

Introduction: Maritime archaeology and the ancient economy

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Maritime trade and the economy

This volume focuses on the maritime dimension of the trading economy of the ancient Mediterranean, using the evidence from shipwrecks, harbour archaeology, and the distribution of traded goods on terrestrial sites to explore the development and modalities of maritime trade in antiquity.

The crucial role that maritime trade plays in economic development was obvious to Adam Smith and in the *Wealth of Nations* he presents it as one of the key drivers of development. The ability to reach larger markets abroad makes it worthwhile for businesses to produce more goods than can be consumed locally, encouraging large-scale surplus production and economies of scale, coupled with productivity increases achieved through the division of labour. The supply of these markets, in turn, depends upon the effective transportation of goods from producer to consumer. It is here that maritime transport generally holds an efficiency advantage over other forms of transport, providing cheaper access to larger, distributed markets. Smith gives the following illustration:

A broad wheeled wagon attended by two men, and drawn by eight horses, in about six weeks time, carries and brings back between London and Edinburgh nearly four ton weight of goods. In about the same time, a ship navigated by six or eight men, and sailing between the ports of London and Leith, frequently carries and brings back 200 tons of weight of goods.¹

For Smith the labour productivity benefit of sea transport is abundantly clear, as it allows efficient access to wider markets for a larger quantity of goods at a lower cost. The relatively low cost of sea transport, in comparison to riverine and road transport, has of course been a regular feature of discussions of the ancient economy, and evidence from Diocletian's Prices Edict suggests that the cost ratios were broadly comparable to those in other pre-industrial societies, including eighteenth-century France. The distribution of archaeological material to

a large extent bears this out. Leitch, for example, notes that while North African cooking wares were exported around the western Mediterranean in the Roman period, these export wares were almost exclusively produced in a limited and standardised range of forms at coastal potteries close to major ports from which olive oil was also exported in large quantities (CHAPTER TEN). Although African cooking wares were also produced inland, these demonstrate a wider variety of forms but a more localised distribution. For this product, it is clear that the ability to manufacture cooking wares alongside amphorae, and to also take advantage of their distribution networks, allowed the producers and distributors of a relatively low-cost item to reach a large and widespread overseas market, albeit one predominantly restricted to areas served by coastal and riverine transport networks.² Comparison with the distribution patterns of African Red Slip Ware (ARS), also widely exported overseas, suggests that the ARS tablewares commanded higher prices that could absorb the greater costs of overland transport—they were produced at inland sites in Africa, and are more widespread at inland sites overseas than are the cooking wares. Nevertheless, the pattern of cooking ware manufacture and distribution shows the vital role of maritime transport in supporting large-scale production for large markets.

Indeed, the ability to transport cargo by sea appears to have allowed many types of products access to wider markets. Roof tiles and bricks, for example, would seem an unlikely item of long-distance trade, but their presence on many shipwrecks argues for the contrary: the Punto Scario A wreck, which contained a very large cargo of bricks, 'was certainly not [carrying them as] "ballast" but [as] a real consignment'.³ These bricks were made at Salerno in Campania, and examples with the same stamp have been found at several sites in North Africa.⁴ Indeed, Parker has suggested that there does not seem to be any 'formulaic cut-off point beyond which it was not economic to transport heavy goods by sea, but that

1 Smith 1776, chapter 3, reprinted 2007: 12–13.

2 Leitch, this volume: 177–81.

3 Parker 2008: 187; cf. Parker 1992a: 360, no. 961 for the Punto Scario A wreck.

4 Wilson 2001: brickstamp of Ti. Claudius Felix, found at Leptiminus, Thapsus, Themetra, Hadrumetum; a different stamp of the same producer has also been found at Hippo Regius and Carthage.

circumstances of topography, supply, or demand could all make it on occasion worth sending such goods quite long distances by ship.⁵

It should, therefore, be of little surprise that the sea was at the heart of the cultural, political and economic changes that affected the ancient Mediterranean during the Hellenistic, Roman and early Byzantine periods, which constitute the main temporal focus of this book. While the great social and political changes of the times sit squarely in the background of the volume, obviously, they do not operate independently from the maritime trading economy. The entwined nature of politics and economics and their outcomes are observable in Goddio's study of the rise and fall of the port-city of Heracleion-Thonis (CHAPTER SEVEN). The political decision to open up Egypt to outsiders and to allow the presence of a Greek trading population was taken in the reign of Psammetichus I (664–610 BC) of the Saïte dynasty, who, recognising the opportunities that trade offered for the creation of wealth, allowed the development of an *emporion*.⁶ Trade in this port city thrived, it was the obligatory point of entry to Egypt for vessels coming from the Greek world and the location where customs dues were extracted and a portion paid to the temple (cf. Fabre CHAPTER ONE).⁷ Heracleion's downfall came, in part, from another set of political decisions, this time Alexander the Great's decision to found a new city close by in 331 BC.⁸ The construction of the great Mediterranean-facing harbour and its co-location with the new centre of political power quickly resulted in a reduction in the scale of trade passing through Heracleion, although the port still remained in operation. As Goddio notes, the city also retained some of its former power because of the importance of the Temple of Amun-Gereb in the celebration of dynastic continuity—a clearly important statement for the house of Ptolemy. By the time of the annexation of Egypt by Octavian in 30 BC the temple had lost its significance and the city and its port failed.

Maritime archaeology

This volume seeks to go beyond the simply 'decorative' use of the data recovered from maritime contexts in our interpretations of ancient trade. Often photogenic

illustrations of the excavations of wrecks such as the Madrague de Giens are reproduced in general economic discussions or terms such as 'tramping' are employed without sufficient understanding of the complexities of shipping and its terminology (cf. Arnaud CHAPTER THREE). The economic data provided by maritime archaeologists, however, are more than just decorative; as Stopford would have it 'the oceans are the highways of economic development'⁹ and thus the data recovered from them should be of crucial importance in any interpretation of the ancient economy. The archaeology of shipwrecks contributes to an understanding of shipbuilding technologies and navigation, to the volume and composition of cargoes, and, with a sufficiently large dataset, to chronological changes in routes and perhaps even the intensity of seaborne traffic. The archaeology of harbours reveals the development of technological solutions to the problems of providing sheltered anchorages and loading/unloading facilities and storage, and can shed light on the extent to which states interested themselves in such problems and invested resources in addressing them. The analysis of the distribution of findspots of goods which have been traded overseas, even if found on terrestrial sites, is a further piece of the jigsaw.¹⁰

In the formative years of maritime archaeology, however, the potential of maritime data was largely ignored and the discipline of Classical Archaeology has come a long way since the explicit rejections of the interpretations of the pioneering excavations of George Bass at Cape Gelidonya. Here the presence of Syro-Canaanite sailors on a Late Bronze Age trading vessel led Bass to suggest that traditional explanations of maritime trade, which were derived from textual sources, were wrong, an interpretation that was largely ignored by the archaeological community for the next decade.¹¹ It took the excavation of Bass' second Bronze Age ship, the wreck at Uluburun, for opinion to change, and both vessels now lie at the heart of the scholarly understanding and debate about seafaring and maritime 'trade' in the Late Bronze Age.¹² The potential of maritime archaeology to shift our perspectives is again brought into focus in the paper by Fabre on the shipwrecks from Heracleion-Thonis, Egypt (CHAPTER ONE).¹³ Here a new form of distinctly Egyptian shipbuilding is set out for vessels that

5 Parker discusses a wreck at Les Roches d'Aurette with a 'roof-load' of 300 tiles on a local voyage against which can be set the larger cargo from the Punto Scario A wreck that had been transported a longer distance (Parker 1996: 99–100; 2008: 184–7).
6 Pfeiffer 2010: 17.
7 Cf. Fabre's initial study of the shipwrecks from Heracleion and Yoyotte (2008: 236–240) for a study of the twin stelae from Heracleion and Naukratis.
8 Goddio notes (this volume: 125–6) that aside from purely political motives, Alexander may also have chosen to found

Alexandria on a rocky part of the shore to avoid the geological and geomorphological problems of Heracleion (cf. Stanley *et al.* 2007).
9 Stopford 2009: 5.
10 Particularly well analysed by Parker 2008.
11 Bass 2005: 53; Bass 2010: 800–801.
12 Pulak 2010.
13 Also cf. Wilson (this volume: 40–2) on the increasing acceptance of the regional nature of shipbuilding in the Mediterranean and the unsuitability of linear developmental models for shipbuilding.

would have been equally at home sailing on the Nile or across the Mediterranean. The significance of this is that it adds a further layer of complexity to the patterns of trade in the Egyptian Late Period, where imports of Attic pottery to sites such as the Greek trading settlement at Naukratis or the export of Egyptian products around the Mediterranean were previously assumed to have been undertaken by Greeks or Phoenicians, with Egyptian seafarers and traders largely written out of the economic history of this period.¹⁴ The shipwrecks at Heracleion-Thonis clearly offer us the opportunity to rethink the dynamics of Egyptian seaborne trade during this period.

Given the comparatively under-developed state of studies on the archaeology of the economy of the Classical and (to a slightly lesser extent) Hellenistic worlds, maritime archaeology has great potential to play a particularly important role in illuminating the nature of long-distance exchange for these periods. So long as the major excavations of Classical sites persist in publishing only a selection of the finer pottery discovered, chosen for its perceived art historical value, rather than presenting fully-quantified ceramic assemblages, the study of the ancient Greek economy will be deprived of a major source of information on the reach and intensity of ancient exchange networks. But while we therefore lack good economic data from terrestrial sites for the Classical and Hellenistic periods, the evidence of ancient shipwrecks takes on a particular importance, providing information on quantities and compositions of well-dated cargoes. The fourth-century BC El Sec wreck, for example, found off Ibiza, carried a mixed cargo of metalwares and wine amphorae, together with some Attic black gloss and red figure wares.¹⁵ Analysis of the cargo suggests that it was loaded at a central Mediterranean emporium, probably in Punic North Africa or Sicily, and that the Attic pottery had already passed through one or two sets of intermediate merchants, thus casting doubt on the assumption common in art historical studies that there were direct links between Attic potters and particular overseas markets for Greek fine pottery which influenced Attic potters or painters to produce material in particular styles for particular consumers.

Much more work, however, has been done on the economic ramifications of maritime archaeology for the Roman period, among which must be singled out for special mention the pioneering work of A. J. Parker, and

the researches especially of French scholars working on shipwrecks and amphorae.¹⁶ The strongly Roman focus of most of the contributions to this volume reflects this tradition. It is also the case that a very large proportion of the known ancient Mediterranean shipwrecks dates from the Roman period, as shown clearly by graphs of the frequency of these wrecks over time, initially plotted by Parker and more recently updated by Wilson (CHAPTER TWO).¹⁷ These graphs unambiguously demonstrate in absolute terms the rise and fall in the numbers of archaeologically observable shipwrecks, but of course they reveal more about the archaeological visibility of amphorae, pottery, tiles, stone and metal ingots¹⁸ than an exact indication of the scale of trade *per se*.¹⁹ The rise in wreck numbers from the Archaic period to the Late Republican period, during which time the amphora was the main maritime transport container, broadly reflects an increase in maritime trading activity over this period. But from the first century BC onwards the rise of the barrel as an alternative container, but one less likely to be preserved in shipwrecks, complicates the issue. The apparent peak in wreck numbers in the first century AD, and sharp fall thereafter, may conceal a partial switch in containers from amphorae to barrels. Discrepancies between the evidence from shipwrecks and the terrestrial data suggest that this and other factors combine to make the maritime dataset a less than straightforward reflection of the volumes of maritime trade over time.²⁰

The shape of the overall graphs conceals important regional and chronological variations, some of which Parker explored 20 years ago.²¹ Over 70 per cent of the 282 wrecks recorded off the southern coast of France in Parker's *Ancient Shipwrecks of the Mediterranean and Roman Provinces* date to the period from the second century BC to the first century AD.²² Although the chronological distribution of these wrecks follows the general upward trend in shipwreck numbers seen elsewhere in the Mediterranean, off southern France the number of wrecks, and hence the intensity of archaeologically observed maritime trade, peaks in the first century BC rather than in the first century AD.²³ In this case it is principally because of the highly lucrative and large-scale trade in wine from Italy in exchange for slaves from Gaul in the Late Republic, which relied on massive price differentials in the economies of the two cultures concerned—Diodorus Siculus says that the Gauls would

14 E.g., Smith 2009: 63–74, especially 71 'during the first millennium BCE, the carrying business in the eastern Mediterranean gradually shifted from the Phoenicians to the Greeks'.

15 Arribas *et al.* 1987.

16 E.g., Parker 1987; 1990a; 1990b; 1992a; 1992b; 1995; 1996; 2008; Tchernia 1980; 1983; 1986; 1997; 2006.

17 Parker 1992a: fig. 3, reproduced in Wilson, this volume: figure 2.1. Also see Wilson 2009: 219–229.

18 Parker 1996: 103, fig. 5.

19 Cf. Wilson 2009; and this volume: 33–9.

20 *Ibid.*

21 Parker 1992a; see now Parker 2008: 188, 189–191.

22 Parker 1992a: 9; 1996: 102. We are also grateful to Rachel Matheny for her work on these data based on Parker 1992a.

23 Cf. Wilson, this volume (Chapter 2): 34, Fig. 2.2; Parker 1992a: 9.

exchange a slave for an amphora of wine.²⁴ Two of the largest ancient wrecks yet found, the Albenga and the La Madrague de Giens wrecks, were carrying cargoes of wine amphorae on these routes, around 100/90 BC and 60/50 BC respectively. But this intense, and intensely lucrative, trade did not survive Caesar's conquest of Gaul, which ended the local dynamic of inter-tribal slave raiding that fuelled it, and pushed the slaving frontier further north, to Britain. The growth of viticulture within the new Gallic provinces gradually further reduced the market for Italian wines. During the first century AD, wreck cargoes off southern Gaul are composed primarily of Dressel 2–4 Italian and Spanish wine amphorae and Dressel 20 Spanish olive oil amphorae, after which the Dressel 2–4s fall away in numbers leaving Spanish oil amphorae dominant, demonstrating how changing economic circumstances—here the switch between the export of Italian wine to Spain and Gaul, to Italy importing Spanish oil—resulted in different patterns in the cargoes from shipwrecks.²⁵ It is unsurprising, although reassuring, to note that similar patterns emerge from the amphorae assemblage from the excavation of the Terme del Nuotatore discussed by Rice in this volume (CHAPTER FOUR: 84–5).

In a similar way, Russell's analysis of shipwrecks carrying stone cargoes (principally marble) demonstrates that they peak much later, in the third century AD, clearly indicating that patterns of demand for decorative stone were very different from those for oil and wine lost off the southern coast of France (CHAPTER EIGHT: 145). The trend within the stone data is due to the changing patterns of consumption in the cities of the empire and, in particular, to increasing levels of demand for eastern marbles. According to Russell, the ships carrying these marbles had to make longer voyages and sail through more dangerous waters and thus stood a greater chance of being wrecked than vessels carrying white Luna marbles along the western coast of Italy, which are curiously under-represented in the data set given their importance in the first century AD. Consequently, this study reminds us that not all voyages stood an equal chance of wreck and that it is highly likely that the relative risk of sailing on certain shipping routes may have significantly affected the density of wrecks in particular locations.²⁶

The complexity of maritime trading patterns

The cargo composition of ancient shipwrecks and the documentary evidence for institutions and sailing practices suggests a variety of different voyaging patterns in antiquity, although few historians and almost no archaeologists would now dispute the idea that direct traffic between ports, often involving long voyages over open water, predominated over coastal tramping (Wilson CHAPTER TWO; Arnaud CHAPTER THREE; Schörle CHAPTER FIVE).²⁷ In practice, though, it was not a simple binary opposition between these two extremes: voyages might go direct from one major port (emporium) to another with either a single or a mixed cargo; or to or from a major emporium to a lesser regional or local port in its catchment area; or from one emporium to another with a supplementary cargo taken on at an intermediate stop. Whereas many of these voyages between pairs of emporia or between emporia and subsidiary ports relied on the existence of a large enough market at the destination port, and on sufficient knowledge about that market that the shipper could be confident of selling the cargo on arrival without lining up specific buyers beforehand, other voyages might involve cargoes that had been specially ordered or commissioned.²⁸ Much less important in the Mediterranean of the Classical, Hellenistic and Roman periods was the phenomenon of tramping (often referred to in Anglophone literature as 'cabotage'; though see Arnaud [CHAPTER THREE] for the rather different French, Italian and Spanish use of the term), sailing along a coast calling at one port after another, selling whatever the local market would buy and buying whatever was on sale. Such activity is more casual and reflects less specific advance information about markets than the directed trade that largely characterised Roman maritime commerce; tramping became more common again in the early Medieval period after the collapse of the Roman empire.

This trade, or at least the archaeologically observable portion of it, revolved around the seaborne transportation of bulk goods moving from areas of surplus production to often distant places of consumption. The Athenian grain trade is an excellent example of this maritime trade, albeit one that is unobservable in the shipwreck evidence, with crops moving from the grain lands of Sicily, the Black Sea,

24 Diodorus Siculus *Bibliothèque* 5.26.3; cf. Tchernia 1983.

25 *Ibid.*, 105, fig. 8.

26 The phenomenon of the ancient 'ship trap' (Throckmorton 1964: 51–61) is well known, with Gould (2000: 13–19) for example, noting that over 2,000 ships have been wrecked off the three large capes off North Carolina since the 16th century.

27 See also Nieto 1997; Boetto, forthcoming. For an exception: Bang 2008: 133–6, a work largely innocent of engagement with the relevant archaeological evidence.

28 Cf. Parker 1996: 100–102 for the example of the La Fourmigue C wreck, which could have been an example of a private, command, voyage.

and Egypt to Athens.²⁹ In Athens, the pressures that drove this trade came from the inability of a growing city state to feed its own population. In fifth-century BC Egypt, maritime imports supplied a demand for commodities that could not be obtained or made locally; an insight into the types of products imported into Egypt via the emporia of the western Delta during the Late Period is given by the text of the Aḥiqar scroll, a list of the duty collected from Ionian and Phoenician ships carrying goods to and from Egypt in 475 BC,³⁰ and the texts on the twin stelae from Naukratis and Heracleion-Thonis, erected by Nectanebo I in 378 BC.³¹ From the recurring imported products in these documents—oil, wine, worked and unworked wood, iron and tin—it is likely that these emporia dealt most frequently with a specific set of commodities. The fact that destination ports are usually specified in Greek and Roman maritime loan contracts³² also points towards specific, directed trade. For the Roman-period Mediterranean, the specialised shipments of thousands of wine amphorae documented by the Albenga and Madrague de Giens wrecks reflect the large-scale slave trade with southern Gaul; the heterogeneous cargoes of amphorae and metals and pottery loaded in a single go at one emporium, together with evidence for diaspora trading communities and even offices (*stationes*) of particular groups of merchants and shippers all suggest the growing importance of directed bulk flows of goods between ports, and relatively rich information about distant markets on maritime routes. Together, the evidence suggests the development over time of an increasingly knowledge-rich and well-structured trading world, which in some respects anticipates the directed trade recorded in the voyages of Captain Nathaniel Uring. In 1698 Uring loaded groceries in Ireland and sailed for Barbados where he sold the groceries and bought rum, sugar and molasses, which he intended to trade with the Newfoundland fishermen, from whom he intended to purchase a cargo of fish for Portugal.³³ While Uring's journeys may have wandered geographically, they are conceptually far removed from any accidental or casual patterns of trade: like trade in Late Period and in Roman Egypt, specific goods are shipped for sale in particular destinations, although of course Uring's voyages ranged over a much wider and more politically diverse area than the bounded sea of the Mediterranean under Roman rule.

A somewhat different trading pattern, reflecting even closer links between supplier and customer, is observable for stone, where the majority of ships appear to have been carrying stone objects from a single source.³⁴ This suggests that when the stone cargo was loaded there was

already a destination and often even a buyer in mind; stone cargoes of the Roman and Byzantine periods are often the clearest examples of 'command cargoes' or single-order shipments.

More complicated is the situation documented in the *Periplus of the Erythraean Sea*,³⁵ a navigation and trading guide for the Red Sea and Indian Ocean of the first century AD, which contains information about goods available and in demand at particular ports. While this would have enabled merchants to plan trading voyages to specific destinations for particular cargoes and also allow them to load the most suitable goods to trade, it may also be read as providing information relevant to tramping strategies, or as information that would be useful to a trader who needed to revictual at intermediate ports on a longer route, and needed to know what items of cargo to sell in exchange for fresh provisions. It reflects a rather different world from the Roman Mediterranean of the same date.

A further indication of the structured nature of the trading world of the Mediterranean is that it also appears to have operated at different levels.³⁶ Set against the pattern of the long-distance transportation of stone, wine and tiles discussed above, are more regional patterns sometimes observable in the distribution of amphorae: the majority of amphorae at Carthage, for example, were produced in the province of Africa (i.e., roughly the region of modern Tunisia).³⁷ The difference between Gaul and Spain in the first century BC and Carthage is that here local and regional trade in amphora-borne commodities could supply the majority of the demand. While small quantities of amphorae from other production areas are present in the assemblage, perhaps these should be looked at less in terms of bulk commodities but as exotic or prestige goods aimed at a different sector of the market. The same pattern is also observable in the supply of amphora-borne commodities to Pompeii in the first century BC, where approximately 65 per cent came from regional sources and 35 per cent were imported.³⁸ Here then we can see essentially the same products being deployed in different trading networks: African products may have been local to consumers in Carthage but more exotic imports to those in Pompeii. This idea is further developed by Papaioannou in his analysis of the distribution of Late Roman 3 (LR 3) amphorae (CHAPTER ELEVEN), where he suggests that they were not only distributed by merchants in international, regional and local networks, but that a small number were also circulated in the context of the

29 Moreno 2007.

30 Briant and Descat 1998; Yardeni 1994.

31 Yoyotte 2008; Fabre 2008: 232–3.

32 Arnaud, this volume (Chapter Two).

33 Fayle 1933: 203–5.

34 Russell, this volume: 148.

35 Cf. Casson 1989.

36 Cf. Horden and Purcell 2000.

37 Rice, this volume: 85–6.

38 De Sena and Ikäheimo 2003.

annona militaris.³⁹ This should serve as a reminder that networks and mechanisms outside the sphere of private commerce for the movement of goods by sea also existed in the Classical World. Such supply networks include those through which a variety of goods could be supplied to either the military or the state; the strong concentrations of Dressel 20 olive oil amphorae from Baetica (Spain) at Monte Testaccio in Rome and at Roman military sites on the Rhine frontier and in Britain suggest that Baetican olive oil producers had a particularly close relationship with state supply mechanisms, although it is clear that this oil also circulated in purely private market networks too. The very widespread distribution of African Red Slip pottery has been seen as epiphenomenal on the state-organised *annona* shipments of grain from North Africa to Rome; the ARS would have piggy-backed on the grain cargoes from North Africa to Portus, from where it was distributed around the Mediterranean as part-cargoes on ships making return voyages to other ports trading with Rome.⁴⁰ The extent to which other products may also have been effectively subsidised by *annona* shipments is unclear, though some have assumed that this was considerable, and that from the fourth century AD onwards *annona* mechanisms between Egypt and Constantinople continued to be important as a stimulus underpinning Eastern Mediterranean maritime trade until the Persian conquest of Alexandria in AD 617.⁴¹

It is equally important to note that different products from the same region might have different maritime distribution mechanisms. For example, Leitch notes that African oil amphorae and African cooking wares were often fired at the same sites, perhaps even in the same kilns, and seem to have been exported together.⁴² At the port of Leptiminus in Tunisia, for example, oil was transported from inland production sites and decanted into amphorae produced in the industrial zone around the city.⁴³ The oil was then loaded onto vessels for export, alongside cooking wares which were often used as complementary cargoes. It is noticeable, however, that oil amphorae and cooking wares do not appear to have been part of the same production or distribution mechanism as African Red Slip fineware pottery, which most likely travelled with grain.⁴⁴ Here it is significant that African Red Slip pottery does not appear to have been produced at Leptiminus, suggesting that different ports even within a relatively small geographic location could supply distinct suites of products.

Within the patterns indicating regional trade and

exchange, Ostia stands out as something of an anomaly. With regard to amphorae, from the mid-second century imports from Spain, Gaul and later on the Aegean dominate the assemblage with negligible quantities of Italian amphorae—clearly its needs were not being supplied by its immediate region.⁴⁵ Given the economic pre-eminence of Rome within the empire, however, and its oft-quoted role as the ‘ultimate consumer city’,⁴⁶ the scale of imports in the port of Rome should come as no surprise. It does, however, help us to consider the relationship of different ports to each other. Nieto, for example, proposes a pattern of trade between minor and major ports,⁴⁷ which Schörle expands upon in her analysis of the maritime façade of the central Tyrrhenian coastline.⁴⁸ The discussion includes a range of harbour sizes from the largest at Portus, down to harbours attached to villas, which clearly indicate that they would also have played a role in networks of supply, as well as the role of the smaller ports in the sample, which are often overlooked. Although a range of harbour sizes corresponding to small, medium and large ports is demonstrated, with Portus and Puteoli being the largest, such ports do not simply translate into a model for inter-provincial trade, regional and local trade; as Schörle is quick to point out, some relatively small ports were involved in long-distance trade, such as Cosa.⁴⁹ Indeed, Cosa appears to have been involved in the regional and inter-provincial export of products from local villa estates, most notably those of the Sestii.⁵⁰ The relationship between Andriake and Aperlae, explored by Hohlfelder in CHAPTER TWELVE, is an illustration in a different regional context of the kind of hierarchical relationship modelled by Schörle, with Andriake as a regional port being served by subsidiary smaller ports such as Aperlae.

Institutions and the State

The trend towards directed trade which intensified from the Classical to the Roman periods was supported by (a) the development of trading institutions and (b) advances in technology, in that order. The role of the state in regulating and facilitating maritime trade may be traced back to the earliest example of a written legal code; the 3,600 lines in cuneiform of the Legal Code of Hammurabi from c. 1700 BC stipulate, among other things, the standardisation of the cost of shipbuilding along with a form of year-long warranty on a newly

39 Papaioannou, this volume: 205.

40 Bonifay 2003.

41 E.g., McCormick 1998.

42 Leitch, this volume (Chapter Ten); 2011: 287–92.

43 Stirling and Ben Lazreg 2001; Clarke and Robinson 2011; Mattingly *et al.* forthcoming.

44 Bonifay 2003: 121.

45 Rice, this volume: 84–5.

46 E.g., Finley 1999; Morley 2002: 5–6, 13–21.

47 Nieto 1997: 154–158.

48 Schörle, this volume (Chapter Five): 95–100.

49 *Ibid.*: 102–3.

50 Will 1987: 174–5.

built ship, the costs of hiring a sailor and a boat, and a system of compensation for the loss or damage to the vessel and cargo.⁵¹ Such laws undoubtedly helped to regulate both riverine and maritime trade in the Babylonian empire. The significance and effect of institutions in the Greek and Roman worlds is the specific focus of Arnaud's chapter.⁵² The Classical Greek world saw the development of maritime loans and specific laws governing maritime trade, of which the Rhodian Sea Law, preserved in a seventh-century AD Byzantine version, is perhaps the fullest example, dealing with liability for loss or damage to cargo, especially through jettison. Such legal institutions and mechanisms for dispute resolution were of course fundamental prerequisites for the development of intensive and regular maritime trade between different states. The Roman period saw further institutional developments which completely changed the trading environment; the unification of the Mediterranean under Roman rule brought not only peace but also a common set of legal institutions, a single currency (except for Egypt), and further facilitated the spread of the two main *linguae francae*, Latin and Greek—all of these measures reduced transaction costs. There were further specific interventions by the state, notably tax incentives for shipowners who put their ships at the disposal of the *annona*, the role of which as a stimulus to private trade has been alluded to above.

The vitality and volume of maritime trade was of especial interest to ancient states in the matter of customs dues. Despite some important recent work on customs taxes,⁵³ their importance to the revenue streams of ancient states has been largely underestimated. For the Roman empire, a 25 per cent tax was levied on goods coming across at least some, perhaps all, external frontiers, and this certainly applied to the trade from India through the Red Sea ports. Given the value of this eastern luxury trade, this will have been a very substantial source of state revenues; but we should not forget that the vastly greater volumes of shipping carrying often less exotic cargoes between ports of the Mediterranean still attracted a 2.5 per cent inter-provincial customs tax, which cumulatively must also have raised very substantial sums for the state. The ports of Italy alone were exempt from this tax, a measure which hints at the political power of these civic centres. There is, however, little evidence in antiquity for the protectionist use of customs dues such as the Corn Laws of Britain and Ireland, which had sought to protect home production in the face of cheaper foreign imports by the imposition of heavy

tariffs on imported grain; their repeal in 1846 resulted in the dramatic increase in the grain trade from 1.9 million tons in 1842 to 19.2 million tons in 1887.⁵⁴ The 25 per cent tax on imports and exports across the frontier of the Roman empire does not seem to have deterred this external trade, at least during the first two centuries AD; although it is perhaps possible to read the halving of this duty—the institution of the *octava* or one-eighth tax—in the third century as a means of encouraging a flagging external trade.

Maritime technology

In Britain and Europe in the eighteenth and nineteenth centuries, the engineering technology that encouraged the development of the Industrial Revolution was also responsible for new systems of transportation, including railways and canals, through which raw materials were imported to feed both industrial manufacture and the populations of the growing cities. As trade and the movement of goods was an indispensable part of this new industrial society, it was almost inevitable that merchant shipping should also be transformed. Steam engines, iron hulls, screw propellers and the deep sea cable network that revolutionised communications, all played their part. The John Bowes built in 1865 for the coastal trade in coal is an excellent example of the radical improvements in vessels at this time. This 650-ton ship, which was explicitly designed as a bulk carrier, could make the journey from Newcastle to London and back, including the loading and unloading of her cargo, in five days, increased the productivity over a traditional sailing ship by six hundred per cent.⁵⁵ While such startling developments far outstrip those of Classical antiquity, that is not to say that changes did not also occur in ancient ship design which brought productivity enhancements. These were more gradual and less spectacular, but none the less real.⁵⁶ Perhaps the most obvious is the general but very gradual transition in the western Mediterranean—generally within a 'Greek' context—from vessels whose hull planking was sewn together to hulls fastened with mortise-and-tenon joints.⁵⁷ The reasoning behind such changes were undoubtedly complex. For McGrail it was possibly an outcome of the increasing level of contacts between Greeks and Phoenicians from the late sixth century BC onwards, which allowed the transfer of shipbuilding technology.⁵⁸ This transformation in hull construction appears to have coincided with an increase in the shipping of bulk cargoes, especially in amphorae.⁵⁹ The stacking of amphorae in

51 Legal Code of Hammurabi, Laws 234–40, 277.

52 Chapter Three.

53 Purcell 2005; Duncan-Jones 2006.

54 Stopford 2009: 24, table 1.2.

55 Stopford 2009: 25–6.

56 See especially the papers in Harris and Iara (eds) 2011.

57 Cf. McGrail 2004: 145–164.

58 *Ibid.*: 138.

59 Mark 2005: Chapter 5, especially 61–7.

multiple layers would have led to increased pressure and stresses upon the hull, especially on the seams between the planking. Laced vessels were simply ill-adapted to carrying this type of cargo, resulting in the transition to a form of hull construction that was fit for its purpose as a bulk cargo carrier. Once adopted, the mortise-and-tenon technique continued to be used by shipbuilders into late antiquity, albeit with regional variations.⁶⁰ At the other end of our timescale, the transition in the methodology of ship construction from shell-first to frame-first in the Byzantine period has been interpreted by Steffy as being the result of the pressures of a faltering economy leading to innovations in shipbuilding techniques, seeking to cut labour costs.⁶¹

The increasing opportunities for trade in bulk products resulted in the construction of larger vessels between 100 BC and AD 300, which were often equipped with the latest technological developments, such as the bilge pump and laminated hulls.⁶² They were also experiments in new ship design during this peak period, most obviously in the case of dolium ships from the region around Minturnae in the centuries around the peak of the economic cycle (Heslin CHAPTER NINE). These were specialist wine carriers, which increased their cargo-carrying capacity through the permanent installation of large pottery dolia, each of which could carry up to 2,000–3,000 l, amidships in the vessel. They appear to only have operated on a triangular trading route between the places of production in the hinterland of the port at Minturnae, and consumption sites in southern Gaul and Tarraconensis. The relatively short, 150-year life-span of this vessel type, indicates another of the smaller-scale trends within the overall economic cycle, notably the apparent reduction in the bulk export of wine to Gaul from Italy and perhaps the adoption of a new container technology in the form of the wooden barrel.⁶³

Such specialised vessels as the dolia carriers, however, appear to be far from the norm. As Russell points out, even though Petronius seems to refer to *naves lapidariae*, stone-carrying ships, an analysis of wrecks containing stone cargoes would suggest that there was nothing specialised about these vessels and that simply workaday cargo ships were used.⁶⁴ What would have been more important would have been the development and use of dockside infrastructure and heavy lifting equipment in order to support the loading and unloading of these vessels.⁶⁵ This would have been of even greater significance in the case of the dolia ships, which Heslin suggests would have required the use of force pumps to empty the dolia.⁶⁶

There were significant improvements too in the technologies of harbour construction, especially in the Hellenistic period, when the first treatises on harbour construction were written, and in Roman times when the development of hydraulic pozzolanic concrete, that could set underwater, revolutionised the possibilities for the creation of artificial harbours. The ROMACONS project (Oleson *et al.* CHAPTER SIX) has investigated the use of this material at several Roman ports around the Mediterranean and has also demonstrated that a trade existed in the pozzolanic constituents of this maritime concrete technology. In some cases, such as the harbour of Sebastos at Caesarea Maritima, the technological expertise and indeed some of the materials seem to have been provided from Italy, in this instance as a form of Roman aid to a client king. The use of Roman maritime concrete enabled the creation of artificial harbours and port facilities serving large shipping on coasts that would otherwise have lacked them completely, such as the coast of Tunisia.⁶⁷ Some large-scale harbour works using maritime concrete are major examples of state investment in the infrastructure of maritime transport, e.g., Portus, Centumcellae and Anzio, but the material was also employed even in the smaller but often nonetheless sophisticated harbours of private villas.⁶⁸

But while one can point to a variety of technologies which, cumulatively, helped to reduce the costs of maritime transport, it would be an exaggeration to claim that these *drove* the increase in maritime trade from the Hellenistic period to the high Empire. Rather, institutional factors appear to have driven the process, making the development of—and, crucially, investment in—new technologies worthwhile. These technologies then enabled the new institutional conditions to be exploited more fully, with larger ships, safer harbours and lower transport costs.

Trade and Empire

Although the relationship between war and trade is not the focus of any of the papers in this volume, it is notable that when viewed across the *longue durée* of the world economy, periods of significant growth in maritime trade in states such as Classical Athens, the Roman Empire and Britain at the time of the Industrial Revolution coincided with the ocean-going militarism of their respective states, whose traders in turn reaped the economic benefit of the peace and stability that resulted. Commenting upon the *pax Britannica* of the nineteenth century, Keegan

60 Cf. Wilson, this volume: 41.

61 Steffy 1994: 85.

62 Wilson, this volume (Chapter Three); Steffy 1994: 62–5.

63 Cf. Wilson 2009: 226.

64 Petronius *Satyricon* 117: 12. Russell, this volume: 145–7.

65 Cf. Wilson 2008: 332–45.

66 Heslin, this volume: 164–5.

67 Wilson, this volume: 47–51.

68 Schörle, this volume (Chapter Five).

notes that 'world's great game of trade and warfare... assured freedom of passage for the greatest expansion of maritime commerce...in world history'.⁶⁹ The Punic wars were in large part fought over the commercial rivalry between Rome and Carthage, and treaties between the two states circumscribed zones of permitted trade. Later, the entire trading system of the Roman imperial period was possible under conditions of pan-Mediterranean peace, which removed the variable of warfare-related volatility. This enabled the spread of a common set of institutions, including commercial law and a single currency, across a vast and politically unified area, and

encouraged investment in harbour infrastructure, on the part of the state and indeed by cities and private individuals, and in larger shipping. Some of the effects can be gauged by their inverse when these conditions ceased: at the end of the temporal span of this volume, the defeat of the Byzantine navy at the Battle of the Phoenix (AD 655) had heavy repercussions for maritime trade off the southern Anatolian coast, not the least of which was the abandonment of the city of Aperlae, which had formerly prospered during the favourable economic and trading conditions of the *pax Romana* and withered in the face of danger from a now hostile sea.⁷⁰

69 Keegan 1996: 146–8.

70 Hohlfelder 2005 and this volume: 221.

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