destination.

[1] Pliny *HN* XIV 2.
[2] See Chapter 4.4.

Hazards of interpretation notwithstanding, the importance of these patterns of movement of goods thrown up by this database cannot be over-estimated. More evidence will emerge with continuing research underwater, and will no doubt enlarge or challenge the patterns presented here.

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